PROBLEMS IN REGISTRATION OF A NEW HERBICIDE

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First of all, I want to express my sincere appreciation and that of my organization, the National Agricultural Chemicals Association, for the honor and opportunity of appearing on this program. We want to congratulate the Conference on its great contributions in the fields of weed control and the use of herbicides, and to extend our best wishes for its continued success in the future.

Since my topic deals with the problems connected with the registration of a new herbicide, it seems advisable to explain first just what registration is and how problems may arise under it.

In 1947, Congress passed the Federal Insecticide, Fungicide, and Rodenticide Act. Many states have enacted similar legislation. These acts cover herbicides although they are generally not named in the titles.

The Federal Insecticide, Fungicide, and Rodenticide Act regulates the distribution, sale, and, indirectly, the use of pesticides moving in interstate commerce. It is enforced by the U. S. Department of Agriculture. The state acts, similarly, regulate these products in intrastate commerce.

These acts provide that before any pesticides, including herbicides, are offered for sale they must be registered with some designated official, usually the Secretary of Agriculture. In actual practice, the Secretary delegates this duty and responsibility to some member of his department.

To secure registration, a company must submit to the responsible official an application for registration accompanied by a statement of the composition of the product which is to be offered for sale and a copy of the labeling which is to be used in conjunction with it, including all claims and directions for use. In the case of established products, this does not involve any particular problem. The enforcing official knows the uses for which that particular product is generally accepted, the manner in which it should be applied and any precautions which should be taken in connection with its use. In such a situation, he merely examines the proposed labeling and, if it follows standard practices, registration is granted. However, the enforcement official does have a right to request data which will show that the product is both safe and efficacious for the

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purposes for which it is to be sold and always does so in the case of new products just being introduced and in instances where the manufacturer seeks to sell his product for some use for which it is not generally recognized. If the official is not convinced that the data fully establish the effectiveness and safety of the product, he does not grant the registration and the product cannot be sold. Thus, registration depends upon the ability of the applicant for registration of a new pesticide or a new use of an old pesticide to satisfy the regulatory official that he has sufficient data to justify the use of his product for the purposes and in the manner that he intends to recommend it.

For purposes of discussion, I will confine my remarks to the problems and procedures involved in obtaining federal registration from the U. S. Department of Agriculture, although essentially similar ones are often involved at the state level.

With some over-simplification, it may be said that some years ago the only questions asked concerning a new herbicide were: Did it kill or control weeds, and could it be handled reasonably safely by the applicator? Today, in this era of selective weed killers and their use on and around food crops many more questions are asked and much more information is necessary to answer them and to satisfy the officials before registration is obtained.

Thus, the first problem in the registration of a new herbicide is a technical one and involves the preparation and execution of a research program designed to develop the necessary data. The exact nature and amount of data which must be collected before a product will be accepted for registration by the control officials will vary somewhat depending upon the proposed uses for it. In general, it can be said that much more information will be required when it is proposed to use the herbicide in or around a food crop than when it is intended for non-food uses. All the various types of data which I will discuss hereafter might not be required for any one new herbicide but, on the other hand, in the case of some new herbicides additional data may be required. However, the following are considered to be those points most commonly covered and generally requested.

TYPES OF DATA NORMALLY REQUIRED ON A NEW HERBICIDAL CHEMICAL INTENDED FOR USE ON A FOOD CROP

I. Chemical and Physical Properties

A. Chemical composition
B. Structural formula
C. Degree of purity
D. Nature and amounts of impurities
E. Solubility in water and various solvents
F. Vapor pressure and/or volatility

II. Analytical Methods

A. Macro, for analyzing technical products and formulations containing it
B. Micro, for determining residues on food crops

III. Effectiveness

In terms of (a) percentage reduction or control of weeds compared to check plots, (b) increase in crop yield, or (c) other desirable benefits. Normally these data will have to be collected from large-scale field tests under different climatic conditions.

IV. Residues

Amount of residues remaining in or on the treated crops at harvest following typical application under varying field conditions. Methods for removing residues where they appear excessive.

V. Toxicity

A. Acute toxicity. Determination of LD_{50} on mice, rats and rabbits by oral ingestion, and, where pertinent, by inhalation and skin absorption.

B. Chronic toxicity. The effect, if any, of repeated and prolonged exposure to the chemical or food treated with it. Normally requires the daily feeding of the chemical in varying amounts to laboratory animals for a minimum period of two years, the normal life span of the smaller lab animals.

C. Other effects on man or animals. Skin irritation, skin absorption, eye injuries, etc.

VI. Plant Injury

Nature and extent of any injury to crop for which product is to be recommended.

VII. Other Adverse Effects on Crop

Any undesirable changes in appearance, flavor or taste of crop.

VIII. Compatibility

Compatibility with other pesticides, if recommended for use with them or in the same spray schedule.

IX. Effect on Soils

Any residual effect on soils which might interfere with the normal use of the soil in succeeding seasons.

X. Other Effects

Effects on other nearby crops, beneficial insects and other forms of animal and plant life.

Items IV and V, Residues and Toxicity, are particularly important since these data are used to determine whether the residue which might remain on the crop at harvest could pose a health hazard to the consumers of the treated crop. The chronic toxicity studies establish the level at which the herbicide may be present in the diet without injury to the consumer. Unless the residue studies show that under normal field conditions the herbicide residues at harvest will be below that level, or that they can be brought below that level by some practical removal treatment, the product will not be accepted for registration, or its use will be restricted to such crops or limited conditions of application that the residues will not constitute a public health hazard.

During its 1954 season, the Congress passed a bill amending the Federal Food, Drug and Cosmetic Act. This bill, now commonly known as the Miller Pesticide Residue Amendment or Public Law 518, provides, in effect, that a residue tolerance must be established by the Food and Drug Administration for each pesticide chemical before it can be used on a food crop. (A residue tolerance specifies the maximum amount of pesticidal residue which may remain in or on a food crop and is set at a level which is considered to protect the public health from any harmful effects from the residue.) Prior to the enactment of the Miller Amendment, a somewhat similar requirement was in effect through a working arrangement between the Food and Drug Administration and the U. S. Department of Agriculture whereby the Food and Drug Administration set informal or unofficial tolerances for various pesticide chemicals. The Food and Drug Administration establishes such tolerances only after comprehensive chronic toxicity data have been collected and presented to them to justify a tolerance.

For some years, it has been the policy of the U. S. Department of Agriculture not to register a product for use on a food crop until these tolerances are established by the Food and Drug Administration, informally in the past but now formally under the Miller Amendment, and the company requesting registration can show that its proposed directions for use will result in residues below the tolerance.

This situation has resulted in many herbicides and other pesticides of proven value to agriculture not being registered and offered for use on food crops or being limited in their use on food crops. Today it is not sufficient to show that a product will control weeds or insects. A company must also show that it can be used on a food crop without hazard to the consumers of the food. Failure or inability to obtain registration for any use of a pesticide makes it unlawful for a manufacturer to offer his product commercially for such use.

The cost of obtaining all the previously outlined data, which are a prerequisite for registration, poses a financial problem. Surveys among manufacturers indicate that the average cost of developing and marketing a successful pesticide chemical amounts to about one and one-half million dollars.

Even in the case of pesticide chemicals with known potentials for use on food crops, the costs involved in obtaining some of the necessary information, such as, developing satisfactory analytical methods, collecting data on crop residues, and conducting chronic toxicity tests may amount to $200,000. This often serves to discourage companies from seeking to obtain a tolerance and registration. A company has no assurance that the investment in time and money to obtain these data can ever be recovered through subsequent sales of its product. This is particularly true with regards to chemicals in which no one company has a special proprietary interest through patent protection or unique manufacturing position. Here is an economic problem which can probably be solved only by the public agencies carrying a larger share of the research programs necessary to develop the requisite data.

There is another point which I believe warrants your attention and consideration.

The Miller Pesticide Residue Amendment which is scheduled to become fully effective on July 22, 1955 makes it unlawful for a residue of a pesticide chemical to be present in or on a food crop unless a tolerance has been established for that chemical on that crop or, if a tolerance has been established, for a residue in excess of the tolerance to be present. Food bearing such illegal residues are subject to seizure and condemnation by the Food and Drug Administration.

It is therefore the responsibility of both manufacturers and federal and state agricultural authorities to be sure that they do not recommend a pesticide chemical which may leave a residue for use on a food crop where there is no tolerance or exemption in effect for that use or, if a tolerance is in effect, do not recommend the use of the pesticide in such a manner that a residue in excess of the tolerance will result.

Apart from our moral and legal duties in this regard, there are also financial considerations.

If a grower follows recommendations or directions for use which result in an illegal residue and his crop is seized, he will undoubtedly seek to recover the value of his crop from the person and/or organization which made such recommendations or gave such directions for use. Without attempting to discuss all the legal points involved, it can be said that the responsible person or organization may be held liable to the grower.

We believe that the Miller Amendment, by providing a definite procedure for the establishment of residue tolerances, will lessen but not eliminate some of the problems associated with registration. The basic time-consuming problem of collecting all the necessary data we will always have with us. However, by recognizing what is needed and why, and planning our research programs accordingly, we will make more progress faster in the development and use of herbicides.

Again, our thanks to the Conference for the opportunity of appearing on this program and our best wishes for a most successful meeting.

PROMISING NEW CHEMICALS

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Many chemicals were tested as new herbicides in the Northeastern region in 1954. Those listed below show promise in the areas indicated. The list is not necessarily complete as to chemicals included and areas of promise since it was not possible to obtain and assemble data from all workers in the region.

1. 2,2-dichloropropionic acid (sodium salt) - DALAPON.

   a. Pasture renovation
   b. Control of perennial grasses including quackgrass, Johnson grass, and *Phragmites communis*.
   c. Control of bedstraw (*Galium mollugo*) in birdsfoot trefoil.

2. 3-amino-1,2,4-triazole - Amino triazole

   a. Pasture renovation.
   b. Control of perennial weeds.
   c. Control of *Lachnanthis tinctoria* (redroot) in cranberries.

3. 3,4-dichlorophenoxyacetic acid. Control where alfalfa is involved.

4. 2,3,6-trichlorobenzoic acid and its sodium salt. Pre-emergence control in corn.

5. Sodium 2,4,5-trichlorophenoxyethyl sulfate and related chemicals.

   a. Control in tomatoes.
   b. Control of goosegrass (*Eleusine indica*) in golf-greens.

6. 3-(3-4,dichlorophenyl)-1, 1-dimethylurea. Certain advantages in longer weed control and greater safety to vegetables in some instances than CMU.

7. 2,4,5-trichlorophenoxypropionic acid. Pre-emergence control in corn.

8. 2-chloroethyl N-(3-chlorophenyl)-carbamate and 2-(1-chloropropyl) N-(3-chlorophenyl)-carbamate. Control in mustard greens, cabbage, and related vegetables where CIPC is somewhat toxic.

9. Disodium methyl arsonate. Crabgrass control.

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RELATIVE BIOLOGICAL ACTIVITIES OF THE FOUR MONOCHLORO ORTHO CRESOXY ACETIC ACIDS

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Contemporary with the commercial development of 2,4-dichlorophenoxy acetic acid in the United States as a herbicide, there was a parallel development in the use of monochlorinated ortho cresoxy acetic acid in England.

The reason for this is that the cresols are in general much more readily available in England from the type of coal tar available from gas plants and are relatively cheaper before refining than is phenol in the United States. The research groups working with the I.C.I. and in governmental and university laboratories early established the data which resulted in the development of a crude type of chlorinated cresoxy acetic acid suitable for herbicidal work. (1)

Whereas in the United States and elsewhere 2,4-D was put on the market with a purity of over 98% the corresponding 2 methyl 4 chloro phenoxy acetic acid type herbicide originally appeared as a very impure aequeous solution of the sodium salt, and even when it later appeared in the acid form as a dry product contained only about 60% of the active 2 methyl 4 chloro isomer. Probably the main reason for the lack of any endeavor to market a type having a purity comparable with 2,4-D was the fact that there appeared to be no possibility of getting a subsidiary product of herbicidal value by chlorination of the by-products which would be obtained from purification of the crude 2 methyl 4 chloro phenol. In the manufacture of 2,4-D this is an important economic consideration where pentachloro phenol is produced from the by-product.

An additional reason for the delay in marketing a product better than 60% 2 methyl 4 chlorophenoxy acetic acid was the persistent claim that the remaining 40% of isomers played an important part in the herbicidal activity of the crude product. The question of possible synergism will not be discussed in this paper but we decided in this laboratory that at least the controversial point regarding the individual acids could be best settled by preparing the four isomeric monochloro ortho cresoxy acetic acids in an uncontrovertably pure form and put them through a series of biological tests in order to arrive if possible at a quantitative estimate of their relative responses and ultimately of their commercial value as herbicides

Similar methods were used for the synthesis of these isomers as were used in our earlier work on the isomeric mono-, di-, and trichlorophenoxy acetic acids, i.e., we started from carefully prepared pure chloro cresoxy acetamides which were in most cases not previously described in the literature. (2). These highly purified amides were then hydrolysed to the corresponding acids which were again recrystallized and both amides and acids were used in the phytobiological experiments described below.

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The details of the synthesis will not be gone into further here as they are being described elsewhere. (3). In Table 1 will be found the melting points of the compounds ultimately used.

Table 1

Uncorrected melting points of 2 methyl phenoxy acetic acid, its four monochloro substituted acids and the corresponding amid.

Position of chlorine group in nucleus	M. P. of Amide	M. P. of Acid
0	130-131	155
3	*150-151	*160-161
4	152-153	122-123
5	*136-137	*129-130
6	124-125	111.5-112.5

* Not previously reported in literature.

It was decided to use a variety of plants for the biological work since previous experience showed that important specificities might be overlooked if only one type of plant were used. The observations made included root growth inhibition, cell proliferation, pre- and post emergence herbicidal effects.

Root growth inhibition

For this work the method of Macht was chosen using three day old roots of Lupinus albus seedlings immersed in various concentrations of aequeous solutions of the sodium salts of the acids being tested mixed with Shive's nutrient solution. (4). Five concentrations were used ranging from 1000 ppm to 0.1 ppm and the period of exposure was 24 hours at 20'C in absence of light. The "percentage of inhibition" was calculated in the same way we used in the previous work. (2). The results obtained with the four isomeric acids and the unchlorinated 2 methyl phenoxy acetic acid are shown in Table 2.

Since the percentage of inhibition does not seem to follow strictly an exponential course with regard to the concentration, the graphs are not quite straight lines. Hence, if we try to grade the variation of effect with each isomer in inhibition of root growth, we would get somewhat different figures according to which portion of the curve is employed. However, we have usually found that the comparison of concentrations needed to produce 50% inhibition of growth will give a useful figure and so we have employed this method here.

In Table 3 we have thus arranged the five acids according to this rating with an additional column showing the "inhibitory effect", the figure used being proportional to the reciprocal of the figure in the first column, the 2 methyl 4 chloro isomer being given a rating of 100.

Table 2

Inhibition of root growth of Lupinus albus with various concentrations of 2 methyl phenoxy acetic acid and its mono chlorinated isomers.

Position of Cl group in nucleus	Inhibition with 0.1 ppm	Inhibition with 1 ppm	Inhibition with 10 ppm	Inhibition with 100 ppm	Inhibition with 1000 ppm
0	41.0%	44.5%	54.5%	73.0%	84.5%
3	-5%	17.0%	37.0%	61.0%	97.0%
4	47.5%	65.0%	66.0%	75.0%	97.0%
5	-2%	34.5%	54.5%	67.5%	88.0%
6	-5%	10.0%	18.5%	48.5%	88.0%

The minus figures of course represent acceleration of growth. The graphs drawn from Table 2 are shown in Figure 1.

Table 3

Relative concentration of isomeric acids needed for 50% inhibition of growth

Position of Cl group in nucleus	Parts per million needed for 50% inhibition	Relative inhibitory rating
0	14.0	0.72
3	40.0	0.28
4	0.11	100.00
5	14.2	0.70
6	120.0	0.09

It appears from Table 3 that as far as root inhibition is concerned, the monochloro derivatives other than the 4 chloro as well as the unchlorinated acid are comparatively inactive.

Hormonal Reactions

To explore any hormonal effects of the same compounds as well as their corresponding amides, young snapbean plants (var. Tendergreen) were used and the chemicals applied as a 1% lanolin-Tween 20 paste to the stem at a point midway between the first and second nodes. After 18 days observations were made which are listed in Table 4.

Table 4.

Response of young snapbean plants (Tendergreen) to some phenoxy compounds applied as a 1% lanolin-Tween 20 paste to the stem at a point midway between the first and second nodes. Observations recorded 18 days after treatment.

	% Reduction of terminal growth	Cell proliferation	Formative effects	Epinasty	Stem curvature	Root initiation
Phenoxy acetic acids						
2-Methyl	0	2	1	0	0	2
2-Methyl 3-Chloro	0	2	1	0	0	2
2-Methyl 4-Chloro	97	3	*	0	2	0
2-Methyl 5-Chloro	0	3	0	0	0	3
2-Methyl 6-Chloro	0	1	3	0	0	0
Phenoxy acetamides						
2-Methyl						
2-Methyl 3-Chloro	0	0	3	0	1	0
2-Methyl 4-Chloro	96	3	*	0	2	[illegible]
2-Methyl 5-Chloro	0	3	0	0	0	3
2-Methyl 6-Chloro	0	0	3	0	0	0

* Treatment too severe for evaluation
Rating scale: 0 - no apparent activity, 1 - slight, 2 - moderate, 3 - marked activity, 4 - plants dead

It will be seen that the percentage reduction of terminal growth checks very well with the root inhibition tests. With cell proliferation the 4 chloro and 5 chloro isomers are outstanding. In formative effects it is remarkable that the 6 chloro isomer, both acid and amide, are very active, while in root initiation the 5 chloro isomer stands out. These various effects may give clues to specific practical applications of certain of these compounds. This angle is being pursued further.

Herbicidal Effects

For these tests a series of flats were seeded with a selection of grasses and broadleaf plants for examination with the pre- and post emergence techniques. The results are tabulated in Table 5.

Table 5. Degree of herbicidal activity of some phenoxy compounds when applied pre- (16#/A) and post (8#/A)*
emergence to plants grown under greenhouse conditions.

	Grasses					Broadleaf Plants				
	Corn	Wheat	Rye-grass	Crab-grass	Giant Foxtail	Cotton	Soy bean	Red Clover	Tomato	Pig weed
	*	*	*	*	*	*	*	*	*	*
Phenoxyacetic Acids										
2-Methyl	1	2	1	4	3	2	2	2	4	4
2-Methyl 3-Chloro-	1	0	0	1	1	3	1	1	2	4
2-Methyl 4-Chloro-	3 2	4 0	4 1	4 1	4 4	4 4	4 4	4 4	4	4 4
2-Methyl 5-Chloro-	2	1	1	3	3	3	3	3	4	4
2-Methyl 6-Chloro-	1	0	0	0	0	3	0	0	1	4
Phenoxyacetamides										
2-Methyl 3-Chloro-	1 1	0 0	1 0	0 0	2 0	2 2	0 0	2 0	0	4 3
2-Methyl 4-Chloro-	3 2	4 0	4 1	4 1	4 3	4 4	4 4	4 4	4	4 4
2-Methyl 5-Chloro-	1 0	0 0	3 0	2 0	4 2	0 3	3 3	4 3	3	4 4
2-Methyl 6-Chloro-	1 0	0 0	0 0	1 0	1 0	1 1	0 3	3 2	1	3 2

Rating scale: 0 - no apparent activity, 1 - slight, 2 - moderate, 3 - marked activity,
4 - plants dead

It will be seen that the results in general follow those obtained with root growth tests, with the 5 chloro isomer showing up a little better on pre-emergence with most plants than would be expected. It is also notable that with pigweed there is very little difference in effectiveness with any of the isomers, so that if it happened that this plant were the sole type tested very little differentiation would be noted between any of the isomeric acids.

In conclusion, it should be stated that Dr. P. Sørensen of the Kemisk Vaerk Køge, Copenhagen (5) and also Dr. Warren Shaw of the USDA at Beltsville whom we supplied with samples of the pure acids described above, obtained practically the same results as ourselves with somewhat different tests. (6). We wish here to thank the latter two biologists for the opportunity they gave us of seeing their results before publication.

Literature References

1) British Patent 623,217 (1949)
2) Leaper and Bishop; Bot. Gaz. 112, 250-258 (1951)
3) Leaper, Bishop and Anderson; In press.
4) Macht and Livingston; Jour. Gen. Physiol. 5, 573-584, (1922)
5) Dr. P. Sørensen; Private Communication.
6) Dr. Warren Shaw; Private Communication.

FIELD STUDIES WITH A NEW CLASS OF HERBICIDAL CHEMICALS

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Many workers have reported that annual grasses are becoming a serious problem in most cultivated crops. In fact, last December, a leading academic weed specialist reported that "So far, there has been no new herbicide that will take annual grasses out of corn, and there is not likely to be one soon, since both types of plants belong to the grass family". Even as this statement was being made certain compounds, unknown to him, were already doing this job. Certain amides of chloroacetic acid, including α-chloro-N,N-diallylacetamide and α-chloro-N,N-diethylacetamide show promise as pre-emergence herbicides for the solution of this problem. It now appears that you will be able to eliminate weedy grasses from among certain grass as well as broadleaf crops without injury to the crop. The α-chloroacetamides selectively eliminate various foxtail species, including giant foxtail, crabgrass and certain other annual weedy grasses without damage to cultivated agronomic and horticultural crops.

Test sites were located in the Mid-west, Southeast and Northwest covering a wide spectrum of soils, climatic conditions, crops and weed species. In field trials, involving more than 2700 plots, these new herbicides were compared with most commercially available sales and developmental herbicides. Under certain conditions, which will be described later α-chloro-N,N-diallylacetamide and α-chloro-N,N-diethylacetamide definitely demonstrated their superiority as pre-emergence grass specific herbicides.

Certain α-chloroacetamides were evaluated at four Mid-west locations. The soils representative of the area were silt loam and clay loam type. To insure weed infestation in many of the test plots Italian millet (*Setaria italica*), and rape were seeded as grass and broadleaf indicators. At all locations, excellent control of the grasses was obtained with the two chloroacetamides, with rates ranging from 3 - 6 pounds per acre. In addition to the grasses, certain broadleaf weeds, such as pigweed and purslane were satisfactorily controlled.

The chloroacetamides, when used as pre-emergence herbicides, gave very satisfactory weed control in horticultural crops, such as sweet corn, onions, carrots, broccoli, spinach, snapbeans, lima beans, turnips, radishes and table beets. α-chloro-N,N-diethylacetamide appeared to be slightly better than the α-chloro-N,N-diallylacetamide in over-all weed control in these crops. In fact, at one location where these compounds were extensively tested, no weed species developed during the entire growing season where a 6-pound-per-acre rate of α-chloro-N,N-diethylacetamide was applied. The two chloroacetamides were also used on a limited basis as residual sprays on asparagus and onions. Weed control was equal or superior to that obtained with already commercially available compounds, without apparent stunting of the crop or reduction of final yields.

In order to determine if the chloroacetamides could selectively control annual grasses in corn, a cooperative field program was set up with a large commercial seed corn grower. One-acre plots in seven different areas were involved. All plots were infested with giant foxtail (*Setaria faberii*), green foxtail (*Setaria viridis*), and yellow foxtail (*Setaria lutescens*). 13" band treatments were made with an over-all rate of 6 pounds per acre of α-chloro-N,N-diallylacetamide, resulting in excellent control of all three grass species and reduced the stand and vigor of certain broadleaved weeds. The broadleaf infestation was primarily pigweed.

Crop injury was also nearly lacking where the α-chloroacetamides were applied. When used at a 12-pound-per-acre rate, which is twice the rate necessary for satisfactory weed control, the two chloroacetamides caused no visible crop injury or reduction in yield of the major cultivated agronomic and horticultural crops -- cucurbits being the exception. In addition to these crops, flax, peanuts and cotton were not injured. Slight injury was noted in alfalfa, ladino clover, red clover and birdsfoot trefoil when pre-emergence and post-emergence applications were made.

The α-chloroacetamides are highly effective, even though pre-emergence applications are made on soils low in moisture -- perhaps because of the relatively high water solubility of the compounds. For example, only 0.8 of an inch of rain fell during the 18 days prior to applying the chemicals in a soybean experiment in the Mid-west. Only 0.26 of an inch fell during the two-week period following application, after which 1½ inches fell during a 24-hour period. Five weeks after application, the α-chloro-N,N-diethylacetamide at 4 pounds per acre resulted in 90% grass control, while α-chloro-N,N-diallylacetamide at the same rate gave 93% grass control. In this same experiment, 8 pounds of chloro-IPC were needed for comparable grass control. This rate of chloro-IPC treatment resulted in reduced crop vigor. Even at 12 pounds per acre, the α-chloroacetamides did not reduce vigor or crop stand.

Rain, soon after application of these chloroacetamide herbicides, has not reduced weed control or been detrimental to the vigor of the crop. In another soybean experiment in the Mid-west, ½ inch of rain fell immediately after application of the herbicide. Weed control with both chloroacetamides at the 3-pound rate was exceptionally good. In this experiment there was no crop injury, even at the high rate of 9 pounds per acre. One might expect water soluble chemicals to be readily leached, but this has not been the case with these compounds on the heavy soils. Laboratory data show that the chloroacetamides are adsorbed by the organic matter and/or clay in the soil, but not reversibly. Apparently, quick adsorption at the surface layer prevents significant leaching of the chemicals into the crop root zone. It appears that organic matter may play an important favorable role in successful weed control with these new herbicides, since it was found that as the organic matter content increased in sandy soils of the Southeast, weed control treatments lasted longer.

With reference to soil residue, our chemists have indicated that the breakdown of the α-chloroacetamides in the soil can occur by hydrolysis at the α-chlorine atom and/or the amide linkage. The following reactions can occur separately or concurrently in the soil.

$$R_2N - \overset{\overset{O}{\|}}{C} - CH_2CL \longrightarrow \underset{\text{glycolic acid amides}}{R_2N - C - CH_2OH} \longrightarrow \underset{\text{Amine glycolic acid}}{R_2NH + HO - \overset{\overset{O}{\|}}{C} - CH_2OH}$$

$$\downarrow$$

$$\underset{\text{Amine chloroacetic acid}}{R_2NH + HO\overset{\overset{O}{\|}}{C} - CH_2Cl} \longrightarrow \underset{\text{glycolic acid}}{HO - \overset{\overset{O}{\|}}{CH} - CH_2OH}$$

By either route the reaction products are glycolic acid and amine. As other side reactions the amine may react with chloroacetic or glycolic acid to give amine salts. Breakdown by enzymatic action may proceed similarly or by a totally different route, for which we have no data. These breakdown compounds occur normally in the soil with no lasting ill effects.

Preliminary animal toxicity studies indicate that the α-chloroacetamides should present no serious hazards in the concentrations used for field application. Technical grade materials are slightly toxic if ingested (approximately the same degree as 2,4-dichlorophenoxyacetic acid). Both may be absorbed through the unbroken skin, with the diallyl compound more readily absorbed than the diethyl. If allowed to remain in contact with the skin, α-chloroacetamides in full strength will cause serious irritation. Areas of contact develop temporary sensitivity to heat and cold. Undiluted material accidentally contacting eye tissues can cause serious damage if not immediately removed.

Oral toxicity studies with rats indicate that the approximate LD_{50} for α-chloro-N,N-diallylacetamide is approximately 700 milligrams per kilogram of body weight. In the case of the α-chloro-N,N-diethylacetamide, the approximate oral LD_{50} for rats is 500 milligrams per kilogram.

In summary, based on extensive field data it appears that the two α-chloroacetamides referred to have the following characteristics:

1. They are highly effective as grass-specific pre-emergence herbicides for use among a wide variety of agronomic and horticultural crops.

2. They cause relatively little crop damage, even when applied at twice the normal rates needed for adequate weed control.

3. They have been extremely successful on heavy clay soils. Unlike most other herbicides, they have also performed well on high organic matter soils.

4. Weed control effectiveness is not greatly modified by variation in moisture prior to or following application.

5. They are highly effective at low rates -- in the range of a broadcast application of 3 to 6 pounds per acre.

6. Applications should not result in serious hazards.

THE ABSORPTION AND TRANSLOCATION OF DALAPON*

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Recently, a new herbicide active on grasses was introduced by the Dow Chemical Company. It is 2,2-dichloropropionic acid, the sodium salt of which has been named Dalapon. The physiological response of plants to Dalapon is similar to the response of plants to TCA, but Dalapon is believed to translocate to a greater degree within the plant, and to be more toxic per unit of active material. Greenhouse studies were conducted to discover how Dalapon acts on a grass plant.

Dow (1) reported that Dalapon differs from other grass control compounds in that it is translocated by living grass foliage. Its absorption is not restricted to leaves since adequate amounts can be absorbed by the roots to kill the plant. A. S. Crafts and P. B. Kaufman (Dow, 2) conducted greenhouse toxicity tests using Johnsongrass, Bermuda grass, yellow nutgrass, water grass, corn, barley, tomatoes, sugar beets, rough pigweed and cotton. The plants were sprayed at three stages: 1, at emergence; 2, 7 to 14 days later; 3, 2 weeks later. They found that a solution of 100,000 parts per million killed all plants at all stages, but they do not indicate the amount applied. Ten thousand ppm killed all but Bermuda grass and nutgrass at stages one and two and killed none at stage three. At 1,000 ppm, stage one, corn and water grass were dying; some others were stunted. At stage three there was no severe damage. When 100 ppm was used at any stage, there was only a little stunting; and 10 ppm resulted in no damage whatsoever.

METHODS

The experiments here reported were conducted in the greenhouse at the Ohio State University. The soil generally used was a volumetric mixture of 30 percent sifted Brookston soil, 30 percent medium brown sand and 40 percent dry commercial peat moss. Quackgrass was chosen as the test plant as it is a rhizomatous, perennial grass weed. Two node, approximately 2-inch, sections of large healthy rhizomes were selected and planted one-half inch deep in the soil mixture in 4-inch clay pots.

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The foliage was treated at one of four stages, according to the height of the plant:

1. Plants 3 - 6 cm tall, no unrolled leaves, only a pointed shoot present

2. Plants 6 - 12 cm tall, the first leaf usually opened, the second leaf still rolled in the bud

3. Plants 12 - 18 cm tall, the second leaf usually started to flatten out, the rolled third leaf easily observable in the bud

4. Plants over 18 cm tall, three or more leaves unrolled

Two general methods, spraying and dipping, were used to apply Dalapon in the greenhouse. Modifications of these methods will be explained with the discussion of the individual experiment.

Rates of 10, 100, 1,000, 5,000, 10,000, 50,000, and 100,000 parts per million by weight of Dalapon in water were used in the dipping experiments. To insure thorough wetting of the foliage, the quackgrass shoots were immersed for approximately 2 seconds in a Dalapon solution containing 0.1% of a wetting agent. The pot was not set upright until the Dalapon had dried on the foliage. All treatments were replicated 4 to 6 times.

All pots were observed frequently after treatment. At 20, 30, 60, and 75 days after treatment injury ratings were made on each pot, according to a scale of 0 to 10 as follows: 0, no visible effect; 1,2,3, slight injury, leaf tips or lower leaves dead, plants may recover, some stunting; 4,5,6, increasingly serious injury, plants may or may not recover, leaves about one-third to one-half brown, plants stunted; 7,8,9, severe injury, plants usually do not recover, plant severely stunted; 10, all top growth killed. This rating scale was strictly on the basis of foliage appearance.

RESULTS AND DISCUSSION

<u>The mode of entry of Dalapon into quackgrass plants.</u> An experiment was set up to determine the optimum concentrations of Dalapon for plant killing, the influence of the height of the plant and the area of greatest susceptibility to the herbicide. Table 1 gives the vigor ratings of the treated plants 20 and 60 days after treatment. By 60 days the two higher concentrations of Dalapon had killed most or all of the plants, regardless of the method of treatment. One thousand ppm did not kill all the plants but they were severely injured. When the soil alone was treated, the tall plants died much more slowly (as evidenced by the 20-day ratings) than the young plants. When only the foliage was treated, the height of the plant did not have so much influence on the time of death; although the taller plants perhaps died sooner.

Table 1. Vigor ratings of different-sized quackgrass plants of which only the soil, the foliage or both were treated with several concentrations of Dalapon. Ratings at 20 and 60 days. Figures are average of 5 or 6 replicates.

0 = no damage, 10 = complete kill

Treatment	Ht.	1,000 ppm 20 D.	1,000 ppm 60 D.	5,000 ppm 20 D.	5,000 ppm 60 D.	10,000 ppm 20 D.	10,000 ppm 60 D.
	cm						
Soil treated	0-6	3.7	8.0	8.7	10.0	8.7	10.0
	6-12	4.6	8.0x	7.2	9.8x	6.6	10.0
	12-18	2.0	6.5x	3.4	10.0x	7.8	10.0x
	18+	3.0	10.0x	4.0	10.0x	5.7	10.0x
Foliage treated	0-6	2.8	9.6x	5.0	7.5x	4.4	7.7x
	6-12	2.0	8.4x	3.2	9.4x	5.8	9.2x
	12-18	3.6	9.2x	5.8	9.2x	6.6	10.0x
	18+	0.8	6.2x	6.0	10.0x	7.2	10.0x
Both treated	6-12	4.3	3.7x	3.0	10.0	6.7	9.9
	12-18	0.7	10.0x	6.0	10.0x	8.3	9.3x

x Indicates that in some pots new shoots came up from the rhizome after one shoot had died.

Generally, the speed of kill was proportional to the concentration of Dalapon used. However, it must be noted that in most cases there were new shoots from the rhizome by the time 60 days had passed. A superscript x in all the tables of this report indicate where this new growth occurred. It is apparent that Dalapon did not kill the rhizomes, only the foliage above ground at the time of treatment.

The foliage alone or the foliage and the soil were also treated with concentrations of 10 and 100 ppm, but these were too weak to have any toxic effects.

<u>Translocation of Dalapon through quackgrass rhizomes.</u> In studying the translocation of Dalapon, rhizomes which had two shoots were used. One shoot was treated and marked and translocation assumed to have occurred if the untreated shoot died or showed injury. The data are reported in Table 2. In these experiments the first shoot to come up is called the primary shoot, and all others are secondary shoots. It is realized that with relation to the entire plant before cutting the rhizome the primary shoot of these experiments is not necessarily the primary or apical shoot of the plant.

Table 2. Vigor ratings of quackgrass plants of which one of two shoots on a rhizome was immersed in Dalapon. All heights in the table are those of the primary shoot. Ratings 20 and 60 days after treatment. Figures are average of 5 or 6 replicates.

0 = no damage, 10 = complete kill

Ht.	Shoot	1,000 ppm 20 D.	1,000 ppm 60 D.	5,000 ppm 20 D.	5,000 ppm 60 D.	50,000 ppm 20 D.	50,000 ppm 60 D.
		Primary shoot treated					
cm. 0-6	Treated	1.4	3.0	4.6	10.0	9.4	10.0
	Untreated	0.8	2.7	0.0	3.0	2.8	10.0x
6-12	Treated	2.3	10.0	9.0	9.2	9.2	10.0
	Untreated	0.0	4.3	3.0	5.2	2.2	7.5
12-18	Treated	0.0	—	5.5	9.2	9.0	10.0
	Untreated	0.0	5.0x	1.5	9.2x	6.2	10.0x
18+	Treated	2.7	9.3	2.7	10.0	9.4	10.0
	Untreated	0.7	10.0x	0.0	7.3	5.6	10.0x
		Secondary shoot treated					
6-12	Treated	2.3	10.0	4.7	10.0	8.4	10.0
	Untreated	0.0	5.0x	0.0	3.7x	4.4	6.8x
12-18	Treated	4.0	8.0	7.0	10.0	9.6	10.0
	Untreated	1.7	3.5x	0.0	3.3x	6.8x	10.0x
18+	Treated	3.3	5.0	8.0	9.7	8.4	10.0
	Untreated	0.7	4.0x	2.7	4.3x	2.8	9.4x

x Indicates that in some pots new shoots came up from the rhizome.

In most instances the severity of damage and speed of kill were directly proportional to the concentration of Dalapon. By the end of 60 days, all plants treated exhibited translocation to a greater or lesser degree. In general, the taller the plant, the greater the degree of translocation; however, there are exceptions to this. Translocation occurred in both directions across the rhizome, either from the secondary shoot or from the primary. When the primary shoot was treated, a high degree of translocation occurred at the 12 to 18 cm height and with a minimum concentration of 50,000 ppm. Therefore, this combination was chosen for many of the translocation studies which follow.

To determine the effect of injuring the leaf on the absorption and translocation of Dalapon, the leaves of some shoots were stuck thirty times with a pin before treatment. However, injuring the plant did not materially increase either absorption or translocation. Apparently Dalapon can enter the leaf through the epidermis as easily as through wounds.

The most comprehensive studies of herbicide translocation have been done using 2,4-D, usually with bean plants. Mitchell and Brown (3) found that leaves in the dark responded more slowly to 2,4-D than did those in the light. 2,4-D growth stimulus was translocated only in the presence of light, indicating that the movement was associated with the products of photosynthesis and the translocation of organic food materials. Linder, et al. (4), obtained similar results. Rohrbaugh and Rice (5) and Weintraub and Brown (6) found that the addition of sucrose to plants which were treated with 2,4-D in the dark increased the amount of translocation.

To determine whether Dalapon was translocated with the photosynthate as is 2,4-D, a series of plants were placed in the dark for 48 hours in order to deplete the leaves of photosynthate. The plants were then brought into the light for about 2 minutes for treatment, then returned to the dark for another period of 24 hours. One series was not returned to the dark for this latter period. Twenty-four hours after treatment, all treated shoots were carefully washed and then placed in the light. Table 3 shows the ratings of plants treated in this manner.

Table 3. Vigor ratings of 12 to 18 cm. quackgrass plants which had one of two shoots from a rhizome dipped into different concentrations of Dalapon. Different light conditions were used to discover their effect on translocation. Ratings 20 and 60 days after treatment. Average of 5 or 6 replicates.

0 = no damage, 10 = complete kill

Treatment	Shoot	5,000 ppm 20 D.	5,000 ppm 60 D.	10,000 ppm 20 D.	10,000 ppm 60 D.	50,000 ppm 20 D.	50,000 ppm 60 D.
Plants in dark before and after treatment	Treated	4.3	10.0	5.2	10.0	9.8	10.0
	Untreated	0.7	2.5x	0.5	3.4x	3.2	6.0x
Plants in dark before and in light after treatment	Treated	5.0	10.0	3.5	10.0	7.0	10.0
	Untreated	3.0	6.0x	2.0	6.5x	2.8	10.0x
Plants in light before and after treatment	Treated	5.5	9.2	6.8	10.0	9.0	10.0
	Untreated	1.5	9.2x	0.0	6.8	7.2	10.0x

x Indicates that in some pots new shoots came up from the rhizome.

Placing the plants in the dark before and after treatment did not affect the degree of kill of the treated shoot as compared to plants which had received no dark treatment. However, it greatly decreased the translocation of Dalapon into the secondary shoot. Apparently Dalapon was translocated at least in part with the products of photosynthesis.

In the previous experiment, the plants were brought from the dark into light for treatment, then returned to the dark. It was feared that the brief exposure to light may have triggered a translocation mechanism other than that having to do with photosynthesis, so some plants were treated in total darkness but were otherwise handled as above (dark before and after treatment). However, the brief exposure to light was found to have no effect on the final results.

Table 4. Vigor ratings of 12 to 18 cm. quackgrass plants which had one of two shoots on a rhizome treated with Dalapon, water or a 10 percent sugar solution. Plants were kept in dark before, during and after treatment by the jar method, except normal Dalapon treatment which was in the light. Ratings 20 and 60 days after treatment. The concentrations apply to Dalapon only. Figures are an average of 5 or 6 replicates.

0 = no damage, 10 = complete kill

Treatment	Shoot	5,000 ppm 20 D.	5,000 ppm 60 D.	50,000 ppm 20 D.	50,000 ppm 60 D.
Water only	Treated	1.0	1.2	1.0	1.2
	Untreated	0.7	2.3x	0.7	2.3x
Sucrose only	Treated	1.0	2.0	1.0	2.0
	Untreated	1.2	1.0x	1.2	1.0x
Dalapon only	Treated	5.6	-	4.3	10.0
	Untreated	0.8	2.3x	2.3	2.5x
Dalapon + sugar	Treated	3.6	6.0	6.0	6.0
	Untreated	0.4	2.2	1.7	2.2
Normal Dalapon treatment	Treated	10.0	10.0	10.0	10.0
	Untreated	7.3	10.0x	6.0	10.0x

x Indicates that in some pots new shoots came up from the rhizome.

To pursue the translocation studies further, sugar was used as it had been in the experiments with 2,4-D. Here, the jar method was used as it was thought that continued immersion in the sugar solution would be more efficient than only dipping. Plants were dipped in water only, 10% sucrose solution only, Dalapon only and Dalapon plus 10% sucrose.

The water and sucrose treatments alone did not damage the plants. Dalapon alone damaged the treated shoot but was not translocated appreciably if the plants were placed in the dark. However, the addition of sucrose to the herbicide solution was of no help at all as no increase in translocation was measured in terms of damage to the secondary shoot.

From some of the experiments already reported here, it appeared that Dalapon entered the plant easily and rapidly. In order to check this, plants were treated (one of two shoots from a rhizome) and then the treated shoot was carefully washed at varying periods of time after treatment. The object of this was to remove all external Dalapon, and then the amount of Dalapon that had entered the foliage could be measured by the degree of damage to the plant. Also, as a measure of the speed of translocation, some treated shoots were cut off instead of being washed. As the cutting would remove any possible source of Dalapon to the untreated shoot, any damage to that shoot would be caused by Dalapon that had been translocated out of the treated shoot in the allotted period of time. The results of this experiment are shown in Table 5.

Table 5. Vigor ratings of 12 to 18 cm. quackgrass plants which had one of two shoots from one rhizome immersed in 50,000 ppm of Dalapon. It was then cut off or washed at various periods after treatment. The check was treated but not washed or cut. Ratings 20 and 60 days after treatment. Figures are an average of 5 or 6 replications.

0 = no damage, 10 = complete kill

Time	Shoot	Shoot washed		Shoot cut off	
		20 Days	60 Days	20 Days	60 Days
min.					
0	Treated	1.4	2.0	-	-
	Untreated	1.0	2.0x	-	-
5	Treated	5.0	9.0	-	-
	Untreated	2.0	6.0x	0.0x	2.7x
30	Treated	6.7	10.0	-	-
	Untreated	4.0	10.0x	-	-
60	Treated	7.0	10.0	-	-
	Untreated	4.3x	10.0x	0.0	2.0x
180	Treated	-	-	-	-
	Untreated	-	-	3.0	8.3x
Check	Treated	9.0	10.0	9.0	10.0
	Untreated	6.2	10.0x	6.2	10.0x

x Indicates that in some pots new shoots came up from the rhizome.

Apparently the washing of the treated shoots removed all the external Dalapon, as the shoots washed immediately after treatment showed no herbicide injury. However, in 5 minutes enough Dalapon had entered the leaf and translocated to the untreated shoot to cause damage within a period of 60 days. By the time 30 minutes had passed, sufficient Dalapon had entered the leaf to eventually kill the untreated shoot. This would seem to show that the entry of Dalapon into a leaf of quackgrass is quite rapid. Translocation of Dalapon from the leaf is much slower. Even after 60 minutes had passed before cutting off the treated shoot, little translocation had occurred as evidenced by the low ratings given to the untreated shoots. However, by the time 3 hours had passed, enough Dalapon had moved out of the treated shoot to seriously damage the untreated shoots.

SUMMARY

Two node sections of quackgrass rhizomes were planted in pots in the greenhouse. After emergence of the shoots they were treated by spraying or by immersion in Dalapon. Treatment was made at several height stages, and with concentrations varying from 10 to 100,000 ppm Dalapon by weight. Translocation studies were made by treating only one of two shoots from a single rhizome. Translocation was assumed to have occurred if the untreated shoot showed symptoms of herbicide injury.

Ten and 100 ppm of Dalapon caused no injury, 1,000 ppm caused severe foliage injury, and 5,000 to 100,000 ppm caused rapid foliage death. However, there was new growth from the rhizome in most instances. The herbicide acted with equal efficiency through the foliage or through the soil. The age or size of the treated plant did not consistently affect the results obtained.

Dalapon was found to be easily translocated through living quackgrass rhizomes in either direction. Translocation occurred very well when shoots 12 to 18 cm. tall were treated at concentrations of 50,000 ppm or higher. When the mechanism of translocation was studied by using dark periods before treatment in order to deplete the leaves of photosynthates, it was found that Dalapon probably is translocated with photosynthates in plants, but that that is not the only means of translocation.

Dalapon was found to enter the leaf rapidly, enough entering in 5 minutes to damage the treated leaf. Within 30 minutes after treatment enough had entered to be subsequently translocated out and to kill the untreated shoot, but it took at least 3 hours for this translocation to occur.

LITERATURE CITED

1. Dow Chemical Co. "Dalapon Bulletin No. 2." December, 1953.

2. Dow Chemical Co. "Dalapon Bulletin No. 1." May, 1953.

3. Mitchell, J. W., and Brown, J. W. "Movement of 2,4-Dichlorophenoxyacetic Acid Stimulus and Its Relation to the Translocation of Organic Food Materials in Plants." Bot. Gaz. 107:393-407, 1946.

4. Linder, P. J., Brown, J. W., and Mitchell, J. W. "Movement of Externally Applied Phenoxy Compounds in Bean Plants in Relation to Conditions Favoring Carbohydrate Translocation." Bot. Gaz. 110:628-632, 1948.

5. Rohrbaugh, L. M., and Rice, E. L. "Effect of Application of Sugar on the Translocation of Sodium 2,4-Dichlorophenoxyacetate by Bean Plants in the Dark." Bot. Gaz. 111:85-89, 1949.

6. Weintraub, R. L., and Brown, J. W. "Translocation of Exogenous Growth Regulators in Bean Seedlings." Pl. Phys. 25:140-149, 1950.

"PROGRESS REPORT OF CROP TOLERANCE PERIOD FOLLOWING VARIOUS RATES OF AMIZOL (3-amino-1,2,4-triazole) ON EWINGSVILLE SOIL"

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Amizol is the trade mark of American Chemical Paint Company for the chemical 3-amino-1,2,4-triazole and will be used hereafter in this paper in place of the chemical name.

Amizol has been tested in the greenhouse and in extensive field trials for the past three years for growth regulating properties. When this material is sprayed on plants, it is absorbed by the roots and aerial parts of plants and is translocated within the plants. Work reported from Texas(1) indicates that Amizol causes chlorophyll destruction and interferes with chlorophyll synthesis prior to the protochlorophyll stage, affects carbohydrate metabolism and distribution, stimulates respiration, and inhibits growth responses of other tissues. In mature but physiologically active plants, this chemical was primarily translocated to the meristematic regions. When high concentrations of Amizol were applied, the pathway of transport was mainly upward to the terminal meristem and young tissues; death of the terminal meristem occurred, followed by necrosis which progressed downward along the stem.

Three years' work on Amizol in the southern and southwestern part of the United States has shown that this chemical is an excellent cotton defoliant with the unique property of inhibiting regrowth. When used as an additive with some of the standard commercial defoliants, Amizol gave an increased percentage of defoliation with inhibition of regrowth. It also demonstrated good commercial defoliation with inhibition of regrowth when used alone as a defoliant on cotton.

This chemical has shown promise for use as a herbicide on some perennial broadleaf weeds and grasses such as Canada thistle (Cirsium arvense), milk weed (Ascelpias syriaca), quack grass (Agropyren repens), Bermuda grass (Cynodon Dactylon) and nut grass (Cyperus rotundus and esculentus). Work in Georgia(2) indicates that Amizol translocates thru the root system of nut grass beyond the first nut formation. It has also been reported in Georgia(3) that Amizol translocates thru Johnson grass root system when applied to the foliage. Work done at the American Chemical Paint Company's research farm demonstrated similar translocation of Amizol into the quack grass root system from foliage application.

[1]American Chemical Paint Company, Ambler, Pennsylvania

Extensive field trials at Penn State[4] and on a commercial farm in Emmaus, Penna.[5] with Amizol, showed excellent quack grass control when application was made in early spring to young quack grass plants (4 to 6 inches tall), followed by heavy discing or plowing. Further tests were made to determine when and if a crop such as corn could be planted after Amizol had been applied followed by a discing or plowing. It was observed, from these tests, that corn could be planted as early as one week after Amizol had been applied. Not only was the corn not affected when planted at this time interval after spraying, but quack grass control was good.

Procedure

Test I

From these and other extensive trials with Amizol, it became evident that this compound was very promising for control of perennial weeds and grasses. This test was planned and carried out in 1954 on the American Chemical Paint Company's research farm in Ambler, in an effort to observe possible residual effects of Amizol on some crops that might be planted after Amizol had been applied. In June, 1954, a field 1100' long by 700' wide was divided into six plots 172' long and 110' wide. Each of these plots was divided in half for replication. With a tractor mounted spray rig, five of the (172' x 110') plots were sprayed on the same day with Amizol at a rate of 40 gallons of water per acre. The individual plots were sprayed with different rates of Amizol per acre: 4 lb./A, 8 lb./A, 12 lb./A, 20 lb./A and 40 lb./A. One plot area was kept as an unsprayed check plot. Field corn (U. S. 13), and soybeans (Hawkeye) were seeded and tomato transplants (Rutgers) were planted in both the sprayed areas and the unsprayed check plot at different time intervals after spray was applied. The crops were planted in an area 86' x 55' within each (172' x 110') plot. The treatments were replicated twice. Plantings were made 3, 7, 11, 14, 21, 28 and 49 days after application of Amizol was made.

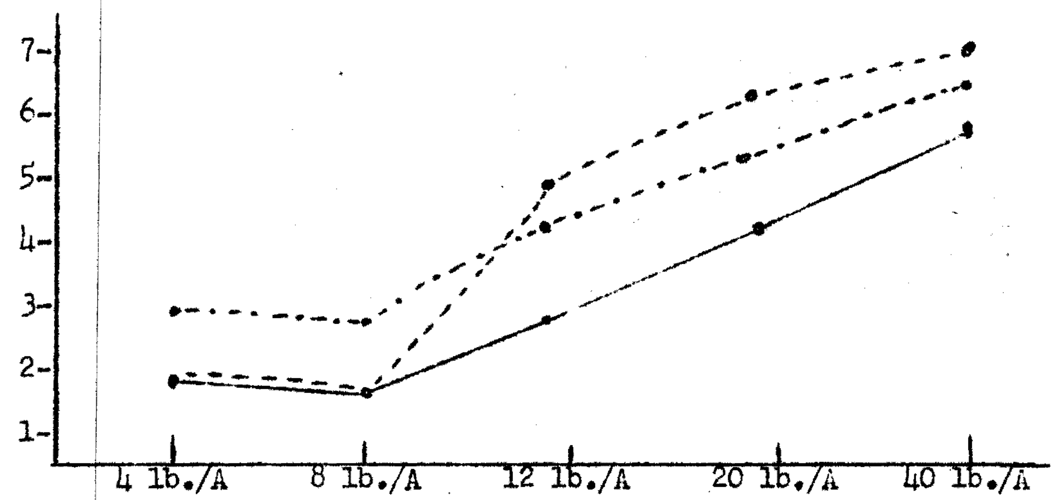
Before sprays were applied, representative soil samples were taken from the entire field on June 1, 1954, and sent to Penn State University for analysis; pH - 6.3, phosphorus - 9 ppm, potassium - 80 ppm. and organic matter 1.9. Before the land was prepared for spraying and planting, a ton of limestone and 1200 lbs. of 10-10-10 fertilizer were applied to the soil. On July 30, six weeks after spraying another analysis of soil was made. At this time pH was 6.2, phosphorus - 27 ppm., potassium - 170 ppm. and organic matter 2.5. Complete rainfall records were kept throughout the test period (see Table 7).

Results

Close observations of each individual plot were made twice a week to determine any residual effect on crops from the pre-planting sprays of Amizol.

For ease of presentation, the data from the five sprayed plots is presented graphically for each time interval of planting after spray. Under the conditions of this test, it is interesting to note that crops planted 7 days after Amizol was sprayed at 4 and 8 lb./A showed no visible injury (see Table 2). These crops indicated only slight chlorosis when planted 3 days after the 4 and 8 lb./A spray was applied, tomato being most effected (refer to Table 1). However, all crops outgrew this chlorosis within 2 to 3 weeks and appeared normal. At the 12 lb./A rate, tomato growth was not affected by the spray applied 7 days after planting, whereas, corn and soybean plants did show symptoms of Amizol injury. Soybeans showed more severe symptoms of injury than corn plants in both the 3-day and 7-day planting in the 12 lb./A application plot (see Tables1 and 2). Corn demonstrated severe chlorosis in the 3-day planting and only slight chlorosis in the 7-day planting, whereas soybeans not only exhibited severe chlorosis, but germination was decreased and remaining plants were stunted. It was interesting that in the 20 lb./A rate although injury to all crops was more severe in the plantings made 3 or 7 days after spray than the 12 lb. rate, no symptoms of Amizol injury were observed in crops planted 11 or more days after spraying (see Tables 3 and 4). Injury to all crops was quite severe where 40 lb./A was sprayed even when crops were planted 7 weeks after application (see Tables 5 and 6).

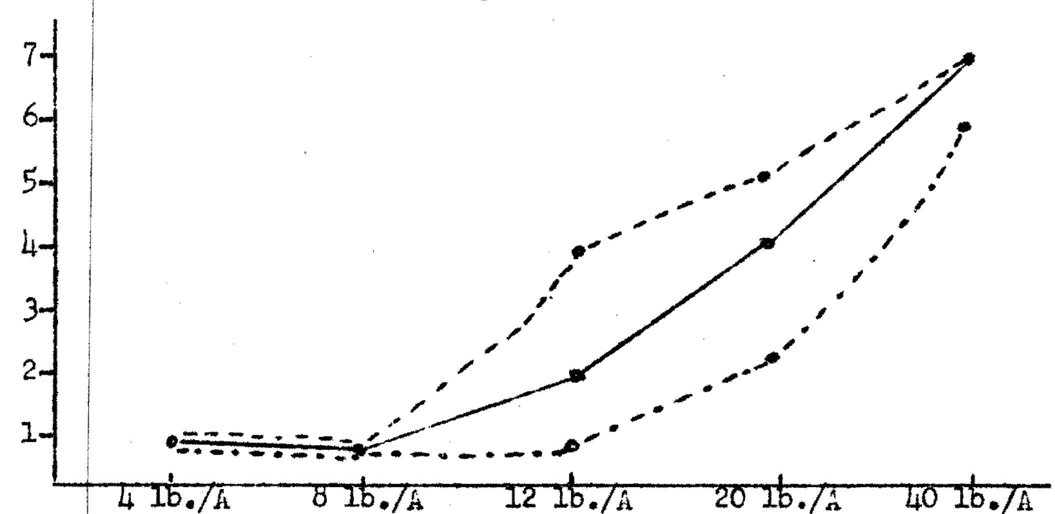
Table 1



planted 3 days after spray

rainfall from spray to planting - 0

Table 2



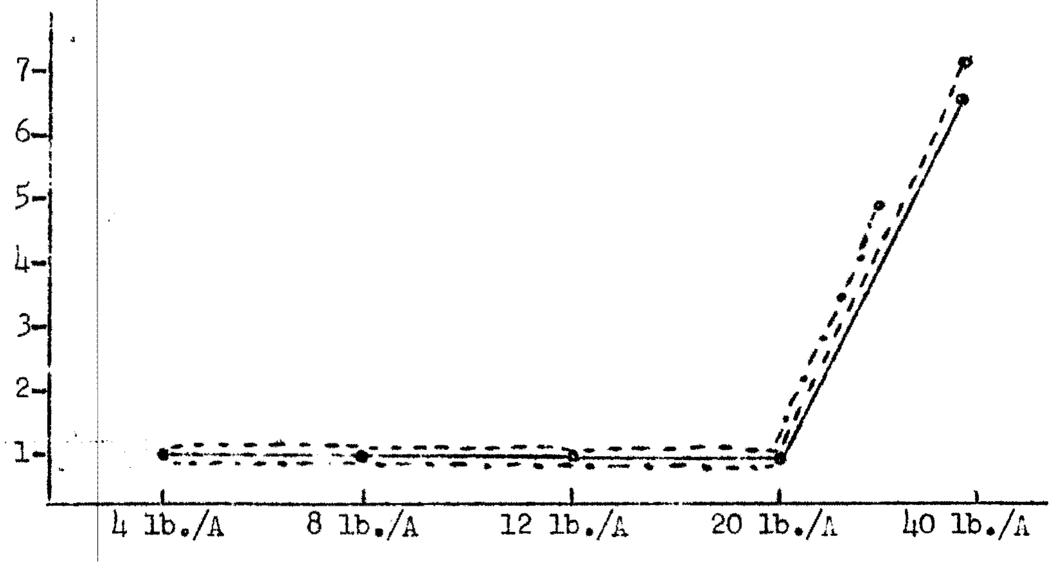
planted 7 days after spray

rainfall from spray to planting - 0.86"

1 = Normal
7 = 100% Kill

——— Corn
- - - - Soybean
-.-.- Tomato

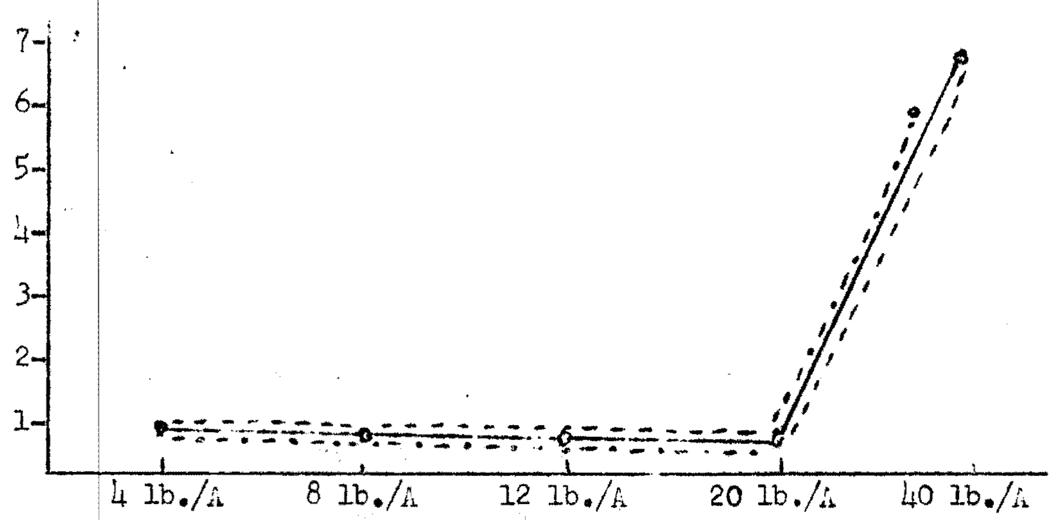
Table 3



planted 11 days after spraying

rainfall from spray to planting - 1.99"

Table 4



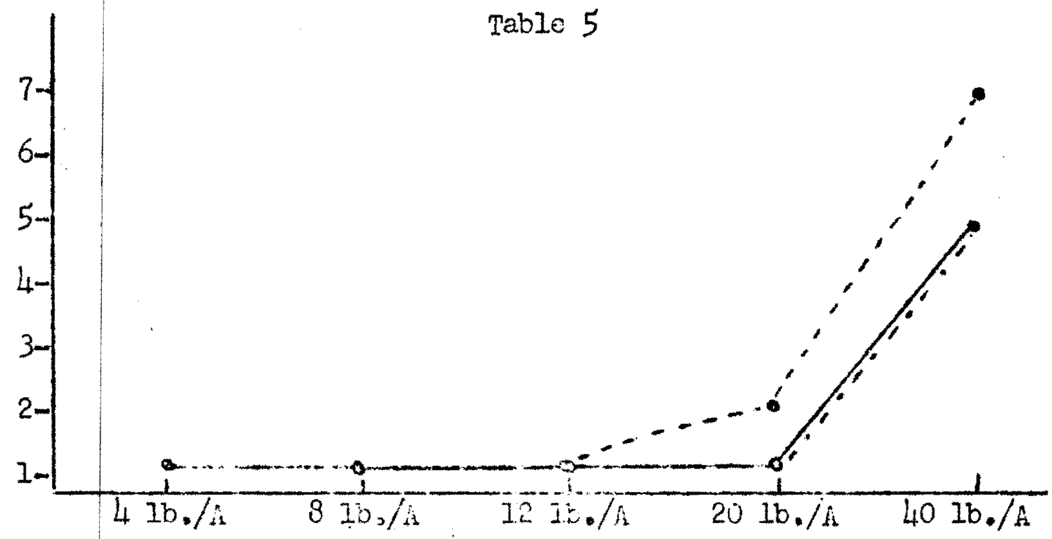
planted 14 days after spraying

rainfall from spray to planting - 1.99"

1 = Normal
7 = 100% Kill

——— Corn
----- Soybean
-.-.- Tomato

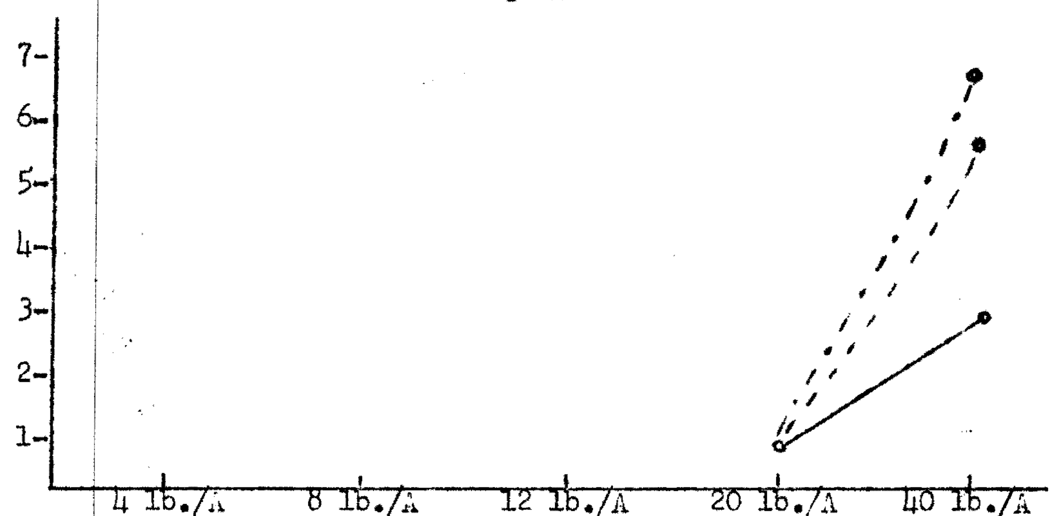
Table 5



planted 21 days after spraying

rainfall from spray to planting - 1.99"

Table 6



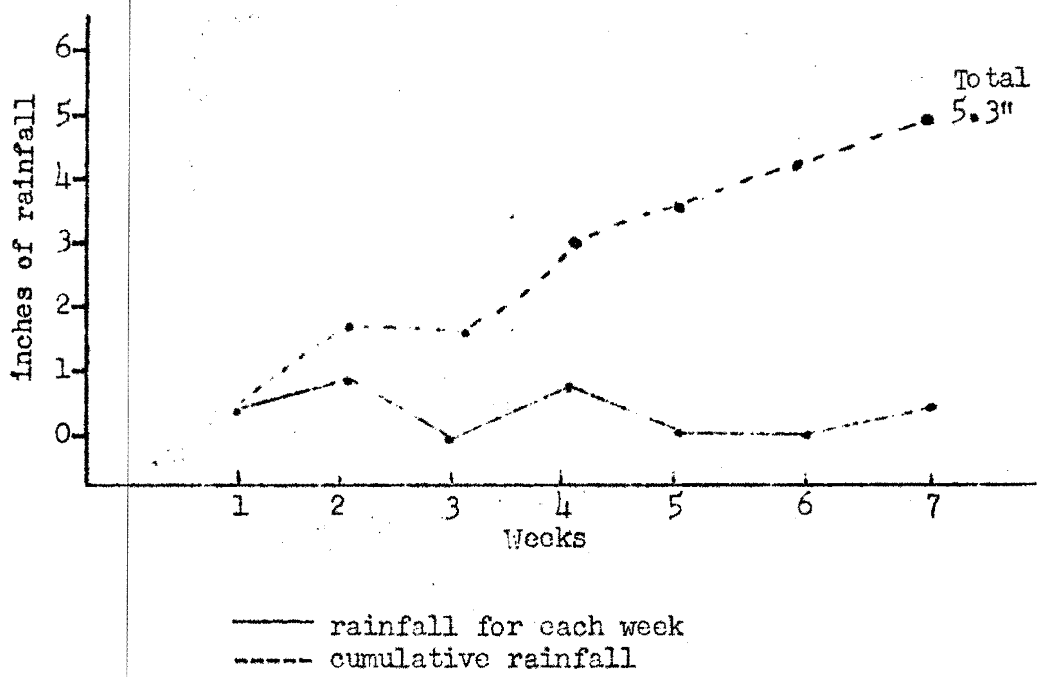
planted 28 days after spraying

rainfall from spray to planting - 3.26"

1 = Normal
7 = 100% Kill

——— Corn
----- Soybean
-.-.- Tomato

Table 7



Test II

Another test was carried out in a similar manner with vegetable crops seeded at various time intervals after the spray was applied. Crops seeded were spinach, peas, squash, cauliflower, broccoli, lima beans, beets, onions, lettuce and cabbage. Application of Amizol was made at 4 and 8 lb./A and crops were seeded at time intervals of 3, 7, 14 and 28 days after application. Plot size was 10' x 10' replicated 2 times.

Results

Planted 3 days after Amizol was applied at 4 lb./A, all crops except lima beans developed moderate to severe injury. In the same planting at the 8 lb./A rate severe injury was observed in all crops. Injury consisted of stunting, chlorosis, and in many cases decreased stand. Crops planted 7 days after Amizol was applied were somewhat less affected by both rates applied.

Lima beans, squash, beets and lettuce produced no symptoms of injury at either rate of the pre-planting treatment of Amizol; all other crops showed slight to moderate injury in the form of stunting and chlorosis. Injury to these crops was more severe at the 8 lb./A rate; the only crops showing injury when planted 14 days after treatment were cabbage, cauliflower and peas. When crops were planted 28 days after treatment, no injury was observed at either rate used.

Conclusions

The following conclusions are preliminary and are based entirely on such conditions as soil, rainfall, temperature, etc. prevailing throughout this particular test.

1. No injury was observed on either corn, soybean or tomatoes when planted 7 days after Amizol had been applied to the soil at both 4 and 8 lb./A. Only slight chlorosis appeared in these crops when they were planted 3 days after 4 and 8 lb./A of Amizol was applied. Plants outgrew this effect within 2 to 3 weeks.

2. Corn, soybean and tomatoes planted 14 days after 12 and 20 lb./A of Amizol was applied to the soil produced no injury, although moderate to severe injury developed in crops planted 3 days and 7 days after Amizol was applied at these rates.

3. Corn, tomato and soybean plants were severely injured when planted as late as 7 weeks after the 40 lb./A rate of Amizol had been sprayed.

4. All crops except lima beans were injured when planted 3 days after 4 lb./A of Amizol was applied. Injury did occur to lima beans when planted 3 days after being sprayed with 8 lb./A of Amizol.

5. Lima beans, squash, beets and lettuce were the only crops not affected when planted 7 days following the application of Amizol at both 4 and 8 lb./A.

6. Cabbage, cauliflower and peas were the only crops that showed injury when crops were planted 14 days after Amizol was applied at both 4 and 8 lb./A.

7. No injury was observed in any crops planted 28 days after Amizol treatments of 4 and 8 lb./A.

Literature Cited

1. Hall, W., Texas A & M. Personal correspondence. 1954.

2. Hauser, E., Georgia Agricultural Experiment Station. Personal correspondence. 1954.

3. Hauser, E., Georgia Agricultural Experiment Station. Personal correspondence. 1954.

4. Raleigh, S., Pennsylvania State University. Personal correspondence. 1954.

5. Seems, J., Emmaus, Pennsylvania. Personal correspondence. 1954.

EQUIPMENT FACTORS AFFECTING THE APPLICATION OF WETTABLE POWDER FORMULATIONS OF SUBSTITUTED UREA HERBICIDES

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INTRODUCTION

Proper application of substituted urea herbicides in conventional spray equipment has been more difficult than application of many other weed killers. The low solubility of these materials in water and common organic solvents has made it desirable to formulate them as wettable powders. Heretofore, herbicides have been used almost exclusively as emulsifiable liquids or water soluble products. Hence, spray equipment developed to apply such materials has been provided with little or no agitation; small nozzles protected by fine screens have often been used to permit the application of small volumes of liquid per unit area. Wettable powders cannot be used in such equipment since they will settle from suspension without efficient agitation, they can plug restrictive strainers and screens, and they can form sediment in large diameter spray booms at low rates of flow.

These difficulties were studied and simple modifications to existing equipment were devised to permit satisfactory application of wettable powder formulations of the substituted urea herbicides. Both pre-emergence crop sprays and soil sterility applications have been considered. Power requirements for hydraulic agitation and the proper screen and boom sizes were defined.

AGITATION

Mechanical agitation is generally preferred and, where present, is usually adequate. To date, no detailed studies have been made of the design requirements for such agitation. However, observation and consideration of basic principles make it evident that the mere presence of a mechanical agitation assembly does not necessarily assure adequate agitation. A common cause of poor mechanical agitation results from operation of the agitator at slower than normal speeds. This often occurs when the pump capacity is greatly above that required for spraying and the power unit is "idled" or operated at a reduced speed.

Air agitation should be avoided. It is not considered effective for agitation of wettable powder formulations and has the serious drawback of inducing excessive foaming. In extreme cases, the wettable powder may be carried into the foam as burden and result in inaccurate applications.

Objectives in the studies of hydraulic agitation were (1) to determine whether jet agitation is feasible for use with "Karmex"* W or "Telvar"* W wettable powders; (2) to ascertain quantitative hydraulic power requirements; and (3) to examine briefly such factors as power distribution (number and positioning of jets) and tank geometry.

Experimental Procedure

A simulated spray rig was set up with a 55-gallon drum as the tank. A concentration of approximately 5 pounds of "Karmex" W per 100 gallons of water was employed. The volume used was 50 gallons.

To evaluate the effectiveness of the agitation, two sampling techniques were used. In the first, multiple samples were withdrawn from several horizontal positions at three depths in the tank. The second procedure consisted of sampling the nozzle discharge at various times as the tank contents were sprayed out. The solids content of each sample was determined by filtering, drying, and weighing.

To provide jet agitation, commercially available jet caps having well-rounded orifices were attached to the end of the agitation line. This line was secured to the wall of the tank and extended within one-half inch of the tank bottom. Resulting jet streams were directed horizontally along the tank bottom. A single jet arrangement and a combination of two jets were studied.

Varying degrees of agitation power were obtained by orifice size selection and pressure control in the agitation line. Uniformity of solids distribution (and hence effectiveness of agitation) was judged from the percent solids in the samples collected for analysis.

Discussion of Results

Based on laboratory results with the simulated spray rig, jet agitation appeared quite feasible. Agitation with jets was markedly better than with the conventional open-end by-pass line, and was essentially as good as that obtained mechanically with a propeller agitator. This is shown in Figure 1, in which the average percent solids content at three depths is given for four agitation trials: single jet, two jets, open-end by-pass, and mechanical.

It was found that a calculated power level (determined from measured flow through the jet orifices and pressure thereon) of

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* "Karmex" and "Telvar" are du Pont registered trade-marks. They contain 3-(p-chlorophenyl)-1,1-dimethylurea as the active ingredient. "Karmex" is for agricultural use; "Telvar" is for industrial use.

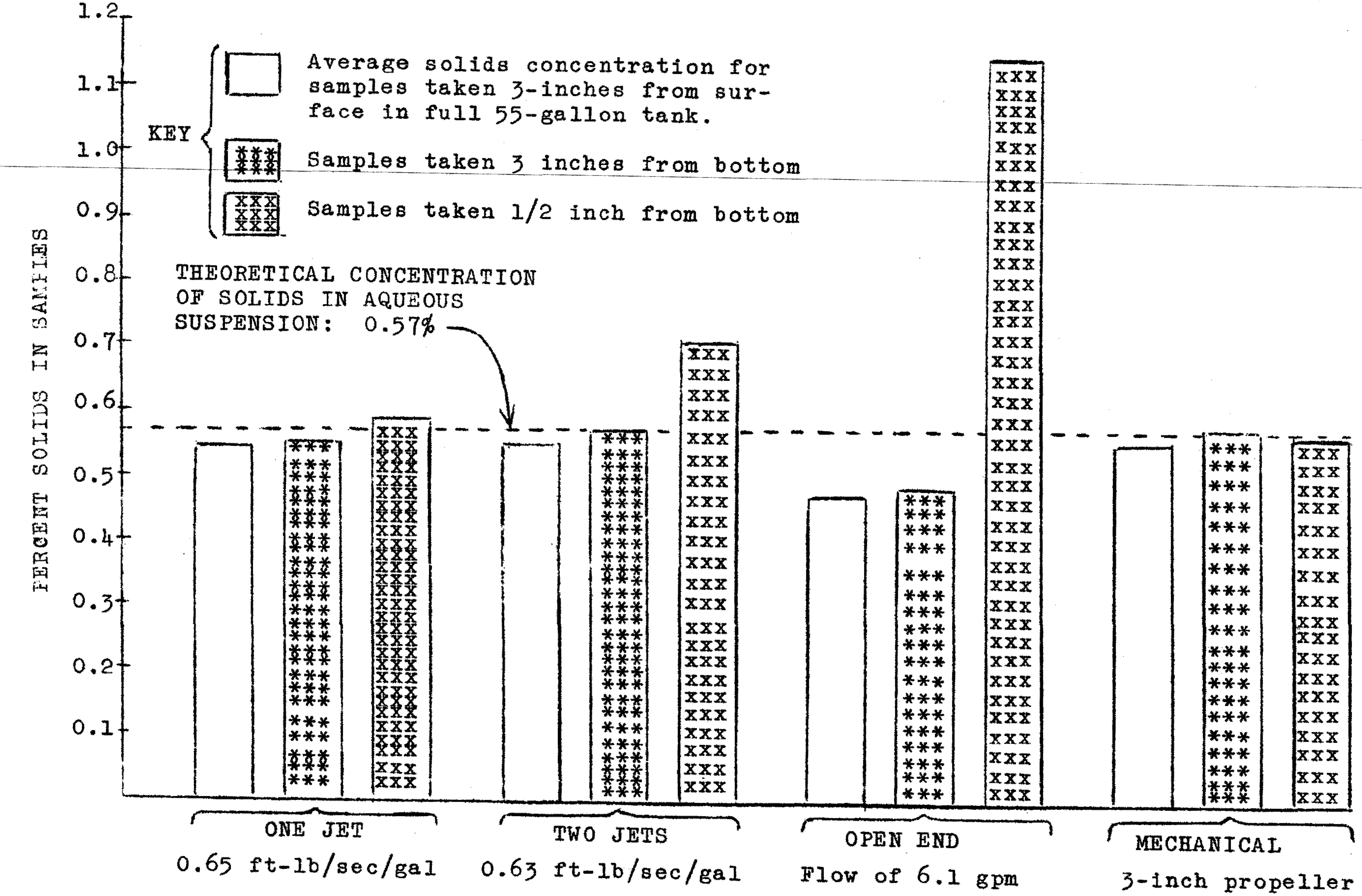

FIGURE 1

EFFECTIVENESS OF AGITATION TECHNIQUES FOR RESUSPENDING "KARMEX" W HERBICIDE about 0.6 foot pound per second per gallon (ft-lb/sec/gal) is required to resuspend sediment of "Karmex" W Herbicide from the tank bottom.

The most effective distribution with hydraulic agitation occurred with one jet operated at 20 pounds per square inch, gauge (psig) and delivering 5 gallons per minute (gpm) for a calculated power of 0.65 ft-lb/sec/gal. The jet was mounted so that a swirling motion was imparted to the tank contents. The "Karmex" W had been mixed with the water and allowed to settle before starting the agitation. Therefore, the measurements represent the agitation requirement for resuspension in a full tank. No baffling was employed and a troublesome vortex resulted with the tank in the vertical position. This allowed the pump to pull air when the tank contents were reduced by half or more.

Trials were conducted with two jet orifices mounted together in the same plane, with a 90° angle between the jets. Total power input was approximately equal to that for the single jet just described. As expected, a relatively dead area existed near the jets in the included angle between the two streams; this was reflected by the high concentration found for one sample collected on the tank bottom. However, in view of the absence of any tendency to vortex and the relatively small variations in concentration of the other samples, this jet arrangement was judged satisfactory. This was substantiated by results using the second sampling technique. By this procedure, solids concentration was found to vary between 0.57% and 0.59% for nozzle samples taken at intervals while the tank was being completely discharged. Theoretical concentration was 0.57%. Use of more than two jets, however, would provide better distribution of a given amount of power and help prevent dead spots.

A definite difference was found between the power necessary to maintain a wettable powder in suspension and that necessary to resuspend sediment once it occurs. Approximately 0.3 ft-lb/sec/gal adequately maintained a suspension obtained by stirring, but was not effective in resuspending sediment from the tank bottom.

A summary of the studies with hydraulic agitation is given in Table 1. Higher operating pressure on the by-pass line than the 20-23 psig employed in these studies could provide the same or greater power for agitation and yet reduce the gallons per minute required. (This is true because volumetric flow increases only as the square root of head.) Such procedure would in effect utilize more of the work available at the pump source.

Results above are from trials in a vertical tank. In tests with a horizontal tank (55-gallon drum type), jet orifices were fitted to oppose each other 180° and were centrally located on the tank bottom so that streams were directed toward the end walls. At a power input of the same order as that used in

Table 1

Efficiency of Jet Agitation vs. Jet Power

Orifice Diameter inches	Number of Jets	Measured gpm/jet	Line Pressure psig	Calculated Total Power ft-lb/sec per 50 gal.	Calculated Total Power ft-lb/sec per 1 gal.	Remarks
7/32 (well rounded orifice)	1	5.07	20	32.6	0.65*	Effective resuspension; serious vortex
1/8 (well rounded orifice)	2	2.1	23	31.6	0.63*	Effective resuspension; no vortex problem
7/64 (sharp-edged orifice; low overall co-efficient)	2	1.12	20	14.4	0.288*	Ineffective resuspension; marginal for maintaining suspension
half-inch open end pipe	0	6.1	-	-	-	Ineffective

Note: * For practical purposes, 0.6 ft-lb/sec/gal was selected as the minimum power value to give effective resuspension of sediment; the value to maintain the suspension was established at an even 0.3 ft-lb/sec/gal.

vertical tank studies, agitation was satisfactory. However, a dead area in the vicinity of the jet assembly suggests the use of a third jet directed toward the curved side wall.

The piping scheme to supply the agitation line is an important consideration. For temporary use in crop sprayers, properly sized jets have been attached to the end of the regular by-pass line. Such procedure is not recommended, however, since it interferes with the intended purpose of the pressure regulator and by-pass lines. Causing the by-pass line to operate under pressure by constricting it with orifices creates a system in which adjustment to increase agitator pressure is done at the expense of the nozzle pressure and vice versa.

For permanent use, it is preferable to leave the existing by-pass arrangement intact and install a separate line for the agitator (see Figure 2). In this case, the agitator would operate at essentially the same pressure as the spray nozzles, and may be visualized simply as the addition of extra nozzles to the system. A similar approach may be taken for larger spray tanks. In certain instances, such as railroad tank cars, conditions may require the installation of a separate pump to supply the agitation system. Yet, this may still be more convenient and economical than modification for mechanical agitation.

All nozzles used in the experimental studies delivered solid stream patterns. Such nozzles are available commercially in a wide range of sizes. For field applications, nozzles delivering a hard-hitting narrow fan pattern (10-15°), such as those used for industrial washing and degreasing, may be advantageous from a distribution standpoint but have not been carefully evaluated. A minimum pressure of 20 psig is suggested for the agitation line.

The extent to which the experimentally established power requirement may be extrapolated to different tank sizes and shapes has not been fully explored. In one or two trials, however, the power of 0.6 ft-lb/sec/gal (1.2 horsepower/1000 gal) plus a safety factor of approximately 50%, has been found satisfactory in railroad tank cars, provided careful attention was given to the number, sizes, and arrangement of jet orifices.

In one specific instance, the following suggestions were made for the adaptation of hydraulic agitation to an 8000 gallon tank car. The horsepower required for 8000 gallons of slurry is 13.6. This amount of power will be obtained if the product of the recirculated liquid volume (gallons per minute) and the pressure under which it is recirculated (pounds per sq. in.) equals 23,300. The tabulation below gives volume requirements for pressure increments of 50 pounds per square inch.

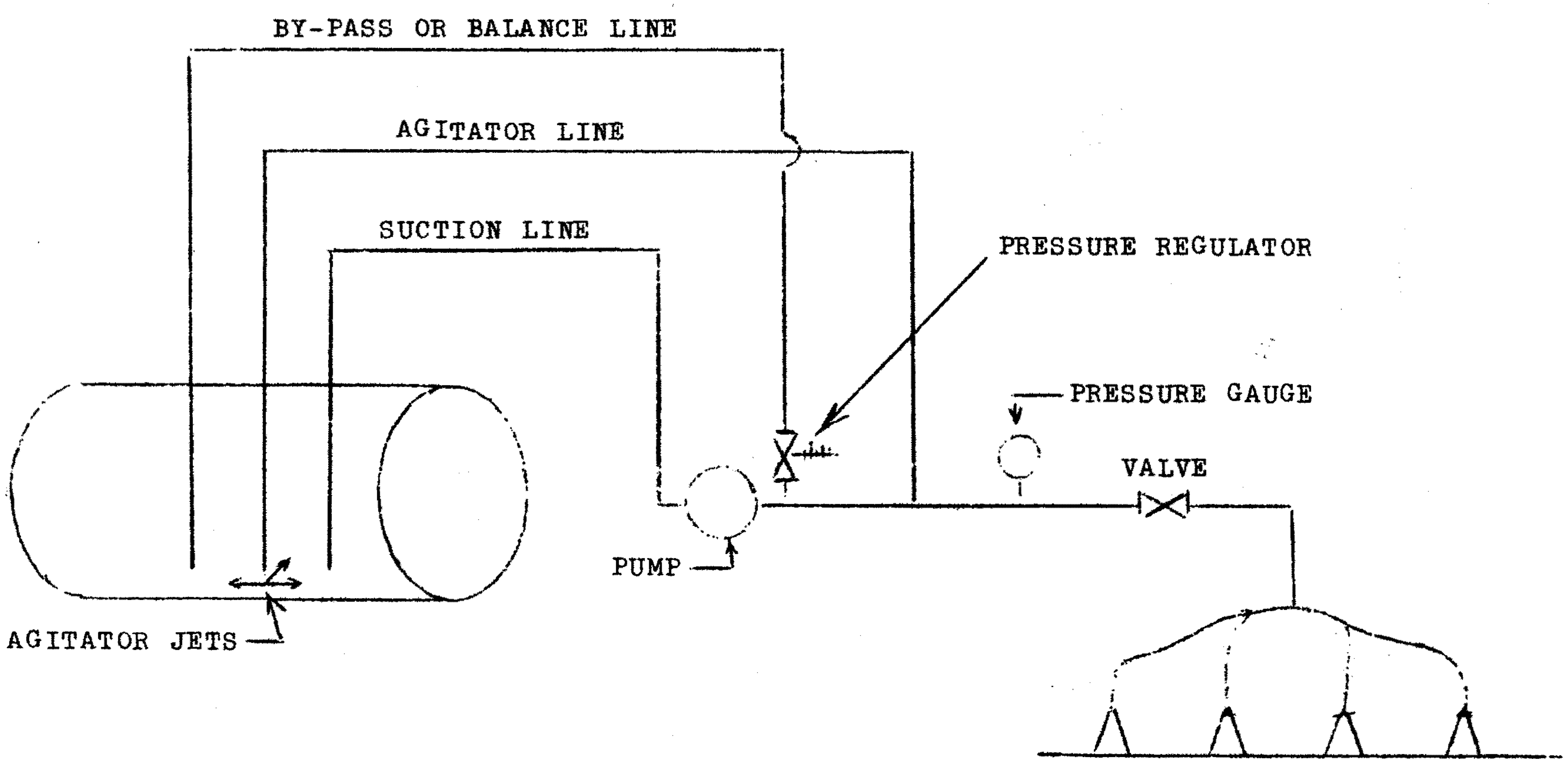

FIGURE 2

SCHEMATIC DIAGRAM OF PREFERRED PIPING
ARRANGEMENT FOR HYDRAULIC JET AGITATION

Total Volume Recirculated Gallons/minute	Pressure (lbs./sq. inch)
466	50
233	100
155	150
117	200

Nozzles should be located on a manifold pipe that runs the entire length of the car. The pipe should run parallel to the long axis of the tank car. It should be about 1-1/2 feet above the lowest point of the tank car and supported at about 3 inches from the side wall. Minimum pipe size of 2 inches is suggested for the manifold. The nozzles should be spaced at intervals of about 12 inches on the manifold and pointed directly at the bottom of the tank. They should be of a type that will deliver a narrow vee, flat spray pattern such as that obtained with certain industrial washing or degreasing nozzles. Exact size will depend upon the pumping pressure available for agitation.

SCREEN SIZES

The screen size which can be satisfactorily used with a wettable powder depends largely on the properties of the specific product. Trial under conditions simulating as nearly as possible actual use conditions is perhaps the simplest approach for determining suitable screen sizes.

The nominal 100 and 80-mesh wire screens available with most agricultural nozzles and line strainers plugged rapidly with "Karmex" W. However, the ordinary 50-mesh screen was found very satisfactory for concentrations of 5 to 6 pounds of "Karmex" W per 100 gallons of water. At the same time, openings in this size screen will effectively protect the nozzle orifice required for the usual volumes of pre-emergence crop sprays.

The usable concentration of "Karmex" W goes up rapidly with increasing size of screen openings. For example, a slotted strainer equivalent to approximately 25-mesh did not plug with concentrations as high as 1 lb/gal. Two types of punched metal screens with approximately 0.035 inch openings were also satisfactory with the 1 lb/gal concentration. These screen sizes will apply to most applicators for industrial weed control. In some instances, conditions are such that nozzle screens will not be required, leaving line strainers as the only screens of concern.

SEDIMENTATION STUDIES

Studies were undertaken to define the boom sedimentation problem and to establish practical size limitations for the piping of sprayers for application of wettable powders such as "Karmex" W and "Telvar" W. With sprayers used to apply pre-emergence sprays to bands over the rows, as in cotton, a boom is used only occasionally. The nozzle for each row is more often supplied by an individual hose of small diameter in which velocity is sufficient to prevent sediment. Suction lines, by-pass lines, etc., which normally have flows of several gallons per minute, are also of little concern. The question of sediment thus is most important with conventional booms, as used for blanket rather than band applications. Present practices for asparagus fall in this category as do most applications for industrial weed control.

Experimental Procedure

A suspension of "Karmex" W in water was pumped through transparent plastic tubing so that the entire system was filled with a known concentration. By means of a variable speed drive, the pump output was reduced until the product could be seen to drop out of the flowing stream and start to build up in a horizontal run of the tubing. Flow in gallons per minute was measured at this point. Flow rates at which this sediment could be resuspended were also established.

Two concentrations, 10 and 20 pounds of "Karmex" W Herbicide per 100 gallons of water, were studied with each of four tube sizes, ranging from 0.25 to 0.86 inch inside diameter.

Discussion of Results

In Figure 3, the measured flow in gallons per minute and corresponding calculated velocity in feet per second (fps) are plotted for the various tube diameters. The curves drawn are for the most extreme conditions of the study, that is, for resuspension of the 20 pounds/100 gallon concentration. It may be noted that linear velocities required for resuspension (1.1 to 1.3 fps) were practically independent of tube size.

Actually, values recorded for the two concentrations varied only slightly, other factors remaining the same. As expected, velocities needed for resuspension of sediment were somewhat greater than those required to prevent settling of the powder.

Ignoring the possible effect of surface roughness, the data in Figure 3 can be used as a guide in determining boom diameter to minimize or eliminate sedimentation difficulties.

MISCELLANEOUS FACTORS AFFECTING APPLICATION

1. Mixing

The wettable powder products mix easily with water. They should be added slowly to the water that is being agitated so that a uniform dispersion is obtained as the powder wets. The

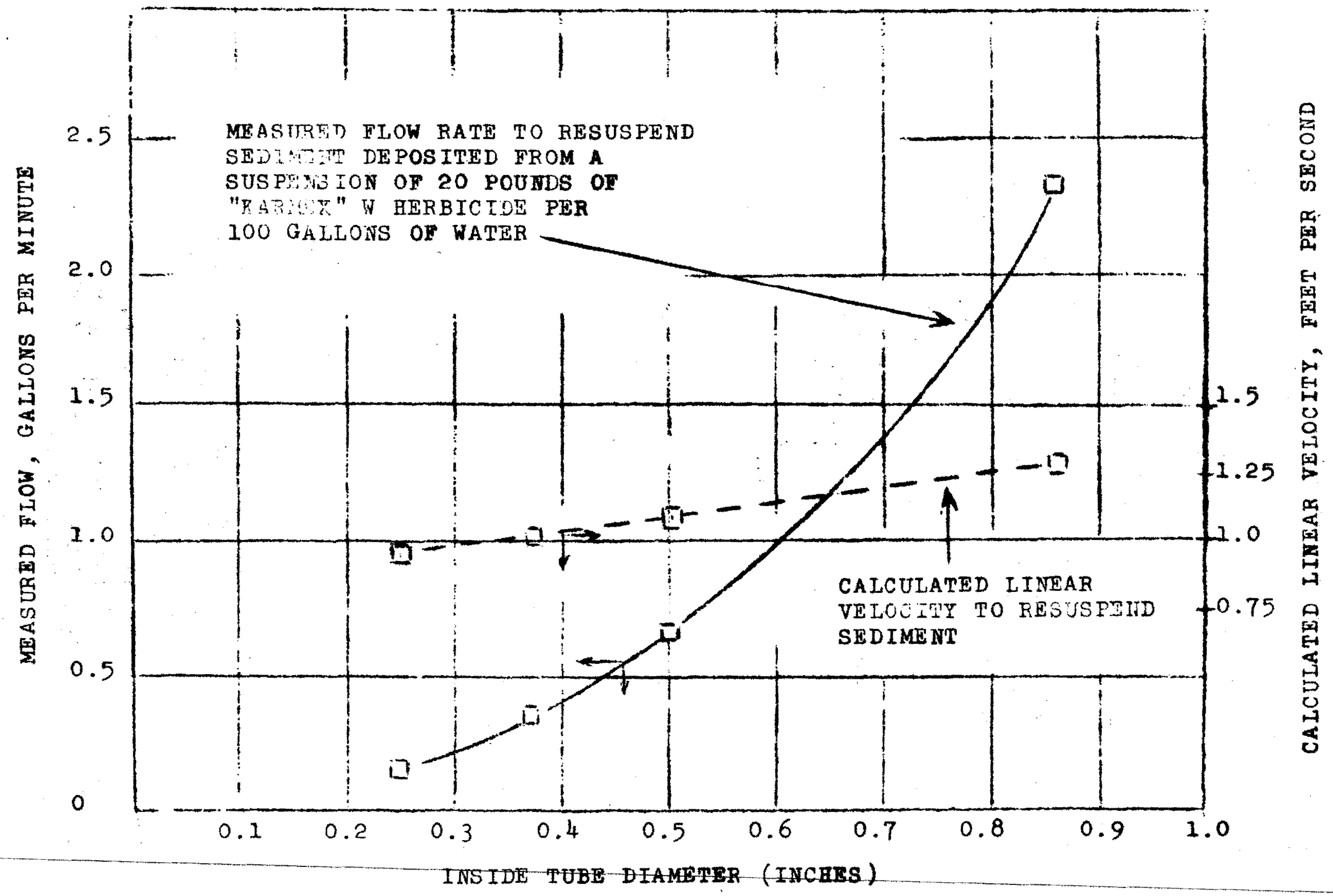

FIGURE 3

FLOW RATES TO RESUSPEND SEDIMENT OF "KARMEX" W HERBICIDE IN PLASTIC TUBING chemical should not be added to an empty tank before water is introduced. With mechanical agitation, the blades of the agitator should be well covered with water before adding the product.

2. Foaming

Under some application conditions, air entrainment may cause excessive and bothersome foaming. (This is characteristic of many formulations of agricultural chemicals.) Small leaks on the suction side of the pump, or impingement of the by-pass volume on the surface of the liquid are frequently at fault. Such irregularities should be corrected as preventive measures.

Occasionally diesel oil or kerosene has been used as an antifoam agent in water suspensions of the wettable powders. Although oils are effective as foam breakers, laboratory tests with these agents under conditions conducive to foaming have resulted in a greasy burden that may not be detectable in a closed tank, but is nevertheless very undesirable. The use of commercial antifoam agents is preferred if bothersome foam persists. Dow Corning Antifoam A (emulsion) at approximately 8 liquid ounces per 100 gallons of spray has been found very effective.

3. Oil Suspensions

Straight oils such as diesel fuel oil or aromatic herbicidal oils are satisfactory carriers for "Karmex" W or "Telvar" W. Special care during mixing is necessary to assure good dispersion. This may be easily accomplished by making a slurry of the required amount of material before further dilution in the spray tank. Agitation requirements for oil diluents have not been studied experimentally, but for the light herbicidal oils they should not be greatly different than for water.

Suspensions of the wettable powder in oil-water emulsions have been prepared for certain uses. Such mixes are relatively difficult to prepare and depend to a great extent on specific properties of the oil, oil-water ratios, type emulsifier, etc. General instructions covering all possible mixes are not feasible; each condition requires special consideration.

PUBLIC ACCEPTANCE OF CHEMICAL CONTROL OF ROADSIDE VEGETATION

Raymond J. McMahon[1]

One of the most unique essays in English literature is a sort of reflective piece, written by William Hazlitt about a century and a quarter ago, in which he states that, if he had "sufficient provocation", he would describe the Public "in good set terms nearly as follows. There is not a more mean, stupid, dastardly, pitiful, selfish, spiteful, envious, ungrateful animal than the PUBLIC."

Obviously, Mr. Hazlitt was not one to mince words. He did not call a spade a spade, but a dirty spade.

Now, I do not mean to imply, by the use of his language, that I agree with Mr. Hazlitt or that I am in any way in sympathy with his description of that heterogeneous mass of which I am a moderately articulate member. I am, however, grateful to him for providing an excellent check-list of possible impediments to a successful campaign in the chemical control of roadside vegetation.

Since we are all the Public, it may be well, before embarking on any enterprise of public scope, to take a good look at ourselves. If you purchase a television set, have the picture fail during the first Saturday afternoon's football game, set out Monday morning to speak your mind to the dealer and find that your new 1955 car won't start, grab a bus and get jostled all the way into town, pay your fare on the way out and on the curb find you've been short-changed, I dare say you would by that time be thinking unkind thoughts about the Public; and by the time you finished with the television dealer, the auto agency and the traction company, they would have similar regards for you. On such a day Mr. Hazlitt would be totally inadequate; and it is doubtful that Satan himself could find words for you all.

Not let us suppose that on the evening of that same day you come home, and on that short walk from the bus stop to your "little home in the country" you suddenly observe that that fellow on the truck, who you thought was just watering the roadside grass last week, had burned up your new hedge of multiflora roses and killed your whole long bank of stonecrop.

I wonder if the Superintendent of Highways could weather the storm; or if the contractor he hired to do this job could appease you by saying that you shouldn't have planted multiflora anyway, that the stone-crop looked like weeds and both were in the highway right-of-way.

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In this sad tale of an average, modern day, you have both seen and been Mr. Hazlitt's Public; and as you sit in your favorite chair that evening with no television, no car, no roses and no stone-crop, and unable to read the paper for the tears in your eyes, you may, upon the setting in of relaxed exhaustion, observe the simple truth that all of your misery could have been avoided if only there were in the world good products, good service, good people, good sense!

I have included roadside spraying with the more knowledgeable ailment of our times because it belongs with them. There is nothing about it that deserves from the public any special consideration. It will be accepted or condemned on exactly the same basis as will everything else; and the principal thing that will condemn it is bad work, which can be avoided by an intelligent conception of the work in the light of the power of the chemical, the problems it is to solve, and the ones it is not to create.

Such a process of planning, followed by skillful performance, will produce at every turn of the road a most receptive and encouraging public. And well it might; for that public has, in such a program, a great deal to gain and nothing to lose. If there by any doubt about it, let us examine the matter from the point of view of the first segment of the PUBLIC we encounter, the PUBLIC OFFICIAL.

The Highway Official, within whose special domain the work is to be done, is offered the most economical and most effective service of maintenance that he has ever been asked to evaluate. Every alert highway superintendent in America already knows this to be true; or if there be those whose burdens have been so great that they are behind-hand in this matter, they may, in a single day, wherever they may live, reach a point where the truth of it may be promptly determined.

If, as we well know, chemical control marks the end of weeds in his roadsides; the end of the hazardous repetition of mowing during the growing season; the end of plant poisoning among his crews; the end of hacking away at brush; the development of that sound turf that he has paid for, but never received because of the incessant invasion of volunteer growth; the development of a roadside beauty which, even to the unobserving soul, constitutes at least a complete lack of ugliness (which I shall accept as the very essence of beauty) --- if, as I say, these benefits are definitely to be had, why is there the slightest hesitation on the part of the Highway Official?

Especially, why is there such hesitation, when his positive decision will create a billboard as long as his highway system, proclaiming his exceptional service to his constituents? By this "billboard", I mean endless grassy roadsides that can hardly escape the notice of every motorist.

Why is there hesistation on the part of Health Officers, who have the same billboard to announce their work in the elimination of poisonous ivy, oak, sumac, parsnip, and ragweed?

Why do our State Departments of Agriculture and supporting colleges and universities labor so hard to educate the farmer in the use of herbicides (without which all will admit he cannot survive in a competitive market) when that same billboard is available to demonstrate the effectiveness of these chemicals at his very door, while at the same time sparing him the reinfestation of fields he has cultivated?

Why are not all these separate officials vieing to be first to be credited with the institution of such a spraying program, instead of playing the turtle?

For the answer to these questions let us borrow another passage from Mr. Hazlitt:

"The idea of what the Public will think prevents the Public from ever thinking at all, and acts as a spell on the exercise of private judgment, so that in short the Public ear is at the mercy of the first impudent pretender who chooses to fill it with noisy assertions, or false surmises or secret whispers."

Such assertions, surmises and whispers are familiar to us all. They are just as familiar to the public official; and therein lies the principal impediment to our progress; after, of course, bad work. "Bad work", however, is often a relative term, and I would speak of it quickly at this point.

A superintendent of highways at town level generally estimates the value of a chemical program by the mass of the brownout. He imagines he cares not at all about the weeds, especially if his weeds have been destroyed in the process of killing brush. His general cry is "kill more". He is speaking of brush. To him a green roadside during a spraying program is "bad work".

The state highway official takes the opposite view. To him any noticeable brownout is "bad work".

The county official is a half-town-half-state combination. His work is the most exacting, for what is good work in one county may be "bad work" in another, or the same work may be either good or bad within the same county depending upon the road.

For such reasons as these our own company has devised a simple process whereby the operator is made aware at each crossroad just how the next section of highway is to be treated. That is what I have earlier referred to as an intelligent concept of the work to be done. In this same category falls the establishing of the program itself; the number of sprayings per season and the number of seasons duration. Here there will be variations in all factors depending upon the results contemplated, and we oblige in all matters that are not founded in ignorance of the problem and subject to disappointment and failure.

There is such a thing as just plain bad work, per se: it is not relative. It is made up of the damaging of private plants both in and out of the right of way and failure to kill what is supposed to be killed. This may be attributed to inadequate training of operators, lack of on-the-job supervision, improper equipment, equipment out of repair or adjustment, various errors in judgment or, in summary, just plain growing pains. Such things have happened to us all; and in our own case we had sprayed over 30,000 miles before we felt we had matured to a point where we could bring all failings under control.

But I would hasten to say in our own defense that even to date we have less than a single complaint of damage for every thousand miles we have sprayed. Every complaint has been investigated by personal call and all damages amended or in the process. The total cost of correction has been less than $200 in our complete history. Where we failed to kill what should have been killed, we failed first to analyze our problem fully, or depended too much on the frail human.

In these regards, I might observe, that there is little or no progress evident in the succession of human generations. Science advances, not the scientist. It is still not possible for the child to understand the word "burn" until he puts his hand on the stove; nor for the adult to comprehend "don't" until he does. A single century will produce in a single human carcass the entire human development of a million years. We are grateful for a universal understanding of these truths; for such has made our blunders tolerable to some very considerate public officials and rural residents. We have found ourselves in no trouble that did not result in a happy meeting with new friends.

So, if the sponsor of chemical control of vegetation is sincere and has a sensible program honestly presented to the public official, and to the public by way of lucid releases to the press, radio and television, and further supported by talks before groups on interested citizens, he need not be concerned about public acceptance of his work. An informed citizenry is, in this case, an extremely cooperative and enthusiastic one.

If it is true that this chemical is good, and that the best interest of the public is to be served by its use----and I say that it is true, and that thousands of public officials know it----then let us all join in telling the public so, in order that the official will sense support in its use.

In such a course of action, let us set out with the determination that we must be guided by objective truths and right reason. Let us not attribute to our work more than its due, nor back away from unjust or misguided condemnation of it. In this latter regard I might suggest that even the most gentle Saint, Francis of Assisi, never turned his back on error for want of spirit to differ with it. Rather he wished ardently to be a "channel" that would bring love where there was hatred; forgiveness where there was wrong; harmony where there was discord; truth where there was error; light where there was shadow and faith where there was doubt.

I believe I may safely recommend such an active course to you; and should you encounter one of Mr. Hazlitt's noisy critics, who cannot be stilled by such efforts, then, by all means, leave him to Heaven!

EQUIPMENT AVAILABLE FOR APPLYING SOLUBLES, EMULSIONS AND WETTABLE POWDERS

by

E. D. Markwardt and W. W. Gunkel 1/

The equipment needs for spraying herbicides have greatly changed since the farmers first started applying 2-4-D. A simple, inexpensive sprayer with a small gear pump seemed to be adequate then. However, as new chemicals were found which required higher rates per acre and were abrasive or corrosive to the equipment or caused nozzles and strainer clogging, the needs for better equipment increased. Growers and custom operators demanded more durable, less troublesome equipment and also equipment that could be used for a greater variety of spraying jobs. The equipment industry responded with better valves, strainers, pressure regulators, pumps, nozzles, booms and mounts. They used metals and synthetic rubbers that better withstood the action of the chemicals and had a longer life. Hardened steel nozzles lasted longer when spraying abrasive sprays and a more uniform application was possible. The inexpensive pumps which were adequate for 5 or 10 gallons per acre of 2-4-D sprays wore out rapidly when used with some of the more abrasive spray materials. Many growers began to see the need for equipment and particularly a pump that would have a longer life when used with wettable powders. It placed greater emphasis on the need for the grower to select carefully a pump that would meet his needs.

Factors that must be considered in selecting a pump for a sprayer are:

1. Type of materials to be used.
2. The spraying pressures required.
3. The capacity of the pump based upon:
    a) Width of boom
    b) Speed of travel
    c) Rate per acre applied
4. Cost.

Many of the improvements in pump design have made them more practical for the farm spraying job. There is probably no one "ideal" pump that is suitable for all spraying needs. However, one should select a pump that

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will have an economical service life for the type of spraying job that is being done.

To provide more information on the durability of various pumps, a series of tests were conducted both in the field and in the laboratory. The field tests were performed on Hypro Roller Vane, Model 750, power take-off pump, that had been used by growers one season. We wanted to find out how these pumps had stood up pumping various types of spray materials as they were used by growers. The results are summarized in the typical performance curves of the pumps used for wettable powders and for emulsions and solutions.

Most pumps that had been used for pumping emulsions and solutions were in generally good condition. In general, the capacity of these pumps had been reduced very little with a season's use. A typical performance curve for one of these pumps is shown in figure 1 where the pump had been used 80 hours. It is compared with a new pump.

Most pumps that had been used for pumping suspensions of wettable powders were severely worn. Those that had been used quite extensively were worn to the point where very little liquid was discharged above a pressure of 50 psi. A typical performance curve is shown in figure 2. The capacity of a pump used 35 hours with wettable powders was greatly reduced when compared with a new pump. A new set of nylon rollers was installed in one of the worn pumps. The curve obtained was identical to that of the pump with the old rollers. A slight increase in the performance sometimes resulted when the neoprene seals were replaced.

In addition to the field tests, laboratory tests were conducted by Professor Gunkel on various types of pumps. These tests might be considered an accelerated wear test primarily to determine the ability of the pump to handle abrasive materials. The spray material used in these tests was 24 pounds of hydrated lime, 48 pounds of wettable sulfur per 100 gallons of water. All of the pumps were run at 80 pounds pressure with the exception of the Centrifugal which would not develop much over 60 pounds. The spray material was changed frequently.

The results of the laboratory tests are summarized in figure 3. The Centrifugal and the two diaphragm pumps had many more useful hours left when removed from the test stand even though they had been used over 500 hours. The Centrifugal pump has practical limitations as far as discharge pressure is concerned and the operating speed has to be very high to develop even 60 psi pressure.

The single diaphragm pump seemed to be the most practical pump for pumping suspensions of wettable powders at pressures up to 100 pounds per square inch. It has a capacity of about 5 gallons per minute at power take-off speed. It is very easily mounted and not excessively heavy. The price is about comparable to the Hypro Roller Vane pump. The double diaphragm is not made for power take-off operation.

Many of us have recognized for some time that there was a need for a fairly small, reasonably priced pump that had these qualifications:

1. That it could be quickly and easily mounted (preferably on P.T.O.).
2. That it would handle wettable powder sprays as well as solutions and emulsions.
3. That it would develop fairly high pressures.
4. That it would have a fairly good capacity.

At least three manufacturers (F. E. Meyers Brothers, John Bear Manufacturing Company, Friend Manufacturing Company) have also put on the market last year a small piston type of pump that can be mounted and driven directly from the power take-off. We have had these pumps but have not run an endurance test on them. However, quite a number of the Meyers pumps were used by growers this year and we observed their performance. Our observations were that these pumps have stood up very well pumping abrasive sprays at quite high pressures. The pump capacity is about 6 to 7 gallons per minute and will operate at 300 pounds per square inch. They have also been used with chloro I.P.C. and have not given any difficulty while several other pumps with neoprene seals have given trouble.

There are some problems with other parts of the sprayer as well. One is the problem of tank corrosion. Many of the chemicals rather severely corrode ordinary steel drums. While stainless steel is resistant to most materials, it is too expensive. A less expensive metal or plastic tank is needed. A protective coating that will not be attacked by commonly used chemicals or that will make a good bond between the metal and the coating would at least partially answer the problem. However, a large opening would have to be made in many of the tanks before the coating could be applied.

There is also a very great need for manufacturers to provide a mechanical agitator for tanks. A device that could be easily mounted on a barrel, that would not be too expensive, may be the answer. Mechanical agitation is needed for some emulsions and with all wettable powders. This need is accentuated now that there are power take-off pumps available that will handle suspensions of wettable powders.

It seems to me that more manufacturers should be making available kits for attaching nozzles or small booms to planters, cultivators, etc. I would also like to see more dealers handling low recording speedometers. If more speedometers were used, it would contribute to a more effective spraying job.

Figure 1

Typical performance curve of Hypro pumps when used with emulsions and solutions

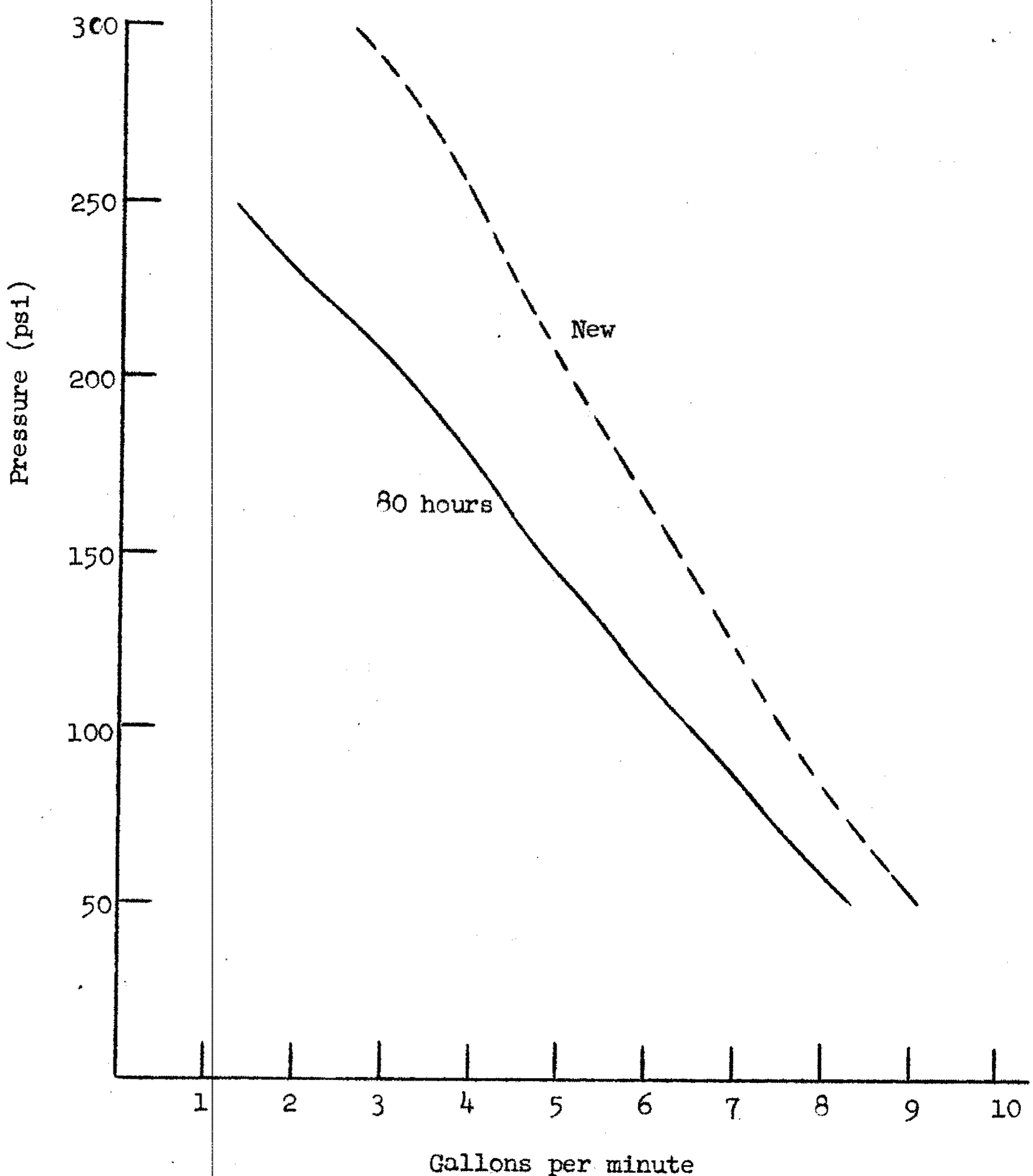


Figure 2

Typical performance curve of Hypro pumps when used with wettable powder sprays

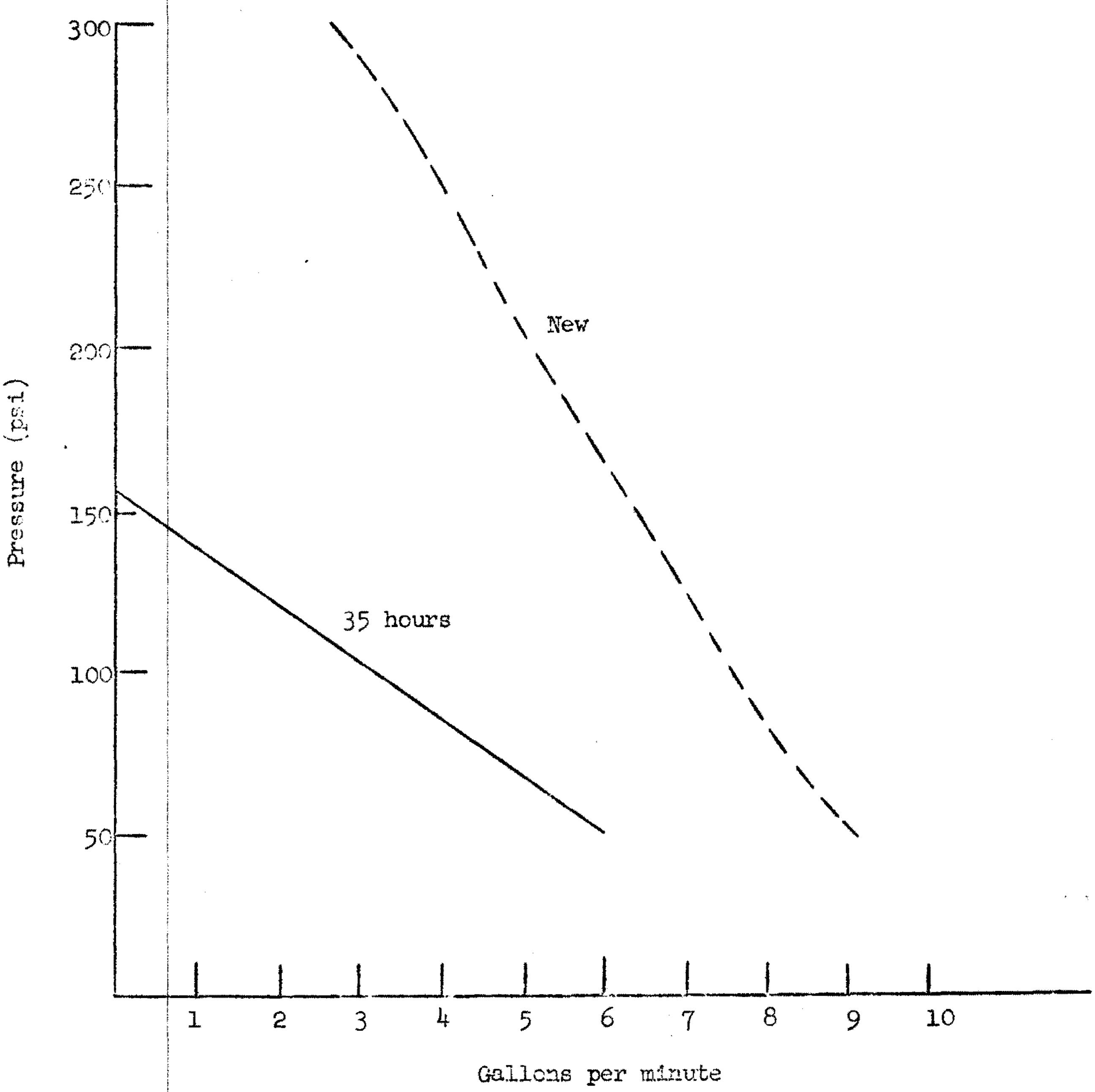
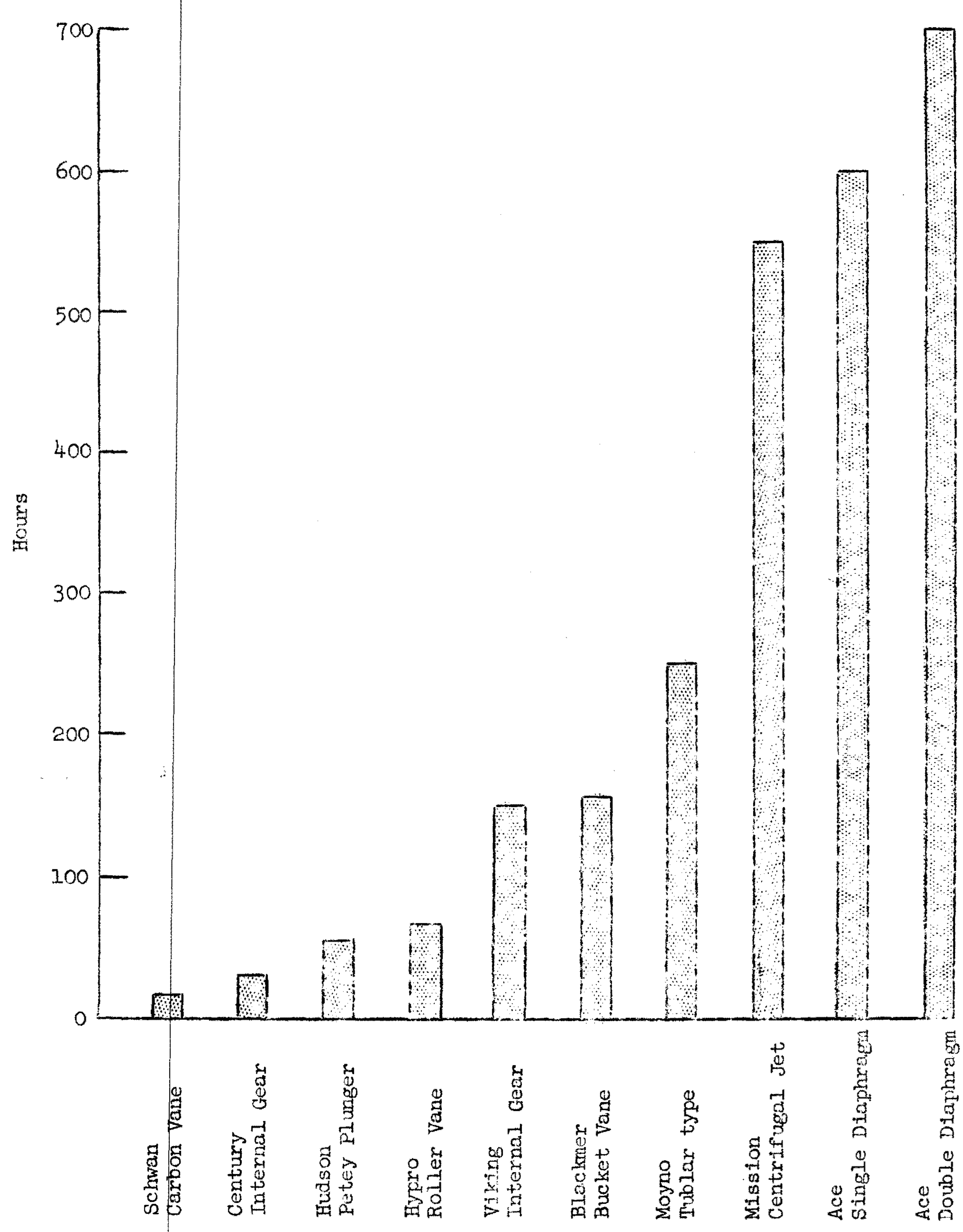


Figure 3

Number of hours pump used before capacity was reduced
to about 2 gallons per minute



AN ENGINEERING ANALYSIS OF THE BOOM VERSUS THE BOOMLESS SPRAYER

R. E. Patterson, S. M. Raleigh and P. M. Anderson*

In this discussion we will refer to the boom sprayer as any power sprayer which delivers the desired solution to the immediate vicinity of application by means of a pipe or boom, such as the conventional row crop sprayer or boom sprayer for weed control. By a boomless sprayer we will refer to the type of sprayer wherein the solution is delivered to one or more nozzles in a cluster and thence sprayed to the full width of the swath. Unless specified otherwise the nozzles in the boom sprayer will be fan type and at the spacing and height as specified by the manufacturer. The boomless sprayer uses a cluster of nozzles specially designed to throw a wide spray at uniform rate throughout its entire width.

The analysis will be limited largely to the use of these sprayers for weed control in field crops and pasture, with only slight reference to the control of insects and fungi.

Since the performance of any sprayer varies widely depending upon the chemicals used we shall group the chemicals into three classes: Contact, translocated, and volatile. With contact chemicals only the area of the plant actually covered by the chemical is affected or only those insects or fungi actually hit with the chemical will be controlled, e.g., dinitro on plants or nicotene sulfate on insects. Chemicals which penetrate the surface and move about from one part of the plant to the other are referred to as being translocated, e.g., 2,4-D on bean plants. Many chemicals vaporize after application and these vapors move about giving weed, insect or fungi control long after the sprayer has passed.

The width of swath varies greatly depending upon the terrain, both as to slope and amount of stones and degree of roughness. Generally, the width of swath of the boom sprayer is about twenty feet for weed control and up to about forty feet for insect control in row crops. A wide boom on rough terrain results in excessive whipping which causes boom breakage and decreases uniformity of application. This has been reduced in some cases on wide booms by the use of very light wheels on the booms. With the boomless sprayer obviously no boom damage will result from rough land or large stones, but certainly the uniformity of application and the effective swath will be changed. The boomless sprayer will usually cover about forty feet but may go up to about sixty feet. This varies largely due to the nozzle design and the operating pressure. Pressure has negligible effect on the boom sprayers width of swath.

Both sprayers are designed to give uniform application in gallons per acre throughout the swath on all relatively low field crops and pasture. Along fence rows or roadsides the boom may be tilted and raised or lowered, or permitted to swing around obstructions such as trees or posts. With the boomless sprayer it is seldom necessary to even tilt the nozzle for fence-rows, roadsides, stonepiles or brushpiles.

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Droplet Size. Now let us analyze the spray solution at the exact point of application. What determines the uniformity of application? Gallons per acre is one factor but to any particular weed or leaf or insect it is coverage and droplet size. With contact chemicals the ideal situation is to have complete and uniform coverage. This can be accomplished only with small droplets unless large volumes of solution are used. You cannot easily break a solution into very small droplets at a nozzle then throw it great distances without high pressure or wind velocity. With the boom sprayer and fine nozzles a very uniform coverage is obtained with fine droplets and with relatively low pressure and power requirement. It is a very short distance from the nozzle to the point of application and usually downward. However, with the boomless sprayer it is up to 20 or 30 feet and largely horizontal. With precision machining it is not difficult to design and build a nozzle which will give relatively uniform application in gallons per acre even at 20 to 30 feet. In order to travel 20 to 30 feet the particle must have enough mass and velocity to overcome the wind resistance. With present designed sprayers and nozzles operating on relatively low pressure the mass of the particle is large and its velocity relatively low. Thus, we cannot expect as uniform coverage at the same gallons per acre applied with the boomless sprayer as with the boom sprayer.

Effect of Wind. Another difference in the two sprayers is in the effect the wind has on uniform coverage. With the boom sprayer it takes a relatively strong wind to effect the spray pattern substantially. When the boomless sprayer is used in the conventional method, that is with the spray directed up and out in a fan pattern, any breeze at all will blow the spray. This not only changes the spray pattern, but if much of a breeze may also result in spraying the equipment and operator. If, however, the spray is applied with the fan shape parallel to the ground and this kept at about the same height as the boom sprayer then of course there would be little effect by a moderate wind. However, this would tend to give heavier application at the end of the spray. There would be some point in between the vertical and horizontal which would give the best results for the uniformity of application and minimum wind drift. Since in actual operation the velocity and direction of the wind is constantly changing any angle used would have to be an average and compromise. It does permit the use of the boomless sprayer under wind conditions which otherwise would be unsatifactory.

Effect of Adjustment, Movement and Wear. Practically every sprayer of either type manufactured today has sufficient adjustment to give complete range of operation within the capabilities of the equipment. Pressure is usually adjustable and rates are largely determined by nozzle orifice size and design. Width of swath is fixed on the boom sprayer whereas it may be changed some on the boomless by changing nozzles, angle of the nozzles and pressure on the solution. A change in adjustment will effect a stream being thrown 20 feet more than one being thrown 20 inches. It would probably require actual tests to determine the effect of wear on each unit. Probably it would be about equal. More of the solution will come in contact with the orifices in several small nozzles than in one large one, but again a change in orifice size will probably effect a long stream more than a short one. The movement of the sprayer over rough terrain will effect the uniformity of either unit. If the boom dips down too low, it will have several narrow skips while the boomless will give a narrower swath on that side, giving one wider skip unless a large overlap is being used. On the side being raised complete coverage would result on both sprayers.

<u>Experimental Tests.</u> After making the above analysis it should be tested experimentally to determine the accuracy of the analysis. Although this has not been tested completely several tests have been conducted at Pennsylvania State University. During the past year tests were conducted by pre-emergence application of 2,4-D on corn; chlordane and benzene hexachloride on spittle bugs; dinitro on lambs quarter; measurements of drift due to winds at right angle to the direction of travel; high speed pictures of the droplets and droplet size, and coverage along the swath as the spray hit various surfaces, particularly blotting paper. Although these tests are not complete, enough information has been secured to give good indications.

In the corn good results were obtained with the boomless sprayer, but better and more uniform control was obtained with the boom sprayer, with the same gallons per acre of solution. The boomless sprayer used for spraying spittle bugs gave unsatisfactory control with chlordane and good control with BHC. Test average showed 104 spittle masses in the chlordane check plot, 78 in the boomless sprayed plot and 41 in the boom sprayed plot. On the B.H.C. plots there were 90 spittle masses in the check, 13.8 in the boomless and 1.0 in the boom sprayed plots. The difference in the effect of the two chemicals is obvious with BHC being superior but the difference in the sprayers is also noticeable. Although the boomless sprayer gave satisfactory control with BHC there was evidence of non-uniform coverage. For each spittle mass found 4 ft. from where the nozzle passed there were about 6 spittle masses found 15 ft. from the nozzle which was covering a 20 ft. swath.

When spraying lambs quarter with dinitro, the variation in the width of swath was negligible with the boom sprayer. With the boomless sprayer, variations of over 50% in the distance from the nozzle to the edge of the swath was caused by small gusts of wind similar to those occuring on many days of the spraying season. Actual measurements with the boomless sprayer stationary and spraying into the wind showed an average decrease of 1 ft. in the length of the main stream for each mile per hour increase in wind velocity. The finer particles in the stream were blown back much more. The sprayer was used as recommended by the manufacturer. With the same wind conditions and the fan shaped spray in the horizontal plane the variation in width was reduced to about 10 percent in a 6 MPH wind. Uniformity of application was not measured in this test. High speed pictures of the droplets showed about the same sized droplets from the boom sprayer and within about three feet of the nozzle on the boomless and at the ground level. As the distance was increased from the nozzle on the boomless sprayer, the droplets got progressively larger with the pressure at 60 psi. However, when the pressure was increased up to 200 psi the droplet size decreased, as would be expected. In the latter case the test was in a closed laboratory. If any breeze had been blowing the drift would have been very high.

<u>Conclusions.</u> In conclusion, the boom sprayer gives very good control under practically all circumstances because of very uniform coverage, although it may be a little inconvenient to mount and operate because of the long boom. The boomless sprayer will give satisfactory control in most cases where translocative or volatile sprays are used as long as wind is not a contending factor. It is simple to mount and easier to operate around fences. With a sprayer , the same as other equipment when used within its limitations it will perform satisfactory and do the job for which it was designed.

WEED CONTROL: PAST, PRESENT, PROSPECTS

C. J. Willard[1]

If any of you are waiting to learn about modern weed control until the situation clears up and settles a bit, I can assure you that no such comfortable period is anywhere in sight.

Since Adam and Eve were banished from the garden of Eden, the control of undesired plants has been a basic feature of all types of agriculture. The past decade, however, has brought forth more unsettling changes than have taken place in the entire time that has gone before. The period ahead looks just as unsettling. Where are we then, today, in this new-old fight?

In the first place, we have in 10 years tremendously reduced the time and labor cost of weed control in the majority of crops. Estimates are, that, in 1952, 9½ million acres of corn and almost 18 million acres of small grain were sprayed for weed control in the United States.

Cotton is rapidly emerging from its age-long dependence on hand chopping of weeds. Many weeds are being commercially treated in sugar beets by chemical means. The chemical control of weeds in soybeans is chemically in sight--not yet economically in sight.

Perhaps the most important single aspect of this revolution in weed control is our greater ability to control woody plants. Herbicides which move from one part of the plant to the other kill the roots as well as the tops of the great majority of woody plants.

Much agricultural and pasture land in the United States fills in with trees and brush if it isn't cultivated. Before the appearance of the translocated herbicides, the only methods of checking this encroachment were expensive and ineffective.

Now we can clear hardwood land and prevent the stumps from sprouting. We can clear mesquite from 100 million acres of Texas land. We can kill brush and trees on highways and rights-of-way and in pastures. Ten years ago, these were only hopes.

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[1]Professor of Agronomy, Ohio State University, Columbus, Ohio. This is the condensation of an address which, as retiring president of the American Society of Agronomy, he delivered before the Society annual meeting at St. Paul, Minnesota, November 10, 1954.

Weed control is not and will not be purely chemical. The fundamental cultural methods of weed control are well known, and will continue to be used.

In addition, methods which depend on competition are extensively used. The control of crabgrass by high-cut, well-fertilized bluegrass, of Bermudagrass by soybeans or cowpeas grown solid are merely examples. The principle includes practically all crops.

Fertilizers and fertilizer placement here play an important part in weed control. The new band seeding method of sowing legumes is in part based on fertilizing the crop, not the weeds.

Another triumph of late years is the control of weed species by insects. Until recently, the control of prickly pear in Australia was the great success story in this field. Prickly pear has overrun millions of acres in Australia. Everything else had failed, when the introduction of one of its insect pests all but exterminated it.

A more recent example of weed control by insects is found in California. Klamath weed or St. Johnswort has been successfully attacked by brining in insects which feed on it. Hundreds of thousands of acres of range land, too rough and low in value to be reclaimed otherwise, are thereby returning to use.

What of the future? In the first place, chemical weed control is a supplement to, not a substitute for cultural methods. Furthermore, with just enough exceptions "to prove the rule", it will always remain supplementary to cultural methods.

"Weeds" do not belong to any particular botanical family. Many plants that we are trying to kill and many plants that we are trying to save are closely related. Even crop plants may be weeds under some circumstances. It is almost unthinkable that we shall find, for any crop, an herbicide which will kill <u>all</u> the "weeds" which might be growing in it and not even injure the crop.

It follows, then, that any selective herbicide will almost always fail to kill some weeds. If no other ways are used to get the weeds the chemical does not kill, these weeds will reproduce and before long become dominant.

This is not pure theory. It is happening in the Cotton Belt and in the Corn Belt today. The weedy grasses and may serious broadleaved weeds are not killed by 2,4-D. As a consequence, the common broadleaved weeds are diminishing and the grasses increasing in importance throughout the Corn Belt. It is only a matter of time, in many corn fields, when it will not pay to use 2,4-D as we are using it today.

Many weeds may develop resistant strains, as flies have developed strains resistant to DDT. Of course, we have only one generation of weeds in a year, instead of the many generations of flies, and the process will take longer. There is much evidence that this thing is happening. It is certain to happen when any moderately resistant weed is exposed to continuous applications of any one weed killer.

All growth-regulating herbicides act basically upon enzyme systems in plants. The number of such systems is very great, and the number of herbicidal actions against these systems is equally great.

It is clear from this that each growth-regulating chemical will have one kind of action on one plant and entirely different action on the next one. This cannot be overemphasized.

Notable here are several varieties of oats, many inbred lines of corn, and the Winesap group of apples, all of which are more sensitive to 2,4-D than the species in general. Growers have found the failure of many general weed-killing recommendations, made without sufficient checking, an expensive experience.

There are manifold difficulties in herbicide applications after the weeds and crop have become established (post-emergence spraying). To get away from these, a vast amount of work has been done with the application of herbicides to the soil before either the crop seed or the weeds are up.

We have grown corn to maturity (at Columbus, Ohio) with practically no weeds in fields where untreated corn was completely choked by weeds. We have done the same with soybeans. At the same time, there have been numerous failures to control weeds, and damage to the crops, with products which were successful elsewhere.

It is hardly necessary to point out what a complex medium the soil is. When you add complex organic compounds to soil, its properties have much to do with the final results. For example, practically every block of our experimental area at Columbus includes light-colored, low-organic-matter silty clay loam and dark-colored high-organic-matter soils within a few feet of each other.

On two plots of oats undersown with alfalfa, not 25 feet apart, both treated with 3 pounds per acre of CIPC pre-emergence on the same day, both oats and alfalfa were killed in the low-organic-matter plot. Neither was killed in the high-organic-matter plot. This relationship to organic matter holds for a large number of herbicides.

However, the most serious problem with most pre-emergence herbicides lies in their behavior where rain or drouth is concerned. Most of them will not kill weed seedlings if they are applied on dry soil and no rain follows until after the weeds are established. On the other hand, many of them will kill both the weeds and the crop if too much rain comes between the time of application and the emergence of the crop.

Perhaps the ideal is an herbicide which is not readily carried down to the at-least-somewhat tolerant crop seed, but does reach the shallower germinating weed seed. The recently introduced substituted urea herbicides come close to acting this way, but more must be learned about them before they can be recommended without qualification.

Only a few of these problems affect the herbicides known as the soil sterilants. These are the herbicides which are applied to the soil, or to the plant and washed into the soil, so that their main action is through the soil, and which kill all, or essentially all, vegetation.

This is the mode of action of sodium chlorate, the first generally effective weed killer, and still one of the best. The great difficulty with it and most others of the group is that once applied to the soil, they stay there for a long time. Chlorate on tight, low-organic-matter soils may sterilize them for 4 or 5 years or more.

The manufacturer who develops a quick-acting soil sterilant, which disappears in a short time, will reap a fortune. It must kill seeds, plants, and roots in the soil and it must be offered at a cost compatible with field use. Calcium cyanamide has made a promising start in this direction on soils where the nitrogen carried is later needed as fertilizer for the crop.

For the future, weed control has a tremendous load of fundamental unfinished business to complete. This flood of new chemicals caught us largely unprepared. We are almost entirely without the detailed life history information about each weed plant which is essential for intelligent weed control work.

Few plants are universal weeds. They are weeds only in specific situations. We need to know why a weed is a weed here and not there; how it grows, and how its growth is modified by temperature, moisture, fertility, shade, and all other environmental factors; what its strong points and weak points are. Why is field bindweed rather a minor problem in humid Ohio, and the No. 1 weed enemy west of the Missouri. That is just a tiny sample of the unfinished business which is all around us.

We must educate the public in more accurate recognition of weeds, and to a realization of the importance of that recognition. We cannot give prescriptions for the control of "weeds" in corn. We will in the future give specific prescriptions for the control of specific weeds in specific crops under specified soil and climatic conditions...this, not because we wish to be fussy or highat, but because we can obtain satisfactory results only with such accurate prescriptions. If a man asks us how to control bindweed when his problem actually is climbing milkweed, he will not get satisfactory results.

We have done a pretty good job of getting started at the business of controlling unwanted plant growth. But for the future, I cannot do better than echo the words of Dr. E. J. Kraus, former head of the Department of Botany in the University of Chicago and one of the botanical pioneers in this new-old field, "Gentlemen, you ain't seen nothing yet!"

REVIEW OF RECENT ADVANCES IN CHEMICALS AND PRACTICES IN WEED CONTROL AMONG VARIOUS CROPS

By
Ernest R. Marshall*

There is no need to discuss with this group the advent of modern chemical weed control or how it has grown in recent years. This has been told time and time again and I'm sure we're all familiar with it. Of more importance are the changes that are now taking place in chemical weed control and weed control practices, and the reasons for these changes. Chemical weed control like any biological science is not static. Changes are being made continually. Older practices are giving way to newer ones. New practices are coming in where none existed before. Even though chemical weed control is considered a new science, many of the practices which had their birth ten years or less ago are now becoming antiquated. In the time available here it would be impossible to discuss each new advance that has occurred in recent years. Specific changes can be found by studying the research coordinating committee reports. Perhaps one of the best ways to discuss these changes is to discuss some individual crops and what changes are taking place relative to these crops. We may then see these changes as general trends that are in the making.

One of the most logical places to start would be corn. Corn was one of the first crops that chemical weed control, as we know it today, was accepted on and is a crop grown generally throughout the Northeast. 2,4-D was readily accepted for weed control in corn because of the tolerance of corn for 2,4-D and also because of the severe weed problem in many corn fields. Some of the earliest work showed that the most effective time to apply 2,4-D to corn was as a pre-emergence spray. The reasons for this I believe are obvious. There is less chance of crop injury; weeds - particularly annual grasses are smaller and more easily controlled, and the ground is often in better shape for applying 2,4-D.

Even though the pre-emergence method of weed control was presented early in the development of modern chemical weed control, it did not take hold reasily. Growers were not used to chemical weed control and many of them would not apply 2,4-D until the weeds were actually large enough to become a serious problem. So it became more or less a general practice on corn to wait until the weeds were a real problem and then to spray with post-emergence applications. The net result was poorer weed control, more injury to corn and actually the neglecting of spraying some fields because field conditions were not favorable at the time the corn should be sprayed.

This condition existed pretty well up until a couple of years ago when we began to notice a shift back towards pre-emergence weed control. There are several reasons for this shift. First, growers were noticing more and more injury from post-emergence 2,4-D applications. More cases of injury were occurring because 2,4-D was being used under more different environmental conditions on different varieties,etc. Also, growers were

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more familiar with the type of 2,4-D injury to be found and recognized these symptoms more easily.

A second cause of the shift back towards pre-emergence applications was that new materials such as the low volatile esters of 2,4-D and the dinitros had been thoroughly tested as pre-emergence herbicides and had been shown to be in many cases safer and more sure for weed control than the earlier amine 2,4-D materials. In addition they suppressed some of the perennial weeds that were becoming more and more of a problem. These materials also gave longer residual weed control with better results in the face of adverse conditions.

A third and major reason for this shift back to pre-emergence weed control can be tied in with the historical experience of entomologists and plant pathologists in the use of insecticides and fungicides. In the early years, these pesticides were generally used only when a particular insect or disease was actually a problem and some pesticide was then used to eradicate the pest. But as the use of these materials grew, farmers learned of the damage that could be done in many cases before the presence of the pest was known. They changed from an eradicative type of program towards a more preventative one. I think we are seeing this same trend evolve in the field of chemical weed control today. Farmers have learned that on certain fields year in and year out, many farm weeds are a problem, therefore, why not get rid of them before they are a problem in the crop and have already done damage.

This change started very gradually but has picked up momentum in the last couple of years, and I believe it will move even faster in the future. This type of thinking by farmers and by this I mean a preventative type weed control program encourages other changes which I feel are going to proceed rapidly. Applications of herbicides made at the time the corn is being planted have been shown to be a successful method of weed control. Granted, that this method is more costly insofar as chemical costs are concerned, still it has certain merits which will tend to push it along and increase its use. It eliminates one spraying operation, thereby reducing labor costs. There is no better time to get on the land than when the corn is being planted. This may be the only chance to make a pre-emergence application because weather conditions may prevent any further tractor operation on the land until the corn emerges. Equipment, which is simple and efficient, is available for making these applications and by banding the chemical cost can be reduced. An exact placement of chemical can be made over the row by attaching the sprayer to the planter, whereas this is difficult when banding is attempted as a separate operation. We are noticing a definite trend towards this type of corn spraying, particularly as new materials are developed which will give a longer residual control than those now available commercially.

Perhaps we should touch briefly on changes which are occurring in the chemicals being used. I have already mentioned the use of low volatile forms of 2,4-D and the dinitros. The use of low volatile 2,4-D has grown very rapidly and will increase in the future. These materials give a longer residual control than the amine or volatile ester forms and are generally slightly more effective on hard to kill species than the amines and safer to use than the volatile esters. The water soluble dinitros are growing in favor and many thousands of acres of corn were treated pre-emergence with dinitros during 1954 in the Northeast. Dinitros find a preference principally in three situations : on light sandy soils where 2,4-D has been shown to give injury; on 2,4-D sensitive corn varieties; and in areas where corn is grown adjacent to 2,4-D sensitive crops such as tomatoes, grapes, etc. Other materials such as TCB and CMU which have a long residual effect have looked very promising and may well be the answer when more experience has been had with them. I feel that a chemical weed killer, which is safe to use on corn, has a long residual effect so that it can be applied at planting and is cheaper than the dinitros now being used would be a real advance for corn growing in the Northeast and, furthermore, I feel that such a compound will be developed.

The previous discussion has dealt primarily with broadleave weed and annual grass control. These have certainly been the primary problem in corn in the past. Now, however, with the increased use of more effective weed control chemicals, a new light is thrown on other problems which are becoming more important. I refer to the problem of perennial weed and grass control in corn. These pests are becoming increasingly more important and at present chemical control measures are just becoming established. Ten years ago a farmer asked what his big weed control problem in corn was would reply - mustard, ragweed, foxtail, smartweed or one of the other numbrous annual weeds omnipresent in corn fields a decade ago. Five years ago this same farmer, if he had begun using chemical weed control would probably reply with the names of some of the more 2,4-D resistant weeds such as smartweed, or barnyard grass. But not today - today the answer is quackgrass, nutgrass, horsenettle or some other perennial weed. In the Northeast the odds are about 9 to 1 that he would say "quackgrass". What is the story - are these weeds worse or has the elimination of the more rapid and rank growing annuals just showed them up ? I think both. The elimination of annuals gives more advantage to the slower growing perennials so that they make better growth. Then, too, their presence is much more obvious with the elimination of the gross showy effect of the annual species. What is the effect of this change on recent advances in chemicals and practices ? Just this - today we are finding much work directed toward the control of this type of weed. During 1955 you will see a lot of Northeastern farmers trying chemicals for the control of quackgrass. Aminotriazole, TCA, and Dalapon have done excellent jobs of controlling quackgrass in research plots during 1954. These are the materials which you will have a chance to look at this year, others are on the way.

What does this mean to those in extension ? Just this - we know that many farmers today are not using chemical weed control even though they should. This is always the case with any new practice so we have to keep encouraging this group to get on the band-wagon, so to speak, and try it for themselves. On the other hand we have the other group and lets call them the leaders, who have been in chemical weed control for as long as eight years. They have the desire, they have the experience and they have the equipment. Many of them now have a serious problem with perennial weeds and there are chemicals to help them, so as extension workers you have a real program, let's say a double-barrelled program; one for the newcomer and one for the veteran.

The next crop I'd like to discuss is hay. Many million of acres are grown in the Northeast, certainly a crop of prime importance to any extension worker. Hay, of course, can be divided into permanent and rotation pastures, so first let's consider the rotation hayfield.

Weed control in this crop starts the year the seeding is made. In the Northeast the hay may be seeded either in the Spring or in the Fall. Spring seeded hay is usually done using oats as a nurse crop so that the weed control program actually begins in oats. 2,4-D was readily accepted for use on oats which were not underseeded with legumes and many operators who were very careful with these applications could also successfully use 2,4-D on oats which were underseeded with legumes. However, in many cases severe injury occurred to the legumes so in an attempt to find a material safer on legumes than 2,4-D,many compounds have been screened for legume tolerance. Two materials MCP and 3,4-D have been shown to produce less injury to certain legumes than 2,4-D. The situation at present looks something like this. MCP produces less injury to clover than either 2,4-D or 3,4-D but more injury to alfalfa than 3,4-D and about the same as 2,4-D. 3,4-D produces less injury to alfalfa than MCP or 2,4-D but more injury to clover than MCP and about the same as 2,4-D. So, what is the extension worker going to say. Well, at first it looks simple - use MCP on oats seeded with clover and 3,4-D on oats seeded with alfalfa. But in New York State for instance, the great majority of the seedings are mixed alfalfa - clover seedings so you say to the farmer "which is the most important"? His answer, "They are both important". To further complicate the picture is the fact that these materials are more costly than 2,4-D. MCP has seen sold in the Northeast for several years and we find a certain number of growers who are using the material primarily for two reasons - it gives less injury to oats and also less injury to clover then 2,4-D. Where 3,4-D will eventually end up use-wise is not clear at present. Dinitros work fine on underseeded oats but the burning often associated with their use discourages acceptance of them.

Fall seedings of hay are most important on the coast and South of the Pennsylvania-New York line. Winter annuals, such as chickweed have been the prime problem in these areas and this problem has been largely solved by the use of dinitros in the Fall and Winter when grass is in the mixture and dinitro or CIPC when there is no grass in the mixture.

Weeds are usually a problem in first year hay. Many thousands of Spring visitors to the Northeast have remarked about "those beautiful yellow fields." For their sake, I would like to say that it looks like we still have those yellow fields for their children to look at. I do not believe that there is any other single weed that has baffled research workers, insofar as weed control is concerned, as has yellow rocket in first year hay. Certainly today there is no really good control for this pest and yet each Spring we all get the usual flurry of letters asking help. We do find that where underseeded oats are sprayed for weed control,there is a decrease in the stand of yellow rocket the following year. This decrease seldom reaches control proportions and the question is - "of what value is a decrease from two to one plant per square foot when the remaining one can produce 20 - 40 thousand seeds"? We are very much in need of a chemical that will control yellow rocket, and cockle in first year hay.

Permanent pastures are a major part of the economy of the Northeast and are one of the important sources of income for farmers. However, because of the different ways in which they are handled, it is often a question of just how much money should be spent in controlling weeds and brush in them.

2,4-D could be used on millions of acres to reduce stands of susceptible annual and perennial weeds and yet there is very little permanent pastures being sprayed today. Brushkillers could be used to real advantage in many pastures in the Northeast and yet only a token number are being treated. We have a long ways to go in this area and perhaps one of the best ways to do this is to attack the individual problems like wild onion or garlic, Canada thistle, bedstraw, milkweed and a multitude of others that may be problems in permanent pastures.

Wild onion or garlic can be controlled with 2,4-D by treatment three or four years in a row with a low dosage. This treatment also practically eliminates legumes so in many pastures it is a questionable practice.

Canada thistle is a real problem in many pastures and control has been difficult, however, indications are that aminotriazole may offer a real solution to this problem, as well as the milkweed problem.

Bedstraw is over-running acres and acres of beautiful trefoil pasture. Dalapon has shown very promising control and if the 1955 results verify the 1954 ones, we may have a real find insofar as bedstraw control is concerned.

These are only a few of the problems; there are many others but certainly an extension worker who is interested in permanent pastures has plenty of tools at hand to help him.

Another place where rapid strides are being made is in pasture renovation with the aid of chemicals. TCA has been used commercially to some extent and in some cases outstanding stands of birdsfoot trefoil have been produced following TCA treatment with a minimum of discing.

Dalapon may fit into this picture and other materials now under test look real promising. This is a field which, I think, shows great future promise.

Lets leave the dairyman with his problems now and proceed to the cash crop grower. An interesting place to start would be with the potato grower.

Chemical weed control in potatoes is not new. Six or seven years ago several States were recommending dinitros for pre-emergence weed control in potatoes and the practice was good - still few potato growers really went in for chemical weed control. They might try some one year and then the next year revert back to the weeder; some few of course stuck with it. This went on for some five or six years, during which time data and evidence as to the value of chemical weed control in potatoes kept building up. Then Aldrich and co-workers in New Jersey published data, showing that on their soil type pre-emerge chemical weed control followed by one cultivation produced maximum yields and resulted in highest profits. Here was a dollars and cents program which the extension service took and ran with. This program was accepted by Long Island potato growers who were producing potatoes on a similar soil type and here, too, the program rolled. The net result being that three to four times the number of acres of potatoes were sprayed with dinitro in 1954, as were sprayed in 1953.

I bring this up primarily for one reason - the key to any successful program is the extension service. Once research and practical farm use have shown that a new practice is ready for general farm use, if the extension service really want to make it go, it will go. If they just accept it and then say "so what", it may dribble along for years and never amount to much.

I'd just like to mention beans very briefly and by this I mean snap, lima and field beans. Chemical control of weeds in beans with dinitros has been gaining in importance during the past four or five years. Each year sees a proportionate increase in the number of growers using this practice. A more recent change, however, is tied in closely with one of the changes mentioned when corn was discussed. Bean growers are moving their spraying operations back more and more each year towards the planting operation. Probably, fifty per cent of all the field beans sprayed in the Northeast are now sprayed at planting. This per cent will increase. Why - for the same reason mentioned earlier - simplification of operations, accuracy of applications,etc. Another factor important here is that lima and field beans are planted during very warm weather, where come up may occur three to four days after planting so that there is actually little loss of residual chemical activity. This is not the case with snap beans and so in this crop, we see less tendency for a simultaneous planting - spraying operation.

Another change that is occurring can be aptly illustrated by our experiences in chemical weed control in onions and asparagus. Chemical weed control in onions had been developing very slowly for about five years and had become pretty well established as the use of special grade cyanamid as a pre-emergence treatment followed by aero-cyanate as a post-emergence treatment when necessary. When environmental conditions and techniques of application were exactly right, no better weed control could be asked for but let either of these factors vary too much and serious injury could occur and often did. But a great number of growers had had several year's experience and were doing a commendable job of weed control. In the meantime Perkins and others had been testing various other materials which might be safer to use on onions and in the Spring of 1954, CIPC looked like a safer and more promising material. Then a real phenomena took place; growers who had been five years taking to the cyanamid-cyanate program, switched overnight and in one season on one of our largest muck areas, 90 per cent of the growers who had been using the cyanamid-cyanate program switched to CIPC. You will probably say that this is a coincidence, but is it ? Lets move out of New York State now and down to Southern New Jersey.

Chemical weed control in asparagus was a going program in the asparagus are of South Jersey. Over a period of four or five years, two materials were used - granular cyanamid to some extent but the largest portion of the treated acreage was treated with SES or Crag Herbicide 1. The volume used has increased to quite a substantial volume in 1954. Meanwhile Rahn and others had been working with CMU and in the Spring of 1954 the stage was again set. Over fifty percent of the growers switched to CMU at the first application made before cutting. Practically 100 per cent had switched by the second application made at the close of the cutting season. The point brought up is this - once a practice is established - changes in this practice insofar as materials used are concerned are made much more rapidly and completely than the introduction of a new practice. What does this mean - just this. An extension worker who is responsible for chemical weed control must really be on the ball. He's got to know what is being used; what its weaknesses are, if any, and what product might replace it. Because when the time comes, the change is rapid and complete.

This change from SES to CMU has important implications from another viewpoint. SES is a water soluble material; CMU for all practical purposes is insoluble in water and most other solvents and is applied as a wettable powder. Three years ago it was an accepted fact that because of the type of application equipment available, any successful herbicide would have to be soluble in water or some solvent that would emulsify in water. The first thing that was done with a chemical that had shown activity in screening was to find a good solvent for it. This was not always easy and in the case of CMU practically impossible so the only choice was a wettable powder. The first cry I heard from the field after CMU was introduced was "What are we going to do with it - we've got no decent economical equipment to apply it." Then, as I have previously told you, it found a place on asparagus and the complaints began to decrease. We still heard them but less and less until today, it is being used on asparagus with little trouble. This merely points out again that if the chemical will do the job, we'll find a way to use it. I think we're going to see more wettable powders for two primary reasons:

1. Many of the new organic compounds are practically insoluble in any solvent.
2. Wettable powders decrease the chance of crop injury from solvent; something which we have noticed in the field during the past few years.

Just a few words about advances in equipment and then I'll close. When modern chemical weed control first found its place, farmers were not sure of its future or its success, so if they were to be encouraged to use it, the practice must be made to look economically attractive to them. For this reason he was encouraged to procure the cheapest piece of workable equipment possible. In some cases this meant a home-made rig and in others a cheap commercial sprayer. Then as the field grew and the farmer found more and more jobs he could do, he wanted more and more on the sprayer-retractible wing booms, drop-pipes, hand guns, individual boom shutoffs, larger pumps,etc. So that the cheap rig, costing less than one hundred dollars, has now developed into a more durable, versatile rig costing two hundred or more dollars. Nevertheless, he is far ahead in economy from those early days. His sprayer is no longer a "Weed sprayer"; it is a low pressure, low volume sprayer with which he kills brush, sprays forage crops and row crops with insecticides, sprays the barn and performs numerous other jobs totally outside the chemical weed control field. It is rapidly becoming one of the farmer's most indispensable pieces of farm machinery.

I believe the greatest need we have at the present in equipment is that of an economical, light weight power-take-off pump with good volume and pressure that will handle wettable powders. This equipment will be forthcoming when the growth of the usage of wettable powders make a real demand for it.

I have skimmed very lightly over some of the recent advances in chemical weed control and practices. I will close with a brief summary of the points I feel are most important.

Chemical weed control practices on crops which have been weeded successfully for several years are tending to move towards a preventative type weed control program rather than to an eradicative type program. This is in evidence on corn in particular. This is resulting in more pre-emergence applications, more residual type herbicides and more applications made at planting.

As certain weeds are controlled by chemicals, other weeds become problems. This in turn makes a demand for other chemicals to control these new problem weeds. Thus, no chemical is the chemical for any single crop; this is going to vary with the soil, the weed and many other factors.

There are many problems facing us in chemical weed control. We have made great inroads on these problems but as we solve one problem, two more often face us. This makes workers in the field productive because they can get results and answers. It also keeps them interested because there are so many answers yet to be found. Certainly the control of perennial weeds and grasses are among the major control problems still facing us.

The extension service is absolutely essential in the successful operation of any weed control practices. On the other hand extension workers must be sure they know the program they are backing and what results can be expected from it.

Changes in weed control practices are coming more rapidly and more complete because farmers are backing chemical weed control and know the advantages they can gain from a well rounded up-to-date program.

CMU introduced a new type herbicide to farmers - wettable powders. This type of herbicide will increase in popularity because they are safer from a phytotoxicity standpoint and are simpler to formulate. Along with this comes a demand for a suitable sprayer to handle this type material.

The sprayer a farmer buys today is not a "weed sprayer", it is a low volume - low pressure sprayer, almost indispensable on an up-to-date farm of today.

Chemical weed control has made great strides in the past ten years, however, these are small compared to the giant steps we have a chance to make in the future.

VISUAL AIDS TO A WEED CONTROL PROGRAM

Donald A. Schallock[1]

The public is becoming aware that chemical weed control may provide the solution to many plant pest problems. This growing interest has created a demand for more education and information; a demand that must be met by the Extension Service, the Agricultural Experiment Stations, the public service agencies, and the representatives of commercial concerns down to the local store selling agricultural supplies.

The text of weed control information must be technically correct, practical, and economically feasible. The method of dissemination must be attractive and effective, stimulating the enthusiasm and interest of the audience to the point of action.

Superior visual aids contribute greatly to the presentation of this weed control information. New visual aids are available and the aids we are now using should be improved. Flannelgraphs, phosphorescent graphs and pictures, dark light reflections, and various other devices are examples of new visual aids. Better plant mounts, a complete and logical sequence of 2 x 2 slides, movies more specific for the areas and crops involved, and improved quality of publications are some of the improvements that could be made on the commonly accepted visual aids.

The display of the visual aids presented at this conference will acquaint any person interested in the dissemination of weed control information with the possibilities of improving the method of that presentation of material vital to the success of any federal, state, municipal, or commercial effort in weed control. The availability, cost, and facility with which they may be used will be demonstrated for each of the visual aids presented. It is the objective of presenting this display and discussion at this time to contribute one or more new ideas in visual aids that may be immediately used in educating the public to weed control and the solution to some of the weed control problems.

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Effects of Soil Organic Matter on Herbicides Used in Vegetable Production

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Abstract[2]

During the 1953 season results were obtained indicating the importance of soil organic matter in relation to the use of certain herbicide in vegetable crops. These experiments were carried out on old fertility plots wherein various levels of organic matter had become established through the long-term application of manure.

This past season the work was expanded to include a wider range of chemical herbicides and test plants. One experiment was conducted on the "small seeded" crops onions, spinach, and beets. These were treated the day after planting with graduated rates of CMU, PDU, and CIPC. Complete data was taken on their effects on weed and crop plants. In general it was found that the effect of organic matter, per se, was the most important factor involved and overshadowed most of the treatment-organic matter interactions.

The second experiment was carried out on lima beans and sweet corn, "large-seeded" crops, and various rates of CMU, PDU, Telvar, Na PCP, DN, and 2,4-D were applied pre-emergence the day after planting. As might be expected the actual effect of organic matter on these crops was much less pronounced and the treatment effects thus more apparent.

These experiments were put out June 7 and, as the soil was dry, were irrigated immediately afterwards. The weather continued dry and crust formation occurred on the lower organic matter plots interfering with comeup and growth, of the small seeded crops in particular. Under more favorable conditions the results may have been more in line with those reported last year.

2

Summary 1954

[1] Long Island Vegetable Research Farm

[2] To be published in Weeds

Comparison of Granular and Spray Applications of Herbicides on Vegetable Crops 1,2/

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The experimental trials outlined here are a continuation of the initial phases of this work which have been described in earlier publications (1,2,3). The early greenhouse and field trials indicated that the granular applications may prove of practical use due to an increased selectivity as compared to spray applications in the case of certain herbicidal chemicals.

Granular herbicides appear to be of special interest in connection with transplant crops and for use as post-emergence treatments. This does not mean that they may not also be practical for use as pre-emergence treatments where the time consumed in obtaining water is an important element in spraying or where granule spreading equipment is readily available.

The trial use of granular herbicides is possible on a field basis now with equipment that can be purchased as standard items.

Materials, Methods, and Results

Experimental materials, conditions, procedures and results are presented. Observations made during the trials are listed and a brief statement of the conclusions based on the results is given for each trial. A general summary of the work performed in the whole series of trials is presented followed by a table of general conclusions.

The first three trials were organized to provide further information on the relative toxicity of spray and granular application of herbicides on three transplant crops tested in 1953, namely, tomatoes, peppers, and sweet potatoes. In the 1954 trials, the chemicals were applied at lay-by time. All chemicals were applied over-all. Granular materials were brushed off the crop foliage by dragging a burlap bag over the row.

The last trial described involved a comparison of the weedkilling effectiveness of granular and spray applications of various chemicals. This was accomplished by seeding annual rye grass as a sensitive test crop and applying the various chemicals thereafter. Stand counts of the rye grass gave an indication of the activity of the chemical.

1/ Contribution from the Plant Physiology Department, Virginia Truck Experiment Station, Norfolk. Paper No. 121, Journal Series. Approved for publication November 12, 1954.

2/ Acknowledgement of assistance in this work is made to the Columbia-Southern Chemical Corporation for a grant-in-aid and to the Virginia-Carolina Chemical Company and the Zonolite Company for generous assistance in the preparation of experimental granular materials.

Trial I. Comparison of Granular Herbicides With Standard Spray Combinations Now in Commercial Use on Strawberries.

The comparisons used here between Crag Herbicide No. 1 and Sesin are the result of the difficulty of finding suitable solvents for Crag No. 1 for impregnating the chemical on granular carriers. Sesin did not present this problem and it was used because of the similarity of its activity to that of Crag No. 1.

Trial Location: Norfolk Station field.
Soil Type: Sandy clay loam. Crop Variety: Pocahontas. Exp. Design: Rand. block. No. Reps: Four. Plot Size: 10 ft. of 3.5 ft. bed. Plant Spacing: 1 ft. square. Transplanting Date: 11/3/53. Treat. Date: 11/27/53. Cultivation: None. Hand Weeding: As needed in the spring to clear all plots of weeds and prevent interference with normal growth. Harvest Period: 4/26/54 to 6/7/54. Treatments and Rates: See table of yield results.
Rainfall Record: For three week period following treatment. Soil moisture at time of treatment - medium. Rainfall - 1st wk. 0, 2nd wk. 0.72 in., 3rd wk. 1.48 in. Total for three week period - 2.20 in.
Temperature Record: For three week period following treatment in degree-hours above 0°F. 1st wk. 7442, 2nd wk. 6291, 3rd wk. 5134. Total for three week period - 19867.

Observations: Sesin and Crag Herbicide No. 1 both gave excellent control of henbit weed. All combinations containing C-IPC gave good control of chickweed. Two applications of a mixture of C-IPC and Sesin or Crag are necessary for a complete control of winter weeds in strawberries planted in this manner.

Yield Results:

Chemical	Acre Rate	Method of Application	Average Yield Lbs./100 Plants
C-IPC + Crag #1	1 + 2 lbs.	In 50 gals. water	28.0
C-IPC + Crag #1	2 + 2 lbs.	In 50 gals. water	22.8
C-IPC + Sesin	2 + 2 lbs.	Clay plus tobacco pulp	26.5
Ø-IPC	2 lbs.	In 48 lbs. 30-60 Attaclay	24.6
Sesin	2 lbs.	In 48 lbs. tobacco pulp	23.8
Control	--	---	21.0
L. S. D. 5%			5.3
1%			7.4

Conclusions:

1. Rates of 1 and 2 lbs. of C-IPC per acre in either spray or granular form applied before emergence of chickweed will control it but will not control henbit weed.

2. Sesin at the rate of 2 lbs. per acre in granular form applied before emergence of henbit weed controlled it.

3. C-IPC and Crag Herbicide No. 1 applied in spray form gave excellent control of both chickweed and henbit. C-IPC and Sesin applied in granular form gave equal control of these weeds.

Trial II. Comparison of Lay-by Applications of Granular and Spray Forms of C-IPC and Dalapon on Tomatoes and Peppers.

Trial Location: Norfolk Station field.
Soil Type: Sandy clay loam. Crop Varieties: Tomatoes (Rutgers). Peppers (California Wonder). Exp. Design: Rand. block. No. Reps: Five. Plot Size: Tomatoes (10 plants). Peppers (15 plants). Plant Spacing: Tomatoes (2.5 ft.). Peppers (1.5 ft.). Transplanting Date: 4/13/54. Treat. Date: 6/13/54. Developmental Stage at Treatment Time: Early fruiting stage. Some tomato fruits 1.5 inches in diameter. Pepper fruits up to 1 inch in diameter. Cultivation Practice: Usual cultivation as needed. Hand Weeding: As needed to keep all plots clean. Harvest Period: 6/22 - 7/19. Treatments and Rates: See table of yield results. Rainfall Record: For three week period following treatment. Soil moisture at treatment time - very dry. Rainfall - 1st wk. 0, 2nd wk. 0.3 in., 3rd wk. 0. Total for three week period - 0.3 in.
Temperature Record: For three week period following treatment in degree-hours above 0°F. 1st wk. 11720, 2nd wk. 11762, 3rd wk. 12187. Total for three week period - 35669.

Observations: Slight symptoms of foliage injury were observed in the spray application of 2 lbs. of C-IPC and none in the granular applications. Very severe injury to the foliage, blossoms, and fruits occurred in plants sprayed with Dalapon and only slight symptoms of injury occurred where Dalapon in granular form was used.

Extremely dry weather and fruit rots reduced yields generally.

Yield Results:

Chemical	Acre Rate	Method of Application	Average Yield Tomatoes Lbs/10 plants	Average Yield Peppers Lbs/100 plants
C-IPC	2 lbs.	In 50 gals. water	60.4	86.5
C-IPC	2 lbs.	In 48 lbs. 30-60 Attaclay	59.0	111.6
C-IPC	4 lbs.	In 46 lbs. 30-60 Attaclay	65.4	98.1
C-IPC	8 lbs.	In 42 lbs. 30-60 Attaclay	69.8	77.4
Dalapon	4 lbs.	In 50 gals. water	9.3	12.6
Dalapon	4 lbs.	In 46 lbs. 30-60 Attaclay	56.6	120.1
Control	--		60.5	109.0
L. S. D. 5%			22.4	25.9
1%			30.5	35.4

Conclusions:

1. Tomatoes are tolerant of C-IPC applied at lay-by time.

2. Peppers are sensitive to C-IPC applied at lay-by time.

3. Both tomatoes and peppers are very severely injured by spray applications of Dalapon at lay-by time.

4. The use of a granular form of application eliminated or greatly reduced the injurious effect of Dalapon on both peppers and tomatoes.

<u>Trial III.</u> Comparison of Lay-by Applications of Granular and Spray Forms of C-IPC on Sweet Potatoes.

<u>Trial Location</u>: Norfolk Station field.

<u>Soil Type</u>: Sandy clay loam. <u>Crop Variety</u>: Porto Rico. <u>Exp. Design</u>: Rand. block. <u>No. Reps</u>: Five. <u>Plot Size</u>: 25 ft. of 3.5 ft. row. <u>Plant Spacing</u>: 18 inches. <u>Transplanting Date</u>: 5/10/54. <u>Treat. Date</u>: 7/21/54. <u>Plant Developmental Stage at Treatment Time</u>: Plants 3-4 ft. long. <u>Cultivation Practice</u>: Usual cultivation as needed. <u>Hand Weeding</u>: As needed to keep all plots clean. <u>Harvest Date</u>: 10/14/54. <u>Treatments and Rates</u>: See table of yield results.
<u>Rainfall Record</u>: For three week period following treatment. Soil moisture at treatment time - medium. Rainfall - 1st wk. 0.10 in., 2nd wk. 1.56 in., 3rd wk. 0.50 in. Total for three week period - 2.16 in.
<u>Temperature Record</u>: For three week period following treatment in degree-hours above 0°F. 1st wk. 12194, 2nd wk. 12857, 3rd wk. 12273. Total for three week period - 37324.

<u>Observations</u>: No symptoms of injury from the application of C-IPC in either spray or granular form were evident.

<u>Yield Results</u>:

Chemical	Acre Rate	Method of Application	Av. Yield Lbs. Per Plot
C-IPC	2 lbs.	In 50 gals. water	27.7
C-IPC	2 lbs.	In 48 lbs. 30-60 Attaclay	24.9
Control	—	----	22.7
L. S. D. 5%			7.2
1%			9.8

<u>Conclusions</u>:

1. Porto Rico sweet potatoes are very tolerant of C-IPC applied after the plants are well established.

<u>Trial IV.</u> Comparison of Granular and Spray Applications of C-IPC, Crag Herbicide No. 1, Dalapon, and CMU as Post-Planting Treatments on Annual Rye Grass as a Sensitive Test Plant.

As indicated previously, this trial was established to determine the relative effectiveness of these herbicides applied in granular and spray forms and to determine the effectiveness of various granular materials as carrying agents.

<u>Trial Location</u>: Norfolk Station field.
<u>Test Plant</u>: Commercial annual rye grass. <u>Soil Type</u>: Sandy clay loam, pH - 6.3. <u>Exp. Design</u>: Rand. block. <u>No. Reps</u>: Five. <u>Plot Size</u>: Three beds 16.5 ft. long and 3.5 ft. wide. <u>Seeding Rate</u>: Approximately 25 lbs. per acre. <u>Method of Planting</u>: Beds were prepared and seeded immediately with rye grass using a lawn seeder. Seed was raked in with garden rakes on all beds. <u>Method of Treatment</u>: Treatments

followed by raking and rolling. Planting Date: 9/7/54. Treatment Dates: All except Dalapon - 9/7/54. Dalapon applied 9/14/54 when grass was about one inch high. Soil Preparation After Treatment: One bed was hand raked, one was rolled, and one was left undisturbed in each plot after the post-planting treatments. Beds were not disturbed after Dalapon application. Stand Count Date: 10/12/54 through 10/20/54. Treatments and Rates: See table of stand count results. Rainfall Record: For three week period following treatment. Soil moisture at time of planting - surface 1 inch - 6.5%, 3 inch level - 11.5%, 6 inch level - 11.0%. Rainfall - 1st wk. 2.09 in., 2nd wk. 0, 3rd wk. 0.82 in. Total for three week period - 2.91 in.
Temperature Record: For three week period following treatment in degree-hours above 0°F. 1st wk. 11626, 2nd wk. 11514, 3rd wk. 11007. Total for three week period - 34147.

Observations: Soil moisture was optimum for grass seed germination. Granular and spray applications did not appear to differ greatly in effectiveness. C-IPC killed the grass prior to emergence. Grass emerged in CMU plots but turned yellow and died in about two weeks at a height of 1 to 2 inches. Crag Herbicide No. 1 and Dalapon were not effective at the rates used. Large particle size vermiculite (No. 2) tended to wash off the beds in rains.

Results as Measured by Rye Grass Stand:

Chemical	Acre Rate (Lbs.)	Method of Application	Av. No. Grass Plants/Ft.^{2} Raked	Rolled	Not Disturbed
Crag #1	2	50 gals. water	91	98	88
Crag #1	2	24 lbs. Verm. #2	69	89	77
Crag #1	2	43 lbs. Verm. #4	53	63	58
C-IPC	2	50 gals. water	0.2	0	0.2
C-IPC	2	48 lbs. 30-60 Attaclay	0.4	0.2	0
C-IPC	2	48 lbs. tobacco pulp	0.2	0	0
C-IPC	2	24 lbs. Verm. #2	3.2	0.4	2.8
C-IPC	2	43 lbs. Verm. #4	0.2	0.8	2.4
Dalapon	4	50 gals. water	16	17	15
Dalapon	4	48 lbs. tobacco pulp	14	28	26
Dalapon	4	48 lbs. 30-60 Attaclay	9.6	19	14
CMU	1	50 gals. water	4.8	4.6	3.6
CMU	1	24 lbs. Verm. #2	12	19	17
CMU	1	43 lbs. Verm. #4	2.2	1.6	1.0
CMU	2	50 gals. water	0.4	0	0
CMU	2	24 lbs. Verm. #2	4.4	4.0	3.2
CMU	2	43 lbs. Verm. #4	0.6	0.8	0
Control	-	---	85	105	89

L. S. D. 5% 21.4
1% 28.2

Conclusions:

1. Granular applications were as effective as spray applications in these soil treatments.

2. Raking in or rolling the soil following spray or granular treatment did not have any practical effect on the activity of the chemicals involved. These treatments were made under ideal moisture conditions and it is possible that similar results would have been obtained under dry soil conditions.

3. All of the carrying agents used in the granular preparations appeared to be satisfactory for the purpose.

General Summary

C-IPC and Sesin in granular form were compared to C-IPC and Crag Herbicide No. 1 in spray form on Pocahontas strawberries planted in November.

C-IPC and Dalapon in spray and granular form were compared on tomatoes and peppers at lay-by time.

C-IPC in spray and granular forms were compared on sweet potatoes at lay-by time.

C-IPC, Crag Herbicide No. 1, Dalapon, and CMU in spray form were compared with the same chemicals impregnated on various granular materials on newly seeded annual rye grass used as a sensitive test plant. This trial was organized to compare the weed killing effectiveness of the various types of chemicals and carriers.

General Conclusions

1. A combination of C-IPC (1 lb. per acre) and Sesin (2 lbs. per acre) applied in granular forms immediately after planting Pocahontas strawberries in the fall was very effective in killing chickweed and henbit. Two applications per winter are required to control winter and spring weeds.

2. Granular applications of C-IPC (2 lbs. per acre) and Dalapon (4 lbs. per acre) were tolerated quite well at lay-by time by tomatoes and peppers though spray applications of Dalapon at this rate were extremely toxic to these crops.

3. Sweet potatoes showed a practical tolerance of C-IPC (2 lbs. per acre) in granular and spray form applied at lay-by time.

4. Granular applications of herbicides were as effective as sprays using the same amounts of the basic chemicals in pre-emergence treatments.

5. Such granular carriers as Attaclay, vermiculite, and tobacco pulp appeared to be about equally effective within approximately the same particle size range.

6. Rolling or raking the soil following application of granular herbicides did not improve or lessen their effects.

7. The results obtained with granular herbicides in 1954 as described here offer further evidence to support the data obtained in the 1953 trials. Continuation and expansion of these trials offers the possibility of extending greatly the use of herbicides of known value now in general use.

Citations

1. Danielson, L. L. Preliminary weed control trials on the dry application of 3-Chloro-IPC impregnated on clay granules. Virginia Truck Experiment Station Vegetable Growers News. Vol 7 No. 11. May, 1953.

2. Danielson, L. L. Application of granular herbicides in field trials. Virginia Truck Experiment Station Vegetable Growers News. Vol. 8 No. 4. October, 1953.

3. Danielson, L. L. Experimental use of herbicides impregnated on clay granules for control of weeds in certain vegetable crops. Proc. Northeastern Weed Control Conference 1954. pp. 119-126.

Experimental Use of Dalapon and Natrin on Certain Transplanted Vegetable Crops [1]

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The experimental work described here was stimulated by a desire to find practical methods of chemical control for the very serious weed problems which occur in transplanted vegetable crops after the last cultivation or which occur between the plants in the row where hand labor is required to remove them.

Experience of other workers (3) using Dalapon (2, 2-dichloropropionic acid) in field studies have shown that this chemical is quite effective in controlling both annual and perennial grasses but that some broadleaf crops are tolerant. It was felt that this selectivity might prove useful in the transplant crops used in the present study.

Another material of a selective nature which has been used on tomatoes by a number of investigators (1, 2, 4) is Natrin (2, 4, 5-trichlorophenoxy-ethyl sulfate). This material appeared to hold promise and was included in the present trials.

Materials, Methods, and Results

Four separate trials are described. Each trial is presented as a unit, with a brief outline of the methods, materials and conditions and with a table of results. Conclusions drawn from each trial are stated very briefly. A general over-all summary of the work performed in the series is presented, followed by a table of general conclusions.

The trials described here were organized to determine the tolerance of the crops concerned.

The first trial was organized in the greenhouse to determine the amount of Dalapon required for weed control and to obtain some information on the effect of pre-emergence applications on corn and beans.

The second greenhouse trial was organized to determine the effect of various amounts of the chemicals on transplanted tomatoes.

The third and fourth trials were run in the field to determine the effect of the weed killing concentrations of the chemicals on various transplanted crops at lay-by time. The crops used were tomatoes, peppers, and sweet potatoes.

1/ Contribution from the Plant Physiology Department, Virginia Truck Experiment Station, Norfolk. Paper No. 120, Journal Series. Approved for publication November 12, 1954.
2/ Plant Physiologist.
3/ Research Assistant in Plant Physiology.

Trial I. Greenhouse Determination of Phytotoxicity of Dalapon.

Trial Location: Norfolk Station greenhouse.
Soil Type: Sandy clay loam. pH 5.1. Pot Size: 2-gal. glazed crocks. Exp. Design: Rand. block. No. Reps: Ten. Test Crops: Snap Beans (Contender), Sweet Corn (Carmelcross) and annual rye grass. Seeding Rate: Ten seeds each of corn and beans per pot and one gram of rye grass. Method of Planting and Treatment: All seed planted followed by application of chemicals the same day. Planting Date: 1/1/54. Treatment Date: 1/1/54. Sampling Date: 2/8/54 - removed all beans and corn and counted and weighed them. 2/19/54 - rye grass removed and weighed. Measurement of Effects: Stand counts, fresh weights, and observations used to determine the effect of treatments. Treatments and Rates: See table of growth data. Watering Procedure: All pots received equal amounts of water applied on top. Drainage was collected and returned to each pot.
Temperature Record: Degree-hours above 0°F. for 30 days of experimental period 37347.

Observations: No serious injury to beans due to treatment was evident. Some leaf symptoms such as malformation evident in corn at 8 and 10 lb. per acre rates.

Growth Data: Effect of Pre-emergence Dalapon Sprays on the Growth of Snap Beans and Sweet Corn and on Annual Rye Grass as a Sensitive Test Plant.

	Snap Beans			Sweet Corn			Rye Grass
Dalapon Lbs./A.	Av. Initial Stand	Av. Final Stand	Av. Fr. Wt. Per Plant	Av. Initial Stand	Av. Final Stand	Av. Fr. Wt. Per Plant	Fr. Wt. 10 Pots
0	8.7	5.0	5.6	9.1	5.0	3.2	152.0
2	8.9	4.7	5.9	9.3	4.9	3.4	147.5
4	8.5	4.9	6.5	8.6	5.0	3.6	126.0
6	8.0	4.7	6.3	8.7	5.0	4.4	79.0
8	8.8	4.6	6.8	9.0	5.0	3.8	33.0
10	8.4	4.2	5.9	9.4	5.0	3.6	25.5
L. S. D. 5%	2.3	-	-	-	-	-	--
1%	3.0	-	-	-	-	-	--

Conclusions:

1. Snap beans and sweet corn are quite tolerant of Dalapon in early stages of growth.

2. Results on rye grass indicated that 4 to 6 lbs. of Dalapon per acre was the point at which pre-emergence applications were effective against this test crop.

Trial II. Effect of Various Rates of Application of Natrin and Dalapon in Spray Form on the Foliage of Transplanted Tomato Plants in the Greenhouse.

Trial Location: Norfolk Station greenhouse.
Soil Type: Sandy clay loam. Crop Variety: Rutgers. Pot Size: One quart metal containers. Exp. Design: Rand. block. No. Reps: 10 Transplanting Date: 3/22/54.

Treatment Dates: Natrin 4/6/54. Dalapon 4/8/54. Height of plants 8 to 10 cms.
Measurement of Effects: Plant height measurements were made at weekly intervals. Fresh and dry plant weights were obtained when experiment was terminated. Photos of each series were taken. Exp. Terminated: 4/22/54. Treatments and Rates: See table of growth data.
Watering Procedure: All pots were bottom watered to avoid the undesirable effects of surface watering.
Temperature Record: For two weeks following treatment in degree-hours above 0°F. 36,786.
Observations: Natrin produced noticeable growth effects at all rates beginning the day following treatment. Plants became twisted and generally distorted with some swelling of the stems at the nodes. Severity of the symptoms increased with the increasing rate of application.

Dalapon produced necrotic areas on the leaves by the second day following application. These areas appeared over the leaves accompanied by a marginal burn and a tendency for the edges of the leaves to curl under. New foliage became very chlorotic. Growth was much retarded and an increase in the severity of the effect accompanied the increase in rate of application with extremely severe effects at six and eight lbs. per acre.

Growth Data: Effect of Dalapon on Growth of Tomato Plants in a Greenhouse Experiment.

Dalapon Lbs./A.	Average Height in Cms. 1st wk.	2nd wk.	3rd wk.	Av. Total Growth (Cms.)	Av. Wt. Per Plant - Grams Fresh	Dry
0	8.8	15.3	25.2	16.1	22.9	2.759
2	8.5	15.1	23.1	14.5	18.6	1.595
4	9.0	13.1	18.4	9.4	12.3	1.188
6	9.4	12.1	15.4	8.0	7.8	0.809
8	9.5	11.6	10.5	1.2	5.0	0.552
L. S. D. 5%	1.0	2.0	2.0	2.0	5.8	0.651
1%	1.3	2.7	2.7	2.7	8.1	0.902

Effect of Natrin on Growth of Tomato Plants in a Greenhouse Experiment.

Natrin Lbs./A.	Average Height in Cms. 1st wk.	2nd wk.	3rd wk.	Av. Total Growth (Cms.)	Av. Wt. Per Plant - Grams Fresh	Dry
0	8.7	15.2	24.5	15.8	20.3	2.042
2	8.1	14.9	22.3	13.8	17.9	1.393
4	7.9	14.2	17.6	9.7	12.7	1.658
6	8.3	14.6	18.1	10.9	14.5	1.377
8	8.2	14.8	19.4	10.1	13.8	1.711
L. S. D. 5%	0.6	2.1	3.5	3.9	7.6	0.036
1%	0.8	2.8	4.7	5.2	10.6	1.023

Conclusions:

1. Dalapon sprayed on the foliage of small transplanted tomatoes was very toxic. A rate of only two lbs. per acre produced significant reductions in rate of growth. Rates which produce practical weed control are 4 to 6 lbs. per acre.

2. Natrin sprayed on the foliage of small transplanted tomatoes produced symptoms similar to those characteristic of 2,4-D injury. Epinasty occurred, accompanied by a swelling and brittleness of the nodes of the stem. Significant reductions in rate of growth occurred at a rate of 4 lbs. per acre with slight reductions at 2 lbs. per acre. In general, equal rates of Natrin did not produce the same amount of injury as that produced by Dalapon.

Trial III. Field Trials on Spray Applications of Dalapon and Natrin on Tomatoes and Peppers at Lay-by Time.

Trial Location: Norfolk Station field.
Soil Type: Sandy clay loam. Crop Varieties: Tomatoes (Rutgers), Peppers (California Wonder). Exp. Design: Rand. block. No. Reps: Five. Plot Size: Tomatoes (10 plants), Peppers (15 plants). Plant Spacing: Tomatoes (2.5 ft.), Peppers (1.5 ft.). Transplanting Date: 4/13/54. Treatment Date: 6/13/54. Plant Developmental Stage at Treatment Time: Early fruiting stage. Some tomatoes up to 1.5 in. in diameter. Pepper fruits up to 1 in. in diameter. Cultivation Practice: Usual cultivation as needed. Hand Weeding: As needed to keep all plots clean. Harvest Period: 6/22 - 7/19. Treatments and Rates: See table of yield results. Rainfall Record: For three week period following treatment. Soil moisture at treatment time - very dry. Rainfall - 1st wk. 0, 2nd wk. 0.30 in., 3rd wk. 0. Total for three week period 0.30 in.
Temperature Record: For three week period following treatment in degree-hours above 0°F. 1st wk. 11720, 2nd wk. 11762, 3rd wk. 12187. Total for 3 wk. period 35669.

Observations: Severe injury to both the peppers and tomatoes was evident. Terminal growth stopped, fruits and blossoms dropped, and foliage exhibited symptoms of 2,4-D injury. Apical dominance in the pepper plants was broken and extensive growth of lateral shoots occurred late in the season.

Yield Data:

Chemical	Acre Rate (Lbs.)	Method of Application	Average Yield: Tomatoes Lbs./10 Plants	Average Yield: Peppers Lbs./100 Plants
Control	-	--	60.5	109.0
Natrin	2	In 50 gals. water	58.6	122.3
Natrin	4	In 50 gals. water	56.3	124.2
Dalapon	4	In 50 gals. water	9.3	12.6
L. S. D. 5%			22.4	25.9
1%			30.5	35.4

Conclusions:

1. Tomatoes and peppers will not tolerate weed killing concentrations of Dalapon applied as a spray over the foliage at lay-by time.

2. Tomatoes and peppers are tolerant of weed killing concentrations of Natrin applied over the foliage at lay-by time. This chemical may have practical possibilities for field use in these crops.

Trial IV. Field Trials on Spray Applications of Dalapon Compared to CMU and Alanap on Sweet Potatoes at Lay-by Time.

Trial Location: Norfolk Station field.
Soil Type: Sandy clay loam. Crop Variety: Porto Rico. Exp. Design: Rand. block. No. Reps: Five. Plant Spacing: 18 in. in 3.5 ft. rows. Plot Size: 25 ft. of row. Transplanting Date: 5/10/54. Treatment Date: 7/21/54. Plant Developmental Stage: Vegetative. 3 to 4 ft. long. Cultivation Practice: Usual cultivation as needed. Hand Weeding: As needed to keep all plots clean. Harvest Date: 10/14/54. Treatments and Rates: See table of yield results.
Rainfall Record: For three week period following treatment. Soil moisture at treatment time - medium. Rainfall - 1st wk. 0.10 in., 2nd wk. 1.56 in., 3rd wk. 0.50 in. Total for three week period - 2.16 inches.
Temperature Record: For three week period following treatment in degree-hours above 0°F. 1st wk. 12194, 2nd wk. 12857, 3rd wk. 12273. Total for three week period - 37324.

Observations: Dalapon treated plots developed leaf symptoms similar to 2,4-D injury and terminal growth became chlorotic. Some foliage dropped. Observations at harvest time indicated that apical dominance of the plant had been broken because a profuse growth of lateral shoots had occurred. Root development was very limited and misshapen.

CMU applications produced severe foliage burn within two days after treatment and prevented the development of normal roots. Alanap plots appeared normal.

Yield Data:

Chemical	Acre Rate (Lbs.)	Method of Application	Average Yield Pounds Per Plot
Control	-	--	22.7
Dalapon	4	In 50 gallons of water	5.5
Alanap 2	4	In 50 gallons of water	23.3
CMU	11	In 23 pounds Verm. #4	2.8
L. S. D. 5%			7.2
1%			9.8

Conclusions:

1. Dalapon applied in weed killing concentrations in spray form on foliage of sweet potatoes at lay-by time is extremely injurious as reflected by yields.

2. Dalapon breaks apical dominance in the sweet potato plant.

3. CMU is extremely toxic to sweet potato plants as indicated by severe foliage burn and yield reductions.

4. Alanap 2 used as a standard for comparison did not reduce yields or vigor.

General Summary

Greenhouse trials were organized to test in a preliminary way the tolerance of snap beans, sweet corn, and annual rye grass to pre-emergence applications of Dalapon.

Greenhouse trials were run to establish preliminary information on the tolerance of tomato transplants to foliar applications of Dalapon and Natrin.

Field trials were conducted to study the effect of lay-by applications of Dalapon and Natrin on tomatoes and peppers.

Dalapon was applied on sweet potatoes at lay-by time to determine the tolerance of this crop.

Alanap 2 was used as a standard treatment for comparison.

General Conclusions

1. More than four pounds of Dalapon per acre are required as a pre-emergence treatment to control annual grass in sandy clay loam.

2. Sweet corn and snap beans are quite tolerant of up to six pounds of Dalapon per acre applied as a pre-emergence spray.

3. Dalapon and Natrin at weed killing rates are both so toxic to young tomato transplants that they do not appear to have any possibility of practical use at this stage of growth.

4. Tomato and pepper plants are quite tolerant of Natrin at lay-by time indicating that age of the plant may be very important in its tolerance of this chemical since very toxic effects were produced on young tomato transplants.

5. Dalapon is extremely toxic to tomato and pepper plants at lay-by time.

6. Dalapon is extremely toxic to sweet potatoes at lay-by time.

7. Alanap 2 was not injurious to sweet potatoes at four pounds per acre applied at lay-by time.

Citations

1. Menges, Robert M. and Richard J. Aldrich. A comparison of Crag, derivatives of Crag, and CMU for pre-emergence weed control in tomatoes. N.E.W.C.C. Proc. 1954. 137 - 143.

2. Noll, Charles J. and Martin L. Odland. Chemical herbicides as they affect yield of tomatoes. N.E.W.C.C. Proc. 1954. 191 - 192.

3. Watson, A. J. Field performance of Dalapon, a new grass controlling herbicide. Proc. S.W.C.C. 1954. 200 - 204.

4. Zedler, R. J., and J. B. Harry. A comparison of the herbicidal properties of three chlorinated phenoxyethyl compounds: SES, Natrin and Sesin. Proc. S.W.C.C. 1954. 231 - 236.

Pre and Post Emergence Weed Control in Sweet Corn[1]

by S. K. Ries[2] and B. H. Grigsby[3]

The best recommendation for sweet corn weed control in Michigan has been 4 pounds of DNBP per acre, applied when the sweet corn is in the "spike" stage. The use of DNBP in sweet corn has been reported previously by numerous investigators (1) (2) (3) (4) (6). The results generally have indicated good weed control and some temporary burning with post-emergence applications. Hemphill (2) reported burning, stunting, and reduced yields from DNBP applications at the three to five inch stage.

Marshall (3), Hemphill (2) and Sweet (6) have all reported on the use of CMU in corn. At rates below 2 pounds per acre, yields were not reduced, but some stunting was reported.

The following work, which was undertaken in 1954, was designed to determine the following: 1) The response of two varieties of sweet corn at three stages of growth to CMU (W), (3 (P-chlorophenyl) 1,1 dimethyl urea), CMU (DW), (3 (3,4-dichlorophenyl) 1,1 dimethyl urea) and DNBP, (Dinitro-ortho-sec-butylphenol). 2) The effects of time of application on yield, weed control and maturity. 3) A comparison of 2,4-D and SES, (Sodium, 2,4,dichlorophenoxyethyl sulfate) treatments with CMU Amizol (Amino Triazole) and DNBP applications.

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1/ Journal Article 1688 of the Michigan Agricultural Experiment Station.

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Materials and Methods

A split plot factorial design with 2 replications was used. The largest division was for variety. The two varieties used were Golden Cross Bantam and Carmelcross. The smallest divisions included the chemicals, rates and times of application. The three times of application were: 1) At planting time, 2) In the "spike" stage, and 3) At the 3-4 leaf stage.

Both varieties were planted May 20, on a sandy loam soil. The rows were spaced 36 inches apart with plants 12 inches apart in the row.

The varieties did not emerge at the same time. The treatments, therefore, were applied at different dates as shown in Table 1.

The chemicals were applied with a small plot sprayer. They were applied in the equivalent of 27 gallons of water per acre to plots six feet wide and 25 feet long.

TABLE 1

Variety	Planting Time	Spike Stage	3-4 Leaf Stage
	S T A G E		
Carmelcross	May 21	May 29	June 6
Golden Cross Bantam	May 21	June 6	June 10

Weed control ratings were made on June 14. Yield records included the total number, and weight, as well as the marketable number and weight of sweet corn ears.

Results

The weed control ratings are presented in Table 2. The weeds present were pigweed (Amaranthus retroflexus), lamb's quarter's (Chenopodium album), crab-grass (Digitaria sp.), and foxtail (Setaria sp.)

The weeds emerged at the same time even though both varieties of corn did not. This was responsible for a significant interaction between varieties and treatments which was not due to varieties, but to the stage of the weeds at time of application. The weed control rating for SES averaged 9.0 when SES was applied to Carmelcross in the "spike" stage. However, when SES was applied to Golden Cross Bantam in the "spike" stage, some weeds had emerged and the average weed control rating was only 3.5 for the same treatment. There was a similar response with the less soluble form of CMU (DW) applied when the corn had 3 to 4 true leaves. Weed control with the earlier treatment on Carmelcross was 7.5, but it was only 3.0 with the later application on Golden Cross Bantam in the same stage of growth.

Best weed control on both varieties was obtained with 4 pounds of DNBP applied at the 3 to 4 leaf stage. Treatments with 6 pounds of DNBP at planting, 1/2 pound of CMU (DW) at planting, and 1/2 pounds of CMU (DW) at the "spike" stage did not give commercial weed control.

Yields in marketable tons per acre and ears per plots are presented in Table 2. There were no significant differneces between marketable or unmarketable weights or numbers of ears. The coefficient of variation for number of ears was only 13.8%, which indicates that the lack of significance was probably not due to unaccountable variance.

Although the total yield from 4 pounds of DNBP applied in the 3 to 4 leaf stage compared favorably with the check, this treatment delayed maturity.

Weed control from almost all of the treatments compared favorably with the 2,4-D treatment because 2,4-D did not control the annual grasses. On July 8, observations were made on the persistence of weed control effects. At this time the 4 pound application of SES on the Carmelcross had the fewest weeds of any

TABLE 2

Yield and Weed Control of Two Varieties of Sweet Corn from the Application of Chemicals at Three Different Times.

TREATMENTS	STAGE OF CORN GROWTH	WEED CONTROL RATINGS1/	MARKETABLE YIELD TONS/ACRE	NO. OF EARS PER PLOT
1) Check		1.2	4.25	49.2
2) 6# DNBP	At Planting	3.5	4.39	54.0
3) 1/2# CMU (W)	At Planting	6.0	4.17	49.5
4) 1# CMU (W)	At Planting	6.5	3.69	48.5
5) 1/2# CMU (DW)	At Planting	3.8	4.48	51.2
6) 1# CMU (DW)	At Planting	6.8	4.20	52.5
7) 4# Amizole	At Planting	7.0	4.54	53.0
8) 1/2# CMU (W)	Spike Stage	7.5	3.79	49.2
9) 1/2# CMU (DW)	Spike Stage	5.5	4.29	45.0
10) 4# SES	Spike Stage	6.2	3.62	45.0
11) 4# DNBP	Spike Stage	6.8	4.49	50.5
12) 1/2# CMU (W)	3 inches high	6.5	4.09	51.0
13) 1/2# CMU (DW)	3 inches high	5.2	3.81	43.0
14) 4# DNBP	3 inches high	8.8	3.85	41.7
15) 1/2# 2,4-D (l.v.e.)	3 inches high	6.8	4.95	51.2
L.S.D. @ 5%		1.6	N.S.	N.S.
L.S.D. @ 1%		2.2	N.S.	N.S.

1/ Rating Scale: 1 = No control, 6 = Commercial control, 9 = Eradication.

treatment. The 4 pound applications of DNBP, applied both in the spike stage and 3 to 4 leaf stage, were still comparatively free of weeds, as was the 1 pound application of CMU (W) applied at planting time.

Four pounds of DNBP yielded 56 percent as much as the average of the other 14 treatments at the first picking and 165 percent as much as the average at the second picking. This is shown in Table 3.

TABLE 3

Delay in Maturity from DNBP Applied in 3-4 Leaf Stage

(Average Pounds per Plot from 2 Varieties)

	1st Picking	2nd Picking	Total
Average of other 14 treatments	19.5	9.5	29.0
4# DNBP at 3-4 leaves	10.9	15.6	26.5

Four pounds of Amizole caused a chlorosis of corn for about two weeks, but this disappeared without causing any reduction in yield.

Summary

1) None of the 14 treatments significantly reduced yield when compared to check.
2) Both varieties responded similarly to all treatments.
3) The 4-pound application of DNBP in the 3 to 4 leaf stage delayed maturity.
4) The less soluble form of CMU (DW) provided no better weed control than the more soluble (W), and did not result in more persistent weed control.
5) The best time, of those tested, for DNBP applications was in the "spike" stage.
6) Both SES and CMU (DW) were less effective if the weeds were emerging at time of application.

Literature Cited

1) Aldrich, Richard J.
Results with Post Emergence Applications of DNOSBP in Sweet Corn. Proc. 5th Annual NEWCC 1954, pp 209-210.

2) Hemphill, D. D.
Pre-Emergence and Post Emergence Weed Control in Sweet Corn. 10th Annual Res. Report, NCWCC 1953, pp 138-139.

3) Marshall, Ernest R.
Planting and Emergence Applications of Water Soluble Dinitro and CMU to Field Corn. Proc. 7th Annual NEWCC 1953, pp 169-173.

4) Trevett, M. F., R. D. Littlefield, and H. J. Murphy.
Weeding Sweet Corn with Dinitro Herbicides, 1948-1952 Proc. of the Seventh Annual NEWCC 1953, pp. 151-157.

5) ----------------, H. J. Murphy and H. E. Bradbury.
Pre-emergence Weedling of Sweet Corn with 2,4-D, Dinitro, and Isopropyl trichlorobenzoic acid. Proc. 8th Annual NEWCC 1954, pp. 193-201.

6) Sweet, R. D.

The Effect of Certain Environmental Factors on the Response of Sweet Corn to Herbicides. Proc. of 8th Annual NEWCC 1954, pp. 97-105.

Pre-emergence Weeding of Sweet Corn*

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Chemical weed control is now an important operation in the commercial culture of sweet corn. In recent years, 2,4-D and related growth regulators have provided very inexpensive herbicides for grassy crops. Even though the use of 2,4-D for weeding corn has become fairly general throughout the United States, its use in some areas is very restricted because of certain attendant disadvantages, such as drift and volatility of the chemical and susceptibility of some corn varieties. Some weeds, particularly grasses, are resistant to 2,4-D and in pre-emergence applications smartweed is a problem. Then, too, it is a much more difficult task to remove 2,4-D when cleaning out a spray tank than it is to remove other herbicides.

The object of these studies was to find an effective and economical weed killer that was not hormonelike in nature and did not have the drawbacks of 2,4-D.

Materials and Methods

Twenty-two treatments, involving nine chemicals, were applied to plots of Golden Beauty sweet corn; these treatments were replicated three times. The plots consisted of four 24-foot rows each, and the seed was planted by hand with the rows spaced 3 feet apart and the hills 3 feet apart in the row. Records were taken from the two middle plot rows only. The soil, a Scarborough very fine sandy loam, was prepared in the usual manner. A 5-10-10 fertilizer was broadcast at the rate of 2000 pounds per acre. The corn was planted on May 19, five days after the average date for the last spring frost in this locality.

The following chemicals with their respective per-acre rates were applied to the corn four days after planting: 15 and 25 pounds of sodium pentachlorophenate; 0.50, 0.75, and 1.00 pound of Karmex W; 0.50, 1.00, and 1.50 pounds of Karmex DW; 3.0, 4.5, and 6.0 pounds of Dinitro (Premerge); and 1.0 and 2.0 pounds of Amizol. Further treatments, applied eight days after planting, just as the corn seedlings were emerging, were as follows: 1.5 pounds of Kuron, 1.5 pounds of amine 2,4-D, 1.5 pounds of ester 2,4-D and 0.75 and 1.5 pounds of Trichlorobenzoic acid (TCB). Thirteen days after planting when the corn seedlings were about one and one-half inches

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high, 1.50, 3.00, and 4.50 pounds of Dinitro (Premerge) were applied. All the chemicals were diluted with water and applied at the rate of 100 gallons per acre. The sprays were applied with a Brown Open-Hed No. 4 hand-pressure sprayer fitted with a No. 8004 Spraying Systems fan-type nozzle.

The abundant weed population consisted of purslane, smartweed, lamb's quarters, chickweed, pigweed, galinsoga, ragweed and wiregrass. A sparse and variable stand of nutgrass present in the plots was not included in the weed counts. All plots were cultivated once, on July 2.

Results

The results of these tests with corn are presented in Table I. It is clearly evident that the materials tested were very effective in controlling weeds, except Amizol at the one-pound rate. The weed count in all the treated plots was significantly less than that on the check plots. Only Amizol was especially poor in suppressing a vigorous growth of weeds. Particularly effective in this respect were the higher rates of Karmex W, Karmex DW, both rates of trichlorobenzoic acid, and the higher rates of Dinitro when applied postemergence.

Differences in crop vigor of the various treatments were not significant. Although the yields of marketable ears vary considerably from plot to plot, the differences among the treatments are not significant. Some of this variation may be attributed to the damage resulting from a hailstorm on July 31.

When compared to the other hormone-type materials, TCB was particularly outstanding. General observations from these tests indicate that about one pound of TCB per acre, applied pre-emergence, would provide an ideal hormone-type herbicide for corn. Onion-leaf response was not present on any of the plots.

With the exception of Amizol, almost any of the other materials appeared to provide ideal weed-killing properties under the condition of this test as is illustrated in the photographs.

Amizol at two pounds per acre in postemergence applications produced very interesting chlorotic patterns on both weeds and corn without killing either.

Summary

Ideal weed control was accomplished with eight different materials applied as sprays in pre-emergence and with one material applied in postemergence. Trichlorobenzoic acid proved to be a valuable addition to the hormonelike materials for weeding sweet corn. It was evident that most of these materials beside displaying effective weed-killing properties displayed a fairly wide margin of safety in regard to dosage.

Table I. Effect of Chemicals on Weed Control, Growth and Yield of Golden Beauty Sweet Corn - Planted May 19, 1954. Readings made June 28, 1954.

Treatments	Applied	Rate per Acre	Weeds per Sq. ft.	Weed Vigor Rated 1-9*	Crop Vigor Rated 1-9*	Mktable ears Lbs.
Na PCP	5/23	15.0 lb.	3.3	8.0	8.3	24.3
"	"	25.0 "	1.0	8.0	7.7	20.6
Karmex W	"	0.50 "	3.0	6.0	7.0	14.5
" "	"	0.75 "	0.0	9.0	8.0	16.9
" "	"	1.00 "	0.7	9.0	8.0	16.3
Karmex DW	"	0.50 "	1.0	7.0	8.7	19.1
" "	"	1.00 "	0.0	9.0	8.3	16.6
" "	"	1.50 "	0.0	9.0	7.7	18.7
DN (Premerge)	"	3.0 "	4.0	5.7	8.0	18.3
" "	"	4.5 "	0.3	7.3	7.7	15.3
" "	"	6.0 "	0.7	8.3	7.0	17.3
Amizol	"	1.0 "	14.3	1.7	8.7	17.6
"	"	2.0 "	6.3	2.3	8.3	20.8
Kuron	5/27	1.5 "	6.3	7.3	8.3	17.8
Dow Form. 40	"	1.5 "	5.3	7.0	8.3	19.7
Esteron 10-10	"	1.5 "	7.3	7.7	8.3	22.0
TCB	"	0.75 "	1.3	9.0	7.7	19.8
"	"	1.50 "	1.3	9.0	7.7	16.6
DN (Premerge)	6/1	1.50 "	3.0	7.3	6.3	14.5
" "	"	3.00 "	1.3	8.7	8.0	17.8
" "	"	4.50 "	2.3	9.0	7.0	18.8
Check			32.3	1.0	8.0	17.9
L.S.D. at .05			12.0	4.4	N.S.	N.S.
L.S.D. at .01			16.0	5.8	N.S.	N.S.

*In the 1-9 ratings 1 is least desirable and 9 most desirable.

POST-SETTING AND LAY-BY APPLICATIONS OF HERBICIDES TO CANNING TOMATOES IN WESTERN NEW YORK

by

Harold A. Sweet and E. R. Marshall*

Introduction

Approximately 37,000 acres of canning tomatoes are grown in Western New York. Weed control in this crop is an important factor for several reasons. In addition to the usual damage from weeds such as competition for food, light and water, a heavy growth of weeds encourages the development of tomato diseases. Weeds also interfere with harvesting operations and pickers are reluctant to pick weedy fields or if they do they miss many tomato fruits when picking. For these and other reasons it would be desirable to find a chemical suitable for selective weed control in tomatoes.

Menges and Aldrich (1) and Noll and Odland (2) reported to this conference that the Sodium salt of 2,4,5, Trichlorophenoxyethyl sulfate (Natrin) looked promising as a selective weed control chemical for use in tomato planting. Their encouraging results suggested that further tests should be made in Western New York, comparing the effectiveness of Natrin with other herbicides which might show promise. Furthermore, it was desirable tolearn whether or not these chemicals might be applied immediately after transplanting as well as at lay-by. This would be an opportune time to apply a selective herbicide because it would reduce the cost of hand-hoeing, an expensive cost in tomato production. Many growers hand-hoe the weeds in the tomato rows several weeks after transplanting.

The purpose of the following tests was to study the effect of the herbicides on tomatoes when applied immediately after transplanting and at lay-by. These tests will be described separately.

Material and Methods

In the first series of plots, the following chemicals were applied: 2- Chloroethyl N- (3-Chlorophenyl) carbamate (T-595); 2 (1 Chloropropyl) N- (3- Chlorophenyl) carbamate (T-596); Isopropyl N- (3Chlorophenyl)-carbamate (CIPC); Diethanolamine salt of 2,4,5 Trichlorophenoxyethyl sulfate (7977); Sodium salt of 2,4,5,Trichlorophenoxypropyl sulfate (8148); Sodium salt of 2 methyl, 4 chlorophenoxyethyl sulfate (Methin) Diethanolamine salt of 2 methyl, 4 chlorophenoxyethyl sulfate (7976); 2 - (2,4,5,-Trichlorophenoxyethyl benzoate) (6831); Sodium salt of 2,4,5 Trichlorophenoxyethyl sulfate (Natrin), Sodium salt of 2,4-Dichlorophenoxyethyl sulfate (SES) and Sodium 2,4, Dichlorophenoxyethyl benzoate (Sesin). Two formulations of 6831 were used; one being a liquid concentrate containing 15% active ingredient (6831 liquid) the other being a 50% wettable powder formulation (6831)

*G.L.F. Soil building Service, Ithaca, New York.

Long red tomato transplants were planted by a mechanical planter on the morning of June 1,1954. The soil was a medium loam. The tomato transplants were 4-8 inches in height and in good transplanting condition. Overall spray treatments were applied to duplicated randomized plots immediately after transplanting while the plants were in the wilt. All treatments were applied with a small plot CO_2 sprayer using 25 lbs. pressure and 50 gallons of water per acre. The plots were 24 feet long and 9 feet wide covering 2 tomato rows. The plants were 2 feet apart in the row. T-595 was applied at 2 lbs. per acre, T-596 and CIPC were applied at 2 lbs. and 4 lbs. per acre. All other materials were applied at either 3 lbs. or 4½ lbs. per acre or both. A slow rain fell soon after treatments were applied and by the time this rainfall ended had measured 1/2 inch.

A second lay-by test was applied to Long Red tomatoes on July 23rd. The tomatoes had been planted June 1st and were about 14 inches in height and well branched. Green fruits on the first blossom clusters were 1-1½ inches in diameter and the second and third blossom clusters were blooming. The field had been recently cultivated and all emerged weeds that the cultivator had missed were hand pulled from the plots. Treatments were applied as an over-all spray in 50 gallons of water per acre at 25 lbs. pressure with no attempt being made to avoid spraying the plants. The plots were 22 feet long and 10 feet wide covering 2 rows of tomatoes; all treatments were replicated 4 times. The soil was very dry with the temperature 70° when treatments were applied. No rain fell in this area for two weeks after treatments were applied.

Materials applied in this lay-by test were 7977, Natrin, 6831 applied at 3 lbs. and 4 lbs. per acre and Methin and 7976 applied at 2 lbs. and 3 lbs. per acre.

Results and Discussions

Data on the post setting plots were taken on June 22nd and again on July 17th. These data are presented in Table 1. Ten days after the treatments were applied, the grower replanted the field to fill in where plants had not survived. This prevented accurate survival counts on tomato plants but did enable us to see that certain treatments did not injure these replants and suggested to us that these treatments might be successfully applied before transplanting.

The carbamates T-595, T-596 and CIPC did not injure the tomato plants seriously but gave inadequate broadleaved weed control. CIPC at the higher rate gave excellent grass control. 7977 gave good grass and weed control at the lower rate but did not control smartweed and severely injured the tomato plants. 8148 did not injure the tomato plants but gave practically no weed control at 3 or 4½ lbs. per acre. 6831 injured tomatoes somewhat and was lacking in weed control at the rates used. Natrin gave good weed control but injured tomato transplants. Methin gave good weed control but seriously injured tomatoes. Replants planted in the Methin plots did not show any injury symptoms. 7976 gave outstanding weed control at 3 lbs. per acre even superior to SES at the same rate. 7976 severely injured tomato transplants but not replants. Natrin at 3 lbs. or 4½ lbs. per acre did not injure replants. SES gave outstanding weed control but nearly eliminated all tomato transplants and injured replants. The same was true of Sesin.

Table 1. THE EFFECT OF HERBICIDES APPLIED IMMEDIATELY AFTER TRANSPLANTING ON LONG RED TOMATOES

Treatment		Weed Control*		Tomato Injury**		Remarks
		6/22	7/17	6/22	7/17	
T-595	2#/A	2.5	0	.5	0	
T-596	2#/A	2.5	2.0	3.0	0	
T-596	4#/A	5.0	4.0	4.0	3.0	
CIPC	2#/A	4.0	3.0	2.0	6.0	
CIPC	4#/A	6.0	4.0	6.0	10.0	Complete grass control
7977	3#/A	7.0	8.0	7.0	2.0	Left only smartweed
7977	4.5#/A	9.5	7.0	8.0	8.0	Replants injured
8148	3#/A	5.5	0	0	0	
8148	4.5#/A	4.0	2.0	.5	1.0	
6831 liq.	3#/A	5.5	4.0	2.5	3.0	
6831	4.5#/A	5.5	7.0	4.0	8.0	No injury to replants
Natrin	3#/A	9.5	9.0	8.0	10.0	" " " "
Natrin	4.5#/A	9.0	8.0	8.0	9.0	" " " "
Methin	3#/A	9.5	9.0	8.5	9.0	No injury to replants
7976	3#/A	10.0	10.0	9.0	9.0	Excellent control- no injury to replants
SES	3#/A	10.0	9.0	9.0	9.0	Replants injured
SES	4.5#/A	10.0	10.0	9.0	9.0	Replants injured
Sesin	3#/A	9.5	8.0	6.5	9.0	" "
Sesin	4.5#/A	8.5	9.0	8.0	10.0	Severe injury to replants

* 0 = No weed or grass control, 10 = Perfect control of weeds & grass

**0 = No plant injury, 10 = complete kill of plants

Table 2. EFFECT OF LAY-BY APPLICATIONS OF HERBICIDES ON LONG RED TOMATOES

Treatment	Weed Control* 9/4 Weeds & Grass	10/11 Weeds	10/11 Grass	Plant Injury** 8/26	Plant Injury** 9/24
7977 3#/A	9.0	8.8	7.0	0	2
7977 4#/A	10.0	9.8	8.0	2	4
Natrin 3#/A	8.0	10.0	8.5	4	2
Natrin 4#/A	9.0	10.0	9.5	4	6
6831 3#/A	8.0	8.0	4.8	6	8
6831 4#/A	9.0	7.5	4.5	8	9
Methin 2#/A	10.0	10.0	9.2	4	2
Methin 3#/A	10.0	10.0	9.2	6	4
7976 2#/A	10.0	10.0	7.0	2	6
7976 3#/A	10.0	9.8	8.0	4	8
Check	0	0	0	0	0
L.S.D. .05		1.2	1.8		
L.S.D. .01		1.7	2.4		

* 0 = No weed or grass control, 10 = Perfect weed and grass control
** 0 = No plant injury, 10 = Complete kill of plants

Data from the lay-by test are presented in Table 2. On August 26th weed growth had not proceeded to the point where control ratings could be made so only injury symptoms are presented. On September 4th both injury symptoms and weed control data were taken. On October 11th after the first frost final weed control ratings were taken.

7977 at 3 lbs. and 4 lbs./A gave good weed control and only slight injury; this injury being manifest by slight nodular swelling. This injury was not serious. Natrin gave slightly more injury than 7977 but better weed control. 6831 at 3 lbs. and 4 lbs./A gave inferior weed control and severe injury, resulting in visual decreases in yield and plant stunting by the time of the first frost. Methin at 2 lbs./A gave excellent weed control and only slight injury. At 3 lbs./A Methin gave some injury. Methin at 2 lbs./A gave results comparable to Natrin at 4 lbs./A. 7976 gave excellent weed control but moderate to severe injury at both 2 lbs. and 3 lbs./A.

The materials showing the most promise at the time of lay-by in order of preference were Natrin, 7977 and Methin.

Much of the injury occurring early did not seem to effect the later yield of the plants.

Summary and Conclusion

None of the chemicals tested were satisfactory when applied immediately after transplanting, either because of lack of weed control or severe plant injury.

Replants set in plots having been treated with 3 lbs./A Methin, 4½ lbs./A 6831, 3 lbs. and 4½ lbs./A Natrin, 10 days after treatment did not show visible signs of injury when examined later. This suggested that these materials might be used satisfactorily when applied before planting tomato plants.

The results of lay-by applications of Natrin were in agreement with those of Menges and Aldrich (1) and Noll and Odland (2). In addition other materials which gave satisfactory results insofar as weed and grass control and lack of injury was concerned were 7977 and Methin.

It is the authors' opinions that large scale growers' trials should be conducted comparing Natrin, 7977 and Methin for selective weed control at lay-by in tomatoes.

(1) Menges, Robert M. and Richard J. Aldrich. A comparison of Crag, Derivatives of Crag and CMU for pre-emergence weed control in tomatoes.
Proc. N.E.W.C.C. 1954: 137-143. 1954

(2) Noll, Charles J. and Martin L. Odland. Chemical herbicides as they effect yield of tomatoes.
Proc. N.E.W.C.C. 1954: 191-192. 1954

THE RESPONSES OF TOMATOES TO NATRIN AND DERIVATIVES AS AFFECTED BY TIME OF APPLICATION AND IRRIGATION[1]

Robert M. Menges and Richard J. Aldrich[2]

2,4-dichlorophenoxyethyl sulfate (SES) and several derivatives appear to be especially dependent on soil moisture for their effect on both weeds and crop plants. It was indicated by Kates (1) that, in sweet corn, addition of water after application of SES enhanced weed control but decreased yields. Sweet (2) has reported that after applying 3.1 inches of water subsequent to SES applications in sweet corn, marked crop injury was observed. Contrasting results (3,4,5) using SES and derivatives in tomatoes might be explained partially by the effects of water relationships in the soil after chemical application.

The present experiment was primarily initiated to compare the relative effectiveness of the chemicals in weed control and to measure the response of tomatoes to the chemicals. The earlier findings have suggested the need of field studies to include the effect of different irrigation levels following applications of certain derivatives of 2,4-dichlorophenoxyethyl sulfate. Chemicals were to be applied at the early or late stage of plant growth in order to compare chemical toxicities at these stages.

Materials and Methods

The chemicals tested were: 2,4,5-trichlorophenoxyethyl sulfate, a compound related to 2,4,5-trichlorophenoxyethyl sulfate, and the diethanolamine salt of 2,4,5-trichlorophenoxyethanol; these materials are referred to in the remainder of this paper as Natrin, E.H. 6831, and E.H. 7977 respectively.

A split-split-plot design with 3 replications was used. The smallest division was a check and 2 rates of the chemicals. The next division was early and late application. The largest division was 2 levels of irrigation namely 1/4 and 1½ inches. This latter division merely split the experiment in half.

Rutgers variety tomatoes were transplanted June 2, 1954 to a Sassafras sandy loam soil. The plant spacing was 3.5 feet by 3.5 feet in plots 2 by 6 hills in size. Data were recorded on 2 by 5 hills in each plot. The plants were dusted throughout the season with 3% DDT as required for insect control. Fertilizer of a 10-10-10 analysis was applied as recommended. Plots were maintained weed-free with cultivation and hand-hoeing until the date of treatment.

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[1]Cooperative investigations between the New Jersey Agricultural Experiment Station and the Field Crops Research Branch, Agricultural Research Service, U.S. Dept. of Agriculture.

[2]Research Fellow in Farm Crops, Rutgers University, and Agronomist, Field Crops Research Branch, ARS, U.S. Dept. of Agriculture, respectively. Acknowledgement is made to the Carbide and Carbon Chemical Company for their support of this project.

The chemicals were applied in 100 gallons of solution per acre on either June 30 or July 28. At the time of the late spray, July 28, the tomato plants were in primary stages of blossoming. Sprays were directed over the entire plant in order to note any deleterious effects of the chemical on the plants. A bicycle-type sprayer was used for chemical applications. The rates used were $2\frac{1}{2}$ and 5 pounds per acre of each chemical. Immediately following the early treatment, the soil of one-half of the experiment was irrigated to a depth of 1/4 inch and the remainder to a depth of $1\frac{1}{2}$ inches. This variable in soil moisture was maintained for approximately 4 weeks. No test for irrigation levels was possible after the late application due to frequent rains.

Observations were made periodically on the condition of the plants. Broadleaf and grass weeds were counted approximately five weeks after the early application. Visual estimates of percentage weed control on each plot were made seven weeks after the early application. No data were recorded concerning weed control after the late application as there was practically no weed problem. Notes were recorded during harvests concerning the chemical effects on the fruit. Harvests were made August 19, 26 and 30, September 3, 7, 10, 15, 23 and 29, and October 6.

Results and Discussion

The treated plants exhibited epinastic and formative effects from the early-applied chemicals during the second week after application. No differences in chemical injury could be noted between treated plots irrigated to a soil depth of 1/4 inch and those irrigated to a depth of $1\frac{1}{2}$ inches. No differences in injury were recorded between the rates of any one chemical. Plants treated with E.H. 6831 were most seriously affected as shown by epinasty, leaf plasticity and stem proliferations. Plants treated with Natrin were considerably injured whereas those treated with E.H. 7977 were only moderately injured. Occasionally nodal swellings and stem proliferations were observed on plants treated with any one chemical. Treated plants recovered most rapidly from E.H. 7977, followed by Natrin, then E.H. 6831. Recovery was somewhat more rapid in all treated plots irrigated 1/4 inch.

The results given in Table 1 show that there was no appreciable difference in weed control between the chemicals applied with 1/4 inch irrigation and the same chemicals applied with $1\frac{1}{2}$ inches of irrigation. Natrin and E.H. 7977 controlled weeds very satisfactorily at both rates of application whereas comparable rates of E.H. 6831 were somewhat inferior in weed control. Weed counts show that these materials controlled broadleaves and grasses equally well.

Table 1. Effect of early applications of Natrin and derivatives on weed control in tomatoes. New Brunswick, N.J. 1954.

Pounds of chemical applied per acre		Percentage Control - Average of 3 replications	
		1/4 inch irrigation	$1\frac{1}{2}$ inches irrigation
Natrin	$2\frac{1}{2}$	83.3	88.3
	5	90.8	95.8
E.H. 6831	$2\frac{1}{2}$	75.8	67.5
	5	80.8	80.0
E.H. 7977	$2\frac{1}{2}$	74.2	85.8
	5	90.3	92.5
Cultivated check		97.5	95.8
Ave. all chemicals		82.5	84.9

Although there were 4.35 inches of rain recorded within two weeks after the late spray application, the plants treated with Natrin and E.H. 7977 exhibited only very slight hormone effects. Plants treated with E.H. 6831, however, showed moderate hormone effects. Occasionally, a plant possessing stem proliferations could be observed in plots treated with any of the three materials.

Table 2 illustrates a trend toward higher yields resulting from either the late applications of chemicals or checks over those yields from the early applications. The yields obtained from the 5 pound per acre rates of application of each chemical were somewhat higher than yields from plants treated with the same rate of Natrin.

An attempt was made to discover the possibility of increased early fruit-set due to chemical application. SES and related materials tended to increase early fruit-set in the 1953 harvests. However, 1954 yields of treated plots from the first four harvests have shown no increase over yields of checks from the same harvests.

There was a tendency for the average size of treated fruit from late applications to be larger than that from early applications.

It is evident from Table 3 that the chemicals generally did not increase the percentage of discard fruit above that of checks. The 5 pound rate of each chemical increased the percentage discard fruit slightly over that percentage resulting from the $2\frac{1}{2}$ pound applications. The 5 pound rate of Natrin apparently caused somewhat higher percentage discard fruit than

Table 2. Yields of tomatoes as influenced by applications of Natrin and derivatives, New Brunswick, N. J. 1954.

Pounds of chemical per acre		Total pounds from 30 plants				
		1/4 inch irrigation		1½ inches irrigation		Average of irrigations and dates
		Early treatment	Late treatment	Early treatment	Late treatment	
Natrin	2½	280.0	348.8	278.3	374.8	320.5
	5	336.1	320.2	205.6	294.4	289.1
E.H. 6831	2½	301.3	345.2	304.5	356.2	326.8
	5	252.4	379.2	254.5	363.1	312.3
E.H. 7977	2½	316.7	347.5	309.7	331.2	326.3
	5	361.6	315.0	227.5	351.2	313.8
Average of all treated plots		308.0	342.6	263.4	345.2	314.8
Average of irrigations and chemicals		325.3		304.3		
Cultivated check		376.7	400.2	384.2	317.6	369.7
Uncultivated check		331.4	355.2	249.9	401.2	334.4

Table 3. Discard fruit as influenced by applications of Natrin and derivatives, New Brunswick, N. J. 1954.

Pounds of chemical per acre		Average percentage discard fruit in 3 reps. (4 harvests)				
		1/4 inch irrigation		1½ inches irrigation		Average irrigations and dates
		Early treatment	Late treatment	Early treatment	Late treatment	
Natrin	2½	40.3	55.0	38.1	41.2	43.7
	5	40.0	48.8	53.5	59.7	50.5
E.H. 6831	2½	36.8	42.9	50.3	37.5	41.8
	5	43.9	31.7	45.2	46.7	41.9
E.H. 7977	2½	28.6	34.4	44.9	47.6	38.9
	5	40.1	44.0	50.0	43.7	44.4
Average of all treated plots		42.1	42.8	47.0	46.1	44.5
Cultivated check		34.0	43.9	38.9	48.5	41.3

did the same rates of E.H. 6831 and E.H. 7977. Early applications of each chemical tended to increase the percentage discard fruit whereas late applications had no effect.

The exterior quality of the fruit was generally mediocre during the summer of 1954 due to stem-end cracking. Table 4 shows that quality differences between chemicals were small. Rate of application, time of application, and irrigation level did not materially influence seedlessness.

Table 4. Exterior quality of tomato fruit as influenced by applications of Natrin and derivatives, New Brunswick, N. J. 1954.

Pounds of chemical per acre		Average ratings of 3 replications (total harvest)[1]				
		1/4 inch irrigation		1½ inches irrigation		Average irrigations and dates
		Early treatment	Late treatment	Early treatment	Late treatment	
Natrin	2½	3.0	2.9	2.9	3.0	3.0
	5	3.0	2.9	3.3	3.1	3.1
E.H. 6831	2½	2.8	3.4	2.8	3.0	3.0
	5	3.1	2.9	3.2	3.2	3.1
E.H. 7977	2½	2.7	2.8	3.1	2.9	2.9
	5	2.6	3.1	3.1	2.8	2.9
Average all treated plots		2.9	3.0	3.1	3.0	3.0
Cultivated check		2.7	2.7	2.7	3.0	2.8

[1]Quality ratings:
1 = excellent   4 = poor
2 = good   5 = very poor
3 = fair

Summary

Although the data presented has not yet been satistically analyzed, several conclusions may be drawn.

Natrin and E.H. 7977 at 2½ and 5 pounds per acre effectively controlled both broadleaf and grass weeds. Comparable rates of E.H. 6831 were somewhat less effective. Different levels of irrigation did not affect weed control.

Hormone effects exhibited in plants early-sprayed with E.H. 7977, Natrin, and E.H. 6831 were moderate, considerable and serious, respectively. Chemical applications supplemented with 1/4 inch of water affected the hormone display the same as those applications with $1\frac{1}{4}$ inches of water.

Regardless of wet weather following the late applications, the only material causing appreciable hormone effects in t... plants was E.H. 6831.

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Progress Report
On the Use of
Experimental Herbicide NATRIN 80S
in Tomatoes

R. J. Zedler
Carbide & Carbon Chemicals Company

Experimental Herbicide
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at 20 locations. These
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IATRIN is an extremely pro-
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weed control in tomatoes and

ather	Weed Control	Crop Response
equate isture	Satisfactory	Slight injury
equate isture	Satisfactory	Severe injury
	Satisfactory	
ery hot dry	Satisfactory	All plants killed

Location & Researcher	Dosage in lbs./Acre	Time of Application	Weather	Weed Control	Crop Response
New Jersey (R. M. Menges)	2-1/2 & 5	Approx. at transplanting	Irr.	Satisfactory	Some injury
(R. M. Menges)	2-1/2 & 5	Approx. at transplanting	Not irr.	Satisfactory	Some injury
New York (R. D. Sweet)	2 & 4	Approx. at transplanting	Wet (irr.)	Satisfactory	None
Pennsylvania (C. J. Noll)	3 & 4-1/2	Approx. at transplanting	Wet (irr.)	Unsatisfactory	None
(C. J. Noll)	3 & 4-1/2	Approx. at transplanting	Wet (no irr.)	Unsatisfactory	None
Ontario, Canada (J. J. Neilson)	5	Approx. at transplanting	Very dry	No problem too dry	None
(C. G. Waywell)	4	Approx. at transplanting	Fair moisture conditions	Satisfactory	Slight
(C. G. Waywell)	6	Approx. at transplanting	Fair moisture conditions	Satisfactory	Severe
Indiana (G. F. Warren)	4 & 8	At approx. 1st bloom	Hot & dry	No problem	None
Michigan (S. K. Ries)	2 & 4	At approx. 1st bloom		Satisfactory	
Missouri (D. D. Hemphill)	4	At approx. 1st bloom	Very hot & dry	Unsatisfactory	Considerable injury
(D. D. Hemphill)	6	At approx. 1st bloom	Very hot & dry	Satisfactory	Serious injury
(D. D. Hemphill)	8	At approx. 1st bloom	Very hot & dry	Satisfactory	Killed all plants
New Jersey (R. M. Menges)	2-1/2 & 5	At approx. 1st bloom	Wet	No problem	None
New York (Boyce Thompson Institute)	3	At approx. 1st bloom	Wet (irr.)	Fair	Slight injury
(Boyce Thompson Institute)	3	At approx. 1st bloom	Average	No records taken	None

Location & Researcher	Dosage in lbs./Acre	Time of Application	Weather	Weed Control	Crop Response
Ohio (H. J. Heinz Co.)	4	At approx. 1st bloom	Average	Satisfactory	None
Pennsylvania (C. J. Noll)	3 & 4-1/2	At approx. 1st bloom	Wet (irr.)	Unsatisfactory	None
(C. J. Noll)	3 & 4-1/2	At approx. 1st bloom	No irr.	Unsatisfactory	None
Ontario, Canada (W. Ferguson)	5	At approx. 1st bloom	Cool & wet	Satisfactory	Slight
Pennsylvania (C. J. Noll)	3 & 4-1/2	At approx. transplanting & at approx. 1st bloom	Wet (irr.)	Unsatisfactory	None
(C. J. Noll)	3 & 4-1/2	At approx. transplanting & at approx. 1st bloom	No Irr.	Unsatisfactory	None
Delaware (E. M. Rahn)	1-1/2 & 3	At lay-by	Very dry	No problem too dry	None
Illinois (Campbell Soup Co.)	4	At lay-by	Wet	No problem	None
Indiana (G. F. Warren)	4 & 8	At lay-by	Irr.	No problem	None
Maryland (A. A. Duncan)	6	At lay-by	Dry	Satisfactory	Slight injury
New Jersey (Campbell Soup Co.)	2 & 4	At lay-by	Wet	Fair control erratic	None
New York (L. W. Feddema)	2 & 4	At lay-by	Dry	Satisfactory	None
(W. A. Stern)	1	At lay-by	Dry	No problem too dry	None
(R. D. Sweet)	2 & 4	At lay-by	Dry (irr.)	No problem too dry	None
Virginia (L. L. Danielson)	2 & 4	At lay-by	Dry (Crop irr.)	Satisfactory	Slight injury

Location & Researcher	Dosage in lbs./Acre	Time of Application	Weather	Weed Control	Crop Response
Virginia (W. E. Chappell)	2			No problem	None
Alberta, Canada (R. J. Hilton)	6		Wet	Satisfactory	Slight injury

PRELIMINARY REPORT ON THE CONTROL OF QUACKGRASS AND ANNUAL WEEDS IN MICHIGAN ASPARAGUS PLANTINGS (1)

By

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Introduction

Quackgrass (Agropyron repens) has become the principle weed problem in Michigan asparagus plantings since the general use of new herbicides. With good cultural conditions an asparagus planting may remain a profitable crop for 15 or 20 years. A few isolated clumps of quackgrass if not removed, will become a serious problem in one or two years and thus shorten the profitable cutting period of an asparagus planting.

The satisfactory control of annual weeds in asparagus with CMU has been reported by Carlson and Grigsby (1) Dolan (2) and Kates (3). Dolan (2) used 50 and 75 lb. 90% sodium TCA per acre in addition to CMU treatments but stated that differences in grass control from these treatments were not significant based on counts made 30 days after treatment. Full effect of the TCA treatment was probably not evident from counts made after such a short time interval. Peters (4) comparing dalapon sodium salt with sodium TCA concluded that dalapon offered promise as an herbicide for quackgrass because its action is largely independent of rainfall.

The Report of The Research Coordinating Committee of the Northeastern Weed Control Conference for 1954 stated that one of the problems needing more work was the control of perennial grasses in asparagus. The North Central Weed Control Conference has had no recommendation for perennial grass control in asparagus.

The objective of this work was therefore to find a treatment or combination of treatments which would give satisfactory quackgrass control in asparagus.

Materials and Methods

The tests described here were conducted in four fields located in southwestern and central Michigan and in some test plots at East Lansing. Ages of the plantings ranged from three to ten years. The soils were predominantly loamy sand or sandy loam.

The following materials were used:

Dalapon (2,2-dichloropropionic acid) sodium salt, 68% acid equivalent,

CMU (3-(p-chlorophenyl)-1,1-dimethylurea - 80%)

(1) Journal article 1694 of Michigan Agricultural Experiment Station

Silvex (2(2,4,5-trichlorophenoxy)propionic acid) propylene glycol butyl ether ester, 4 lb. acid equivalent.

The tests applied in southwestern and central Michigan were made with a modified power garden sprayer which applied the spray at the rate of 30 gallons per acre. The equipment used at East Lansing was a hand sprayer which also delivered 30 gallons of spray per acre.

Treatments were evaluated by making counts of the green quackgrass shoots in replicated one half square yard areas.

Results

Dalapon sodium salt was used in 1953 by R. F. Carlson at East Lansing at concentrations of 3 and 5 pounds acid equivalent per acre as an after harvest spray in a screening test in asparagus. In 1954 a preharvest application of dalapon sodium salt was applied on these same plots by the authors. The amount of dalapon was increased to 5 and 10 pounds per acre respectively on the plots previously receiving 3 and 5 pounds.

The 1954 yield on these single plots from eighteen cuttings on the 3 and 5 pound treatments was, 55 pounds of snapped asparagus, compared to 50 pounds from an adjacent check. The 5 and 10 pound combined application yielded 37 pounds compared to 35 pounds from an adjacent untreated plot.

An eight year old asparagus field with a uniform heavy infestation of quackgrass in southwestern Michigan was used for comparing preharvest (April 28) and postharvest (June 26) applications of dalapon. On April 28 the quackgrass was approximately 6" to 8" tall after early spring discing. On June 26 the quackgrass was heading. Before the latter spraying asparagus fern growth was cut so as to reduce the possibility of absorption of the spray by the asparagus foliage. Plot size was 60 feet square or larger. Quackgrass control observations made on August 10 and November 11 are shown in Table 1.

Table 1. Ratings of Quackgrass Control From Preharvest and Post Harvest Applications of Dalapon Sodium Salt in an Asparagus Planting

Treatment	(lbs. per Acre)	Date Applied	Quackgrass Control August 10	Quackgrass Control November 11
Untreated			1	1
	3.5	April 28	1	1
Dalapon	7	April 28	4	2
(acid equivalent)	7	June 26	4	3
	13.5	April 28	5	3.5
	13.5	June 26	5	4
	20.5	June 26	5	4.5

Ratings 1 to 5   1 - No control of quackgrass.
5 - No green quackgrass showing.

Quackgrass control appeared good during the summer from rates as low as 7 pounds per acre. Rainfall during the summer was average but in September and October rainfall was much above normal and regrowth of quackgrass occurred in all plots. The 13.5 pound and higher rates continued to give good quackgrass control even under the favorable conditions of growth which occurred in the fall.

A ten year old asparagus planting in the west central portion of Michigan was used for a postharvest experiment with dalapon. The owner was about ready to abandon this field due to the heavy growth of quackgrass over the entire planting. Duplicate plots 20 feet by 60 feet received dalapon sodium salt at 6.8, 13.6 and 20.4 pounds acid equivalent per acre. Sprays were applied June 22 when quackgrass was heading. In this test the asparagus fern growth was not removed prior to spraying. Observations on August 4 indicated all treatments to be equally effective in showing no quackgrass growth. Table 2 shows the quackgrass control indicated by shoot counts made November 8.

Table 2. Quackgrass Control In Asparagus From After Harvest Applications of Dalapon, Sodium Salt Applied June 22.

Treatment	(lbs. per Acre)	Average Number of Quackgrass Shoots In 1/2 Square Yard Area - November 8
Untreated		232**
Dalapon	6.8	80
(acid equivalent)	13.6	47
	20.4	13

** The F value from the analysis of variance for no treatment versus treatment was significant at 1%.

Another experiment was conducted in a three year old asparagus planting adjacent to the one described above. This field had been given an after harvest discing 4 days prior to spraying. Most of the quackgrass foliage and some annual weed foliage was showing. Asparagus fern growth was snapped off prior to spraying. Duplicate plots 10 feet by 60 feet were sprayed June 22, 1954. Table 3 shows the average weed control ratings of annual weeds and quackgrass at two dates of observation, August 4 and November 8. The predominant weed species were: Quackgrass (Agropyron repens), yellow foxtail (Setaria lutescens), ragweed (Ambrosia artemisiifolia) and lambsquarters (Chenopodium album).

Table 3. Weed Control Ratings on Annual Weeds and Quackgrass. Figures Are An Average of Observations Made August 4 and November 8

Treatment	(lbs. per Acre)	Average Weed Control Ratings: Annual Weeds	Quackgrass
Untreated		1.0	1.0
Dalapon (acid equivalent)	6.8	2.2	3.8
Dalapon (acid equivalent)	13.6	4.0	5.0
CMU (active)	2	3.8	1.0
Silvex ester (acid equivalent)	4	3.8	1.1
Dalapon 13.6 lb. + CMU 2 lb.		5.0	5.0
Dalapon 13.6 lb. + Silvex 4 lb.		5.0	5.0
L.S.D. at 5%		.8	.6
L.S.D. at 1%		1.2	1.0

Ratings 1 to 5   1 - No control of quackgrass.
5 - No green quackgrass showing.

The 13.6 lb. per acre rate of dalapon either alone or in combination with CMU or silvex gave excellent control of quackgrass and annual weeds.

Annual weed control in general from CMU and silvex was good. The ratings shown in Table 3 reflect the presence of ragweed which was not controlled. The combination of silvex and dalapon may have resulted in slight stunting of asparagus.

Although no evidence of injury to asparagus was noted from the applications of dalapon sodium salt made in these experiments it should be noted that this report covers primarily the results from only one season. The limited trials of repeated applications did not show any injury this year but should be repeated and tried on various soil types.

The control of quackgrass in fields to be planted to asparagus is one of the most important steps in field preparation. Preplanting treatments of dalapon sodium salt made in the fall preceeding spring planting is an aid in quackgrass control. Table 4 shows the degree of quackgrass control obtained from dalapon applications made at two different dates during the preceeding fall. Duplicate 1/4 acre plots were used in this experiment. The first application date on August 26 was made after the quackgrass sod had been thoroughly disced and only the exposed roots were showing. The second application date was October 9 when quackgrass foliage growth was 6 to 8 inches tall.

Table 4. Quackgrass Control From Preplanting Applications of Dalapon Made the Preceeding Fall.

Treatment	(lbs. per Acre)	Date of Application	Average Number of Live Quackgrass Shoots In 1/2 sq. yd. area April 9, 1954
Untreated			70.5
	10	August 26, 1953	5.3
Dalapon	20	August 26, 1953	1.8
(acid equivalent)	10	October 9, 1953	3.4
	20	October 9, 1953	0.3

The degree of quackgrass control obtained in this experiment when accompanied by deep plowing in the spring and normal crop cultivation was excellent.

Summary

Quackgrass control in asparagus was obtained from dalapon sodium salt at concentrations ranging from 7 pounds to 15 pounds acid equivalent per acre. Quackgrass regrowth may occur at the lower rates when favorable growth conditions occur. Combinations of dalapon at the 15 pound acid equivalent rate with CMU or silvex gave excellent all season control of both annual weeds and quackgrass. The combination of dalapon and silvex may be somewhat injurious to asparagus when used as a post-emergence spray.

It is probable that some quackgrass regrowth will occur late in the fall and repeat applications the following spring will be necessary for complete eradication.

Before this program can be recommended more information on yield, soil type and residue information is necessary. Preplanting treatments of dalapon applied in the fall preceeding asparagus planting in the spring may be an aid in preparing a field for asparagus.

Literature Cited:

1. Carlson, R. F. and Grigsby, B. H. Weed Control in Established Asparagus Plantings With CMU. Proceedings Northeastern Weed Control Conference, pp 73-76. 1954

2. Dolan, D. D. Pre-Emergence Treatments For Weed Control In Asparagus. Proceedings Northeastern Weed Control Conference, pp 117-118. 1953.

3. Kates, A. H. Chemical Weed Control in Asparagus In Newly Set Beds and Older Established Beds - 1953. Proceedings Northeastern Weed Control Conference, pp 63-65. 1954

4. Peters, R. A. Some Factors Involved In The Chemical Control of Quackgrass. Proceedings Northeastern Weed Control Conference, pp 257-264. 1954

EFFECT OF KARMEX-W ON THE FLAVOR OF CANNED AND FROZEN ASPARAGUS

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Karmex-W (formerly CMU) has been reported as an effective herbicide for asparagus (1,2,3,4 and 5). Weed control persists for two to three months, and no injury to asparagus has been reported. Kates (2) reported no effect of Karmex-W on the flavor of frozen asparagus, but no reports were found in the literature concerning canned asparagus.

The purpose of this paper is to report on a study concerning the effect of Karmex-W on frozen and canned asparagus.

Materials and Methods

Two asparagus fields, each about one acre in area, were used for this study. The soil was Evesboro loamy sand. One field was used for the frozen asparagus test, and the canning test was conducted with spears from the second field. Methods and results for the two tests will be presented separately.

Frozen Asparagus. Karmex-W was sprayed at the rate of two pounds per acre (active ingredient) to one-half of a small asparagus field on April 22, 1954. The untreated half of the field served as the control. No asparagus had emerged at the time of treatment. Asparagus was harvested from this field once each week, starting April 27 and continuing through June 14, 1954. The asparagus from each picking in this series was prepared for freezing according to standard practices, which include washing, blanching, packaging and freezing. The material was held in frozen storage for subsequent flavor evaluation, which was begun on September 27, and continued through October 13, 1954.

Canned Asparagus. On June 1, 1954, Karmex-W was sprayed at two pounds per acre (active ingredient) to one-half of the second asparagus field, leaving the unsprayed area to serve as a control. Spears were emerged at the time of treatment, and were contacted by the spray. These same spears were harvested on June 1 for taste study, and subsequent cuttings were made on June 2,3,4,7 and 14, 1954. The asparagus from each harvest was canned on the day received, according to standard canning practices, and was held for flavor evaluation. These evaluations were started on October 15 and concluded on October 25, 1954.

Flavor Tests. Flavor evaluations on the asparagus were made using the triangle test technique (6). In the triangle test, two samples were alike and one was different. Each judge received three coded samples on a divided plate. He was then asked to select the odd sample. Two triangle tests were made on each harvest of asparagus by each judge. The panel size varied from seven to nine judges.

Asparagus which had been frozen was cooked and served hot to the panel.

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That which had been canned was served at room temperature.

The panel judgements on each set of samples were analyzed statistically to ascertain whether flavor differences were detectable.

Results

Frozen Asparagus. A difference in the flavor of Karmex-W treated frozen asparagus was detected in two of the eight sampling dates, and not detected in the other six (Table 1).

Table 1. Frozen Asparagus

Harvest Date 1954	A flavor difference between Karmex-W treated sample and the control was:
April 27	not detectable
May 4	not detectable
May 11	not detectable
May 18	not detectable
May 25	detectable*
June 1	detectable*
June 7	not detectable
June 14	not detectable

*Significant at .05 level.

Canned Asparagus. No flavor difference due to Karmex-W treatment could be detected in the canned asparagus (Table 2).

Table 2. Canned Asparagus

Harvest Date 1954	A flavor difference between Karmex-W treated sample and the control was:
June 1	not detectable
June 2	not detectable
June 3	not detectable
June 4	not detectable
June 7	not detectable
June 14	not detectable

The above results do not indicate whether or not the flavor difference due to Karmex-W was of practical significance. The results indicate only that the panel was able to detect a difference and identify the treated and untreated frozen samples harvested on May 25 and June 1.

In order to determine whether the flavor difference due to Karmex-W was of great enough magnitude to be significant to the processing trade, quality control personnel from the trade will be called in to examine subsequent samples. If the differences are no greater than the normal day to day variation permitted by the commercial quality control workers, the difference can be considered insignificant. On the other hand, if the detectable difference due to Karmex-W is greater than the normal variation allowed by the commercial quality control people, then the difference would be undesirable from the standpoint of maintaining a uniform product.

Any evaluation of differences by commercial quality control personnel will have to be carried out at a later date.

Summary

Flavor evaluations were made on asparagus which had been treated with Karmex-W at two pounds per acre. Out of eight weekly harvest dates, a detectable flavor difference was found between treated and untreated (frozen) asparagus on only two of the harvest dates. Another field was treated similarly with Karmex-W, and six harvests were made for a canning test. No difference in flavor could be detected between treated and untreated canned asparagus at any of the harvest dates.

References

1. Carlson, R.F. and B.H. Grigsby. Weed control in established asparagus plantings with CMU (3-(p-chlorophenyl)-1, 1 dimethylurea), Proc. N.E.W.C.C.:73-76. 1954.

2. Kates, Allen H. Chemical weed control in asparagus in newly set beds and older established beds - 1953. Proc. N.E.W.C.C.:63-67. 1954.

3. Marshall, E.R. and N.A. Ferrant. Preliminary results with several new herbicides applied to asparagus plantings. Proc. N.E.W.C.C.:59-62. 1954.

4. Noll, Charles H. and Martin L. Odland. Weeding of seedling asparagus in a pre-emergence application. Proc. N.E.W.C.C.:55-58. 1954.

5. Rahn, E.M. CMU-Value for weed control and effect on yields of asparagus. Proc. N.E.W.C.C.:69-71. 1954.

6. Roessler, E.B., J. Warren and F.J. Guyman. Significance in triangular taste tests. Food Research 13:503-505. 1948.

HERBICIDES FOR TOMATOES

by

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Tomatoes are one of the few remaining important vegetable crops for which there is as yet no chemical commercially accepted for weed control purposes. It has been reported (1,2,3,4) that such materials as Crag, Natrin, Sesin, and CMU show promise.

The purpose of these tests was twofold (A) to screen additional chemicals for possible use as tomato herbicides, and (B) to study more intensively, Natrin, the material that seems to be one of the best selective herbicides commercially available.

METHODS

Screening tests were conducted on a well drained silt loam soil with an organic content of about 4.0% and pH of about 6.0. The principal weed pest was redroot pigweed, *Amaranthus retroflexus*. The variety of tomato used was Longred. Moderately hardened plants about 8 weeks of age were set into the field on June 8 and 9th. The following day treatments were sprayed in a 2-foot strip directly over the plants. The remaining 3-foot space was kept weed-free by mechanical cultivation. Each plot was a single row containing 7 plants spaced 3 feet apart in the row. There were two replications.

On the afternoon of June 11 and morning of June 12 a total of 1 inch of overhead irrigation was applied. The slow rate of irrigating was used to prevent run-off and possible border effects between treatments. Later that same day a series of showers occurred which supplied slightly more than an additional 1 inch of water.

Later in the season on July 14, when the tomato plants had small fruit on at least one cluster, but before the vines had gone down, a second area of the tomato field was treated with some of the more promising chemicals applied a month earlier. Also two new ones were added. No chemical was applied on plants that had received an early treatment. Irrigation at the rate of 1 inch was applied immediately after treating.

A list of chemicals and rates used are given in Table 1. In addition 14 unidentified chemicals from the American Chemical Paint Company and 2 from the Standard Oil Development Company were applied. The results with these latter 16 chemicals will not be presented.

Data were recorded on weed control, vine growth, fruit set and yield of field-ripe fruit.

1/ Paper No. 385 of the Department of Vegetable Crops.

2/ Part of this research was made possible by grants in aid from Carbide and Carbon Chemicals Corp. and from Standard Oil Development Co.

Table 1. Chemicals and their designations used as herbicides on tomatoes.

Designation	Active Ingredient
1. Silvex	2(2,4,5-trichlorophenoxy) proprionic acid
2. Kuron	propylene glycol butyl ether esters of Silvex
3. TCB (S)	sodium salt of 2,3,6 isomer of trichlorobenzoic acid
4. TCB (AD)	dispersible acid " "
5. Crag 1	2,4-dichlorophenoxy ethyl sulfate
6. Natrin	2,4,5-trichlorophenoxy ethyl sulfate
7. Sesin E	emulsifiable 2,4-dichlorophenoxy ethyl benzoate
8. Sesin 50 W	wettable powder "
9. 6711	Na 2 methyl-4 chloro ethyl sulfate
10. 6831 WP	wettable powder Crag-1 type derivative
11. 6831 L	emulsifiable " "
12. 7976	diethanolamine 2-methyl 4-chloro phenoxy ethyl sulfate
13. 7977	" 2,4,5-trichloro phenoxy ethyl sulfate
14. 8148	Crag-1 type derivative
15. Karmex W	3-(p-chlorophenyl)-1, 1-dimethylurea
16. Karmex DW	wettable powder 3-(3,4-dichlorophenyl)-1, 1-dimethylurea
17. Karmex DL	emulsifiable " "
18. Karmex FW	phenyl dimethyl urea
19. Amizol	3-Amino 1,2,4-triazole
20. Dalapon	sodium salt of 2,2 dichloroproprionic acid
21. 6249	proprionic derivative similar to Dalapon

Table 2. Tomato and weed response to herbicides applied at transplanting and at lay-by.

Treatment Chemical	Rate	Vine Growth 1/ Trpl.	Vine Growth 1/ Lay-by	Fruit 2/ Set Trpl.	Weed 3/ Control Trpl.	Yield-lbs./plot Trpl.	Yield-lbs./plot Lay-by
Silvex	2 oz.	8.0	-	12	4.0	51.4	-
"	4 "	6.0	-	7	6.5	32.4	-
Kuron	2 "	6.0	-	10	2.5	41.4	-
"	4 "	5.0	-	6	3.5	34.2	-
TCB (S)	2 "	6.0	-	0	4.5	65.3	-
"	4 "	6.0	-	0	3.5	65.7	-
TCB (AD)	2 "	6.5	-	0	6.0	67.4	-
"	4 "	6.5	-	0	7.0	57.8	-
Crag-1	2 lbs.	5.5	7.0	10	9.0	33.5	65.7
"	4 "	3.5	5.0	4	9.0	13.0*	65.8
Natrin	2 "	8.5	9.0	12	7.0	78.1	70.3
"	4 "	8.0	9.0	11	9.0	86.7	70.7
Sesin E	2 "	5.0	-	8	9.0	38.3	-
"	4 "	4.0	-	5	9.0	14.7*	-
Sesin 50W	2 "	7.0	5.0	12	8.0	44.2	67.6
"	4 "	2.5	3.0	2	9.0	7.3*	51.4
6711	2 "	5.5	-	11	9.0	33.2	-
"	4 "	5.0	-	13	8.5	24.7*	-
"	1/2"	-	9.0	-	-	-	46.9
"	1 "	-	9.0	-	-	-	56.2
"	2 "	-	9.0	-	-	-	70.1
6831 WP	2 "	7.0	-	12	4.0	47.7	-
"	4 "	6.0	-	13	7.0	56.1	-
6831 L	2 "	9.0	-	13	3.0	68.0	-
"	4 "	7.5	-	13	6.0	53.6	-

1/ Ratings of 9 - normal vigorous growth.
2/ Fruit set - number of first clusters with fruit per 14 plants.
3/ Weed control rating of 9 - complete kill of all weeds; 7 - commercial control; 1 - complete ground cover.

Table 2. (continued) Tomato and weed response to herbicides applied at transplanting and at lay-by.

Treatment Chemical	Rate	Vine Growth Trpl.	Vine Growth Lay-by	Fruit Set Trpl.	Weed Control Trpl.	Yield-lbs./plot Trpl.	Yield-lbs./plot Lay-by
7976	2 lbs.	8.5	9.0	8	9.0	54.8	66.1
"	3 "	-	9.0	-	-	-	67.3
"	4 "	3.5	9.0	3	9.0	14.4*	52.7
8148	2 "	9.0	-	11	1.5	53.3	-
"	4 "	8.0	-	10	2.5	66.0	-
Karmex W	1/2"	9.0	9.0	12	5.0	58.2	75.7
"	1 "	8.0	8.0	8	8.0	50.8	65.5
Karmex DW	1/2"	8.0	8.0	12	5.0	63.7	70.4
"	1 "	6.5	8.0	3	7.5	30.6	65.9
Karmex DL	1/2"	-	9.0	-	-	-	70.8
"	1 "	-	8.0	-	-	-	47.0
Karmex FW	1/2"	7.5	9.0	12	8.5	64.1	60.4
"	1 "	3.5	8.5	0	9.0	27.5	57.0
Amino Triazole	1 "	2.5	-	0	1.0	0*	-
"	2 "	2.0	-	0	1.0	0*	-
Dalapon	2 "	-	9v	-	-	-	26.7D
"	4 "	-	9v	-	-	-	18.8D
6249	2 "	-	9v	-	-	-	49.3D
"	4 "	-	9v	-	-	-	15.3D
7977	2 "	-	9	-	-	-	X
"	3 "	-	8	-	-	-	71.7
"	4 "	-	9	-	-	-	63.7
Check (lay-by)	-	-	9	-	-	-	68.0
Check	-	8.5	-	1.0	13	72.3	-
Check	-	8.0	-	1.0	12	69.2	-

* Significantly lower than check at 5% level as tested by Duncan's Multiple Range Test $S_{\bar{x}}$ - 6.6

D Significantly different from checks at 5% level as tested by Extreme-means test.

v - excessively vegetative.

RESULTS

Detailed observations were made on vine growth about one month following the early treatment, and about 6 weeks following the late treatment. There were marked differences between treatments (Table 2).

The majority of chemicals applied at time of transplanting caused either or both formative effects and stunting. Several chemicals, namely: Crag 1, Sesin, 6711, 7976, Karmex FW and Aminotriazol, particularly at the higher rate used, exhibited severe injury on the plants. A few materials i.e. Natrin, 6831, 8148 and Karmex W caused little or no visible vine growth differences. Of these four materials, however, only Natrin and Karmex W gave adequate weed control.

In the late application most of the chemicals which earlier had given either severe plant symptoms or poor weed control were eliminated. Generally speaking chemicals applied at lay-by seemed to give slightly less injury to vines than the same materials applied at transplanting. Natrin and Karmex W again performed well. Karmex compounds DW, DL, and FW were also satisfactory. Materials 6711, 7976, 7977 at low rates performed well. The most striking vine response was observed in the plants treated with Dalapon and Cyanamid 6249. There was extremely heavy vegetative growth in these plots. Some formative effects were also apparent.

Weed control, principally redroot pigweed, *Amaranthus retroflexus*, varied from none to very nearly perfect in the treatments applied at time of transplanting. In the lay-by plots, weeds were removed from between the plants by hand, prior to treating. No later infestation occurred even though irrigation was given. No weed observations could be made therefore on any of these plots. Data on weed control from the early treatment are presented in Table 2.

Crag 1, Natrin, Sesin, 6711, 7976, and the highest rates of Karmex W, DW, DL and FW gave excellent weed control. Karmex FW performed well also at lower rates. Such materials as Silvex, Kuron, TCB (S), 6831, 8148, and Aminotriazol were ineffective.

In measuring the effect of chemicals on tomatoes, one of the important considerations is the influence on early yield. This is particularly important for the early market crop and for the processing crop where length of season is borderline or definitely limiting yields. One effect of injuring plants can be manifested by a failure to set fruit on the early clusters. Data were obtained on the number of plants per treatment that had a set of fruit on the first or crown cluster. It is the presence or absence of fruit in this cluster, that determines the amount of early fruit possible from a given planting. In Table 2 one can see the number of clusters varied from almost 1 per plant on the safer treatments and checks to none on the plants in some of the harsher treatments.

From Table 2 one can conclude that early yields are not possible from Aminotriazol or TCB (S) or TCB (AD). Furthermore the higher rates of chemicals such as Crag 1, Sesin, 7976, and the three Karmex compounds caused so much reduction in first cluster-set that they could not be considered safe. Natrin was one of the very safe materials.

Total yields, with only one exception, follow the trend indicated by first cluster-set. As is shown in Table 2, 6711 had no effect on first cluster set, but yielded significantly poorer than the check. The other significantly low yielding treatments Crag 1, Sesin E, Sesin 50 W, Aminotriazol, and the high rate of 7976 correlate closely with poor first cluster set. Part of this correlation is undoubtedly due to the fact that frost was a limiting factor in determining total yields. In fact, anything which reduced earliness was likely to reduce total yield.

Chemicals in general seemed to be less harmful when applied at lay-by than when applied at transplanting. In the plots treated late there was considerable variation. Consequently no statistical significance is present. Judging from the numerical trend in yield and the visual effects on vines, however, the authors believe Dalapon and 6249 to be unsafe.

When one considers the effects of chemicals on vine growth, fruit set, total yield and weed control, Natrin appears to be outstanding among the materials tested for use on tomatoes. Since the Karmex compounds were variable in their performance depending on rate and time of application, and furthermore since their effectiveness is influenced by differences in soil organic matter, their use on tomatoes need much more investigation.

NATRIN STUDIES

Although favorable results were obtained in the work reported above and in previous years (3,4) some investigators (5,6) have found Natrin to be toxic. Many factors could be responsible for these contradictory responses. Differences in soil organic matter and moisture content are commonly accepted as factors influencing herbicidal activity. Crop age and physiological condition often influence response to herbicides. In a few instances crop varieties affect responses.

The purpose of these tests was to learn if possible why Natrin is sometimes toxic to tomatoes. Since in work already reported there seemed to be little correlation between soils and tomato response to Natrin, this factor was omitted. Furthermore, heavy rains occurred within a few hours of treating both in Western New York where injury occurred (5) and in Ithaca where no injury occurred. It was decided thus to omit this phase. Injury in Virginia (6), however, was particularly severe in greenhouse tests.

By eliminating the least likely causes of variation in response, the important factors remaining to be tested here (A) crop varietal differences and (B) age and condition of plants at the time of treating. The varietal aspects are being investigated but are not yet ready for report. Several aspects of age and condition have been carried far enough along to warrant inclusion in this report.

Effect of Age of Plant. It is entirely possible that age and size of plant can be important factors influencing plant response. In a preliminary greenhouse test large tomato plants, 12-18 inches tall 9 weeks of age in pots were treated with Natrin at rates of 4,8,12,24 and 36 lbs. an acre on a surface area basis. No symptoms were observed at rates of Natrin up to 12 pounds. The 24 pound rate caused some adventitious roots to develop and the lower stems did not appear normal. The 36 pound rate resulted in severe wilting and eventual death of some plants in the treatment.

This preliminary work, indicated that rate of Natrin in ranges likely to be used was unimportant and that large relatively old plants were quite tolerant. To test further the effect of age, a second more detailed experiment was established. Thirty-two small flats were seeded to tomatoes of the Longred variety, the one used throughout these studies. In each flat 4 rows of 12 seeds each were planted. Two rates, 8 and 16 lbs. of Natrin, were used. The two spray rates were applied to 2 flats at each of 6 different times beginning 3 days following seeding. The second application was made at emergence, 4 days following the first treatment date. Approximately 75 to 80% of the potential total plants could be seen at this time. The 3rd treatment was made two weeks following seeding, when the young seedlings were definitely above ground and had well developed cotyledonary leaves, but no "true" leaves were visible. Three succeeding treatments were arbitrarily made at weekly intervals. At the 6th time of treating, 2 flats will be sprayed as in the previous treatments, but an additional two flats will be transplanted and then treated. At the time of writing, this last treatment No. 6 has not been made.

Observations have been made on five times of treating. No plants have been killed. Hormonal type symptoms are not apparent. There is, however, noticeable stunting of all plants sprayed. There is no effect of time of application. Stunting has occurred whether the spray was applied pre- or post-emergence.

From these tests the authors believe that factors other than age of plant per se, influence its response to Natrin.

Effect of Condition of Plant. Since physiological condition of the plant could be an important factor influencing response to herbicides, and since in at least one instance (6) plants were under greenhouse conditions when injury occurred, it was decided to check this possibility fairly carefully.

An elaborate factorial experiment was designed. The factors included as treatments prior to spraying were 2 levels of fertility two levels of light, and 2 levels of soil moisture. Following spraying, the pre-treatments were divided into three groups for post-spraying treatments of (A) watered from below (B) watered from above and (C) not watered, allowed to wilt before water was supplied. A uniform herbicidal spray of 4 lbs. of Natrin was applied to all plants except the spray-treatment checks.

No conclusive data were obtained from these plants. Part of the difficulty may have been due to foliage injury of all plants by a fumigation of the experimental area. Another factor may have been the relatively low rate (4 lbs.) of Natrin for greenhouse conditions. The pre- and post-cultural treatments resulted in very marked horticultural differences in plants.

To pursue this investigation further another experiment was designed. In this test the cultural treatments were less drastic and the spray treatment rates and methods were increased in potential severity.

Two weeks following seeding in vermiculite media, tomatoes seedlings were pricked-off to regular greenhouse flats filled with soil. Five days later part of the plants were started on a treatment in which water was gradually withhold. The remaining plants received normal water. Three weeks later some of the plants in both watering treatments were heavily shaded for 3 days. At the end of the shading treatment all plants were removed from the flats and much of the soil gently removed. Small roots were broken in this procedure, but each plant retained a satisfactory number of healthy unbroken roots. All plants were wrapped in moist paper for 4 hours. An herbicidal treatment of Natrin at the rate of 12 lbs. to the acre in 100 gallons of water was applied to the entire pulled plants lying in a horizontal position. Leaves, stems and roots were thoroughly covered with spray.

Immediately following the herbicidal spray, the plants were potted. One-half of the plants were placed in moist soil and watered immediately. The remaining plants were placed in relatively dry soil without watering. After 24 hours this group was severely wilted and consequently were given a thorough watering.

In this test there was a decided response to spraying. Four days following spraying all plants receiving herbicide were wilting. One week following spraying, some plants had died. Two weeks later many plants were dead. All treatments had some dead plants. Since so many plants died, the treatment obviously was too drastic. Either the rate should be lowered, or perhaps the application directly on the roots should be changed.

The cultural treatments used did influence plant response to Natrin. There was considerable variability between plants within a treatment. Also, the condition of the plants changed from day to day. It is difficult therefore to present data that would not be misleading.

Based on the number of plants surviving spraying, the following conclusions are drawn:

1. Plants kept in the light and not hardened performed best.

2. Plants severely hardened by withholding water prior to treating did not recover readily.

3. Moisture differences following treating had relatively little influence on plant response.

Although these tests cannot be regarded as conclusive, it appears that one of the important factors influencing the response of tomatoes to Natrin is the amount of hardening that has occurred prior to transplanting and treating. The above work correlates sufficiently well with that of Loomis (7) to permit the hypothesis that Natrin applications tend to interfere with new root growth. Plants with badly injured roots or in a physiological condition unfavorable for new root development are likely to be more severely damaged. The authors suggest that further work be undertaken to determine whether or not the ability to generate new roots following treatment with Natrin is the primary cause for differential responses reported.

SUMMARY

Applications of herbicides were made to tomatoes immediately following field-setting and at lay-by. Observations were made on vine growth, fruit-set, and yield as well as weed control. When both plant response and weed control are considered, Natrin was outstanding. Other materials showing promise were 7976, 7977, and the several Karmex compounds.

More intensive work was conducted with Natrin in the greenhouse to help determine possible causes of failure due to crop damage. It is proposed that physiological condition of the plant rather than age influences its response to Natrin. Plants capable of rapid root replacement appear to be more tolerant than those severely hardened or shaded prior to treating.

LITERATURE CITED

1. King, L. J. and Lambrech, J. A. A new chemical for use in pre-emergence weeding. Proc. NEWCC pp. 34-35. 1949.

2. McNew, G. L. and Hoffman, O. L. The growth-regulant, herbicidal and physical properties of 2,4-D and related compounds. Iowa State College Journal of Science 24: 189-208. 1950.

3. Menges, R. M. and Aldrich, R. J. A comparison of Crag, Crag derivatives and CMU for pre-emergence weed control in tomatoes. Proc. NEWCC 137-143. 1954.

4. Ries, S. K. and Sweet, R. D. Post-emergence application of certain esters of 2,4-Dichlorophenoxyethanol on tomatoes. Proc. NEWCC 103-107. 1953.

5. Marshall, E. R. Personal Communications. 1954.

6. Danielson, L. L. Personal Communications. 1954.

7. Loomis, W. E. Studies in the transplanting of vegetable plants. Cornell University Memoir 87. 1925.

EXPERIMENTAL TRIALS AND GROWER USAGE OF HERBICIDES ON MUCK GROWN ONIONS IN NEW YORK STATE IN 1954

by

M. J. Papai, W. Baran and E. R. Marshall*

Introduction

The control of weeds in muck grown onions is of extreme importance to growers in New York State. The increasing high cost of hand weeding has forced growers to look towards chemicals for help in their weed control problem. Potassium cyanate and calcium cyanamid have been used commercially for several years and weed control results with these materials have been on the whole good. In more recent years Perkins (1),(2), (3) and others (4), (5) have reported favorable results with use of Isopropyl N-(3 chlorophenyl) carbamate (CIPC). Other materials such as 3 -p- chlorophenyl - 1 - 1 - Dimethylurea (CMU) have also shown promise. Results of small plot tests with these and other materials as well as results of wide spread grower usage of CIPC during the 1954 season will be reported in the following paper

Materials and Methods

Three separate comparisons were made in the Orange county muck area in the spring of 1954 between different compounds which might show promise for weed control in muck onions.

The first comparison was between three different urea compounds: 3-p-chlorophenyl - 1 - 1-dimethylurea (CMU), phenyldimethyl urea(PDU) and 3,4-dichlorophenyl - 1 - 1-dimethylurea (DMU). Each of these materials were applied to 1/2 acre plots of muck grown onions on April 21, two weeks after planting and three days before the onions emerged. The materials were applied in 90 gallons of solution per acre and at 200 psi pressure.

The second series of plots was applied post-emergence to muck grown seed onions on May 13th when the onions were in the 3-4 leaf stage. These onions had been planted on March 28th. The treatments were applied in 50 gallons of solution per acre at 25 psi pressure. Materials compared in this test were:
Sodium salt of 2,4-Dichlorophenoxyethyl sulfate (SES)
Sodium salt of 2,4,5 Trichlorophenoxyethyl sulfate (Natrin)
Diethanolamine salt of 2,4,5 Trichlorophenoxyethyl sulfate (7977)
Sodium salt of 2,4,5 Trichlorophenoxypropyl sulfate (8148)
Sodium salt of 2 methyl 4 chlorophenoxyethyl sulfate (Methin)
2 - (2,4,5- Trichlorophenoxyethyl benzoate) (6831)
applied both as a liquid formulation and a wettable powder formulation.
Diethanolamine salt of 2 methyl 4 chlorophenoxyethyl sulfate (7976), two formulations of Hydrin (Hydrin X and Hydrin T) 2-chloroethyl N-(3 chlorophenyl) carbamate (T-595), 2 -chloropropyl N-(3 chlorophenyl) carbamate (T-596), CIPC, 2,4,6 trichlorobenzoic acid (TCB), CMU, PDU, and DMU.

The third series of plots was applied to seed onions while they were in the crook stage on May 13th. These onions had been planted on April 13th. Treatments were applied in 50 gallons of solution per acre at 25 p.s.i. pressure. The plots were 36 feet long and 6 feet wide, covering 4 rows of onions. There were four replicates. Materials used in this test were Hydrin X, Hydrin T, CIPC, T-595, and T-596. The carbamates T-595 and T-596 had looked very promising in earlier tests in Virginia when compared with CIPC.

In addition to the above three tests, observations were made on wide scale grower trials of CIPC used both pre and post-emergence on seed and set onions. These observations will be reported later.

Results and Discussions

From observations taken one month after the plots were applied, excellent weed control results were obtained with the use of CMU, PDU, and DMU when each was used at 2 lbs. active ingredients per acre. Weed control results with PDU showed up sooner than with the other two materials. DMU gave better weed control results than CMU. Some chickweed and smartweed survived in the CMU plots. There was no injury to the onions with any materials in this test.

Weed control results and the amount of injury to the onions in the second series of plots is shown in Table 1.

Table 1. EFFECT OF DIFFERENT HERBICIDES APPLIED AT 3-4 LEAF STAGE ON WEED GROWTH AND ONIONS

Treatment	Weed Control*		Onion Injury**	
	5/22	6/3	5/22	6/3
SES 6#/A	0	4	0	0
Natrin 6#/A	0	5	0	0
7977 6#/A	0	3	0	0
8148 6#/A	3	4	0	0
6711 6#/A	0	2	0	0
6831 liquid 6#/A	6	6	0	0
6831 powder 6#/A	4	4	0	0
7976 6#/A	0	0	0	0
Hydrin X 7:1	7	8	6	4
Hydrin T 7:1	9	9	5	5
T-595 6#/A	8	7	2	5
T-596 6#/A	8	7	2	3
CIPC 6#/A	8	8	2	1
TCB 2#/A	6	9	5	7
TCB 4#/A	9	10	6	9
CMU 2#/A	10	9	1	2
PDU 2#/A	9	9	2	3
DMU 2#/A	9	8	3	4

* 0 = no weed control 10 = perfect weed control
**0 = No onion injury 10 = complete kill of onions

In this test SES, Natrin, 7977, 8148, 6711, 6831 liquid, 6831 powder and 7976 gave no injury to the onions. Weed control at 6 lbs. active per acre was not satisfactory. The weeds were about 1/2 inch in height when the materials were applied. This probably explains the lack of control with the above listed materials since they are most effective when applied before weed seeds germinate. The data show that considerably more weed control was noticed on June 3rd than was seen on May 22nd. The plots were cultivated and weeded on June 5th so further weed control results could not be observed. Hydrin X and Hydrin T in a 7:1 dilution with water and applied at 50 gallons of this solution per acre gave good weed control but also injured the onions. The carbamatesT-595, T-596 and CIPC at 6 pounds active per acre gave good weed control with varying degrees of injury. CIPC gave the least injury and T-595 the most. TCB gave excellent weed control at both 2 lbs. and 4 lbs. per acre but injury to the onions was severe. The onions in the TCB plots were severely stunted and showed marked twisting and curling of the foliage. No other material in the test showed epinasty of this type. The ureas CMU, PDU and DMU gave the best weed control. CMU was the most satisfactory material in the test on the basis of weed control and lack of onion injury.

Results of the third test are shown in Table 2.

Table 2. EFFECT OF VARIOUS HERBICIDES APPLIED DURING CROOK STAGE ON WEED GROWTH AND INJURY OF MUCK GROWN SEED ONIONS

Treatment		Weed Control*			Onion Injury**		
		5/20	5/27	6/3	5/20	5/27	6/3
Hydrin X	7:1	9.8	9.8	1.0	7.5	8.2	8.5
Hydrin T	7:1	10.0	9.2	2.5	7.2	7.8	7.5
Hydrin X	9:1	9.5	9.5	2.2	6.8	7.2	8.0
Hydrin T	9:1	9.0	9.0	5.5	5.5	5.8	4.2
CIPC	6#/A	2.8	7.5	5.5	1.2	.5	1.5
CIPC	12#/A	7.5	9.2	9.2	3.2	5.0	4.8
T-595	6#/A	5.8	8.8	2.5	3.0	5.5	4.8
T-595	12#/A	9.0	9.8	5.8	5.8	7.8	6.8
T-596	6#/A	5.2	9.2	5.8	.8	1.5	1.2
T-596	12#/A	6.5	9.8	8.8	2.8	4.2	3.0
L.S.D.	.05	2.0	.9	1.6	2.0	.2	2.0
L.S.D.	.01	2.7	1.2	2.1	2.6	.3	2.6

* 0 = no weed control 10 = no weeds present

**0 = no injury 10 = complete kill

Hydrin X and Hydrin T were very similar in their action although Hydrin T consistently showed less injury to the onion foliage. Weed control was good for two to three weeks after application but then the weeds came in very rapidly in the Hydrin plots. The 7:1 concentration of water and Hydrin gave more injury than the 9:1 concentration. T-596 gave better weed control than CIPC and injured the onions less. T-595 gave the most serious onion injury of the carbamates tested. The carbamates gave longer residual control than Hydrin and injured the onions less. On the basis of these results T-596 shows promise as a more selective and more effective material for use as a herbicide for muck onions.

Several hundred acres of muck onions in New York State were treated with CIPC for weed control during the 1954 season. Observations were made throughout the season and observational type records were taken. Many interesting developments occurred during the season which we feel will be interesting to this conference.

Previous experience with the Phytotoxic effect of various insecticides in solvents on onion foliage suggested to us that various formulations of CIPC might show differences in phytotoxicity. In the Fall of 1953 formulations of CIPC from numerous commercial sources and others especially formulated by ourselves were gathered together. During the early Fall these formulations were tested for shelf-life, emulsifiability and other factors. The satisfactory formulations were then taken to Florida and tested during the winter months for phytotoxicity to onion foliage. At the same time other treatments were applied to greenhouse grown onions in Ithaca. The results of these tests confirmed our thinking as marked differences in foliage injury did occur. The formulation which gave the least injury in these tests was later used in wide-scale grower trials in New York State. During the season of use, these formulation differences continued to re-appear. From these observations it is clear that the various emulsifiers and solvents used in formulating CIPC may show markedly different phytotoxic effects on onion foliage.

Another problem encountered involved grower usage of CIPC. Several instances of onion injury was reported and where these cases were investigated, most of the injury was found to be the result of excessively heavy applications of CIPC. In some cases rates up to 24 lbs. per acre were applied. These rates were largely the result of banding applications when only 1/3 - 1/4 of the area was treated and the amount per acre was on the basis of total coverage. In one case where 18 lbs. of CIPC per acre was banded over the row the onions showed injury early but later recovered and produced a good yield.

These grower trials showed that CIPC could be used very successfully for both pre- and post-emergence weed control on seed and set onions. Weeds which were most successfully controlled were purslane, smartweed, chickweed and annual grasses. Ragweed and red root pigweed were controlled in many cases but in a few cases they were only stunted.

Lambsquarters was not controlled by CIPC and in some fields became a primary weed problem after CIPC had removed purslane and other weeds.

Several times during the season reports were made that CIPC was not giving weed control. However, later examination showed that growers were expecting results too soon. They were familiar with the rapid action of potassium cyanate and were expecting similar action from CIPC. This is not the case and sometimes two weeks may pass before weed control results will begin to show following treatment with CIPC.

In general New York State Growers were well satisfied with the weed control results obtained from CIPC and are enthusiastic about its future on the onion crop.

SUMMARY AND CONCLUSIONS

Small plot trials of numerous herbicides on muck grown seed onions during the 1954 season were conducted. The three urea compounds CMU, PDU and DMU all gave good weed control with no onion injury when applied pre-emergence. CMU proved to be as good as either PDU or DMU. Hydrin gave good initial weed control but lacked residual control and injured the onions somewhat. TCB gave excellent weed control at 2 lbs. per acre but produced severe epinasty and onion injury.

T-596 showed promise as a selective herbicide for use on onions and should be compared further with CIPC.

Wide scale grower trials during 1954 in New York State emphasized the importance of formulation, accuracy of application, etc., CIPC has been found to be a safe and effective selective chemical for onion weed control. T-596 promises to be even a safer and more effective material than CIPC.

1. Perkins, D. Y. Pre-emergence weed control in muck grown seeded onions. Proc. N.E.W.C.C. 1954 : 111- 114. 1954

2. ____________ Post-emergence weed control in muck grown seeded onions. Proc. N.E.W.C.C. 1954 : 115-117. 1954

3. ____________ A progress report on the use of stem sprays for onion weed control on muck soils. Proc. N.E.W.C.C. 1954 : 87-90. 1954

4. Lachman, William H. Weeding set onions with Chloro IPC. Proc. N.E.W.C.C. 1954 : 85-86. 1954

5. Warren, G.F. and J. E. Larsen. Weed control in onions with CIPC. 10th Annual Research Report. N.C.W.C.C.: 136-137. 1953

Weed Control in Set Onions with Pre-emergence and Post-emergence Application of Herbicides[1]

Charles J. Noll and Martin L. Odland

Lachman (1) reported in 1953 that Chloro IPC had been used successfully to weed set onions grown on mineral soils in a pre-emergence application. Perkins (4,5,6) reported that onions grown from seed on muck were successfully weeded in either a pre-emergence or post-emergence application of chemicals. The most promising chemicals were Chloro IPC and CMU in the pre-emergence application and Chloro IPC in the post-emergence application. Noll and Odland (2,3) reported that Endothal, CMU and Chloro IPC offered possibilities for onion weeding when applied in a pre-emergence application and potassium cyanate applied in a post-emergence application. The use of potassium cyanate in a post-emergence application is a generally recommended practice.

To get more information on the weeding of onions with chemicals an experiment was set up to compare the most promising chemicals in both a pre-emergence and post-emergence treatment and in all possible combinations of pre-emergence and post-emergence applications.

Procedure

Onions received 7 pre-emergence treatments and 3 post-emergence treatments and all possible combinations of the pre- and post-emergence treatments. The pre-emergence treatments were nothing, Chloro IPC at 4, 8 and 12 lbs. per acre, CMU at 1 lb. per acre, Na PCP at 20 lbs. per acre and Endothal at 8 lbs. per acre. The post-emergence applications were nothing, KOCN at 16 lbs. per acre applied in water at the rate of 100 gallons per acre and Chloro IPC at 4 lbs. per acre.

Onion sets of the variety Ebenezer were planted on the 21st and 22nd of April. The pre-emergence applications of herbicides were made on the 24th of April and the post-emergence applications on the 30th of April, most of the onions were through the ground at that time.

The plots were 23 feet long and 1 1/2 feet wide and repeated 10 times in a completely randomized block. The treatments covered the entire plot. The soil was Hagerstown silt loam.

Weed control records were made on the 25th of June. These estimates were on the basis of 1-10, 1 being perfect weed control and 10 no weed control. Plots with good weed control at this time continued to have good weed control until harvest time. The plots received no cultivation. Weight of mature onions was taken on the 11th of August.

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[1]Authorized for publication on Nov. 26, 1954 as Paper No. 1925 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

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Results and Discussion

The results are presented in Table I. All chemically treated plots had highly significant increase in weed control as compared to the untreated check plot. In the pre-emergence treatments there was no significant difference in weed control between Chloro IPC at 12 lbs., CMU at 1 lb., Na PCP at 20 lbs., and Endothal at 8 lbs. These treatments were highly significantly better than Chloro IPC at 8 and 4 lbs.

In the post-emergence treatments KOCN and Chloro IPC improved the weed control with all treatments. Where the pre-emergence treatment was very good the increased weed control was not significant. Weed control with Chloro IPC at 4 lbs. per acre was better than weed control with KOCN at 16 lbs. in 100 gallons of water in all comparisons and significantly better if the pre-emergence treatment resulted in inadequate weed control.

The following treatments resulted in significant increase in yield: Post-emergence treatments of KOCN and Chloro IPC and the pre-emergence, post-emergence combination treatment of Chloro IPC at 4 lbs. per acre followed by the KOCN. Endothal in the pre-emergence treatment reduced the yield. Other treatments had no significant effect on yield.

Conclusions

Under the condition of this experiment the best treatments for chemical weeding of set onions considering weed control, yield, and cost of application were Chloro IPC at 4 lbs. per acre and KOCN at 16 lbs. in 100 gallons per acre applied in a post-emergence application. Chloro IPC at 4 lbs. in a pre-emergence application followed by KOCN in a post-emergence application gave equally good yield with better weed control than KOCN alone.

Literature Cited

1. Lachman, William H. Weeding set onions with Chloro IPC. Northeastern Weed Control Conference Proc. 7:85-86. 1953.

2. Noll, Charles J. and Martin L. Odland. Chemical weeding of onions. Northeastern Weed Control Conference Proc. 7:91-93. 1953.

3. Noll, Charles J., and Martin L. Odland. Weeding of seeded onions with chemicals. Northeastern Weed Control Conference Proc. 8:187-189. 1954.

4. Perkins, D. Y. A progress report on the use of stem sprays for onion weed control of muck onions. Northeastern Weed Control Conference Proc. 7:87-90. 1953.

5. Perkins, D. Y. Pre-emergence weed control in muck grown seeded onions. Northeastern Weed Control Conference Proc. 8:111-114. 1954.

6. Perkins, D. Y. Post-emergence weed control in muck grown seeded onions. Northeastern Weed Control Conference Proc. 8:115-117. 1954.

Table I. The effect of pre-emergence and post-emergence herbicides on weeds and yield of onions grown from sets.

Pre-emergence treatments: Herbicide	Pre-emergence treatments: Rate per acre active ingredient	Post-emergence treatments: Herbicide	Post-emergence treatments: Rate per acre active ingredient	*Weed Control	Weight of onions in lbs.
Nothing	---	Nothing		8.5	6.97
"	---	KOCN	16 lbs.	3.2	8.94
"	---	Chloro IPC	4 "	2.4	9.12
Chloro IPC	4 lbs.	Nothing		4.4	7.67
" "	4 lbs.	KOCN	16 lbs.	2.3	9.08
" "	4 lbs.	Chloro IPC	4 lbs.	1.3	7.79
Chloro IPC	8 lbs.	Nothing		3.4	7.42
" "	8 lbs.	KOCN	16 lbs.	1.8	8.06
" "	8 lbs.	Chloro IPC	4 lbs.	1.1	7.00
Chloro IPC	12 lbs.	Nothing		1.6	6.15
" "	12 lbs.	KOCN	16 lbs.	1.3	6.14
" "	Chloro IPC	Chloro IPC	4 lbs.	1.2	5.87
CMU	1 lb.	Nothing		1.4	6.60
"	1 lb.	KOCN	16 lbs.	1.2	6.36
"	1 lb.	Chloro IPC	4 lbs.	1.0	5.92
NaPCP	20 lbs.	Nothing		1.6	8.04
"	20 lbs.	KOCN	16 lbs.	1.5	7.21
"	20 lbs.	Chloro IPC	4 lbs.	1.3	7.72
Endo	8 lbs.	Nothing		2.2	4.29
"	8 lbs.	KOCN	16 lbs.	1.9	5.40
"	8 lbs.	Chloro IPC	4 lbs.	1.4	4.84
Least significant difference at .05 level				.8	1.17
Least significant difference at .01 level				1.1	1.54

*Weed Control 1-10: 1 perfect weed control
10 full weed growth

WEED CONTROL IN SWEET SPANISH ONIONS[1]

S. L. Dallyn, R. L. Sawyer, T. H. Haliburton and R. D. Seif [2]

Weed control work on this variety or type of onion has been very limited. Personal correspondence with station workers in the main producing areas indicates few if any active projects underway at the present time. The limited information available, however, indicates that the Sweet Spanish types, especially when grown on mineral soils, may be more sensitive to most herbicides than are the Yellow Globes and other similar varieties.

The importance of this onion on Long Island has increased rather markedly during the past two years. Preliminary experiments were conducted in 1952 and 1953 and the information derived was used to set up more elaborate tests for the 1954 season. The chief objection of new growers of this crop has been the weed problem involved. Our aim is to reduce this problem a maximum amount without adversely (economically) affecting yield or quality of the product.

At the present time, in this area, onions grown from transplants appear to have more promise than those grown from seed. Several growers have expressed interest in direct seeding, but have found the costs of early weeding and thinning to more than offset the higher original costs of transplants. It is quite possible, however, this type of culture could be developed much further if a really satisfactory weed control program was available. For clarity of presentation this paper is divided into two sections on the basis of the type of cultural practices followed.

I. Onions Grown From Transplants

General Methods

The materials used in this experiment were CMU at 1/3 and 2/3 lbs./A., CIPC at 3 and 6 lbs./A., and KOCN as a 1.5% spray. All treatments were applied in both overall and directed sprays, 100 gals./A. One-third of the plots were treated June 11, one-third July 9, and the remaining third on both dates. All treatments were completely randomized in each of four replications.

Texas grown plants of the Sweet Spanish variety were set April 9 on Sassafrass loam at the Long Island Vegetable Research Farm. Rows were 34 inches apart and the plants spaced at 4 inches in the row. Mechanical cultivation of the middles was given at weekly intervals until 3 weeks of harvest when the spreading tops excluded equipment. The rows were clean weeded June 10 and the first treatments applied the next day.

[1] Paper No. 383, Department of Vegetable Crops, Cornell University

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Approximately one month later the check and untreated plots were in need of another row weeding. Weed counts and ratings (considering both effectiveness of weed control and degree of injury to the crop) were made in all plots and the entire area clean weeded July 8. The next day the late series of treatments was applied.

By August 5 a number of the plots were becoming quite weedy again. Accordingly all plots were rated and cleaned up. Throughout the experiment weeds were pulled from the row rather than hoed so as to keep soil disturbance at a minimum and not reduce, any more than possible, the usefullness of the chemical.

RESULTS AND DISCUSSION

The early group of treatments was applied to onions which had been set for two months, were well established, and in a vigorously growing condition. It was felt that at this stage they would be much more resistant to herbicides than younger plants, and would show less adverse effects at harvest time. In addition our two most serious weeds, pusley and summer grass (others present, lambs quarters and chickweed) are not much of a problem before this date so that weed competition was not serious in any event. The second application was designed to continue control of at least the better of the early treatments and to hold the weeds through harvest. On plots receiving only the late treatments our primary objective was to find a good lay-by material.

Results from this experiment are summarized in Table 1. We are primarily interested in the 3 inch minimum grade and our remarks are based on those figures. Actually this is a more severe criterion of the treatments than are total yields since, with equal numbers of bulbs per plot, any yield reduction is magnified by the higher proportion of the bulbs which drop through the three inch chain.

None of the KOCN treatments were satisfactory under the conditions of this experiment. Weed control was negligible and the material was fairly injurious to the crop, especially when it was applied overall or early. More frequent directed sprays would undoubtedly give better weed control but might also reduce yield and would increase the cost of application. It would appear that KOCN has little place in this type of onion culture.

All CMU and CIPC early treatments gave good weed control regardless of whether they were applied overall or directed. Overall sprays of CMU, however, significantly reduced yields. This chemical consistently was more injurious than CIPC to the crop. Overall sprays at the late time of application did not give appreciable weed control. At this stage of plant growth directed sprays are essential for placement of the herbicidal material in the row area.

Rate of CMU had no effect on yield provided the spray was directed but 2/3 lb./A. gave better overall weed control than did 1/3 lb./A. A similar situation existed with the two rates of CIPC. The two chemicals were rated approximately equal as far as weed killing possibilities are concerned. In commercial practice growers often are disinclined to bother with directional equipment. Even in cases where it is used the accuracy is often poor and a considerable amount of the spray may hit the upper parts of the foliage. CIPC would seem to be the preferable material at this time. A summary of the results for directed sprays of the two materials is given in Table 2.

Table 1. Results from the use of selected herbicides in transplanted Sweet Spanish onions.

Treatment				Weed Count[2] July 8	Rating[3] July 8	Rating[3] Aug. 5	Yield Bushels per Acre 3" Min.	Total
1. Check				33	1.0	1.0	728	742
2. CMU	1/3 lb./A.	June 11	directed	19	3.5	3.3	640	669
3. "	" "	"	overall	9	3.5	3.0	586	624
4. "	2/3 "	"	directed	6	4.0	4.0	650	688
5. "	" "	"	overall	3	4.0	3.8	525	582
6.[1] "	1/3 "	"	directed	11	4.0	4.3	642	667
7.[1] "	" "	"	overall	10	3.5	4.0	490	566
8.[1] "	2/3 "	"	directed	4	4.0	5.0	622	670
9.[1] "	" "	"	overall	5	4.0	4.8	341	482
10. "	1/3 "	July 9	directed	—	—	3.5	702	722
11. "	" "	"	overall	—	—	1.5	546	606
12. "	2/3 "	"	directed	—	—	3.3	710	736
13. "	" "	"	overall	—	—	2.8	470	629
14. CIPC	3 lbs./A.	June 11	directed	10	4.0	3.8	698	730
15. "	"	"	overall	9	4.0	4.0	699	714
16. "	6 "	"	directed	5	5.0	4.8	707	720
17. "	" "	"	overall	3	5.0	4.3	666	698
18.[1] "	3 "	"	directed	4	4.5	4.8	685	701
19.[1] "	" "	"	overall	7	4.0	4.0	646	659
20.[1] "	6 "	"	directed	3	4.5	4.8	648	680
21.[1] "	" "	"	overall	4	4.5	4.5	619	656
22. "	3 "	July 9	directed	—	—	3.3	701	717
23. "	" "	"	overall	—	—	2.0	624	646
24. "	6 "	"	directed	—	—	2.5	667	688
25. "	" "	"	overall	—	—	2.0	688	707
26. KOCN	1.5%	June 11	directed	26	2.0	1.5	637	669
27. "	"	"	overall	36	1.0	1.8	454	550
28.[1] "	"	"	directed	27	2.0	3.3	698	717
29.[1] "	"	"	overall	34	1.5	1.5	424	549
30. "	"	July 9	directed	—	—	2.5	662	698
31. "	"	"	overall	—	—	1.5	605	651
32. Check				52	1.0	1.8	634	659
L.S.D. 5%				16			80	65

1 Received the same treatment again on July 9.

2 Average count per 4' of row

3. Considering both effectiveness of weed control (no. and size of weeds) and degree of injury to the crop. 1-poor, essentially no weed control. 5-excellent, complete control, little or no crop injury.

TABLE 2. The Effect of Directed Sprays of CMU and CIPC on Weeds and Yield of Onions.

TREATMENT	CMU Rating[1]	CMU Yield	CIPC Rating[1]	CIPC Yield
1. Low rate early	3.3	640	3.8	698
2. High " "	4.0	650	4.8	707
3. Low " " and late	4.3	642	4.8	685
4. High " " " "	5.0	622	4.8	648
5. Low " late	3.5	702	3.3	701
6. High " "	3.3	710	2.5	667
7. Mean of two checks	1.4	681	1.4	681
L.S.D. 5%		73 bus./A.		

[1] August 5

Treatments with a rating above 3.5 gave satisfactory control through August 24 on which date crop was harvested. As seen from Table 2 either chemical used early at the high rates, or either rate when used early and late gave good control from June 11 through harvest. Lay-by treatment alone was not entirely satisfactory, probably because of incomplete ground coverage in the row area. The most promising combination, at the present time, appears to be 3-6 lbs. CIPC/A. (depending on severity of weed problem) applied as a directed spray to well established onions, followed by a similar treatment 4-6 weeks before harvest. Where a severe grass problem exists and where good directional equipment is available CMU at 1/3-2/3 lbs./A. might be substituted in the lay-by treatment.

Results from this and previous experiments indicate that with the proper use of a herbicide, satisfactory onion yields can be obtained with a maximum of two hand weedings. This would mean the elimination of 2-3 hand operations under our conditions. Further information is needed to determine how soon after plant-setting chemical treatments may be started and whether if, under a severe weed environment, more than two applications of CIPC are advisable.

SUMMARY

1. The chemicals CMU, CIPC and KOCN were used at various rates, and times and methods of application on transplanted Sweet Spanish onions.
2. Directed sprays were superior to overall sprays both in effectiveness of weed control and minimization of crop injury.
3. CMU and CIPC were about equally effective in weed control but in most cases CMU was more damaging to the crop.
4. 3-6 lbs./A. CIPC as a directed spray 6-8 weeks after setting plus a repeat treatment 4-6 weeks before harvest appears to be the most promising. Under our conditions this treatment should eliminate 2-3 hand weedings and should make possible satisfactory crop production with a maximum of two such operations.
5. KOCN was found to be of little value in this type of onion culture.

II. Onions Grown From Seed

GENERAL METHODS

Seed of the Sweet Spanish variety was sown April 7 on Sassafrass loam at the Long Island Vegetable Research Farm. Two rates each of CMU (1/3 and 2/3 lb./A.) and CIPC (3 and 6 lbs./A.) were applied April 13, at which time the onion seed was well sprouted. Two percent KOCN was an additional material used and its application was delayed until the seedlings were just starting to break the ground (April 19). Four replications per treatment, each 210 feet long, were used.

Stand and weed counts were made June 8 and a week later the plots were thinned to 1 plant every 4 inches. Time records were kept of this operation since a treatment which reduced stand without hurting yield could be an advantage. Shortly after the June 8 counts the plots were hand weeded in the row, care being taken to disturb the soil as little as possible. Time records were taken of this and also of a subsequent weeding July 9. There appeared to be little residual effect from any of the materials after this point and weeds came in very rapidly. Accordingly, on July 19 the entire area was clean weeded again and a series of post emergence treatments put on.

Each pre-emergence plot was split into 10 equal sub plots which received the following treatments: 1/3 and 2/3 lb./A. CMU overall and directed, 3 and 6 lbs./A. CIPC overall and directed, KOCN 1.5% directed and a check. Visual observations of the treatments were made August 16 and the crop pulled September 7. Throughout the course of the experiment the middles received normal mechanical cultivation though care was taken not to throw fresh soil into the row.

RESULTS AND DISCUSSION

Pre-emergence Treatments

Pertinent data on this phase of the experiment is given in Table 3.

(1) Weed Control. Weed counts were significantly lower on all treated plots up to two months after application and CMU plots were free, essentially, of weed growth at this time. The labor involved in weeding these and the CIPC plots was only a fraction of that required for the checks or the KOCN plots. Residual effects from four of the pre-emergence treatments were still definitely in evidence at the end of three months. The general trend of the data, and visual observations, might indicate CMU to be more effective in control but less persistant than CIPC. The use of these treatments reduced hand labor during the first three months of the growing season to as little as 30% that required for non-treated onions.

(2) STAND. The higher rate of CMU and both rates of CIPC caused a reduction in stand. Since the primary objective in growing this type of onion is to produce large uniformly shaped bulbs it is necessary to thin to single plants 2-4" apart. A certain amount of chemical thinning by the herbicide would be no disadvantage and if properly controlled would reduce the hand labor in the thinning operation. Six lbs. of CIPC was much too severe and

Table 3. The Role of Several Pre-Emergence Treatments in the Production of Sweet Spanish Onions from Seed

Treatment	Onion Stand[1] June 8	Thinning Time[2] June 15	Weed Count[3] June 8	Weed Count[3] July 8	Weeding Time[4] June 11	Weeding Time[4] July 9	Total Yield Bus./A.
1. Check	181	100	17.8	143	30	29	568
2. CMU 1/3 lb./A.	168	97	1.5	84	9	22	598
3. " 2/3 "	123	60	1.8	72	4	18	512
4. CIPC 3 "	95	67	5.8	49	11	16	529
5. " 6 "	50	42	6.0	52	5	11	340
6. KOCN 2%	160	90	9.0	150	27	30	610
L.S.D. 5%	34	24	6.6	58	8	7	115

[1] Number of plants per 9' of row
[2] Minutes to thin to 4" in the row (210')
[3] Number of weeds per 9' of row
[4] Minutes of hand labor required per row (210')

the stand reduced to the extent that it was impossible to get a plant every four inches. Plants which did survive grew well and produced normal bulbs. Two-thirds lb. CMU and 3 lbs. CIPC greatly reduced the time required for thinning the crop yet had no adverse effects on yields.

(3) YIELD. Six lbs./A. CIPC was the only treatment to reduce yields significantly. In this experiment data was not taken on the yield of 3-inch minimum bulbs as it was felt this grade would represent too small a proportion of the crop, as produced from seed this season. Actual differences between any specific treatment and the check would be emphasised by such a breakdown in grades since approximately equal numbers of bulbs were present in each plot (with the exception of treatment #5). Considering all aspects of the experiment, 1/3 lb. CMU or 3 lbs. CIPC per acre would appear to be reasonably promising as pre-emergence materials for onions in this area.

Post-emergence Treatments

The application of the post emergence treatments was delayed until the effects of the pre-emergence materials were exhausted. This was roughly three months after planting and the onions were well along in the bulbing stage. Plants in this condition would be expected to be relatively tolerant of many herbicides. A treatment which would control weeds from this point through harvest would be desirable.

On August 16 visual observations were made on all plots. Directed treatments in most cases gave weed control far superior to overall. KOCN did not give satisfactory results. The higher rates of CMU and CIPC gave excellent control extending through harvest. The lower rates gave good control for 4-5 weeks but were fairly weedy by harvest time. Both materials were rated about equal overall, with CMU somewhat better against grass but not as effective as CIPC against pusley.

Table 4 contains the specific effect of post emergence treatments on yields. These figures were taken from sub plots on the main pre-emergence check plots.

TABLE 4. The Effect of Several Post Emergence Treatments on the Yield of Onions.

Treatments			Total Yield Bus./A.
1. Check			567
2. CMU 1/3 lb./A.	directed		559
3. " "	overall		542
4. " 2/3 "	directed		615
5. " " "	overall		469
6. CIPC 3 lbs./A.	directed		645
7. " "	overall		662
8. " 6 "	directed		667
9. " " "	overall		688
10. KOCN 1.5%	directed		619
		L.S.D.	102

The sum of squares for treatments in the analysis was highly significant. It is interesting to note, however, that 2/3 lb. of CMU applied overall was the only treatment which tended to lower yields. The average of a number of the others was definitely higher than the check. This effect was probably due to weed competition in the check plots though we had tried to clean these up each time before the weeds became any appreciable problem.

The split plot analysis of the experiment is presented in Table 5.

Table 5. Data Analysis on Pre and Post Emergence Weed Control in Onions

Source	D.F.	S.S.	Variance	F
Main Plots				
Treatments (pre)	5	9113.7	1822.74	28.95**
Reps	3	1673.0	557.67	8.86**
Error A	15	944.5	62.97	
Subplots				
Treatments (post)	9	2055.0	228.33	8.13**
Pre x Post	45	1019.6	22.66	
Error B	162	4549.5	28.08	

** Exceeds required F at 1% point

This analysis corroborates the significance of both pre and post treatments effects found in the previous individual analyses. The important point here, however, is the non-significance of the pre x post interaction. Pre-emergence treatments, even where injurious, did not predispose surviving plants to increased subsequent injury from post emergence treatments. This is an extremely important relationship and if it proves to be consistent year after year will greatly simplify the development of a satisfactory weed control program for onions in this area. The best late application or lay-by treatment, depending somewhat on conditions, would appear to be one of the following:

(1) Either 3 or 6 lbs. of CIPC depending on severity of weed problem with directed application preferable for maximum weed control. The material does not appear to reduce yield when applied overall at this time, however.
(2) One-third pound CMU directed, where weed problem is not too severe. Where a heavy infestation is present, and especially if grass is one of the major weeds, 2/3 lb. CMU directed may be best overall treatment. Care should be taken to keep this material off the foliage.

SUMMARY

(1) CMU, CIPC, and KOCN were used at various rates, both pre and post emergence and as both overall and directed sprays, for weed control in seeded Sweet Spanish onions.
(2) The most satisfactory pre-emergence treatments in this experiment were 1/3 lb./A. CMU or 3 lbs. CIPC.
(3) The most promising post emergence treatments, applied 6-8 weeks before harvest, were directed sprays of either CMU or CIPC. CIPC is probably the safer material to use and CMU would not be recommended except in the case of a severe grass problem and then only if good directional equipment were available. Rate of CIPC 3-6 lbs./A. depending on severity of weed problem; CMU should not exceed 1/3-½ lb. in most cases.

Chemical Weed Control in Onion, Squash and Tomatoes[1]

W. Ferguson and J.J. Jasmin[2]

Chloro IPC (isopropyl N-3-chlorophenyl carbamate) has been reported upon favorably for weed control in onions by a number of workers including Lachman (4), Noll and Odland (6) and Perkin (8, 9).

To evaluate the action of Chloro IPC under conditions at Ottawa, onion seed (Brigham Yellow Globe) was sown in plots 8 by 27 feet on May 17, 1954. Fertilizer 5-10-13 at 400 pounds per acre had been worked into the soil several days prior to seeding. On May 18 pre-emergence spray treatments of Chloro IPC in water at the rate of 50 gallons per acre were applied across the rows using a compressed air sprayer with an 8-foot boom mounted on a garden tractor. A week of dry weather followed these treatments. Post-emergence applications were made on June 9. All treatments were duplicated and are shown in Table 1 with the weed and onion counts made on June 18. Weed counts were based on the number of grasses and broad-leaved weeds per square foot at three random locations in each plot and onions per 24 feet of row were counted in three random rows in each plot.

TABLE 1. -- WEED COUNTS AND STAND OF ONIONS ON JUNE 18, 1954

Treatments: Rate of Chloro IPC per acre	Average number of weeds per sq. ft.			Average number of onions per 24 feet of row.
	Grasses	Broad-leaved weeds	Total	
4 lb. pre-emergence	12	22	34	104
8 lb. pre-emregence	6	10	16	82
4 lb. pre-emergence plus 4 lb. post-emergence	9	27	36	95
4 lb. pre-emergence plus 8 lb. post-emergence	4	11	15	91
8 lb. pre-emergence plus 4 lb. post-emergence	5	6	11	85
8 lb. pre-emergence plus 8 lb. post-emergence	2	6	8	97
Control - no weeding	54	92	146	149

1. Contribution No. 836 from the Horticulture Division, Experimental Farms Service, Canada Department of Agriculture.
2. Principal Horticulturist and Horticulturist, Horticulture Division, Central Experimental Farm, Ottawa, Canada.

Table 1 shows that Chloro IPC treatments reduced the weed population considerably and were accompanied by some reduction in onions.

However, 1.14 inches of rain in the week following post-emergence applications and further heavy rains later induced rapid growth increase. As a result the control plots 10 weeks after seeding were covered with a dense stand of barnyard grass and the onions had disappeared. Fair weed control was obtained from the 4-pound-per-acre treatments with barnyard grass being the most prevalent weed. The onion population and general vigor were good. The 8-pounds-per-acre treatments showed excellent weed control in most cases and the weeds present did not offer serious competition to the onions. On the other hand, the growth of onions was delayed or the vigor of the plants reduced, and the stand was poorer.

This experiment demonstrates the potentialities of Chloro IPC for weed control in onions but also shows the necessity for further investigation under conditions in Eastern Canada, especially in view of the cool, wet season this year.

At the muck soil Experimental Substation, Ste.Clothilde de Chateauguay, Que., onion foliage which had received a post-emergence application of Chloro IPC was severely yellowed, symptomatic of severe nitrogen deficiency. Hale, Chappell and Hulcher (3) reported that the activity of nitrifying organisms is inhibited by the action of Chloro IPC. However, it is not certain Chloro IPC caused this effect at Ste. Clothilde because nitrification was retarded by the cool wet season. However it seems possible that post-emergence applications may have a detrimental effect on onions growing on northern muck soils when they are in need of a readily available supply of nitrogen.

Squash and Pumpkin

Successful weed control, using Alanap-1 (N-1, naphthyl phthalamic acid) as a herbicide, in vine crops has been reported by Warren (14) and others including Cruickshank (1), Ferguson (2) and Sweet and Ries (11). In further experiments at Ottawa in 1953 post-emergence applications of 4 and 8 pounds per acre on Summer Crookneck and Golden Table Queen squash caused some suppression of plant growth, and delayed fruit maturity. Citron, cucumber, muskmelon and pumpkin were not injured. The detrimental effect on squash confirms similar observations by Lachman (5), Rahn (10) and Sweet and Ries (12).

To determine the reaction of a wider range of squash varieties Alanap-1 was applied at 2, 4 and 6 pounds in 50 gallons of water per acre on seven varieties of cucurbits. Seed was sown June 8, 1954, in a clay-loam soil. Pre-emergence treatments were applied June 9. The plants emerged June 17. Post-emergence treatments were applied on July 6. Each plot, 16 by 60 feet, contained eight plants of each variety made up of pumpkin - Connecticut Field (Cucurbita pepo); marrow - Long White Bush (C. pepo), and the squashes - Butternut (C. moschata), Buttercup and Golden Hubbard (C. maxima), Crystal Bell and Golden Table Queen (C. pepo).

No rain fell in the five days preceding the pre-emergence application but 1.1 inches fell during the following five days. At the time of post-emergence treatment rainfall was 0.57 inches in the five days preceding and only 0.03 inches in the five days following. The rest of the growing season was cool and wet.

Results of Pre-Emergence Treatments

Final observations were made eight weeks after treatment.

2 lb./acre. <u>C. pepo</u> - Table Queen squash plants were small and severely retarded. Connecticut Field pumpkin, White Bush marrow and Crystal Bell squash, were vigorous and healthy although the last was slightly retarded.

<u>C. moschata</u> - Butternut was vigorous and healthy but slightly retarded.

<u>C. maxima</u> - Buttercup and Golden Hubbard plants were poor, spindly and greatly retarded.

4 lb./acre. All varieties of <u>C. pepo</u> and <u>C. moschata</u> were small, weak, with pale green foliage and greatly retarded growth.

<u>C. maxima</u> - Buttercup and Golden Hubbard were strong, and vigorous; the plants were only slightly retarded in comparison with the cultivated control.

6 lb./acre. <u>C. pepo</u> - Connecticut Field and White Bush marrow were neither injured nor retarded in growth; while Table Queen and Crystal Bell were seriously retarded.

<u>C. moschata</u> - Butternut and <u>C. maxima</u> Buttercup and Golden Hubbard were not harmfully retarded although growth was not equal to the cultivated control.

Weed control was not complete in the 4-and 6-pound treatments but good enough to be termed practical. The weeds present were mostly oak-leaved goosefoot and purslane. Barnyard grass, lamb's quarters and red root pigweed were largely eliminated. Large numbers of all five kinds were present in the 2-pound treatment which showed little or no weed control.

Results of Post-Emergence Treatments

Final observations were made four weeks after treatment.

2 lb./acre. No weed control, and the cucurbits were completely smothered by the dense weed stand, mostly red root pigweed.

4 lb./acre. The Connecticut Field plants spindly and with pale green foliage, were approximately one-third the size of the cultivated control. All the other varieties were killed or were very small, completely retarded plants. Weeds including barnyard grass, red root pigweed and lamb's quarters were numerous, but they too were short, stunted and pale or yellow-green in color.

6 lb./acre. This treatment caused even more retardation and stunting of both crop and weed plants.

Tomatoes

Weeds in tomato fields can be kept under control by cultivation during the first half of the season. After that the plants become too large and when cultivation is stopped weeds may become a serious problem. In 1953 at Ottawa, Sesin (2,4-dichlorophenoxyethyl benzoate) was applied on duplicate plots (30 by 30 feet) of tomatoes (var. Ottawa TO-20) at the rate of 8 pounds per acre immediately after the last cultivation. Applied as an overall spray, Sesin caused some leaf curling and distortion of the young leaflets which persisted through the rest of the season. Treatment caused no appreciable difference in yield nor any fruit abnormalities. Somewhat similar results have been reported by Sweet and Ries (13) and Noll and Odland (7). However, weeds were so few in this experiment that treated and control plot showed little if any difference.

In 1954 five varieties of tomatoes were grown for treatment. Three single plots each 45 by 60 feet were planted with one row (15 plants) of each variety on June 8. Cultivation stopped on July 23 and the following treatments were applied: Natrin (sodium 2,4,5-trichlorophenoxyethyl sulphate) at the rate of 5 pounds per acre; Sesin at 8 pounds per acre, and a control plot without further weeding. Rainfall amounted to 0.23 inches in the following week. Natrin and Sesin, both applied as overall sprays, affected the plants differently.

In the Sesin plot foliage or leaflets of the new growth on the indeterminate plants was much reduced with curling or distortion common. Consequently, the tops of the plants had a thin, lacy appearance. The determinate plants with less terminal growth were much less affected. All the foliage was a darker, slightly grayer, green than in the control plot.

Natrin had no apparent effect on the young foliage that developed after treatment but it caused severe burning on the older foliage which had received the spray. This was a yellowing followed by scorching. Affected areas varied from spots or narrow portions of leaf margins to large irregular areas involving half a leaflet to several leaflets and petioles. Damage was marked, extensive and so severe that two weeks after treatment the plants were all smaller than the controls.

The ripe fruit was harvested with the yields shown in Table 2.

TABLE 2. -- EFFECT OF NATRIN AND SESIN ON THE MARKETABLE YIELDS OF RIPE TOMATOES, AUGUST 18 TO SEPTEMBER 10

	Natrin 5 lb./ac. lb.	Sesin 8 lb./ac. lb.	Control lb.
Indeterminate varieties			
Carleton	75.3	87.7	83.1
Geneva John Baer	34.6	43.8	42.0
Longred	25.4	23.3	25.6
Quebec 5	97.5	111.4	86.2
Stokeschatham	49.4	40.2	40.2
Total	282.2	306.4	277.1
Determinate varieties			
Bounty	61.6	96.3	94.4
Early Chatham	108.1	135.8	143.9
Meteor	91.8	128.2	113.8
Monarch	77.7	78.9	121.6
Ottawa TO-24	33.8	42.4	54.0
Total	373.0	481.6	527.7

Tomato yields in general were low in 1954 because of cool weather in late summer. This effect is apparent in the low yields shown in Table 2. Natrin and Sesin had no harmful effect on the yielding ability of the indeterminate varieties. On the other hand, the much lower yield of the Natrin-treated determinate varieties indicates a severe detrimental effect. Apparently the indeterminate varieties were able to outgrow the injury from Natrin and as a result produced a full crop whereas the determinate varieties because of their growth habit were unable to add sufficient new growth to overcome the injurious effect.

Although no weed counts were made, visual comparison with the control at the end of the season indicated approximately 90 per cent weed reduction in the Sesin-treated plot. The few weeds remaining were barnyard grass and red root pigweed. Weeds were more numerous in the Natrin-treated plot but even in this plot reduction was approximately 70 per cent. The weeds were barnyard grass, red root pigweed and oak-leaved goosefoot. Weeds were much more numerous in the control plot but were not sufficient to be considered a serious problem. Weeds in this plot included lamb's quarters in addition to those already mentioned.

Conclusions

One or two applications of Chloro IPC at 4 pounds per acre apparently had no harmful effect on the growth and vigor of onions. Applications at 8 pounds per acre gave better weed control but delayed growth and reduced the vigor of the plants.

Under conditions prevailing in Eastern Canada in 1954, Alanap-1 at 2 pounds per acre was insufficient to control weeds in squash and pumpkin. Treatments of 4 or 6 pounds gave better weed control but varietal reaction of the crop was quite variable.

Sesin at 8 pounds per acre was more effective in controlling weeds in tomatoes than Natrin at 5 pounds per acre. Natrin injured the tomato plants severely; yields from the determinate or bush varieties were decreased but yields from indeterminate varieties were not affected.

1. Cruickshank, J.A. Present status of naphthyl phthalamic acid. Proc. Seventh Meeting East. Sec. Nat. Weed Comm., pp.124-126,1953.
2. Ferguson, W. Chemical weed control in vegetable crops in Canada. Rept. XIIIth International Hort. Cong. 1: 349-360. 1952.
3. Hale, M.G. W.E. Chappell and F.H. Hulcher. Effect of certain herbicides on O_2 uptake by soil previously enriched with nitrifiers. Proc. Eighth Ann. N.E. Weed Control Conf., pp.22-28. 1954.
4. Lachman, W.H. Weeding set onions with Chloro IPC. Proc. Seventh Ann. N.E. Weed Control Conf., pp. 85-86. 1953.
5. Lachman, W.H. Some observations on the use of Alanap-1 on vine crops. Proc. Eighth Ann. N.E. Weed Control Conf., p. 89. 1954.
6. Noll, C.J. and M.L. Odland. Weeding of seeded onions with chemicals. Proc. Eighth Ann. N.E. Weed Control Conf., pp. 187-189. 1954.
7. Noll, C.J. and M.L. Odland. Chemical herbicides as they affect yield of tomatoes. Proc. Eighth Ann. N.E. Weed Control Conf., pp. 191-192. 1954.

8. Perkins, D.Y. A progress report on the use of stem sprays for onion weed control on muck soils. Proc. Seventh Ann. N.E. Weed Control Conf., pp. 87-90. 1953.

9. Perkins, D.Y. Pre-emergence weed control on muck grown seeded onions. Proc. Eighth Ann. N.E. Weed Control Conf., pp.111-114. 1954.

10. Rahn, E.M. Alanap-1 as a herbicide for vine crops in 1953. Proc. Eighth Ann. N.E. Weed Control Conf., pp. 83-87. 1954.

11. Sweet, R.D. and S.K. Ries. Chemical weeding of cucurbits. Proc. Sixth Ann. N.E. Weed Control Conf., pp. 187-191. 1952.

12. Sweet, R.D. and S.K. Ries. N-1 naphthyl phthalamic acid and Crag Herbicide 1 on cucumbers, muskmelons, watermelons and squash. Proc. Seventh Ann. N.E. Weed Control Conf., pp.57-63. 1953.

13. Sweet, R.D. and S.K. Ries. Post-emergence application of five herbicides on ten vegetable crops. Proc. Seventh Ann. N.E. Weed Control Conf., pp. 81-84. 1953.

14. Warren, G.F. Crabgrass control in muskmelons. Res. Rept. Seventh Ann. N.C. Weed Control Conf., p. 167. 1950.

ENVIRONMENT AND RATE OF APPLICATION STUDIES ON BEAN PRE-EMERGENCE WEED CONTROL WITH CIPC

Guenter Loeffler*

In extensive field studies on the effect of Isopropyl N-3-Chlorophenyl Carbamate (CIPC) on dry beans during 1954, this material showed promise in controlling grasses in this crop. Therefore, it was decided to study the influence of the environment on bean response to CIPC.

It was shown by Anderson, et al (1) that carbamates evaporate at a relatively high rapid rate at moderate or relatively high temperatures. Danielson (2) reported that 12000 or more degree hours above 40°F. are necessary in the first three weeks after the application of 2 pounds of CIPC on spinach to avoid injury. Stand reduction and growth retardation of spinach have been experienced at 8000 degree hour levels.

Shaw (4) states that even though the carbamates are highly volatile, the activity of their vapor is relatively low on tolerant plants such as cotton and soybeans. Work concerning the influence of the vapor activity of CIPC on plants has been reported by Linder, Shaw, and Marth (3). They found that vapors of volatile carbamates will penetrate and injure seedlings prior to emergence. It was shown that the stage of development of the seedling at which the greatest injury occurs is when the primary root is emerging through the broken seedcoat. This sensitive stage of growth was the same for each species, but the time required to reach this stage varies with species.

The following experiment was conducted to test the influence of temperature on CIPC injury as ! might vary when applied at certain times of the day.

Materials and Methods

Red Kidney beans were planted on August 9, 1954 at the Cornell University Experiment fields near Varna, New York. On August 14, when the primary roots averaged about 2.5 cm in length, CIPC was sprayed on 0.001 acre plots. The treatments were applied at three different times during the daylight period in order to obtain the different temperatures. Rates of 4 to 20 pounds per acre of actual material were applied. A split plot design with four replications was used in which the three application times for any given rate were grouped together. In order to avoid drift, one guard row was left between treated rows. Mean air temperature during the morning application was 58°F. and the soil temperature was 57°F.

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During the application of the early afternoon treatment, the temperatures were 94°F. and 84.6°F., and for the evening application 71°F. and 72°F. for the air and soil respectively. The average daily temperature for the next two weeks was 65.3°F. The soil surface was in a very moist condition and there was a light rain shortly after the last application. The treatments were applied in 500 cc. of water per plot with a small CO_2 sprayer.

On September 18, a ten-foot section of each plot was harvested and fresh weight determined. The data were treated statistically, applying analysis of variance and single degree of freedom comparisons were extracted for temperatures and rates.

Results

Emergence of the bean plants was uniform, and no obvious differences in the appearance of the plots could be seen at the time of emergence. No stand reduction resulted from any of the treatments. No differences could be seen between low and high application rates until three weeks after application of the CIPC sprays. At that time a stunting of the bean plants was noticed in the plot treated with higher rates. The table shows the average fresh weights of the harvested plots.

Table I. Fresh weights of beans harvested from plots treated with 5 rates of CIPC at three different times. (Data are presented as grams per 10 foot of row, average of four replications).

Treatment	Morning	Noon	Evening	Means of Rates
Check	686	700	605	664
CIPC 4#/A	655	530	632	606
" 8#/A	442	401	543	462
" 12#/A	425	431	631	496
" 16#/A	410	390	435	412
" 20#/A	396	315	403	371
Means of Times	502	461	541	502

The analysis of variance showed highly significant differences between rates, but no differences between temperatures. Using the method for comparing single degrees of freedom it was found that.

(1) Check plot yields were greater than those of treated plots. These differences were highly significant.

Fig. 1 - Fresh weights of bean plants as influenced by different rates of CIPC and application temperatures.

(2) Comparing the noon application with the evening application for the total of all the rates, there was a significantly higher average yield for the evening application.

(3) At the 12 pound rate the yields from the plots of the morning and evening applications were significantly higher than the yields of the plots from the noon application.

(4) Comparing rates within the three application times the decrease in fresh weight with increase in CIPC concentration is only significant at the high temperature application between the check and the 4 pound rate.

Discussion

The data suggests that the temperature at the time of application might influence the later growth of the bean plants. Greater volatility occurs at higher temperatures and the vapors must affect bean plants which have not yet emerged. The application of only 4 pounds of CIPC at the highest temperature resulted in a significant decrease in yields. The significant decrease of the yields at the 12 pound rate applied at noon over the morning and the evening treatment would indicate that the influence of the temperature was greater at the intermediate than at the lower and higher rates. This can be explained by the fact that lower rates are sufficiently low in toxicity and that little differences are found due to temperature variations. At the higher rates, phytotoxicity is so severe that the effect of temperature is not expressed. However, at the intermediate rates the differences due to temperature are expressed at their maximum values. This relationship between temperature and rate of application is shown in figure 1.

The results of this field experiment suggest that vapors of volatile carbamates like CIPC, will penetrate the seedling prior to emergence. These results are in agreement with those of Linder, et al. These results further suggest that the temperature at the time of application is an important factor in the amount of injury occurring from CIPC applications to Red Kidney beans.

Bibliography

1. Anderson, W. P., Linder, P. J., and Mitchel, I. W., Evaporation of some plant growth regulators and its possible effect on their activity. Science 116, 1952 p. 502

2. Danielson, L. L. and France, Virginia, Experimental and field use of 3-Chloro-IPC on vegetable crops in Tidewater, Virginia. Proceedings N.E.W.C.C., 1953 p. 73.

3. Linder, P. J., Shaw, W. C., Marth, P. C., The relative vapor activity of several carbamates. Proceedings N.E.W.C.C., 1954 p. 11 (Abstract)

4. Shaw, W. C., Linder, P. J. and Marth, P. C., The importance of the relative vapor activity of chemicals in the development and use of herbicides. Proceedings S.W.C.C., 1953 p. 45.

Weed Control in Lima Beans with Various Herbicides[1]

Charles J. Noll and Martin L. Odland[2]

Pennsylvania farmers grew 4400 acres of lima beans for processing in 1954 with an average value of 100 dollars per acre. Most of the acreage is on general farms where machine cultivated equipment is adequate and between the row weeds are readily controlled. However, hand labor is limited, thus precluding hand weeding of the lima bean row. The need for a practical method of weeding the row exists in early season especially under wet conditions when fast growing weeds smother the seedling lima bean plants.

This report is a continuation of work started in 1948, and is a comparison of new herbicides with the most successfully used herbicides tested in previous years.

Procedure

Ten chemicals, Premerge, ACP-L-685, ACP-L-469, Chloro IPC, ACP-L-702, Aero Cyanamid Sol., Kuron, NP-1475 E50, EH 6029, and Stoddard Sol, were tested at State College in 1954. The herbicides were applied at from 1 to 3 rates with a small sprayer over the row for a width of one foot. The weeds between the row were controlled through machine cultivation.

The land was prepared June 13 and Fordhook 242 lima beans were planted on June 14. The chemicals were not applied at predetermined dates, rather they were applied at the time when it was believed that maximum weed control would be obtained with minimum damage to the lima bean plants. The treatments were arranged at random in each of ten replicated blocks. Each plot consisted of a single row 22 feet long by 3 feet wide.

In the check plots the weeds in the row were numerous and early presented a serious threat to a satisfactory yield. The number of plants and yield per plot was obtained at a single harvest in September.

Results

A summary of results is presented in Table I. Seven of the ten herbicides used gave significant increases in weed control, significant increases in yield and no significant reduction of stand at one or more rates of application.

Premerge (alkanolamine sale of Dinitro-o-sec-Butylphenol, 3 lbs. per gallon) applied at the rate of 3 gallons the day the beans were planted, 2 gallons three days after planting and 1 gallon at time of bean emergence gave perfect weed control, without reduction in stand of lima beans and a highly significant increase in yield as compared to the untreated check.

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[1]Authorized for publication on Nov. 26, 1954 as Paper No. 1923 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

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ACP-L-685 (2,4-dichlorophenoxy propionic acid, 4 lbs. per gallon) applied at the rates of 1/4 and 3/8 gallon per acre 3 days after the beans were planted gave good weed control, with no significant reduction of stand and a highly significant increase in yield as compared to the untreated check. Although both treatments resulted in a reduction of stand of beans the decrease was not significant.

ACP-L-469 (Sodium Pentachlorophenate 2.92 lbs. per gallon) applied at the rates of 6 and 9 gallons per acre 2 days after planting resulted in excellent weed control, no significant reduction of bean stand and highly significant increases in yield. The sodium pentachlorophenate in the liquid as well as the powder form has given consistent good results on lima beans at State College.

Chloro IPC (Isopropyl N (3 chlorophenyl) carbamate, 4 lbs. per gallon) applied at the rates of 1 1/2 and 2 1/4 gallons per acre 2 days after planting resulted in excellent weed control, no significant reduction of bean stand and a significant increase in yield. Although there was no significant difference between the yields of the two Chloro IPC plots the plot with the lesser rate of Chloro IPC had the bigger yield.

ACP-L-702 (MCP propionic acid, 4 lbs. per gallon) applied at 1/4 and 1/2 gallon per acre 3 days after planting gave highly significant better weed control than the untreated check, stand of beans was not significantly reduced and the yield was highly significantly increased. The weed control at the 1/2 gallon per acre rate was highly significantly better than the same chemical at 1/4 gallon per acre.

Aero Cyanamid Soluble (Monosodium cyanamid 85% ingredient) applied at the rates of 40 and 60 lbs. per acre 3 days after the beans were planted resulted in highly significant increases in weed control, no reduction of plant stand and significant increases in yield. The 60 lb. rate was significantly better in regards to weed control and yield as compared to the 40 lb. rate.

Kuron (2- (2,4,5 trichlorophenoxy) propionic acid, Silvex acid equivalent 4 lbs. per gallon) applied at the rate of 1 and 1 1/2 gallons per acre 2 days after the beans were planted gave excellent weed control with a highly significant reduction in stand of lima beans. The yield was equal to the untreated check with the higher rate of treatment significantly better than the check at the lower rate of treatment.

NP-1475 E50 (Organic phosphate, 4 lbs. per gallon) applied at the rate of 2 1/2 gallons and 3 3/4 gallons per acre two days after beans were planted gave good weed control, no reduction of stand of lima beans and a significant increase in yield of beans as compared to the untreated check. The higher rate of treatment resulted in significantly better weed control than the lower rate of treatment.

EH 6029 (3 amino-1,2,4 triazole, 50% soluble powder) applied at the rate of 10 and 15 lbs. per acre 2 days after the beans were planted resulted in significantly less weed control than the better of the other chemicals tried. Stand was not reduced and yield not significantly improved by these treatments.

Stoddard Solvent applied at the rate of 100 gallons per acre 3 days after the beans were planted resulted in practically no weed control and had no significant effect on stand or yields.

Conclusions

Weather conditions this year were such as to encourage weed growth. All chemicals in this experiment resulted in significant increases in weed control. Eight of the chemicals at one or more rates resulted in significant increases in yield as compared to the untreated check plot, yield increases being in many cases 40% or more.

Outstanding results were obtained with Premerge applied from time of seeding to emergence. Sodium Pentachlorophenate gave equally good results when applied two days after planting. This is in line with results obtained in other years.

Other chemicals that offer promise in the weeding of this crop are 2,4-dichlorophenoxy propionic acid, Chloro IPC, MCP propionic acid, Monosodium cyamamid and organic phosphate. The rate, time of application, and effect of environmental factors on these chemicals have not been extensively investigated at State College.

Table I. Effect of herbicides on weeds and stand and yield of lima beans.

Herbicide	Rate per acre	Application Days after Planting	*Weed Control	Beans per Plot Stand	Beans per Plot Yield lbs.
Nothing	----	----	9.5	59.9	11.1
Premerge	3 gal	0	1.0	58.3	15.3
"	2 gal	3	1.0	60.0	16.4
"	1 gal	8	1.1	57.3	15.6
1 ACP-L-685	1/4 gal	3	1.9	52.4	14.7
"	3/8 gal	3	1.2	53.1	15.1
2 ACP-L-469	6 gal	2	1.3	58.4	16.8
Chloro IPC	1 1/2 gal	2	1.7	57.3	15.8
" "	2 1/4 gal	2	1.3	54.5	13.7
3 ACP-L-702	1/4 gal	3	3.1	56.1	15.8
"	1/2 gal	3	1.4	53.3	16.3
Aero Cyanamid Sol.	40 lb.	3	1.8	57.8	13.8
" " "	60 lbs.	3	1.0	58.1	16.4
Kuron	1 gal	2	1.5	41.4	15.1
"	1 1/2 gal	2	1.0	34.6	10.6
4 NP-1475 E50	2 1/2 gal	2	2.3	56.5	14.1
"	3 3/4 gal	2	1.4	58.1	15.5
5 EH 6029	10 lbs.	2	3.2	58.4	12.5
"	15 lbs.	2	2.6	58.6	13.1
Stoddard Sol.	100 gal	3	7.4	53.9	10.7
Least significant difference at .05 level			0.8	7.7	2.4
" " " " .01 "			1.1	10.1	3.2

1 2,4-dichlorophenoxy propionic acid, 4 lbs per gallon
2 Sodium pentachlorophenate, 2.92 lbs per gallon
3 MCP propionic acid, 4 lbs per gallon
4 Organic phosphate, 4 lbs per gallon
5 2 amino-1,2,4 triazole 50% soluble powder

*Weed Control (1-10) 1- perfect weed control
10- full weed growth

DEFOLIATION OF DRY BEANS[1]

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Introduction

Chemical defoliation has been used as a regular practice before harvesting cotton, wheat, rice, soybeans, hops and various seed crops. It is now being used commercially for aiding the harvesting of dry beans. Screening tests for the last three years indicated that Endothal, Shed-A-Leaf, Aero-Cyanate, De-Fol-Ate, and monochloroacetic acid are promising defoliants for dry beans.

The objectives of the following experiments were:

(1) To find the most effective defoliants for dry beans
(2) To study the effects of different gallonages and pressures in applying defoliants
(3) To study the responses of bean plants at various stages of maturity to the defoliants

Methods and Materials

Two field experiments were conducted during 1953 and 1954 on Red Kidney beans. Two gallonages, 15 and 30 gallons per acre, and two pressures, 40 and 80 pounds, were used.

The experiment in 1953 consisted of two replicates of 36 different treatments. The treatments included three rates of three chemicals with two gallonages and two pressures. The rates of chemicals were 1/4, 1/2 and 3/4 pound per acre of Endothal; 4, 8 and 12 pounds per acre of Shed-A-Leaf; and 3, 5 and 7 pounds per acre of monochloroacetic acid. The plants were treated on September 19. The maximum daily temperature was 68°F. and the minimum was 39°F. The average temperature of the following ten days after treatment was a maximum of 69.1°F. and a minimum of 46.5°F. The number of leaves of five plants in each plot were counted before and 20 days after treatment. Leaves which were desiccated were counted separately.

Three planting dates, May 15, May 25 and June 15, were included in the 1954 experiment with three replicates of 16 treatments consisting

[1]This study was conducted to fulfill partial requirements for a Ph.D. degree at Cornell University and was made possible by a fellowship from the China International Foundation.

of four chemicals at one rate applied at two pressures and two gallonages for each planting date. The chemicals and rates were Endothal at 2/3 pound, Shed-A-Leaf at 1 1/2 gallons, Aero-Cyanate at 10 pounds, and De-Fol-Ate at 6 pounds per acre. The plots were sprayed on September 2, 1954, when the maximum daily temperature was 74°F. and the minimum temperature was 45°F. The average temperature of the following ten days was a maximum of 77.2°F. and a minimum of 57.5°F. Leaf-counts were made before spraying and ten days after treatment.

The percentages of defoliation and desiccation were calculated from the leaf-counts. Analysis of Variance and Multiple Range Tests (1) were computed to test the significance of differences between the chemicals and the different gallonages, pressures, and planting dates.

Results and Discussion

The percentages of defoliation and desiccation of treated plots in both of these two experiments were significantly higher than those of the check at odds of 99:1.

In 1953, the average percentage of defoliation of either Endothal or Shed-A-Leaf was significantly higher than that of MCA at odds of 99:1. The results are summarized in table 1.

Table 1. The Average Percentages of Defoliation of Three Chemicals in 1953

Defoliants	Average percentages of defoliation
Endothal	83.83
Shed-A-Leaf	81.22
Monochloroacetic Acid	61.89
Check	43.00

In 1954, Aero-Cyanate and De-Fol-Ate were included and MCA was eliminated because it caused spotting of the beans. Endothal and Shed-A-Leaf were found to be superior to either Aero-Cyanate or De-Fol-Ate, as shown in table 2. A higher rate of these two materials is apparently required for good defoliation. There was no significant difference between Endothal and Shed-A-Leaf in either of these two experiments.

Table 2. The Average Percentages of Defoliation for Four Chemicals at Three Planting Dates in 1954

Planting Dates	May 15	May 25	June 15	Means
Endothal	88.32	86.16	71.48	81.99
Shed-A-Leaf	91.11	88.11	68.66	82.63
Aero-Cyanate	76.41	85.16	60.04	73.87
De-Fol-Ate	81.11	86.64	97	78.91
Check	45.50	75.96	2[illegible].47	48.31
Means	76.49	84.41	58.72	

When the plots were treated on September 2, 1954 the plants of the third planting date, June 15, were still green whereas those of the other planting dates were considerably more mature as indicated by yellowing of the older leaves. The average percentage of defoliation of the June 15 planting was 58.72 per cent as compared to 76.49 per cent for the May 15 and 84.41 for the May 25 plantings. The May 25 planting , located on a slope above the May 15 planting and the soil was drier. The plants of May 25 were more mature than those of the earlier planting date, and the percentage of defoliation was also higher. However, there is no significant difference between the May 15 and 25 planting dates.

The Analysis of Variance indicated that there were highly significant differences for the interactions between chemicals and gallonages. By using the Multiple Range Test, there was no significant difference found between any two gallonages within each chemical. (Table 3.)

Table 3. The Average Percentages of Defoliation for Four Chemicals and Two Gallonages in 1954

	Endothal	Shed-A-Leaf	Aero-Cyanate	De-Fol-Ate	Means
15 gal./A	86.96	82.95	69.03	78.54	79.37
30 gal./A	77.01	82.30	78.71	79.27	79.32

The combinations of high gallonage with high pressure or low gallonage with low pressure gave higher percentages of defoliation than either high gallonage with low pressure or low gallonage with high pressure as indicated in table 4.

Table 4. The Average Percentages of Defoliation of Two Gallonages and Two Pressures of Spraying in 1954

	15 gallons/acre	30 gallons/acre
40 pounds	65.56	60.95
80 pounds	61.43	65.96

There was no significant difference between the percentages of desiccation of Endothal and Shed-A-Leaf in either of these experiments. Both of these chemicals were significantly lower than MCA, in 1953, and than Aero-Cyanate, in 1954, at odds of 99:1, as indicated in table 5.

Table 5. The Average Percentages of Desiccation of Five Chemicals in 1953 and 1954

Chemicals	Percentages of Desiccation 1953	1954
Endothal	8.96	4.57
Shed-A-Leaf	13.41	8.36
MCA	29.23	--
Aero-Cyanate	--	17.50
De-Fol-Ate	--	10.78
Check	6.63	2.90

There was more desiccation of the younger plants than of the more mature plants as indicated in table 6.

Table 6. The Average Percentages of Desiccation of Three Planting Dates in 1954

Planting Dates	Percentages of Desiccation
May 15	6.01
May 25	4.81
June 15	10.25

There were highly significant differences between the gallonages and pressures, as shown in tables 7 and 8. The low gallonage caused more desiccation than the high gallonage, and the high pressure caused more desiccation than the low pressure.

Table 7. The Average Percentages of Desiccation of Four Chemicals and Two Gallonages in 1954

	Endothal	Shed-A-Leaf	Aero-Cyanate	De-Fol-Ate	Means
15 gal./A	7.03	10.69	25.16	14.37	14.31
30 gal./A	2.12	6.04	9.85	7.19	6.30

Table 8. The Average Percentages of Desiccation of Four Chemicals and Two Pressures in 1954

	Endothal	Shed-A-Leaf	Aero-Cyanate	De-Fol-Ate	Means
40 pounds	1.71	6.87	12.79	9.35	7.68
80 pounds	7.44	9.86	22.22	12.20	12.93

Conclusion

All the treated plots in these experiments showed significantly higher percentages of defoliation or desiccation than the untreated plots. Endothal and Shed-A-Leaf showed better defoliation and less desiccation than the other defoliants.

Different gallonages and different pressures used in applying defoliants gave no significant effect on defoliation when considered separately, however, the interaction between pressure and gallonage was significant. Low gallonage or high pressure generally caused more desiccation than high gallonage or low pressure.

After treating with defoliants, the more mature plants had higher percentages of defoliation and less desiccation than the immature plants.

Reference

1. Duncan, David B. Multiple Range and Multiple F Tests Technical Report No. 9. Department of Statistics and Statistical Laboratory, Virginia Agricultural Experiment Station. June 1954.

Pre-Emergence Weeding of Squash*

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When optimum conditions prevail, N-1 naphthyl phthalamic acid serves as a good weed killer in the culture of some vine crops. When the soil is dry at the time of application, however, weed control is very unsatisfactory. Even under optimum conditions, this herbicide is somewhat toxic to some of the crops, particularly Butternut squash.

Methods

In order to study this problem further, two rates of three materials and one rate of a fourth material were applied pre-emergence on plantings of two varieties of squash. The materials used were N-1 naphthyl phthalamic acid, 90 per cent wettable powder (Alanap-1), a 1:1 mixture of N-1 naphthyl phthalamic acid and N-1 naphthyl phthalimide, 90 per cent wettable powder (Alanap-5), and N-1 naphthyl phthalamic acid, 50 per cent wettable powder (Alanap-50W). The fourth material was alkanolamine salt of DNOSBP (Premerge).

Seed of the Blue Hubbard and Butternut varieties were planted on June 17, 1954, and the herbicides were applied to the appropriate plots on the same day. The treatments were replicated three times. About three-quarters of an inch of rain had fallen on June 15, and the soil moisture was considered fairly good for weed control with the various Alanap formulations. There was no more rain until June 23, however, when .36 inch fell.

Results

The results noted on July 13 are presented in Table I. The Alanap formulations were definitely effective in controlling many weeds, with statistical significance when compared to the check, but the weed control was not so spectacular as in some earlier exploratory tests. It is clearly seen in the table that there is an association between the amounts of Alanap applied to the soil and actual weed control, but the differences among these treatments are not significant. Also, larger dosages suppressed the development of weeds as indicated under "Weed Size" in Table I, but again the differences are not real. When compared with the Check, however, all treatments were very effective in suppressing the development of any weeds that had germinated.

The Butternut variety showed a marked dwarfing effect as compared to Blue Hubbard as a result of the Alanap treatments. Alanap-1 was not so toxic as the two other Alanap materials.

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*Thanks are due to the Naugatuck Chemical Company for supplying the Alanap formulations.

Contribution No. 985, Massachusetts Agricultural Experiment Station, University of Massachusetts, Amherst.

Perhaps the most interesting result was the tolerance of both squash varieties to the Dinitro treatment. The relatively large seed of squash allows for the depth protection in the soil necessary for pre-emergence weeding with Dinitros, and this treatment rated best among those under test in this experiment.

It was not considered feasible to report yields in these tests because of the damage from a severe hailstorm on July 31 and hurricane damage on August 31 and September 11.

Summary

Butternut squash plants were much more susceptible to injury than Blue Hubbard from three different phthalamic acid compounds. Alanap-1 was apparently more desirable than Alanap 5 or Alanap 50W for killing weeds in the vine crops. Dinitro at the three pound rate gave the best weed control and least crop damage than any of the Alanap treatments.

Table I. Effects of Alanap Formulations and Premerge on Blue Hubbard and Butternut Squash

Treatment	Lbs. per acre	Weeds per sq. ft.	Weed size 1-9*	Blue Hubbard response 1-9	Butternut response 1-9
Alanap-1	2	11.7	5.0	8.3	7.7
Alanap-1	4	6.7	6.7	7.7	7.3
Alanap-5	2	11.7	6.0	8.3	7.7
Alanap-5	4	8.0	6.7	7.3	5.7
Alanap-50W	2	8.7	7.0	8.3	7.0
Alanap-50W	4	5.0	7.3	8.3	6.0
DN (Premerge)	3	4.3	7.3	8.7	9.0
Check		28.4	1.0	9.0	9.0
L.S.D. at .05		15.2	3.8	N.S.	2.2
L.S.D. at .01		21.2	5.4	N.S.	3.0

*In the 1-9 ratings 1 is least desirable and 9 most desirable.

RESPONSE OF SQUASHES TO ALANAP-1

(N-1 naphthyl phthalamic acid) 1/ 2/

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Although Alanap-1 (N-1 naphthyl phthalamic acid) has been used successfully on cucumbers, watermelons and muskmelons, certain squashes have been injured by applications of this chemical. It has been reported (1, 4) that at least some of the injury is correlated with varietal response. The purpose of the work reported here was to explore further the possible relationship between crop variety and response to Alanap-1.

METHODS

The following eight varieties were included in these tests: Acorn, C. pepo, Blue Hubbard, C. maxima, Boston Marrow, C. maxima, Buttercup, C. maxima, Butternut, C. moschata, Cocozelle, C. pepo, Golden Delicious, C. maxima, and Straightneck, C. pepo. Each variety was planted in a single 100-foot row for each of 3 replications. Variety rows were arranged at random in each replicate. One spray treatment was assigned at random to a 20 foot section of variety row.

The following treatments were applied: 3 and 6 pounds of active Alanap-1 applied pre-emergence June 23 (six days following planting) when squash and weeds had sprouted but not emerged. Similar rates were applied to other plots July 12 when the squash had well-developed true leaves but had not yet developed runners. Weeds had emerged but were not large and well-established. Chemical treatments were restricted to a 2-foot strip over the crop row. The middle areas were cultivated to remove weeds. No hand weeding was done on any plot. Sprays were applied by means of a small-plot sprayer (3) which used CO_2 as a source of pressure.

The principal weed pests were red-root pigweed Amaranthus retroflexus, and crabgrass, Digitaria sp. Weed infestation on the untreated plots was moderate. Only the more careful growers would have considered the weeds severe enough to warrant hand work. Ratings of weed growth were made at harvest time.

The soil type was a relatively heavy but well-drained silt loam having an organic matter content of about 4.0% and a pH of about 6.0. Surface soil moisture was good at each time of spraying; 0.57 inch of rain fell immediately following the June 23 treatment, and 0.47 inch fell 3 days following the July 12 treatment.

Crop vine growth was normal except for the Acorn and Butternut varieties which lacked vigor. Maturity of the crop was slow due to a cool season. The

1/ Paper No. 384 of the Department of Vegetable Crops, Cornell University
2/ Part of this work was supported by a grant in aid from the Standard Oil Development Co., Linden, New Jersey.

crop was killed by a severe frost in early October. No large well-developed fruit was obtained from the latest varieties.

The treatments were evaluated on the basis of vine growth, number and weight of fruit, as well as for weed control.

RESULTS

Crop growth ratings are presented in Table 1. Statistical analysis of the data indicated that the varieties had different vine vigor, but that there was no significant variety-treatment interaction.

Table 1. The response of squash vine growth to Alanap-1 as measured by visual ratings. 1/

Varieties	Treatments: Pre-emergence 3 lbs.	Pre-emergence 6 lbs.	Post-emergence 3 lbs.	Post-emergence 6 lbs.	Check
Boston Marrow	25	24	23	24	25
Golden Delicious	26	26	26	26	25
Blue Hubbard	23	23	25	20	24
Butternut	22	21	18	15	23
Buttercup	25	24	23	22	25
Acorn	24	21	19	18	26
Straightneck	26	24	23	24	26
Cocozelle	24	24	24	22	23

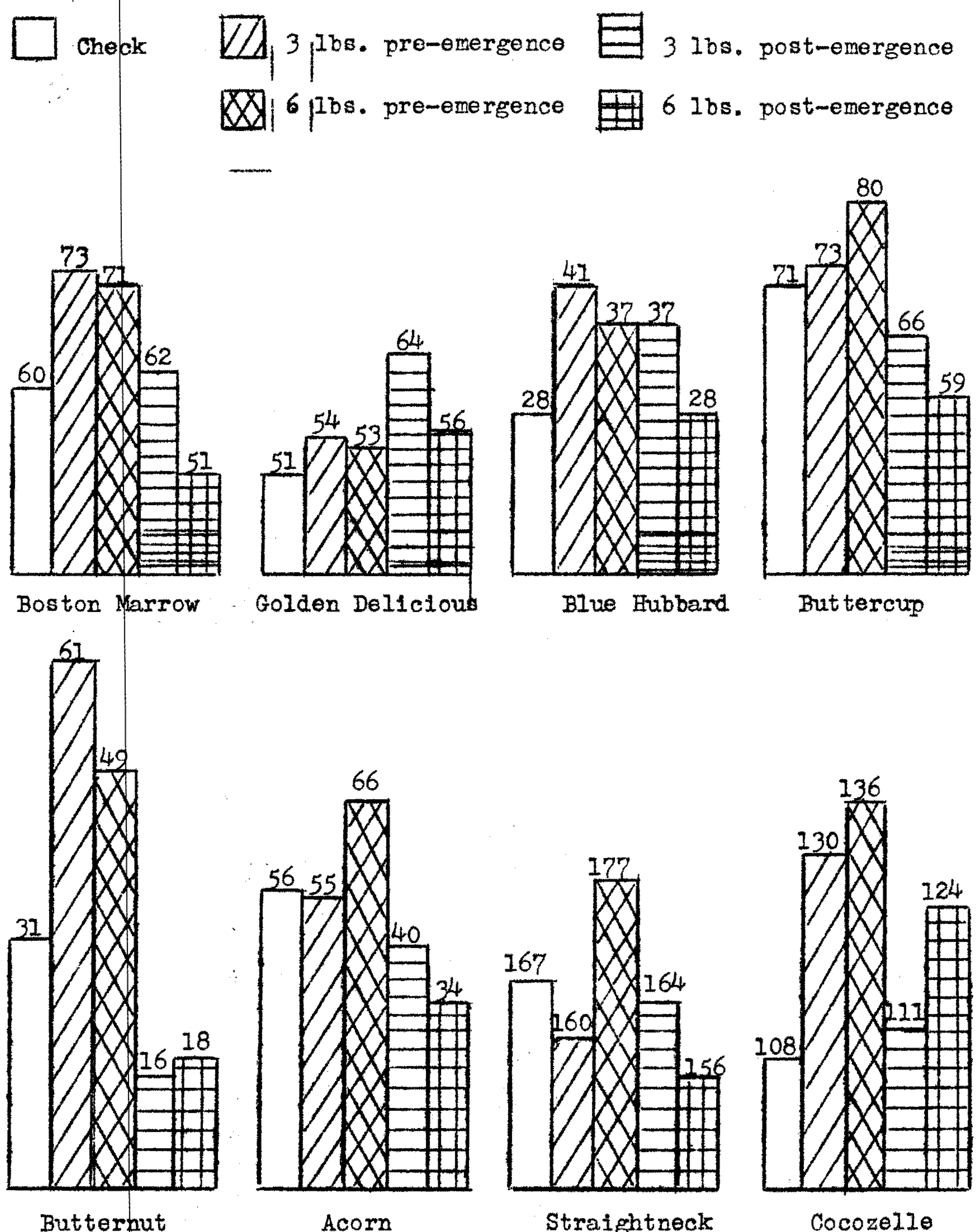
1/ Ratings of 9 - normal growth; 1 - killed. Values in Table 1 are totals for 3 replications.

There was a significant depression in vine growth by the 6 vs the 3 pound rate of Alanap-1. Post-emergence applications were more injurious than pre-emergence applications. Even the Butternut and Acorn varieties were fairly tolerant of the 3 pound rate applied pre-emergence. Vine growth was substantially reduced in these two varieties by both the 3 and 6 pound rates when applied post-emergence. Although the generally lower vigor of these two varieties in these tests may be a contributing factor to the injury noted, previous work and observations of others (1,4) has shown these varieties to be injured by Alanap-1.

The results of the yield data, number and weight of fruit, are presented in graphic form Figure 1 and 2. 2/, respectively.

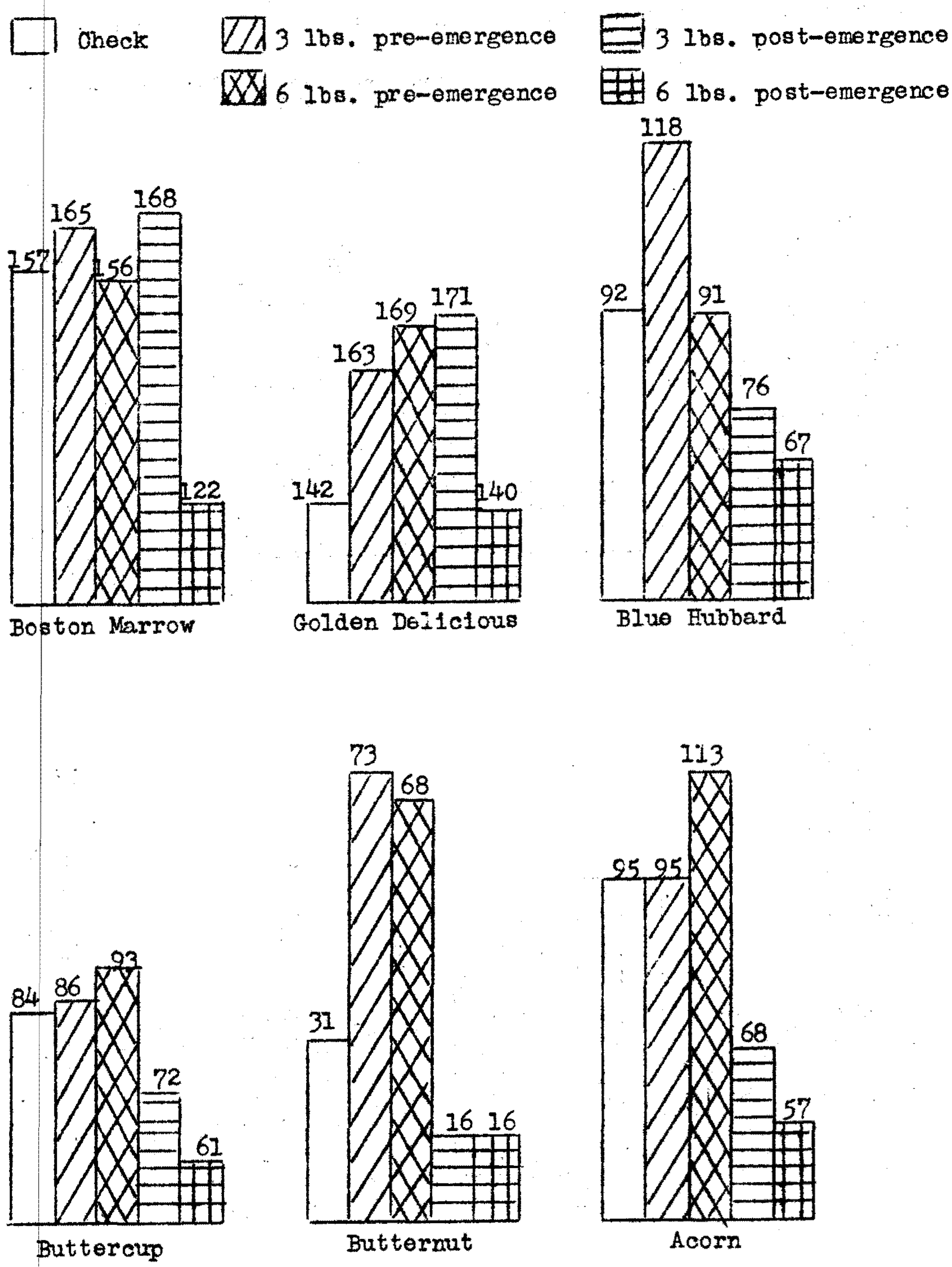
2/ Fruit weight of Straightneck and Cocozelle are omitted because a days difference in development at time of harvest unduly influenced fruit weight.

Figure 1. The number of squash harvested from eight varieties treated with Alanap-1. 3/



3/ Values are totals of three replications.
Bars for each variety are of the same scale but with different bases.

Figure 2. The weight of squash harvested from six varieties treated with Alanap-1.



It is shown in Figure 1 that there is a significant difference in variety response. Fruit numbers for the Acorn and Butternut varieties were reduced by the post-emergence treatments. However, fruit weights (Figure 2) show that all varieties yielded significantly less in the treatments applied post-emergence. On the other hand all varieties were safely treated pre-emergence at the low rate, and only Blue Hubbard yields were reduced by 6 pounds applied pre-emergence. Generally the checks were numerically inferior to the 3 lb. rate applied pre-emergence. This is probably a measure of weed competition.

No detailed data on weed control will be presented. However, gross differences were readily apparent at harvest time. There was no difference between the 3 and 6 pound rate. Time of application, on the other hand, had a striking effect on weed control. Pre-emergence application, when weeds were sprouting, gave almost complete control of the major weeds, redroot and crab-grass. Sprays made two and one-half weeks later, when many of the weeds had emerged, were rated at no better than the check plots. Similar good results on weed control by a pre-emergence spray have been reported (4).

SUMMARY

Squash varieties differed in their response to Alanap-1 sprays. The summer squash, Straightneck, C. pepo, and Cocozelle, C. pepo, varieties were more tolerant than Acorn, C. pepo, and Butternut, C. moschata, Buttercup, C. maxima, Boston Marrow, C. maxima, Golden Delicious, C. maxima, and Blue Hubbard, C. maxima, were intermediate. Both the safety and effectiveness of Alanap-1 treatments were markedly influenced by timing. Applications pre-emergence to both crop and weeds gave less crop damage and at the same time better weed control than sprays made post-emergence.

There was no consistent correlation between variety response and botanical species classification.

LITERATURE CITED

Lachman, W. H. Some Observations on the Use of Alanap-1 on Vine Crops. Proc. NEWCC 89. 1954.

Rahn, E. M. Alanap-1 As a Herbicide for Vine Crops in 1953. NEWCC 83-87. 1954.

Ries, S. K. and Terry, C. W. The Design and Evaluation of a Small-Plot Sprayer. WEEDS 1, No. 2. 160-173. 1952.

Sweet, R. D. and Ries, S. K. N-1 Naphthyl Phthalamic Acid and Crag Herbicide 1 on Cucumbers, muskmelons, Watermelons and Squash. Proc. NEWCC 57-63. 1953.

THE SUSCEPTIBILITY OF CUCURBITA VARIETIES TO N-1 NAPTHYL PHTHALAMIC ACID[1]

S. K. Ries[2] and J. T. Howell[3]

N-1 Napthyl Phthalamic acid (NP) has been used successfully for control of annual weeds in muskmelons, cucumbers and watermelons. The results from applying this material to squash and pumpkin (Cucurbita sp.) have been variable even though these species are members of the family Cucurbitaceae.

Sweet and Ries (5) reported visual injury to the varieties Table Queen and Blue Hubbard at 2, 4 and 8 pounds of NP per acre. Sweet and Ries (6), during the following year, treated the varieties Butternut, Table Queen and Blue Hubbard with 2 and 4 pounds of NP per acre just before emergence. There was no significant reduction in yield in any of these varieties from these treatments. Hemphill (1) reported injury to White Bush Scallop from 4 and 6 pounds of NP applied as a pre-emergence treatment. Rahn (3) reported that 2 pounds of NP applied after seeding Boston Marrow, reduced the stand 40 per cent. A 1-pound application to the same variety one month after seeding failed to reduce the yield. Lachman (2) noted a different response of varieties to NP. He reported Uconn and Butternut as being particularly sensitive.

Because of this inconsistent response of Cucurbita species to NP, recommendations have not been forthcoming for its use on squash and pumpkin varieties. It was the objective of this work to determine which types of varieties, if any, were tolerant of NP under similar environmental conditions in both the field and laboratory, and if this tolerance was restricted to a single species (pepo, maxima or moschata).

Field Test

Materials and Methods

Ten varieties, representing three Cucurbita species, were seeded with a V-belt planter on July 5 in a sandy loam soil. Each variety plot was split for treatment and randomized in each replication of a factorial experiment. The smallest plots were 6 feet wide and 8 feet long. The treatments were applied with a small plot sprayer immediately after planting. The treatments were 0, 4 and 8 pounds acid equivalent of NP.

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Stand counts were made 2 weeks after planting and growth ratings made 5 weeks after planting.

Results

The stand counts and growth ratings are presented in Table 1. There was no clear break between tolerance and resistance in the various squash varieties. Of the three *Cucurbita* species tested none seemed to have a uniform tolerance for NP. Of the varieties within the species tested, the most tolerant variety was Zucchini. Neither its stand nor growth was reduced significantly by 4 and 8 pounds per acre. The stand counts and growth ratings of the following varieties did not differ significantly from their check at the 4 pound rate: Sweet Cheese, Delicious, Boston Marrow and Buttercup. Those varieties which had either stand, growth, or both, reduced by the 4 pound rate were Early Summer Crookneck, Sugar Pie, Butternut, Green Striped Cushaw and Blue Hubbard.

Table 1. Stand Counts and Growth Ratings from Pre-emergence Applications of NP to 10 *Cucurbita* Varieties.

Variety	Species	Rate lbs/acre	Stand Counts	Growth Ratings[1/]
Zucchini	*C. pepo*	None	13.0	9.0
		4	13.6	8.6
		8	12.3	8.3
L.S.D. at 5%			N.S.	N.S.
L.S.D. at 1%			N.S.	N.S.
Early Summer Crookneck	*C. pepo*	None	10.0	8.6
		4	5.6	6.6
		8	4.6	5.3
L.S.D. at 5%			3.2	1.8
L.S.D. at 1%			N.S.	N.S.
Sugar Pie	*C. pepo*	None	10.3	8.6
		4	8.0	6.3
		8	5.3	7.0

Table 1 (cont'd)

Variety Sugar Pie (cont'd)	Species	Rate lbs/acre	Stand Counts	Growth Ratings[1/]
L.S.D. at 5%			2.2	N.S.
L.S.D. at 1%			3.7	N.S.
Butternut	C. moschata	None	11.3	9.0
		4	9.0	5.6
		8	6.0	5.0
L.S.D. at 5%			2.2	1.6
L.S.D. at 1%			3.7	2.6
Sweet Cheese	C. moschata	None	6.0	8.3
		4	4.0	7.0
		8	1.3	4.3
L.S.D. at 5%			2.8	2.8
L.S.D. at 1%			N.S.	N.S.
Green Striped Cushaw	C. moschata	None	10.6	9.0
		4	7.3	8.0
		8	5.0	8.0
L.S.D. at 5%			2.0	N.S.
L.S.D. at 1%			3.4	N.S.
Delicious	C. maxima	None	6.0	9.0
		4	4.0	8.6
		8	2.3	6.0
L.S.D. at 5%			2.1	.8
L.S.D. at 1%			N.S.	1.9

Table 1 (cont'd)

Variety	Species	Rate lbs/acre	Stand Counts	Growth Ratings1/
Boston Marrow	C. maxima	None	11.3	9.0
		4	10.6	8.3
		8	10.0	5.0
L.S.D. at 5%			N.S.	.9
L.S.D. at 1%			N.S.	1.5
Blue Hubbard	C. maxima	None	11.0	9.0
		4	7.3	8.0
		8	4.6	6.3
L.S.D. at 5%			1.1	.8
L.S.D. at 1%			1.9	1.3
Buttercup	C. maxima	None	12.6	8.6
		4	10.6	7.0
		8	8.6	7.0
L.S.D. at 5%			2.5	N.S.
L.S.D. at 1%			N.S.	N.S.

1/ Rating Scale 1 = Complete Inhibition 9 = No obvious inhibition

Laboratory Tests

Materials and Methods

A solution of 100 ppm, made up from the technical grade of N-1 Napthyl Phthalamic acid, and dilutions of this solution were used to test the comparative performance of Cucurbita varieties in the laboratory. Seeds were soaked in cool running water for 3 to 6 hours. This treatment results in reduced fungus growth and better growth of squash seedlings (4).

Eight seeds were germinated on two filter papers moistened with 7 ml. of solution in each petri dish. There were 4 replications of each treatment.

The seedlings were germinated in a dark chamber maintained at 29° C. The seedlings were removed after 4 days, and the roots weighed, using a Roller-Smith Precision balance. Prior work had shown that root weights gave a better measure of NP activity than does measurements of primary root length, because the weights measure lateral root inhibition as well as the inhibition of the primary root.

Results

Table 2 shows the results of testing 6 *Cucurbita* varieties at concentrations of 0, 1, 10 and 100 ppm compared with a cucumber (*Cucumis sativus*) variety at the same concentrations. The roots of all six *Cucurbita* varieties were severely inhibited by 10 ppm of NP. The cucumber variety SR-6 was inhibited only slightly by 100 ppm. One ppm of NP stimulated growth of SR-6 as compared to the check. A concentration of 1 ppm did not depress growth in any variety. At 10 ppm Butternut grew only 28 per cent of its check compared to growth of 50 per cent or more by other varieties.

Table 2. Average Root Weight in Mg. of 7 Varieties Treated with NP at 0, 1, 10 and 100 ppm.

Conc. ppm	Blue Hubbard	Butter-nut	Butter-cup	Ey. Pro. Straightneck	Sugar Pie	Delicious	SR-6 (Cucumber)
0	215	79	113	94	54	160	55
1	244	74	112	88	48	146	64
10	150	22	63	45	30	109	56
100	56	12	41	25	25	64	47
L.S.D. at 5%	47	24	20	21	14	36	7
L.S.D at 1%	35	34	28	29	20	51	10

The data from this test indicate that if there is a division between tolerant and resistant varieties, it must be at a concentration between 1 and 10 ppm.

Two other tests were completed in the laboratory, in which the concentrations were varied between 0 and 10 ppm to determine if the threshold value for certain varieties was in this range. The results of these two tests are presented in Table 3.

There was no reduction in root weight for any variety at concentrations from 0 to 5 ppm. The average root weights of all varieties tested except

Boston Marrow and Zucchini, in one instance, were reduced at 10 ppm. The weight of roots from Zucchini was reduced at 10 ppm only in Test 2.

Table 3. Average Root Weights in Mg. of Varieties Treated with NP.

Conc.	Butternut	Buttercup	Boston Marrow	Zucchini
0	44	102	101	61
.1	40	89	125	69
1.0	38	118	119	82
5.0	45	104	104	81
10.0	28	66	130	68
L.S.D. at 5%	11	27	N.S.	N.S.
L.S.D. at 1%	N.S.	30	N.S.	N.S.

Conc.	Zucchini	Early Prolific Straightneck	Early Summer Crookneck
0	88	98	65
1.0	103	126	64
2.5	85	101	59
5.0	79	88	47
10.0	60	55	35
L.S.D. at 5%	25	31	29
L.S.D. at 1%	N.S.	45	N.S.

The results from these two tests substantiate the previous test, and indicate that there is no large differential response between varieties in the laboratory to NP. If there is a definite threshold concentration, it is probably between 5 and 10 ppm.

The number of seeds that germinated was not correlated with the concentrations used in any of the laborary tests.

In a previous study (4), it was demonstrated that the variety Eary Prolific Straightneck was more susceptible to injury from Chloro IPC when the seed coat was removed. The following experiment was initiated to compare the differential effect of NP when the seed coat was removed. Neither the whole seeds nor seeds without a seed coat were leached in running water as in previous experiments. The results are presented in Table 4.

Table 4. Growth of 4 Varieties With and Without a Seedcoat After Treatment with NP (mm elongation of primary root)

	Variety							
	Butternut		Early Prolific Straightneck		Green Striped Cushaw		Zucchini	
Conc. ppm	With S.C.*	Without S.C.*	With S.C.*	Without S.C.*	With S.C.*	Without S.C.*	With S.C.*	Without S.C.*
0	58	102	47	94	79	113	57	77
1	43	56	55	82	100	106	58	58
10	28	20	45	49	75	79	50	45
100	25	20	32	53	53	78	33	42
L.S.D. at 5%	13	25	N.S.	17	14	17	20	19
L.S.D. at 1%	19	37	N.S.	25	21	25	N.S.	N.S.

* S.C. = seedcoat

The seedlings of all varieties grew best with the seed coats removed. With the whole seeds, 10 ppm depressed the growth of Butternut and 100 ppm caused a reduction in growth of Green Striped Cushaw and Zucchini. With the seedcoat removed 1 ppm caused a reduction in growth of Butternut and 10 ppm depressed the growth of the other three varieties.

Discussion

The classification used in the field test separated the varieties of Cucurbita into three groups by using differences necessary for statistical significance. These differences are not only dependent on the chemical treatments but on the variability due to the plant species and their environment.

Although reductions in stands were observed in the field, there was no reduced germination in the laboratory. This indicates that stand reduction is probably due to the effect secondary factors have on seedlings affected by the NP.

Neither the field tests nor laboratory tests demonstrated a well defined tolerance for NP among the Cucurbita species tested (pepo, maxima or moschata).

The varieties tested did exhibit a range of tolerance. Zucchini, of the species pepo, was the most resistant and Butternut, species moschata, was the most susceptible. There is not as much difference between squash varieties as there is between cucumber varieties and the squash species tested. No well defined group of varieties are resistant to NP. NP must be used with much more caution on Cucurbita varieties than on cucumbers in the field.

Summary

1) Of the species tested, pepo, moschata and maxima, none demonstrated a uniform resistance to NP in field or laboratory tests.

2) Zucchini was the most tolerant variety tested in the field. Sweet Cheese, Delicious, Boston Marrow and Buttercup were not seriously injured by the 4 pound rate in the field. Early Summer Crookneck, Sugar Pie, Butternut, Green Striped Cushaw and Blue Hubbard were injured by the 4 pound rate in the field.

3) The stand reduction observed in the field is probably due indirectly to NP injury and directly to secondary factors.

4) Ten ppm depressed the growth of all species in the laboratory with the exception of Boston Marrow, and Zucchini in one test. In comparison the cucumber variety SR-6 was only slightly inhibited at 100 ppm.

5) For most varieties the range of tolerance was between 5 and 10 ppm.

6) Removal of the seed coat resulted in increased root growth. These seedlings showed a significant depression of growth at lower concentrations, because their checks grew more than those with seedcoats intact.

Literature Cited

1) Hemphill, D. D. Chemical Weed Control in Cucurbits. Research Report Tenth Annual NEWCC, 1953 pp. 142-143.

2) Lachman, William H. Some Observations on the Use of Alanap-1 on Vine Crops. Proc. of Eighth Annual NEWCC, 1954 p. 89.

3) Rahn, E. M. Alanap-1 as a Herbicide for Vine Crops in 1953. Proc. of Eighth Annual NEWCC, 1954 pp. 83-87.

4) Ries, S. K. Studies on the Selective Mechanism of Chloro IPC. Ph.D. Thesis 1954, Cornell University.

5) Sweet, R. D. and S. K. Ries. Chemical Weeding of Cucurbits. Proc. of Sixth Annual NEWCC 1952 pp. 187-191.

6) Sweet, R. D. and S. K. Ries. N-1 Napthyl Phthalamic Acid and Crag Herbicide 1 on Cucumbers, Muskmelons, Watermelons and Squash. Proc. of Seventh Annual NEWCC, 1953 pp. 57-63.

PRELIMINARY TESTS WITH CMU FOR WEED CONTROL IN ESTABLISHED VINEYARDS

By R. F. Carlson[1]

The established grape vineyard usually harbors annual and perennial weeds and grasses in the rows. Between the rows, cultivation is generally practiced for cleaning out weeds that come in from time to time. The weeds in the rows are often covered by plowing into the rows from both sides, and then, the conventional "grape hoe" is used to remove the sod and weeds from the rows. Some grape growers are of the opinion that mechanical tools used in the rows in this vigorous manner produce injury and loss of vine vigor. On the other hand, if left alone the weeds will soon become entwined with the grape foliage. Before harvest, the weeds must be cut at the base and pulled from the vines by hand to provide for uniform ripening and easier picking.

Temporary weed control in the rows is also obtained by the use of "oil-dinitro" sprays. Such contact sprays work satisfactorily early in the season until the grape foliage reaches the ground, at which time it is difficult to spray without "burning" the leaves. A herbicide with longer residual effects which would last during the season would eliminate costly hand and mechanical operations. This report deals with the use of "CMU" (3-(p-chlorophenyl)-1, 1-dimethylurea) for this purpose.

Materials and Methods

CMU was used in two established Concord vineyards - one in the Paw Paw area and the other in the Grand Rapids area of Michigan - both on a clay-loam type soil. The first application of CMU was made on May 24 at 2.5 and 5 pounds in 60 gallons of water per acre. A second application was put on different plots on July 22 at rates of 7.5, 10.0, and 12.5 pounds per acre. Each treatment consisted of a 50-foot row section, and the material was applied as a directional basal spray. Various types of broadleaved weeds and grasses were growing in both vineyards (Table 1).

Results and Discussion

Control of Weeds: Most of the broadleaved weeds were controlled for the entire growing season at all rates of CMU. Common Ragweed and Lambsquarters were controlled completely at 2.5 pounds; Dandelion, at 7.5 pounds; Canada Thistle and Common Mallow, at 10.0 pounds; and Field Sorrel, Butter and Eggs, June-grass, and Tickle-grass, at 12.5 pounds per acre. Quack-grass was the most persistent of the weeds but was nearly eliminated at 12.5 pounds per acre (Table 1).

The weeds were well established at the time of the application which probably accounts for the rather high rates of CMU required for complete control in contrast to the low rates of one to two pounds per acre usually needed for seedling weeds.

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Table 1. Representative Weeds Growing in Established Vineyards and Estimated Control from Several Rates of CMU.

Typical Weeds in Vineyards	Weed Rating* 2.5 Lbs.	5.0 Lbs.	7.5 Lbs.	10.0 Lbs.	12.5 Lbs.
Canada Thistle (*Cirsium arvense*)	4	7	8	10	10
Dandelion (*Taraxacum officinale*)	7	9	10	10	10
Common Ragweed (*Ambrosia elatior*)	10	10	10	10	10
Field Sorrel (*Rumex acetosella*)	6	7	8	9	10
Lambsquarters (*Chenopodium album*)	10	10	10	10	10
Common Mallow (*Malva rotundifolia*)	7	8	9	10	10
Butter and Eggs (*Linaria vulgaris*)	3	5	6	9	10
June-grass (*Poa pratensis*)	5	6	7	9	10
Tickle-grass (*Panicum cappillare*)	6	7	8	9	10
Quack-grass (*Agropyron repens*)	3	4	5	7	8

* 0 = No Weed Control
10 = Excellent Weed Control

Effects on Grape Vines: No visible injury could be detected on either foliage or fruit during the summer and fall. Apparently the chemical applied as a directional row-spray at the base of the bull canes does not contact the smaller feeding roots which lie away from the row. According to Partridge and Veatch (1), the roots of grapes spread 5 to 6 feet in a downward horizontal direction away from the plants with some of them reaching to a depth of 4 to 5 feet. Aside from the fact that the grape vines may be tolerant to CMU, the relationship of root distribution and focus of application may have a bearing on the use of this material in the vineyard.

The effects on grape vines of repeated basal focus applications of CMU remains to be learned. At the higher rates, the material may accumulate and eventually cause injury. Further excess moisture may cause the chemical to migrate into other root zones and be absorbed.

Apparently CMU can be used safely at about 5 pounds per acre as a row application in early spring. The higher rates should be used only on a trial basis.

Literature Cited

1. Partridge, N. L. and J. O. Veatch. Fertilizers and Soils in Relation to Concord Grapes in Southwestern Michigan. Technical Bulletin No. 114, 1931, Michigan State College, East Lansing, Michigan.

SOME RESULTS WITH PRE-EMERGENCE APPLICATIONS OF SEVERAL HERBICIDES AROUND RHODODENDRONS AND TAXUS

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This experiment was undertaken to find the relative effectiveness of several chemicals as pre-emergence herbicides applied at two dates during the growing season.

Procedure

The test plantings consisted of seven rows of Taxus, five rows 120 feet long and two rows 180 feet long, and nine rows 120 long, of Rhododendrons grown in Gloucester fine sandy loam. The 120 foot rows of Taxus were planted in 1948; while one of the 180 foot rows was planted in 1950, and one in the spring of 1954. A greater weed population was noted around the newer plantings of Taxus. The Rhododendrons were a group of Catawbiense hybrid seedlings planted in 1948.

Before each application of chemicals, weeds were eliminated from the area to be treated. Chemicals were applied to the soil before weed germination. Applications of chemicals were made around the Taxus on May 20 and on July 16, while applications to the Rhododendrons were made on May 26, and the second on July 26.

A total of 12 treatments, including 11 chemical treatments and the check, were applied to the Taxus. Thirteen chemical treatments and the check were used around the Rhododendrons. The chemicals used in the two applications were not exactly the same. Each chemical was replicated four times on plots, 20 x 2 foot, in each planting at each application.

All chemicals were applied with a one gallon glass jug using a "Weedone Sprayer" nozzle at rates of application suggested by the manufacturers. A separate jug was used for each chemical and each rate to avoid the possibility of contamination due to an improperly cleaned sprayer. Each amount of chemical was weighed or measured separately for each replication. Proper distribution of the chemicals was achieved by use of water at the rate of 400 gallons per acre or 1400 cc per plot.

Contribution of Massachusetts Agricultural Experiment Station No. 984.

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Weed counts were made on four one square foot areas of each plot. Separate records were taken of the grasses and broadleaved weeds were taken, but the analysis of variance was applied to the total weed population. Weed counts were taken on July 1 and October 5 around the Taxus and on July 8 and October 8 around the Rhododendrons. Fresh weight of the weed tops was determined after the second applications because some chemicals inhibited growth but did not reduce the number of weeds.

Rainfall after the first application of chemicals around the Taxus amounted to 5.68 inches; after the second application, it was 18.35 inches. For the two applications around the Rhododendrons the rainfall was 3.61 and 17.45 inches, respectively.

Results and Observations

No injury attributable to the chemical treatments was observed in any of the Rhododendrons or Taxus. The chemical treatments used, the rates of application per acre, and the average number of weeds per four square feet are listed in tables one through four.

Table 1. Average number of weeds per 4 square feet in established Taxus after treatment with 11 chemicals on May 20, 1954. Records taken July 1, 1954.

Chemical	Amount per acre	Number of weeds per 4 square feet
1. Check		48.8
2. N.P.A.	4.0 lb.	42.8
3. N.P.A.	6.0 lb.	45.0
4. Chloro IPC	6.0 lb.	14.5
5. Herbisan	2.0 gal.	57.3
6. KCN	10.0 lb.	86.5
7. Crag Herbicide 1	2.0 lb.	51.8
8. Crag Herbicide 1	4.0 lb.	58.8
9. N.I.X.	8.0 lb.	79.5
10. C.M.U.	1.0 lb.	10.8
11. Karmex DW	1.0 lb.	1.0
12. P.C.P.	10.0 gal.	15.8
	L.S.D. .05 =	43.2
	.01 =	48.3

Table 2. Average number of weeds per 4 square feet in established Rhododendrons after treatment with 12 chemicals on May 26, 1954. Records taken July 8, 1954.

Chemical	Amount per acre	Number of weeds per 4 square feet
1. Check		42.8
2. N.P.A.	4.0 lb.	15.0
3. N.P.A.	6.0 lb.	21.0
4. Chloro IPC	6.0 lb.	11.0
5. Herbisan	2.0 gal.	21.0
6. KCN	10.0 lb.	37.5
7. Crag Herbicide 1	2.0 lb.	15.8
8. Crag Herbicide 1	4.0 lb.	33.3
9. N.I.X.	8.0 lb.	37.0
10. C.M.U.	1.0 lb.	10.5
11. Karmex DW	1.0 lb.	13.0
12. P.C.P.	10.0 gal.	27.0
13. Oktone	1 qt./15 gal. oil	13.0
	L.S.D. .05 =	24.5
	.01 =	27.2

Table 3. Average number of weeds and fresh weight of the tops per 4 square feet in established Taxus after treatment with 11 chemicals on July 16, 1954. Records taken October 5, 1954.

Chemical	Amt./A	Number of weeds per 4 square feet	Weed Wt./ 4 sq.ft. (grm.)
1. Check		198.3	164.7
2. N.P.A.	4.0 lb.	159.7	35.5
3. N.P.A.	6.0 lb.	191.3	14.3
4. Alanap-3	4.0 lb.	343.0	16.0
5. Alanap-3	6.0 lb.	212.7	144.3
6. Chloro IPC	6.0 lb.	21.0	18.0
7. Herbisan	2.0 gal.	244.3	175.0
8. Crag Herbicide 1	4.0 lb.	215.0	132.0
9. Crag Herbicide 1	6.0 lb.	239.3	105.7
10. C.M.U.	1.0 lb.	174.0	11.7
11. Karmex DW	1.0 lb.	41.0	1.3
12. ACP-L-195A	10.0 gal.	151.7	58.7
	L.S.D. .05 =	N.S.	102.0
	.01 =	N.S.	139.4

Table 4. Average number of weeds and fresh weight of the tops per 4 square feet in established Rhododendrons after treatment with 12 chemicals on July 26, 1954. Records taken October 8, 1954.

Chemical	Amt./A	Number of weeds per 4 square feet.	Weed Wt./ 4 sq.ft. (grm.)
1. Check		131.3	94.8
2. N.P.A.	4.0 lb.	158.3	32.0
3. N.P.A.	6.0 lb.	97.3	28.3
4. Alanap-3	4.0 lb.	149.5	29.8
5. Alanap-3	6.0 lb.	157.5	14.5
6. Chloro IPC	6.0 lb.	26.0	17.3
7. Herbisan	2.0 gal.	175.3	97.3
8. Crag Herbicide 1	4.0 lb.	127.8	30.8
9. Crag Herbicide 1	6.0 lb.	145.0	93.0
10. C.M.U.	1.0 lb.	25.0	3.8
11. Karmex DW	1.0 lb.	39.5	12.3
12. ACP-L-195A	10.0 gal.	138.8	66.8
13. Oktone	1 qt./15 gal. oil	141.8	94.8
	L.S.D. .05 =	97.9	60.8
	.01 =	108.8	67.7

Only one chemical Karmex DW [3-(3,4-dichlorophenyl)-1,1-dimethyl urea] gave results significantly better than the check in the first application around the Taxus. Other chemicals that looked promising were Chloro IPC (Isopropyl N 3-chloro phenyl carbamate), C.M.U. [3-(p-chlorophenyl) - 1, 1-dimethyl urea] and P.C.P. (pentachlorophenol).

Several materials provided statistically significant weed control when applied around the Rhododendrons in May. These chemicals were N.P.A. (N-1 naphthyl phthalamic acid) at 4 pounds per acre, Chloro IPC, Crag Herbicide 1 (2,4 dichlorophenoxyethyl sulfate), C.M.U., Karmex D.W., and Oktone.

None of the chemicals applied in July around the Taxus reduced the number of weeds, probably the cause was the rather long interval between the date of application and the time the records were taken. The data for weed weight indicate that definite inhibition of weed growth was caused by some chemicals. These were N.P.A., Alanap-3 (sodium salt of N-1 naphthyl phthalamic acid), Chloro IPC, C.M.U., Karmex DW, and ACP-L-195A (sodium pentachlorophenate).

Only Chloro IPC and CMU significantly reduced the number of weeds in the Rhododendrons after the second application of chemicals. Weed weight was markedly reduced by N.P.A., Alanap-3, Chloro IPC, Crag Herbicide 1 at four pounds per acre, C.M.U. and Karmex DW.

The percentage of grass in relation to total weeds was determined for each chemical and for both dates of application. The percentage of grass in N.P.A. sprayed plots was lower than that found in the check plots of Taxus, but the reverse was true in the Rhododendrons. This same trend but to a lesser degree, was found in the plots treated with Crag Herbicide 1. Shading of the soil surface by the Rhododendrons may have caused the difference. The lowest percentage of grass in relation to total weeds was achieved by Chloro IPC, C.M.U. and Karmex DW, which were the most effective in controlling weeds.

Conclusions

Chemical treatment did not injure the Rhododendrons or Taxus.

Chloro IPC, C.M.U., and Karmex DW gave excellent weed control when applied as pre-emergence herbicides. Further applications around young stock will be necessary to determine whether there is a cumulative effect on growth.

No so effective but promising were N.P.A. and its sodium salt. The number of weeds was not reduced but was greatly inhibited by these materials.

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GRASS CONTROL IN RED RASPBERRIES

By R. F. Carlson[1]

One of the limiting factors in the production of quality raspberries is the encroachment of various perennial grasses in the planting. Quack-grass (*Agropyron repens*), June-grass (*Poa pratensis*), and Canadian Blue-grass (*Poa compressa*) are the most persistent grasses and the most difficult to control. These grasses compete for valuable moisture and nutrients, as well as interfere with the picking of the raspberries. The use of sodium trichloroacetate for control of these grasses has been reported, but at higher rates this material caused injury to the raspberry plants (1).

Materials and Methods

O-isopropyl-N-3-(chlorophenyl) carbamate, referred to hereafter as CIPC, was used on the same plots for two years at five and eight pounds per acre and sodium salt of 2,2-dichloroproprionic acid, hereafter referred to as "Dalapon", on other plots at five, eight, and ten pounds per acre. CIPC was used on the Latham variety and "Dalapon" on the Taylor raspberry variety. In each case the materials were applied in late October after cessation of growth. Each treatment was composed of 20-foot row sections, and each was replicated four times. In order to sufficiently wet the grass foliage in the raspberry rows, the chemicals were applied in a volume of 100 gallons per acre as directional sprays.

Several factors were considered in the evaluation of these chemicals: namely, fruit-yield, cane length, cane diameter, plant abnormalities, and weed control.

Discussion of Results

CIPC Treatments: The various treated and check plots were observed regularly to determine if CIPC caused injury to the raspberry plants. No abnormal growth characteristics caused by the treatments were found in any of the plots after three years from initial applications.

Four pickings were made as the fruit matured. The yield of fruit was increased by 27.8 and 30.7 percent with treatments of five and eight pounds of CIPC respectively in 1953 and by 43.2 and 47.7 percent in 1954 (Table 1). Cane lengths and diameters did not show any significant difference between treated and untreated plants (Table 3).

In June, 1953, eight months after the first treatments, there was an average of 62 percent less grass in plots treated with five pounds of CIPC and 68 percent less in the eight-pound per acre plots. The same plots in June, 1954, after having received two fall applications of five and eight pounds per acre, showed an average reduction in grass stand of 67 and 76 percent respectively as based on untreated plots.

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Table 1. Average Yields from Four Replications of Latham Raspberries Treated with CIPC.

CIPC lbs/acre	Quarts per Acre from Four Pickings					Percent Increase
	1	2	3	4	Total	
			Yields in 1953			
5	374.4	548.2	684.2	538.9	2145.7	27.8
8	386.9	560.8	696.7	551.4	2195.8	30.7
0	257.9	431.8	567.6	422.3	1679.6	
			Yields in 1954			
5	75.6	243.0	783.0	523.8	1625.4	43.2
8	81.0	202.0	826.2	567.0	1676.2	47.7
0	56.0	202.0	518.4	359.1	1135.5	

Considering the increased yield of fruit per acre and satisfactory general plant growth, it appears that CIPC was beneficial mainly because competition from grasses was reduced. In addition to subduing grass growth, CIPC also killed all chickweed present at the time of the applications.

<u>"Dalapon" Treatments</u>: The Dalapon material caused no visible abnormal growth of the raspberry plants when treated with five, eight, and ten pounds per acre. Since this material was used only in 1953, no data are available on possible injury from successive treatments. It was evident that the material, at the rates used, produced no injury to the raspberry plants as measured by cane length and cane diameter (Table 3).

There was 35.8 and 16.3 percent respectively more fruit from five and eight-pound plots than from untreated plots. No increase in yield occurred in the ten-pound plots; however, there was no significant reduction in yield (Table 2).

Table 2. Average Yields in 1954 from Four Replications of Taylor Raspberries Treated with "Dalapon".

"Dalapon" lbs/acre	Quarts per Acre from Four Pickings					Percent Increase
	1	2	3	4	Total	
5	126.0	253.8	810.0	472.5	1662.3	35.8
8	124.2	237.6	623.7	437.4	1422.9	16.3
10	110.7	218.7	523.8	353.7	1206.9	00.0
0	78.3	202.5	572.4	369.9	1223.1	

Counts of grasses made in June, 1954, averaged 62.0, 78.1, and 86.2 percent respectively less at the three rates, five, eight, and ten pounds per acre than on untreated plots. Some regrowth of the grasses occurred later in the season, especially at the lower rates. It appears that annual fall applications, or possibly early spring applications, of "Dalapon" at low rates of five to eight pounds per acre will control the grasses and improve productiveness and appearance of the planting.

Table 3. Average Cane Length and Cane Diameter in the Fall of 1954 and Percent Grass Control in June of 1953 and 1954.

Material	lbs/acre	Cane Length (inches)	Cane Diameter (mm)	(Grass Control (Percent) 1953	1954
CIPC	5	55.7	10.4	62.3	67.2
CIPC	8	55.7	10.6	68.0	76.3
Check	0	53.3	10.7		
"Dalapon"	5	59.4	11.6		62.0
"Dalapon"	8	61.1	11.8		78.1
"Dalapon"	10	58.5	11.1		86.2
Check	0	60.3	10.9		

Summary

Fall applications of CIPC were used successively for two years on raspberry plants at five and eight pounds per acre with no apparent injury to the plants. Fruit-yields were increased by 30 percent in 1953 and by over 40 percent in 1954. The Quack-grass, June-grass, and Canadian Blue-grass were reduced by 68 percent in 1953 and by 76 percent in 1954.

Grasses apparently can be controlled with annual applications of CIPC, thus eliminating their competition for moisture and nutrients. Eight pounds of actual CIPC per acre, applied in 100 gallons of water as a directional spray late in October or in November, are suggested for grass control in raspberry plantings. This amount is based on the area sprayed, so that it should cover about three acres of raspberries planted in rows spaced eight feet apart.

"Dalapon" also was used one year in the fall at five, eight, and ten pounds per acre with satisfactory results. No injury to the plants could be determined from cane measurements or foliar observations. Aside from reducing grass population in the raspberry row, "Dalapon" also increased fruit-yields by 35 percent at the five-pound rate and by 16 percent at the eight-pound rate.

Until further tests have been completed, "Dalapon" should not be used at rates above eight pounds of actual chemical per acre. Fall applications appear to be the safest, but spring applications may be tried on a small scale.

Literature Cited

1. Carlson, R. F. and J. E. Moulton. Control of Grasses in Raspberries by Fall, Spring, and Summer Applications of Sodium Trichloroacetate. Proc. Amer. Soc. Hort. Sci. 53:241-246. 1949.

FALL APPLICATIONS WITH CIPC ON THREE STRAWBERRY VARIETIES FOR CONTROL OF COMMON CHICKWEED[1]

By R. F. Carlson[2]

Most strawberry growers in the northern states are concerned about common chickweed (Stellaria media) which so often invades their plantings. If left alone, this weed will greatly reduce yield and hamper picking. In fact, considerable acreages of strawberries are sometimes abandoned, since the removal of chickweed by hand is too costly. A practical means of control of this weed is by the use of selective herbicides. Earlier, IPC was reported as a successful control for common chickweed (1). The present report deals with the use of CIPC (O-isopropyl N-3-(chlorophenyl) carbamate).

Materials and Methods

The CIPC tests were made on October 20, 1953 at three different locations in the Traverse City area in one- and two-year-old plantings of Catskill, Sparkle, and Robinson strawberries. CIPC was applied with power sprayers at rates of 1.5, 2.5, and 3.4 pounds in 60 gallons of water per acre. Each treatment covered 0.6 acre. The temperature ranged from 70 to 78° F. during the day the chemical was applied. The chickweed was well leaved out and covered most of the surface around and under the strawberry plants when the spray was applied. The spray was forced under the strawberry foliage by setting the nozzles at a 45-degree angle to the ground.

Discussion of Results

Control of Weeds: Observations made a month after the applications indicated slight wilting and yellowing of chickweed. By May 11, 1954, the chickweed was dead in all plots treated with CIPC. The untreated portions of the fields were green and matted with the weed.

The mouse-ear chickweed (Cerastium vulgatum) present in one of the fields was not controlled with any of the rates of CIPC.

Field sorrell (Rumex acetosella) was also growing in one of the treated fields, and at the higher concentration (3.4 pounds per acre) about 80 percent of it was controlled. This weed is becoming an annual problem in many strawberry plantings in Michigan. It germinates both in the spring and in the fall, and consequently, soon becomes established in the strawberry row. A selective herbicide is needed for its control.

Effects on Plants and Fruits: The CIPC apparently had no serious deleterious effect on the strawberry plants. The first new leaves produced in the

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[1]The author wishes to acknowledge the cooperation and assistance of Clarence Mullett, District Horticultural Agent.

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spring showed some yellowing similating nitrogen deficiency, but as the leaves grew, this symptom soon disappeared. At the highest rate per acre of CIPC, temporary stunting occurred in the form of short petioles forming rosette-like plants. By June this abnormality had disappeared.

Fruit harvested from treated areas compared favorably in size, color, and quality to that from untreated plots as observed by growers, county agents, and district horticultural agents. At the high rate of 3.4 pounds per acre, the fruit appeared slightly lighter in color. Although the growers did not keep accurate yield data, they did not report any apparent reduction in yield.

Variety Response: The varieties, Catskill, Sparkle, and Robinson, treated in the field, showed no varietal response to CIPC. Apparently, where CIPC is used at low rates for control of common chickweed, no visual differences occur in varieties.

Summary

1. CIPC was used as a fall application for the control of common chickweed in strawberry plantings of Catskill, Sparkle, and Robinson.

2. Common chickweed was completely controlled with CIPC at rates of 1.5, 2.5, and 3.4 pounds per acre. The mouse-ear chickweed was not controlled. Field sorrell was checked in development, so that about 80 percent succumbed.

3. Strawberry plants tolerated CIPC; however, some yellowing of newly formed leaves occurred in the spring at the higher rates of CIPC. Recovery was rapid.

4. No apparent reduction in yield was evident. There was no visual differences in response of the strawberry varieties to CIPC.

5. Where common chickweed is a problem in strawberries, fall applications of CIPC at the rate of 2 pounds per acre appear to be safe.

Literature Cited

1. Carlson, R. F. and J. E. Moulton. Chickweed Control in Strawberries with IPC. Proc. Amer. Soc. Hort. Sci. 54:200-204. 1949.

Beet Weed Control Experiments in 1954[1]

Charles J. Noll and Martin L. Odland[2]

The generally accepted practice of weeding beets with chemicals is to apply a concentrated salt solution at the time the beet has 4 to 5 true leaves. Weeds commonly found in beet fields such as purselane and lamb's quarters are not killed by this treatment. Other weeds susceptible to the salt spray when small may be large enough at the time of treatment to survive the spray. Other chemicals that have been used successfully are CMU, Endothal, Endothal combined with TCA and Na PCP. The results of the use of these chemicals have varied greatly from year to year.

Because information was lacking on which to base good recommendations for herbicidal weeding of beets it was decided to test as many chemicals as possible. Not all chemicals were tested at optimum rates for weed control and no injury resulted to the beets.

Procedure

Fourteen chemicals, used at from 1 to 3 rates or in combinations with other chemicals, together with an untreated check were tested in the experiment. The treatments were arranged at random in each of ten replicated blocks. The soil was dry at the time beets were seeded. Following a 1-inch rain on the fifth day after planting the first herbicides were applied. Each plot consisted of a single row 23 feet long by 2 feet wide. The herbicides were applied over the row for a width of one foot. Weeds between the rows were controlled through cultivation.

Based on the results of the first experiment Endothal and TCA and combinations of the two were further tested. In the experiment Endothal was used at the rate of 12, 18, and 24 lbs. per acre and TCA at 10 and 20 lbs. per acre. Beet seeds were planted and the herbicides applied on July 22 in dry soil. The first rain, following planting, fell July 29 and totaled 7/10 of an inch.

Results

A summary of the first experiment is presented in Table 1. Many chemicals resulted in highly significant increases in weed control as compared to the untreated check. Only two chemicals, salt and DCU, had stands not significantly reduced by the treatment as compared to the check. Endothal and Endothal plus TCA were the only two treatments that resulted in a significant increase in yield as compared to the untreated check.

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2 Assistant Professor and Professor of Olericulture respectively, Department of Horticulture, The Pennsylvania State University, State College, Pa.

In the second experiment using Endothal and TCA and combinations of the two no significant differences were found in weed control and stand and weight of beets as compared to the untreated check with any treatment.

Conclusion

The most promising treatment for the weeding of beets is Endothal applied in a pre-emergence application when there is sufficient moisture in the soil to encourage weed germination. Endothal applied in a pre-emergence application on dry soil had no effect on weed control or on stand or yield of beets.

Table 1. The effect of herbicides on weeds, stand and yield of beets.

Herbicide	Rate per acre	Application days after planting	*Weed Control	Beet Stand	Beet Yield lbs.
Nothing	---	---	6.8	38.5	2.6
Na Cyan	20 lbs.	5	6.8	32.2	1.4
" "	40 "	5	7.6	29.0	1.1
" "	60 "	5	6.4	24.9	1.6
Na Cyan	20 lbs.	20	1.4	9.9	0.4
" "	40 "	20	1.3	.7	0.0
" "	60 "	20	1.1	.0	0.0
Na Cyan	20 lbs.	27	4.1	15.6	0.4
" "	40 "	27	3.6	5.0	0.1
" "	60 "	27	3.2	2.5	0.1
Salt	400 "	27	5.5	39.1	3.2
Endo	24 lbs.	5	1.1	25.9	5.5
Endo + TCA	24 lbs. + 10 lbs.	6	1.0	25.6	5.0
1.NP 1475 E50	5 gal.	5	2.8	25.6	2.0
" " "	10 gal.	6	1.9	10.8	1.4
DALAPON	5 lbs.	5	7.1	26.9	1.3
"	10 lbs.	5	3.2	26.3	1.8
2.EH 6029	3 lbs.	6	4.3	23.0	1.8
" "	6 lbs.	6	2.4	10.7	1.0
Na PCP	35 lbs.	6	1.1	2.6	0.6
" "	70 lbs.	6	1.0	3.9	0.4
DCU	7 lbs.	6	3.1	29.8	3.1
"	14 lbs.	6	3.8	34.4	1.9
MCP	4 lbs.	6	1.3	1.1	0.2
"	8 lbs.	6	1.0	0	0.0
Chloro IPC	4 lbs.	6	1.9	20.5	1.7
" "	8 lbs.	6	1.4	7.9	1.0
3,4D	4 lbs.	6	1.9	15.1	1.5
"	8 lbs.	6	1.1	7.6	0.7
CMU	1 lb.	6	1.4	18.7	3.2
"	2 lbs.	6	1.2	5.2	1.2
Least significant difference at .05 level			1.6	11.6	1.4
" " " " .01 level			2.1	15.2	1.9

1. Organic phosphate, 4 lbs per gallon
2. 3 Amino-1,2,4 Triazole 50%

*Weed Control (1-10): 1 perfect weed control
10 full weed growth

PRE-EMERGENCE HERBICIDES AND CULTIVATION FOR WEED CONTROL IN POTATOES

R. L. Sawyer and S. L. Dallyn

This pre-emergence experiment was set up to evaluate the use of cultivation for purposes other than weed control while testing eight chemicals including a dinitro, three urea compounds, three hormonal type of sprays, and sodium pentachlorophenate.

MATERIALS AND METHODS

Potatoes of Katahdin variety were planted April 8 in 34 inch rows and fertilized with a ton 7-7-7 fertilizer per acre. Karmex W, Karmex DW, Karmex FW, Premerge, Sodium Pentachlorophenate, Craig I, Sesin, and Natrin were applied on April 30 just before the potatoes emerged. Plots were four rows wide and 34 feet long. Yield data was taken from the two center rows.

The plot design was such that in each replication there were two randomized sets of the eight chemical treatments and check. One set in each replication had the normal cultivation practices of the area carried out throughout the growing season and the other set had late cultivation only. On June 7 when the normal cultivation plots were receiving their fifth cultivation, the delayed cultivation plots were picked up and both sets received similar cultivation for the rest of the season. The normal cultivation plots received two weeding operations and 5 cultivations. The delayed cultivation plots received the last three regular cultivations and one extra cultivation on June 2 to control the weeds in plots where chemicals had given poor control.

Potato foliage damage from the delayed cultivation plots was recorded on May 18 when the plants were 2 to 4 inches high and again June 7 when the plants were 8 to 10 inches high. Weed counts were made from 9 square feet in each delayed cultivation plot on June 1. The plots were harvested on September 22 and yield records taken of total and U.S. No. 1 tubers. Specific gravity readings were made and samples saved for chipping.

RESULTS AND DISCUSSION

All chemicals but Sesin and Natrin gave good weed control until about May 25 at which time Sesin, Natrin and check plots had considerable grass and broad leaved weeds showing. The results of the weed count analysis given in table 1, indicates that Karmex FW, Karmex W, Karmex DW, Premerge, Sodium pentachlorophenate and Craig I all gave significantly better weed control than Sesin, Natrin and check plots. There was no statistical significance among Sesin, Natrin and check plots.

There were no significant statistical differences among the Premerge, Craig I and check plots in yield of U.S. No. 1 tubers. Karmex FW, Karmex W, Karmex DW, Natrin and Sesin plots gave a highly significant reduction in yield when compared to check plots. In a comparison of the three homonal type sprays, Craig plots significantly outyielded Natrin and Sesin plots. In a comparison of the three urea sprays, Karmex DW plots gave significantly better yields than Karmex W plots, and both Karmex W and DW plots gave better yields than Karmex FW plots.

A comparison of normal cultivation and delayed cultivation plots indicated no beneficial or detrimental effects from cultivation other than weed control. The weed counts indicate what the picture would probably have been had the delayed cultivation plots not been cultivated for an additional two weeks. Check plots and plots with ineffective sprays probably would have then shown an advantage for cultivation due to weed control.

Potato vine tolerance readings were made at two different dates. As can be seen from the data presented in table 1, results depended a great deal on when the readings were made. In a comparison of the three urea sprays the early reading indicated little damage caused by Karmex FW and somewhat more damage by Karmex W and DW. The June 7 reading, however, indicated that Karmex DW plots now look as good as check plots with Karmex W plots having very little damage and Karmex FW plots a great deal of vine damage. A comparison of the three hormonal type of sprays indicates that the plants in Natrin and Craig I plots outgrew their foliage damage much faster than plants in the Sesin plots. There were no statistically significant differences among Premerge, sodium pentachlorophenate and check plots at either reading.

In the analysis of the specific gravity data the three urea sprays stand out from all of the other chemicals and the check. Potatoes from the urea plots had a much lower specific gravity reading than potatoes from any of the other plots. Potato foliage in Karmex W and FW plots were still very green when foliage in the other plots had died down due to maturity. This could possible explain why Karmex W and FW have lower specific gravities. It does not explain the reason for the low specific gravity of tubers in Karmex DW plots, however, since the foliage in these plots out-grew the chemical damage quickly and the vines were at a similar growth stage to the vines from plots with treatments other than Karmex W and FW.

SUMMARY

1. A comparison was made of eight chemicals. The plot layout was such that an evaluation could be made of the advantages or disadvantages of cultivation for purposes other than weed control. The results indicate no advantages or disadvantages from cultivation other than for weed control.

2. The three urea compounds gave good weed control, but caused considerable reduction in yield and specific gravity.

3. The three hormonal sprays caused considerable early vine damage, however, the vines in both Natrin and Craig plots out-grew this damage quickly. Craig I was the only one of the three which gave good weed control and yields comparable to those from the check.

4. Taking all such factors as yield, weed counts, potato vine tolerance rating and specific gravity into consideration, none of the materials gave as good results as the dinitro, Premerge. Premerge gave good weed control with as good yields and specific gravities as the check treatment with little if any foliage damage. Craig I and sodium pentachlorophenate were the next best chemicals in this overall evaluation.

Table 1. The Effect of Several Pre-emergence Potato Sprays on Weed Control, Potato Foliage Tolerance, Yield and Specific Gravity of Tubers.

Materials-Dosage	Yield U.S.No.1 Bu./A.	Weed Count 9 sq. ft.	Vine Tolerance* May 18	Vine Tolerance* June 7	Specific Gravity
Karmex FW-1½ lbs./A.	345	39	7.87	2.25	1.0700
" W " "	435	5	6.18	7.87	1.0715
" DW " "	503	2	7.31	9.00	1.0710
Premerge- 1 gal./A.	587	52	8.43	9.00	1.0745
Sodium pen.-15 lbs./A.	543	20	8.43	9.00	1.1055
Craig I- 4 lbs./A.	567	44	3.37	7.87	1.0760
Sesin " "	523	165	5.06	5.62	1.0750
Natrin " "	513	151	3.37	9.00	1.0750
Check	612	248	9.00	9.00	1.0750
L.S.D. 5%	52	132	1.03	.57	1.0017
L.S.D. 1%	70	184	1.39	.78	1.0023

* Ratings 1 through 9 with 9 indicating normal plant foliage.

CHEMICAL CONTROL OF NORTHERN NUTGRASS IN POTATO FIELDS (Progress Report No. 1)1/

R. S. Bell and E. J. Bannister, Jr. 2/

Introduction

Northern Nutgrass (Cyperus esculentus L.) is becoming a serious pest on a number of potato farms in Rhode Island. Growers have asked about the possibility of using some chemical that will control the nutgrass without damaging the potato crop. In attempting to find a solution to this problem, several small trials were established in 1953 to determine the tolerance of potatoes and nutgrass to such materials as CMU, Dalapon, PMAS, TCA and other herbicides alone and in combination. The area selected for the test was heavily infested with nutgrass. The plots were located along the north border of the field where potato yields were low due to competition with nutgrass and a border hedge.

Katahdin potatoes were planted in 34-inch rows and spaced 7 inches apart in the row. Eight hundred pounds of 7-7-7-2 fertilizer per acre were plowed under while 2200 pounds of 5-10-10-2 were placed in the bands at planting. The plots were cultivated, hilled and sprayed for insect and disease control the same as the rest of the potato fields on the farm.

The treatments, total average bushels of potatoes per acre, and estimated average percent control of nutgrass are shown in Table 1. The chemicals were applied by hand sprayers in late June. There were four replicates of each treatment.

The heavy infestation of nutgrass and nearness to the border hedge resulted in low yields on nearly all plots. The check plots averaged only 120 bushels of potatoes per acre. CMU at 10, 15 and 20 pounds per acre resulted in decreasing yields of potatoes; 70, 22 and 2 bushels per acre, respectively. The accompanying estimated nutgrass control was 66, 96 and 98 percent. The treatment with 5 pounds per acre of CMU and 5½ quarts of PMAS produced yields slightly higher than those of the check plot and averaged 56 percent control of nutgrass. Since PMAS alone at this rate was very favorable to potatoes and did slight damage to this weed, the control from the combination treatment is probably due to the CMU.

Twenty-five, 50 and 75 pounds of NaTCA resulted in decreasing potato production; 90, 77 and 51 bushels per acre, respectively. The corresponding estimated nutgrass control was 60, 62, and 94 percent.

Chloro IPC, PMAS, maleic hydrazide, 2,4-D and the latter combined with 2,4-5-T or PMAS, at the rates used, did not control the nutgrass.

One application of 5½ quarts per acre of PMAS produced the highest average yield of potatoes, 192 bushels. This increase may have been due to the fungicidal property of PMAS. The use of 8 quarts of PMAS resulted in 132 bushels of potatoes per acre.

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Table 1. Average Yields of Potatoes and Estimated Percent Control of Nutgrass on the Kingsley Farm, North Kingstown, Rhode Island, 1953.

Materials	Rate per Acre	Yield Bu./A	Control %
Check		120	None
CMU (80%)	10 lb.	70	66
CMU	15 lb.	22	96
CMU	20 lb.	2	98
NaTCA (80%)	25 lb.	90	60
NaTCA	50 lb.	77	62
NaTCA	75 lb.	51	94
Chloro IPC (40.6%)	10 lb.	77	3
PMAS (10%)	5½ qts.	192	11
PMAS	8 qts.	132	15
CMU & PMAS	5 lb. & 5½ qts.	138	56
2,4-D Ester & PMAS	3 qts. & 5½ qts.	121	26
2,4-D Ester (46%)	3 qts.	160	4
2,4-D Ester & 2,4-5-T (43%)	1 qt. & 2 qts.	59	3
MH 30	27 lb.	38	12

Tests and Results, 1954

The plots which were located in the same area as during 1953 contained 200 square feet and included four rows of Katahdin potatoes.

On June 21 and 22, when the nutgrass plants were from 3 to 6 inches high, four replicate plots were sprayed with the CMU, Dalapon, TCA and certain combinations as shown in Table 2. Most of these treatments were repeated on July 1st on two of the four replicates, which meant duplicate plots. No space along the edge of the field remained for the PMAS plots so these were established on July 8 just south of the other plots where growing conditions were slightly better. Duplicate plots received 1, 2, 3 and 4 applications of PMAS, respectively.

The amounts of herbicides used, the yields of potato tubers, and the dry weight of nutgrass in pounds per acre are presented in Table 2. The yields of potatoes in the control plots ranged from 244 to 287 bushels and the nutgrass from 2565 to 3101 pounds per acre.

The average yields of potatoes receiving 1 and 2 sprayings with 5 pounds of CMU were 84 and 26 bushels per acre, respectively. The dry weight of nutgrass showed a similar pattern, 243 and 29 pounds. Where 5½ quarts of PMAS were combined with 5 pounds of CMU, the yields of potatoes were 67 and 10 bushels respectively for 1 and 2 treatments. The nutgrass harvest was practically the same as with CMU alone.

Potatoes treated with 5 pounds of Dalapon in 1 and 2 applications per acre averaged almost identical yields, 295 and 285 bushels per acre. The dry weight of nutgrass was reduced considerably compared to the check plots but no killing of the pest occurred. The potatoes sprayed with Dalapon were dark green and vigorous.

Table 2. Average Yields of Potatoes and Pounds Dry Weight of Nutgrass on the Kingsley Farm, North Kingstown, Rhode Island, 1954.

Materials	Rate per Acre	Potatoes 1 Tmt Bu./A	Potatoes 2 Tmt Bu./A	Nutgrass 1 Tmt Lb./A	Nutgrass 2 Tmt Lb./A
Control	(no treatment)	287	244	3101	2565
CMU (80%)	5 lb.	84	26	243	29
CMU & PMAS	5 lb. & 5½ qts.	67	10	232	31
CMU & Dalapon	1 lb. & 4 lb.	258	160	527	327
Dalapon (78%)	5 lb.	295	285	1093	973
Dalapon & PMAS	5 lb. & 5½ qts.	257	242	1949	318
NaTCA (80%)	25 lb.	326	-	214	-
NaTCA & Dalapon	25 lb. & 5 lb.	283	-	200	-
PMAS (10%)	5½ qts.	322	311	1621	2314
PMAS	5½ qts.	265*	275*	1639*	1236*

* 3 and 4 treatments, respectively.

When 1 pound of CMU was combined with 4 pounds of Dalapon, potatoes yielded 258 and 160 bushels, and the nutgrass 527 and 327 pounds per acre for 1 and 2 treatments. Unfortunately, CMU alone at the 1 pound rate was not included. It is probable, however, that the CMU was the more damaging agent in this mixture. According to Orsenigo and Smith,[1] CMU at low rates such as 1 pound per acre will reduce competition from nutgrass.

The repeat application of 5 pounds of Dalapon and 5½ quarts of PMAS provided a surprising reduction in total dry weight of nutgrass per acre, while the yields of potatoes was about as good as in the check plots. Further testing is needed to determine the real merit of this combination.

The largest yield of potatoes, 326 bushels per acre, and good control of nutgrass occurred in the plots sprayed with NaTCA. Where 5 pounds of Dalapon was combined with the NaTCA, the yields of potatoes were comparable to those in the control plots but no particular improvement over TCA alone was noted for nutgrass control.

In treatments employing only PMAS the nutgrass was 8-12 inches high when the first applications were applied on July 8th. The treatments yellowed the nutgrass and killed a few very small plants. The older plants recovered and grew vigorously. Three or four applications of PMAS caused somewhat lower yields of potatoes than did 1 or 2.

Discussion and Conclusions

None of the tested chemicals completely eradicated northern nutgrass. CMU at rates exceeding 1 to 2 pounds to acre reduced potato yields considerably and brought about a material reduction in the numbers and vigor of nutgrass. It is possible that 1 pound of CMU as a pre-emergence spray would weaken the nutgrass as well as reduce stands of annual weeds. Perhaps use of low rates of CMU in this manner for several years combined with cultivation or some post-emergence

1 Orsenigo, J. R. and Smith, Ora, 1953. The Chemical Control of Northern Nutgrass, *Cyperus esculentus* L., Proc. NEWCC. pp. 329-339.

herbicide might gradually eliminate the weed. NaTCA at 25 pounds to the acre seemed more effective during 1954 than 1953. Because of the rather rapid breakdown of TCA in soil it probably should not be applied before mid-June when the nuts are beginning to sprout. Further research is needed with CMU, TCA, and other new chemicals, before definite recommendations for control of northern nutgrass in potato plantings can be formulated.

TOLERANCE OF POTATOES TO SIX MATERIALS USED AS LAY-BY SPRAYS

R. L. Sawyer, S. L. Dallyn and R. D. Seif

There is need on Long Island for a suitable chemical to be used as a lay-by spray on potatoes for the control of annual grasses. The planting and harvest season is spread over a long period leaving a large proportion of the crop vulnerable to annual grasses for several weeks. Potatoes planted in early April are given their last cultivation in late June, depending somewhat on the growing conditions. These potato vines will not die down until the last part of August and much of this acreage is not dug until sometime in October. This leaves a considerable period of time for annual grasses to take over.

These lay-by experiments were set up to evaluate the lay-by spray effects of certain chemicals on potato foliage and yields. The chemicals used have previously been reported to control annual grasses by other workers. This experiment will be followed up next year by taking the materials which look promising onto farms which have late season weed problems.

MATERIALS AND METHODS

Dalapon, Craig I, Sesin, Natrin and Alanap 2 were applied as over-all and directed sprays to potato foliage at a dosage of 4 lbs./A. active ingredient. Potatoes of Katahdin variety were planted April 2, 1954. The normal fertilization and cultivation practices for Long Island were carried out through the growing season. The last cultivation, which is a hilling up process, was done June 25 and the lay-by sprays were applied on June 28. There was no rain for a 24 hour period following the spray application, however, the second day after the material was applied there was .09 inch of rain.

Plots were 34 feet long and replicated four times. Foliage damage ratings were made on July 8. Yield records of total and U. S. No. 1 tubers were taken at harvest time on September 28. Specific gravity readings were made in the field at harvest and replicated samples were stored at 40° and 50° F. to determine effects on keeping quality. Samples were also saved for chipping tests.

Amino Triazole was applied as an overall spray only, on August 4, 1954 to potatoes which had been planted April 1 and May 1. The dosages used were ½ and 2 pounds active ingredient per acre. Plots were 30 feet long and replicated three times. Yield records of total and U. S. No. 1 tubers were taken at harvest time on September 28. Specific gravity readings were made in the field at harvest time and replicated samples were saved and stored at 40°F. and 50°F. to determine effects on keeping quality. Samples were saved for chipping tests.

RESULTS AND DISCUSSION

In the lay-by experiment containing Dalapon, Craig I, Sesin, Natrin and Alanap 2, only Dalapon gave visual foliage damage. With the directed spray the injury was very slight. There were no significant differences in yield between overall and directed spray applications. However, when an average for all chemicals is compared with the check treatment, the chemicals have had a general depressing effect on yields at the 5% level of statistical significance. It should be noted that there was no weed problem in the field where this experiment was conducted. Thus, there were no adverse effects due to weeds in the check plots which could have favored yields from the chemically treated plots in a weedy field. Table 1 gives the yields of U. S. No. 1 tubers from plots treated with the overall and directed lay-by sprays and the average specific gravities.

Table 1. Yield of U.S. No. 1 Tubers from Plots Treated with Overall and Directed Lay-By Sprays and Their Average Specific Gravities.

Materials	Bushels per Acre Overall	Directed	Specific Gravity
Dalapon	534	602	1.0692
Craig I	610	586	1.0708
Sesin	516	550	1.0700
Natrin	544	582	1.0692
Alanap 2	589	632	1.0727
Check	645	662	1.0702
L.S.D. 5%	NS	NS	1.0023
1%	NS	NS	1.0032

The specific gravity of tubers from the Alanap 2 plots was significantly higher than Dalapon and Natrin plots at the 1% level and higher than Sesin and check plots at the 5% level of significance. There were no significant differences among the other chemicals.

Amino Triazole at 2 lbs./A. caused a highly significant reduction in yield. A high percentage of tubers from these plots had soft rot when dug. There was a slight amount of rot showing in the ½ lb./A. plot while the check plots had no rot. Although there was no reduction in yields at the ½ lb./A. dosage it would seem inadvisable to continue work with this material as a lay-by spray even at low dosages because of the rot involved. There were no differences in specific gravity amoung the two dosages of amino triazole and check treatments. There was no significant interaction between date of planting and chemical treatment either in yield or in specific gravity. Table 2 gives the yield of U.S. No. 1 tubers and specific gravities from amino triazole and check plots.

Table 2. Yield of U.S. No. 1 tubers and specific gravity from plots treated with Amino Triazole.

Materials	Bushels per Acre	Specific Gravity
Amino Triazole-½ lb./A.	495	1.0721
Amino Triazole-2 lbs./A.	186	1.0715
Check	550	1.0741
L.S.D. 5%	90	NS
1%	130	NS

SUMMARY

1. Dalapon, Craig I, Sesin, Natrin and Alanap 2 were applied as directed and overall sprays on potatoes at last cultivation.

2. Plots with overall sprays had as good yields as plots with directed sprays.

3. In general the chemicals used had a slight depressing effect on yield.

4. Potatoes from plots sprayed with Alanap 2 had a significantly higher specific gravity than all other treatments except Craig I.

5. Amino Triazole at 2 lbs./A. caused a considerable amount of soft rot and reduction in yield. Some rot showed up at ½ lb./A. although it did not cause a significant yield reduction. Because of the rot involved it seems inadvisable t o continute further lay-by work with this material even at low dosages.

CHEMICALS APPLIED PRE-AND POST-EMERGENCE FOR CONTROLLING WEEDS IN POTATOES

R. J. Aldrich and J. C. Campbell[1]

The chemical DNOSBP (4,6-dinitro-o-sec. butylphenol) has proven satisfactory for the pre-emergence control of many annual weeds in potatoes. A possible limitation to its use, however, is that its effective period of weed control, ordinarily ranging from 4 to 8 weeks, is frequently too short. It would be desirable to have a chemical that would control weeds for the entire cultivating period so that it would not be necessary to cultivate for that purpose.

Annual weeds, particularly grasses, which germinate after the last cultivation are also a problem in potatoes. These late germinating weeds probably do not affect yields to any great extent but they do interfere with mechanical harvesting.

The present investigation includes comparisons of chemicals applied for pre-emergence and post-emergence control of weeds in potatoes.

Materials and Methods

1953 Tests

Katahdin potatoes planted April 29 were treated pre-emergence May 14 with DNOSBP acid, ammonium salt, and amine salt at rates of 3 and 4½ pounds per acre, and CMU (3-*p*-chlorophenyl-1, 1-dimethylurea) as rates of ½, 1, and 2 pounds per acre. Heavy rains occurred May 15 and 17. Potatoes had largely emerged by May 18. Weed counts were taken just prior to cultivating June 9. All plots were hand-hoed June 12 and June 15. Post-emergence chemicals were applied June 15 in 40 gallons of water per acre. Drop booms were used to avoid extensive contact of sprays with potato foliage. The post-emergence chemicals included CMU at ½ and ¾ pound per acre and SESIN (2,4-dichlorophenoxyethyl benzoate) at 1½ and 3 pounds per acre. All plots treated post-emergence were treated pre-emergence with 3 pounds of DNOSBP amine so that weeds were not a factor in potato growth until after the post-emergence treatments.

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[1]Agronomist, Field Crops Research Branch, ARS, U.S. Dept. of Agriculture and Assistant Research Specialist, New Jersey Agricultural Experiment Station; and Associate Research Specialist, New Jersey Agricultural Experiment Station, respectively.

1954 Tests

The pre-emergence test was a comparison of rates of CMU since this chemical was outstanding in the 1953 experiment. Katahdin potatoes planted April 22 were treated pre-emergence May 7 with ½, 1, and 2 pounds per acre of CMU. It was planned to treat one-half of each plot immediately prior to irrigating and the remaining half immediately after irrigating to measure the effect on injury to potatoes and on weed control. However, 2.36 inches of rain fell immediately after the first treatment so that it was not necessary to irrigate. A weedy and a hand-weeded check were included for comparison. Weed counts were made June 1. Cultivation was omitted so that information could be obtained on the persistence of weed control.

The area for the post-emergence test was treated pre-emergence with dinitro and was cultivated June 22. Two and 4 pounds per acre of NATRIN (sodium 2,4,5-trichlorophenoxyethyl sulfate) and SESIN 50W (sodium 2,4-dichlorophenoxyethyl benzoate) and ½, 1, and 2 pounds per acre of CMU were applied June 28. The sprays were directed to the soil to avoid extensive contact with potato foliage. DALAPON (sodium 2,2-dichloropropionate) at 5 and 10 pounds per acre and at 5 pounds per acre in conjunction with ½ pound of 2,4-D was applied September 1 after annual grasses and some annual broad-leaved weeds were established.

Results and Discussion

Pre-emergence

The effect of the pre-emergence herbicides on yields and on weed control is shown in Table 1. Rain just before or immediately after applying CMU did not affect weed control or yield of the potatoes. The mean yield of plots treated before the rain was 249.0 bushels and that of plots treated after the rain 249.9 bushels. Therefore, yields presented in Table 1 are the average for appropriate plots treated before and after the rain. Of the chemicals applied pre-emergence CMU at 2 pounds per acre reduced yields significantly in both years when compared with lower rates of CMU. Yields were not reduced by ½ and 1 pound of CMU as measured by comparison with effective DNOSBP treatments in 1953 and with hand-weeded checks in 1954. The significantly lower yield of plots treated with ½ pound of CMU in 1954 as compared with hand-weeded check plots was due to competition from weeds which came in after the treatment lost is effectiveness. As can be seen from the weed counts, however, there was complete control with ½ pound three weeks after treatment. This rate of application also resulted in practically complete control for the early part of the cultivating season in 1953. The period of control was not a factor in yields in 1953 since plots were cultivated and hand-hoed after weed counts were taken. There were some differences in yield among DNOSBP formulations and rates but it is believed that these were due to uneven weed stands after cultivation and to variations in soil. Differences in control between the three DNOSBP formulations were slight although there appeared to be slightly poorer control with the ammonium salt than with the acid or amine salt. Control with all rates of CMU was more complete and more lasting than control with the best DNOSBP treatment. Although it is apparent that potatoes can be injured by pre-emergence applications of CMU it would appear that the rate necessary for control is sufficiently low for the chemical to be used safely. Additional work is needed, however, on other soils common to the potato area.

Table 1. Effect of herbicides applied pre-emergence on yields of Katahdin potatoes in 1953 and 1954 and on weed control in 1954, New Brunswick, N. J.

Treatment		Weeds per square foot June 1		Bushels U.S.#1 per acre	
Chemical	Pounds per acre	Broad-leaved	Grasses	1953	1954
DNOSBP Acid	3			195.0	
" "	4½			247.1	
" Ammonium	3			276.4	
" "	4½			210.8	
" Amine	3			249.5	
" "	4½			297.3	
CMU	½	0.2	0.1	239.4	235.7
"	1	0.0	0.1	246.7	279.7
"	2	0.1	0.0	183.3	235.7
Check		23.3	22.2	163.0	83.2
Check (hand-weeded)					295.8
L.S.D. .05				51.8	47.7
.01				N.S.	66.9

Post-emergence

Comparative weed control and yields from plots treated post-emergence are shown in Table 2. The only treatments which significantly reduced yields were the 1 and 2 pound per acre applications of CMU in 1954. Both CMU and SESIN resulted in "fair" weed control in 1953 but control did not last for the entire period between time of treatment and harvest. All rates of CMU and SESIN used in 1954 gave what could be termed commercially satisfactory weed control up to the time plots were harvested. The post-emergence treatments in 1953 were followed by a 30 day period in which no rain occurred which caused early die-back of potatoes and decreased the competition potato vines ordinarily provide for these late weeds. It also delayed germination of the weeds. Two pounds of CMU in 1954 controlled completely all late-germinating weeds so that these plots were free of weeds when harvested in October. NATRIN was less effective although 4 pounds resulted in measurable control. The DALAPON treatments were made too late for best weed control. The treatments did serve to indicate, however, that the potatoes were not damaged by any of the treatments. The combination of DALAPON and 2,4-D gave better control than DALAPON alone. Control of crabgrass appeared superior with this treatment as was control of the broad-leaved weeds.

Table 2. Effect of herbicides applied after the last cultivation on yields of Katahdin potatoes in 1953 and 1954 and on weed control in 1953, New Brunswick, N. J.

Chemical	Pounds per acre	Weed control rating[1]	Bushels U.S. #1 per acre 1953	Bushels U.S. #1 per acre 1954
Check		0	163.0	252.0
Check hand-weeded				275.4
CMU	¼	5.0	207.4	
"	½	7.0	204.4	277.8
"	1			226.2
"	2			180.0
SESIN	1½	8.0	235.2	
"	3	7.0	269.8	
"	2			297.8
"	4			259.5
NATRIN	2			279.5
"	4			258.1
DALAPON	5			281.3
"	10			289.3
" + 2,4-D	5, ½			299.2
L.S.D. .05			51.8	17.9

[1] 0 = no weed control and 10 = complete control

The relative effect of early and late emerging weeds on potato yields is indicated by comparing 1953 and 1954 yields. Weeds in check plots in 1953 were allowed to grow for approximately 4 weeks after potatoes emerged. Weeds were kept out of check plots during the remainder of the growing season. Nevertheless, the average yield of check plots was 33.7% less than the average yield of plots treated pre-emergence with DNOSBP. Weeds in check plots in the post-emergence test in 1954 were controlled until post-emergence treatments were made June 28 after which weeds were allowed to grow unchecked. The check plots were heavily infested with weeds at harvest time but yields were reduced only 8.5% when compared with hand-weeded plots.

Summary

1. Weed growth during the few weeks immediately following potato emergence was particularly detrimental to yields and was much more deleterious than weed growth after the last cultivation.

2. Under the conditions of the test the dintro formulations were similar in weed control and none of them injured the potatoes.

3. One-half pound of CMU per acre applied prior to emergence of potatoes effectively controlled annual weeds for a longer period of time than recommended applications of DNOSBP.

4. CMU and SESIN applied after the last cultivation showed promise for the control of late germinating weeds.

5. A combination of DALAPON and 2,4-D appeared promising for the control of late germinating weeds and should be investigated further in an application earlier than was made in the present investigation.

6. Rates of application of CMU in excess of 1 pound per acre pre-emergence and $\frac{1}{2}$ pound per acre post-emergence reduced vine growth and yields.

THE EFFECT OF HERBICIDES UPON POTATOES USED FOR CHIPPING

By Tom Eastwood, Wise Potato Chip Company, and
J. S. Cobb, The Pennsylvania State University

A continuation of the research reported previously (1,2,3,4,5,6,7) was carried on in 1953. The pre-emergence herbicidal treatments used are listed in Table 6. All materials, except $CaCN_2$ which was applied dry, were applied in water at the rate of about 50 gallons per acre.

Both the Katahdin and the Russet Rural varieties were grown. They were planted on 3 June, 1953. Herbicidal applications were put on 16 June, 1953. These potatoes were dug on 13-14 October, 1953. The potatoes were graded on 14 October, 1953, and the first chipping tests were started on 16 October, 1953.

Yield data and weed counts were reported previously (3).

The 120 pound samples from each herbicide treatment were a composite from the four field replicates for each treatment. Each composite sample was divided into three groups. The first group (A series) received no cold storage treatment. The second group (B series) was placed into cold storage for a period of 9 weeks at an average temperature of 55° F. for the first three weeks and at an average temperature of 44° F. for the rest of this period. The third group (C series) was held in cold storage for a period of eighteen weeks, the second nine week period being at an average temperature of 39° F.

All these potatoes received a curing storage treatment of eight weeks duration following their respective periods of cold storage. The first lot (A series) was held in curing storage conditions at an average of 69° F. The second lot (B series) was held in curing storage at an average of 71° F. The third lot (C series) was held in curing storage at an average of 70° F.

The weight of all the samples which went into curing storage was 30 pounds. During the eight week periods of curing storage of each of several groups of potatoes, weekly chipping tests were conducted. Each series received an initial test plus eight weekly ones, making a total of 27 observations for each herbicidal treatment. These chipping tests included: specific gravity, Table 1; chip color (fry test), Table 2; percent reducing sugar, Table 3; and whenever possible, chip taste, Table 4. Because of the general poor to fair chipping quality of these potatoes grown during the 1953 season, it was difficult to secure a satisfactory supply of samples for use by the taste panel. Also, percent losses were estimated for curing storage (Table 5) and for cold storage (Table 6).

SUMMARY

Significant changes in specific gravity of the potatoes were caused by the use of the weed killing chemicals. The 1953 results were similar to those obtained in 1952. However, the same general decrease in specific gravity that was reported in the 1951 experiment was not found in this year's experiment (1953).

Weather conditions may be a causal agent in the influence of the herbicidal treatment effect upon the specific gravity of the potato tubers. Good weather conditions occurred in 1951 in respect to growing good chipping potatoes. Poor weather conditions, which appeared to produce potatoes with poor chipping qualities, were prevalent in 1952 and 1953.

The strong interaction between herbicide and potato variety indicated that herbicidal effect was governed, to some extent, by the potato variety under test. In 1952 and 1953 when the varieties Katahdin and Russet Rural could be compared directly, The former variety appeared to be more responsive. Also, this response was mostly in the direction of reduced specific gravity for the Katahdin variety.

The cold storage treatment appeared to interfere with the direct herbicide effect upon specific gravity as a strong statistical interaction was present for both the 1952 and the 1953 data. The trends were erratic with no precise direction present.

This year's work showing the lack of effect of the herbicides upon chip color were in agreement with the 1951 and the 1952 work. However, as is usual, the variety Katahdin produced a better chip color than did the variety Russet Rural in the A series. This year both varieties were of similar color in the B series, while (as usual) the Russet Rural had the better color in the C series.

The chip color produced by these potatoes this year was not satisfactory. Only the initial fry of the A series produced chips of acceptable chip color, averaging 3.3 (grade 4.0 is the maximum acceptable). At the end of the first week in curing storage both varieties produced chip color that was not acceptable, and this condition persisted until the end of the eight week's curing storage period. Only a small number of the B or the C series potatoes made chips of acceptable color for both varieties. Probably weather conditions were responsible.

Herbicides had no effect upon the amount of reducing sugar in the potato tubers this year. This checked well with the 1951 and the 1952 data. Neither potato variety nor cold storage treatment interacted with this response.

Table 1.

Mean Specific Gravity Values of Potatoes From Plants Which Had Received Pre-Emergence Herbicidal Treatments - 1953

Herbicides		Previous Cold Storage Periods - Weeks											
Mat.	Amt/A	0 weeks (A)			9 Weeks (B)			18 Weeks (C)			0-18 Weeks (ABC)		
		Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean
Check	-	1.0759	1.0795	1.0777	1.0768	1.0825	1.0796	1.0775	1.0842	1.0809	1.0767	1.0821	1.0794
CH-1	5 lbs.	1.0736	1.0783	1.0759	1.0731	1.0794	1.0762	1.0786	1.0842	1.0814	1.0751	1.0806	1.0779
DN(Dow)	4 qts.	1.0712	1.0836	1.0774	1.0691	1.0853	1.0772	1.0728	1.0860	1.0794	1.0710	1.0850	1.0780
DN(Std.)	4 qts.	1.0715	1.0801	1.0758	1.0762	1.0812	1.0787	1.0774	1.0870	1.0822	1.0750	1.0828	1.0789
$CaCN_2$	800 lbs.	1.0764	1.0799	1.0781	1.0761	1.0807	1.0784	1.0793	1.0821	1.0807	1.0773	1.0809	1.0791
NaPCP	20 lbs.	1.0723	1.0806	1.0764	1.0725	1.0777	1.0751	1.0748	1.0801	1.0774	1.0732	1.0795	1.0763
CMU	2 lbs.	1.0763	1.0827	1.0795	1.0760	1.0817	1.0788	1.0790	1.0796	1.0793	1.0744	1.0813	1.0792
CH-1	10 lbs.	1.0756	1.0821	1.0788	1.0724	1.0806	1.0765	1.0718	1.0876	1.0797	1.0733	1.0834	1.0783
MCP	2 qts.	1.0711	1.0784	1.0748	1.0728	1.0791	1.0759	1.0744	1.0816	1.0781	1.0727	1.0797	1.0762
Var. Means	-	1.0738	1.0806	1.0772	1.0739	1.0809	1.0774	1.0762	1.0836	1.0799	1.0746	1.0817	1.0781
LSD Values		5%	1%		5%	1%		5%	1%		5%	1%	
Cure Time		0.0019	0.0025		0.0021	0.0028		0.0016	0.0022		0.0011	0.0015	
Herb.		0.0019	0.0025		0.0021	0.0028		0.0016	0.0022		0.0011	0.0015	
Var.		0.0019	0.0012		0.0010	0.0013		0.0008	0.0013		0.0005	0.0007	
Herb. x Var.		0.0027	0.0035		0.0030	0.0040		0.0023	0.0031		0.0016	0.0021	
Cold Stg.		-	-		-	-		-	-		0.0006	0.0008	
Cold Stg.x Herb.		-	-		-	-		-	-		0.0019	0.0025	
C.Stg.x Var.		-	-		-	-		-	-		-	-	
C.Stg. x Herb. x Var.		-	-		-	-		-	-		0.0027	0.0036	

Table 2.

Mean Chip Color Values of Potatoes from Plants Which Had Received Pre-Emergence Herbicidal Treatments - 1953.

Herbicides		Previous Cold Storage Periods - Weeks											
Mat.	Amt/A	0 Weeks (A)			9 Weeks (B)			18 Weeks (C)			0-18 Weeks (ABC)		
		Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean
Check	--	4.8	5.3	5.1	7.0	6.1	6.6	7.2	6.2	6.7	6.4	5.9	6.1
CH-1	5 lbs.	4.4	4.7	4.6	6.0	6.4	6.2	7.3	5.9	6.6	5.9	5.7	5.8
DN (Dow)	4 qts.	4.2	5.1	4.7	6.9	6.2	6.6	7.2	5.8	6.5	6.1	5.7	5.9
DN (Std.)	4 qts.	4.5	5.0	4.8	6.8	6.4	6.6	7.8	6.2	7.0	6.4	5.9	6.1
$CaCN_2$	800 lbs.	4.7	4.8	4.8	5.8	6.7	6.2	7.9	6.7	7.3	6.1	6.1	6.1
NaPCP	20 lbs.	4.7	5.4	5.1	6.2	6.2	6.2	7.3	6.1	6.7	6.1	5.9	6.0
CMU	2 lbs.	4.4	5.3	4.9	6.2	6.6	6.4	7.4	6.9	7.2	6.0	6.3	6.1
CH-1	10 lbs.	4.2	5.8	5.1	6.1	6.7	6.4	7.1	6.4	6.8	5.8	6.3	6.1
MCP	2 qts.	5.0	5.7	5.4	6.3	6.3	6.3	7.3	6.3	6.8	6.2	6.1	6.2
Var. Means	---	4.6	5.3	4.9	6.4	6.4	6.4	7.4	6.3	6.8	6.1	6.0	6.1
LSD Values		5%	1%		5%	1%		5%	1%		5%	1%	
Cure Time		0.6	0.7		0.6	0.8		0.6	0.8		0.6	0.8	
Herb.		-	--		-	-		-	-		-	-	
Var.		0.3	0.3		-	-		0.3	0.4		-	-	
Herb. x Var.		-	-		-	-		-	-		-	-	
Cold Stg.		-	-		-	-		-	-		0.4	0.5	
Cold Stg. x Herb.		-	-		-	-		-	-		-	-	
Cold Stg. x Var.		-	-		-	-		-	-		0.5	0.7	
Cold Stg. x Herb. x Var.		-	--		-	-		-	-		-	-	

Table 3.

Mean Percent Reducing Sugar Values of Potatoes From Plants Which Had Received Pre-Emergence Herbicidal Treatments - 1953

Herbicides		Previous Cold Storage Periods - Weeks											
Mat.	Amt/A	0 Weeks (A)			9 Weeks (B)			18 Weeks (C)			0-18 Weeks (ABC)		
		Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean
Check	-	0.07	0.08	0.08	0.16	0.11	0.14	0.20	0.10	0.15	0.14	0.10	0.12
CH-1	5 lbs.	0.07	0.07	0.07	0.15	0.11	0.13	0.19	0.11	0.15	0.14	0.10	0.12
DN (Dow)	4 qts.	0.07	0.07	0.07	0.17	0.11	0.14	0.16	0.12	0.14	0.13	0.10	0.12
DN (Std.)	4 qts.	0.07	0.07	0.07	0.16	0.14	0.15	0.19	0.10	0.15	0.14	0.10	0.12
$CaCN_2$	800 lbs.	0.08	0.07	0.07	0.11	0.14	0.13	0.20	0.11	0.16	0.13	0.11	0.12
NaPCP	20 lbs.	0.07	0.07	0.07	0.13	0.12	0.13	0.18	0.10	0.14	0.13	0.10	0.11
CMU	2 lbs.	0.07	0.07	0.07	0.13	0.12	0.12	0.16	0.10	0.13	0.12	0.10	0.11
CH-1	10 lbs.	0.07	0.09	0.08	0.16	0.13	0.15	0.15	0.11	0.13	0.13	0.11	0.12
MCP	2 qts.	0.07	0.08	0.08	0.14	0.13	0.13	0.16	0.12	0.14	0.12	0.11	0.12
Var. Means	-	0.07	0.08	0.08	0.15	0.12	0.14	0.17	0.11	0.14	0.13	0.10	0.12
LSD Values		5%	1%		5%	1%		5%	1%		5%	1%	
Cure Time		-	-		0.04	0.05		0.03	0.04		0.02	0.03	
Herb.		-	-		-	-		-	-		-	-	
Var.		-	-		0.02	0.03		0.01	0.02		0.01	0.01	
Herb. x Var.		-	-		-	-		-	-		-	-	
Cold Stg.		-	-		-	-		-	-		0.01	0.02	
Cold Stg. x Herb.		-	-		-	-		-	-		-	-	
Cold Stg. x Var.		-	-		-	-		-	-		0.02	0.02	
C. Stg. x Herb. x Var.		-	-		-	-		-	-		-	-	

Table 4.

Mean Chip Taste Values of Potatoes From Plants Which Had Received Pre-Emergence Herbicidal Treatments - 1953.

Herbicides		Previous Cold Storage Periods - Weeks											
Mat.	Amt/A	0 Weeks (A)			9 Weeks (B)			18 Weeks (C)			0-18 Weeks (ABC)		
		Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean
Check	-	2.0	2.1	2.1	-	2.2	2.2	3.0	2.5	2.8	2.5	2.3	2.4
CH-1	5 lbs.	1.7	1.6	1.7	1.9	2.1	2.0	3.6	2.1	2.9	2.4	1.9	2.2
DN (Dow)	4 qts.	1.7	1.9	1.8	-	2.3	2.3	-	2.1	2.1	1.7	2.1	2.1
DN (Std.)	4 qts.	1.6	1.8	1.7	3.2	1.7	2.5	-	2.5	2.5	2.4	2.0	2.2
$CaCN_2$	800 lbs.	1.6	1.8	1.7	2.0	2.3	2.2	1.4	2.7	2.1	1.7	2.3	2.0
NaPCP	20 lbs.	1.6	2.4	2.0	2.1	1.9	2.0	2.1	2.1	2.1	2.0	2.1	2.0
CMU	2 lbs.	1.9	2.3	2.1	-	1.8	1.8	2.7	2.8	2.8	1.9	2.3	2.2
CH-1	10 lbs.	1.9	1.7	1.8	2.0	2.8	2.4	2.8	1.7	2.3	2.2	2.1	2.2
MCP	2 qts.	1.8	-	1.8	2.4	2.1	2.3	-	2.3	2.3	2.1	2.2	2.1
Var. Means	-	1.8	2.0	1.9	2.3	2.1	2.2	2.6	2.3	2.4	2.2	2.1	2.2
No. obser./Treatment		20-40	10-35		0-20	10-20		0-10	10-30		0-40	10-35	

Note: Used chips of Lab. Grades 1-5 for flavor tests thru Taste Panel.

Table 5.

Mean Percent Curing Storage Loss Values of Potatoes from Plants Which Had Received Pre-Emergence Herbicidal Treatments - 1953

Herbicides		Previous Cold Storage Periods - Weeks											
Mat.	Amt/A	0 Weeks (A)			9 Weeks (B)			18 Weeks (C)			0-18 Weeks (ABC)		
		Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean	Kat.	R.R.	Herb. Mean
Check	-	11.7	27.0	19.4	17.7	17.0	17.4	11.7	22.7	17.2	13.7	22.2	18.0
CH-1	5 lbs.	11.0	15.0	13.0	9.3	16.7	13.0	14.3	26.7	20.5	11.5	19.5	15.5
DN (Dow)	4 qts.	16.0	27.0	21.5	9.3	15.0	12.2	12.3	19.0	15.7	12.5	20.3	16.4
DN (Std.)	4 qts.	16.0	21.3	18.7	11.0	21.0	16.0	13.0	24.7	18.9	13.3	22.3	17.8
$CaCN_2$	800 lbs.	18.3	26.0	22.2	11.3	18.7	15.0	16.3	23.0	19.7	15.3	22.6	18.9
NaPCP	20 lbs.	10.0	21.6	15.8	8.7	15.3	12.0	12.0	21.7	16.9	10.2	19.5	14.9
CMU	2 lbs.	13.7	24.3	19.0	10.7	17.3	14.0	12.3	20.3	16.3	12.2	20.6	16.4
CH-1	10 lbs.	11.3	25.3	18.3	9.7	19.7	14.7	12.0	19.7	15.9	11.0	21.6	16.3
MCP	2 qts.	11.0	28.3	19.7	12.7	17.7	15.2	11.7	22.0	16.9	11.8	22.7	17.2
Var. Means	-	13.2	24.0	18.6	11.2	17.6	14.4	12.8	22.2	17.5	12.4	21.3	16.8

LSD Values	5%	1%	5%	1%	5%	1%	5%	1%
Herb.	-	-	-	-	-	-	-	-
Var.	3.3	4.8	2.4	3.6	1.7	2.4	1.7	2.3
Herb. x Var.	-	-	-	-	-	-	-	-
Cold Stg.	-	-	-	-	-	-	2.1	2.9
Cold Stg. x Herb.	-	-	-	-	-	-	-	-
Cold Stg. x Var.	-	-	-	-	-	-	-	-

Table 6.

Mean Percent Cold Storage Loss Values of Potatoes from Plants Which Had Received Pre-Emergence Herbicidal Treatments-1953.

Herbicides Mat.	Amt/A	Kat.	R.R.	Herb. Means
Check	-	3.5	4.3	3.9
CH-1	5 lbs.	3.5	5.0	4.3
DN (Dow)	4 qts.	3.8	5.4	4.6
DN (Std.)	4 qts.	4.2	7.5	5.9
$CaCN_2$	800 lbs.	4.3	6.0	5.2
NaPCP	20 lbs.	4.1	7.8	6.0
CMU	2 lbs.	3.8	5.0	4.4
CH-1	10 lbs.	3.3	7.5	5.4
MCP	2 qts	4.1	5.2	4.7
Var. Means	-	3.8	6.0	4.9

Herbicidal Treatments Used

Amt/A	"Trade" Name	Chemical Name
--	Check	---
5 lbs.	CH-1	Sodium 2, 4, - dichlorophenoxy ethyl sulfate
(3.0 lbs.) 4 qts.	CN (Premerge)	Alkanclamine Salt (Ethanol and isopropanol series) of dinitro-o-sec-butyl phenol, 53% (Equiv. 3 lbs. DNCSBP per gal
(5.1 lbs.) 4 qts.	DN (Sinox General	dinitro-o-sec-butyl phenol, 50%; and dinitro-o-sec-amyl phenol, 10%. (Equiv. 5.1 lbs. DNOSBP per gal.) Use 10 gal. No. 2 oil per gal. with DN material.
800 lbs.	Cyanamid	$CaCN_2$
20 lbs.	NaPCP (Dow G.)	Sodium pentachlorophenate, 85%
2 lbs.	CMU	3-p-chlorophenyl-1-1-dimethyl urea, 80%
10 lbs.	CH-1	---
2 qts.	MCP	2-methyl-4-chlorophenoxy acetic acid (equiv. 2 lbs./gal.)

However, the potato variety varied in the amount of reducing sugar in the tubers, depending upon the cold storage treatment. In the A series, the reducing sugar percentage in the tubers was low and similar for both varieties. In the B and the C series, the Katahdin variety contained more reducing sugar in the tubers than did the Russet Rural variety.

Insufficient taste observations prevented proper evaluation of the taste results. Incomplete data and uneven sets of data for taste results were caused by the poor chip color quality of the potatoes. Chips of Laboratory Grade 5 were even used to try to get enough samples. The usual procedure is to use only chips of grade 4 or less for taste work.

Thus, it was not possible to support the observations upon taste secured in 1951 and 1952. In 1951 definite impairment in chip flavor was caused by the use of the herbicides. In 1952, significant results were secured, but definite straight line results like those in 1951 were not obtained. These variable results of the possible effect of herbicide applications upon chip taste quality may be related to the different weather conditions experienced during the three years. Soil type may not be a factor because in 1951 both varieties were grown under different soil conditions and definite clear cut results were obtained. In 1952 and 1953, similar soil types were used, but unclear results were obtained.

The use of the herbicides had no effect upon the keeping quality of the potato tubers in the several curing storage periods for all three years. In 1952 and 1953, wherein a direct comparison was possible, the losses for Katahdin were noticeably less than those for Russet Rural.

The herbicidal materials had no influence upon the keeping quality of the potato tubers in cold storage. This held for all three years.

REFERENCES

1. Cobb, J.S.
1952 Pre-Emergence Weed Control Treatments on Potatoes., Proced. 6th Ann. Mtg. NEWCC, NYC, Jan. 52, p 193.

2. Cobb, J.S.
1953 Pre-Emergence Weed Control Treatments on Potatoes., Proced. 7th Ann. Mtg. NEWCC, NYC, Jan. 53, (presented verbally).

3. Cobb, J.S.
1954 Pre-Emergence Weed Control Treatments on Potatoes., Proced. 8th Ann. Mtg. NEWCC, NYC, Jan. 54, p 165.

4. Eastwood, Tom, and Cobb, J.S.
1953 The Effect of Herbicides Upon Potatoes Used For Chipping., Proced. 7th Ann. Mtg. NEWCC, NYC, Jan. 53, p 241-246.

5. Eastwood, Tom, and Cobb, J.S.
1954 The Effect of Herbicides Upon Potatoes Used For Chipping., Proced. 8th Ann. Mtg. NEWCC, NYC, Jan. 54, p 167-173.

6. Eastwood, Tom
1952 The Effect of Herbicides Upon Potatoes Used for Chipping., The Guidepost, Vol. 30, No. 3, March, 52, p 3-4.

7. Eastwood, Tom
1952 The Effect of Herbicides Upon Potatoes Used for Chipping., Am. Pot. Jour., Vol. 29, No. 7, July, 52, pp 160-164.

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Chemical Weed Control in Potatoes

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The season of 1954 had very favorable weed growing weather. The temperature was cool and the rainfall about 4 inches per month evenly distributed.

Chemical treatments were sprayed across the row two weeks after planting, two days before any appreciable emergence of the potato plants. At the same time a part of the field was harrowed.

Weed counts were made just before harvesting the crop. The counts are not actual numbers of weeds but rather represent a gradation from 20 for the largest number of weeds down to 0 for no weeds.

Two cultivations were made between the rows during the season.

The yields are significantly different only on the check plots. This gives a striking effect of weed growth on yield.

A slight albinism of a few leaves on the amino triazole plots were the only evidences of top damage from any of the treatments.

The data show good weed control for all treatments.

Chemical Weed Control in Potatoes
1954 Tests

Treatments			Average Weed Counts Dicot.	Mono.	Katahdin Yields - Bu./A. U.S. 1	U.S. 2
1.	CMU	1 lb.	2.5	3.0	270.4	20.6
2.	CMU	2 lbs.	1.0	1.7	324.4	19.0
3.	Sinox G.	2 qts.	2.5	4.5	335.5	19.4
4.	Sinox G.	4 qts.	1.2	2.2	334.4	20.0
5.	Premerge	8 qts.	1.2	3.7	366.2	21.8
6.	Dow G.	15 lbs.	2.5	5.5	335.6	16.9
7.	Dow G.	25 lbs.	1.7	3.7	347.5	18.7
8.	A. Triazole	2 lbs.	3.5	3.7	416.8	20.0
9.	A. Triazole	5 lbs.	2.7	3.0	358.1	16.2
10.	A. Triazole	8 lbs.	2.0	3.7	379.6	23.1
11.	Check		13.2	3.2	195.0	22.1
12.	Hoed		1.5	2.2	365.0	16.9
	Harrowed Area		3.0	3.0	376.0	22.1

			Average Weed Counts Dicot.	Mono.	Russets Yields - Bu./A. U.S. 1	U.S. 2
1.	CMU	1 lb.	1.5	2.0	256.2	32.5
2.	CMU	2 lbs.	1.0	1.5	332.5	37.5
3.	Sinox G.	2 qts.	1.5	2.7	276.7	29.7
4.	Sinox G.	4 qts.	1.0	2.2	246.6	23.1
5.	Premerge	8 qts.	1.5	2.2	294.4	28.1
6.	Dow G.	15 lbs.	1.5	2.7	270.6	28.1
7.	Dow G.	25 lbs.	1.2	2.0	284.2	28.7
8.	A. Triazole	2 lbs.	2.5	2.0	284.1	23.7
9.	A. Triazole	5 lbs.	1.2	1.7	228.5	21.8
10.	A. Triazole	8 lbs.	2.0	2.5	289.4	23.1
11.	Check		16.5	6.5	38.7	20.6
12.	Hoed		1.0	1.0	150.1	23.1
	Harrowed Area		3.0	3.0	325.0	29.6

WEED CONTROL IN FIELD CORN FOLLOWING PLANTING AND EMERGENCE APPLICATIONS OF HERBICIDES

Ernest R. Marshall*

In a previous paper (1) the author described weed control tests conducted on field corn plots. These tests showed that herbicides applied just as the corn was emerging often gave maximum weed control with minimum crop injury. Certain herbicides applied at the time of planting also resulted in good weed control. One of the problems associated with applications of herbicides at planting time is that of residual weed control. Field corn growers in the Northeast are shifting more and more to emergence or pre-emergence applications of herbicides and away from post-emergence applications. Several factors account for this shift. There is usually less chance of crop injury from pre-emergence applications of herbicides. New materials have proven more effective as pre-emergence applications. Also, it is often to the farmer's advantage to apply weed control materials before the corn emerges insofar as labor and soil conditions are concerned.

Certainly one of the most advantageous times to make a pre-emergence herbicidal application would be at the time the corn is being planted. Such an application could save one complete spraying operation and at the same time would eliminate the possibility of adverse weather conditions preventing spraying operations.

Applicationsmade at this time, however, are faced with the necessity of a long residual effect. Therefore, one of the prime requisites of a material satisfactory for planting applications is that it should have a long residual effect. Secondly, of course, this material should not be injurious to the crop upon which it is to be used.

The tests described in this paper were conducted with the above thoughts in mind. This problem of a longer residual effect was approached from several angles:

1. New materials were screened in hopes that they might show longer residual effects.

2. New types of formulations were tried to see if formulation would effect residual activity.

3. Combinations of materials were used to see if length of residual activity could be increased.

Materials and Methods

For these tests field corn was planted on June 8th. Materials used in these tests were applied at two different times; the day the corn was planted and when the corn was emerging. All materials were applied with a small plot CO_2 sprayer in 50 gallons of water per acre and at 25 lbs. pressure. Each plot was 23 feet long and 9 feet

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Table 1. CHEMICALS AND RATES USED IN CORN WEED CONTROL TEST PLOTS

Material	Lbs. Active Applied per Acre: Planting Low	Planting High	Emergence Low	Emergence High	Abbreviation
Amine 2,4-Dichlorophenoxyproprionic acid	1½	2	1	1½	2,4-DP amine
Amine MCP proprionic acid	1½	2	1	1½	MCP amine
Amine 2,4-D (GLF Weed Killer 66)	1½	2	1	1½	2,4-D amine
Butoxy ethanol ester 2,4-D (Weedone LV4)	1½	2	1	1½	LV4
3-p-chlorophenyl -1-1-dimethyl urea(Karmex W)	1	1½	3/4	1	CMU
Phenyl dimethyl urea (Karmex FW)	1	1½	3/4	1	PDU
3,4 dichlorophenyl 1-1-dimethyl urea (Karmex DW)	1	1½	3/4	1	DMU
Sodium pentachlorophenate liq. (ACP Garden Weeder)	8	12	6	8	195 A
Sodium " powder (Dowcide-G)	8	12	6	8	NAPCP
Pentachlorophenol (GLF Penta 10 Weedkiller	8	12	6	8	PCP
Amine Dinitro Ortho Sec. butyl phenol (Sinox PE)	4½	6	3	4½	Sinox PE
2-Chloroethyl N (3 chlorophenyl) carbamate	2	4	2	4	T-595
2-Chloropropyl-N(3 chlorophenyl) carbamate	2	4	2	4	T-596
Isopropyl N-(3 chlorophenyl)carbamate(GLF Chloro IPC)	2	4	2	4	CIPC
2,3,6 trichlorobenzoic acid	1½	2	1	1½	TCB
2,4 Dichlorophenoxyacetamide	1¼	1 2/3	1½	2	2,4-D amide
Amino Triazole salt of Pentachlorophenol		3 1/3	2	4	AT-PCP
Amino Triazole salt of 2,4,5-T	1¼	1 2/3	1½	2	AT-2,4,5-T
2,4-D emulsifiable acid	1	1½	3/4	1	2,4-D acid
Butoxyethanol ester 2,4-D Proprionic acid	1½	2	1	1½	LV 2,4 DP
2,4,5 trichlorophenoxyethyl sulfate	4½	6	4½	6	Natrin
Amino triazole	2	4	1	2	AT
2,4,5 trichlorophenoxyacetamide	1¼	1 2/3	1½	2	2,4,5-T amide
2,4,5 trichlorophenoxyacetic acid	1½	2	1	1½	2,4,5-T acid
Iron salt of 2,4,5-T	1¼	1 2/3	1½	2	Fe-2,4,5-T
2,4-dichlorophenoxyethyl sulfate (Crag Herb.1)	3	4½	3	4½	SES
2,4-dichlorophenoxyethyl benzoate	3	4½		4½	Sesin
LV 4 + SES	½ + 1½	1+2	½+1½	1 +2	LV4-SES
LV 4 + Sesin	½ + 1½	1+2	½+1½		LV4-Sesin
LV 4 + Natrin	½ + 2	1+4	½+2	1+4	LV4-Natrin

wide, covering three rows of corn. Each treatment was replicated three times and data given are means of three replicates. The treatments were applied to a medium loam soil which was dry at the time the treatments were applied. The principal weed problems were mustard (Brassica arvensis), redroot pigweed (Ambrosia retroflexus) and annual grasses (Setaria sp.) . In some cases higher rates of materials were applied at planting than at emergence. The various materials along with the amount of material applied at each date of application is shown in Table 1. Two rates of each chemical were applied at each date of application. Both experimental and commercially available materials were used in this test and sources of these materials are shown by trade names. If trade names are not listed, the materials are experimental materials.

Results and Discussion

In order to study the results of this experiment it was deemed advisable to group the experimental materials in certain classes of compounds. The results of the tests are given in tables 2, 3, 4 and 5. The carbamate materials T-595, T-596 and CIPC did not give any measure of weed control so they are not included in the tables. MCP proprionic did not show any particular advantages so it will not be included in the tables.

Data taken from plots treated with growth regulator type materials are shown in Table 2.

These data show that better weed control was obtained by the treatment applied as the corn was emerging even though lower rates were used in the emergence treatments. On this medium loam soil, it took about 2 lbs. acid equivalent material to get adequate weed control when the materials were applied at planting. A pound and a half will do as good or better job when the treatments are delayed until corn emergence. The most outstanding material in this group was TCB. Applied at planting TCB gave excellent weed control and a very long residual effect. Another material which showed promise was the Amide of 2,4-D. This material was applied as a wettable powder and although weed control data do not show it too clearly, field observations indicated that further testing with this material should be done. LV4 gave good weed control when applied as the corn was emerging. Further work should be done with improved wettable powder formulations of insoluble forms of 2,4-D to see whether or not it would be practical to use this method to obtain a longer residual effect. The amino triazole salt of 2,4,5-T showed some promise but because of formulation difficulties, the application of this material was not uniform and further tests should be conducted under more uniform conditions.

Table 2. WEED CONTROL IN CORN FOLLOWING PLANTING AND EMERGENCE APPLICATIONS OF GROWTH REGULATORS

		At Planting			At Emergence		
		Weeds/Unit area	Rating**		Weeds/Unit area	Rating	
Material*	Rate*	6/24	6/24	7/12	6/24	6/24	7/12
2,4-D Acid	Low	23.7	5.6	5.4	11.3	8.0	7.4
	High	18.3	6.6	8.6	5.7	8.4	8.4
2,4-D Amine	Low	32.7	6.4	7.0	11.0	7.6	6.4
	High	14.7	7.0	7.0	6.0	7.6	8.4
LV-4	Low	38.3	4.4	5.4	11.3	7.6	8.6
	High	19.3	7.0	6.6	6.7	9.4	9.6
2,4-D Amide	Low	32.0	6.6	6.4	3.7	8.4	8.4
	High	20.0	7.4	7.0	3.7	9.0	9.0
2,4,5-T Acid	Low	30.3	5.4	4.4	11.7	8.0	6.0
	High	26.7	6.6	6.0	7.3	8.4	7.6
Fe 2,4,5-T	Low	27.1	4.4	4.4	17.0	6.0	5.6
	High	16.0	7.4	5.4	12.7	6.6	6.0
2,4,5-T Amide	Low	24.3	7.0	6.0	14.3	8.2	6.6
	High	25.1	7.0	6.4	8.7	8.6	7.4
AT-2,4,5-T	Low	40.0	5.4	4.0	6.0	8.4	6.4
	High	21.3	7.4	4.6	2.3	9.4	8.6
2,4-D P Amine	Low	33.7	6.0	5.0	36.3	5.0	4.0
	High	17.7	6.4	5.4	10.0	7.4	5.0
LV 2,4-DP	Low	25.3	5.0	5.4	15.3	7.4	6.4
	High	28.0	7.4	6.6	7.0	8.0	7.6
TCB	Low	24.3	5.6	9.4	31.3	5.4	8.6
	High	18.0	7.4	9.4	17.0	6.4	9.4
Check		33.1	.6	1.6	31.7	0	.4

* Complete name of material and rates applied at each date, in Table 1.

**0 = No weed control 10 = perfect weed control

Table 3 presents data from plots treated with contact and residual type weed killers, generally considered to be of the non-growth regulator type. These materials at the rates applied showed weed control superior to the growth regulator types in Table 1 when data were taken on June 24th. The residual effect of these materials had been lost to some extent by July 12th. This was not the case with TCB and other materials listed in Table 2. The most outstanding material of those listed in Table 3 was Sinox PE. Field observations indicated that the amino triazole salt of pentachlorophenal was giving good weed control and showed promise for future testing. No consistent differences were found between comparable rates of NaPCP, 195A and PCP.

Table 3. WEED CONTROL IN CORN FOLLOWING PLANTING AND EMERGENCE APPLICATIONS OF RESIDUAL TYPE HERBICIDES

		At Planting			At Emergence		
		Weeds/Unit area	Ratings**		Weeds/Unit area	Ratings	
Material*	Rate*	6/24	6/24	7/12	6/24	6/24	7/12
NaPCP	Low	19.7	6.6	6.0	6.0	9.0	6.4
	High	10.7	8.4	7.6	4.3	9.0	7.0
195A	Low	18.0	6.6	5.0	6.3	8.6	6.4
	High	12.3	8.0	8.0	4.7	8.6	7.6
PCP	Low	15.0	8.0	5.6	6.3	8.4	6.4
	High	8.3	8.4	7.6	3.0	9.6	8.0
AT-PCP	Low	28.7	6.4	7.4	13.3	8.0	6.0
	High	9.7	8.4	8.0	2.7	9.4	8.0
Sinox PE	Low	14.7	8.4	7.4	3.3	9.6	7.0
	High	2.0	9.6	8.4	2.0	10.0	8.6
Check		33.1	.6	1.6	31.7	0	.4

* Complete name of materials and rates applied at each date in Table 1.

**0 = No weed control 10 = perfect weed control

Table 4. WEED CONTROL IN CORN FOLLOWING PLANTING AND EMERGENCE APPLICATION OF SUBSTITUTED UREA COMPOUNDS

		At Planting			At Emergence		
		Weeds/Unit area	Ratings**		Weeds/Unit areas	Ratings	
Material*	Rate*	6/24	6/24	7/12	6/24	6/24	7/12
CMU	Low	17.7	7.4	6.6	18.0	7.0	7.0
	High	6.3	8.6	9.4	10.3	7.0	7.0
PDU	Low	21.3	7.4	8.6	14.3	9.0	8.4
	High	14.7	7.6	9.4	5.7	9.6	8.4
DMU	Low	62.7	5.6	6.4	16.3	7.4	6.6
	High	19.3	6.6	9.0	4.3	8.0	7.0
Check		33.1	.6	1.6	31.7	0	.4

* Complete name of materials and rates applied at each date in Table 1.

**0 = No weed control 10 = perfect weed control

Table 5. WEED CONTROL IN CORN FOLLOWING PLANTING AND EMERGENCE APPLICATIONS OF HERBICIDES & HERBICIDAL COMBINATIONS

		At Planting			At Emergence		
		Weeds/Unit area	Ratings**		Weeds/Unit areas	Ratings	
Materials*	Rate*	6/24	6/24	7/12	6/24	6/24	7/12
SES	Low	40	4.6	6.0	19.0	3.6	4.6
	High				41.0	1.6	3.0
Sesin	Low	29	5.4	6.4			
	High	13	7.0	6.6	19.7	5.6	6.0
Natrin	Low	33	5.4	5.4	71.0	2.0	3.4
	High	28	6.6	5.4	38.7	4.4	3.4
LV4 + SES	Low	16.0	6.6	6.0	14.7	7.0	7.6
	High	29.1	7.0	6.6	9.3	8.0	8.6
LV4 + Sesin	Low	43.7	6.0	5.4	27.3	2.0	1.0
	High	14.0	6.4	4.6			
LV4 + Natrin	Low	34.3	5.0	4.0	15.0	9.0	7.6
	High	32.0	5.0	5.6	5.0	9.0	9.0
Check		33.1	.6	1.6	31.7	0	.4

* Complete name of materials and rates applied at each date in Table 1.

** 0 = No weed control 10 = perfect weed control

Three substituted urea compounds are compared in Table 4. These materials worked very effectively when applied at planting. PDU gave slightly better weed control than CMU and DMU slightly poorer.

It was thought that perhaps by applying a combination of materials; one to give kill of emerged weeds and the other to give residual kill of germinating weed seeds, desirable weed control could be obtained.

Table 5 shows results of tests with herbicides which kill germinating weeds and combinations of these herbicides with LV4 which is effective on emerged weeds. In general weed control results with these materials were not satisfactory. The two most satisfactory combinations were the LV4 + SES combination and LV4 + Natrin.

Table 6. WEED CONTROL RANKING OF DIFFERENT HERBICIDES IN ORDER OF CONTROL - SUMMARY OF FOUR DATES OF RATING*

Material	Lbs.Applied per Acre		Ranking		
	Planting	Emergence	Planting	Emergence	Total
Sinox PE	6	4½	7	7	14
TCB	2	1½	5	4	9
CMU	1½	1	4	0	9
PDU	1	3/4	4	5	9
PDU	1½	1	5	3	8
LV4	2	1½	0	8	8
TCB	1½	1	5	2	7
AT-PCP	3.3	4	4	3	7
PCP	12	8	3	4	7
Sinox PE	4½	3	3	4	7

* See text for description of ranking system

In order to determine which materials gave the most consistent and best weed control results, a ranking system was employed. This system consisted of ranking the various treatments according to their rating at each date the ratings were made. Only materials giving good weed control were included. Rankings were from 5 for the highest rated material down to 1. In case two materials had the same rating, they were given the same ranking. The sum of the rankings were taken for each material at each date of rating and a total ranking obtained by adding the planting and emergence ranking. These rankings are shown in Table 6. Sinox PE was the outstanding material by this ranking system. LV4 did not rank with the leading materials applied at planting but at emergence was the outstanding material.

Summary and Conclusions

Thirty different herbicides or combination of herbicides were applied at two times of application to field corn. These times were when the corn was planted and as it was emerging. These materials included experimental materials, residual type herbicides and combination of herbicides.

The carbamates T-595, T-596 and CIPC at the rates used did not give satisfactory weed control.

Better weed control was obtained from applications made as the corn was emerging than at planting time.

The most outstanding material of the growth regulator type was TCB. Other materials showing promise were 2,4-D amide, AT-2,4,5-T and LV4.

Results with residual type contact herbicides indicate that these materials gave early weed control superior to the growth regulator type herbicides at the rates used. This residual effect was maintained at the higher rates but it was not superior to that of TCB. Sinox PE was the most effective material in this group. AT-PCP gave good weed control and should be tested further. No consistent differences in weed control were found between NaPCP, 195 A or PCP. Three substituted urea compounds were compared and PDU gave slightly better weed control than CMU.

Combinations of LV4 + SES, LV4 + Sesin and LV4 + Natrin gave no better weed control than several of the other materials tested.

A ranking system showed that the most effective materials tested in order of control were Sinox PE, TCB , CMU, PDU, LV4, AT-PCP and PCP.

Of the materials tested other than those now commercially available TCB, AT-PCP, AT-2,4,5-T, PDU, and 2,4-D Amide should be tested further on larger scale plots to determine if they would be satisfactory for weed control in corn when applied at planting.

Control of Weeds in Corn by Pre-emergence, Emergence and Post-emergence Treatments[1]

Collins Veatch[2]

Introduction

Weed control plots were established in corn fields on the Experiment Station farms at Point Pleasant, Reedsville and Wardensville. A heavy rain at Wardensville, over two inches in less than an hour, shortly after the corn emerged washed the field so severely that the area was disced and seeded to soybeans and sudan grass. At Reedsville the persistant and abundant growth of quack grass, in the plot area, nullified any differential effect of the treatments applied. The plots established at Point Pleasant came through the season without a major disaster. The original plans called for a cultivation at lay-by but the weed counts were so low on June 23 that it was decided to leave these plots without further disturbance.

Methods & Procedure

The plot area was fertilized and seeded uniformly by machine. The indicated spray materials were applied with a special mechanized plot sprayer. The plots were four rows wide by 12 hills long which gave a center plot of 2 rows by 10 hills for yield determinations. Treatments were replicated four times. Weed counts were made on a four square foot area on June 23 and an estimate of the weed coverage was made at harvest which is recorded as the Average weed index, 0 indicating no weeds and 9 rather complete weed coverage. Yields were corrected for stand and reported on the basis of 15.5% moisture.

Discussion of Results

The results of weed control trials at Point Pleasant in 1954 are reported in Tables I, II, III.

Pre-emergence

The corn was planted on May 17 and the pre-emergence spray was applied May 20. In this trial (Table I) the cultivated check gave the highest yield of 124.4 bushels. The plots with no weed control gave an average yield of 120.3 bushels indicating that weeds, although present late in the season, were not a serious factor in reducing yields in these trials. Four treatments gave yields that were within the range of the cultivated check less the least significant difference (L.S.D. .05) of 17.08 bushels. They were (1) Premerge at 9 pounds per acre (116.6 bushels), (2) Premerge at 6 pounds per acre (114.3 bushels),

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[1] Scientific Paper No. 495, West Virginia Agriculture Experiment Station.
[2] Associate Agronomist, West Virginia Agriculture Experiment Station.

(3) 2,4-D amine at 1.5 pounds per acre (113.5 bushels) and (4) C.M.U. at 1.5 pounds per acre (112.8 bushels). These plots were all relatively free of weeds at harvest time as indicated by the weed index.

The predominating weeds on this area were crabgrass (<u>Digitaria sanguinalis</u>), three-seeded-mercury (<u>Acalypha virginica</u>) and lambsquarters (<u>Chenopodium album</u>). Lambsquarters were the predominating weeds found in the lower yielding plots.

Emergence

The emergence spray treatments (Table II) were applied May 27, 10 days after planting. Some of the plants were 2 to 3 inches in height at this time but no burning or other damage was observed as a result of the spray applications tested.

The cultivated checks averaged 125.5 bushels per acre in yield. Only two of the treatments gave yields within the range of the check less the L.S.D. (17.62 bushels). The plots sprayed with Premerge at the rate of 6 pounds per acre gave a yield of 117.2 bushels per acre while those sprayed with M.C.P. at the rate of 1 pound per acre gave a yield of 112.5 bushels per acre. The 2,4-D sprays at 1 pound per acre gave somewhat better weed control than the Premerge or M.C.P. as indicated by the weed count and the weed index.

Post-emergence

The post-emergence treatments (Table III) were applied June 8 about a week after the plot area was harrowed. The cultivated checks gave an average yield of 127.8 bushels per acre. One series of plots receiving no weed control averaged 115.8 bushels per acre while another series averaged 102.7 bushels showing some variation in weed competition or soil fertility. Besides the above mentioned no control plot there were only three treatments within the range of the cultivated plot less the L.S.D. (24.02). The plots sprayed with 1/2 pound of 2,4-D gave an average yield of 118.7 bushels, the Ses plots at 2 pounds per acre gave an average yield of 112.7 bushels, while the plots sprayed with 2,4-D at 1 pound per acre gave an average yield of 105.3 bushels per acre. The 2,4-D sprayed plots gave better weed control than the other treatments as indicated by the weed count and the weed index.

<u>Summary</u>

Pre-emergence, emergence and post-emergence treatments were applied on corn plots at Point Pleasant. The cultivated plots were in all cases the highest in yield. Those plots where the weeds were not controlled in the pre-emergence and post-emergence treatments yielded less than the cultivated plots although within the experimental error as determined by the least significant difference (L.S.D. .05). Many of the chemical treatments actually resulted in lower yields than where no attempt was made to control the weeds.

Cultivation gave superior results, in all cases here reported, in yield and weed control. Seasonal or weather conditions in 1954 seemed to emphasize the

advantages to be gained from cultivation. There was sufficient rainfall to permit normal growth early in the season followed by an abundance of rain after the middle of July. Late or fall weeds made a good growth but did not necessarily compete with the corn for moisture.

Some of the chemicals, namely 2,4-D and Premerge, gave surprisingly good weed control considering the mid and late season rainfall. Pre-emergence and emergence treatments gave better weed control than comparable post-emergence treatments.

References

1. Schaller, F.W., Weed Killers vs. Cultivation in 1948, Mimeograph Circular No. 61. Agriculture Experiment Station, West Virginia University, Morgantown, West Virginia.

2. Veatch, Collins, Weed Control and Corn Yields in 1949, Mimeograph Circular No. 63, Agricultural Experiment Station, West Virginia University, Morgantown, West Virginia.

3. Veatch, Collins, Four Years of Weed Control in Corn in West Virginia, Proceedings of the Sixth Annual Meeting of the Northeastern Weed Control Conference, January 1952, pg. 217.

4. Veatch, Collins, Effect of Some Chemicals on Weed Growth in Corn Production, Proceedings of the Seventh Annual Meeting of the Northeastern Weed Control Conference, January 1954, pg. 273.

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Table I

Corn Yields, Weed Index and Weed Counts Following Pre-emergence Treatments at Point Pleasant 1954

	Treatment	Rate per A. lbs.	Aver. Yield Bu./A.	Aver. Weed Index (0-9)	Aver. Weeds per 4 sq.ft. June 23	Predominating Weeds
1	2,4-D Amine	1	99.8	1.75	4.00	----------------------
2	2,4-D Amine	1.5	113.5	1.25	1.75	----------------------
3	2,4-D Amine	2.0	100.3	1.25	2.00	----------------------
4	2,4-D LV-4	1.0	105.8	1.75	2.25	Three seeded mercury
5	2,4-D LV-4	1.5	107.2	1.50	1.25	----------------------
6	2,4-D LV-4	2.0	107.3	1.00	.75	----------------------
7	2,4-D Kathon	1.0	107.2	1.75	1.25	----------------------
8	Premerge	6	114.3	2.00	3.00	Crabgrass
9	Premerge	9	116.6	1.50	.25	Crabgrass
10	C.M.U.	1.0	104.4	2.00	3.25	Crabgrass
11	C.M.U.	1.5	112.8	1.25	1.75	----------------------
12	Amizol	4	101.9	4.00	11.50	Lambsquarters
13	Amizol	8	94.9	3.25	4.75	Lambsquarters
14	No control	----	120.3	2.75	19.25	Three seeded mercury
15	Check	Cult.	124.4	1.50	.25	----------------------
16	C.I.P.C.	4	99.0	3.25	8.50	Lambsquarters
17	Herbisan	2 gal.	89.1	4.25	15.00	Lambsquarters
18	Herbisan	3 gal.	99.5	3.00	6.75	Lambsquarters
	L.S.D. .05		17.08			

Table II

Corn Yields, Weed Index and Weed Counts Following Emergence Treatments at Point Pleasant 1954

	Treatment	Rate per A. lbs.	Aver. Yield Bu./A.	Aver. Weed Index (0-9)	Aver. Weeds per 4 sq.ft. June 23	Predominating Weeds
1	2,4-D Amine	1	102.5	2.00	2.75	Smartweed
2	2,4-D LV-4	1	106.7	1.25	.50	Three seeded mercury
3	Premerge	3	106.7	2.75	5.50	Three seeded mercury
4	Premerge	6	117.2	2.50	2.75	Three seeded mercury
5	Alanap #5	3	87.5	4.50	8.50	Lambsquarters
6	Alanap #5	6	88.2	3.50	5.25	Lambsquarters
7	Crag #1	1.8	94.2	2.75	4.00	Black nightshade
8	Crag #1	3.6	106.2	2.00	1.50	Smartweed
9	Sessin	1.8	93.5	3.50	3.00	Lambsquarters & smartweed
10	Sessin	3.6	100.2	2.50	3.50	Smartweed
11	Sessin Emul.	2.0	96.9	4.00	4.75	Lamcsquarters & smartweed
12	Sessin Emul.	4.0	103.1	3.25	2.75	Smartweed
13	Herbisan	2 qt.	103.6	4.00	5.50	Lambsquarters, three seeded mercury
14	M.C.P.	1	112.5	2.00	1.50	Smartweed
15	Amizol	4	100.2	4.00	3.50	Lambsquarters
16	Check Cult.		125.5	2.00	----	Three seeded mercury
	L.S.D. .05		17.62			

Table III

Corn Yields, Weed Index and Weed Counts Following Post-emergence Treatments at Point Pleasant 1954

	Treatment	Rate per A. lbs.	Aver. Yield Bu./A.	Aver. Weed Index (0-9)	Aver. Weeds per 4 sq.ft. area	Predominating Weeds
1	2,4-D Amine	1/2	118.7	1.75	4.00	Smartweed
2	2,4-D Amine	1	105.3	1.25	2.50	Annual grasses
3	Crag #1 (Ses)	2	112.7	3.25	2.50	Smartweed, three seeded mercury
4	Crag #1 (Ses)	4	87.4	2.75	5.00	Lambsquarters
5	Sessin	2	97.3	3.25	5.50	Lambsquarters, three seeded mercury
6	No control	---	102.7	1.75	6.00	Lambsquarters, three seeded mercury
7	Alanap #5	3	101.2	2.50	4.75	Smartweed, three seeded mercury
8	Sessin	4	98.7	3.00	8.25	Lambsquarters, three seeded mercury
9	Sessin Emul.	1.11	86.9	2.50	4.50	Lambsquarters
10	Sessin Emul.	2.22	99.1	4.25	6.25	Lambsquarters, three seeded mercury
11	No control	---	115.8	2.75	6.25	Lambsquarters, galinsoga
12	Check cult.	---	127.8	1.50	----	--------------------
	L.S.D. .05		24.02			

CHEMICAL WEED CONTROL IN FIELD CORN

Jonas Vengris[2]

The weed flora in field corn consists mainly of dicot and monocot annuals.

Since the introduction of 2,4-D, the chemical control of dicot weeds has proved to be relatively simple. However, the unsolved problem of the chemical control of monocot weeds still remains.

Dinitrophenols have been suggested and even used to a considerable extent. Available information (1) appears to indicate that the proper application of DN might result in a more effective control of weedy grasses in field corn than that achieved by the application of 2,4-D. However, a definite answer has not yet been found.

In order to investigate this problem further, two field experiments were laid out at the Massachusetts Experiment Station in the Spring of 1954 for the purpose of comparing the efficiency of DN and 2,4-D in controlling annual weedy grasses in field corn.

EXPERIMENT I

Procedure

The soil was a Merrimac sandy loam with rather good drainage. A randomized block design with three replicates was used. The plots were 9 feet by 40 feet in size. Field corn of the variety Ohio M-15 was planted on June 7, 1954. Six days after planting, on June 13, 1954, when about 5 per cent of the corn plants had already emerged, the pre-emergence weed sprays were applied. The treatments included 2,4-D and DN. Low volatile butoxyethanol ester of 2,4-D (LV4-ACP) and alkanolamine salts of Dinitro-o-sec-butylphenol (Dow Premerge) were used.

The rates were:1-2 lb. 2,4-D and 3 and 6 lbs. DN per acre. 2,4-D was applied with 30 gallons, and DN with 60 gallons of water per acre.

Five days later, on June 18, 1954, when the corn plants were in the two- -leaf stage of growth and about 2 to 3 inches tall, the post-emergence weed treatments with DN were applied. Two rates, 3 and 6 lb. per acre, were used.

Besides these pre-emergence and post- emergence weed treatments, a combined treatment was used in this experiment. The plots so treated received

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3 lb. DN per acre on June 13, 1954, and another 3 lb. DN per acre on June 18, 1954.

RESULTS AND DISCUSSION

No injury to the corn plants resulted from pre-emergence weed treatments with DN. On plots treated with 2,4-D pre-emergence spray a few plants showed slight abnormalities (rolled, malformed leaves), but soon regained their normal appearance.

A quite different picture was shown by the plots treated with DN at the two-leaf stage of growth of the corn plants. A burning effect was evident. In general, about 1/3 of the leaf surface had turned brown. There was no significant differentiation between the burning effects of the 3-lb. or the 6-lb. rate of application.

The effect of the different treatments on the weed population was twice determined by estimation — four weeks and seven weeks after planting. The most prevalent weeds were lamb's-quarters and crab-grass. At the first examination (4 weeks after planting) the weed stand as a whole was estimated, but at the examination three weeks later the annual weedy grasses and the dicot weeds were estimated separately. The data are presented in Table I.

The first estimation (4 weeks after planting) of thd weed stands showed a significant control by all treatments. But there were differences in the degrees of control. The best results were obtained from treatments of 2 lb./A of 2,4-D and 6 lb./A of DN.

TABLE I. Field corn weed control by different treatments. Check plot weed stand = 100.

Treatments			4 weeks after planting weed stand	7 weeks after planting: Monocot weed stand	Dicot weed stand
1. Check			100	100	100
2. 2,4-D	1 lb./A	pre-emergence	12	33	22
3. 2,4-D	2 lb./A	pre-emergence	7	20	12
4. DN	3 lb./A	pre-emergence	18	65	12
5. DN	6 lb./A	pre-emergence	8	45	5
6. DN	3 lb./A	post-emergence	10	63	5
7. DN	6 lb./A	post-emergence	5	37	5
8. DN 3 + 3	lb./A	pre-emergence and post-emergence	5	29	5
L.S.D. at 1% level			10	25	
L.S.D. at 5% level			7	18	

The combined treatment with 6 lb./A DN (half as pre-emergence and half at the two-leaf stage) resulted in no better control of the weeds than 6 lb./A DN applied singly as a pre-emergence or post-emergence spray. An application of 3 lb./A DN at the two-leaf stage of corn growth was significantly better than an application at the same rate used at once as pre-emergence treatment. In general, however, the treatments with 3 lb./A DN and 1 lb./A 2,4-D were the least effective. Apparently, these rates were too low to be effective under the given conditions of the experiment.

The plots were maintained without cultivation, and 3 weeks later (7 weeks after planting) the weed stands were surveyed again. This time particular attention was paid to the influence of the different treatments on weedy grasses.

The facts were somewhat surprising. Contrary to what was expected, the best control of the weedy grasses was obtained from the treatments with 2 lb./A 2,4-D applied as pre-emergence spray, when the corn plants still were in the coleoptile stage of growth. The second most effective control was from the treatments with 1 lb./A 2,4-D and 6 lb./A DN.

Unfortunately, the final corn yields could not be determined because of destructive damage from hurricane Carol. So we had to confine ourselves to a close examination of the corn stands at the time that they should have been harvested. The corn plants looked yellowish and suppressed on the check plots, obviously affected by the competition with the companion weed crop. No growth differences were apparent on the treated plots.

EXPERIMENT II

Later in the season, plots were laid out (9 feet by 40 feet), variously treated, to control weedy grasses in field corn (Table II). The corn was about 30 inches tall, and crab-grass seedlings were small (0.5 to 2.0 inches tall). Chemicals were applied directly with 60 gallons of water per acre. Only the check and the Dalapon plots were replicated three times. No replicates were applied for the other treatments.

The results were obtained by estimation. The number 100 was assigned to the stand of weedy grasses on the check plots, and the respective stands of these weeds on the other plots were estimated relative to the checks.(Table II).

TABLE II. Annual weedy grass control in field corn. (Check plot weedy grass stand = 100.)

Treatments	Weedy grass stand
1. Checks	100
2. Dalapon 3 lb./A acid eq.	12
3. Dalapon 6 lb./A acid eq.	5
4. CIPC 4 lb./A acid eq.	25
5. CIPC 8 lb./A acid eq.	18
6. Amino-triazole 2 lb./A acid eq.	12
7. Amino-triazole 4 lb./A acid eq.	8
8. Endothal S-3003 2 lb./A acid eq.	55
9. Endothal S-3003 4 lb./A acid eq.	40
10. MH 5 lb./A acid eq.	27

Under the conditions of the test, Dalapon and Amino-triazole showed the most promising possibilities of controlling weedy grasses. However, the corn suffered some injury, especially when higher rates of the chemicals were applied. The lower rates of MH, CIPC, and Dalapon did not result in any injury to the corn plants. Higher rates of CIPC and of Dalapon caused a slight injury. Corn was severely injured on plots treated with Endothal. The injury manifested itself by a browning of the lower leaves, and was more marked at higher rates of application.

Corn treated with Amino-triazole showed symptoms of albinism. This injury accompanied by a general depression of growth was quite apparent when this chemical was used at the rate of 4 lb./A. Evidence of injury persisted during subsequent growth.

SUMMARY AND CONCLUSIONS

1) An excellent general control of weeds in field corn was obtained by the pre-emergence applications of a low volatile ester of 2,4-D or dinitro for at least four weeks. On plots where the higher rates of DN were applied as pre-emergence or at the two-leaf stage as post-emergence sprays, the results did not differ. The data obtained indicate that under the conditions of this experiment 1 lb./A of 2,4-D is below the optimum rate and also that the rates of DN should have been higher than 3 lb./A.

2) Best results of weedy grasses in field corn were obtained from treatments with 1 and 2 lb./A of 2,4-D and 6 lb./A of DN. It appears that post-emergence DN applications were slightly better than pre-emergence sprays.

3) When the herbicides were applied at "laying by" time, the most effective chemicals for controlling small seedlings of weedy grasses in field corn were Dalapon and Amino-tráazole.

LITERATURE CITED

1. Southwick, Lawrence. Premerge Shows Promise for Early Post-Emergence Grass Control in Sweet and Field Corn. Down To Earth. Vol. 9, No. 4, pp.14-15,1954.

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Weed Control in Corn

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Pre-emergence applications of 1, 2 and 3 pounds per acre of 2,4-D amine, ester, low volatile ester, MCP, Kuron and the acid and sodium salt of trichlorobenzoic acid, ½, 1 and 2 pounds of CMU, 4, 6 and 8 pounds of CIPC, 2, 4 and 6 gallons of Premerge and 400, 600 and 800 pounds of calcium cyanamide over the row in a band 12 inches wide were applied to corn within 24 hours of planting.

There was little rain between time of application and come-up of the corn. The corn was planted with a four-row planter. The center rows only were treated. The weed population was rather low on the checks. Most materials gave fairly good weed control.

There was some stunting with all materials except the sodium salt and acid of trichlorobenzoic acid, CMU and Kuron. Plants on the area treated with trichlorobenzoic acid and the sodium salt had a more upright and turgid appearance. Unlike other years, CMU did not stunt the corn. The one and two pound rate gave good weed control. Kuron at 2 and 3 pounds gave good weed control without injury to the corn.

All 2,4-D and MCP treatments stunted the corn slightly, the heavier rates were more severe than the lighter rates. The damage from MCP was much more severe than from 2,4-D. There was no observeable difference between different 2,4-D materials. In the past we have not observed damage caused by calcium cyanamide. The Dinitro and CIPC also stunted the plants. CIPC at the heavier rate reduced the stand of corn slightly.

Pre-emergence application of 1 pound of low volatile ester was applied to corn on May 23, 1954, which was four days after planting. The area where the corn was planted was an irrigation experiment started in 1950 consisting of orchardgrass-Ladino clover, Kentucky bluegrass-white clover, alfalfa and alfalfa-bromegrass. There were two rates of fertilizer, 0-80-80 and 0-160-160 and three levels of moisture for each forage planting. In 1952 and 1953 an application of 50 pounds of nitrogen was applied to half the orchardgrass-Ladino clover and Kentucky bluegrass-white clover plots, after each cutting. In March 1954, a uniform application of 50 pounds of nitrogen was applied to all plots.

There were very few weeds in the entire experiment. The corn grown on the area treated by pre-emergence application was slightly taller and tasseled a little earlier on all plots except the orchardgrass-Ladino clover and Kentucky bluegrass-white clover plots which had 50 pounds of nitrogen after each cutting.

The plant disease corn breeding inbred lines and crosses were sprayed with one and one quarter pounds of low volatile ester when the plants were 10 inches tall. We were aiming to kill 50% of the corn, but we severely injured less than 5% of the corn.

Four tests of directional sprays were applied on foxtail which was 4-8 inches tall in corn. The pressure, volume of water, rates of the chemicals and nozzle angle were varied.

A wide angle nozzle is better than a narrow angle nozzle because less material will get on the corn and weeds will be covered more completely because the nozzle shoots up under the corn leaves and not down on the corn leaves. Increasing the pressure is more desirable than increasing the volume of water. The amount of chemical necessary to kill the grass depends upon the size of the grass plants.

Endathol (Clovercide) with Uran and solution 2, Endathol nursery defoliant each at 2 pounds per acre gave fairly good control. Dalapon at 2 pounds stunted the grass badly but did not kill it. Amino triazole at 1 and 2 pounds colored up the corn and stunted many plants. Premerge was a little harder on the corn than Endathol in relation to the kill of the grasses.

Quackgrass Control

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Applications of 4, 8 and 12 pounds of Amino triazole with and without wetting agent and in combination with 2 pounds of ester of 2,4-D, 245T, MCP and 5 and 20 of TCA, Dalapon without wetting agent and CMU at 10, 20 and 30 pounds, two pounds of esters of 2,4-D, 245T, MCP and 5 and 20 of TCA were applied August 11, 1953, to a heavy quackgrass sod without plowing. The 20 pounds of TCA gave 100% kill without cultivation. In previous seasons we have used 100 to 200 pounds of TCA where the soil was not plowed without satisfactory kills of quackgrass.

CMU at 30 pounds gave complete kill while 20 pounds was nearly complete kill. Amino triazole with 2,4-D and 245T was poorer than Amino triazole alone; Amino triazole with MCP was better than Amino triazole alone. In no case did Amino triazole or Dalapon give satisfactory kill of quackgrass under these conditions.

Quackgrass sod which was plowed in the fall of 1953 was treated with 6 and 12 pounds of Amino triazole and Maleic hydrazide on April 30, 1954, using two replications. The quackgrass growth was about 4 inches tall when treated. Two areas across the treatments were disked 4, 7, 10, 13 and 16 days after treatment; a five foot strip was left without disking between each treatment. The early diskings were done when the soil was somewhat wet. The 12 pounds of Amino triazole killed about 99% of the quackgrass under all conditions. The 6 pounds of Amino triazole killed about 98% when disked under good conditions; under wet conditions about 95% was killed. The 12 pounds of Maleic hydrazide was about as effective as 6 pounds of Amino triazole. The 6 pounds of Maleic hydrazide was a littler poorer.

Plots 12x20 feet were treated with 10 and 20 pounds of MH40, Dalapon, TCA and Chloro IPC, Amino triazole at 2, 4, 8 pounds and Amino triazole with 50% wetting agent at 4, 8, and 16 pounds. There were three replications and two dates of application--May 13 and 17, 1954.

Four furrows were plowed on May 21 and the rest on May 24. The area was disked and planted May 25, 1954.

The MH40 and the Amino triazole killed 98-99% of the quackgrass without injury to the corn. TCA at 10 and 20 pounds killed about 80 and 90% of the quackgrass. Dalapon at 10 and 20 pounds killed about 90 and 95% of the quackgrass. The TCA and Dalapon treatments injured or killed most of the corn plants on the area plowed May 24. There was much less injury on the Dalapon area plowed May 21. There was little control and no injury with 10 and 20 pounds of Chloro IPC.

Quackgrass in head was treated June 2 with 4 and 8 pounds of Amino triazole with and without wetting agent. Twenty foot strips were plowed across the treatments each week for five weeks. There was no difference in time of plowing. All treatments controlled about 99% of the quackgrass. The few plants which did survive were at the edge of the furrow and where stones interfered with plowing. In areas not plowed quackgrass was badly injured but not killed. Dalapon applied at the same time but not plowed did not give satisfactory kill.

A quackgrass sod was treated with Amino triazole using 14 wetting agents or formulations at 1, 2 and 4 pounds per acre, Dalapon, American Cyanamide 6249 and CMU at 10, 20 and 40 pounds and TCA at 20, 40 and 80 pounds per acre, on August 17 and 18.

Part of each plot was plowed August 26 and September 17. Part of the plot was left without plowing.

There was little difference between wetting agents used with Amino triazole. The control with these rates is rather poor. The two top rates of Dalapon, TCA and CMU look very good; 6249 is considerably poorer than Dalapon.

The indications are, for best results with Amino triazole, that applications should be made on the quackgrass sod in the spring 10 to 20 days before planting corn, plow disk and plant corn immediately. Then cultivate 3 or 4 times during the growing season.

The Amino triazole translocates rapidly; slows down the rate of growth of the quackgrass so it is easily killed by cultivation.

PRELIMINARY STUDIES ON THE CHEMICAL DESICCATION OF ALFALFA FOR HAY[1]

Ernest K. Shaw and Gilbert H. Ahlgren[2]

Field curing of hay under natural conditions is a slow process even during favorable weather. When cut forage has to remain in the field several days to cure, the quality is reduced. If there was some manner by which forage could be cut, dried, and cured during the same day, much palatable forage could be saved.

One method offering a degree of success is the use of a mower-crusher machine. By crushing the stems, forage is sometimes cured for storage in a single day.

The use of chemicals that have the ability to desiccate may sometime prove another technique. There are a number of chemical formulations which possess some of the desirable qualities of a desiccating agent.

Pre-harvest applications of chemicals as desiccants and defoliants are now being used quite extensively on cotton, and to a limited extent on potatoes, soybeans, and more recently for seed crops of the clovers and alfalfa. Phillips (2) working with chemicals in the eradication of weeds, found that there was a reduction in the moisture content of alfalfa and weed samples taken 52 hours after application of the herbicide. Slife (4) in a similar study found that herbicide treated red clover dried faster than the untreated. Shafer (3) found that certain herbicides would reduce the moisture content of soybeans. Kennedy, Hesse and Johnson (1) in their study on hay drying by the use of herbicides found that dinitro-ortho-secondary-butyl phenol and disodium 3, 6-endoxyhexahydrophthalate had the best forage drying properties of the herbicides tested.

Preliminary screening tests for satisfactory forage desiccants were started at the New Jersey Agricultural Experiment Station during the summer of 1953 and continued during the summer of 1954. More than 200 chemicals were screened during this 2-year period.

Chemicals tried included organic acids, aldehydes, and salts and esters of organic acids. The basis for selection was to determine the effect of various chain lengths, branching of the chain, ion substitutions, effect of various group

[1]Acknowledgment is made to Frank J. Sowa of the Sowa Chemical Company, 305 East 46th St., New York City for supplying the chemicals used in these investigations. Credit is given the Grange League Federation for partial support of these studies.

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substitutions in the chain, and the relative effects of saturated and unsaturated groupings. This paper represents results secured primarily during the summer of 1954.

The chemical names and numbers used are shown in Table 1, hereinafter referred to generally by number. In all the tests, 25 to 50 gram samples of forage were taken at random in replicates of three or five at two 3-hour intervals. All samples (treated and untreated) were weighed immediately, and the samples allowed to dry to a constant weight in a forced-air dryer. Dry weights were then taken and the difference determined and expressed in percent moisture. Experiment I was repeated on four successive days and the hourly and daily ratings averaged and expressed numerically. Experiments II, III, and IV were repeated three times, and the different days and types of treatment, temperature, and humidity expressed as an average for each individual type of treatment. These averages represent the percent moisture loss in excess of the moisture loss by the untreated check plots or percent moisture removed attributed to chemical treatment. In Experiment III, the effect of cutting immediately after chemical application was tested. A wetting agent (Igepol) was used with each chemical to aid in solubility and to decrease the surface tension. There was some degree of variation in the temperature, humidity, and the extent of growth of the test material during the period of treatment. On the days of treatment, the chemicals were normally applied in the morning between 8 and 10 o'clock. Although this work was done on alfalfa, the results would probably be applicable to other crops.

Experiment I. Screening Chemicals for their Desiccating Effect on Standing Alfalfa

Purpose: To determine the best desiccants from a lot of 29.

Materials and Methods

Alfalfa plants in full bloom and suffering somewhat from drought were sprayed with 29 different chemicals. The chemicals were applied on four successive days at the rate of 25 and 50 pounds per acre in 50 gallons of water.

The chemicals were applied to 3 x 3 foot plots with a conventional household, hand-type sprayer and enough volume of each chemical was made up for the four equal applications.

The chemicals were applied on July 20, 21, 22 and 23, between 8:00 and 10:00 A.M. Continuous hourly observations were made daily and at 24 hour intervals for four days. Numerical ratings were given each plot on the basis of the desiccating properties of each chemical. The scale used was as follows: 1 - Very satisfactory; 2 - Good; 3 - Fair; 4 - Very slight; and 5 - Unsatisfactory.

Results and Discussion

The data as shown in Table 1 indicate the cumulative average rating for the four day period. Chemicals 506, 501, 523, and 528 were consistently superior in their desiccating qualities at the rates applied. On this basis, these chemicals were selected for further testing.

Table 1. Average rating of 29 chemical desiccants.

Chemical	Number	Rating
2-Ethylhexanoic acid	506	1.0
Ammonium 2 Ethylhexanoate	501	1.4
Caproic acid	528	1.6
Chloroacetic acid	505	1.6
2-Ethylhexaldehyde	523	1.7
Sodium 2-ethylhexanoate	500	2.5
2 ethylbutyric acid	530	2.6
"A" chloropropionic acid	502	3.0
Glycol diformate	513	3.0
"Flexol"	515	3.5
2-Hydroxyethyl 2-ethylhexanoate	504	3.6
Sodium chloroacetate	503	4.2
Polyethyleneoxy-2-ethylhexanoate	508	4.2
"Flexol"	516	4.2
Isopropyl 2-ethylhexanoate	509	4.4
2-ethylhexyl acetate	512	4.4
2-ethyl-3-propylacrolein	524	4.6
Butyric acid	527	4.6
Isobutyl isobutyrate	539	4.6
"Flexol"	518	4.7
Crotonaldehyde	521	4.9
Sorbic acid	531	4.9
Isopropenyl acetate	514	5.0
Glyoxal	525	5.0
Methacrolein	526	5.0
	545	5.0

Treatment Dates	Mean Temperature °F.	Relative Humidity
July 20	84	72
July 21	84	70
July 22	82	66
July 23	79	58

Table 1 - continued

	Effects of highest rated chemicals
506	Very rapid reaction, slight wilt after 15 minutes. Leaves crackly after one hour. Stems appear somewhat drier after 4-6 hours. Leaves completely dry after 10 hours. Stems dry after 24 hours. No visual increase in drying after 36 hours. The green color is lost from the terminal to the basal end progressively.
501	Rapid reaction, indication of wilt in one hour. Leaves become slightly brittle after 2nd hour. Leaves and stems appeared dry after 24 hours. Color lost the same as 506.
505	Semi-rapid drying, initial affects do not appear to be as rapid as 506 and 501. Drying appears to increase after one hour.
528	Reactions approximate those of 505.
523	Has promise as a quick acting desiccant, but did not appear to be consistent. As with all the other chemicals as shown above, the green color gradually faded after 24 hours.

Experiment II. Effect of Desiccant Applied at Different Rates

Purpose: To determine the effect of rate on chemical desiccation of alfalfa

Materials and Methods

Five chemicals showing promise in Experiment I were selected for Experiment II. Plots 3 by 12 feet were used in making the applications. Desiccants 501, 505, 506, 523, and 528 were applied at rates of 10, 25, 50 and 100 pounds per acre in 50 gallons of water during the months of July, August and September.

The order of application of the chemicals was selected at random. The rate of application was applied in order. Control samples from untreated plots were taken at the time of initial application. Replicate samples (3 per plot) were taken at two 3-hour intervals. Visual observations were made periodically and after 24 and 36 hours.

The experiment was repeated three times to determine the effect of variations in temperature, humidity and growth conditions of the plants.

Results and Discussion

The data in Table II shows the average percent of moisture loss by the treated plots over the untreated for the three treatment dates. The average percent moisture of the untreated plots for the three days of treatment was 72.1%. The average percent moisture present in the treated plots after three and six hours can be determined by substracting the percent moisture loss, as shown in Table II from the average percent moisture in the control.

Table 2. Average percentage reduction in moisture content of treated plots compared with untreated plots.[1]

		Percent Moisture Loss[2] Average of 3 dates of application at two 3-hour intervals		
Chem. No.	Rate[3]	3 hours	6 hours	Average
505	10	5.3	6.7	6.0
	25	13.8	13.8	13.8
	50	22.0	25.2	23.4
	100	25.0	30.8	27.9
501	10	3.4	6.7	5.0
	25	14.1	9.1	11.6
	50	21.0	23.9	22.1
	100	28.6	30.8	30.0
505	10	1.5	3.4	2.5
	25	4.6	6.9	5.8
	50	17.7	18.2	17.9
	100	24.7	24.6	24.6
528	10	4.3	3.1	3.7
	25	13.7	14.6	16.2
	50	21.1	22.8	21.9
	100	27.6	28.7	28.1
523	10	4.0	4.1	4.7
	25	7.6	13.9	9.3
	50	13.9	14.2	14.0
	100	15.3	15.8	15.5

[1] Average percentage moisture of control at time of treatment was 72.1 percent.

[2] Percentages were not converted to angles before averaging.

[3] 10 and 25 lbs. rates applied July 27, 30 and Sept. 25. 50 and 100 lb. rates applied July 27, August 16, and Sept. 25. Average temperature 73°F. Average relative humidity 73 percent.

The greatest amount of moisture reduction appears to take place during the first three hours after treatment. The difference between the moisture reduction percentages at the various levels of treatment for the different chemicals does not appear to be significant. However, on the three days of treatment 506 did appear to be a better desiccant than 501 and 505, and 501 and 505 removed a greater percentage of water than 528 and 523.

The 10 and 25 pound rate appears to be a little less than adequate under the conditions and with the equipment used. The 100 pound rate did not show a proportional increase over the 50 pound rate in any of the tests.

Experiment III. Effects of Cutting Alfalfa Immediately After Chemical Application Compared to Allowing it to Remain Uncut for Three and Six Hours

Purpose: Determination of the effect of natural drying in addition to chemical treatment

Materials and Methods

The three desiccants showing the greatest desiccating effect in Experiment II were used in Experiment III. Plots of $4\frac{1}{2}$ x 24 feet with a rank growth of alfalfa were used in making the applications. Desiccants 505, 506, and 501 were applied at rates of 25 and 50 pounds per acre in 50 gallons of water on three days during the month of August. The chemical was applied to the plots with a 3 nozzle milk-bottle type hand sprayer operated at 30 pounds pressure. The pressure was supplied by CO_2 from a small cylinder.

The plots that were to be mowed, were cut immediately after chemical application with a small power mower. After cutting, the forage was allowed to cure in the plots for 3 and 6 hours. Five samples were taken from each plot (cut and uncut) at two 3-hour intervals. The uncut controls were taken at the time of initial application. The cut control samples were taken at 3 and 6 hours after cutting.

Results and Discussion

The three chemicals tested at both the 25 and 50 pound rate were more effective in terms of total moisture loss when the forage was cut immediately after application. As is shown in Table 3, the cut materials had a greater decrease in moisture in 3 hours than the uncut in 6 hours. The 2-ethylhexanoic acid treatment with natural curing removed 32.8 percent moisture at the 50 lb. level, whereas the uncut but 2-ethylhexanoic acid treated plots had lost only 14.6 percent moisture.

Table 3. Comparison of rate of drying alfalfa cut immediately after chemical application to that allowed to stand for 3 and 6 hours.[1]

Chem. No.	Rate	% Moisture Loss[2] - Av. for 3 Treatment Dates[3]					
		3 hours			6 hours		
		Cut	Uncut	Difference	Cut	Uncut	Difference
501	25	21.2	6.2	15.1	28.9	7.3	21.6
	50	23.8	11.6	12.2	28.5	12.9	15.6
505	25	21.0	6.5	14.4	24.6	8.7	15.9
	50	27.6	14.5	13.2	29.7	13.4	16.4
506	25	21.8	17.2	4.5	25.9	12.0	13.9
	50	23.4	17.7	5.7	32.8	14.6	18.2

[1]Average percent moisture for uncut and untreated plots (control) equal 78.6 percent for 3 and 6 hours.

[2]Percentages were not converted to angles before averaging.

[3]Treatment dates, August 13, 25 and 30. Average temperature 74°F. Average relative humidity 74 percent.

Table 4 is a comparison of chemical plus natural drying to natural drying alone. The results would seem to indicate that the increase in drying over the uncut is due to cutting, and not to increased activity of the chemical.

Table 4. Comparison of chemical plus natural drying to natural drying alone.[1]

Chem. No.	Rate	Percent Moisture Loss - Av. for 3 Treatment Dates[2]						
		3 hours			6 hours			Av. difference
		Cutting Alone	Chemical plus cutting	Difference	Cutting Alone	Chemical plus cutting	Difference	
501	25	15.4	21.2	5.9	24.6	28.9	4.3	5.1
	50	15.4	23.8	8.4	24.6	28.5	3.9	6.2
505	25	15.4	21.0	5.6	24.6	29.2	4.6	5.1
	50	15.4	27.6	12.3	24.6	29.7	5.1	8.7
506	25	15.4	21.8	6.4	24.6	25.9	1.3	3.8
	50	15.4	23.3	7.9	24.6	32.8	8.2	8.0

[1]Average percent moisture of untreated cut plots (control), for the three treatment days equal 62.8 percent for 3 hours and 54.8 percent for 6 hours.

[2]Treatment dates, temperature and humidity same as Table 3.

Experiment IV. Comparative Drying Rates of 2-Ethylhexanoic Acid (506) and Lauryl Ammonium 2-ethylhexanoto (228)

Purpose: Determination of the relative effects of two chemicals showing promise as desiccants.

Materials and Methods

The two chemicals showing the greatest consistency and effectiveness as desiccants (228 was the outstanding desiccant in screening trials conducted during the summer of 1953) were used in Experiment IV. The chemicals were applied at 50 pounds per acre in 50 gallons of water to 3 x 3 foot plots of alfalfa of rank growth, replicated four times in a randomized block design.

A small household, hand-type sprayer was used in applying the chemicals, and the trials were repeated on three days during the month of October. Three samples were taken from each replication at two 3-hour intervals. The percentage moisture loss, temperature and humidity was averaged for the three days of treatment and sampling for the two 3-hour intervals.

Results and Discussion

The difference in the percent moisture loss for the 3 days of treatment does not appear to be significant between these two chemicals. Low temperatures and high humidities, no doubt, affected the results of this experiment. Even so losses of 14 and 15 percent moisture were secured within 3-hours following the spray treatment.

Table 5. Comparative effects of Lauryl ammonium 2-ethylhexanoate (228) and 2-ethylhexanoic acid (506).

Chem. No.	Rate lb.	Percent Moisture Loss[1]- Av. for 3 Treatment Dates[2] 3 hours	6 hours	Average
228	50	15.1	12.8	14.0
506	50	14.0	14.7	14.4

[1]Percentages were not converted to angles before averaging.

[2]Treatment dates, October 1, 8, 12. Average temperature 67°F; average relative humidity 77 percent.

Discussion and Summary

Several hundred chemicals were screened over a 2-year period for their desiccating properties on forage for hay especially alfalfa. Of those initially tried 29 were selected for additional rating and of these, 5 were studied in detail. Data on temperature, relative humidity, stage of plant growth, and degree of plant succulence was recorded.

Of the chemicals studied, 2-ethylhexanoic acid and ammonium 2-ethylhexanoate gave the most consistent and favorable response as desiccants. The lauryl ammonium 2-ethylhexanoate was also promising but tests were started with this too late in the season to obtain a good rating index.

Rates of chemical application at 10, 25, 50 and 100 pounds per acre were tried. The 50 pound rate reduced the moisture in green standing alfalfa by 15 to 20 percent in 3 hours. This was approximately equal to the amount of moisture lost from cut alfalfa by natural drying. The 10 pound rate was relatively ineffective for all chemicals; the 25 pound rate was considered fair; and only a small advantage was found for 100 pounds over the 50 pound rate.

The greatest moisture loss due to chemical drying occurred during the first 3 hours after treatment. Moisture samples drawn 6 hours following chemical application showed only small increases in desiccation that could be attributed to the chemicals.

Forage treated with a desiccant and cut immediately dried faster than that treated and allowed to stand. Also chemical treatment plus cutting gave faster drying than cutting with natural curing only.

With all desiccants it was apparent that the leaves dried most rapidly and the stems much more slowly. Also the green color was lost, this being related to time following treatment. The loss of color began at the terminal end and progressed eventually to the bottom of the stems. The color dissipation appears to be one of the most serious drawbacks to the present studies on chemical drying of hay.

References

1. Kennedy, W. K., Hesse, W. H. and Johnson, C. M. The effect of herbicides on the drying rate of hay crops. Agron. Jour. 46: 199-203. 1954.

2. Phillips, W. M. The use of chemicals for desiccating alfalfa and weeds. Res. Rpt. of North Central Weed Control Conf. 10: 154. 1953.

3. Shafer, Neal E. Chemical drying of soybeans and weeds with airplane spraying. Res. Rpt. North Central Weed Control Conf. 9: 148. 1952.

4. Slife, F. W. Preharvest sprays for red clover. Res. Rpt. North Central Weed Control Conf. 9: 150. 1952.

TOLERANCE OF RED CLOVER AND ALFALFA TO FALL APPLICATIONS OF 2,4-D, MCP, 3,4-D AND 4-chloro[1]

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Weed control in hay legumes and in small grains underseeded to legumes must be considered an unsolved problem in the Northeast. DNOSBP, 2,4-D and MCP have received considerable attention by research workers and are used commercially to a limited extent. These chemicals will control many of the weeds commonly a problem in these crops but it is recognized that injury to the legumes or the grains may occur. Information presented at last year's conference suggested that 3,4-D and possibly 4-chlorophenoxyacetic acid held promise for selective control where alfalfa was the legume involved.

The present test was initiated to compare the effect of 2,4-D, MCP, 3,4-D and 4-chloro on alfalfa and red clover when applied after dormancy in the fall.

Materials and Methods

The four phenoxy compounds were applied at rates of $\frac{1}{4}$ and $\frac{1}{8}$ pound per acre November 28, 1953. The legume had "frosted-back" so that one afforded no protection from sprays for the other. Diethanolamine salts were used to eliminate formulation as a variable. Plots were 5 x 7 feet in size in a 9 x 9 Latin square. The mixture was seeded in April and approximately equal in red clover and alfalfa. However, disease and pea aphids damaged red clover in early 1954 resulting in a forage approximately 2/3 alfalfa and 1/3 red clover. Hand separations of harvests were made to measure accurately yields of the two legumes.

Results

Yields of dry matter for the first and second cuttings are shown in the accompanying table. There was a striking difference between the two legumes in their tolerance of the phenoxy compounds used. 2,4-D, 3,4-D and 4-chloro were particularly injurious to red clover with 4-chloro apparently being more injurious than the other two. It was observed that the 4-chloro affected red clover plants longer into the 1954 season than did

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any other chemical, which may explain the greater injury resulting with it. MCP resulted in pronounced increases in red clover yields due to the tolerance of the red clover for MCP and to reduced competition resulting from removal of alfalfa.

Table 1. Effect of four phenoxy compounds applied November 28, 1953, on dry matter yields of alfalfa and red clover, New Brunswick, N. J. 1954.

Treatment	Pounds of Dry Matter Per Acre			
	Alfalfa		Red Clover	
	First cutting	Second cutting	First cutting	Second cutting
Check	2210	1318	1090	138
1/4 pound				
2,4-D	825	786	619	317
MCP	1147	755	1640	509
3,4-D	2234	1180	647	212
4-Cl	1746	1100	315	230
1/2 pound				
2,4-D	416	840	114	288
MCP	608	687	2289	363
3,4-D	2116	1137	552	167
4-Cl	1539	1140	134	152
L.S.D. .05	592	251	463	174
.01	779	330	609	230

Even at ½ pound per acre 3,4-D did not reduce first cutting yields of alfalfa and observations of plants during the 1954 season showed no effect of the chemical on growth. Alfalfa also showed measurable tolerance for 4-chloro. The yield from plots treated with ¼ pound was not significantly less than the check and was only significantly less at the 5 per cent level for ½ pound. Less injury from 4-chloro than from 2,4-D and MCP cannot be attributed to less unit activity since 4-chloro was the most injurious of the chemicals used on red clover. MCP and 2,4-D were equally injurious to alfalfa.

Summary

1. Alfalfa growth was not affected and yields were not reduced by 1/4 and 1/2 pound of 3,4-D. This is consistent with results reported last year for spring applications.

2. Alfalfa showed measurable tolerance for 4-chloro but yields were significantly reduced by 1/2 pound.

3. Less injury of alfalfa by 3,4-D and 4-chloro than by 2,4-D and MCP cannot be attributed to less activity of the former since they both injured red clover with 4-chloro being the most injurious of all chemicals used.

4. Red clover was tolerant of 1/4 and 1/2 pound of MCP.

5. Both legumes were severely injured by even 1/4 pound of 2,4-D.

THE EFFECT OF SELECTED HERBICIDES APPLIED AT THE TIME OF BAND SEEDING ALFALFA 1/

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INTRODUCTION

Most of the alfalfa grown in Maryland is established in late August or early September. Experience in the State has shown that satisfactory stands are difficult to obtain when alfalfa is seeded in the spring with a small grain that is grown for grain production. Competition from annual weeds has always been a factor in the establishment of late summer and early fall seedings. The first or second time that alfalfa is established on a particular soil the weed competition is usually from summer annual weeds that are killed by the first heavy frost in the fall and satisfactory alfalfa stands are obtained. When alfalfa is grown on the particular piece of land for a longer period of time and with liberal lime and fertilizer application, there is a tendency for the development of more winter annual weeds that can seriously hinder alfalfa establishment.

Previous work at several experiment stations in the northeastern United States has shown that chickweed, Stellaria media (L) Cyrillo, can be successfully controlled by post emergence application of dinitro compounds, such as dinitro-ortho-secondary-butyl-phenyl, or isopropyl N-(3-chlorophenyl) carbamate (CIPC). Previous work at some stations has shown that this weed competition can be effectively reduced through the use of calcium cyanamide as a pre-planting treatment on the soil surface.

Previous research in Maryland has shown that in addition to chickweed, winter cress, Barbarea vulgaris R. Br., and field pepper grass, Lapidium campestre R. Br., often compete with the new alfalfa seedlings. Alkanolamine salt of 2-methyl, 4-chlorophenoxyacetic acid (MCP) has been found to be effective in reducing competition from these weeds but is often injurious to the alfalfa.

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In reviewing previous research it appears that pre-planting treatments are not entirely satisfactory for general farm use because of the problem of suitable moisture conditions to activate the calcium cyanamide and the delay that is needed for the activity of this material to decline to a point where it is safe to seed alfalfa. At times this may delay planting beyond the satisfactory date for alfalfa seeding.

The post emergence control of broadleaf weeds is not always satisfactory because of the need to control these weeds soon after the alfalfa starts growth and the care that must be exercised to avoid injury to the alfalfa. This research was begun to try a new approach to meeting these problems. Specifically, the band seeding method of establishment was used with the application of selected herbicides between the rows of alfalfa at the time of seeding to aid in the control of weeds.

OBJECTIVES

To determine the effect of calcium cyanamide, CIPC and MCP on weed control for alfalfa establishment with band seeding in the spring and late summer at several locations in Maryland, these chemicals being applied to the soil surface between the rows of alfalfa seed.

MATERIALS AND METHODS

The location, time of seeding, and soil type for each location were as follows:

Location No.	Name and Address	Date of Seeding	Soil Type
1	Plant Research Farm, College Pk.	3/21/53	Beltsville silt loam
2	Willis Farm, Trappe	4/ 1/53	Sassafras loam
3	Turner Farm, Pope's Creek	4/ 2/53	Sassafras sandy loam
4	Willis Farm, Trappe	8/25/53	Sassafras loam
5	Md. State College, Princess Anne	8/26/53	Greenwich sandy loam
6	Doughoregan Manor, Ellicott City	9/ 1/53	Glenelg loam

At each location a randomized block design with four replications was used. Individual plots were 8 by 30 feet.

Band seeding was accomplished by converting a standard disk grain drill through the use of garden hose so that the seed from the grass and legume seed box was delivered about 6 inches behind each disk. The drill was set to place fertilizer in the soil about 2 inches below the soil surface and the seed was dropped on top of the soil as it settled over the fertilizer. The soil was cultipacked prior to seeding to get a firm seedbed. In all but one case this seedbed was prepared by plowing and working the soil to provide a reasonably fine surface. For the seeding at Doughoregan Manor, on September 1, 1953, the soil was prepared by disking of small grain stubble.

In the spring seeding the calcium cyanamide was applied between the rows with a Gandy spreader which had been equipped with a guide to aid in applying the material between the rows of seed. The CIPC and MCP combination was applied with a hand pushed bicycle wheel sprayer with the boom lowered to 6 inches above the soil surface so as to direct the spray between the rows.

In the late summer seedings a boom was placed on the back of the drill to apply the CIPC and MCP. In these late summer seedings both grades of calcium cyanamide were applied by hand with the amount needed for each space between rows being separately weighed.

An attempt was made throughout the study to apply the herbicides in bands between the rows of alfalfa seed. These rows of alfalfa seed were 7 inches apart and it was attempted to have the sprayed or dusted band cover approximately 5 inches, leaving 1 inch free of herbicide on either side of the seed. The methods used in the spring seeding did not accurately place the herbicides, while the methods used in the late summer seeding appeared to place the herbicides as desired.

Lime was applied at all locations to bring the soil pH to 6.5 or higher, except for the Willis Farm. Soil tests at the Willis Farm showed that the soil was pH 5.8, which was lower than desirable for best alfalfa establishment.

In the spring seedings, 80 pounds of P_2O_5 and 80 pounds of K_2O were placed in the row below the seed. Nitrogen was used only in selected treatments as are indicated in Table 1 of the results. In the late summer seedings the same amounts of phosphorus and potash were used as for the spring seedings. Nitrogen was applied as indicated in Table 2 of the results.

The success of seedling establishment was measured by the average number of alfalfa plants per square foot. This average was determined by counting 6 locations at random in each plot. Each count was based on a 36-inch length of row, obtained by counting an 18-inch length in each of two adjacent rows. Williamsburg alfalfa was used throughout the trial. Sixteen and 8-pound rates per acre were used for selected treatments in the spring plantings and 16 pounds per acre for all treatments in the late summer plantings.

The data here summarized are a portion of the over-all study of seeding efficiency with alfalfa. The entire study includes comparisons in addition to the use of herbicides.

EXPERIMENTAL RESULTS

Spring Seeding: The use of granular calcium cyanamide or MCP plus CIPC as a spray between the rows of alfalfa seed reduced the average number of plants per square foot at both the 16 and 8 pound rates of seeding per acre, as shown in Table 1. Inspection of the plots at each location indicated that this damage to the alfalfa stand was due in large part to the fact that the treatments were not applied with accuracy between the rows. In all plots the stands tended to be spotty, indicating that the herbicides were applied in the rows as well as between the rows of seed.

Table 1. The effect of selected herbicides on seedling establishment of band seeded alfalfa at three locations in Maryland.1/

Fertilizer rate in the row. Lbs.P/A2/	Herbicide. Lbs. P/A3/	Plants Per Square Foot			
		Location 1	Location 2	Location 3	Ave.
N, P_2O_5, K_2O		7/28/53	7/8/53	5/22/53	
	16 Lbs. of Seed Per Acre				
0-80-80	None	10.7	16.4	37.6	21.6
0-80-80	400# granular calcium cyanamide	6.7	8.4	17.1	10.7
60-80-80	1/4# MCP = 1# CIPC	8.1	9.0	21.4	12.8
	8 Lbs. of Seed Per Acre				
0-80-80	None	10.4	10.3	17.4	12.7
0-80-80	400# granular calcium cyanamide	4.8	6.2	7.0	6.0
0-80-80	600# granular calcium cyanamide	4.1	5.8	9.7	6.5
30-80-80	None	7.4	11.5	23.1	14.0
30-80-80	1/4# MCP + 1# CIPC	4.9	7.5	8.6	7.0
	LSD .05	2.6	4.2	9.7	

1/ All seedings made in the spring of 1953.

2/ Not including nitrogen supplied by calcium cyanamide.

3/ Expressed in pounds per acre on a basis of actual area covered. Treatments designed to cover 5 inches between rows of seed which were 7 inches apart.

The fact that the plant counts averaged much higher at Location 3 does not appear to be of importance. Previous work has shown that the earlier the plant count is made following establishment of the seeding, the higher the counts are likely to be.

Inspection of the plots at the various locations showed that a period of 4 to 6 weeks elapsed following planting before weeds were noticeable. By this time the herbicides did not appear to have any deterrent effect on the germination or growth of the weeds.

Late Summer Seeding: Alfalfa was seeded for the first time on the land at Locations 4 and 5 but had been grown for many years on the land used at Location 6. The weeds that developed following seeding were:

Location 4 - Bitter dock, *Rumex obtusifolius* (L); shepherd's purse, *Capsella Bursa-pastoris* (L) Medic; dogfennel, *Anthemis arvensis* (L). These weeds appeared as a light stand throughout the test area and did not appear as competitive to alfalfa establishment.

Location 5 - English plantain, *Plantago lanceolata* (L). This weed occurred as a heavy stand at the time of the first alfalfa hay harvest but did not appear to be particularly competitive with the alfalfa.

Location 6 - Chickweed; mouse-ear chickweed, *Cerastium vulgatum* (L); winter cress; mouse-ear cress, *Arabidopsis Thaliana* (L) Heyn; field pepper grass. All of these weeds except the mouse-ear chickweed were in sufficient numbers to appear competitive with the establishment of the alfalfa.

At all locations the application of herbicides at the time of planting had a noticeable effect on the growth of weeds between the rows of alfalfa. This effect was not striking at Locations 4 and 5 because of the sparce growth of weeds in the fall following seeding. At Location 6 the abundant growth of weeds offered an excellent opportunity to judge the value of these herbicides for reducing weed growth in the early development of the alfalfa seedlings. From late September, when the first growth of alfalfa and weeds was noticed, until early December there was a marked reduction in all weeds treated with pulverized calcium cyanamide, CIPC, and the MCP-CIPC combination. The effect of granular cyanamide and the MCP appeared to be more irregular with the weeds controlled in some areas that had been treated and not in others.

At Location 6 where more weed species were found and the number of weeds was large, these treatments did not control the weeds in the rows of alfalfa. These weeds made some growth during the fall period and appeared to be quite competitive by late winter and early spring. The growth of chickweed was particularly vigorous in the plots that received the two grades of calcium cyanamide, apparently due to the additional nitrogen on the surface. By late January the effects of all treatments could no longer be observed.

The success in establishment of the alfalfa as determined by the number of alfalfa plants per square foot is shown in Table 2 for plant counts made following harvest of the first alfalfa hay crop.

Table 2. The effect of selected herbicides on seedling establishment of band seeded alfalfa at three locations in Maryland. 1/

Fertilizer rate in the row. Lbs.P/A 2/	Herbicide. Lbs.P/A 3/	Plants Per Square Foot			
		Location 4	Location 5	Location 6	Ave.
N, P_2O_5, K_2O		7/14/54	7/14/54	6/4/54	
0-80-80	None	12.2	10.8	6.9	10.0
0-80-80	400# granular calcium cyanamide	9.2	8.2	6.5	8.0
0-80-80	300# pulverized calcium cyanamide 4/	12.6	8.8	6.6	9.3
28-80-80	None	12.3	8.7	6.6	9.2
28-80-80	1# CIPC	8.3	---	5.9	7.1
28-80-80	1/4# MCP	10.2	7.7	5.7	7.9
28-80-80	1/4# MCP = 1# CIPC	8.6	---	6.2	7.4
	LSD .05	3.0	2.9	N.S.	

1/ All seedings made in the late summer of 1953 at the rate of 16 pounds per acre.

2/ Not including nitrogen supplied by calcium cyanamide.

3/ Expressed in pounds per acre on a basis of actual area covered. Treatments designed to cover 5 inches between rows of seed which were 7 inches apart.

4/ The material referred to as pulverized calcium cyanamide was supplied by the American Cyanamid Company as a special grade of cyanamid composed of very finely divided material.

In no case was the stand from alfalfa which received the weed control treatments significantly superior to untreated alfalfa. Among the herbicides tried and the rates used, the pulverized calcium cyanamide appeared most promising. In general the use of herbicides reduced the stand of alfalfa.

The stand counts were higher at Locations 4 and 5 where there was less weed competition than at Location 6 where weed competition was greater.

DISCUSSION

The research here reported was set up to determine whether herbicides applied at the time of planting could satisfactorily control weeds in band seeded alfalfa. It would appear that this method and time of application may have greatest promise where weed competition is heavy. It would also appear that for this method and time of application to have value it would have to be accompanied by a post emergence application of herbicides to control weeds during the winter and spring period where seedings are made in late summer.

One problem that was encountered in using a converted drill for band seeding of alfalfa was the fact that the seed bed is left in ridges with the seed being dropped below the average level of the soil in the seed bed and with the herbicide being applied on the ridges. Rains that came following seeding tended to level the seed bed. This may have spread the herbicide over the rows of seed. The use of some seeders developed for band seeding tends to leave the seed bed more level and may make a treatment with herbicides between the rows less destructive to the seedings. Research along these lines is now under way at the Maryland Agricultural Experiment Station.

The pulverized grade of calcium cyanamide appeared promising in these tests but may not be economically practical unless there is response of the alfalfa to the added nitrogen. Observations in this trial did not indicate that the additional nitrogen benefited the alfalfa.

SUMMARY

Seedings were made at 6 locations in Maryland in 1953 to study the possibility of band seeding alfalfa with a converted grain disk drill, and using herbicides to control weeds between the rows of alfalfa. Seedings were made at 3 locations in the spring and 3 locations in late summer. Herbicides used were granular calcium cyanamide, pulverized calcium cyanamide, MCP, CIPC, and a combination of MCP and CIPC. These herbicides were applied at the time of seeding between the rows of alfalfa. The principal findings in this study were:

1. These herbicides were not effective in controlling weeds in the spring planting, largely because the weeds developed from 4 to 6 weeks after the time of planting.

2. In the late summer seeded alfalfa, the pulverized calcium cyanamide, CIPC, and the combination of CIPC and MCP reduced weed competition for a period of about 2 months. This reduction in weed competition did not result in increased alfalfa plant stands by the time of the first harvest of alfalfa the next spring.

DOWNY CHESS CONTROL IN ALFALFA[1]

Jonas Vengris[2]

In the eastern part of Massachusetts, particularly in Bristol and Plymouth Counties, down chess (Bromus tectorum) and occasionally soft chess (Bromus mollis) have become rather prevalent and serious, noxious weeds on dairy farms. Downy chess appears to be an annual or winter annual grass. Both grasses prefer dry sandy or gravelly soil, both spread by seed, and both mature rather early in the season. If these weeds are growing in an alfalfa field, their seeds mature before alfalfa is harvested, fall on the ground, thus spreading rapidly.

The feeding value of the harvested hay is also often adversely affected. By the time alfalfa is usually harvested, the weeds have already become mature, woody, and unpalatable.

MANAGEMENT

There is some possibility that an effective control of these weeds could be achieved, if management practices could be adjusted. An earlier harvest of alfalfa would have two important effects: (1) Reseeding of the weeds would be prevented and thus stop their spreading. (2) The hay would be more valuable if the mixture were cut at a time when the weeds were still in a somewhat younger stage of growth. However, the possibilities in this direction are not too promising. Changes in farm management practices are usually made slowly. Early cutting may result in serious injury to the alfalfa stand. Therefore, chemical control may be the most practical means of controlling downy chess and soft chess in Massachusetts.

CHEMICAL CONTROL OF DOWNY CHESS

Preliminary studies on control of downy chess by herbicides were started in the Fall of 1953 in Plymouth County. In these trials we included 5 lb/A and 10 lb/A acid equivalent of CIPC and Endothal (S-3003). Herbicides were applied on 10/26/53. In the Fall of 1953 and the Spring of 1954, observations on both chemicals indicated a decrease of downy chess in alfalfa stands. Tests also indicated that Endothal was the more effective; however, injury to alfalfa by Endothal was quite apparent. It is interesting to note that the effectiveness of these materials appeared to decrease with time.

Procedure

On March 23, 1954, downy chess control experiments were conducted in Bristol

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County on the Thwaites farm. These tests included treatments with CIPC, Endothal, and Dalapon. A randomized block with three replicates design was used. Chemicals were applied with 40 gallons of water per acre. The plot size was 300 square feet. At the time of herbicide application (3/23/54), alfalfa and downy chess were dormant. The downy chess stand was made of seedlings that came up in the Fall of 1953.

Results and Discussion

Both rates of Dalapon almost totally eliminated downy chess. Good control was also obtained by CIPC treatments. No response was apparent from spring applications of Endothal. Dalapon 6 lb/A injured alfalfa; plants were slightly suppressed and shorter. All other treatments of alfalfa did not differ noticeably from checks.

Shortly before maturity of downy chess on 6/9/54, plots were harvested, and yields and botanical plant composition were determined. Data are presented in Table I.

Table I. Effect of herbicides in controlling downy chess in Alfalfa.

Treatments	Botanical Composition Percent of Weight				Yields lb/A
	Alfalfa	Downy Chess	Other Weeds	Total	Alfalfa Only
1. Check	49.2	49.2	1.6	5,364	2,639
2. Dalapon 3 lb/A acid eq.	97.0	1.1	1.9	3,828	3,712
3. Dalapon 6 lb/A acid eq.	97.0	0-	3.0	2,990	2,990
4. CIPC 4 lb/A acid eq.	68.0	20.6	11.4	4,947	3,364
5. CIPC 8 lb/A acid eq.	74.6	21.5	3.9	4,413	3,292
6. Endothal 3 lb/A acid eq.	47.3	48.3	4.4	4,905	2,320
7. Endothal 6 lb/A acid eq.	55.1	44.9	0	4,789	2,639
L.S.D. at 5% level					652
L.S.D. at 1% level					1,044

The data speak for themselves. Both rates of Dalapon eliminated downy chess. Also, CIPC rates significantly decreased the amount of this weedy grass. It is interesting to note that the two CIPC rates did not differ. Other weeds besides downy chess on the experimental plots were (refer Table I): quackgrass (Agropyron repens). shepherd's-purse (Capsella Bursa-pastoris), and yarrow (Achillea Millefolium).

Endothal as these tests indicate was not effective.

The highest total air-dry yields were obtained from the check and plots treated with CIPC and Endothal; the lowest total yields, from Dalapon plots. Quite a different picture appears when we compare pure alfalfa hay yields obtained from the different treatments: the highest pure alfalfa yields were from Dalapon 3 lb/A plots. In comparison with the controls, the difference is highly significant. The second and third most effective treatments were the CIPC plots. But in the CIPC treatments, as the data indicate, more than 20% of the yield is from downy chess. Because of the presence of downy chess, hay palatability is decreased, and the quality of the hay cannot be compared to the pure alfalfa from the Dalapon treatments.

SUMMARY AND CONCLUSIONS

1. Downy Chess (Bromus tectorum) and occasionally soft chess (Bromus mollis) are spreading rapidly in the eastern part of Massachusetts on dairy farms. These weedy grasses have become particularly prevalent in alfalfa stands.

2. Data from limited tests indicate that Dalapon at rates of 3 lb/A acid eq., applied early in the spring (March), are very effective in eliminating downy chess on established alfalfa sods. CIPC 4 lb/A and 8 lb/A rates decreased the amount of this weed in alfalfa hay significantly but did not eliminate it. Endothal was not effective.

3. At present, as long as Dalapon is not cleared by the Food and Drug Administration, CIPC might be used. Also other herbicides should be investigated (e.g. TCA, Karmex W.). Where possible, the early mowing of alfalfa before weedy grass seeds are mature may be of practical value.

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CHEMICAL WEED CONTROL IN NEW GRASS-LEGUME SEEDINGS[1]

Jonas Vengris and Wm. G. Colby[2]

Weed control is perhaps one of the most important factors in the establishment of new grass-legume seedings in Massachusetts. In fall seedings, especially in the eastern part of the state, the control of chickweed is often of first importance. On the other hand, annual weedy grasses are more common with the spring seedings.

The main objective of these experiments was to investigate the value of herbicides in the establishment of grass-legume seedings. In the scope of this paper we present data of two field plot experiments conducted in 1954 at the Massachusetts Agricultural Experiment Station, Amherst, Mass.

EXPERIMENT I

The experiment was conducted on T.C. Kentfield's farm, South Amherst. The soil was a fine sandy loam with fair drainage and heavily infested with many kinds of weeds. The original objective was to study the control of chickweed. However, it developed that the most prevalent and detrimental weeds on the area were mustard (<u>Brassica Kaber</u> L.S.), lamb's-quarters, smartweed (<u>Polygonum pensylvanicum</u> and <u>Polygonum Hydropiper</u>), ragweed, pigweed (<u>Amaranthus retroflexus</u>) and plantain (<u>Plantago major</u>). The objective was therefore changed to include the control of all weeds in grass-legume seedings without a nurse crop.

Procedure

A randomized block design with three replicates was used. Plots were 120 square feet in size. A mixture of alfalfa, ladino, and timothy was seeded on May 7, 1954. Two herbicides were used: (a) alkanolamine salts of Dinitro-o-sec-Butyl-phenol (Dow Premerge) and (b) triethanolamine salt of 3,4-D (APL-569). Dinitro (DN) was applied with 55 gallons of water and 3,4-D with 20 gallons of water per acre. The herbicides were applied at two different times. For comparison, two clipping treatments were included in the experiment. The clippings were made at 5 to 6 cm. from the ground.

Description of treatments and stage of growth of plants when herbicides were applied are given in Table I.

On June 8, 1954, when the first application of the herbicides was made, the weeds were more advanced than the cultural plants and provided only a fair canopy. On June 17, weeds had made a lush growth and provided a rather good canopy.

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Table I. Treatments, date of application of herbicides, and plant stage of growth.

Treatments	Date of application	Plant	Stage of plant growth 6/8/54 Number of true leaves	6/17/54 Number of true leaves
1. Check		Alfalfa	3-4	5-7
2. DN 0.75* lb/A ,I	6/8/54	Ladino clover	2-3	3-4
3. DN 1.50 lb/A, I	6/8/54	Timothy	1-2	2-3
4. 3,4-D 1/6 lb/A, I	6/8/54	Lamb's-quarters	3-5	9-11
5. 3,4-D 1/4 lb/A, I	6/8/54	Mustard	heading	bloom
6. DN 0.75 lb/A, II	6/17/54	Ragweed	3-7	8-12
7. DN 1.50 lb/A, II	6/17/54	Smartweed	3-7	8-10
8. 3,4-D 1/4 lb/A, II	6/17/54	Plantain	rosette	rosette
9. 3,4-D 1/2 lb/A, II	6/17/54			
10. Clipping I	6/8/54 6/17/54 7/6/54			
11. Clipping II	6/17/54 7/6/54			

* Acid equivalent

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RESULTS AND DISCUSSIONS

Ten days after application of the chemicals, a critical examination of the effects of the herbicides was made. A summary of the results is presented below.

DN 0.75, I	Slight injury at first to legumes and timothy (about 10 per cent)*; later, normal appearance regained. Smaller lamb's-quarters and smartweeds killed. Larger weeds burned and heavily suppressed. Mustard almost totally eliminated. Bare surface area 5 to 10 per cent.
DN 1.50, I	The response more pronounced than with DN at 0.75 lb/A. Cultural plant injury 35 per cent. Bare area about 20 per cent of the plot surface.
3,4-D 1/6, I	Very slight injury to legumes. In general, weeds were more suppressed and stunted than cultural plants. Growing conditions for legumes and grasses seemingly improved.
3,4-D 1/4, I	The response a little more pronounced than on the 1/6 lb/A treatment.

*) Rating = No injury - 0 and total elimination - 100.

DN 0.75, II and DN 1.50, II	Injury to legumes especially with the higher rate of DN evident, but plants later recovered. Weeds even with the lower rate were injured and suppressed. At this stage of growth 1.50 lb/A might be preferable.
3,4-D 1/4, II	Legumes affected only slightly. All weeds injured. Smartweed not dead but leaves were stunted and stiff. Lower leaves yellow-reddish. Lamb's-quarters affected in the same way: leaves stiff, turned down and dying, but plants not dead. Plants by both rates affected in the same way, differences only in degree.

On July 19, 1954, all plots were clipped. At that time the plots treated with DN and 3,4-D plots, in comparison with the controls, were the best.

The actual effects of the herbicides and the clipping treatments were measured by comparing the yields of these plots. On September 8, 1954, the plots were harvested. Also, samples for botanical analyses and the determination of dry matter were taken. The data obtained are presented in Table II.

Table II. Total yields, weed percentage, and cultural plant yields.

Treatment	Total yields lb./plot	Weed %	Cultural plant yields lb./plot
1. Check	6.6	49.6	3.1
2. DN 0.75, I	8.8	38.5	5.4
3. DN 1.50, I	8.8	22.8	6.8
4. 3,4-D 1/6, I	8.7	33.0	5.9
5. 3,4-D 1/4, I	8.2	34.2	5.3
6. DN 0.75, II	9.4	45.7	5.1
7. DN 1.50, II	9.6	31.3	6.6
8. 3,4-D 1/4, II	7.9	36.2	5.0
9. 3,4-D 1/2, II	8.7	39.5	5.2
10. Clipping, I	10.8	68.2	3.4
11. Clipping, II	10.4	71.2	3.0
L.S.D. at 1% level	2.4	16.7	1.7
L.S.D. at 5% level	1.7	12.3	1.3

The highest total yields were obtained by clipping treatments. The controls furnished the lowest total yields. The effect of the chemical treatments is apparent when the proportion of weeds in harvested forage from the different plots is taken into consideration. The clipping treatments did not prevent a rather high percentage of weeds in the yield as compared with the plots treated chemically. Rather rainy, cool weather during the growing season might have favored the regrowth of weeds after clipping. Under dry weather conditions the results might have been different. All chemical treatments decreased the percentage of weeds in the yield and increased the yield of the cultural grasses and legumes. The lowest weed percentage and the highest yield of the cultural plants were obtained with both DN 1.5 lb/A treatments. The data indicate that the rate of 0.75 lb/A of DN is too low to be effective. On the other hand, there is evidence that some injury of the cultural plants occurs when higher rates are used. This occurred at the outset only. The plants recovered rapidly, and in the end this treatment was best in yield and quality of forage.

The check plots could be considered as a total failure. At harvest time the stand was very poor, 20 to 25 per cent of the plot surface being totally barren, and alfalfa had been almost eliminated in the plant stand.

No significant differences in the extent of injury to alfalfa and ladino clover were observed by using DN and 3,4-D. Also no significant differences were found between the two dates of application.

During the late summer, the whole experimental area was invaded by annual weedy grasses (barnyard grass, old witch grass, crab-grass). In general, the plots treated with DN became more extensively infested with these grasses than the plots treated with 3,4-D. This is easily explained by the fact that DN, as a fast and effective agent in suppressing the spring growth of dicot weeds, reduces the ground cover and thereby provides a more favorable opportunity for the development of summer weedy grasses. Heavier rates of 3,4-D acted in a similar way, which explains the relatively high percentage of weeds in the resulting yields.

SUMMARY

Under the conditions of our tests it appears that even on very weedy fields properly selected herbicides are able to provide real assistance in the establishing of new grass-legume seedings even without a companion crop. Dinitro and 3,4-D proved to be promising chemicals for this purpose. Yield data and critical observations indicated that dinitro is probably the most practical herbicide to use. Optimum rates are 1.0 and 1.5 lb/A. If the canopy is poor, the rates should be decreased. Time of application appears to be when alfalfa has 3 to 5 true leaves and ladino 2 to 4 true leaves.

In our experiments clipping treatments were of no value.

EXPERIMENT II

The objective of this experiment was to compare 2,4-D, 3,4-D, and dinitro in the control of weeds in new grass-legume seedings made with a companion crop of oats. We were especially interested in 3,4-D. It is known that alfalfa is more susceptible to 2,4-D or MCP than ladino clover, for example. Recent data (1) suggest that it is safer to use 3,4-D than 2,4-D on alfalfa seedings. We were especially interested in investigating the potentialities of 3,4-D in the control of weeds in new alfalfa-clover-grass mixtures.

Procedure

The experiment was conducted in 1954 on the Experiment Station Farm at Amherst, Massachusetts. The soil was a fine sandy loam with fair drainage. Randomized blocks with three replicates were used. Plots were 120 square feet in size. As in Experiment I, an alfalfa, ladino, and timothy mixture was seeded on May 6, 1954, with 40 lb/A of oats as a nurse crop. Because of rather poor viability the oat stand was thin. Herbicides used were: (a) amine 2,4-D, (b) triethanolamine 3,4-D, and (c) alkanolamine salt of dinitro (Dow Premerge). The following treatments were applied: DN 0.75, 1.00, 1.50 lb/ A; 2,4-D and 3,4-D 1/8, 1/4, and 1/2 lb/A. Phenoxy compounds were applied with 20 gallons of water, and DN with 55 gallons of water per acre. The chemicals were sprayed on June 11, 1954, when alfalfa had 3 to 4 true leaves and ladino 2 to 3 true leaves. Oats at that time were about 10 inches tall. Main weeds were: chickweed, smartweed (*Polygonum pensylvanicum*), ragweed, and lamb's-quarters. Weeds had 3 to 7 true leaves.

RESULTS AND DISCUSSION

Seven days after application of the herbicides the response of weeds and cultural plants to the different treatments was estimated. The data for dinitro treatments are presented in Table III.

Table III. Response of oats, legumes and chickweed to dinitro treatments. Relative values. Checks = 100.

Treatments	Oat Stand	Legume Stand	Chick-weed Stand	Remarks
1. Check	100	100	100	Beside chickweed, other weeds were injured proportionally to the rates applied. Smaller weeds killed. It appeared that the most practical treatment was DN 1.00 lb/A.
2. DN 0.75	90	90	5	
3. DN 1.00	90	90	5	
4. DN 1.50	70	80	0	

In general, the use of 2,4-D and 3,4-D resulted in a somewhat stunting effect on both the weeds and the legumes. The injury appeared to be proportional to the rate applied. Alfalfa responded differently to the two phenoxy compounds. More injury resulted from 2,4-D than from 3,4-D. However, neither 2,4-D nor 3,4-D injured the oats. No significant control of chickweed could be obtained by these two systemic phenoxy compounds.

On July 8, 1954, all plots were clipped. In order to evaluate the responses of weeds and cultural plants to the different treatments, samples were taken for botanical analyses. Data are presented in Table IV.

In the control of chickweed, only dinitro treatments were effective. All applied treatments decreased the percentage of dicot weeds in the yield. However, 2,4-D was more efficient. No differences in the response of ladino clover to these two chemicals were apparent.

Table IV. Response of oats, alfalfa, chickweed, and other dicot weeds to herbicide treatments.

	Percent of Air-dry Weight			
Treatments	Alfalfa	Chickweed	Other dicot weeds	Oat Stand *
1. Check	14.6	14.9	21.1	100
2. DN 0.75 lb/A	23.2	1.3	9.4	90
3. DN 1.00 lb/A	25.5	0.8	11.7	85
4. DN 1.50 lb/A	25.8	0.1	9.6	75
5. 3,4-D 1/8 lb/A	18.7	15.0	18.7	100
6. 3,4-D 1/4 lb/A	16.5	17.0	13.8	92
7. 3,4-D 1/2 lb/A	12.4	9.7	8.6	100
8. 2,4-D 1/8 lb/A	12.0	14.4	13.1	100
9. 2,4-D 1/4 lb/A	7.7	14.4	12.1	95
10. 2,4-D 1/2 lb/A	5.1	8.3	5.0	100
L.S.D. at 1% level	8.6			
L.S.D. at 5% level	6.3			

*Data obtained by estimation at harvest time on July 8, 1954.

The experimental plots were observed during the whole growing season. The performance of annual weedy grasses showed the same pattern as in Experiment I. Their appearance was also directly proportional to the control of dicot weeds early in the season.

SUMMARY

Weed control. Chickweed was effectively and significantly controlled only by dinitro treatments. Other dicot weeds were effectively controlled by all herbicides used, especially at higher rates. Our data show that 2,4-D was more effective in controlling dicot weeds than 3,4-D. With increased control of dicot weeds early in the season the annual weedy grasses gained in the late summer.

Cultural plant injury. Most interesting to note is that alfalfa was less susceptible to 3,4-D than to 2,4-D. On the other hand we could not notice any significant difference in the susceptibility of ladino clover to 2,4-D and 3,4-D.

At higher rates of DN, oats were injured. Later in the season the symptoms of injury inclined to disappear and only the higher rates of DN might have affected the oat yields.

FINAL CONCLUSIONS

1. In heavy infestations of chickweed, dinitro at a rate as low as 0.75 lb/A or even 0.50 lb/A can provide a good control. If the canopy over the cultural plants is thin, the rates should not exceed 1.0 lb/A.

2. Our experiments with and without a nurse crop indicate that under conditions of heavy infestation with common dicot weeds, DN and 3,4-D can be of material assistance in establishing new grass-legume seedings. In our trials, dinitro gave better results than the phenoxy compounds investigated.

3. Where weeds susceptible to phenoxy compounds are prevalent (e.g. mustard) and where alfalfa is in the mixture, better results by the use of 3,4-D can be expected than by the use of 2,4-D.

4. In new grass-legume mixtures where the weed smothering effect is not too serious, the value of herbicide applications is questionable.

5. Clippings under the conditions of our tests were not effective as a measure of weed control.

LITERATURE CITED

1. Tafuro, A. S. et al. The Effect of Six Herbicides on Alfalfa and Clovers Underseeded to Spring Oats. Proceedings of the Eighth Annual Meeting of NEWCC, New York, pp. 307-311, (1954).

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SECOND YEAR EFFECTS OF VARIOUS HERBICIDES ON THE YIELD AND BOTANICAL COMPOSITION OF LEGUMES.

Marvin M. Schreiber and Stanford N. Fertig[1]/

Introduction

This is a report of the second year effects of herbicides on the yield and botanical composition of legume hay. The first year results of this experiment were reported at the last meeting of the Northeastern Weed Control Conference (2).

This phase was originally initiated as a part of a larger study on the control of yellow rocket (Barbarea vulgaris) in forage legumes. Experimental plots were set out in several counties in New York representing various seeding mixtures and soil types used in the State. The results for the first and second year were based on the data obtained from two specific areas, Tioga and Madison Counties.

To rapidly summarize the results of the first year effects of treatment, the following points could be made in reference to yield and botanical composition:

(a) Marked changes in the botanical composition of grass-legume hay were obtained by the fall application of 2,4-D and MCP.

(b) Alfalfa was equally sensitive to MCP and 2,4-D at the same concentration by fall application and its percentage composition decreased with increased concentration of both materials.

(c) Chloro IPC and the dinitro treatments brought about no significant changes in botanical composition or yield of grass-legume hay.

These conclusions appeared to be warranted from the data of the first year. However, to determine to what extent these results were permanent, it was necessary to take second year data on yield and botanical composition.

Results and Discussions

Yield

The yield data for 1953 and 1954 for the first cutting in Tioga and Madison Counties are given in tables 1 and 2, respectively. The analysis of variance for 1954 is given at the bottom of each table. In Tioga County highly significant differences were obtained between treatments, chemicals, and levels. Similar significance was shown in 1953. However, Madison County showed no significant differences in 1954 -- a complete reverse of the 1953 results.

Table 1 shows that in 1953 the significance due to treatment was contributed by 2,4-D at a 1/2 pound per acre. However, the 1954 results show that the significance is due to Chloro-IPC. The discussion of these results will be taken up under the section on Botanical Composition Studies.

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Table 1. Effect of Herbicides on the Yield of Hay (Lbs. Dry Matter per Acre), Tioga County, First Cuttings

Treatment	Mean 1953	Mean 1954	Mean by Chemicals 1953	Mean by Chemicals 1954
1. 2,4-D,1/8#/A., G.L.F.	4065	4586		
2. " ,1/4#/A., "	3115	4643		
3. " ,1/2#/A., "	1772	4024	8952	13253
4. MCP 60%, 1/8#/A., ACP	3777	4504		
5. " " , 1/4#/A., "	4175	5109		
6. " " , 1/2#/A., "	4048	4060	12000	13673
7. MCP 60%, 1/8#/A., Chip.	4123	4472		
8. " " , 1/4#/A., "	3625	5052		
9. " " , 1/2#/A., "	3665	4542	11413	14066
10. MCP 90%, 1/8#/A., Dow	3967	4409		
11. " " , 1/4#/A., "	4625	4726		
12. " " , 1/2#/A., "	3652	4201	12244	13336
13. Sinox PE., 1 qt./A.	4077	4475		
14. " " , 2 qts./A.	3925	4773		
15. " " , 3 qts./A.	4162	4302	12164	13550
16. Dow Selective, 5 pts./A.	4270	4640		
17. " " , 7 " /A.	3738	4880		
18. " " , 9 " /A.	3468	4258	11476	13778
19. CIPC 2#/A., U.S.I.	4172	3447		
20. " 4#/A., "	3930	3477		
21. " 6#/A., "	3880	3036	11982	9960
22. Check	4463	4359		

Mean by Levels

Level	1953	1954
All Chemicals		
1.	28451	30533
2.	27133	36357
3.	24647	28423
Translocated (4)		
1.	15932	17971
2.	15540	19530
3.	13137	16827
Contact (3)		
1.	12519	12562
2.	11593	13130
3.	11510	11590

Analysis of Variance (1954 data)

Source	DF	SS	MS	F
Treatments	21	22,051,898	1,050,090	2.69**
Chemicals	6	15,796,780	2,632,797	6.75**
Levels	2	5,121,649	2,560,325	6.56**
Chem. x levels	12	1,123,434		
Check vs. rest	1	10,035		
Error	63	24,578,912		

** 1% HS

Table 2. Effect of Herbicides on the Yield of Hay (Lbs. Dry Matter per Acre)
Madison County, First Cutting

Treatment	Mean 1953	Mean 1954	Mean by Chemicals 1953	Mean by Chemicals 1954
1. 2,4-D, 1/8#/A., G.L.F.	4103	4614		
2. " , 1/4#/A., "	4162	4904		
3. " , 1/2#/A., "	3237	4193	11504	13711
4. MCP 60%, 1/8#/A. ACP	4355	4603		
5. " " , 1/4#/A. "	3803	4775		
6. " " , 1/2#/A. "	3545	4452	11703	13830
7. MCP 60%, 1/8#/A. Chip.	4227	4531		
8. " " , 1/4#/A. "	3803	3987		
9. " " , 1/2#/A. "	3540	4269	11570	12787
10. MCP 90%, 1/8#/A. Dow	4173	4590		
11. " " , 1/4#/A. "	4075	4358		
12. " " , 1/2#/A. "	3680	4233	11928	13181
13. Sinox PE, 1 qt./A.	4803	4178		
14. " ", 2 qts./A.	4342	5027		
15. " ", 3 qts./A.	4667	4433	13812	13638
16. Dow Selective 5 pts./A.	4553	4682		
17. " " 7 " /A.	4830	4999		
18. " " 9 " /A.	4482	4347	13865	14028
19. CIPC, 2#/A. U.S.I.	4445	4404		
20. " , 4#/A. "	3960	4357		
21. " , 6#/A. "	5127	4849	13532	13610
22. Check	4333	4602		

Mean by Levels

All Chemicals

	1953	1954
1.	29793	31602
2.	28975	32407
3.	29146	30776

Translocated (4)

	1953	1954
1.	16858	18338
2.	15843	18024
3.	14002	17147

Contact (3)

	1953	1954
1.	13801	13264
2.	13132	14383
3.	14276	13629

Analysis of Variance (1954 data)

No significant differences.

The differences exhibited in the first hay year, 1953, have been in every case, except for CIPC in Tioga County, eliminated by the second hay year. No loss of total dry matter has occurred in the second year after spraying. This, however, does not mean that all the treated plots have produced the same quality of hay.

Botanical Composition

The botanical composition studies made in Tioga and Madison Counties for 1954 are represented in Figure 1 through Figure 4. The 1953 data, second cutting, for Madison County is included for comparison (Figures 5 and 6). Marked similarity can be seen by comparing the composition data for 1954 with that of the second cutting, 1953, particularly in reference to the relative percentage of alfalfa. In most instances the trends are the same. With the translocated herbicides, the percentage of alfalfa decreases with an increase in concentration. A large percentage of clover has been lost and in essence, grass has taken its place.

By close examination of the CIPC treatments in Tioga County (Figure 2) one notes a marked reduction in the grass content. This fact is responsible for the differences obtained in the yield determination. This reduction is quite unexpected in view of the lack of response to the treatments in 1953. There was no evidence in any of the areas sampled in 1953 to indicate that timothy had been injured by CIPC application. However, observations made in Albany County indicated that in the spring of 1953 some reduction of grass had occurred. If this area had been sampled, the reduction would have first showed up in 1953.

All previous information concerning the residual of CIPC should eliminate the view of possible carry over in the soil. It has been shown that 50 pounds of CIPC had a residual period of a little over eight weeks (1). The highest rate in this experiment was 6.0 pounds. Some damage must have occurred to the timothy plants immediately after treatment, yet did not manifest itself until the second hay year.

According to the early work of Waters (3), cormlets of the timothy plant may develop early in the growth of the plant. These cormlets are responsible for the following year's growth. It is suggested, therefore, that the conditions for cormlet development as well as for herbicide effectiveness were optimum soon after treatment in the fall or early spring. Hence, the growth for the 1953 hay crop was normal but the potential for subsequent growth was lacking.

Figure 1. The Effect of Herbicides on the Botanical Composition of Hay 1st cutting, 1954, Tioga Co. Translocated Herbicides

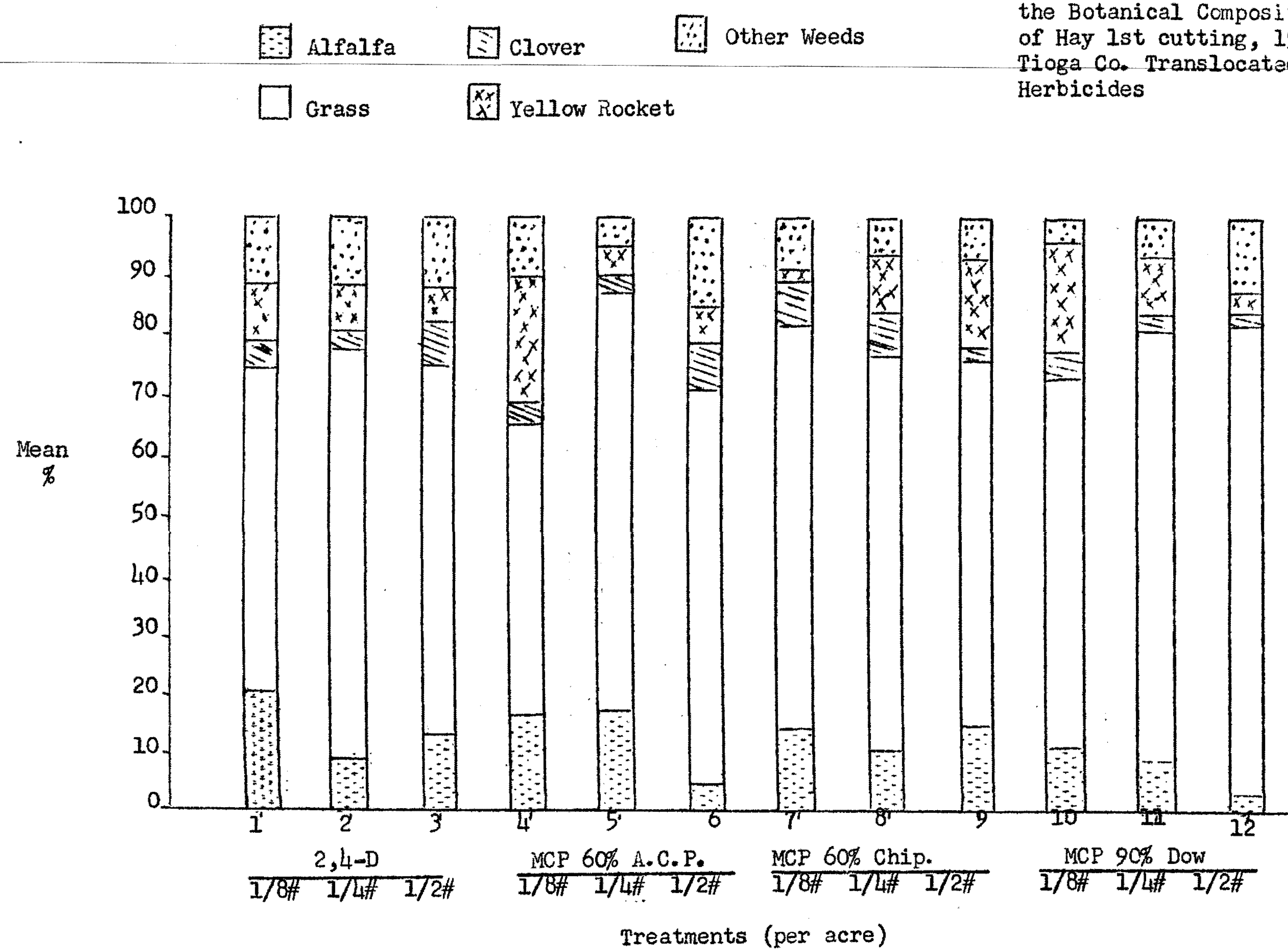


Figure 2. The Effect of Herbicides on the Botanical Composition of Hay 1st cutting, 1954, Tioga Co. Contact Herbicides

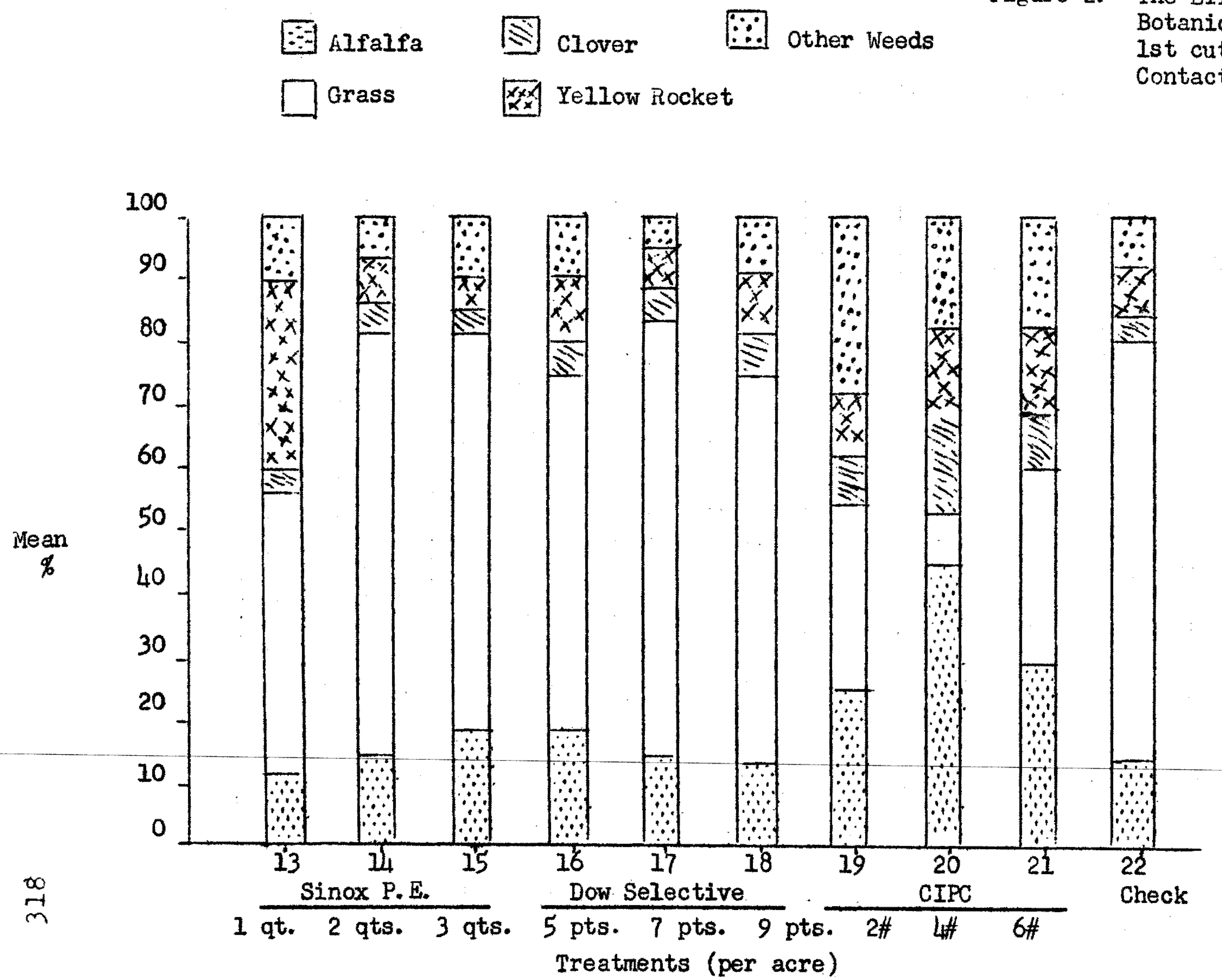


Figure 3. The Effect of Herbicides on the Botanical Composition of Hay 1st cutting, 1954. Madison Co. Translocated Herbicides

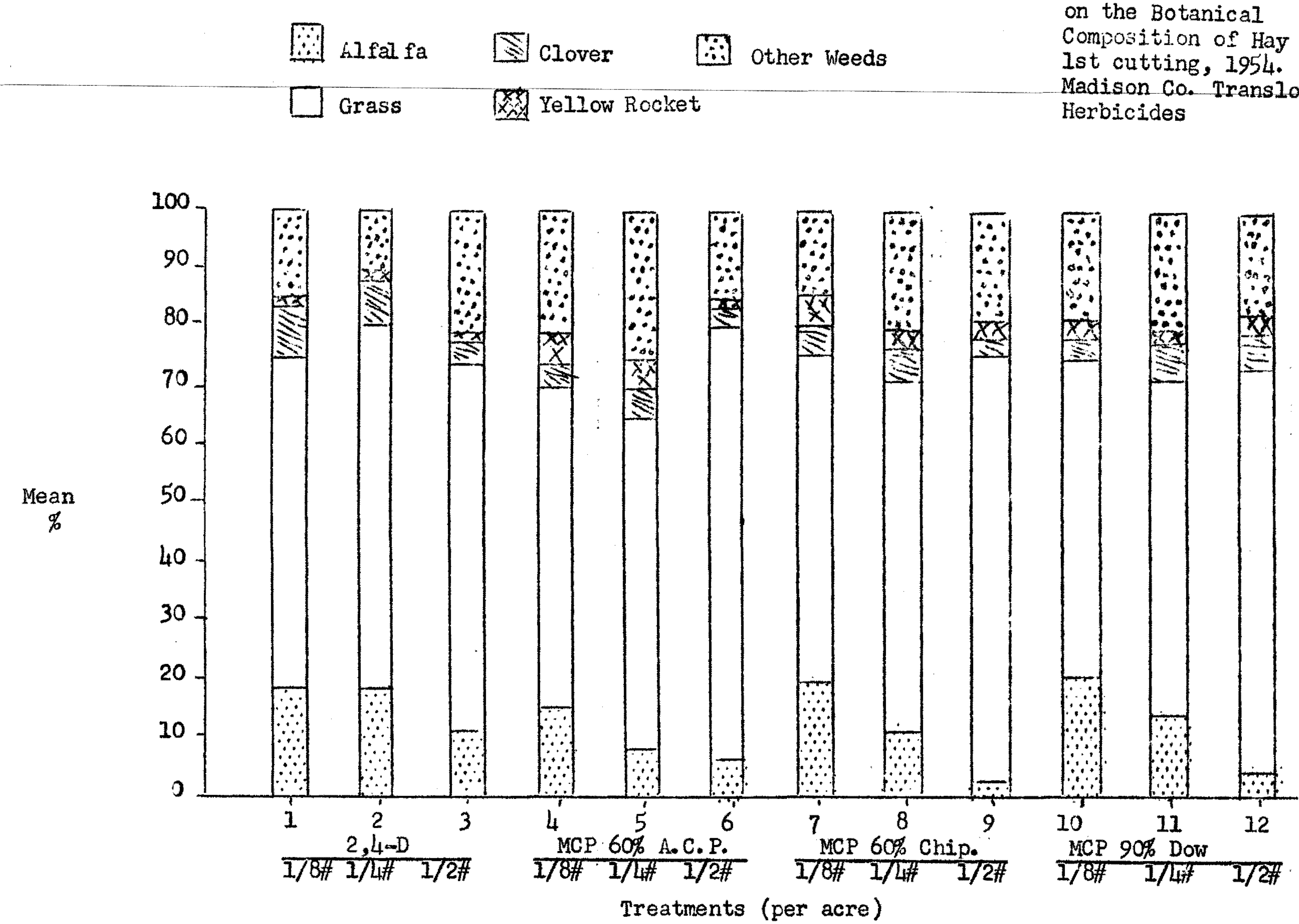


Figure 4. The Effect of Herbicides on the Botanical Composition of Hay 1st cutting, 1954. Madison Co. Contact Herbicides

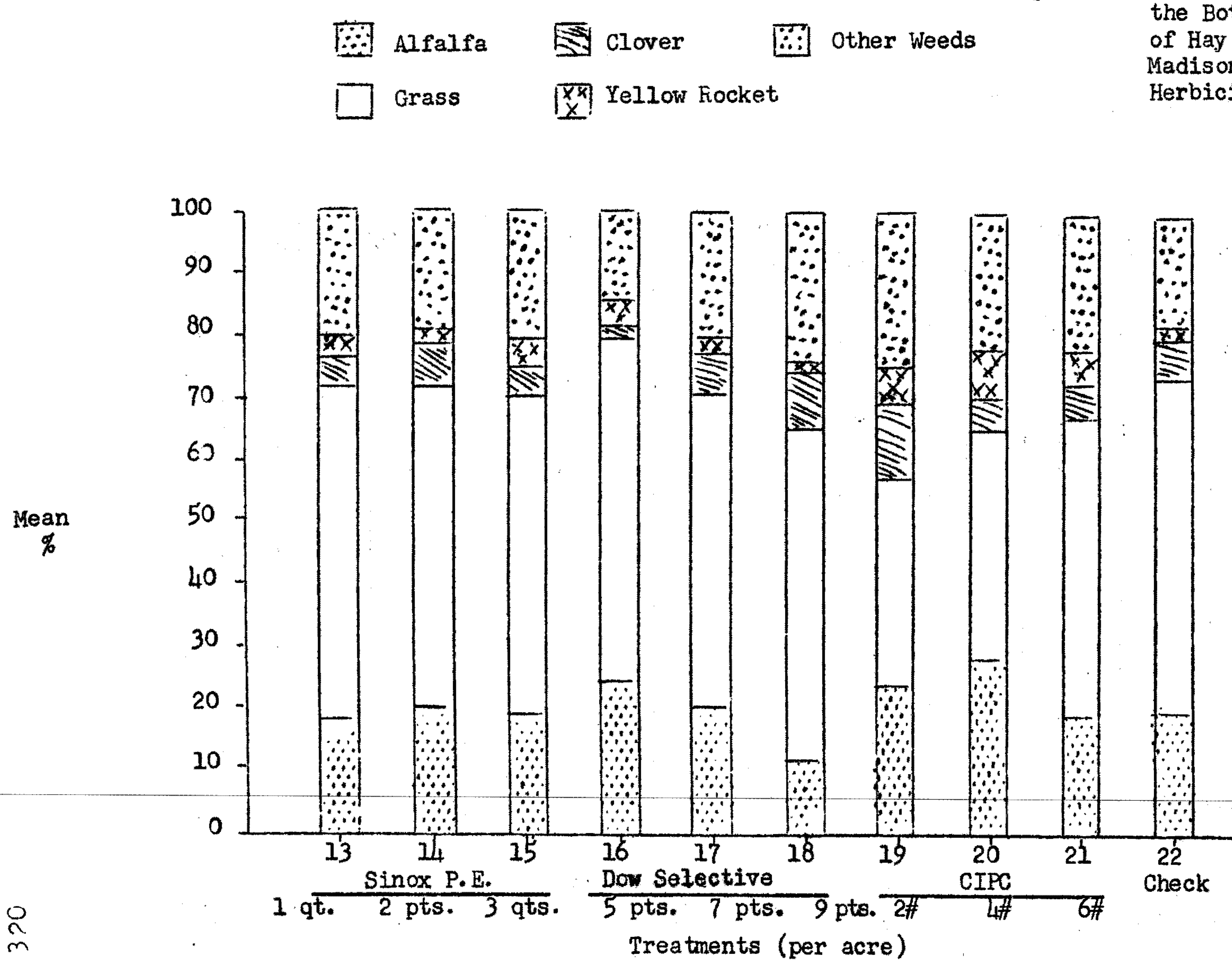


Figure 5. The Effect of Herbicides on the Botanical Composition of Hay 2nd Cutting, 1953. Madison Co. Translocated Herbicides

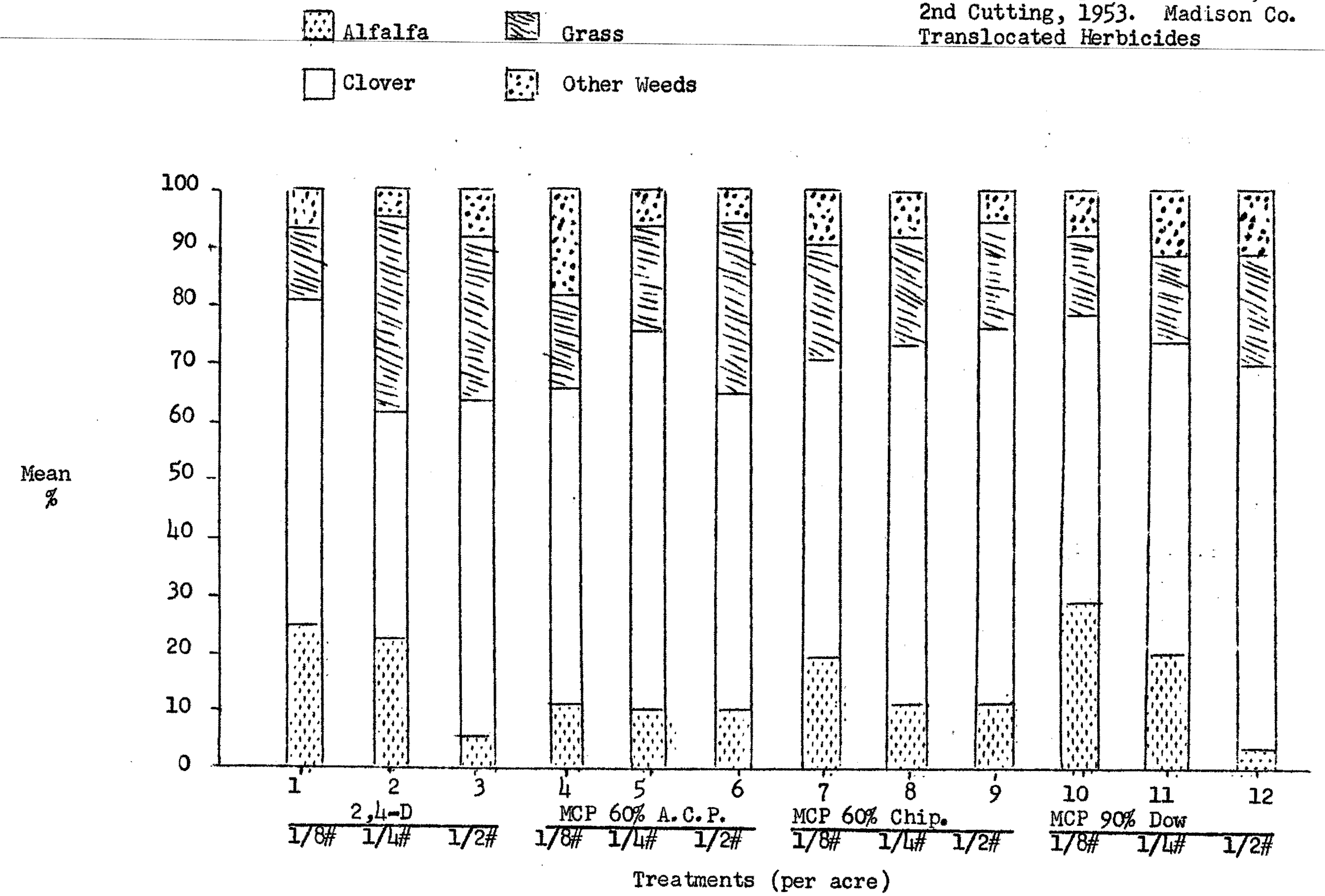
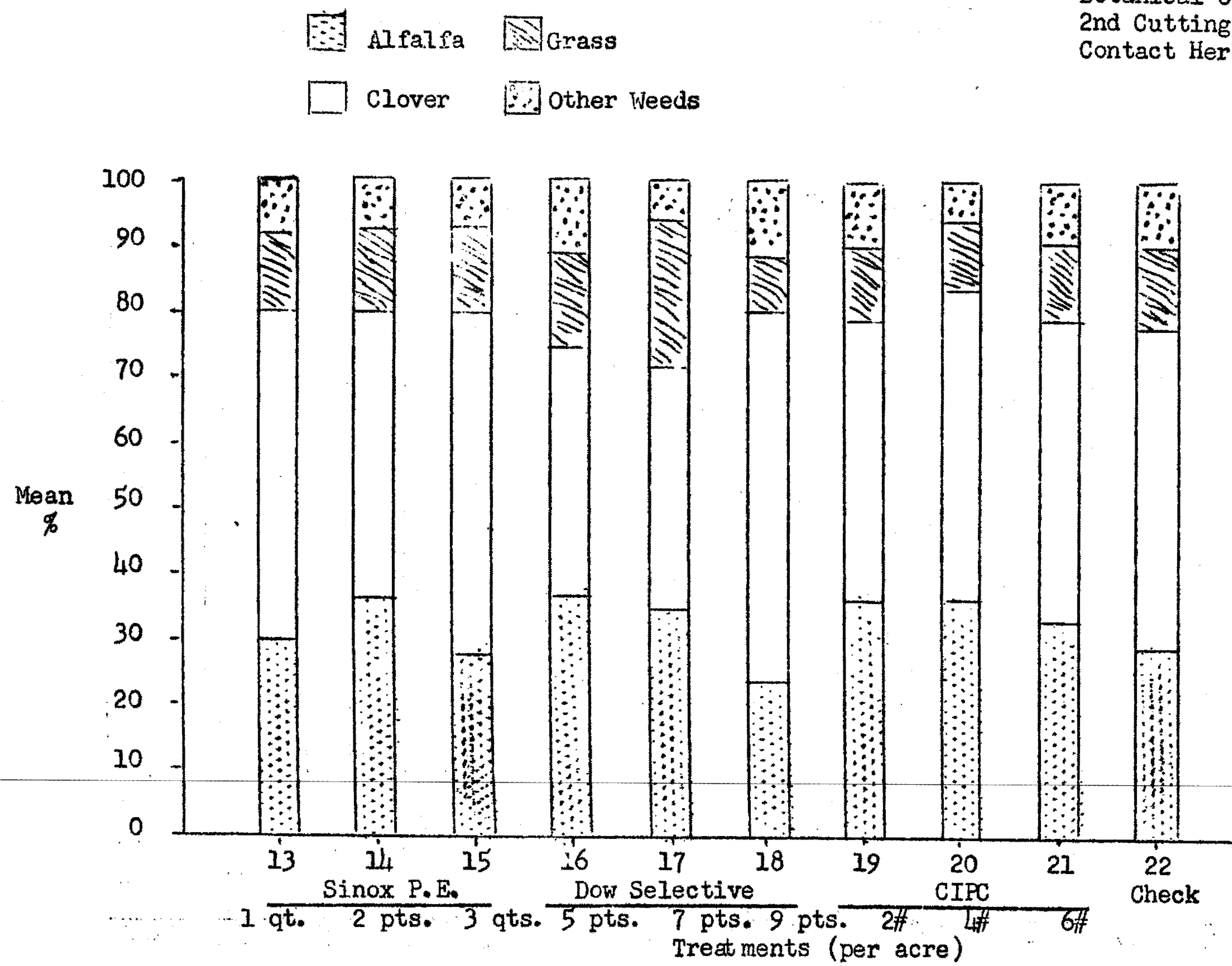


Figure 6. The Effect of Herbicides on the Botanical Composition of Hay 2nd Cutting, 1953. Madison Co. Contact Herbicides.



Conclusion

This second year data brings out several points which we feel are extremely important in the final evaluation of chemical weed control results in forage crops.

(a) Recovery is an important factor in the final evaluation of crop injury. This can only be judged in long-time experiments (two or more years).

(b) The reduction of alfalfa with increased concentration of translocated herbicides is permanent. No differences between 2,4-D and MCP were obtained.

(c) The detrimental effects of CIPC on forage grasses such as timothy can be completely masked in the first hay year after spraying.

(d) Where at all possible, botanical composition studies can greatly supplement yield data to obtain a true picture of herbicidal effect.

Literature Cited

(1) Moore, D. H., George, D. K., Martin, V. O., and Garman, J. A. Carbamate Herbicides. Evaluation of three carbamate herbicides in comparison with isopropyl N-(3-chlorophenyl) carbamate. Agricultural and Food Chemistry 1:1154-1158, 1953.

(2) Schreiber, M. M., and Fertig, S. N. The effects of various herbicides on the yield and botanical composition of legumes. NEWCC Proc. 8:363-376, 1954.

(3) Waters, H. J. Studies of the timothy plant. Mo. Agric. Exp. Sta. Res. Bul. 19 and 20, 1915.

A COMPARISON OF MCP AND 2,4-D FOR WEED CONTROL IN FORAGE LEGUMES

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Introduction

Since the results obtained with the chemicals available have been so inconsistent in the past, particularly in the response of the legumes involved, this experiment was initiated in an effort to clarify some of the variability in results reported in the literature on forage legume work.

Leefe (7) found that 1/8, 1/4 and ½ pound of 2,4-D ester or amine was not injurious to red clover. Others (3, 9) have found 1/4 of a pound and above of 2,4-D reduced stands of medium red clover as well as alfalfa and ladino. Buchholtz (2) and Van Geluwe and Marshall (12) have repeatedly found MCP less injurious to red clover than 2,4-D. Although many investigators have found marked injury with most formulations of 2,4-D on the most susceptible legume species, alfalfa and sweet clover, Miller and Dunham (8) and Bolton and Coupland (1) have reported no reduction of alfalfa with the sodium and amine salts.

The results with MCP have been just as variable as 2,4-D. Several investigators (4, 10, 12) claim the MCP 60% materials to be less injurious than the MCP 90% materials. Tafuro and Marshall (10) found concentrations of 1/6 to 1/4 pound per acre of MCP safe to use on alfalfa seedings.

In direct comparison of 2,4-D with MCP, results have been obtained which show very little, if any, difference in selectivity. Buchholtz (2), Knowles (6) and Timmons (11) have reported no difference between MCP and 2,4-D at the same concentration and formulation. Similar results have recently been obtained by Forsberg and Friesen (5) and Bolton and Coupland (1).

In this study, as many of the important factors as practically possible were taken into consideration: herbicides, formulations, concentrations, stage of growth, and legume species. In order to avoid the problem of canopy effect (which may be reason for inconsistent results), pure stands of legumes were used. Thus, the injurious effects observed and the yields obtained would be a direct function of herbicidal selectivity under the conditions of the experiment.

Materials and Methods

This experiment was started in the fall of 1951 and the spring of 1952. The experimental design used was a split block, split plot completely randomized with eight replications. This plot design was chosen because it allowed for the study of a number of different factors simultaneously, thus supplying information not only on main effects but on their interactions. Each replicate or block was divided into three parts each constituting a single stage. Thus a study could be made over three different stages of growth. Each stage was subdivided into four parts which constituted four different legume species or crops. To complete the split plot, 13 treatments were applied across all crops in each stage. The individual plots, 1248 in all, were 6 feet wide and 20 feet long.

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The following legume species were used: alfalfa (Narragansett), medium red clover (Penn Scott), birdsfoot trefoil (Empire), and ladino clover (certified). These four legumes were chosen primarily because of their wide use in the Northeast.

Of the three treatment stages chosen, two were to be made in the late summer and one in early spring before legumes broke dormancy. Because of an extremely wet spring in 1953, the spring treatment was delayed. The following are the dates and stages of legume growth at time of spraying:

Stage 1	July 20, 1952	All legumes from	2 to 4 inches tall
" 2	Aug. 6, 1952	" " "	5 to 7 inches tall
" 3	May 20, 1953	" " "	10 to 12 inches tall

Since the legumes were seeded without a companion crop, an extremely dense stand of field mustard (Brassica arvensis) outgrew the legumes in the stand. To insure even distribution of the spray and to have direct exposure of the crops, the mustard was cut at a height of 3 inches from the ground and removed on July 2, 1953.

Treatments were applied using an Allis Chalmers "G" model tractor converted especially for plot spraying. Treatments consisted of four chemicals at three different concentrations -- 1/8, 1/4, and ½ pound per acre. The following materials were used: (a) Dow 2,4-D, alkanolamine salts of ethanol and isopropanol series, (b) Dow MCP 90% alkanolamine salt (same as (a)), (c) Chipman's MCP 'Methoxone' sodium salt and (d) ACP's MCP 'Weedar MCP' diethanalamine salt. Stage 1 treatments were applied in 5 gallons of water per acre and stages 2 and 3 were applied in 10 gallons of water per acre. Applications were made starting with the lowest concentration of each chemical and progressing to the highest. With each change of chemical, the spray equipment was washed with 5 gallons of ammonia plus water (ratio 1:100) followed by 5 gallons of water to prevent contamination.

Yield data were obtained for the first and second cuttings 1953 and the first cutting 1954 by taking a three-foot swath through the middle full length of the plot. Total green and dry weights were determined. Due to extensive ground-hog damage on medium red clover, no yield data were taken for this crop after first cutting 1953. Yield data for 1953, first and second cuttings, were analyzed by the analysis of variance method and by single degree of freedom analysis (SDFA).

Results and Discussion

Table 1 represents the mean yield and analysis of variance obtained on the first cutting for all crops and stages. All sources of variance measured were significant at the 1% level except for the stage x crop interaction which is significant at the 5% level only. SDFA was employed to determine where the significance existed. The figures presented in this paper represent some of the individial degrees of freedom that were significant at the 1% level. The significance exhibited in these figures is due to the difference in the slopes of the curves, not the levels (which represent main effects only).

The linear and quadratic rate relationships of the two materials (2,4-D and MCP), over all crops and all stages is shown in Figure 1. 2,4-D is more

Table 1. Mean Yields First Cutting, 1953. Dry Weight, Lbs./A. Mean of 8 Replicates.

Treatment Lbs./A.	Alfalfa			Birdsfoot			Ladino			Med. Red Clover		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
1. 2,4-D, ½	1125	2205	955	822	1352	328	876	1146	715	3185	4041	2395
2. 2,4-D, 1/4	2033	2889	1333	1120	2444	774	823	1229	682	3767	4514	3115
3. 2,4-D, 1/8	3163	2947	1703	1568	2447	983	1668	1596	982	4555	4848	3511
4. MCP 90%, ½	2131	2194	1016	449	1020	485	921	964	456	3654	3728	3634
5. MCP 90%, 1/4	2606	2449	1472	988	1448	683	1300	1487	778	4332	4393	4014
6. MCP 90%, 1/8	2973	2962	1602	1296	2004	777	1240	1541	891	4026	4586	3815
7. MCP 60% Na, ½	1465	2114	1040	456	996	599	935	1351	538	4293	4518	3504
8. MCP 60% Na, 1/4	2535	2500	1151	888	1516	664	935	1220	618	4173	4462	3732
9. MCP 60% NA, 1/8	2736	3005	1604	1116	1521	1110	1363	1450	835	4726	4473	3913
10. MCP 60%, ½	1852	2045	970	506	1676	550	830	1410	485	4285	4495	3474
11. MCP 60%, 1/4	2548	2686	1279	851	1261	600	1114	1072	744	4314	4108	3983
12. MCP 60%, 1/8	2579	2991	1699	996	1989	858	1078	1499	945	4244	4652	4335
13. Check	2933	3033	2831	1143	1952	1740	1013	1393	1171	4419	4303	4630

Analysis of Variance

Source	DF	MS	F
Stages	2	73,081,450	15.77**
Error (a)	14	4,633,514	
Crop	3	617,854,500	459.4 **
Error (b)	21	1,344,671	
Stage x Crop	6	3,870,116	3.16*
Error (c)	42	1,223,040	
Treatment	12	8,386,708	21.30**
Treat. x Stages	24	1,153,304	2.92**
Error (d)	252	393,731	
Treatment x Crop	36	976,108	5.02**
Treat. x Crop x Stage	72	309,880	1.59**
Error (e)	756	194,408	

**Highly significant 1% *Significant 5%

affected by linear rate than MCP. MCP on the other hand is more affected by quadratic rate than 2,4-D. With 2,4-D as the concentration increases the injury as measured by yield reduction increases. The results show that once the concentration of MCP reaches a certain level of injury, a higher concentration brings about less change. This does not mean that MCP is less injurious than 2,4-D over all stages and over all crops. It means that at higher concentrations one can expect more injury from 2,4-D than MCP.

In the crop x treatment interaction of which there were 36 degrees of freedom, 18 of them or 50 percent were highly significant. It thus becomes quite evident that legume species have different degrees of tolerance to herbicide treatment. In response to the herbicide type (MCP vs. 2,4-D) to the four legume species, alfalfa and birdsfoot trefoil show more favorable to 2,4-D than MCP while ladino and medium red clover are more favorable to MCP than 2,4-D (Figure 2.) In Figure 3, it can be seen that birdsfoot trefoil is more affected by herbicide type than alfalfa, birdsfoot trefoil being more favorable to 2,4-D than MCP. The results showed a reverse situation for medium red clover.

Only 1/3 or 8 out of 24 of the total degrees of freedom for the stage x treatment interaction were highly significant by SDFA. In relation to herbicide type, 2,4-D appeared to be more injurious than MCP when the crops are more susceptible (Figure 4.) When the above relationship is observed with linear rate, the picture becomes much clearer (Figure 5). A greater response to linear rate with 2,4-D than MCP instage is apparent from yield data (Table 1). This same trend occurs in stages 1 and 2. However, in stages 1 and 2, 2,4-D appears to be in the same favorable position as seen in Figure 1, particularly at the lower rates. It should also be pointed out that the linear rate of MCP does not differ between stages as 2,4-D does. Between stage 1 and 2, 2,4-D shows more response than MCP (Figure 6). This again is related to 2,4-D at higher concentrations and the crop susceptibility at various stages. Stage 2 is much more favorable to 2,4-D than MCP while in stage 1 a much narrower relationship exists.

The difference in stage response, especially between stage 1 and stage 2 in the first cutting may be directly related to the weather conditions before and after spraying. Two inches of rain fell in two days after spraying stage 1.

The previous results and discussions have been based on main effects and on first order interaction effects. They were discussed to lay the groundwork for the more important and practical aspects involving the three major factors together - - crop x stage x treatment interaction. A close look at the relationship of 2,4-D and MCP in the second order interactions shows some very interesting points.

In Figure 8, it becomes quite evident that birdsfoot trefoil is more affected by herbicide type than alfalfa in stages 1 and 2, with MCP being less favorable than 2,4-D. It also suggests no significant difference between 2,4-D and MCP with alfalfa in any of the stages tested.

With medium and red clover and ladino, however, the situation is different. A much greater difference between MCP and 2,4-D within stages with medium red clover is shown in Figure 9. MCP is less injurious on medium red clover in the more susceptible stage (stage 3.) than 2,4-D. The reverse situation exists slightly for ladino clover. Between stage 1 and stage 2 it was earlier established that probably due to rainfall the former stage was more injurious. At that time, MCP was less injurious. Here, again, it becomes evident that MCP is less injurious than 2,4-D when medium red clover is in the more susceptible stage.

Fig. 1 Relation of linear and quadratic rate of herbicide types

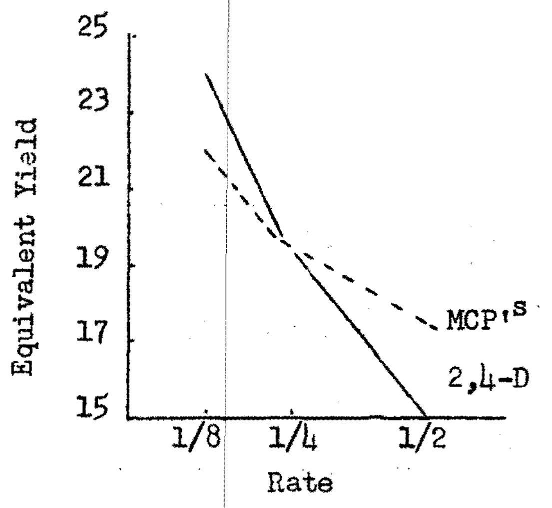


Fig. 2 Relation of four crop species to herbicide types

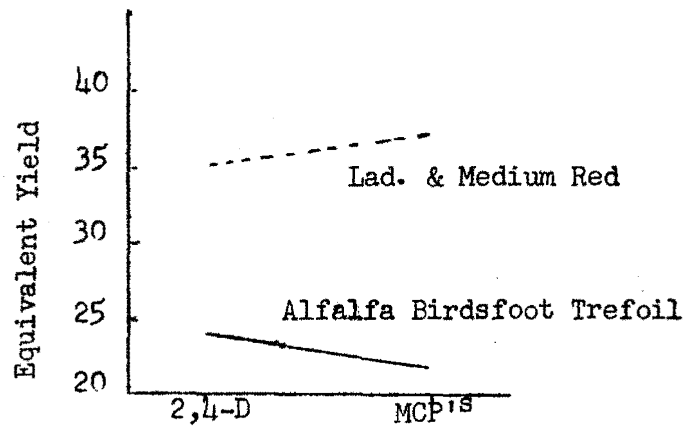


Fig. 3 Relation of two crop species to herbicide types

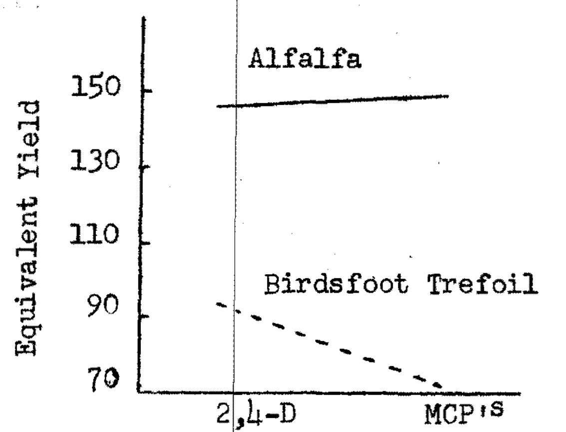


Fig. 4 Relation of herbicide types to three stages

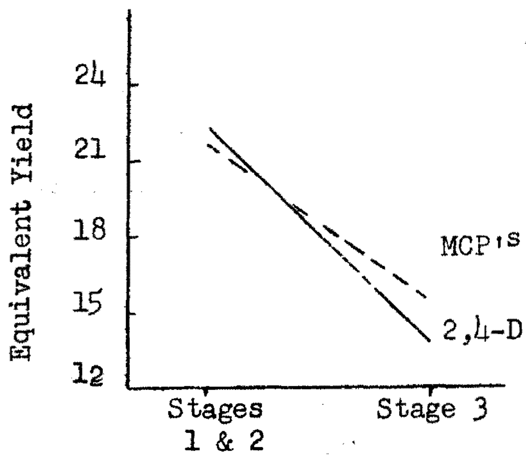


Fig. 5 Relation of linear rate of herbicide type to stages.

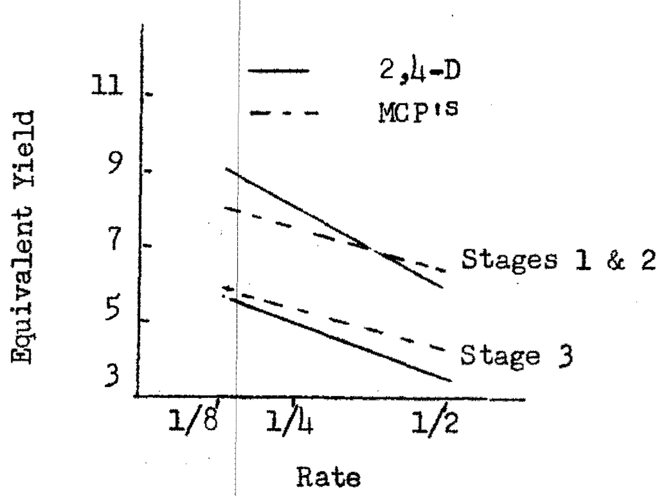


Fig. 6 Relation of herbicide type to two stages

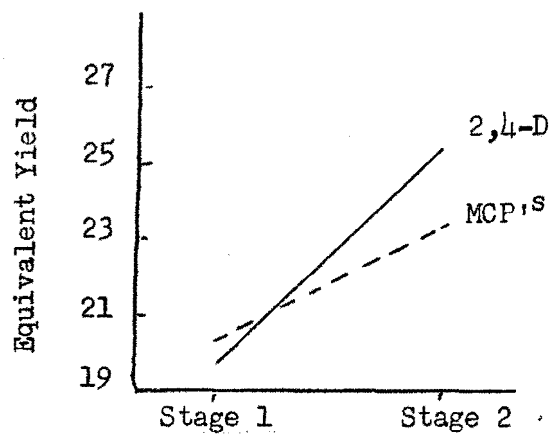


Fig. 7. Relation of crop species to MCP herbicide types or stages

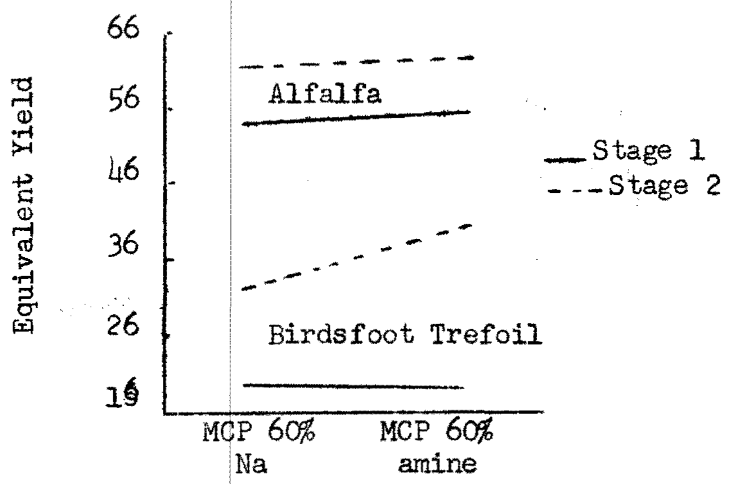


Fig. 8. Relation of herbicide type to crop species at three stages. (Alfalfa and Birdsfoot)

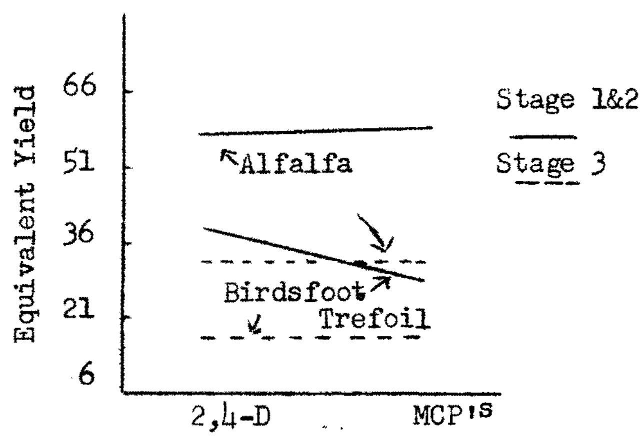


Fig. 9. Relation of herbicide type to crop species at three stages (ladino and med. red)

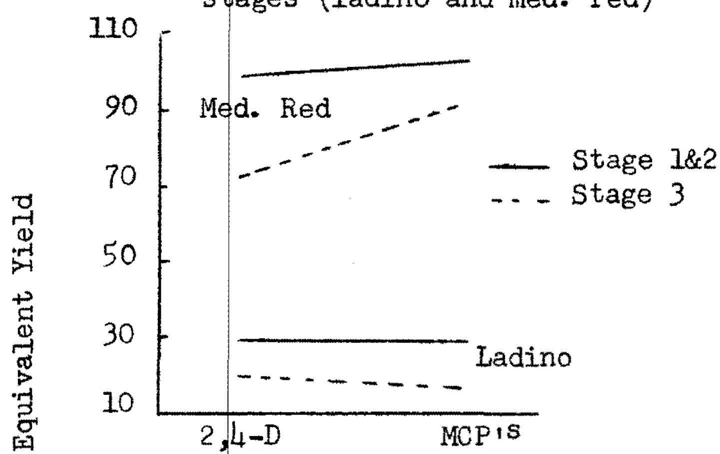


Fig. 10. Relation of herbicide type to two stages. 2nd cutting.

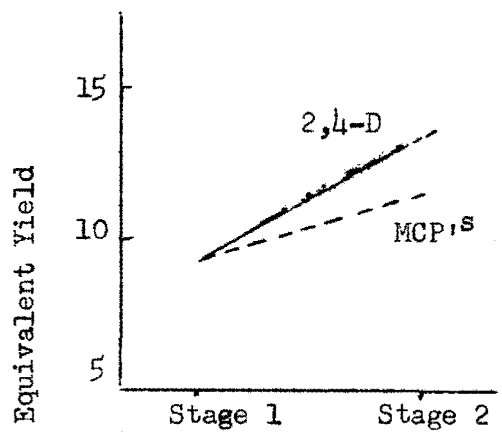


Fig. 11. Relation of two crop species to two herbicide types. 2nd cutting.

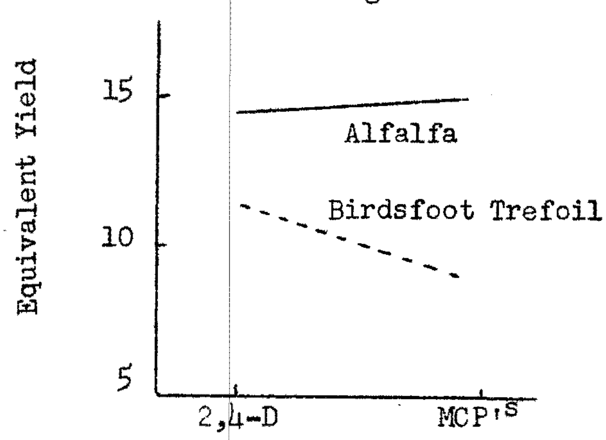
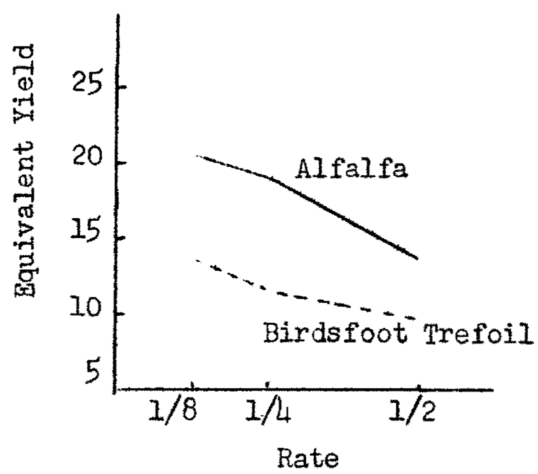


Fig. 12. Relation of two crop species on linear and quadratic rate.



The question now arises what about the differences in MCP formulations on stage and crop. It was found that in stage 3 there were no differences observed between MCP 90 and MCP 60 materials with any of the crops involved. When the plants are susceptible, injury from one is the same as from the other. However, in stages 1 and 2 a reverse relationship exists between crops. MCP 60's were more injurious to alfalfa and birdsfoot trefoil and MCP 90 more injurious to ladino and medium red clover. Alfalfa and birdsfoot trefoil are more affected by MCP formulation in stage 1 than in stage 2. There is no difference between stages with ladino and medium red clover in relation to MCP 90 and MCP 60. No difference with the amine or sodium salt of MCP 60 was shown with the alfalfa in stage 1 and stage 2 (Figure 7). Birdsfoot trefoil, on the other hand, shows a greater response in stage 2 than in stage 1 in favor of the amine salt formulation.

The mean yields and analysis of variance for the second cutting is represented in Table 2. An extremely important point which is certainly indicated by the mean yields shows a remarkable recovery of alfalfa and birdsfoot trefoil in stages 2 and 3. Thus, it appears that as the crop species has more vegetation exposed at the time of spraying, the fatal effects of herbicides are greatly reduced. Apparently, the first cutting actually is a measure of the knock-down and stunting capacity of the various herbicides.

The similarity of Figures 10 and 6 shows the permanent response of herbicide type on stage of growth. 2,4-D still shows more response than MCP being more favorable in stage 2 than MCP and as favorable in stage 1. The effect shown in Figure 4 is maintained in the second cutting. Alfalfa and birdsfoot trefoil are more affected than ladino with 2,4-D being more favorable than MCP. Between alfalfa and birdsfoot trefoil, the latter is again more favorable to 2,4-D than MCP while the former shows very little difference (Figure 11).

The relation of linear rate to alfalfa and birdsfoot trefoil in the second cutting is the same as in the first cutting (Figure 12). Alfalfa shows greater response than birdsfoot trefoil. However, a quadratic effect becomes more significant with alfalfa in the second cutting that is altogether different from that expressed in the first cutting. The usual quadratic effect (first cutting) is expressed by a larger decrease in yield between 1/8 and 1/4 pound per acre than between 1/4 and 1/2 pound per acre. However, in the second cutting the reverse is true. This strongly suggests a greater recovery from initial injury at the 1/4-pound concentration over that of the $\frac{1}{2}$-pound concentration.

Medium red clover was not considered in the second cutting because of the serious damage inflicted by ground hogs. This fact reduced the total of degrees of freedom for second order interactions. However, a marked reduction of highly significant degrees of second order interactions occurred more than can be accounted for by the loss of one crop. On a percentage basis, only 6 per cent occurred in the second cutting as compared with 23 per cent in the first cutting.

Due to the excessive wettness of the field in the spring of 1954, yield data from most of the plots was not taken. All of the ladino and most of the birdsfoot trefoil plots were affected to the extent that data could not be accurately taken and evaluated. Table 3 represents the mean yield values for the alfalfa plots that were considered unaffected by spring conditions. Stages 1 and 2 are averages of 5 replications while stage 3 is the average of 4 replicates.

Although the alfalfa yields for 1954 were not statistically analyzed, many of the original 1953 yield observations could be readily observed. The linear rate relationship within chemicals and between chemicals observed to be

Table 2. Mean Yields Second Cutting, 1953. Dry Weight Lbs./A.
Mean of 8 Replicates

Treatment Lbs./A.	Alfalfa Stage 1	Alfalfa Stage 2	Alfalfa Stage 3	Birdsfoot Stage 1	Birdsfoot Stage 2	Birdsfoot Stage 3	Ladino Stage 1	Ladino Stage 2	Ladino Stage 3
1. 2,4-D, ½	1001	1837	1118	930	1441	1533	864	1362	1301
2. 2,4-D, 1/4	1553	2196	1971	969	1636	1683	949	1288	1205
3. 2,4-D, 1/8	1850	2249	2482	1307	1923	1638	1142	1278	1161
4. MCP 90%, ½	1531	1850	1415	648	1007	1113	1007	1221	1180
5. MCP 90%, 1/4	1754	1940	2443	895	1261	1363	1034	1286	1211
6. MCP 90%, 1/8	1872	2004	2404	961	1473	1688	1075	1116	1351
7. MCP 60%, Na, ½	1151	1809	1247	631	1077	1039	1119	1245	1232
8. MCP 60%, Na, 1/4	1737	1806	2080	853	1238	1345	1158	1057	1111
9. MCP 60%, Na, 1/8	1924	2161	2515	1051	1348	1435	1253	1083	1120
10. MCP 60%, ½	1340	1778	1252	728	1159	890	1018	1287	1117
11. MCP 60%, 1/4	1772	2155	2238	941	1245	1200	986	1226	1237
12. MCP 60%, 1/8	1861	2074	2532	1096	1455	1477	982	1116	1197
13. Check	1970	2195	2488	1092	1479	1554	881	1226	1264

Analysis of Variance

Source	DF	MS	F
Stages	2	11,203,150	8.80**
Error (a)	14	1,273,035	
Crop	2	51,014,150	142.43**
Error (b)	14	358,157	
Stage x Crop	4	658,700	5.05**
Error (c)	28	130,336	
Treatment	12	1,947,183	11.86**
Treat. x Stages	24	589,441	3.59**
Error (d)	252	164,106	
Treat. x Crop	24	890,583	13.98**
Treat. x Crop x Stages	48	153,950	2.42**
Error (e)	504	63,702	

**Highly Significant 1%

Table 3. Mean Yields of Alfalfa First Cutting, 1954
Dry Weight, Lbs./A.

Treatment	Stage 1	Stage 2	Stage 3
1. 2,4-D, ½	1145	1858	391
2. 2,4-D, 1/4	1340	2195	1647
3. 2,4-D, 1/8	1777	1932	2066
4. MCP 90%, ½	1338	1782	806
5. MCP 90%, 1/4	1917	1787	1675
6. MCP 90%, 1/8	1524	2155	1883
7. MCP 60%, Na, ½	1336	2047	691
8. MCP 60%, Na, 1/4	1696	1708	1716
9. MCP 60%, Na, 1/8	1813	2093	1983
10. MCP 60%, ½	1415	1730	816
11. MCP 60%, 1/4	1756	1993	1963
12. MCP 60%, 1/8	1960	2147	2102
13. Check	1741	1867	1963

significant in both the first and second cuttings, 1953, seems to be maintained in 1954. Stage 2 yields are again superior to both the first and third stages.

From the data it appears that MCP yielded higher in stage 1 only. One other point seems to be extremely interesting. That is the second year effects of the 1/2 pound concentrations in stage 3. As was shown in the 1953 data, a marked recovery was noted in stage 3 second cutting over that of the first cutting. This recovery was noticeable at all concentrations although the quadratic curves showed greater responses between 1/4 and 1/2 pound per acre than between 1/8 and 1/4 pound per acre. A similar and more obvious quadratic effect was shown in stage 3 in 1954. The 1/2 pound concentrations in stage 3 show a definite reduction. It would thus appear that a delayed response may occur after high concentrations of the MCP and 2,4-D are applied to alfalfa when in advanced stages of growth (10 to 12 inches tall). Two explanations may account for the response indicated above:

1. Stand reduction may have occurred after treatment in 1953, although it was not generally observed. A definite stunting took place to give the marked reduction in the first cutting, 1953. If a reduction did take place, it is quite possible that fewer plants could produce higher yield by increasing the amount of vegetation per plant. That would account for increased yields for the second cutting, 1953. It is also quite possible, however, that by the second cutting limited recovery from initial stunting could have taken place. If a reduction in stand did occur, the generally poor conditions for growth in the spring of 1954 would not have allowed for increased vegetative growth per plant to be fully amplified.
2. If a reduction in stand did not occur and a genuine recovery was made for the second cutting 1953, it is quite possible that a delayed physiological response could have occurred. This could be manifested in a number of ways:
   - (a) Disrupted normal bud development so that with or without stand reduction or adverse environmental conditions, total vegetation produced would be less than normal.
   - (b) Depleted root reserves sufficiently to bring about pronounced winterkilling above that which may normally happen.

Conclusions

From the data obtained, the following factors become quite evident:

(1) 2,4-D was more injurious on medium red clover than MCP when crop was most susceptible.

(2) At low concentrations (1/8 to 1/4 pound per acre) one can expect equal injury to alfalfa from application of 2,4-D or MCP.

(3) 2,4-D was less injurious to birdsfoot trefoil than MCP when crop 3 to 7 inches tall.

(4) Ladino clover showed no difference in response to 2,4-D or MCP at any stage of growth.

(5) The taller the plant at the time of application of 2,4-D or MCP at concentrations up to 1/4 pound per acre, the more recovery was obtained in subsequent cuttings.

(6) The ½-pound concentrations of 2,4-D and MCP's were injurious to all crops at all growth stages tested.

(7) Greater recovery was observed at the 1/4 pound concentration of 2,4-D and MCP than at the 1/8 or ½-pound concentration.

(8) Over-all stages and crops there was no significant difference between MCP formulations.

Literature Cited

1. Bolton, J. L., and Coupland, R. T. Effect of herbicides on floral development of alfalfa. NCWCC Rec. Rpt. 10:117. 1953.
2. Buchholtz, K. P. Response of red clover and alfalfa seedlings to MCP and 2,4-D applied at several rates. NCWCC Res. Rpt. 6:92. 1949.
3. Churchill, B. R., and Grigsby, B. H. Effects of 2,4-D and dinitro sprays upon clover and alfalfa seedlings made in oats. NCWCC Res. Rpt. 6:94. 1949.
4. Fertig, S. N. Preliminary report on weed control in small grains where legumes are seeded using MCP and dinitros. NEWCC Proc. 6: 235-243. 1952.
5. Forsberg, D. E., and Friesen, H. A. Effect of herbicides on legume seedlings. NCWCC Res. Rpt. 10:120-121. 1953.
6. Knowles, G. Progress report weed control in field crops. Proc. Eastern Section National Weed Committee. 7:149. 1954.
7. Leefe, J. S. Use of 2,4-D as a selective herbicide in controlling weeds in red clover seeded with oats. NCWCC Res. Rpt. 5:46. 1948.
8. Miller, T. H., and Dunham, R. S. Response of seedling legumes in flax to herbicides. NCWCC Res. Rpt. 10:122. 1953.
9. Shaw, W. C., and Swanson, C. P. The effect of 2,4-D on clovers and alfalfa sown in small grains. NCWCC Proc. 6:96. 1949.
10. Tafuro, A. J., and Marshall, E. R. Effect of different applications of varying rates of MCP to irrigated and non-irrigated alfalfa seedlings at different stages of growth. NEWCC Proc. 6:259-264. 1952.
11. Timmons, F. L. The effect on crop plants of pre-emergence treatment with 2,4-D. NCWCC Proc. 4:244. 1947.
12. Van Geluwe, J., and Marshall, E. R. Further comparison of MCP and 2,4-D as selective herbicides for use in small grains seeded with mixed legumes. NEWCC Proc. 6:245-299. 1952.

RESULTS OF FIELD TRIALS WITH 3,4-D ON ALFALFA AND MEDIUM RED CLOVER.

Marvin M. Schreiber[1/]

Introduction

The possibility of 3,4-D as a selective herbicide in forage legumes was first reported by Thompson (3). Hanson and Ogle (1) found 3,4-D much less injurious to alfalfa and medium red clover than either MCP or 2,4-D. Similar results have been obtained by Tafuro et al (2).

The favorable response observed in the screening test of 1953 (4) with 3,4-D strongly suggested the need for field evaluation. These experiments were initiated to determine the effect of 3,4-D as well as 2,4-D and MCP on forage legumes and yellow rocket control when applied in the winter and spring.

Lansing, N. Y.

Materials and Methods

The seeding mixture used in the Lansing experiment was as follows: medium red clover at five quarts per acre, timothy at four quarts per acre, and ladino clover at two pounds per acre. The seeding was made in oats in the spring of 1953 and treated in the spring of the first hay year. The field was heavily manured during the late winter and early spring and contained at time of application an even stand of yellow rocket.

The field plot design was a randomized block with four replicates. The plots were 8 feet wide and 30 feet long. Ten-foot alleyways were left between replicates, the treatments were applied with a Model "G" Allis Chalmers tractor especially designed for plot spraying. All materials were applied at the rate of 10 gallons per acre. The amine formulations of all materials were used. The treatments are listed in Table 1. Treatments were made on the 28th of March, 1954. The temperature was 50° F. with a slight wind and a clear sunny sky. At time of spraying the growth stages of the crop and weed species were as follows: yellow rocket-rosette, red clover and ladino clover, 2 to 3 leaflets about 2 inches tall. The botanical and yield determinations were made and observations were made at various time from spraying until harvest.

Results and Discussion

Observations

All treatments were observed to have given good control of yellow rocket. The measure of control corresponded to the concentrations: as the concentration increased weed control increased. However, the stand of yellow rocket was not as uniform as was expected from earlier observations. The variation in weed population may have been due to the presence of the manure at time of application which may have covered and thus protected many of the yellow rocket plants. This appears to be quite conceivable since even at the ½ pound

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concentrations yellow rocket plants were present.

2,4-D and MCP gave somewhat better control of yellow rocket than 3,4-D at the ½ pound concentration. This may be due to the lower activity of 3,4-D when compared to the other two materials. In respect to legume injury, 2,4-D caused severe epinasty and leaf curl on medium red clover. Some slight leaf curl was noticed on ladino. The leaf curl on medium red clover reduced the height of the stand at harvest time and the subsequent yield particularly at the ½ pound per acre concentration.

Yield

Table 1 represents the mean yields and analysis of variance for the first cutting, 1954, Lansing, N. Y.

Table 1. Mean Yield and Analysis of Variance
Lansing, N. Y., First Cutting, 1954.
Lbs. Dry Matter per Acre.

Treatment	Mean Yield	Mean of Chemicals	Mean of Levels	
1. 2,4-D, 1/4#/A	4645			
2. 2,4-D, ½# /A	3749	8394	1/4#/A	13945
3. 3,4-D, 1/4#/A	4481		½#/A	12723
4. 3,4-D, ½# /A	4663	9144		
5. MCP 90%, 1/4#/A	4819			
6. MCP 90%, ½# /A	4311	9130		
7. Check	4802			

Analysis of Variance

Source	DF	MS	F
Total	27		
Replicate	3		
Treatment	6	559,902	6.18**
Chemicals	2	367,275	4.05*
Levels	1	995,930	10.99*
C x L	2	595,215	6.59**
Ck. vs. Rest	1	438,500	4.84*
Error	18	90,619	

**Significant 1%   *Significant 5%

Highly significant differences were found for treatments which were broken down to chemicals, levels and chemicals x levels interaction. 2,4-D significantly reduced the yield when compared with MCP and 3,4-D. This was more pronounced at the ½ pound concentration. These results corroborate the earlier findings on medium red clover. Both 3,4-D and MCP seem to be quite selective with medium red clover.

Botanical Composition

The following figures represent the mean percentages and actual yield on dry weight basis of medium red clover and yellow rocket in the first cutting.

	Med. Red Clover		Yellow Rocket	
Treatment	Mean %	Actual Lbs./A	Mean %	Actual Lbs./A
1. 2,4-D, 1/4#/A	90	4181	3	139
2. 2,4-D, ½# /A	96	3599	1	37
3. 3,4-D, 1/4#/A	93	4167	2	89
4. 3,4-D, +# /A	95	4429	1	47
5. MCP 90%, 1/4#/A	89	4289	6	289
6. MCP 90%, ½# /A	91	3923	1	43
7. Check	80	3842	14	672

On the basis of mean percentages, all treatments had higher percentages of medium red clover than the check. On the basis of actual yield of medium red clover 2,4-D at ½ pound was the only treatment lower than the check. This was due to the significant reduction in total yield. As the concentration increased, yellow rocket control, or actual yield of yellow rocket on dry weight basis decreased.

McLean, N. Y.

Materials and Methods

The materials and methods for the McLean, New York, experiment were exactly the same as for those at Lansing, New York, except for the seeding mixture and subsequent stage of growth at time of application. The seeding mixture used was as follows: alfalfa 6 quarts per acre; medium red clover, 4 quarts per acre and timothy, 4 quarts per acre.

At time of application the alfalfa was about 2 inches tall and the yellow rocket was in the rosette stage. No appreciable amount of red clover was present in the mixture.

Results and Discussions

Observations

A greater degree of weed control was obtained with 2,4-D and MCP than with 3,4-D at the concentrations used. However, the reverse relationship existed with regard to legume injury. 2,4-D brought about serious leaf curl on alfalfa at both the 1/4 and ½ pound concentration. MCP showed initial stunting of the crop while no visible response to treatment was observed with 3,4-D. The difference in weed control may be due again to the presence of manure which may have covered and protected some yellow rocket plants from the spray material.

Although initial injury particularly with 2,4-D was severe, the recovery factor became important at harvest time. New growth from damaged shoots was normal. At harvest time only the 2,4-D at ½ pound concentration could be distinguished because of a slight reduction in height of crop and a slight reduction in stand.

Yield

The yield data as shown in Table 2 shows no significant differences due to treatment.

Table 2. Mean Yield and Analysis of Variance, McLean, N. Y.
First Cutting, 1954
Lbs. Dry Matter per Acre.

Treatment	Mean Yield	Mean of Chemicals	Mean of Levels	
1. 2,4-D, 1/4#/A	4448			
2. 2,4-D, ½# /A	3821	8269	1/4#/A	13399
3. 3,4-D, 1/4#/A	4604		½# /A	12474
4. 3,4-D, ½# /A	4468	9072		
5. MCP, 1/4#/A	4347			
6. MCP, ½# /A	4185	8532		
7. Check	4677			

No significant differences.

Though there was no significant difference due to treatment, the yield at ½ pound of 2,4-D per acre had noticeably reduced the yield of alfalfa and when measured by chemical, 2,4-D and MCP were lower in yield than 3,4-D. This would tend to suggest a higher tolerance of alfalfa to 3,4-D than to 2,4-D or MCP. This was earlier predicted from results of the screening tests in 1953.

Botanical Composition Studies

The mixture at time of harvest was principally composed of alfalfa and timothy. The following figures represent the mean percentages and actual yields on a dry weight basis of alfalfa and yellow rocket in the first cutting.

	Alfalfa		Yellow Rocket	
Treatment	Mean %	Actual Lbs./A	Mean %	Actual Lbs./A
1. 2,4-D, 1/4#/A	58	2580	3	133
2. 2,4-D, ½#/A	54	2063	5	191
3. 3,4-D, 1/4#/A	62	2854	13	599
4. 3,4-D, ½# /A	62	2770	4	179
5. MCP, 1/4#/A	54	2347	5	217
6. MCP, ½# /A	60	2511	6	251
7. Check	64	2933	4	187

On the basis of mean percentages and actual yield of alfalfa, 3,4-D was higher than any of the other herbicides. The mean percentages of yellow rocket were extremely variable due to the hand spreading of manure before treatment.

A third experiment was set out to field test 3,4-D along with 2,4-D, MCP and 4-Chloro. In this experiment 3,4-D was included not only at the 1/4 and ½ pound per acre but at the 1 pound per acre concentration. The seeding mixture was primarily red clover and one of the dates of spraying was a day earlier than the Lansing and McLean experiments reported above.

The 1 pound per acre concentration of 3,4-D gave better yield of red clover than any of the other herbicides at any concentration. Weed control with the 1-pound concentration of 3,4-D was superior to all other treatments based on botanical composition studies.

Conclusions

Although these experiments were of a preliminary nature since they were our first field trials with 3,4-D, several important responses were quite evident.

(1) 3,4-D appeared to have lower activity than 2,4-D and MCP thus requiring concentrations of ½ to 1 pound per acre for the control of yellow rocket (Barbarea vulgaris) in the rosette stage.

(2) From the results of the experiments 3,4-D was less injurious to forage legumes (alfalfa and medium red clover) than 2,4-D or MCP.

(3) It appears from the data that 2,4-D was extremely injurious to medium red clover.

(4) Recovery from initial injury appears to be an important factor in the final evaluation of herbicidal materials.

Literature Cited

(1) Hansen, Jr., and Ogle, R. E. Response of eighteen plant species to DPA (3,4-D) 2,4-D and MCP. NEWCC Proc. pps. 29-31. 1954.

(2) Tafuro, A. J., Beatty, R. H., and Jack, C. C. The effect of six herbicides on alfalfa and clovers underseeded to spring oats. NEWCC Proc. 8:307-311. 1954.

(3) Thompson, H. W. New growth-regulating compounds -- summary of growth activities of some organic compounds as determined by three tests. Bot. Gaz. 107:476-507. 1946.

(4) Schreiber, M. M., and Fertig, S. N. Preliminary results of pre- and post-emergence screening experiments on legumes. NEWCC Proc. 8:313-317. 1954.

TWO YEARS' TEST AND DEMONSTRATION WORK IN TURF RENOVATION USING CALCIUM CYANAMID

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In mid-August, 1953, the Nassau County Extension Service, in cooperation with the Nassau County Park in East Hempstead, set up a series of tests using calcium cyanamid for turf renovation purposes. Observations and results of this test series were reported in Bulletin 49 of the New York State Turf Association.

Plots were examined later in the fall of 1953, and weed control observations were reported in Table One. Where cyanamid had been applied at forty, sixty, and eighty pounds per thousand square feet, and three methods of application used, namely cyanamid applied on old turf and rototilled in four inches, area rototilled to four inches then cyanamid applied on surface, and half cyanamid on surface - then rototilled four inches - then other half of cyanamid applied to surface of tilled soil, weed control was good; and in some plots, observed and recorded as excellent. Common weeds in the area of treatment included crabgrass, purslane, chickweed, corngrass, dandelion, plantain, and dock.

Appearance of Plots One Year Later

During the 1954 growing season, all plots treated with cyanamid and check plots were fertilized twice, once in the spring with ten pounds of 10-6-4 per thousand square feet, and again in August with two pounds of Urea per thousand square feet. All plots were watched closely during the spring and summer of 1954; and in the fall, were examined again for weed infestations. These observations are recorded in Table A. The plots that were weed-free in the fall of 1953 continued to remain relatively free of weed infestations throughout the growing season of 1954, whereas check or untreated were quite heavily infested with crabgrass, plantain, dandelion, purslane, chickweed, clover, and dock. This relatively weed-free turf is the result of actual killing of weed seeds and germinating seedlings by the calcium cyanamid when applied in mid-August of 1953 and also because of the crowding out of weeds by the thick growth of grass in all cyanamid-treated plots. Crabgrass, our most common turf weed on Long Island, was almost completed eliminated in the cyanamid-treated plots. In treated plots, only an occasional crabgrass plant was noticed. It was difficult to single out the best treatment. All plots that received forty to eighty pounds of calcium cyanamid two weeks prior to sowing seed continued relatively weed-free. In all cyanamid-treated areas, there was a light infestation of clover. However, untreated or check areas were quite heavily infested.

No chemicals were applied to this demonstration area to control weeds during the 1954 growing season, so lasting weed control can be attributed to the calcium cyanamid applications during the seedbed preparation stage the previous August.

Seedbed Preparation in Early Spring

To determine the value of calcium cyanamid for early spring seedbed preparation, a test was set up on March 29, 1954. An area was tilled and calcium cyanamid at forty, sixty, and eighty pounds per thousand square feet, was applied to the soil surface and lightly scratched in. A check or untreated area was also tilled. These plots were kept moist by adequate rainfall and two and four weeks later, a lawn seed mixture of fifty per cent red fescue, thirty per cent Kentucky bluegrass, and twenty per cent Colonial bent, was sown at the rate of four pounds per thousand square feet. Soil temperature at six inch depth in early April was thirty-eight to forty-four degrees.

Very poor results were noted. None of the common weeds in the area were killed or reduced in germination, and a very inadequate stand of grass resulted. We were not surprised by these poor results because experience has shown that calcium cyanamid works best in seedbed preparation when the soil temperature is above sixty degrees.

Fall, 1954, Applications of Calcium Cyanamid

On August 13, 1954, a portion of the 1953 work was repeated. Old sod was tilled and raked, and calcium cyanamid at sixty pounds per thousand square feet was applied and lightly scratched into the soil surface. During the two-week waiting period when free cyanamid kills weeds and weed seeds in the soil surface, temperatures were slightly less than the corresponding period in 1953 and there was much more rain. At the lower temperatures and increased amount of rainfall, calcium cyanamid at sixty pounds per thousand square feet killed germinating weeds of chickweed, plantain, dandelion, purslane, sourgrass, lambs quarters, and crabgrass; but some of the larger grass sod clumps that were broken up and turned under by the rototiller were not completely killed by the material and so resprouting of ryegrass resulted. Air and soil temperatures, and most important, rainfall, were a lot different than in 1953. Air temperature, which affects the temperature in the upper inch of soil where calcium cyanamid had worked in, showed, in 1953, an average maximum for August 15 to September 1 at 85 degrees. In contrast to this, in 1954 during the same two-week period, average maximum temperature was 79.2 degrees. The average maximum temperature for 1954 was 6.3 degrees lower than 1953. While probably of incidental value when compared with rainfall, lower temperatures have the effect of reducing the complete effectiveness of calcium cyanamid. Rainfall and soil moisture are far more important.

In 1953, from August 15 to September 1, during the calcium cyanamid working period, and when excellent weed control was noted, we had .14 inches of rainfall. This was supplemented by another inch supplied as light sprinklings to keep the soil surface moist. In 1954, we had 4.76 inches of rainfall during this same two-week working period. The very heavy rainfall during the 1954 trials, appeared to reduce the complete effectiveness of the calcium cyanamid. Tender germinating weed seedlings were killed, but an occasional turned-in sod clump resprouted.

Calcium Cyanamid and Crabgrass Seed Control

To further test calcium cyanamid against crabgrass seed, we planted crabgrass seed in flats and treated the soil surface with calcium cyanamid at forty, sixty, and eighty pounds per thousand square feet in late September. One flat was left without cyanamid as a check. The flats were placed in the greenhouse where the soil temperature was between 65 to 75 degrees. One month later, crabgrass seedlings appeared only in the check or untreated flat indicating that the cyanamid applications at forty to eighty pounds per thousand square feet applied to tilled soil and lightly scratched in had killed the crabgrass in the seed or seedling stage.

General Conclusions

After working with calcium cyanamid for two years in turf seedbed preparations, the following conclusions, based on tests and demonstration work, and by observing several lawns put in commercially using the material are made:

1. Lasting weed control resulted through the 1954 growing season from mid-August applications of calcium cyanamid in 1953.

2. Calcium cyanamid for turf seedbed preparation worked best when there is a slight amount of moisture in the soil. Heavy rainfall or too much irrigation following calcium cyanamid applications at weed killing rates will tend to reduce the weed killing potential of the material.

3. Soil temperature also has an effect on the usefulness of calcium cyanamid in seedbed preparation. When soil temperatures were around 70 degrees, weed-free stands of grass resulted. Poor weed control was observed when calcium cyanamid was applied to a cold soil (40 degrees). Early spring applications of calcium cyanamid for turf seedbed preparation are not recommended.

4. A wide variety of weed seed and seedlings were killed by calcium cyanamid applications in August, 1953 and 1954, when rates of application were between 40 to 80 pounds per thousand square feet. Seed and seedlings killed include crabgrass, chickweed, plantain, dandelion, purslane, sourgrass, lambs quarters, corngrass, and dock.

Table A. Weed Control in Renovated Turf One Year Following Seedbed Treatment with Calcium Cyanamid in mid-August, 1953.

Method of application	lbs. of calcium cyanamid to 1000 square feet 80	60	40	25	20
Cyanamid on old turf then rototilled to 4"	G	G	G	-	-
Rototilled to 4" then cyanamid on surface	G	G	G	-	-
Half cyanamid on surface then rototilled to 4", then other half cyanamid on surface	E	G	G	-	-

Symbols for weed control:
- E--Excellent weed control; for all practical purposes, no weeds.
- G--Good weed control - an occasional weed observed.
- P--Poor weed control
- \- No treatment applied at this rate.

A light clover infestation noted in all plants.

The Pre-emergence Control of Smooth Crabgrass with Chemicals in Lawn Turf [1]

S. W. Hart and J. A. DeFrance [2]

The object of many years' search and research has been the discovery of a chemical control for crabgrass. Several materials have been found that will effectively control crabgrass without injury to the basic turf grasses after they have germinated and became established in turf. Up to the present time, however, little work has been reported concerning the elimination of crabgrass before it has become evident and started its invasion.

Treatment of turf with chemicals that affect the germinating seeds has many advantages. Gallagher and Musser (1) state that early treatment with chemicals not only reduces the amount of discoloration to the permanent turf, but that lower rates of chemicals can be used. Simmons and DeFrance (2) working on putting-green turf have shown that phenyl mercuric acetate as a pre-emergence treatment in repeated applications gave satisfactory control of crabgrass. Repeated observations at the Rhode Island Agricultural Experiment Station have shown that early control of crabgrass helped to maintain a good stand of desirable grasses during the critical part of the growing season.

The purpose of this paper is to report on the findings of an experiment conducted during the spring and summer of 1954 at the Rhode Island Agricultural Experiment Station on the effectiveness of several herbicides for the pre-emergence control of crabgrass.

Methods and Materials

The tests were conducted on a portion of the athletic field of the University of Rhode Island. The turf, composed of Kentucky bluegrass, Chewing's fescue and Astoria Colonial bent, was mowed at a height of approximately one inch and received minimum maintenance. The previous season the area was uniformly infested with smooth crabgrass, *Digitaria ischaemum*.

The experimental design consisted of four blocks, each containing 18 plots of 100 sqaure feet. There were 17 treatments and one check plot randomized in each block. A split-plot treatment was employed with one half of the plot receiving six treatments at 14-day intervals, and the other half plot receiving three treatments at monthly intervals.

The materials used, the percent active ingredient in each material and the rates applied, were as follows:

1. Experimental herbicide Sesin 30E (30% 2,4-dichlorophenoxyethyl benzoate-emulsion); 3 and 6 pounds per acre.

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[1] Contribution No. 852 of the R. I. Agricultural Experiment Station.

[2] Research Assistant in Agronomy and Agronomist, respectively.

2. Experimental herbicide Sesin 50W (50% 2,4-dichlorophenoxyethyl benzoate wettable powder). 3 and 6 pounds per acre.

3. Experimental herbicide Natrin (85% sodium 2,4,5-trichlorophenoxyethyl sulfate). 3 and 6 pounds per acre.

4. ACP L-670 (5% 2,4,5-trichlorophenoxyacetamide-dust). 6 pounds per acre.

5. Crag Herbicide-1 (90% sodium 2,4-dichlorophenoxyethyl sulfate). 3 and 6 pounds per acre.

6. Experimental herbicide DCU 73-W (73% dichloral urea). 4 and 7 pounds per acre.

7. 2,4-D amine (38% 2,4-dichlorophenoxyacetic acid equivalent as the triethanolamine). 1 and 1½ pounds per acre.

8. PMAS (10% phenyl mercuric acetate). 5 and 7 pints per acre.

9. Alanap No. 1 (90% N-1 Naphthyl phthalamic acid). 8 pounds per acre.

10. Scutl F-1 (0.74% phenyl mercuric acetate impregnated in vermiculite). Approximately 2.5 lbs. per 1000 square feet for the first three treatments and approximately 3.3 lbs. per 1000 square feet for the last three.

Sesin 30-E, Sesin 50-W, Natrin, ACP L-670, Crag No. 1, DCU 73-W, 2,4-D amine, PMAS and Alanap No. 1 were mixed with water and were applied at a rate of 10 gallons per 1000 square feet with a 15-gallon power sprayer. Scutl F-1 was applied with a Scott's spreader at settings number six and seven.

The first application was made to the entire plot on May 13, before any crabgrass had germinated. Subsequent treatments were made on a split-plot basis, one half of each plot being treated every 14 days and the whole plot monthly until a total of six treatments had been made.

Discoloration notes were taken seven days following the first 4 treatments. No discoloration followed the fifth or sixth treatments. Crabgrass notes were taken on October 1, 1954 and were recorded as estimates of the percent of area covered by crabgrass. Crabgrass was slow to germinate even on the check plots, because of the cool weather and dense, healthy growth of the basic turf grasses. The percent of crabgrass figures given in table 1 are averages determined from the four replicates of each treatment. The percent control figures for each treatment are based on the differences between the amount of crabgrass on the treated plots and that on the check.

Clover and weed control figures as reported in table 2 were also taken on October 1, and the percent control figures based on the difference between treated plots and the checks. Weed population consisted mainly of narrow-leaved plantain (<u>Plantago lancelolata</u>), broad-leaved plantain (<u>Plantago major</u>), chickweed (<u>Stellaria media</u>) and dandelion (<u>Taraxacum officinalle</u>).

Results and Discussion

The results obtained for crabgrass control are presented in table 1. Although the amount of crabgrass on the treated plots and the checks was very light, this situation was found to exist throughout the area as a whole. Weather conditions were such that the turf grew very well and presented stiff competition for seedling crabgrass to become established. PMAS and Alanap No. 1 were the most effective treatments giving 100% control of crabgrass.

PMAS at both five and seven pints per acre gave 100% control with only slight amount of discoloration. Discoloration was not evident after the third treatment.

Alanap No. 1 at eight pounds per acre also gave very effective control. The discoloration following treatments with this material was moderate, but no discoloration occurred after the third treatment.

Scutl F-1 at setting number six for the first three treatments and setting number seven for the remaining three treatments gave 73% and 90% control respectively. No turf discoloration resulted from this treatment.

Experimental herbicide OCU-73W at four pounds per acre gave 79% control with three treatments and 85% control with 6 treatments with no turf discoloration. At 7 pounds per acre with three treatments 85% control resulted, and the same rate at six applications gave 90% control. The seven-pounds-per-acre rate resulted in only slight turf discoloration.

Experimental herbicide Natrin at three pounds per acre gave 70% control with three treatments and 80% control with six treatments. At six pounds per acre, this material provided 85% control with three treatments and 91% control with six treatments. Only a slight amount of turf discoloration occurred.

ACP L-670 at six lbs. per acre was not too effective in this test. With three treatments only 30% control resulted and with six treatments, 45% control was obtained. No turf discoloration was evident with this material.

2,4-D amine at the low rate of one pint per acre was moderately effective as a control material for crabgrass giving only 30% control with three treatments and 55% control with six treatments. The one and one half-pints-per-acre rate gave 79% control with three applications and 40% with six treatments. Discoloration was only slight with this material.

Crag Herbicide-1 at four and seven pounds per acre resulted in 65% and 40% control respectively for three applications. With six applications, the four-pound rate gave 69% control and the seven-pound rate, 60% control. This material produced no turf discoloration.

Experimental herbicide Sesin 30-E at three and six pounds per acre g ave 60% control with three applications. Crabgrass control with six applications was 60% for the three-pound rate and 65% for the six-pound rate. No discoloration was found with this material.

Experimental herbicide Sesin 50-W at three pounds per acre resulted in 65% control with both three and six applications. At the six pound rate 79% control was provided. This material caused no discoloring of the turf.

While the object of this experiment was primarily crabgrass control, some of the materials were also selective for broad-leaved weeds. For this reason, the results for weed and clover control are presented in table 2.

The most effective materials for clover contril with three treatments were 2,4-D amine and Alanap No-1 which provided control from 91% to 95%. None of the other materials used were very effective although they did reduce the clover population.

Six treatments provided much better results. Sesin 30-E, Sesin 50-W, Natrin, 2,4-D amine and PMAS, all gave over 90% control of clover.

Weed population with three treatments was most effectively reduced with Sesin 30-E, Sesin 50-W, and 2-4-D amine. These same chemicals provided 90% control with six treatments. The other materials were ineffective in this test against weeds.

Summary and Conclusions

Tests for the pre-emergence control of crabgrass were conducted during the spring and summer of 1954 on a typical lawn area at the Rhode Island Agricultural Experiment Station. Chemicals used were Sesin 30-E, Sesin 50-W, Natrin, ACP L-670, Alanap No. 1, PMAS, Scutl F-1, Crag-1, and 2,4-D amine.

With three treatments at monthly intervals, PMAS, Alanap No. 1, Natrin, and DCU 73-W provided control of crabgrass averaging from 85% to 100%. PMAS, Alanap No. 1, Natrin, Scutl F-1, and DCU 73-W with six applications at 14-day intervals gave crabgrass control ranging from 85% to 100%. 2,4-D amine and ACP L-670 were not too effective in this test.

Turf discoloration from some of the chemicals was noticeable, but no permanent injury to the basic grasses resulted. Discoloration ranked from least to greatest in the following order: Natrin, DCU 73-W, 2,4-D amine, PMAS and Alanap No. 1. No discoloration resulted from the use of Scutl F-1, Sesin 30-E, Sesin 50-W, ACP L-670, or Crag 1.

Clover control was provided by 2,4-D and Alanap No. 1 with three treatments and Sesin 30-E, Sesin 50-W, Natrin, 2,4-D amine and PMAS at six treatments.

Weed control was provided by the Sesin 30-E, Sesin 50-W, and 2,4-D treatments at both three and six application.

From the results obtained in these tests, it appears that crabgrass can be effectively controlled in lawn turf by pre-emergence treatments with chemicals. PMAS at five and seven pints per acre and Alanap No. 1 at eight pounds per acre, appear to be the most satisfactory treatments.

Combined crabgrass and weed control appears promising from the results obtained, but further testing to determine the correct application rates and number of treatments is necessary.

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Literature Cited

1. Gallagher, John E. and H. B. Musser. Methods of Crabgrass Control. Proc. 23rd Annual Penn State Turfgrass Conference. pp. 12-16, Feb. 1954.

2. Simmons, J. A. and J. A. DeFrance. Chemicals for the Control of Crabgrass in Putting-green Turf. Proc. 7th Annual Meeting NEWCC, pp. 255-62. Jan. 1953

Table 1. Pre-emergence Control of Smooth Crabgrass in Lawn Turf with Various Chemicals

Rhode Island Agricultural Experiment Station, 1954

Material	Rate	Method of Application	% crab after 3 trts.	% Control	% crab after 6 trts.	% Control	Discoloration* after 1st Trt.	2nd Trt.	3rd Trt.	4th Trt.
Sesin 30-E	3 lbs./A	10 gal. H_2O	1.0	60.0	1.0	60.0	0	0	0	0
Sesin 30-E	6 lbs./A	10 gal. H_2O	1.0	60.0	0.875	65.0	0	0	0	0
Sesin 50-W	3 lbs./A	10 gal. H_2O	0.875	65.0	0.875	65.0	0	0	0	0
Sesin 50-W	6 lbs./A	10 gal. H_2O	0.525	79.0	0.525	79.0	0	0	0	0
Natrin	3 lbs./A	10 gal. H_2O	0.75	70.0	0.5	80.0	0	0	0.5	0
Natrin	6 lbs./A	10 gal. H_2O	0.375	85.0	0.275	91.0	0	0	1.0	0
ACP L-670	6 lbs./A	10 gal. H_2O	1.75	30.0	1.375	45.0	0	0	0	0
Crag-1	3 lbs./A	10 gal. H_2O	0.875	65.0	0.775	69.0	0	0	0	0
Crag-1	6 lbs./A	10 gal. H_2O	1.5	40.0	1.0	60.0	0	0	0	0
DCU 73-W	4 lbs./A	10 gal. H_2O	0.525	79.0	0.375	85.0	0	0	0	0
DCU 73-W	7 lbs./A	10 gal. H_2O	0.375	85.0	0.25	90.0	0	0	1	0
2,4-D amine	1 lb./A	10 gal. H_2O	1.75	30.0	1.125	55.0	0	0	1	0
2,4-D amine	1½ lbs./A	10 gal. H_2O	0.525	79.0	1.5	40.0	0	0	1	0
PMAS	5 pts./A	10 gal. H_2O	0	100.0	0	100.0	0	1	1	0
PMAS	7 pts./A	10 gal. H_2O	0	100.0	0	100.0	1	1	1	0
Alanap No. 1	8 lbs./A	10 gal. H_2O	0	100.0	0	100.0	0	2	2	0
Scutl F-1	2.2&3.3 lbs./M	Scott's Spreader	0.675	73.0	0.25	90.0	0	0	0	0
Check	———	————	2.5	0	2.5	0	0	0	0	0

* Discoloration index - 0 = none, 1 = slight, 2 = moderate, 3 = severe, 4 = turf injury

**First 3 treatments made at Scott's spreader setting number 6 and last 3 at setting number 7. Treatments begun on May 13, 1954.

Table 2. Clover and Weed Control in Lawn Turf with Various Chemicals at the

Rhode Island Agricultural Experiment Station, 1954.

Material	Rate	Method of Application	% clover after 3 trt.	% clover control	% clover after 6 trt.	% clover control	% weeds * after 3 trt.	% weed control	% weeds after 6 trt.	% weed control
Sesin 30-E	3 lbs./A	10 gal. H_2O	1.025	48.8	0.075	96.25	0.675	87.2	0.525	90.0
Sesin 30-E	6 lbs./A	10 gal. H_2O	0.625	68.8	0.125	93.75	0.325	93.9	0.075	98.6
Sesin 50-W	3 lbs./A	10 gal. H_2O	0.9	55.0	0.075	96.25	0.05	99.1	0.22	95.8
Sesin 50-W	6 lbs./A	10 gal. H_2O	0.875	56.25	0.075	96.25	0.05	99.1	0.22	95.8
Natrin	3 lbs./A	10 gal. H_2O	0.75	62.5	0.075	96.25	1.025	80.5	1.55	70.5
Natrin	6 lbs./A	10 gal. H_2O	0.925	53.75	0.075	96.25	0.8	84.8	0.3	94.3
ACP L-670	6 lbs./A	10 gal. H_2O	0.675	66.25	0.55	82.5	2.125	69.4	1.025	80.5
Crag-1	3 lbs./A	10 gal. H_2O	0.65	68.5	1.275	36.25	3.125	40.5	2.375	55.8
Crag-1	6 lbs./A	10 gal. H_2O	1.125	43.75	1.025	48.8	2.875	45.3	1.625	69.1
DCU 73-W	4 lbs./A	10 gal. H_2O	1.625	18.75	1.5	25.0	5.0	4.8	7.0	0.0
DCU 73-W	7 lbs./A	10 gal. H_2O	0.65	68.5	0.425	78.75	9.5	0	6.5	0
2,4-D amine	1 lb./A	10 gal. H_2O	0.175	91.75	0.075	96.25	0.2375	83.1	0.1	98.1
2,4-D amine	1½ lbs./A	10 gal. H_2O	0.175	91.75	0.05	91.5	0.15	97.2	0.1	98.1
PMAS	5 pts./A	10 gal. H_2O	0.775	61.25	0.1	95.0	0.2	96.2	1.0	80.8
PMAS	7 pts./A	10 gal. H_2O	0.1	95.0	0.1	95.0	1.75	63.7	1.0	80.8
Alanap No-1	8 lbs./A	10 gal. H_2O	1.0	50.0	0.3	85.0	2.0	62.0	3.25	38.1
Acutl F-1	2.2&3.3 lbs./M	Scott's Spreader	1.775	11.25	0.425	78.75	4.0	23.9	2.75	47.7
Check	———	———	2.0	———	2.0	———	5.25	———	5.25	———

* Weed include narrow-leaved plantain, broad-leaved plantain, chickweed, and dandelion.

CONTROL OF ANNUAL BLUEGRASS (*Poa Annua*) IN FAIRWAY-TYPE TURF[1]

R. E. Engel and R. J. Aldrich[2]

Chemicals developed in the herbicide field suggest that annual bluegrass might be controlled selectively. Prevention of seedhead development or pre-emergence control offer the most promising approaches since most turf areas must remain in continuous use. These possibilities have been explored on a bentgrass-*Poa annua* type of turf with thirteen different chemicals.

Procedure

Trials plots, 5 x 20 feet in size, on a practice fairway at the Baltusrol Golf Course, were treated with sodium arsenite, potassium cyanate, 3-p-chlorophenyl-1, 1-dimethylurea (CMU), isopropyl N-(3-chlorophenyl)-carbamate (CIPC), sodium 3,6-endoxohexahydrophthalate (Endothal), maleic hydrazide, sodium arsenite plus 2,4-D, and S1998-Bis (alkyl, di-2-hydroxyethyl-amine) boronium fluoride during the spring of 1952 and 1953. All chemicals were applied 1 to 3 times each season in 100 gallons of water per acre. In 1952, the first application was made on April 24, the second May 6, and the third May 19. In 1953, the first application was made March 31, the second on April 14, and the third May 5. The plots were rated for turf injury and the effect of the treatment on *Poa annua*, bentgrass, and clover.

On August 19 and September 2, 1952, sodium arsenite, sodium arsenite plus 2,4-D, Endothal, CIPC, 4-chloro IPC, maleic hydrazide, CMU, sodium 2,4-dichlorophenoxyethyl sulfate (SES), dichloral urea, and 2,4-D were applied according to the same procedures used for the spring treatments. Observations were made for turf injury and *Poa annua* germination.

Treatments of maleic hydrazide, sodium arsenite plus 2,4-D, alpha-naphthalene acetic acid, and Endothal were made during the spring of 1954 on a bentgrass fairway turf at the Canoe Brook Golf Club. All chemicals were applied in 40 gallons of water per acre on plots 30 feet wide that extended across the

[1]Acknowledgment is made to Edward Casey, Superintendent, Baltusrol Golf Club, Springfield, N. J. and Jack Ormond, Superintendent, Canoe Brook Country Club, Summit, N. J. for their cooperation in tests conducted on their respective golf courses.

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width of the fairway. Maleic hydrazide was applied at a rate of 2 pounds per acre April 2 and 21, and alpha-naphthalene acetic acid was applied at the rate of 3 pounds per acre May 7. All other treatments were applied April 2, April 21, and May 7. The plots were rated for effect of the treatment on seed set of Poa annua and on the established plants of bentgrass, Poa annua, and clover. It is planned to continue treatments on the plots through 1956 or until their effects on botanical composition have been established.

Results and Discussion

Results of the trial plots in 1952 and 1953 showed sodium arsenite, maleic hydrazide, and Endothal to be the most promising for further work with Poa annua. The 1954 results with large scale plots reported in the table show that Endothal-treated plots had 37 per cent more bentgrass than untreated plots and ranked with sodium arsenite for low Poa annua readings. The Endothal treatments eliminated all but a trace of the clover. The maleic hydrazide-treated plots showed very good control of Poa annua seedheads, but the injury inflicted on the turf grasses resulted in a 142 per cent increase in clover as compared with the check.

The late summer treatments made in 1952 were considered unsuccessful because of the excessive amount of turf injury experienced. No summer treatments were made during 1953 or 1954.

Table 1. Effect of chemicals on production of Poa annua seedheads, composition of turf, and discoloration of turf, Canoe Brook Country Club, Summit, N. J. 1954.

Chemical	Pounds per acre	Check of Poa annua seedheads	Per cent each species			
			Bentgrass	Poa annua	Clover	Discoloration
Check	--	----	50.0	36.0	10.3	None
Sodium arsenite + 2,4-D	1, $\frac{1}{4}$	fair	57.3	24.0	7.0	Moderate
Maleic hydrazide	1	good	35.3	31.7	25.0	Severe[1]
Endothal	$\frac{1}{2}$	fair[2]	68.3	23.7	1.0	Moderate

[1]Severe discoloration started in late April and continued into June.

[2]The effect of Endothal on seedheads was produced primarily through its action on the plants.

Conclusions and Summary

The results show that Endothal has the most promise of the treatments used. The results obtained with sodium arsenite and the experiences of golf course superintendents with this chemical have indicated it can be beneficial for those who understand its use. Additional treatments will be made to determine the long-term effect of the several treatments.

Chemical treatments of *Poa annua* in the early spring were very consistent. Moisture and growth conditions are usually less variable at this season. The treatments as used are not considered promising for general use at other seasons or on areas that do not contain enough bentgrass in the turf to replace the *Poa annua*.

PRELIMINARY RESULTS OF CHEMICAL CONTROL OF GOOSEGRASS (*Eleusine indica*) IN GREENS-TYPE TURF

R. E. Engel and R. J. Aldrich[1]

Established goosegrass plants destroy the playing quality of fine-turf areas, particularly golf greens. They tolerate severe chemical and mechanical treatments tried for control. Effective chemical treatment for elimination of this weed at the time of germination offers the simplest type of solution. Exploratory work with several chemicals was started in 1953 in New Jersey.

Methods and Procedures

1953 Tests

Trial applications of 3-p-chlorophenyl-1, 1-dimethylurea (CMU), 2,4-dichlorophenoxyethyl benzoate (SESIN), naphthalene-acetic acid, phenyl mercuric acetate, phenyl mercuric acetate plus 2,4-D, 2,4-D amine, dichloral urea, and lead arsenate were applied on May 29, to an area which was infected with goosegrass in 1952. The plots were 5 x 20 feet in size and were located on the approach to a green. All chemicals were applied in water except lead arsenate which was applied dry at the rate of 25 pounds per 1000 square feet. These plots were observed for goosegrass control and turf injury in August 1953.

1954 Tests

Sodium 2,4,5-trichlorophenoxyethyl sulfate (NATRIN) and the emulsifiable formulation of SESIN (SESIN 30E) were applied to a golf-green which was infested with goosegrass in 1953. Treatments were made June 9 and July 23, 1954. Both chemicals were applied at the rate of 3 and 6 pounds per acre and each treatment was replicated 3 times. The chemicals were applied in water at the rate of 100 gallons per acre to plots 5 x 15 feet in size. While *Poa annua* was the dominant turf grass, an appreciable quantity of bentgrass was also present. Goosegrass counts were made August 24.

Results

The SESIN treatment showed the most control of goosegrass with the least injury on the 1953 plots. It was observed that injury to turf from certain chemicals resulted in reduced competition for goosegrass which enabled the weed to make even greater growth.

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[1]Associate Research Specialist, New Jersey Agricultural Experiment Station; and Agronomist, Field Crops Research Branch, ARS, U.S. Dept. of Agriculture and Assistant Research Specialist, New Jersey Agricultural Experiment Station, respectively.

Counts in August 1954 reported in Table 1 show 24 and 52 per cent control of goosegrass with NATRIN, and 82 and 85 per cent control with SESIN 30E at the rate of 3 and 6 pounds per acre respectively. No measurable turf injury was observed.

Table 1. Effect of NATRIN and SESIN 30E on the establishment of goosegrass, New Brunswick, N. J. 1954.

Treatment	Rate	Goosegrass plants per plot - August 24
Check	--	109.7
NATRIN	3	83.3
NATRIN	6	52.3
SESIN 30E	3	20.0
SESIN 30E	6	16.3

Conclusions and Comments

The control obtained with 3 and 6 pounds of SESIN 30E per acre reduced the quantity of goosegrass sufficiently to permit hand weeding and maintenance of a usuable playing surface. The results with NATRIN suggest that the greater solubility of this material limits its value for goosegrass control.

Further testing of SESIN 30E and of materials having similar action is needed. Also, the 1954 results suggest that 3 or more treatments might be required each summer.

A Review of the Crabgrass (*Digitaria ischaemum* and *D. sanguinalis*) with Notes on Their Pre-Emergence Control in Turf [1]

L. J. King and J. A. Kramer, Jr.[2]

Introduction

Two weeds that are serious pests in lawns and special turf are the smooth or low crabgrass (*Digitaria ischaemum* (Schreb) Schreber) and the hairy or tall crabgrass (*Digitaria sanguinalis* (L.) Scopoli). The low crabgrass is a common weed in lawns in many areas; the larger species grows in cultivated fields where it often becomes a serious pest. Although the two species are similar in some respects, there are many important differences in growth, appearance, habitat and other characteristics. A comparison of the two species is presented here.

Distribution

Both species are widely distributed throughout the world. *D. ischaemum* is found in most of the temperate regions of North America, Europe and Northern Asia. *D. sanguinalis* is widespread in the temperate and warm regions of both hemispheres, but not in tropical regions. (Henrard, 1950) Both species are present in the United States and Canada; the smooth crabgrass is found more commonly in northern areas from South Carolina and Arkansas to Quebec, while the hairy crabgrass is more abundant in warmer southern latitudes.

Time of Germination

Crabgrass germinates throughout a period of approximately five months from late spring to early autumn in the northeast. *D. ischaemum* usually begins to germinate in the latter part of April and continues to germinate until late September or possibly early October. *D. sanguinalis*, on the other hand, starts to germinate in late May and continues to germinate through October. Gianfagna and Pridham (1951) suggest that the continued germination of crabgrass may be caused by a steady replenishment of crabgrass seed in the "germination zone" due to the eroding action of heavy rains and turning over of the top layer of soil by common field cultivation practices. The germination zone is several centimeters in depth. We have found that seeds of both species germinated from a depth of 3.5 centimeters. Alternate wetting and drying of surface soil without any disturbance will also promote weed seed germination. (King 1951)

1/ Acknowledgment is given to Mr. Herbert Hatfield for valuable assistance in this work.

2/ Fellows, Boyce Thompson Institute for Plant Research, Inc. and the Carbide and Carbon Chemicals Co. Yonkers, New York.

Seed Dormancy

Freshly harvested <u>Digitaria</u> seed is dormant (Toole and Toole 1941: Gianfagna & Pridham 1951) but this dormancy can be broken by several methods. Toole and Toole (1941) found that changes in the seed which cause the germinative processes to start in both species occur most rapidly in moist seeds at low temperatures ($3^oC.$). Gianfagna & Pridham (1951) induced germination by puncturing or scarifying the seed and by soaking the seed in ethylene chlorohydrin 500 p.p.m. Because the seed requires 28-56 days before germination can start, it is unlikely that any appreciable number of the current seasons' seeds germinate the same season they reach maturity.

Seedling Characteristics

The seedlings of the two species differ markedly in appearance. <u>D. ischaemum</u> seedlings are dark green, tall with linear leaves and almost devoid of noticeable hairs. They are well adapted to survival in turf. Hairy crabgrass seedlings are a lighter green, have broad leaves and a spreading form thus making them not so well adapted to survival in turf. They are conspicuously hairy. Young plants and seedlings of smooth crabgrass were not harmed by early frosts while those of the hairy species suffered severe damage from early frost at the Boyce Thompson farm.

Mature Plant Characteristics

Mature crabgrass plants of the two species differ greatly in size and growth habit. Smooth crabgrass plants reach a height of 15-40 cm., are not too extensively branched and only seldom develop roots at the nodes. Hairy crabgrass plants may reach 1 meter in height, are profusely branched and spreading with extensive rooting at the nodes.

Flowering Period

Hairy crabgrass flowers in Indiana approximately 6 weeks after germination at least in the latter part of the season, while smooth crabgrass requires a somewhat longer period. In the above state the flowering period of hairy crabgrass extends from July 6 to October 2; the smooth flowers from August 3 to October 4. We have observed depauperate flowering plants of both species 5-8 cm. in height on October 1. Temperature and moisture are two factors which undoubtedly play the major role in starting germination in the spring. The dates will vary from north to south as will be shown below.

Habitats

Smooth crabgrass is usually found only in turf areas and may be less common in alkaline soils. Hairy crabgrass is a field weed. It is widely distributed in warmer regions and is a troublesome crop weed regardless of the soil type. Smooth crabgrass germinates under cool conditions.

In the spring the surface soil of turf may be several degrees lower than open soil and this favors germination of smooth crabgrass. Hairy crabgrass, on the other hand, germinates under warm conditions. Since the open soil during early spring is considerably warmer than turf surface soil, especially during the heat of the day, this species germinates first in the open soil areas.

Temperature measurements taken in the top 1/2" of soil in turf and open areas during September and October show that in the early morning the turf was 1.3°F. higher than open soil and in early afternoon the open soil was 2.1°F. higher than turf on the average.

Regional Aspects

Northeast: Both species are commonly found in the northeastern United States. The smooth begins to germinate in open soil and turf after April 10 and the hairy crabgrass begins to germinate later in the spring. It is thought that early flushes of growth of smooth crabgrass are due to temperature and that later flushes are due to moisture. Smooth crabgrass seed will germinate in 3 days in wet soil at 75°F. We have observed small seedlings of smooth crabgrass early in October, but no seedlings of the hairy species could be found at this date.

North Central: In this area hairy crabgrass is more abundant than smooth crabgrass. Smooth crabgrass starts to germinate in mid-May in open soil and a month earlier in turf. Rainfall and temperature are the environmental factors controlling germination in this area also. Smooth crabgrass is known to germinate as late as August 26.

Northwest: Not much information is available for this area on crabgrass. Smooth crabgrass germinates in April and hairy crabgrass starts to germinate in June. Apparently crabgrass is not usually a problem in most of this section.

Southeast: Smooth crabgrass is not common in this area. Hairy crabgrass is very common in cultivated fields and turf. Germination begins in open soil early March in Alabama and in early May in the Carolinas. Germination in turf is about 15 days later in Tennessee. Hairy crabgrass will germinate in September in Tennessee, and as late as December 1 in the gulf region of Alabama.

Southwest: Both species are common to this region. Smooth crabgrass is a pest in turf and cotton, and hairy crabgrass is found in cultivated fields and sometimes in turf. Both species germinate in May in open soil and in late May in turf. Moisture along with high day and night temperatures in the ranges of 60-65°F. are the controlling environmental factors. Smooth crabgrass will germinate as late as September.

Pre-emergence Crabgrass Control with Crag Herbicide 1 (SES)

Crabgrass is an annual plant, and as discussed above, the seeds germinate in the spring and throughout the summer. By mid-summer the crabgrass plants become apparent and start to crowd out the regular lawn grasses, making an unsightly lawn. Bare spots in the lawn result when the mature crabgrass plant is killed by chemicals, or when it dies out naturally in the fall. This requires re-seeding the lawn every fall. If the seedling can be killed, then the crowding out of turf grasses is prevented and obviously no new crabgrass seed will be deposited.

Crag Herbicide 1 has been used successfully to control crabgrass in blue grass turf. This herbicide kills the crabgrass seeds as they germinate and is probably not effective once the seedlings have attained the two to three leaf stage. Because the crabgrass seed germinates over a period of several months frequent applications are required if effective control is to be achieved.

Field experiments conducted during the past two years have indicated that the following are important factors in the successful control of crabgrass in turf using Crag Herbicide 1:

a) Crag Herbicide 1 must be applied 4 to 5 times during the summer, starting the first of May and continuing through August to effectively control crabgrass. Applications should go on every 3 to 4 weeks.

b) The most effective rate to apply Crag Herbicide 1 has been observed to be 6 lbs./A. At this rate no injury or discoloration was observed to the turf.

c) Crag Herbicide 1 is easy to apply being water soluble. It may be applied with a sprinkling can, hose-end sprayer, or conventional sprayers of the type used to apply pesticides or herbicides. The most convenient is the hose-end sprayer.

d) Application of Crag Herbicide 1 to a newly seeded lawn should be delayed until after the second or third cutting to avoid injury to the grass seedling. No injury or discoloration has been experienced with Crag Herbicide 1 applied to established lawns. Crag Herbicide 1 should only be used experimentally on putting greens. Adequate field testing has not been completed to determine its toxicity to the bent grasses.

e) Crag Herbicide 1 will also control germinating annual broadleaved weeds. Crabgrass and other annuals in sand traps on golf courses, can be controlled by the use of Crag Herbicide 1.

When applied to turf, Crag Herbicide 1 has proven to be an effective and safe herbicide for the prevention of crabgrass germination.

References Cited

1. Dyking, Dean, Fults, Jess and Blouch, Roger. 1954.
The control of crabgrass (*Digitaria sanguinalis* (L.) Scop.)
A review of the literature. (Mimeo. Report)

2. Gianfagna, Alfred J. and Pridham, A.M.S. 1951.
Some aspects of dormancy and germination of crabgrass seed, *Digitaria sanguinalis* Scop. Proc. Amer. Soc. Hort. Sci. 58: 291-297.

3. Henrard, J. T. 1950.
Monograph of the genus *Digitaria*. pp. 1-999.
Universitaire Pers. Leiden, Leiden

4. King, L. J. 1952.
Germination and Chemical Control of the Giant Foxtail Grass.
Contrib. Boyce Thompson Inst. 16: 469-487.

5. King, L. J. 1955.
Summary Report on the Crabgrass Questionaire.

6. McWhorter, C. G. 1954.
Unpublished data, Delta Branch Exten. Sta., U.S.D.A.

7. Toole, E. H. and Toole, V. K. 1941.
Progress of germination of seed of *Digitaria* as influenced by germination temperature and other factors.
Jour. Agric. Res. 63: 65-90.

Studies in the Control of Veronica filiformis in Turf Using KOCN, Endothal, 2,4-D and 2,4,5-T

John A. Jagschitz and John F. Cornman[1]

Introduction

Several mat-forming species of Vernoica or Speedwell are found as weeds in turf areas. Veronica filiformis, apparently an escape from rock gardens, is increasingly troublesome in home lawns, for it occurs in dense patches and often spreads rapidly throughout the entire area. The cultural and chemical controls effective against other broad-leaved weeds are reported by home owners to be ineffective against this pest. This paper reports the effectiveness of potassium cyanate, endothal, 2,4-D, and 2,4,5-T as selective controls for Veronica filiformis.

Materials and Methods

The three experiments were located at the Cornell Test Garden on a mixed turf of Kentucky bluegrass and creeping bent.

The chemicals used were: endothal (disodium 3,6-endoxahexahydrophthalate, formulation ME-3003 containing 2 pounds of endothal per gallon); KOCN (potassium cyanate, 91% dry material); 2,4-D (propylene glycol butyl ether esters, Dow Esterone 10-10, 4 pounds acid per gallon); and 2,4,5-T (propylene glycol butyl ether esters 66%, Dow Esteron 245, 4 pounds acid per gallon).

Chemicals were applied as sprays using a small plot sprayer with four fan-type TeeJet nozzles on a hand boom. Pressure at 30 psi were supplied by CO_2. Nozzles were changed for different gallonages. Two timed passes were made over each plot for uniform coverage.

Turf discoloration readings were made after treatment and the scale used was: 0 - none, 1 - light, 2 - moderate or objectionable, 3 - severe, and 4 - complete kill. Three gradations were distinguished between each of these readings. The check plots at the time of reading were considered as 0 (none).

Per cent of veronica control was estimated as the reduction in area covered by veronica leaves from the amount present in each plot before treatment. Before the percentage control was calculated, the base figure for the amount originally present in each plot was adjusted in proportion to the seasonal changes observed in the check plots.

Experiment I

The experimental design was a complete randomized block with three replications. The experimental area as a whole contained 49% veronica. Individual plots measured 4 x 10 feet. Five plots served as checks.

Three treatments, consisting of one application, were made on September 14, 1953 and these were as follows: endothal at the rate of $1\frac{1}{2}$ pounds to the acre and KOCN at the 16 pound rate, each applied as sprays at the rate of 200 gallons of water to the acre; and a mixture of 2,4-D and 2,4,5-T, 1 pound acid equivalent of each to the acre, applied at the rate of 25 gallons of water to the acre.

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1 Turf Research Assistant, and Associate Professor of Ornamental Horticulture, Cornell University, Ithaca, New York, respectively.

Four treatments, consisting of two applications, were made on September 14 and September 22, 1953 and these were as follows: endothal at the 3/4 and 1 pound rate and KOCN at the 8 and 12 pound rate per acre, each applied as sprays at the rate of 200 gallons of water per acre.

Three days before the sprays were to be applied the amount of veronica was estimated and then the experimental area was moved from a 3" to a 1" height and raked at 3 different times. At the time of treatments the temperature was in the high 50's and the soil was slightly moist. Weather for the next 10 days was cool and damp, followed by a drought period. Turf growth was slow and the area was not mowed again that season.

Turf discoloration readings were made September 22, September 30, October 9 and November 3, 1953. Veronica estimates were made November 3, 1953 and October 9, 1954.

Experiment II

Early observation of the plots treated on September 22 (Experiment I) indicated that single applications of endothal and KOCN at lower rates might be effective in controlling veronica. A series of plots, adjacent to those of Experiment I, were estimated, mowed, raked and sprayed on September 25, 1953. The area as a whole contained 65% veronica. Two of the plots, 4 x 10 feet, served as checks.

Two treatments, replicated three times, were as follows: endothal at the 3/4 pound rate and KOCN at the 8 pound rate per acre, each applied as sprays at the rate of 200 gallons of water to the acre.

At the time of treatment, the temperature was in the high 60's and the soil was moist. The following eight days were without rain and maximum temperatures were in the high 70's.

Turf discoloration readings were made on October 4, October 9 and November 3, 1953. Veronica estimates were made on November 3, 1953 and on October 9, 1954.

Experiment III

The experimental design was three complete randomized blocks. The experimental area as a whole contained 51 per cent veronica. Individual plots measured 4 x 10 feet. Four plots served as checks.

One application of each of the following four chemical treatments was applied on April 26, 1954. Endothal at the rate of 3/4 pounds per acre and KOCN at the 12 pound rate were each applied as sprays at the rate of 200 gallons of water to the acre. 2,4-D and 2,4,5-T were each applied as sprays at the rate of 3 pounds of acid equivalent per acre in 50 gallons of water to the acre.

The experimental area was mowed at a $1\frac{1}{2}$ inch height for the first mowing of the season, three days before treatment. Veronica was in flower and the turf and veronica were growing vigorously.

At the time of treatment the temperature was in the low 60's and the soil moisture was high. A very light rain fell after treatment, with heavy rains the following two days.

On June 25, 1953, about two months after the first application, a second application of endothal at 3/4 pound and KOCN at 12 pounds per acre were made, to a duplicate set of plots which had been treated once on April 26, 1953.

At the time of treatment the temperature was in the high 70's and the soil was slightly moist. The turf was mowed the day before treatment. Light showers fell three hours after treatment and the next day the sky was cloudy and the atmosphere humid.

Turf discoloration readings were made May 4, 1954 and estimates of veronica were made June 23 and October 9, 1954.

Results and Discussion

The data in Tables I, II, and III show that endothal was much the most effective chemical treatment. According to our data endothal was equally effective in either spring or fall, though this observation must be considered tentative until a comparable period has elapsed and recovery of veronica from spring applications is noted again.

Potassium cyanate, 2,4-D, and 2,4,5-T at the rates used in these experiments did not produce satisfactory control of veronica. The initial percentages of control were much lower than those from endothal, and during the succeeding months there was a strong regrowth of the weed.

No treatment produced objectionable discoloration of the turf, though the discoloration from the use of endothal was more pronounced than that from the other chemicals. The data for comparable treatments with endothal in fall and spring indicate that the discoloration from fall treatments was the more severe. Turf recovery was also more prompt in the spring. However, these differences may well have been due to the dry weather in the fall, rather than to seasonal changes in susceptibility. In the spring the treated and untreated plots were alike in turf appearance two weeks after the treatments were made. Turf discoloration after the second spring application, not recorded here, was comparable to that produced by the first spring application.

Unreplicated plots, not presented in this paper, indicated that the effectiveness of the endothal was increased when the turf was mowed and raked a few days before treatment.

Conclusions

In mixed turf endothal produced almost complete control of *Veronica filiformis* for at least one year with only moderate, temporary turf discoloration. Potassium cyanate, 2,4-D and 2,4,5-T were much less effective and were inadequate under the conditions of our experiments.

At the present time the home owner has no practical control for *Veronica filiformis*. On the basis of the data presented here and our numerous experiences with endothal in other selective weed control work, we would suggest a tentative recommendation to apply endothal either in spring or fall, when the soil is normally moist and the weather mild. Use 3/4 pound actual endothal in 200 gallons of water per acre and repeat the treatment at the same rate two weeks later.

Table I. Veronica control and turf discoloration in lawn turf treated September 14, 1953 with one and two applications of endothal and KOCN and with one application of a mixture of 2,4-D and 2,4,5-T in Experiment 1.

Chemical	Pounds of active material per acre	Number of treatments	% veronica control: Time after 1st treat.* 7 weeks	% veronica control: Time after 1st treat.* 12 3/4 months	Turf discoloration: Days after 1st treat.* 8	16	25	50
Endothal	1½	1	99	93	1.6	1.0	0.5	0.5
Endothal	1	2	99	97	1.4	1.5	0.9	0.6
Endothal	3/4	2	100	96	1.6	1.3	0.8	0.8
KOCN	16	1	84	38	1.4	0.6	0.2	0.1
KOCN	12	2	96	64	0.8	0.7	0.1	0.0
KOCN	8	2	47	5	0.8	0.7	0.7	0.0
2,4-D and 2,4,5-T	2	1	80	27	0.0	0.2	0.0	0.3
LSD 5%			30	39				
1%			42	54				
Per cent of veronica in check plots (before 49)			54	76				

* 2nd treatment 8 days after 1st

Table II. Veronica control and turf discoloration in lawn turf treated September 25, 1953 with one application of endothal and KOCN in Experiment II.

Chemical	Pounds of active material per acre	% of veronica control: Time after treatment 5½ weeks	% of veronica control: Time after treatment 12½ months	Turf discoloration: Days after treatment 9	14	39
Endothal	3/4	94	72	1.9	1.7	1.4
KOCN	8	58	12	1.6	1.4	0.7
Level of F significance		5%	5%			
Per cent of veronica in check plots (before 64)		55	75			

Table III. Veronica control and turf discoloration in lawn turf treated April 26, 1954 with one application of endothal, KOCN, 2,4-D and 2,4,5-T and a second application of endothal and KOCN on June 25, 1954 in Experiment III.

Chemical	Pounds of active material per acre	Number of treatments	% veronica control, Time after 1st treat.* 2 months	% veronica control, Time after 1st treat.* 5½ months	Turf discoloration, Days after 1st treat. 8
Endothal	3/4	1	95	73	0.6
Endothal	3/4	2	94	88	-
KOCN	12	1	45	6	0.4
KOCN	12	2	46	43	-
2,4-D	3	1	47	15	0.2
2,4,5-T	3	1	69	20	0.1
LSD 5%			39	20	
1%			56	29	
Per cent of veronica in check plots (before 44)			53	69	

* 2nd treatment 2 days after two month estimates

Comparison of 4 Chloro, 3,4-D, MCP, 2,4-D and 2,4,5-T in Various Formulations for the Control of White Clover in Turf

John A. Jagschitz and John F. Cornman[1]

White clover in turf is a serious weed problem on golf courses and athletic fields. 2,4,5-T (1, 3) has offered great promise in the control of clover in turf. Some workers in turf (2,7) have found that MCP produced better control than 2,4-D. Weed control experiments in field crops (4,5,6,8) indicate that phenoxy compounds such as 4 Chloro, 3,4-D, MCP and 2,4-D in various formulations, affect legumes in varying degrees.

This paper presents a comparison of 4 Chloro, 3,4-D, MCP, 2,4-D and 2,4,5-T in various formulations as a control chemical for white clover in turf.

Materials and Methods

The experiment was located on the 4th fairway of the Cornell University Golf Course. The turf was a mixture of Kentucky bluegrass, creeping red fescue, and red top. The experimental area as a whole contained 50% clover.

Forty-one chemical treatments were applied on September 22, 1953 in three complete randomized blocks. Individual plots were 4 x 10 feet. Twenty-seven plots served as checks. Chemicals were applied as sprays at the rate of 50 gallons of water to the acre with a small plot sprayer with four fan-type TeeJet nozzles on a hand boom. Pressure at 30 psi was supplied by CO_2. Two timed passes were made over each plot for uniform coverage.

At the time of application the temperature was in the high 50's, the soil was moist, and about 0.06 inches of rain fell during the application period. The grass and clover, 3 to 5 inches high, was growing vigorously and had not been mowed for a week and was not mowed again that season. Temperatures ranged between 32 and 81°F during a five day period following application. No rain fell for an 11 day period and the soil became dry.

Visual observations of turf and clover browning and yellowing and of clover petiole epinasty were noted October 9, 1953, 17 days after treatment. Clover estimates were made May 31 and September 28, 1954. Per cent of clover control was estimated as the reduction in area covered by clover leaflets from the amount present in each plot before treatment on September 22, 1953. Before the percentage of clover control was calculated, the base figure for the amount originally present in each plot was adjusted in proportion to the variation observed in the check plots.

The following 16 chemicals were applied at the rates mentioned in Table I.

Abbreviation	Chemical and Formulation
4 Chloro (amine)	4 chlorophenoxyacetic acid, amine, A-1022 JT 563-5, Dow, 4 pounds acid per gallon
4 Chloro (ester)	4 chlorophenoxyacetic acid, ester, ACP-L-423, 2 pounds acid per gallon

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[1] Turf Research Assistant, and Associate Professor of Ornamental Horticulture, Cornell University, Ithaca, New York, respectively.

Abbreviation	Chemical and Formulation (continued)
3,4-D (triethanolamine)	3,4-dichlorophenoxyacetic acid, triethanolamine salt, 2% sequestering agent, no wetting agent, Hercules, 4 pounds acid per gallon
3,4-D (diethanolamine)	3,4-dichlorophenoxyacetic acid, diethanolamine salt, ACP-L-569, 4 pounds acid per gallon
3,4-D (butoxy ester)	3,4-dichlorophenoxyacetic acid, butoxy ethanol ester, ACP, 4 pounds acid per gallon
3,4-D (iso-octyl ester)	3,4-dichlorophenoxyacetic acid, iso-octyl ester 66.3%, Hercules, 4 pounds acid per gallon
MCP (diethanolamine)	2-methyl-4-chlorophenoxyacetic acid, *diethanolamine salt 30.5% (*2-M-1-4-chlorophenoxyacetic acid 20.6%), ACP, Weedar MCP 60, 2 pounds acid per gallon
MCP (sodium salt)	2-methyl-4-chlorophenoxyacetic acid, sodium salt 22.2% Chipman, Methoxone, 2 pounds acid per gallon
MCP (alkanolamine)	2-methyl-4-chlorophenoxyacetic acid, alkanolamine salts of the ethanol and isopropanol series, 69.1%, Dow MCP Amine Weed Killer, 4 pounds acid per gallon
2,4-D (triethanolamine)	2,4-dichlorophenoxyacetic acid, triethanolamine salt 63%, GLF Weed Killer 66, 4 pounds acid per gallon
2,4-D (butyl ester)	2,4-dichlorophenoxyacetic acid, propylene glycol butyl ether esters, Dow Esterone 10-10, 4 pounds acid per gallon
2,4-D & 2,4,5-T (amine)	Dimethylamine 2,4-D 24.7% and ethyl amine 2,4,5-T as triethylamine salt 28.6%, Dupont 2,4-D and 2,4,5-T Amine Brush Killer, 2 pounds acid of each per gallon
2,4-D & 2,4,5-T (butyl ester)	An equal mixture of 2,4-D butyl ester and 2,4,5-T butyl ester
2,4,5-T (triethylamine)	2,4,5-trichlorophenoxyacetic acid, ethyl amine 2,4,5-T as triethylamine salt 57%, Dupont 2,4,5-T 57% Amine Brush Killer, 4 pounds acid per gallon
2,4,5-T (pentyl ester)	2,4,5-trichlorophenoxyacetic acid, pentyl ester 2,4,5-T 46% Thompson's Bramblicide, E-2,4,5-T Brush Killer, 3.13 pounds acid per gallon
2,4,5-T (butyl ester)	2,4,5-trichlorophenoxyacetic acid, propylene glycol butyl ether esters 66%, Dow Esteron 245, 4 pounds acid per gallon

Results and Discussion

Visual observations of the treated plots, 17 days after treatment, indicated the turf was not seriously injured by any of the treatments. This was also true the following spring. A few burned spots on the grass blades, possibly resulting from direct chemical contact, were evident from all treatments except those with the two 4 Chloro formulations. Yellowing of the grass blades by most formulations was slight, but was more pronounced with 3,4-D formulations, especially butoxy ester.

Burned spots on the clover leaflets were slightly evident with 3,4-D butoxy ester, 3,4-D iso-octyl ester and MCP sodium salt. Yellowing of the clover leaflets and epinasty of the clover petioles was the most conspicuous with 2,4,5-T followed by 3,4-D, MCP, 2,4-D and 4 Chloro.

Data in Table I show that the best phenoxy compound for the control of clover was 2,4,5-T. The 2,4,5-T formulations, as an average of the 3/4 and $1\frac{1}{2}$ pound rates of acid equivalent per acre, produced significantly better clover control than any of the other compounds tested. The butyl ester formulation of 2,4,5-T at the 3/4 pound rate produced significantly greater clover control (85%) than the triethylamine formulation (43%) and also better than the pentyl ester (65%). There were no significant differences in control between the triethylamine (92%), pentyl ester (83%) and butyl ester formulations (96%) at the $1\frac{1}{2}$ pound rate.

The triethylamine and butyl ester formulations of 2,4,5-T at the 3/4 pound rate produced essentially the same degree of control as the same rate of 2,4,5-T plus 3/4 pounds of 2,4-D butyl ester or amine, respectively.

4 Chloro, 3,4-D and MCP at rates up to 3 pounds acid equivalent per acre and 2,4-D at rates up to $1\frac{1}{2}$ pounds did not produce over 46% clover control 12 months after treatment. There were no significant differences between any of these 4 phenoxy compounds or their formulations as an average of the 3/4 and $1\frac{1}{2}$ pound rates.

Conclusions

Under the conditions of this experiment, 2,4,5-T produced much better clover control than the other compounds and seems worthy of continued study. Formulations of 4 Chloro, 3,4-D, MCP, and 2,4-D were relatively ineffective. Turf injury was not serious from any of the compounds.

The butyl ester formulation of 2,4,5-T produced better clover control than either the triethylamine or pentyl ester formulations at the 3/4 pound rate, while at the $1\frac{1}{2}$ pound rate there was little difference.

The addition of 3/4 pound of 2,4-D to 3/4 pound of 2,4,5-T did not increase the effectiveness over that of 3/4 pound of 2,4,5-T alone.

Literature Cited

1. Daniel, W. H. The use of 2,4,5-T for clover control in turf. A paper presented before the Am. Soc. of Agron., Nov. 1952 and reprinted in the New York State Turf Assoc. Bul. 39 and 40: 156-157 (1953).

2. Escritt, J. R. MSc. Selective weedkillers. Jour. of Sports Turf Research Inst. 8, No. 27: 80-83 (1951).

3. Jagschitz, J. A. and J. F. Cornman. Duration of clover control with endothal and with 2,4,5-T in turf mowed at lawn and fairway height. Proc. NWCC 8: 393-398 (1954).

4. Marshall, E. R. and J. Van Geluwe. Three years results with the use of MCP and 2,4-D for weed control in seeded grains. Proc. NWCC 7: 181-186 (1953).

5. Schreiber, M. M. and S. N. Fertig. Preliminary results of pre- and post-emergence screening experiments on legumes. Proc. NWCC 8:313-317 (1954).

6. ______________________. The effects of various herbicides on the yield and botanical composition of legumes. Proc. NWCC 8: 363-376 (1954).

7. Scragg, E. B. Selective weedkillers: recent developments. Scot. Jour. Agri. 32, No. 3: 124-131 (1952 and 1953).

8. Tafuro, A. J., R. H. Beatty and C. C. Jack. The effect of six herbicides on alfalfa and clovers underseeded to spring oats. Proc. NWCC 8: 307-311. (1954).

Table I. Clover control in fairway turf treated September 22, 1953 with several phenoxy compounds of various formulations.

Chemical and formulation	lb. acid equivalent per acre	Per cent of clover control: Time after treatment 8 months	12 months	Aver. of the 2 low rates at 12 months
4 Chloro (amine)	3/4	0	3	7
	1 1/2	1	10	
	3	10	0	
4 Chloro (ester)	3/4	4	8	
	1 1/2	28	15	12
	3	5	4	
3,4-D (triethanolamine)	3/4	17	7	
	1 1/2	18	11	9
	3	23	18	
3,4-D (diethanolamine)	3/4	12	20	
	1 1/2	17	9	14
	3	39	10	
3,4-D (butoxy ester)	3/4	11	7	
	1 1/2	17	12	10
	3	43	23	
3,4-D (iso-octyl ester)	3/4	26	17	
	1 1/2	34	29	23
	3	54	23	
MCP (diethanolamine)	3/4	23	8	
	1 1/2	40	26	17
	3	57	23	
MCP (sodium salt)	3/4	47	26	
	1 1/2	17	22	24
	3	67	36	
MCP (alkanolamine)	3/4	20	23	
	1 1/2	48	19	21
	3	67	46	
2,4-D (triethanolamine)	3/4	20	12	
	1 1/2	17	6	9
2,4-D (butyl ester)	3/4	22	15	
	1 1/2	41	31	23
2,4-D & 2,4,5-T (amine)	3/4	49	9	
	1 1/2	70	46	28
2,4-D & 2,4,5-T (butyl ester)	3/4	60	45	
	1 1/2	89	74	60
2,4,5-T (triethylamine)	3/4	71	43	
	1 1/2	96	92	68
2,4,5-T (pentyl ester)	3/4	80	65	
	1 1/2	91	83	74
2,4,5-T (butyl ester)	3/4	90	85	
	1 1/2	98	96	90
LSD 5%		26	26	19
1%		34	35	25
Per cent of clover in checks (before treatment 51%)		59	74	

Persistence of Clover Control in Putting Green Turf Treated with Endothal and 2,4,5-T

John A. Jagschitz and John F. Cornman[1]

Six experiments were initiated in 1953 to determine the effectiveness of various formulations of endothal and 2,4,5-T for controlling white clover in putting green turf. These experiments also studied such factors as gallonage, mowing, thatch removal and time of day of application. Tentative results (1953) were presented in a previous paper (1) and we are now able to complete the record by reporting clover control evident in these same experiments more than one year after treatment.

Two additional experiments, initiated in 1953 but not presented previously, are included in this paper. One of these studies reports the comparative effectiveness of endothal and 2,4,5-T and the other compares the effect of one and two applications of endothal and 2,4,5-T.

As a matter of convenience the six experiments are enumerated here in the same order as in the previous report (1), with a repetition here of the 1953 clover counts for comparison. The two experiments not reported before follow these, and are numbered 7 and 8. For further details of the first six experiments see the previous paper (1).

All rates of chemicals used are expressed in pounds of endothal per acre or pounds of 2,4,5-T acid per acre.

Constants in Terminology and Experimental Conditions

Abbreviations	Formulation
ME-3001	16% endothal (disodium 3,6-endoxahexahydrophthalate) and 84% ammonium sulfate (a powder)
ME-3003	2 pounds endothal per gallon
EC-4069	2/3 pound endothal and 3 1/3 pounds ammonium sulfate per gallon
2,4,5-T	
Amine	Triethylamine salt 57%, 4 pounds acid per gallon
Butyl ester	Propylene glycol butyl ether esters 66%, 4 pounds acid per gallon
Pentyl ester	Pentyl ester 46%, 3.13 pounds acid per gallon
Isopropyl ester	Isopropyl ester 32.3% and amyl ester 11.7%, 3.34 pounds acid per gallon

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[1] Turf Research Assistant, and Associate Professor of Ornamental Horticulture, Cornell University, Ithaca, New York, respectively.

Turf Components

On all greens treated there were some patches of velvet bent of varying size and frequency, but most of the grass appeared to be creeping bent.

Method of Application

Sprays were applied with a small-plot sprayer with four fan-type TeeJet nozzles on a hand boom. Constant pressure was supplied by CO_2 between 25 and 30 psi. Nozzles were changed for different gallonages. Two timed passes were made over each plot for uniform coverage. ME-3001, when applied as a dry mixture, was mixed with dry builder's sand which passed a 64-mesh screen and was spread by hand at the rate of 726 pounds per acre.

Turf Discoloration

The turf discoloration scale used was: 0 - none, 1 - light, 2 - moderate or objectionable, 3 - severe, and 4 - complete kill. Three gradations were distinguished between each of these readings. The check plots at the time of reading were considered as 0 (none).

Clover Control

Per cent clover control was estimated as the reduction in area covered by clover leaflets from the amount in each plot before treatment. Before clover control was calculated in terms of per cent, the base figure for the amount originally present in each plot was adjusted in proportion to the variation observed in the check plots. A $\frac{1}{2}$ foot strip just inside each plot boundary served as a border strip.

Experiment 1 - Gallonage and Endothal

Purpose: To determine the influence of gallonage on clover control with endothal on putting green turf.

Results and Discussion

As previously reported (1), clover control using ME-3001 at 1/8 pound, EC-4069 at 3/8 pound and ME-3003 at 3/4 pound of endothal to the acre did not differ from each other significantly and was considered unsatisfactory. Changing the volume of water per acre from 50 to 200 to 800 gallons did not significantly affect the degree of control, but the use of higher gallonage did result in significantly less turf injury.

Observation of the experiment in 1954 indicated that clover control was still unsatisfactory and no attempt was made to take further data.

Experiment 2 - Mowing

Purpose: To determine the effect of mowing putting green turf prior to the application of endothal and 2,4,5-T for clover control.

Results and Discussion

Clover counts in 1953 and 1954 indicate that mowing putting green turf before treatment has no significant effect on the degree of clover control. Clover control estimates presented in Table 1 for each chemical treatment are as an average of the mowed and unmowed plots.

Table 1. Clover control on putting green turf treated with endothal and 2,4,5-T on June 9, 1953 in Experiment 2.

Chemical	Pounds of active material per acre	Per cent of clover control Time after Treatment 15 weeks*	 15 3/4 months
ME-3001 in sand	1/4	96	91
EC-4069	1/2	97	89
ME-3001	1/8	94	86
ME-3003	3/4	94	85
2,4,5-T butyl ester	1/2	91	82
2,4,5-T amine	1/2	82	57
LSD 5%		8	17
1%		11	23
Per cent clover in checks (before 6.5)		8.8	10.9

* Summarized from Table 2, Jagschitz, Cornman, and Fertig (1)

As was found in 1953, the 1954 counts indicate that the ester form of 2,4,5-T produced significantly better clover control than the amine form. There was no significant difference in control between the ester of 2,4,5-T and the endothal treatment.

Turf discoloration produced by the treatments was not considered objectionable. Both 2,4,5-T formulations produced the least discoloration and since the ester form of 2,4,5-T gave better control than the amine, it was considered to be the most satisfactory treatment.

Experiment 3 - Time of Day

Purpose: To determine the effect of time of application during a day on clover control with 2,4,5-T and endothal on putting green turf.

Results and Discussion

Data in 1953 and 1954 indicate that the time of day of application, 6 a.m., 1 p.m., and 9 p.m., had no significant effect on the degree of clover control. The clover control values presented in Table 2 are as an average of the three times of application during a day.

The butyl ester form of 2,4,5-T produced the best clover control of any treatment used, although not significantly better than the amine form. Each material produced some dead patches of turf with the ester form of 2,4,5-T the most severe in this regard. No treatment caused more than light general discoloration after application.

Table 2. Clover control in putting green turf treated with endothal and 2,4,5-T on June 16 and June 17, 1953 in Experiment 3.

Chemical	Pounds of active material per acre	Per cent of clover control — Time of treatment: 15 weeks*	15 3/4 months
2,4,5-T butyl ester	$\frac{1}{2}$	85	77
2,4,5-T amine	$\frac{1}{2}$	74	63
ME-3003	$\frac{1}{2}$	76	57
EC-4069	$\frac{1}{4}$	62	42
LSD 5%		14	17
1%		20	23
Per cent clover in checks (before 23)		21	13

* Summarized from Table 3, Jagschitz, Cornman and Fertig (1)

Experiment 4 - Gallonage and 2,4,5-T

Purpose: To determine the effect of gallonage on clover control with 2,4,5-T amine and butyl ester formulations on putting green turf.

Results and Discussion

It was found that there was no significant difference in clover control, with the 1953 and 1954 readings, between 25, 100 and 400 gallons of water per acre when applying the ester and amine form of 2,4,5-T. The clover control values in Table 3 are presented as an average of the three gallonages used.

Table 3. Clover control in putting green turf treated with two formulations of 2,4,5-T on September 29, 1953 in Experiment 4.

2,4,5-T formulation	lbs. acid per acre	Per cent of clover control — Time after treatment: 6* Weeks	1 Year
Butyl ester	1	92	86
Amine	1	87	73
LSD 5%		NSD	9
1%		"	13
Per cent clover in check plots (before 12)		12	12

* Summarized from Table 4. Jagschitz, Cornman and Fertiz (1)

The data in Table 3 show that clover control one year after treatment was significantly better with ester than with the amine form of 2,4,5-T. Neither treatment produced any obvious turf injury.

Experiment 5 - Thatch Removal and Gallonage

Purpose: To determine the effect of thatch removal and gallonage on clover control with ME-3003 and 2,4,5-T amine on putting green turf.

Results and Discussion

Table 4. Clover control on putting green turf treated with endothal and 2,4,5-T amine on September 18, 1953 in Experiment 5.

			Per cent of clover control				
			Time after treatment				
			2 months*		12 3/4 months		
Chemical	lb./acre	gal./acre	Thatch removed	Thatch not removed	Thatch removed	Thatch not removed	Aver.
ME-3003	3/4	25	87	84	44	39	
		50	91	86	55	41	
		400	90	77	48	43	45
2,4,5-T	1	25	70	72	47	67	
		50	68	78	51	68	
		400	59	65	29	46	51
Per cent of clover in check plots (before 13)			13			11	

* Summarized from Table 5, Jagschitz, Cornman and Fertig (1)

Data in Table 4 present the results of this experiment. There was no significant difference between thatch removal as an average of the two chemical treatments, but the interaction of chemicals x thatch removal was significant in 1954. Perhaps this indicates that better clover control was produced with ME-3003 when the thatch was removed and that with 2,4,5-T amine better control was obtained when the thatch was not removed. Thatch removal under these circumstances could be similar to the removal of some of the clover foliage before treatment.

There was no significant difference between gallonage as an average of the two chemicals, but the interaction of gallonage x chemicals was significant in 1954. Possibly better clover control was produced with 2,4,5-T amine when applied in 25 and 50 gallons of water per acre rather than in 400 gallons while with ME-3003 there was little difference in this regard.

No treatment produced objectionable general turf discoloration, but ME-3003 did produce some areas of dead turf after application. 2,4,5-T amine was considered to be a more satisfactory treatment than ME-3003 in regard to clover control and turf injury.

Experiment 6 - 2,4,5-T Formulations

Purpose: To determine the relative effectiveness of four formulations of 2,4,5-T for clover control on putting green turf.

Results and Discussion

A thatch removal operation similar to that of Experiment 5 was included in this experiment. It was found that thatch removal or any interaction involving thatch removal did not significantly affect the degree of clover control.

Clover control values presented in Table 5 are averages of the thatch-removed and not-removed plots. The butyl, isopropyl and pentyl ester forms of 2,4,5-T produced significantly better clover control than the amine form. None of the treatments under the conditions of this experiment caused turf discoloration or the appearance of dead turf, but there was some indication that the isopropyl ester had retarded turf growth and that the butyl ester had stimulated growth; the amine and pentyl did not appear to differ from the check plots.

Table 5. Clover control in putting green turf treated with four formulations of 2,4,5-T on September 18, 1953 in Experiment 6.

2,4,5-T formulation at 1 lb. per acre	Per cent of clover control Time after Treatment 2 months*	 12 3/4 months
Butyl ester	86	91
Isopropyl ester	87	91
Pentyl ester	77	89
Amine	77	77
LSD 5%	7	9
1%	10	12
Per cent of clover in check plots (before 21)	21	28

* Summarized from Table 6. Jagschitz, Cornman and Fertig (1)

The most satisfactory treatments in this experiment appear to be the pentyl and butyl ester formulations of 2,4,5-T.

Experiment 7 - Endothal and 2,4,5-T Formulations

Purpose: To compare the effectiveness of two formulations of endothal and 2,4,5-T for clover control on putting green turf.

Materials and Methods

The experiment was located on the first and third greens of the Dinsmore Golf Course at Staatsburg, New York. The first and third greens as a whole contained 21 and 25 per cent of clover, respectively.

The experimental design was six complete randomized blocks, three on each green. Individual plots were 4 x 10 feet. Twelve plots served as checks.

Eight chemical treatments were applied as sprays in water at the rate of 50 gallons to the acre on June 17, 1953. These chemicals were: ME-3003 at the rate of 1/2 and 3/4 pounds of endothal per acre; EC-4069 at the 1/4 and 1/2 pound rate of endothal; and 2,4,5-T amine and butyl ester, each at 1/2 and 1 pound acid per acre.

The two greens were mowed two days before and two days after treatment. The first green was mowed 4 hours after the treatments were applied. At the time of treatment the soil was moist; the sky clear; and the temperature was in the high 80's. The following four days had similar high temperature and there was no rain during this period. The greens were watered as normally required, beginning at least three days after treatment.

Turf discoloration readings were made June 26, 1953 and on July 24, 1953 the scattered areas of dead turf that had appeared were estimated. Clover control estimates were made September 28, 1953 and September 30, 1954.

Results and Discussion

The data in Table 6 indicates that all treatments produced some turf discoloration, but it was not considered objectionable. The ester form of 2,4,5-T produced significantly greater discoloration than the amine form at the ½ pound rate, but at the 1 pound rate there was little difference. Both 2,4,5-T formulations produced essentially the same degree of clover control.

Table 6. Clover control, turf discoloration and dead patches on putting green turf treated with endothal and 2,4,5-T on June 17, 1953 in Experiment 7.

Chemical	Pounds of active material per acre	% of clover control — Time after treatment: 15 weeks	15¼ months	Turf discoloration 9 days after treatment	Dead patches % of plot area 5 weeks after treatment
2,4,5-T amine	1/2	92	85	0.2	0.3
	1	97	94	0.7	5.4
2,4,5-T butyl ester	1/2	96	90	0.7	0.9
	1	96	92	0.9	3.4
ME-3003	1/2	86	77	0.5	0.0
	3/4	92	87	0.7	0.9
EC-4069	1/4	68	64	0.5	0.0
	1/2	89	81	1.2	3.0
LSD 5%		--	13	0.4	
1%		--	17	0.5	
Per cent of clover in check plots (before 18)		19	25		

Endothal formulation EC-4069 produced significantly greater discoloration and more dead patches of turf than ME-3003 at comparable rates, but the degree of control was about the same. The amine form of 2,4,5-T produced more dead patches of turf than the ester form, but when both 2,4,5-T formulations are compared to endothal at rates which produced comparable clover control, it is evident that the 2,4,5-T formulations produced less turf injury.

Considering turf discoloration and dead patches of turf, the ½ pound rate of 2,4,5-T formulations produced the most satisfactory clover control of all the treatments.

Experiment 8 - One and Two Applications

Purpose: To compare one and two applications of endothal and 2,4,5-T for clover control on putting green turf.

Materials and Methods

The experiment was located on the 4th green of the Dinsmore Golf Course at Staatsburg, New York. The green as a whole contained 15 per cent clover. The experiment was designed to allow five chemicals to be applied in one, two, and three applications in three complete randomized blocks. After the first application the plots which had the most turf injury in each block remained as plots receiving one application. After the second application, it was not considered necessary to apply a third. This means that one application treatments have three replicates and two application treatments have six replicates.

Four chemical treatments were applied as sprays in water at the rate of 50 gallons to the acre, as follows: ME-3003 at the rate of 1/2 pound of endothal to the acre; EC-4069 at 1/4 pound of endothal; ME-3001 at 1/8 pound of endothal; and 2,4,5-T amine at the rate of 1/2 pound of acid to the acre. The fifth chemical treatment was ME-3001 applied in sand at the rate of 1/4 pound of endothal to the acre. ME-3001, dry endothal powder, was mixed with dry builder's sand and spread by hand at the rate of 726 pounds of sand per acre.

All plots were treated with the first application on June 16, 1953 and the plots receiving a second application were treated on June 25, 1953. At the time of the first and second application the soil was moist and the temperature was in the low 90's. The green was not mowed or watered for at least two days after treatment.

Turf discoloration readings were made June 25, 1953. On July 24, 1953 the scattered areas of dead turf that had appeared were estimated. Clover control estimates were made September 28, 1953 and September 30, 1954.

Results and Discussion

Table 7. Clover control turf discoloration and dead patches of turf on putting green turf treated with one and two applications of endothal and 2,4,5-T on June 16 and June 25, 1953 respectively in Experiment 8.

Chemical	lb./ acre	No. of treatments	% of clover control Time after treatment 15 weeks	$15\frac{1}{4}$ months	Turf discoloration 9 days after treatment	Dead patches % of plot area 5 weeks after treatment
ME-3001	1/8	1	46	50	0.7	0.6
		2	92	89	-	4.0
ME-3001 in sand	1/4	1	67	50	0.6	2.5
		2	99	98	-	0.5
ME-3003	1/2	1	57	62	0.8	0.8
		2	96	93	-	3.5
EC-4069	1/4	1	54	42	0.4	0.0
		2	90	84	-	1.9
2,4,5-T amine	1/2	1	70	59	0.2	0.0
		2	93	89	-	1.0
Per cent of clover in check plots (before 11)			7	11		

All chemicals produced satisfactory and better clover control when applied with two applications rather than one application. No treatment produced objectionable turf discoloration after the first application. It was not possible to make discoloration readings after the second application, but casual observers noted that none of the plots appeared to be objectionable.

All treatments except the one application of EC-4069 and 2,4,5-T produced some dead patches of turf. Except for ME-3001 applied in sand more dead patches of turf were produced with two applications rather than with one.

Considering turf injury and clover control, the most satisfactory treatment was two applications of 2,4,5-T at ½ pound of acid per acre.

Summary and Conclusions

This paper presents the results of eight experiments using various formulations of endothal and 2,4,5-T for the control of clover in putting green turf.

Clover control estimates made one year or more after treatment were in general slightly less than those made 15 weeks or less after treatment. It is felt that this persistence of control was partly maintained by good routine management practices which benefited turf growth.

Mowing putting green turf prior to treatment and the time of day of application had no significant effect on the degree of clover control or turf injury. The removal of thatch before treatment when using endothal appeared to increase control while with 2,4,5-T better control was produced when the thatch was not removed. Thatch removal had little effect on turf injury. Increasing gallonage with endothal from 50 to 800 gallons of water to the acre decreased the degree of turf injury without affecting clover control. There was some indication that 2,4,5-T applied in 400 gallons of water produced less control than when applied in 25 or 50 gallons to the acre. Two applications of endothal or 2,4,5-T gave significantly better control than one application.

As anticipated from previous experiments, formulation ME-3001 was the most effective per pound of endothal used, followed by EC-4069 and then by ME-3003. The butyl ester formulation of 2,4,5-T produced more consistent and better control than the amine formulation.

Endothal and 2,4,5-T at one time or another produced discoloration to the turf and scattered patches of dead turf, but endothal was more severe in this regard. Less turf injury was caused by 2,4,5-T in September than in June.

Under the conditions of these experiments, neither 2,4,5-T nor endothal produced complete control of clover, but considering the degree of control and turf injury, 2,4,5-T was the most satisfactory. An application of 2,4,5-T at the rate of ½ pound acid per acre appears the most satisfactory on putting green turf with repeated applications if clover persists.

Literature Cited

1. Jagschitz, J. A., J. F. Cornman and S. N. Fertig. Selective clover control in putting green turf with endothal and 2,4,5-T formulations. Proc. NWCC 8: 399-410 (1954).

CRABGRASS CONTROL OBSERVATIONS FOR 1954

John E. Gallagher and Barbara H. Emerson[1]

PRE-EMERGENCE

In the Philadelphia area, from the viewpoint of those interested in crabgrass control work, 1954 will be considered a peculiar crabgrass year. Crabgrass emerged as usual in late April, but disappeared during an abnormally dry spring. There was no further natural emergence until mid-August.

Two extensive series of pre-emergence crabgrass control tests produced results which do not justify drawing specific conclusions. In one series the mean number of plants in 20 check plots after 120 days was eleven. All the materials used prevented crabgrass germination.

In the second series of pre-emergence tests, the additional factor of reduced competition from broadleaf weeds--the materials used were substituted phenoxy compounds--combined with poor and spotty crabgrass germination produced a paradox in which the treated plots had a greater crabgrass infestation than the check plots, with no apparent reduction in blue grass.

POST-EMERGENCE

A post-emergence series of tests was undertaken in late August. The finding of an area on a nearby golf course which was uniformly infested with crabgrass located the site for the test. The turf grasses in the area were a mixture of Kentucky blue grass and creeping bent grass. The mean crabgrass coverage per plot was 60 percent. The broadleaf weeds in the test area were those common to lawns of the region such as plantain, clover and dandelion.

Objective

To determine the effectiveness of several chemicals, alone or in combinations, for the control of mature crabgrass.

[1]American Chemical Paint Company, Ambler, Pennsylvania

Material and Methods

The experimental design consisted of three blocks containing randomized 5 x 10' plots with check strips between plots. All materials were applied with a three nozzle boom small plot sprayer. Di sodium methyl arsonate was applied with 100 gallons of water per acre. All other materials were put down at a 50 gallon per acre rate. The materials used and rates per acre were as follows:

Material	Rate/A Lbs.
KOCN	8
KOCN plus Amizol*	4 ≠ ½
Amizol	3/4
Dalapon**	4
Dalapon plus Amizol	4 ≠ 1
Dalapon plus Amizol	1 ≠ 2
Di sodium methyl arsonate	6.8
Naphthalene Acetic Acid	1.3 oz.
Improved Weedone 2,4-D, 2,4,5-T	3
Improved Weedone	1.5
American Cyanamid (#6249)	

* Amizol - 3-amino-1,2,4-triazole
** Dalapon - 2,2 dichloro propionic acid

Population data, based on percent of plot covered was taken before any treatments were made and after all treatments were completed. Percent crabgrass survival and turf grass discoloration data was collected prior to each application and two weeks following the last application.

Treatment dates were August 19, August 27, and September 3. Crabgrass present - predominantly <u>Digitaria sanguinalis</u> was in a mature state with seed heads showing.

Results and Discussion

Table No. 1 shows the crabgrass survival and associated discoloration at two-treatment intervals.

(1) KOCN (potassium cyanate 53.8%) afforded satisfactory control of crabgrass with temporary slight turf grass discoloration.

(2) KOCN at 4#/A plus Amizol at 1/2#/A produced crabgrass control equal to KOCN at 8#/A, but the associated discoloration was too severe.

(3) Amizol alone afforded no control of crabgrass and produced severe turf grass injury.

(4) Dalapon at the 4# rate, alone and in combination with Amizol, was not selective, removing all grasses. The addition of Amizol reduced the percentage of surviving broadleaf weeds. Dalapon at the 1#/A rate plus Amizol at the 1/2#/A rate was not effective.

(5) Di sodium methyl arsonate produced 91% crabgrass control with no turf grass discoloration after the second treatment, and 100% crabgrass control with no turf grass discoloration after the third treatment.

(6) Naphthalene acetic acid and Improved Weedone (2,4-D plus 2,4,5-T) at the 1-1/2#/A rate showed no crabgrass control. Improved Weedone at the 3#/A rate showed a 58% reduction in the stand of crabgrass but the associated turf grass discoloration was severe.

(7) American Cyanamid #6249 produced good crabgrass control but severe turf grass injury.

Table No. 2 shows the population change after three treatments.

(1) Potassium cyanate and di sodium methyl arsonate show approximately a one-third increase in the stand of permanent grasses.

(2) All other materials show either a decrease or only a slight increase in the stand of permanent grasses.

Summary and Conclusions

The late season crabgrass control tests conducted in the Philadelphia area on mature crabgrass compared seven chemicals alone or in combinations. Data was collected on the reduction of the crabgrass stand and turf grass discoloration. Population changes such as the increase or decrease in stand of permanent grasses, and bare ground were recorded at the conclusion of the experiment.

On the basis of this single series of tests, di sodium methyl arsonate provided good control of mature crabgrass with two treatments and complete control with three treatments at 6.8#/A. The additional factor of no discoloration, injury, or apparent inhibition of permanent turf grasses makes this material a promising new chemical for crabgrass control. Potassium cyanate continued to provide satisfactory crabgrass control with temporary slight turf grass discoloration. Dalapon alone and in combination with Amizol, and American Cyanamid #6249, at the rates used, acted as non-selective grass killers. Amizol did not control crabgrass.

Table 1 - Showing percent crabgrass survival and turf grass discoloration one week following the second, and two weeks following the third treatment.

Turf grass discoloration rated on a scale of 0 - 5 with 0 indicating no injury and 5 indicating complete kill.

Material	Rate/A Lbs.	% Surviving Crab One Wk. After 2nd Tmt.	% Surviving Crab 2nd Wk. After 3rd Tmt.	Turfgrass Discoloration After 2nd Tmt.	Turfgrass Discoloration Final
KOCN	8	91	36	1.3	0
KOCN plus Amizol	4 + ½	84	35	1.6	2
Amizol	3/4	114	121	2.5	4
Dalapon	4	31	0	3.1	5
Dalapon plus Amizol	4 + 1	36	0	3.5	5
Dalapon plus Amizol	1 + ½	103	90	1.1	3.6
Di sodium methyl arsonate	6.8	9	0	0	0
Naphthalene acetic acid	1.3 oz.	129	169	0	0
Improved Weedone	3	93	42	1.8	3.3
Improved Weedone	1.5	96	114	1	1.6
American Cyanamid #6249	4	66	22	2	3
Control	0	112	92	0	0

Table 2 - Showing population changes following three treatments.

Material	Rate/A Lbs.	Per. Gr. % Change	Bare Grnd. % Change
KOCN	8	+35	+20
KOCN plus Amizol	4 + ½	- 3	+51
Amizol	3/4	- 8	- 3
Dalapon	4	-28	+88
Dalapon plus Amizol	4 + 1	-11	+97
Dalapon plus Amizol	1 + ½	- 7	+18
Di sodium methyl arsonate	6.8	+35	+45
Naphthalene Acetic Acid	1.3 oz.	-10	- 5
Improved Weedone	3	+ 2	+33
Improved Weedone	1.5	+11	+19
American Cyanamid #6249	4	+10	+32
Control	0	- 8	- 7

The Effect of Herbicidal Treatments on Oats

C. G. Waywell [1]

Reports of damage to oat crops through the use of the hormone-like chemicals have been common for the past few years. In order to obtain some definite information on this matter work was started in 1953 on the Field Husbandry plots at the College. The plot work has been continued through 1954 and will be repeated in 1955. The present report is a progress report of the results obtained in 1953 and 1954.

1953. Materials and Method

The 1953 test was based on a series of rod row yield plots sown to Beaver and Ajax oats. Each plot contained four rows. Treatments were applied with a knapsack sprayer to the centre two rows using a fan shaped spray. The treatments on the variety Beaver consisted of aqueous sprays of 2,4-D butyl ester at 4 and 6 oz. /A, 2,4-D amine at 6 and 8 oz. /A, MCP butyl ester at 4 and 6 oz. /A, and MCP amine at 6 and 8 oz. /A. Treatments commenced on the 13th of June at which time the oats were 6 to 7 inches in height. Additional plots were treated at weekly intervals with a total of seven treatments applied at the lower rate for each chemical and formulation. At the higher rates treatments were applied on the first three dates. The treatments on the variety Ajax were limited to treatments on the first two dates at 6 oz. acid equivalent /A. Approximately twenty gallons of mixture was applied /A. The design of the experiment was that of a simple randomized block with six replicates of each plot.

1953. Results

Inspection of the data concerning yields revealed that there was no consistent pattern. Variation within the untreated checks was as great as that within any single treatment. A complete statistical analysis was therefore considered unnecessary.

1954. Materials and Methods

The 1954 test was limited to the variety Beaver. A simple randomized block design was used but the four row plots

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were reduced to fifteen feet in length in order to consolidate the test area and make possible the use of practically square blocks for each replicate. Six replicates were used for each treatment. Treatments consisted of 2,4-D butyl ester at 4, 6, 8, and 12 oz. acid/A, 2,4-D amine at 6, 8, and 12 oz. acid/A, MCP butyl ester at 4, 6, 8, and 12 oz. acid/A, and MCP amine at 6, 8, and 12 oz. acid/A. Treatments were started one day after emergence and were repeated at two day intervals unless delayed by rain. Both MCP and 2,4-D butyl ester at 8 oz. /A were applied at twenty five periods starting on the 23 of May with the final treatment applied on the 21st of July. MCP and 2,4-D amine at 8 oz. acid /A were both applied for five of the treatment periods from four days after emergence to the sixth date of treatment. All other formulations and rates were applied on the third, fourth, and fifth treatment dates. A small CO_2 powered sprayer was used to apply the spray at the rate of five gallons /A to the two centre rows of each plot. A total of 564 plots were treated and observed.

Seed saved from the plots which received the heaviest rates in 1953 was seeded in single row observation plots. These plots were studied at intervals throughout the season in order to determine whether there were any abnormalities.

1954. Results

On the 14th of June (8th treatment date) some of the earlier treatments were exhibiting an abnormal condition. The seedlings were lighter in colour, the leaves had a definite onion-like appearance, and the leaves did not appear as numerous as on the untreated plots. The first plots to exhibit these symptoms were those treated with 2,4-D butyl ester at 12 oz. /A. Within a few days some plots had plants which were more spreading in habit than normal. The MCP treated plots had few of these abnormalities with either formulation at any of the rates used. The plots treated with 2,4-D butyl ester at 12 oz. /A retained the onion leaf characteristic until harvest. The plants were later in heading, were shorter, and had a tendency to lodge.

The yield data was organized into three parts. One part contained the data for the third, fourth, and fifth dates for both chemicals and formulations at 6, 8, and 12 oz. /A. The second part contained the data for MCP butyl ester at 8 oz. /A for the twenty five treatment periods together with the necessary checks. The third part contained the data for the 2,4-D butyl ester at 8 oz. /A for twenty five treatment periods. An analysis of variance was made on each part. The results of these analyses are presented in the following tables.

Table I (a) Yield of oats after treatment with 2,4-D and MCP. Guelph 1954.

Chemical	Form.	Rate oz/A	Tr P*	Treatments Av.bu./A	Rate Av. bu./A	Formulation Av. bu/A	Chemical Av. bu./A
MCP	BE	6	3	76.8	84.3	83.7	82.0
			4	88.2			
			5	88.4			
		8	3	78.8	82.8		
			4	88.6			
			5	81.3			
		12	3	83.9	83.5		
			4	90.1			
			5	76.4			
	A	6	3	69.1	76.2	80.3	
			4	81.0			
			5	78.8			
		8	3	82.0	84.3		
			4	84.3			
			5	87.1			
		12	3	71.5	80.5		
			4	88.0			
			5	82.0			
2,4-D	BE	6	3	72.0	70.2	66.6	73.2
			4	69.3			
			5	69.8			
		8	3	64.0	67.2		
			4	74.3			
			5	63.6			
		12	3	61.8	62.5		
			4	60.3			
			5	65.3			
	A	6	3	85.4	81.5	80.0	
			4	84.5			
			5	74.5			
		8	3	86.7	77.3		
			4	79.4			
			5	65.9			
		12	3	89.7	80.5		
			4	77.3			
			5	74.5			
Check			-	84.7	84.7		
L.S.D.	1%			20.2	11.7	6.7	4.8
	5%			15.3	8.8	5.1	3.6

BE = butyl ester, A = amine, * Tr P = treatment period
Av. bu./A = average bushels / Acre

An inspection of Table I reveals that there is a marked reduction in yield associated with some treatments. In the column on formulations it is seen that there is an highly significant difference between the 2,4-D butyl ester treatments and all others. When MCP and 2,4-D for both formulations are compared it is apparent that there is an highly significant difference due to the marked reduction through the use of 2,4-D butyl ester. In order to present a clear picture of the effect of rates on yields a tabular form is presented in Table I (b).

When MCP butyl ester is compared with MCP amine it is apparent that there is no significant difference at the rates used. A comparison with 2,4-D butyl ester reveals that there is an highly significant depression in yield caused by all levels of the 2,4-D butyl ester treatments. When a comparison is made between 2,4-D butyl ester and 2,4-D amine it is seen that with one exception the depressing effect of the butyl ester is either significant or highly significant.

Table II Yield of oats in bushels per acre with 8 ounces of MCP or 2,4-D butyl ester at 25 periods of growth. Guelph 1954.

Chemical	Tr	Yield	Tr	Yield	Chemical	Tr	Yield	Tr	Yield
MCP	1	79.8	14	87.5	2,4-D	1	74.7	14	79.8
	2	80.0	15	84.5		2	77.3	15	81.7
	3	78.8	16	78.5		3	64.0	16	85.4
	4	88.6	17	83.5		4	74.3	17	77.9
	5	81.5	18	92.0		5	63.6	18	83.7
	6	89.0	19	77.3		6	59.9	19	91.4
	7	77.7	20	86.7		7	61.8	20	82.4
	8	82.4	21	80.1		8	44.1	21	82.6
	9	86.2	22	83.7		9	70.4	22	87.7
	10	71.3	23	68.4		10	76.0	23	80.3
	11	80.0	24	83.0		11	79.2	24	88.8
	12	73.2	25	93.9		12	73.4	25	84.1
	13	92.9	Ck.	84.7		13	75.3	Ck.	84.7

L.S.D. No significant difference

L.S.D. 1% 18.8
5% 14.3

The data reveals that the there was no significant difference between treatment dates with the MCP treatment. The third, fifth, sixth, seventh, and eighth dates of treatment with 2,4-D show an highly significant reduction in comparison with the check. This characteristic is evident in the graph in Figure 1.

Table I (b) Tabular comparison of the effect of rates on yield - Oats 1954.

				MCP						2,4-D					
				BE			A			BE			A		
			Rate	6	8	12	6	8	12	6	8	12	6	8	12
Chemical	Form.	Rate	Yield	84.3	82.8	83.5	76.2	84.3	80.5	70.2	67.2	62.5	81.5	77.3	80.5
MCP	BE	6	84.3												
		8	82.8	-											
		12	83.5	-	-										
	A	6	76.2	-	-	-									
		8	84.3	-	-	-	-								
		12	80.5	-	-	-	-	-							
2,4-D	BE	6	70.2	##	##	##	-	##	#						
		8	67.2	##	##	##	#	##	##	-					
		12	62.5	##	##	##	##	##	##	-	-				
	A	6	81.5	-	-	-	-	-	-	#	##	##			
		8	77.3	-	-	-	-	-	-	-	#	##	-		
		12	80.5	-	-	-	-	-	-	##	##	##	-	-	
Check		-	84.7	-	-	-	-	-	-	##	##	##	-	-	-

L.S.D. 1% = 11.7 5% = 8.8

= significant ## = highly significant

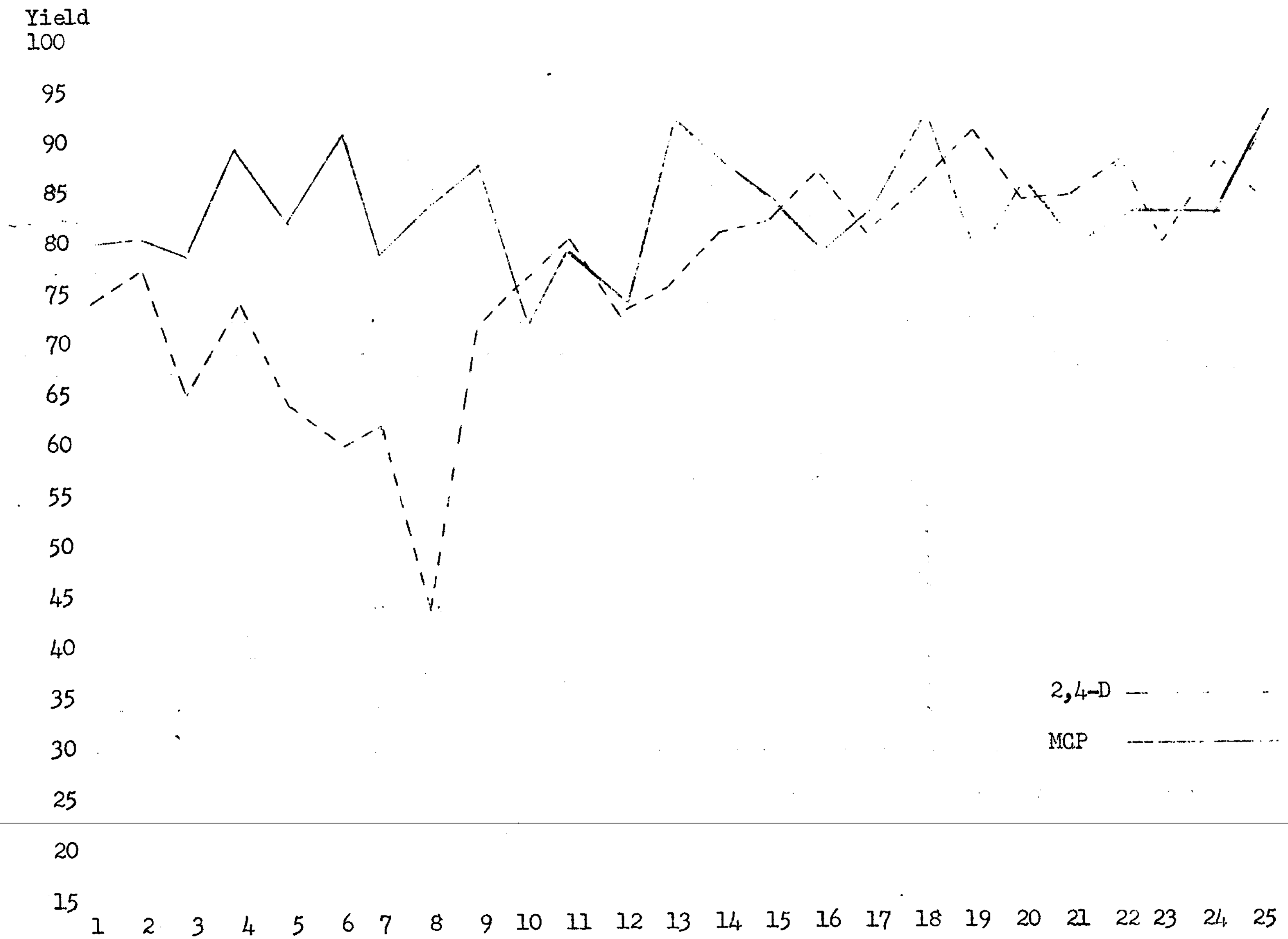

Figure 1. Yield of oats following treatment with MCP and 2,4-D at 25 treatment periods at 8 oz. acid/A.

The single rows of oat plants grown from seed produced by plants treated the previous year appeared normal at the time of each inspection. These inspections were carried out at weekly intervals until harvest.

Conclusions

1. According to the data obtained 2,4-D had a marked depressing effect on yields when compared with MCP.

2. The butyl ester of 2,4-D had a marked depressing effect on yields when compared with the 2,4-D amine.

3. The early period of growth, from shortly after emergence to three and one half weeks after emergence was most susceptible to damage from herbicidial applications.

4. Oat plants grown from seed produced by the oats treated in 1953 at 8 oz. acid /A appeared normal in all morphological characteristics.

QUACKGRASS CONTROL IN FIELD CORN BY PREPLANTING APPLICATIONS OF MALEIC HYDRAZIDE AND DALAPON[1]

Jonas Vengris[2]

Quackgrass (Agropyron repens) is a perennial weedy grass reproducing by rhizomes and by seeds. It is rather difficult to control. Some of the herbicides on the market at present, particularly TCA, are capable of controlling it. However, chemicals are still rather expensive, and residual effects render a soil unproductive for a shorter or longer period of time.

In 1953 some rather successful preliminary experiments on control of quack-grass with MH were carried out at the Massachusetts Experiment Station. Though the rates of MH at this time did not eradicate the quackgrass, growth was effectively suppressed. In any event, it is fėlt that this herbicide may be of some value in controlling quackgrass under certain conditions. The fact that MH affects the plant through the foliage rather than through the soil strengthens the opinion that less concern should be given to residual effects in the soil. It was decided to investigate the possibilities of MH suppressing quackgrass in field corn. In our trials we also included a new herbicide, Dalapon, which is rather promising for grass control.

PROCEDURE

The soil was a Suffield fine sandy loam rather uniformly and heavily infested with quackgrass. In laying out the plots, Zade's long-plot method with four replicates was used (1). Applications of 5 and 10 lb/A each of MH and Dalapon dissolved in 40 gallons of water were made on June 24, 1954. To the MH solution a one percent wetting agent (Triton 1956) was added. At that time the quack-grass was 6-8 inches tall. Four days later, the field was disced and fertilized, and on July 1, 1954, field corn was planted. For the control of dicot weeds 4.5 lb/A of Dow Premerge was sprayed on July 8, 1954. Finally, on July 27, 1954, all plots received a top-dressing with 40 lb/A N in the form of $NaNO_3$.

RESULTS AND DISCUSSION

No injury of the corn plants occurred on plots treated with MH and Dalapon at the rate of 5 lb/A. At the 10 lb/A rate of MH, the corn reacted very slightly. In comparison with the controls, the plants were lighter in color, but this symptom disappeared after the plots were top-dressed with nitrogen 7/27/54. Dalapon at the rate of 10 lb/A had a more pronounced injurious effect. A number of plants showed a stunting curvation, and some later died. However, the number

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of malformed plants never exceeded 10 percent of the total number of plants.

The effect of the different treatments on the quackgrass was determined by taking tiller counts on 8/24/54. On every plot, four one-square-foot areas were taken at random; the tillers were counted, and their length measured. In additin to this, on every plot, two areas 20 inches x 20 inches were taken at random, and the rootstocks dug out. All healthy looking and alive roots were separated, washed, dried, and weighed. On 9/29/54, the corn was harvested. These data are compiled in Table I.

Table I. Quackgrass Control in Field Corn.
Relative Values. (Checks = 100.)

Treatments	Tiller Number	Tiller Height	Rootstock Weight	Corn Yields
1. Checks	100	100	100	100
2. MH 5 lb/A acid eq.	34**	83*	89	105
3. MH 10 lb/A acid eq.	19**	75**	53	94
4. Dalapon 5 lb/A acid eq.	28**	72*	58	96
5. Dalapon 10 lb/A acid eq.	9**	58**	37*	87*

* Significant in comparison with checks at 5% level.
** Significant in comparison with checks at 1% level.

Both chemicals at both rates decreased significantly the number of tillers and their length of growth. However, Dalapon appeared to have been the more effective one.

The rootstocks were in general less affected by the treatments than the parts of the plants above the ground. A significant decrease in the corn yield occurred only on plots where Dalapon was applied at the rate of 10 lb/A. On the other hand, it is also interesting to note that no significant increase in yield resulted from weed control under the conditions of this experiment.

SUMMARY AND CONCLUSIONS

1. Maleic hydrazide as well as Dalapon significantly suppressed growth of quackgrass in field corn when applied seven days before corn planting. The top growth of the quackgrass was affected more than the rootstocks.

2. Under the conditions of the tests, Dalapon at the rate of 10 lb/A injured the corn and significantly decreased the yields.

3. The results of our tests indicate that on heavily infested fields, maleic hydrazide and Dalapon might control quackgrass without noticeable injury to corn plants. The results are promising and warrant further investigation. The lapse of time between herbicidal applications and corn planting should be investigated thoroughly.

LITERATURE CITED

1. Roemer, Th. Der Feldversuch, D.L.G. Berlin 1930.
Acknowledgements are gratefully made to the Dow Chemical Co., Midland, Mich., and to the U. S. Rubber Co., Naugatuck, Conn., for the materials used.

PRELIMINARY REPORT ON THE USE OF SEVERAL NEW ARSENICALS

C. R. Skogley and G. H. Ahlgren[1]

Field and greenhouse screening of experimental arsenicals as contact herbicides and as soil sterilants, has been in progress for several years at the New Jersey Agricultural Experiment Station. Reports by Frans (1) and Skogley (2) have indicated the results of this screening program through 1953. During the winter, spring and summer of 1954 laboratory, greenhouse and field tests with various arsenicals were further extended.

Soil treatments with five different arsenicals at rates of 10, 20, 40, 80, 160, and 320 PPM were tried in the laboratory. The chemicals included were: 1. Monoethanolamine arsenite, 2. Ferric monoethanolamine arsenite, 3. Monoethanolamine Ferric arsenite, 4. Sodium Ferric arsenite and 5. Monoethanolamine arsenite-Monoethanolamine nitroguanidine. Two-hundred gram lots of soil were placed in pint ice cream containers, the arsenicals were added and mixed with the soil, and 20 oat seeds were planted in each. Throughout the test the soil moisture was maintained near field capacity. The covers were kept on the containers at all times and the temperature during the testing period was maintained at 80 to 90 degrees F. Each rate of every chemical was replicated 3 times.

At the end of 30 days, shoot length data were taken as was percent germination. These data showed that as the rate of arsenic increased in the soil shoot length decreased as did percent germination. There was, however, no significant difference between chemicals in either respect.

The second test was conducted in the greenhouse. The same chemicals already indicated and also ammonium arsenite were added to 10-pound lots of soil at the rate of 80 PPM of arsenic. Each treatment was run in quadruplicate. Twenty-five oat seeds were planted in each pot and temperature and moisture conditions satisfactory for good growth were maintained. At the end of 30 days the aboveground portion of the oat plants were harvested, dried and weighed. The average weights by chemical treatment were compared with the average weight of plants grown on untreated soil.

All chemicals greatly reduced yield of oat tops but there was little difference between the individual chemicals.

A second oat crop was planted in the same soil lots and again harvested at the end of 30 days. Although yield differences between treatments were greater for the second crop than the first no chemical was significantly better than any of the others. All chemicals showed highly significant yield reductions over the check.

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In February 1954 the 6 arsenicals already listed, plus sodium arsenite, were applied to field plots of Kentucky bluegrass and creeping bentgrass at the rate of 20 pounds per acre of As_2O_3. The materials were applied in water at the rate of 50 gallons per acre. An anionic wetting agent at 4 pounds per acre was added to aid in spreading and, perhaps, penetration. Again, there was little difference between chemicals in visible phytotoxicity.

None of the materials gave better than an estimated 25% top kill following the February spraying and later observations indicated almost complete recovery of grasses on all plots.

In July 1954 additional arsenical materials were screened in the field. The materials were applied on a young, perennial ryegrass stand badly infested with annual grasses and broadleaved weeds. The materials tested and the results of this test are given in Table 1. The rate of application was 50 pounds per acre of As_2O_3 applied in water at 100 gallons per acre. Treatments were not replicated and plot size was 1/200 acre.

Table 1. Percent stand reduction at several intervals after spraying six different arsenicals. Materials applied July 1, 1954.

Material	Percent stand reduction (estimated) & date							
	7/2	7/6	7/8	7/29	8/6	8/13	9/9	10/7
MEA arsenite	30	40	50	40	40	30	15	5
Cacodylic acid	80	99	99	99	99	99	80	70
Fe MEA arsenite	40	55	75	75	75	40	15	5
MEA Fe arsenite	30	40	60	70	70	60	25	0
Arsenical chloro-glycerol	95	85	90	90	80	60	20	0
Ammonium As	40	70	85	85	80	70	25	10

Cacodylic acid (dimethylarsinic acid), an organic compound containing 54 percent arsenic, gave striking results in this trial. Its initial toxicity was very high and even at the end of a 3 month period had dropped off very little. Arsenical chloroglycerol also exhibited excellent contact properties but regrowth was rapid on the plot sprayed with this chemical. The stand was still reduced by 70 percent 3 months after application on the plot receiving cacodylic acid while none of the other chemicals gave more than a 10 percent stand reduction at this date. Only 2 percent of the cover on the cacodylic acid plot at the end of 3 months consisted of annual grasses while the cover on all other plots consisted of from 50 to 80 percent crabgrass and panicum.

Cacodylic acid, to date, has been used mainly for medicinal purposes and although not definitely substantiated it has been reported that cacodylic acid has a lower order of mammalian toxicity than sodium arsenite.

On July 27 another trial was established on ryegrass sod which included cacodylic acid, sodium arsenite, and MEA arsenite at rates of 5, 20, 80 and 320 pounds of As_2O_3 per acre. The materials were applied in water at the rate of 100 gallons per acre. The plots were 1/400 acre in size and the treatments were in duplicate. The results of this test are given in Table 2.

Table 2. Percent stand reduction at several intervals after applying four rates of three arsenicals. Materials applied July 27, 1954.

Material and Rate	Percent stand reduction (estimated) and rate				
	7/29	8/6	8/13	9/9	10/7
5 lbs. Cacodylic acid	40	90	85	20	2
Sodium As	25	40	20	0	0
MEA As	40	85	77	5	0
No spray	0	0	0	0	0
20 lbs. Cacodylic acid	60	99	96	45	17
Sodium As	45	80	82	23	5
MEA As	55	92	82	15	5
No spray	0	0	0	0	0
80 lbs. Cacodylic acid	80	100	100	80	60
Sodium As	60	95	94	76	55
MEA As	65	80	91	63	60
No Spray	0	0	0	0	0
320 lbs. Cacodylic acid	100	100	100	98	90
Sodium As	55	99	99	97	96
MEA As	75	99	99	98	96
No spray	0	0	0	0	0

One of the interesting observations made following the spray application was the rapidity of top kill obtained with cacodylic acid, especially at the two highest rates. In general, throughout the period of observation the percent stand reduction was greatest with cacodylic acid at all application rates. At the 5 pound rate MEA arsenite showed more phytotoxicity than did sodium arsenite. At all other rates the two were quite comparable and not equal to cacodylic acid.

On October 7th, just over 3 months after the applications were made, crabgrass counts were taken on the plots. The results are given in Table 3.

Table 3. Number of crabgrass plants per 1000 square feet $2\frac{1}{2}$ months after the date of spraying.

Material	Pounds per Acre 5	20	80	320
Cacodylic acid	116	0	0	0
Sodium arsenite	442	116	23	5
MEA arsenite	186	186	209	5
No spray	419	209	419	349

At the time the treatments were made the crabgrass was in the seedling stage. The counts were taken when the plants were nearly mature. At the 5 pound rate, cacodylic acid and MEA arsenite showed considerable control of crabgrass. At rates of 20 pounds and above crabgrass was absent from the cacodylic acid plots but the number of plants was not reduced above the 5 pound level with MEA arsenite until the top rate was reached. Sodium arsenite showed no control at the 5 pound rate but gave increasing control as the rate increased.

On September 28 an additional application of arsenicals was made. A single rate, 5 lbs. per acre based on As_2O_3, was used and the treatments were in duplicate. The vegetation sprayed consisted mainly of ryegrass and nearly mature crabgrass with a few interspersed plants of curly dock (Rumex crispus) and mullein (Verbascum Thapsus). The plot size was 1/400 acre and application of the chemicals was made in water at the rate of 100 gallons per acre. In Table 4 the estimated percent injury to the vegetation at 3 dates is listed. The injury percentage was based on 0 percent as no injury or discoloration to 100 as completely brown.

Table 4. Estimated percent injury to vegetation following the application of arsenical bearing compounds on September 27, 1954.

Material	10/1/54	10/7/54	10/19/54
Di Sodium Methyl Arsonate	20	20	20
Methyl Arsonic Acid	10	20	20
Cacodylic Acid	80	90	90
Sodium As	60	60	50
MEA As	40	50	50

Di sodium methyl arsonate and methyl arsonic acid were very similar in action and exhibited less phytotoxicity than the other three materials tested. Cacodylic acid again appeared to be the most phytotoxic of all the compounds included in the test. Three days after application, when the first injury notes were made, only about 20 percent of the vegetation on the cacodylic acid plots remained green. Sodium arsenite was the next injurious at this date with a 60 percent injury rating. All other materials were rated as giving only 40 percent injury, or less. About 3 weeks later only about 10 percent of the vegetation remained green on the cacodylic acid plots while from 50 to 80 percent green vegetation remained on the plots sprayed with all other materials.

Plants of curly dock and mullein appeared to be almost entirely eliminated from the plots treated with cacodylic acid. On most plants of both of these genera the injury appeared to extend to areas below the soil surface. The injury to these particular plants was only moderate with all other chemicals and recovery was fairly rapid.

On the basis of the season's arsenical screening tests, it is apparent that cacodylic acid, in particular, has phytotoxic properties over and above those generally attributed to arsenic toxicity alone. This compound is being tested further and additional data will be forthcoming.

References

1. Frans, R. E. and Aldrich, R. J. Herbicidal comparison between sodium arsenite and several experimental arsenic compounds. Northeastern Weed Control Conference Proceedings. 1953.

2. Skogley, C. R. The influence of wetting agents on the phytotoxicity of several herbicides. Northeastern Weed Control Conference Proceedings. 1954.

THE EFFECT OF SPRAY VOLUME AND RATE OF DINITRO HERBICIDE ON WEED CONTROL AND CLOVER STAND IN UNDERSEEDED OATS

M. F. Trevett[1]

The test reported in this paper was designed to compare the effect of varying rates of an amine salt of dinitro ortho secondary butyl phenol (DNOSBP)[2] and acre spray volumes on weed control and stand of red clover in underseeded oats.

Procedure

Standard seedbed preparation, fertilizer, and seeding practices were followed.

Herbicides were applied when the oats (Ajax, seeded at the rate of two bushels per acre) were six to eight inches tall, with red clover (Kenland, seeded at the rate of eight pounds per acre) in the unifoliolate and single trifoliolate stage, and weeds in the one- and two-true leaf stage. The principal weeds were: lamb's-quarters (Chenopodium album), red-root pigweed (Amaranthus retroflexus), and common ragweed (Ambrosia artemisiifolia).

Treatments were replicated five times with each treated plot being paired with an adjacent untreated check plot.

Sprays were applied at 40 pounds pressure with a plot sprayer. Tee Jet nozzles were used: No. 8001 for the 20 gallons per acre spray volume, No. 8004 for the 40 gallons per acre volume, and No. 8008 for the 80 gallons per acre volume.

The rates of DNOSBP acid equivalent applied and the acre volumes of water in which the various rates of herbicide were applied follow:

1/ Associate Agronomist, Maine Agricultural Experiment Station, University of Maine, Orono, Maine. Statistical analyses were made by Mildred Covell, Technical Assistant, Departments of Agronomy and Horticulture.

2/ From "Premerge" (three pounds per gallon DNOSBP as the alkanolamine salts of dinitro-o-sec-butyl phenol), supplied by the Dow Chemical Co., Midland, Michigan.

1.87 pounds DNOSBP in 80, 40, and 20 gallons of water per acre
1.50 " " " " " " " " " " " "
1.12 " " " " " " " " " " " "
0.75 " " " " " " " " " " " "

Temperature at the completion of spraying was 72°F.

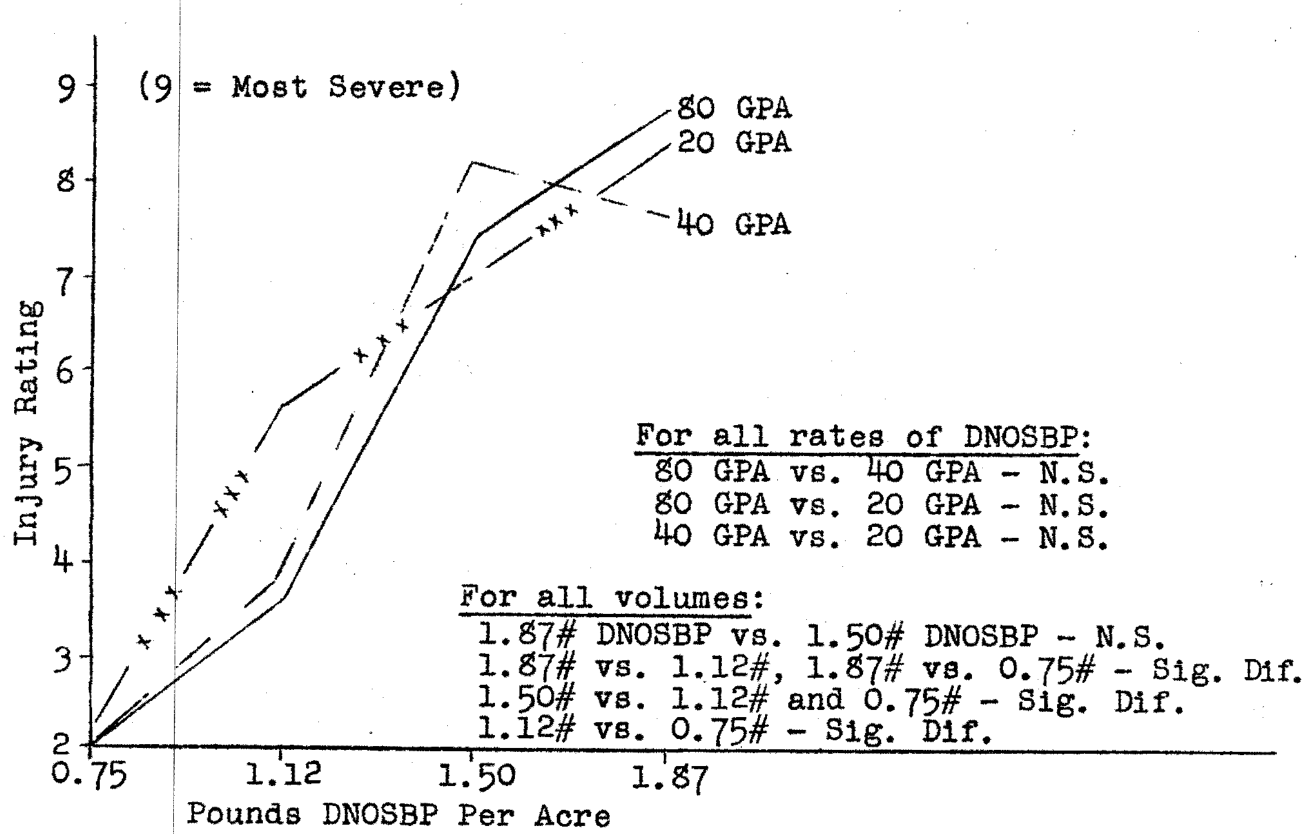
Ratings of injury to oats, broadleaf weed counts, and clover counts were made 10, 22, and 60 days, respectively, after treatment. Weed and clover counts were expressed as % of untreated check plots, and percentages converted to angles for statistical analysis.

Results

A. Effect of Treatment on Oats (Figure 1 & Appendix Table 1)

The severity of foliage injury to oats increased significantly with the rate of herbicides applied up to 1.50 pounds DNOSBP per acre, but was not significantly affected by spray volume.

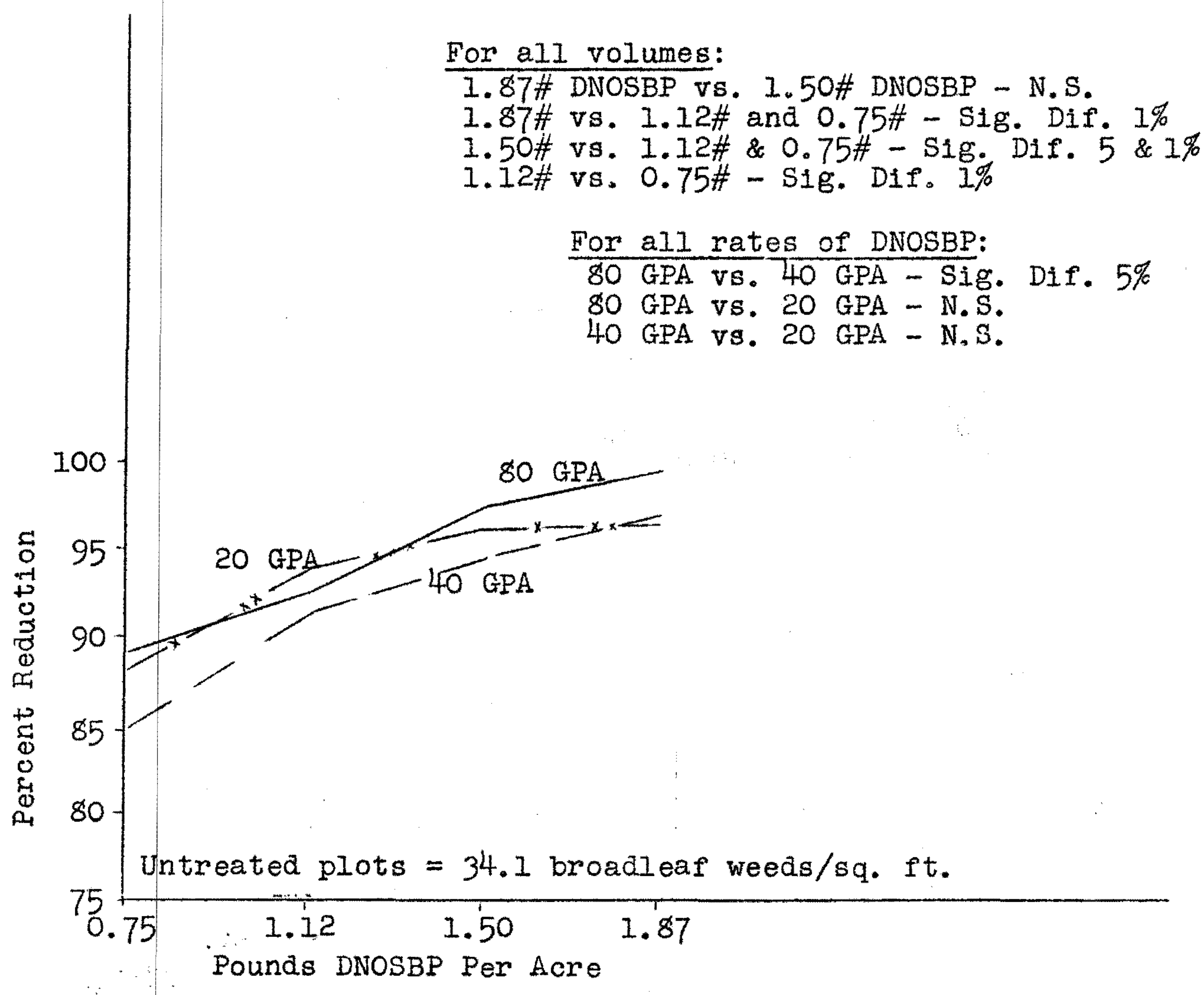
FIGURE 1. FOLIAGE INJURY TO OATS 10 DAYS AFTER DNOSBP TREATMENTS



B. Effect of Treatment on Weed Control (Figure 2 & Appendix Table 2)

For all spray volumes, increasing the rate of DNOSBP applied resulted in significantly better weed control up to 1.50 pounds DNOSBP[3/] per acre. Percent reduction in broadleaf weeds for the 1.87-pound rate of DNOSBP did not differ significantly from the 1.50-pound rate.

FIGURE 2. PERCENT REDUCTION OF BROADLEAF WEEDS 22 DAYS AFTER DNOSBP TREATMENTS



3/ 1.87 pounds DNOSBP per acre is equivalent to a 2.5-quart acre rate of "Premerge"; 1.50 pounds to 2.0 quarts; 1.12 pounds to 1.5 quarts; and 0.75 pound to 1.0 quart.

For all rates of DNOSBP the 80 gallons per acre volume resulted in a significantly higher reduction in broadleaf weeds than the 40 gallons per acre volume; in practice, however, this difference would not be important (Table 1). Significant differences in percent broadleaf weed reduction did not exist between 80 and 20 gallons per acre, nor between 40 and 20 gallons per acre volumes.

TABLE 1. PERCENT REDUCTION OF WEEDS SPRAYED AT ONE- AND TWO-TRUE LEAF STAGE

Pounds DNOSBP Per Acre	80 GPA H_2O %	40 GPA H_2O %	20 GPA H_2O %
1.87	99.2	96.6	96.8
1.50	97.3	94.8	96.1
1.12	92.4	91.5	94.9
0.75	89.0	85.0	88.8

Weeds in untreated plots = 34.1 per sq. ft.

In general, these same relationships apparently exist when weeds at a more advanced stage of development are sprayed. In Table 2 is a summary of data obtained from a block in which treatments were applied when weeds (red-root pigweed and lamb's-quarters) were in the four- and five-true leaf stage.

TABLE 2. PERCENT REDUCTION OF WEEDS SPRAYED AT FOUR- AND FIVE-TRUE LEAF STAGE

Pounds DNOSBP Per Acre	Av. Reduction for All Volumes %	Acre Volumes GPA	Av. Reduction for All Rates DNOSBP %
1.87	94.9	80	86.6
1.50	88.5	40	84.9
1.12	80.1	20	79.9
0.75	68.1		

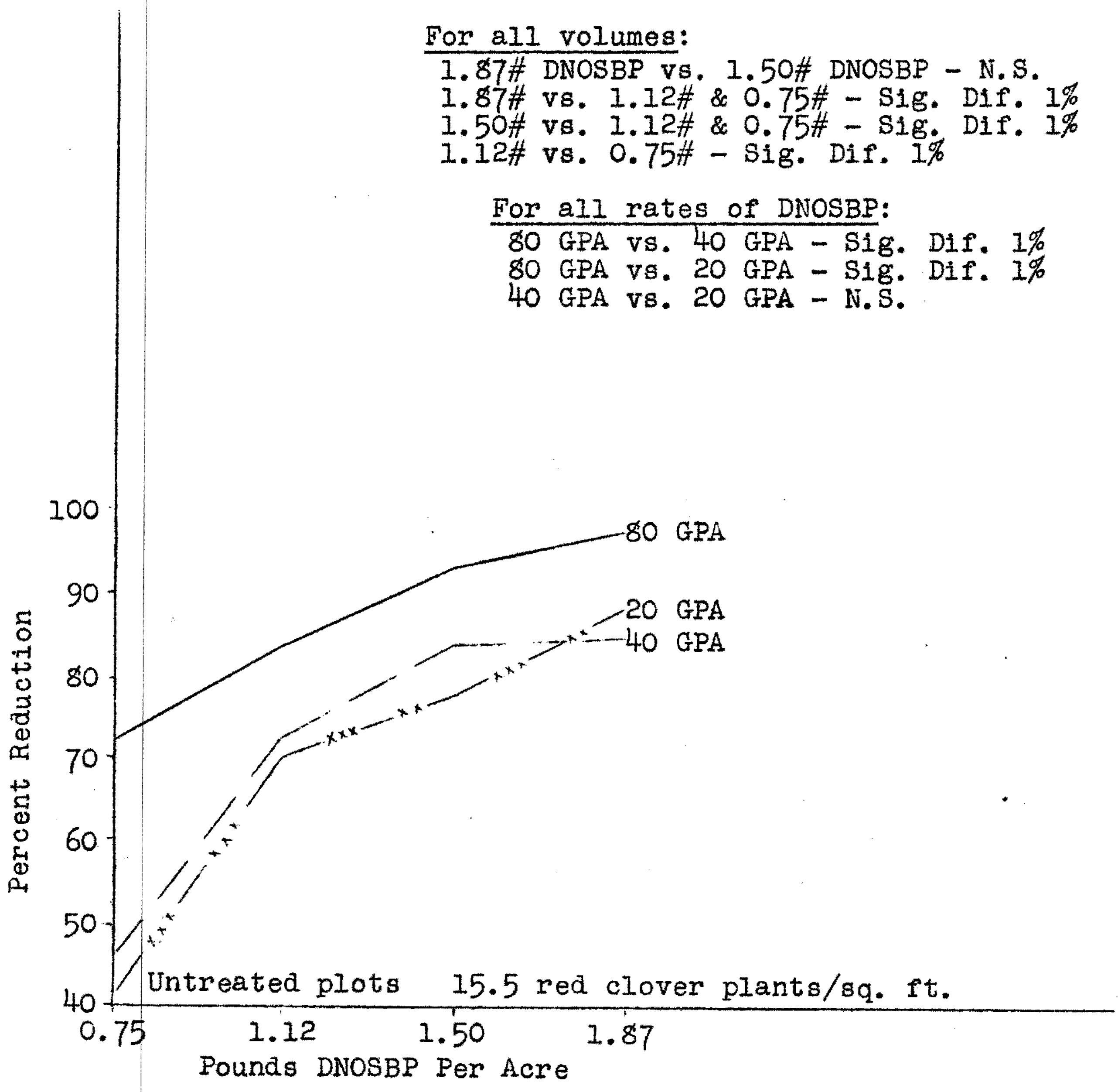
1.87# vs. 1.50# - Sig. Dif. 10%
1.87# vs. 1.12# - Sig. Dif. 1%
1.87# vs. 0.75# - Sig. Dif. 1%
1.50# vs. 1.12# - Sig. Dif. 10%
1.50# vs. 0.75# - Sig. Dif. 1%
1.12# vs. 0.75# - No Sig. Dif.

80 GPA vs. 40 GPA - No Sig. Dif.
80 GPA vs. 20 GPA - Sig. Dif. 10%
40 GPA vs. 20 GPA - No Sig. Dif.

C. Effect of Treatment on Clover Stand (Figure 3 & Appendix Table 3)

For all spray volumes, increasing the rate of DNOSBP resulted in significantly greater reductions in clover stand up to and including 1.50 pounds DNOSBP per acre. Percent reduction in clover stand for the 1.50-pound rate and the 1.87-pound rate did not differ significantly.

FIGURE 3. PERCENT REDUCTION OF CLOVER STAND 60 DAYS AFTER DNOSBP TREATMENTS



For all rates of DNOSBP the 80 gallons per acre spray volume resulted in a significantly greater reduction in clover stand than either the 40 or the 20 gallons per acre volume. Volumes of 40 gallons per acre and 20 gallons per acre did not differ significantly in their effect on reduction of clover stand.

Summary

The degree of foliage injury to oats and of weed control resulting from post-emergence spraying with an amine salt of DNOSBP is a function of the amount of DNOSBP applied and not, within the range of 20 to 80 gallons per acre, of the volume of water in which it is applied. This conclusion is in general conformity with Fertig (2) and Miller (3).

At the susceptible unifoliolate-single-trifoliolate stage (1) of red clover, high spray volume (80 GPA) resulted in a greater reduction in clover stand than either low (20 GPA) or intermediate (40 GPA) spray volumes. Increasing the rate of DNOSBP applied resulted in significantly greater reductions in clover stand up to and including 1.50 pounds DNOSBP per acre. Percent reduction in clover stand for the 1.50-pound and 1.87-pound acre rate of DNOSBP did not differ significantly.

References

1. Alder, F. E. Selective Weed Control in Seedling Grasses and Legumes with Ammonium Di-Nitro Secondary Butyl Phenate. Proceedings of the British Weed Control Conference. 1953.

2. Fertig, S. N. Preliminary Report on Weed Control in Small Grains Where Legumes Are Seeded Using MCP and Dinitros. Proceedings of Northeastern Weed Control Conference. 1952. Pages 235-243.

3. Miller, M. W. Preliminary Investigations with Dinitro and MCP Sprays for Weed Control in Legume-Seeded Peas. Proceedings of Northeastern Weed Control Conference. 1953. Pages 127-134.

APPENDIX

TABLE 1. FOLIAGE INJURY TO OATS DUE TO DNOSBP TREATMENTS

Pounds DNOSBP Per Acre	Spray Volume Gallons/Acre	Injury Rating[1/]
1.87	80	8.8
1.87	20	8.4
1.50	40	8.2
1.87	40	7.6
1.50	80	7.4
1.50	20	7.0
1.12	20	5.6
1.12	40	3.8
1.12	80	3.6
0.75	20	2.2
0.75	80	2.0
0.75	40	2.0
	LSD 5%	1.1
	1%	1.6

1/ 1.0, tips of leaf blades dead; 9.0, leaf blades and sheaths dead. Ratings made 10 days after spraying.

APPENDIX

TABLE 2. REDUCTION IN STAND OF BROADLEAF WEEDS DUE TO TREATMENT WITH DNOSBP (Data Taken 22 Days After Treatment)

Pounds DNOSBP Per Acre	Spray Volume Gallons/Acre	Reduction in Stand1/ Broadleaf Weeds (Angles) Mean	Reconverted to %
1.87	80	84.78	99.2
1.50	80	80.59	97.3
1.87	20	79.63	96.8
1.87	40	79.42	96.6
1.50	20	78.60	96.1
1.12	20	76.90	94.9
1.50	40	76.79	94.8
1.12	80	74.01	92.4
1.12	40	73.08	91.5
0.75	80	70.66	89.0
0.75	20	70.47	88.8
0.75	40	67.20	85.0
	LSD 5%	6.17	
	1%	8.21	

1/ Stand of broadleaf weeds in untreated plots = 34.1 per sq. ft.

APPENDIX

TABLE 3. REDUCTION IN STAND OF RED CLOVER DUE TO TREATMENT WITH DNOSBP (Data Taken 60 Days After Treatment)

Pounds DNOSBP Per Acre	Spray Volume Gallons/Acre	Reduction in Stand[1] Clover (Angles) Mean	Reconverted to %
1.87	80	80.78	97.4
1.50	80	75.26	93.5
1.87	20	70.36	88.7
1.87	40	67.85	85.8
1.50	40	66.81	84.5
1.12	80	66.67	84.3
1.50	20	62.39	78.5
0.75	80	59.15	73.7
1.12	40	58.33	72.4
1.12	20	57.04	70.4
0.75	40	43.65	47.6
0.75	20	40.59	42.3
	LSD 5%	11.24	
	1%	14.95	

1/ Stand of red clover in untreated plots = 15.5 per sq. ft.

PROGRESS REPORT ON THE EFFECT OF CERTAIN BRUSH CONTROL TECHNIQUES AND MATERIALS ON GAME FOOD AND COVER ON A POWER LINE RIGHT-OF-WAY. NO. II

By

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A first report[1] was made on this research project at a previous conference, which included a complete description of the objectives, treatments applied, and the experimental design used. For the purpose of this second report, it seems sufficient to say that a series of large-scale spray tests were set up in the spring of 1953 on a power line right-of-way which had been cleared in the winter of 1951-52 through a typical oak-hickory forest type in central Pennsylvania. The main objective of the spray tests was to follow the effects of the various commercially applied sprays on game food and cover. Six treatments were applied in 4 replications to control brush on the right-of-way; five were applied in the early summer of 1953 and one (E) in the winter of 1954. Complete descriptions of the techniques have been given and they will be briefly characterized here as follows:

Treatment A - No spray
Treatment B - Broadcast foliage spray of 2,4D plus 2,4,5-T butoxy ethanol esters, half and half; at a concentration of 4 lbs. combined acid equivalent per 100 gals. of water.
Treatment C - Oil-water, semi-basal summer spray of emulsifiable acids of 2,4D plus 2,4,5-T, half and half; 3 gals. of spray material to make a concentration of 6 lbs. of combined acid equivalent per 100 gals. spray in an oil-water carrier, 10 gals. of No. 2 fuel oil with 87 gals. water.
Treatment D - General summer basal spray of emulsifiable acids of 2,4D plus 2,4,5-T, half and half; at a concentration of 12 lbs. of combined acid equivalent per 100 gals. of spray, using No. 2 fuel oil as a carrier.
Treatment E - Selective winter basal spray of 2,4,5-T butoxy ethanol ester at a concentration of 12 lbs. acid equivalent per 100 gals. spray, using No. 2 fuel oil as a carrier.
Treatment F - Broadcast foliage spray of Ammate at a concentration of 3/4 lb. per gal. of water; 4 gals. of duPont sticker-spreader was added per 100 gals. of spray.

In June of 1954, a follow-up spray was applied to 1/2 of each treatment area of all techniques except the winter basal. This follow-up consisted of

[1] Bramble, W. C. and W. R. Byrnes. 1954. Progress report on the effect of certain brush control techniques and materials on game food and cover on a power line right-of-way. Proceedings of the 8th Annual Northeastern Weed Control Conference. pp. 465-470.

a summer basal spray applied as in Treatment D to all living, or resprouting, woody brush. Its effect was to immediately kill back all resurgent woody brush and it aimed to obtain a more complete kill than was possible with single applications or with delayed follow-up sprays. This type of spray also has the intent of providing a combination with other techniques, described above, to maintain a right-of-way with as little disturbance to plant cover as possible.

EFFECT OF SPRAYS ON WOODY BRUSH

After clearance of the forest cover on the right-of-way during the winter of 1951-52, a woody Shrub Layer consisting primarily of clumps of tree sprouts developed. After one growing season following clearing, and prior to spraying in 1953, this layer had attained a height ranging from 3 to 6 feet, with a total cover value of 20 to 34 per cent. The species composition of this woody Shrub Layer can be seen in Table 1. All sprays were applied in June 1953, except Treatment E (Selective winter basal) which was applied in January 1954.

In September 1954, two growing seasons after spraying, the Shrub Layer on all sprayed areas was practically non-existent, except for a very few scattered sprout clumps which had been missed, or not thoroughly sprayed. The cover value of the Shrub Layer in 1954 on all sprayed areas was less than 1 per cent, as compared to the unsprayed areas of Treatment A on which it increased from 29 to 54 per cent cover over the same period.

An analysis of the effect of the various sprays on woody brush of the Shrub Layer is given in the following sub-sections.

Top Kill of Original Stems:

An excellent total top kill of original stems, ranging from 94.1 to 99.7 per cent for combined species, was obtained by all of the sprays (Table 1). Treatment B (Foliage D + T) gave the lowest kill of 94.1 per cent while the other four sprays gave a kill between 98.3 and 99.7 per cent. When comparing these figures with those reported in the 1954 report it is interesting to note that there has been, as predicted, a progressive dying of original stems in all cases. The most striking increase in per cent top kill is expressed by Treatment F (Ammate) which progressed from a 33 per cent complete top kill (4/4) in September 1953 to 99.7 per cent in September 1954. Treatment B (Foliage) and C (Oil-water) also showed a greatly increased top kill for the same period.

Resurge of Sprouts from Sprayed Original Stems:

Resprouting of sprayed stems occurred to some degree from all treatments (Table 2). It should be realized that all the living stems recorded in Table 2 are less than 3 feet in height, average from 1.0 to 1.4 feet for the various treatments, and are now a part of the Ground Layer. The oaks in particular resprouted after foliage sprays with both 2,4D + 2,4,5-T and Ammate (Treatments B and F), with Bear Oak and Chestnut Oak being the most difficult to obtain a complete top kill without resprouting. Red Maple and Juneberry were also heavy resprouters, with Red Maple sprouting vigorously on Treatment F (Ammate) and Juneberry sprouting heavily for both foliage sprays (Treatments B and F). Of special interest was the low number of Sassafras sprouts after broadcast foliage, (B) as compared to the large numbers from all other treatments.

Table 1. Top kill of original stems sprayed in June 1953 (E sprayed in January, 1954). Data taken in September 1954 on 4 replications of each treatment. Top kill in this table refers to completely dead stems without foliage or green bark.

Species	A Unsprayed	B Foliage, D+T	C Oil-water, D+T	D Summer Basal	E Winter Basal	F Ammate
		%	%	%	%	%
White Oak	Control - not sprayed	92.7	98.9	99.7	97.6	100.0
Red Oak		92.6	99.1	96.3	94.9	99.7
Black Oak		86.3	100.0	100.0	96.4	100.0
Chestnut Oak		90.9	99.6	97.0	99.7	99.5
Bear Oak		89.4	94.1	98.8	96.7	100.0
Red Maple		98.3	99.4	99.6	99.2	99.6
Sassafras		100.0	100.0	99.7	99.8	100.0
American Chestnut		100.0	100.0	100.0	100.0	100.0
Juneberry		80.0	100.0	100.0	-	92.5
Aspen		100.0	100.0	100.0	100.0	100.0
Black Cherry		100.0	100.0	100.0	100.0	100.0
Fire Cherry		100.0	-	100.0	100.0	100.0
Black Gum		100.0	100.0	100.0	-	100.0
Hawthorn		100.0	100.0	-	-	-
Hickory		100.0	-	100.0	100.0	100.0
Large-leaved Holly		-	-	100.0	-	100.0
Average All Species		94.1	99.0	98.9	98.3	99.7
No. Original Stems Basis Per Acre	Before	17592	18520	20784	25814	22184
	After	1032	176	224	439	64

Table 2. Resurge of sprouts from sprayed stems two growing seasons after spray (except treatment E which had one growing season after spray). Average of four replicates for each treatment was used to obtain the number of sprouts per acre and per cent sprouts resurging.

Treatments	A Unsprayed	B Foliage, D+T		C Oil-water, D+T		D Summer Basal		E Winter Basal		F Ammate	
Species	No.	No.	Per[1] cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
White Oak	1,248	192	16	104	7	32	1	133	3	24	2
Red Oak	1,320	264	15	144	8	88	7	160	5	624	21
Black Oak	368	128	17					66	6	200	52
Chestnut Oak	2,064	1,192	27	260	5	208	6	40	1	3,200	58
Bear Oak	968	1,608	63	376	23	680	25	266	9	368	48
Red Maple	1,432	136	7	304	11	40	2	213	6	904	40
Sassafras	888	80	2	328	9	400	6	425	7	456	6
Chestnut	48	24	6	0		0		0		8	2
Juneberry	72	24	60	0		0				96	30
Aspen		0		0		0		0		0	
Black Cherry		0		0		0		0		0	
Fire Cherry		0				0		0		0	
Black Gum	8	0		0		0				0	
Hawthorn		0		0							
Hickory	8	0				0		0		0	
Holly						0				0	
Dogwood	16					0				0	
All Species	8,440	3,648	21 %	1,536	8 %	1,448	7 %	1,303	5 %	5,880	27 %

[1] Per cent resurge based on number of sprouts present after spraying divided by original number stems.

The summer and winter basal sprays (Treatments D and E)and the oil-water, semi-basal (Treatmnet C) were most successful in preventing resprouting. It is not possible to accurately compare the other treatments with E at this time, however, as records on the winter basal treatment were taken only one growing season after spraying as compared to the other treatments which had two growing seasons since application of sprays. It is entirely possible that resprouting may increase on the areas of Treatment E during the second growing season as it did with other sprays.

It may be noted from Table 2 that the greatest number of new sprouts of all species combined were found on Treatment F (Ammate), which had 27 per cent resprouting, followed by Treatment B (Foliage) with 21 per cent resprouting. The other treatments fell in order as follows: Treatment C (Oil-water) had 8 per cent resprouting and Treatment D (Summer basal) had 7 per cent resprouting. Treatment E (Winter basal) with 5 per cent resprouting, as noted above, had passed through only one growing season after spraying and is expected to show more resprouting next year.

Although sprouting is more proliferous on Treatment F (Ammate), these sprouts, in general, are smaller than the sprouts on any other treatment. The average height of all species of sprouts on Treatment F was 1.0 feet, as compared to 1.3 feet for Treatments C and D, and 1.4 for Treatment B.

EFFECT OF SPRAYS ON THE GENERAL PLANT COVER

The right-of-way vegetation before spraying was divided into two layers for analysis. A Shrub Layer was recognized which had developed to become 3 to 6 feet in height, composed primarily of woody brush produced by tree sprouts and seedlings and tall shrubs. Between and beneath this layer was a Ground Layer which was dominated by a BRACKEN-SEDGE-HERB-BLUEBERRY cover.

Effect of Sprays on the Shrub Layer:

As described in the preceding section, all of the spray treatments caused a complete top kill of woody brush over 3 feet in height, except for occasional misses. The new sprouts and unsprayed seedlings, with very few exceptions, also remained below 3 feet at the end of the growing season of 1954.

The Shrub Layer can, therefore, be said to have been eliminated from all spray areas. The degree of permanence of this elimination will undoubtedly vary with the effectiveness of each treatment not only in killing back the brush but also supressing resprouting. Some of the sprays which show considerable new production now, such as Treatment B and F, should be followed by a quick resurge of woody brush; others, such as C, D, and E should be more lasting in their effect.

The Shrub Layer of the unsprayed areas continued to develope normally into a thicket of tree sprouts and tall shrubs up to 8 feet in height and with a cover value of 54 per cent of the total ground area. Its species composition remained the same as in 1953, with the oaks (White, Red, Black, Chestnut, and Bear Oaks) dominant. In certain replications Sassafras was very abundant, while Red Maple was common throughout.

Effect of Sprays on the Ground Layer:

After the Shrub Layer, i.e. woody vegetation over 3 feet in height, had been eliminated from sprayed areas there remained only a low plant cover on the right-of-way, herein referred to as the Ground Layer. With the exception of a few tall herbs which developed in late summer such as Fireweed and tall grasses, this layer was under 3 feet in height. Woody plants in the Ground Layer at this time consisted of, (1), new sprouts from sprayed trees and shrubs, and (2), small seedlings, seedling sprouts, and suckers. The proportion of these two types of woody stems is given in Table 3. It is of interest to note that Sassafras makes up the greater part of the total stems in all but Treatment B.

Table 3. The proportion of small seedlings, seedling sprouts and suckers in the Ground Layer two growing seasons after spraying.

Treatment	Total No. of Woody Stems per Acre	No. of Sassafras Stems per Acre	Per cent Seedlings, Seedling Sprouts and Suckers	Per cent Sprouts from Sprayed Brush
A	22,560	11,288	63	37
B	4,136	424	12	88
C	2,760	1,432	44	56
D	8,088	6,368	82	18
E	14,097	10,919	91	9
F	7,744	1,976	24	76

Although numerous, these low woody stems are of minor cover value in the Ground Layer at present and are of interest mainly in respect to their possible development into tall brush in future years. However, it is probable that their importance in such treatments as summer basal (D), where a tight ground cover has been maintained, could be over rated. Many small seedlings, for example, will not reach a height where they will require artificial control, as they will be suppressed by other vegetation and destroyed by animals. An exception to this may be in the case of small Sassafras suckers which are very numerous after spraying in at least two replications of all treatments except broadcast foliage spray (B).

Major changes in dominant species of the Ground Layer from the uncut woodland through two growing seasons after spraying are summarized in Table 4. Uncut woodland, before the original right-of-way clearance, had a sparse Ground Layer dominated by a BRACKEN-SEDGE-HERB-BLUEBERRY cover which covered 64 per cent of the ground surface. After the right-of-way was cleared in the winter of 1951-52, the plants of the forest floor spread to cover 79 per cent of the ground surface at the end of the first growing season. The species composition of the Ground Layer on the new right-of-way remained essentially the same as in the forest. The only prominent new invader in this first season was Fireweed, which appeared in abundance in spots where brush had been burned and mineral soil exposed. A few Sweetfern and Blackberry seedlings also appeared in those bare spots probably through seed deposited by birds and other animals.

As a result of spray treatments applied in June of 1953, marked changes began to appear in the Ground Layer; so that by September 1954, two growing seasons after treatment, the cover value and species composition of the Ground Layers on various treatment areas was different enough to make distinction possible between them as follows:

Treatment A - unsprayed:
The total cover value increased from 79 per cent to 96 per cent with no marked change in the original dominant plant cover which remained BRACKEN-SEDGE-HERBS-BLUEBERRY. There was some increase in Bracken, Panic grasses and Low Late Blueberry, but not enough to change dominance other than to add grass as a minor component of the dominant cover.

Treatment B - broadcast foliage spray 2,4-D + 2,4,5-T:
The Ground Layer was almost completely browned after spraying owing to a 100 per cent top kill on most herbs such as Wild Sarsaparilla and Loosestrife, a 90-100 per cent kill on Bracken, and an 80-90 per cent kill on Sedge. Most striking was a light top kill of only 10 per cent on the Panic grasses in nearly all plots. A 90-100 per cent top kill was recorded on low shrubs such as blueberries, Witch-hazel, and Teaberry.

Two growing seasons after spraying, the cover value of the areas had returned to 79 per cent; but the species composition was markedly altered and now dominating the area was a SEDGE-GRASS-Herb plant cover. This grassy type of right-of-way has been developed by Sedge and grasses whose roots were not killed by the hormone 2,4-D + 2,4,5-T spray. Species, which can spread both vegetatively by rhizomes and by seeds, such as the Panic grasses and Upland Bent, typically spread from sparse single plants or small groups to large patches and probably will be more important in the future.

Bracken had been reduced to where it was of small cover value and grew singly rather than in groups or patches. Low shrubs such as blueberries had disappeared or were very sparse.

Although Fireweed had spread to become abundant, it was scattered thinly and in general remained of small cover value. Loosestrife, another herb, was abundant but of small cover value and prominent only in early summer.

Treatment C - oil-water, semi-basal spray, 2,4-D + 2,4,5-T:
This treatment caused a top kill and browning of most of the Ground Layer owing to the incidental spread of the high pressure spray that was used to wet the lower two-thirds of the stems and foliage of woody brush. The browning extended over 40-50 per cent to 80-90 per cent of the area, according to the density of the woody brush sprayed. This left scattered patches of unsprayed ground cover over most of the area. At the end of the 2nd growing season after spraying, the Ground Layer had built up to cover an average of 79 per cent of the ground area. This was caused in a large part by the increase of Fireweed which covered from 1/20 to 1/4 of the area to change the dominant cover to FIREWEED-Bracken-Grass-Sedge. Although a right-of-way cover dominated by a herbaceous annual had been created, it is probable that Fireweed will soon be replaced by perennial plants.

- :

Treatment D - summer basal spray 2,4-D + 2,4,5-T in oil:
As this spray was applied directly to the woody brush, it only affected the Ground Layer immediately around the stems sprayed. The net effect on ground cover, therefore, was negligible and cover value of the Ground Layer after 2 growing seasons was 95 per cent, or about the same as in unsprayed areas. This has been one of the outstanding characteristics of this technique, i.e. maintenance of a tight ground cover.

The dominant plants of the Ground Layer remained practically stable two seasons after spraying. A BRACKEN-SEDGE-HERB-BLUEBERRY cover still dominated, with grasses increasing to become a minor component. Bracken showed a tendency to spread into the other plant covers such as patches of Sedge and Low Blueberry, and maintained its dominance. Sedge and Blueberry on the other hand decreased.

It is of interest to observe that at this time the typical woodland herbs had become crowded and suppressed, or have disappeared. Such species as Wild Sarsaparilla, False Solomon's-seal, Indian Cucumber-root, and Lady's Slipper, which flourish under the canopy of the forest, lost out in competition on the open right-of-way. Of all the herbs of the woodland, only Loosestrife has increased and held its own, so that along with Fireweed it is one of the prominent aspect plants of the Ground Layer on the right-of-way.

Treatment E - winter basal spray 2,4,5-T in oil:
This basal type of spray produced results similar to those by the summer basal described in the previous section. The ground cover was killed only in the areas immediately surrounding sprayed stems. Plant changes were slight during the first season with some increase in Panic Grass and Fireweed in sprayed spots but no increase in low shrub cover. A BRACKEN-SEDGE-HERB-BLUEBERRY-Grass cover dominated the sprayed areas. A large number of tree seedlings and low sprouts were present owing to difficulties in finding them in the course of winter spraying.

Treatment F - broadcast foliage spray with Ammate:
This spray produced nearly complete browning of the Ground Layer for the first growing season and winter after application. A 90-100 per cent top kill was recorded on Bracken and an 80-90 per cent kill on Sedge. The herbs and Panic grasses were completely killed back. Of the shrubs, only Mountain-laurel showed signs of resistance to the spray, while blueberries suffered 90-100 per cent top kill.

Two growing seasons after spraying, a new ground cover had developed to occupy 71 per cent of the ground area mostly owing to invasion of Fireweed which is an annual herb that commonly invades burned and disturbed areas of the region. Most of the woodland herbs had disappeared, and even Loosestrife had become very sparse. Bracken and blueberries were very sparse having been completely killed in most spots by the spray.

Fireweed up to 6 feet tall dominated the treatment areas, and, in moist spots, formed a complete cover. Beneath this tall herb cover were scattered, numerous seedlings and sprouts of species present on the right-of-way before spraying such as Sedge and Panic grasses. Small Blackberry and Sweetfern seedlings were common beneath the Fireweed; other formerly prominent shrubs such as

Table 4. Changes in the dominant plants of the Ground Layer (vegetation under 3 feet in height) on the Penelec right-of-way. Summary of 4 replicates for each treatment.

Status of the right-of-way	Dominant Plant Cover of the Ground Layer					
Uncut woodland	BRACKEN-SEDGE-HERB-BLUEBERRY 64% of the ground surface with plant cover					
June 1953 - First year after initial clearance in winter 1951-52	BRACKEN-SEDGE-HERB-BLUEBERRY 79% of the ground surface with plant cover					
September 1954 - Two growing seasons after spraying in June 1953	Treatment					
	A Unsprayed	B Foliage, D+T	C Oil-water, D+T	D Summer Basal	E Winter Basal	F Ammate
Per cent ground surface in plant cover	96%	79%	78%	95%	91%	71%
Dominant plant cover	BRACKEN SEDGE HERB BLUEBERRY Grass	SEDGE GRASS Herb	FIREWEED Bracken Grass Sedge	BRACKEN SEDGE HERB BLUEBERRY Grass	BRACKEN SEDGE HERB BLUEBERRY Grass	FIREWEED Sedge Grass
Significant changes in plant cover composition	None	To dominant Sedge and grass	To dominant Fireweed	None	None	To dominant Fireweed
Changes in plant cover	Increase of 17%	None	None	Increase of 16%	Increase of 12%	Decrease of 8%

blueberries were lacking or only found in occasional unsprayed spots. Although it is probable that perennial plants will succeed Fireweed in the next few years, the present dominant cover is FIREWEED-Sedge-Grass.

SUMMARY

A replicated series consisting of 5 spray treatments and one control were applied to woody brush by commercial techniques on a power line right-of-way in central Pennsylvania in June 1953 and January 1954. Data was taken two growing seasons after the first applications (one season for winter basal).

The Shrub Layer over 3 feet in height had been eliminated by all the sprays through a 94 to 99 per cent complete top kill on all species of woody brush combined. Brush on unsprayed control areas (Treatment A) had grown to 8 feet height with a 54 per cent cover value; a BRACKEN-SEDGE-HERB-BLUEBERRY-Grass Ground Layer under 3 feet in height had developed between the tall brush.

Treatment B (Broadcast foliage, D + T) after a 94.1 per cent top kill had considerable resprouting (21 per cent) with very few seedlings appearing in the Ground Layer which was dominated by a SEDGE-GRASS-Herb cover after virtual elimination of Bracken and Blueberry. This spray gave the best control of Sassafras.

Treatment C (Oil-water, semi-basal, D + T) was the most effective spray of the series. After a 99 per cent top kill, only 8 per cent resprouting occurred and a small number of seedlings were missed. Owing to extensive killing of ground cover by the spray, the dominant cover was changed to FIREWEED -Bracken-Grass-Sedge.

Treatment D (Summer basal) produced a 98.9 per cent top kill and was superior in suppression of resprouting (7 per cent resprouting). A tight cover of low plants was maintained and the dominant cover remained unchanged as BRACKEN-SEDGE-HERB-BLUEBERRY-Grass. Numerous seedlings and small suckers of Sassafras were present among the ground cover after spraying.

Treatment E (Winter basal) had but one season after application for sprout development. However, it looks promising where Sassafras was not abundant in view of a 98.3 per cent top kill and a low resprouting of 5 per cent. One of its major weaknesses was the large number of seedlings (twice as many as in summer basal) that were left after spraying. Its effect on the ground cover was similar to summer basal (D).

Treatment F (Ammate) gave the highest top kill of 99.7 per cent; but had produced the most sprouts two growing seasons after spraying (27 per cent). After an extensive kill of the ground cover, a Ground Layer of FIREWEED-Sedge-Grass developed. A relatively small number of seedlings and low single sprouts appeared after spraying.

List of Common and Scientific Names[1] of Plants
Referred to in the Report

Aspen	Populus grandidentata Populus tremuloides
Blackberry	Rubus allegheniensis
Blueberries	Vaccinium angustifolium Vaccinium vacillans
Bracken	Pteridium aquilinum
Cherry, Black	Prunus serotina
Fire	Prunus pensylvanica
Chestnut	Castanea dentata
Dogwood, Flowering	Cornus florida
False Solomon's-seal	Smilacina racemosa
Fireweed	Erechtites hieracifolia
Gum, Black	Nyssa sylvatica
Hawthorn	Crataegus spp.
Hickory	Carya spp.
Holly, Large-leaved	Ilex montana
Huckleberry	Gaylussacia baccata
Indian Cucumber-root	Medeola virginiana
Juneberry	Amelanchier arborea
Lady's Slipper	Cypripedium acaulē
Loosestrife	Lysimachia quadrifolia
Maple, Red	Acer rubrum
Mountain Laurel	Kalmia latifolia
Oak, Bear	Quercus ilicifolia
Black	Quercus velutina
Chestnut	Quercus prinus
Red	Quercus rubra
White	Quercus alba
Panic Grasses	Panicum latifolium Panicum commutatum
Sassafras	Sassafras albidum
Sedge	Carex pensylvanica
Sweetfern	Comptonia peregrina
Teaberry	Gaultheria procumbens
Upland Bent	Agrostis perennans
Wild Sarasparilla	Aralia nudicaulis
Witch-hazel	Hamamelis virginiana

[1]From Gray's Manual of Botany. 8th Edition. 1950.

THE PROGRESS OF WEED CONTROL ON CONNECTICUT STATE HIGHWAYS

By

William C. Greene
Landscape Engineer

Weed control is fast becoming one of the most important items in the roadside maintenance program on the Connecticut state highway system. The importance of weed control has developed from the improvement in highway safety, economy in maintenance and the better appearance of the areas under vegetative maintenance.

It contributes to driver safety in that it keeps under control the growth that obstructs the sight-lines and the plant materials that encroach upon the travel area of the roadways. It eradicates the toxic and allergy producing weeds that are troublesome to the abutting property owner, the maintenance employees and the ever-increasing population.

Economic savings are most important in the highway maintenance program. Each tax dollar saved in this work means that it can be put to use in the construction of our much needed roads. And further, we are better able to maintain the increase in our mileage without the added dollars that would be necessary without a weed control program.

How does weed control save money? The elimination of weeds that require constant cutting, the elimination of toxic growth that causes lost time of susceptible employees and reduces the efficient production of the work of others are cited as examples of cost reductions.

As a typical illustration of lost time, let us look into the statistics of the reduction in poison ivy cases of exposed maintenance employees of the department in the last two-year period:

	Employees Exposed	First Aid	Medical	Lost Time Cases	Days Lost
1953	2038	26	26	47	179
1954	2301	25	11	29	82

We do not claim that the spraying of poison ivy is entirely responsible for this reduction in lost time, but it, no doubt, contributed a great deal in the savings of the dollars that would have been expended had not a program of eradication been in effect.

The presence of noxious weeds in our turfed areas, many miles of which are the front door yards of abutting property owners, has an unsightly appearance. With a weed control program in force, this undesirable condition is being eliminated.

Many years ago chemical weed control was attempted on a limited scale to eradicate various harmful agricultural weeds, such as Canada thistle, etc. We did not have the selective chemicals then to make this job efficient. But at least we tried and that was important. Through the years we have used many of the various chemical formulations for control of our weeds, constantly on the alert to make this a successful factor in our maintenance operations.

Now we have the development of the various types of materials that have become such a useful tool when used with proper care.

For the selective control of herbaceous weeds such as ragweed, wild carrot, dandelions, plantain, etc., we use 2-4D of a low volatile ester or amine salt formulation.

In order to eradicate poison ivy and similar growth the selective use of

2,4D and 2,4,5T in a foliage application has proved most effective.

For the eradication of brush and woody growth we use 2,4,5T in oil as a basal spray after the material is cut.

To prevent weed growth in ornamental and functional plantings we have been very successful with the application of Alanap I, a pre-emergence weed spray that has been developed by the Naugatuck Chemical Division of the U.S. Rubber Company.

For the sterilization of soils to prevent growth in concrete expansion joints and under hard-to-mow guide rails we have used Du pont's Telvar W and Telvar DW.

In order to inhibit the growth of grass and thus reduce mowing operations but still maintain valuable turf, our experiments have been very successful with U.S. Rubber Company's product Maleic Hydrazide. However, it is important that this be combined with an application of 2,4D to eliminate weeds in the turf that are not affected by the MH-40.

How do we apply these chemicals in our program? We use small inexpensive low-pressure gear pumps, flex-roller pumps, and piston pumps powered by small gasoline motors. The containers for the solutions are salvaged metal drums.

Our regular trucks are equipped with a simple hydraulically controlled arm with a boom jet nozzle and hand-controlled spray booms with T jet nozzles. We are able to selectively cover our roadsides with a comparative amount of ease when, where, and as necessary by using a minimum amount of manpower.

It's true that Connecticut is a small state. But we have approximately 3,000 miles of highway. It is estimated that there are approximately 8,000 acres under vegetative maintenance. That is a sizeable chunk of land to keep in proper trim. The many hours of manpower with the consequent costs for this work must be considered so the use of selective weed sprays has proved a tremendous boon in the reduction of these costs.

However, we are a conservative group of people. Good public relations are important. Therefore, it is essential that the application of the chemicals in weed control be performed with the greatest of care. Only trained personnel are used to carry out this work. The employees must be observant of ornamental plant materials, vegetable crops, and agricultural fields. It is important that the operators be overly cautious to prevent any damage and thus cause poor public relations.

Foliage spraying of brush is not permitted, to avoid the unsightly brown-outs that are evident in many areas where the use of chemicals is promiscuous. That is the reason we have adopted the method of cutting the brush and applying the 2,4,5T as a basal spray. The control is just as effective and the resultant appearance is better.

It is important that this valuable tool that has been developed in these chemical herbicides not be ruled against because of uncontrolled and inexperienced use. We are, therefore, very alert to the need of selection of only qualified personnel that are thoroughly trained in the application of these materials for the purpose they have been developed.

We believe that the Connecticut State Highway Department has progressed very well in the past several years in its weed control program. We feel that the safety afforded, the economic advantages and the enhancement of appearance are the resultant dividends of progress in weed control.

"A COMPARISON OF FIELD TESTS OF STANDARD AND NEW BRUSH KILLER FORMULATIONS"

W. A. Meyers, W. W. Allen and R. H. Beatty[1]

During the past several years, research workers in the field of woody plant control have attempted to increase the potency of herbicides by two methods; namely by looking for an entirely new type of material unrelated to the phenoxy acids and by improving formulations of existing materials. In this paper, we will be dealing only with the effort to improve the standard 2,4-D - 2,4,5-T type of spray material.

In the early days of the use of 2,4-D in agronomy, there was scarcely any distinction made between esters, amines or salts. At that time, the practice was to use a certain amount of acid equivalent per acre regardless of how the material was formulated. Formulations, as such, were in their infancy. During the years when the use of 2,4-D type herbicides progressed from an experimental method of plant control to an accepted technique widely used in the field, it became increasingly apparent that tremendous differences in performances of the spray materials resulted from the type of formulation employed. Esters are now being used more extensively than amines, acids or Na salts.

This, of course, does not mean that only esters are effective and should be used exclusively. Many things such as volatility, formulation differences, and economics must be taken into account in selecting the type of material to apply on any given area. It must be kept in mind that the way in which the various esters, acids, amines and salts are formulated influences their effectiveness to a very marked degree.

Let us think for a minute about what we mean by differences in formulations affecting the degree of kill on woody plants. It will be of value to look at the results of some of the various formulations that have been applied to woody plants in the past several years. I can not give any information about the actual formulation of these materials in this paper because of patent reasons. However, I would like to discuss the field results we have obtained from several new types of formulations in contrast to the regular types of brush killers. It should be borne in mind that all of these materials contain four pounds acid equivalent per gallon of active ingredient as the butoxy ethanol ester.

[1]American Chemical Paint Company, Ambler, Pennsylvania

In the following tables, reference will be made to "kill" and "regrowth". By "kill", I will be speaking of plants which were defoliated by the initial spray and which have not resprouted either from the stems, lateral rhizomes, or the root collar. Any plants where sprouting has occurred were counted as "regrowth". Some seedlings have appeared in the test area since the initial spray. As far as was possible, these seedlings were eliminated from the counts made on the area.

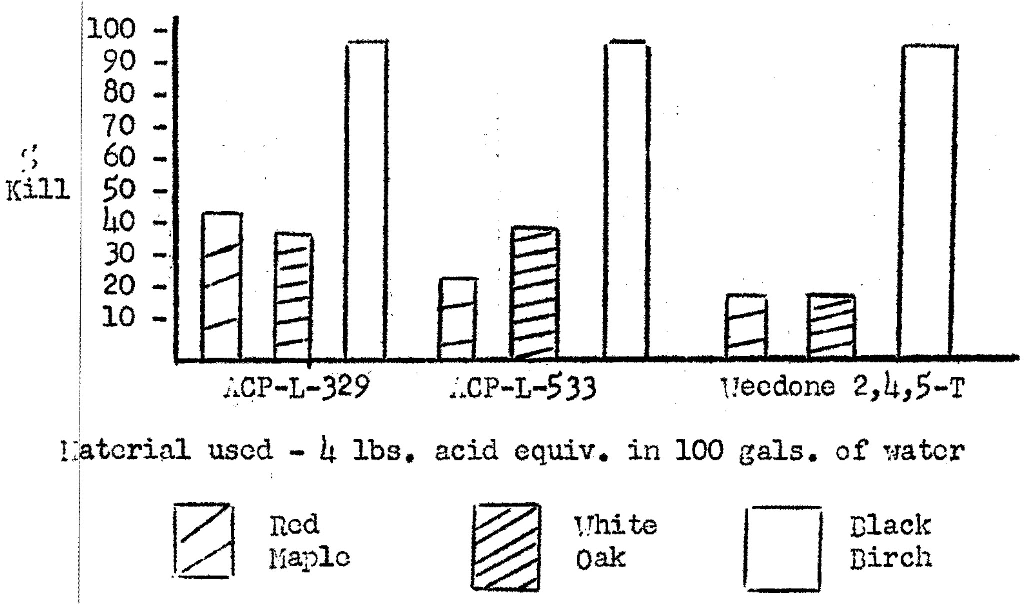
PROCEDURE

The area selected for the foliage tests was chosen because of the uniformity of the woody species occurring on the site, principally white oak, and red maple. The plots were located on the right-of-way of the American Telephone and Telegraph Cable Line near Scranton, Pennsylvania. Each plot was laid out as one-tenth acre in size.

The materials were applied in July of 1953. A pressure of 150 pounds per square inch was used and between 150 and 200 gallons of spray solution per acre were put down. The spray solution was mixed at the rate of four pounds acid equivalent to each one hundred gallons of water. All stems, leaves and branches were thoroughly sprayed to the point of run off. No attempt was made to spray the ground. The brush was of medium density and height, averaging about six thousand stems per acre and four to six feet in height. The results in the data are based on counts made after two growing seasons.

Table I - Effect After Two Years of 2,4,5-T Butoxy Ethanol Ester Formulations

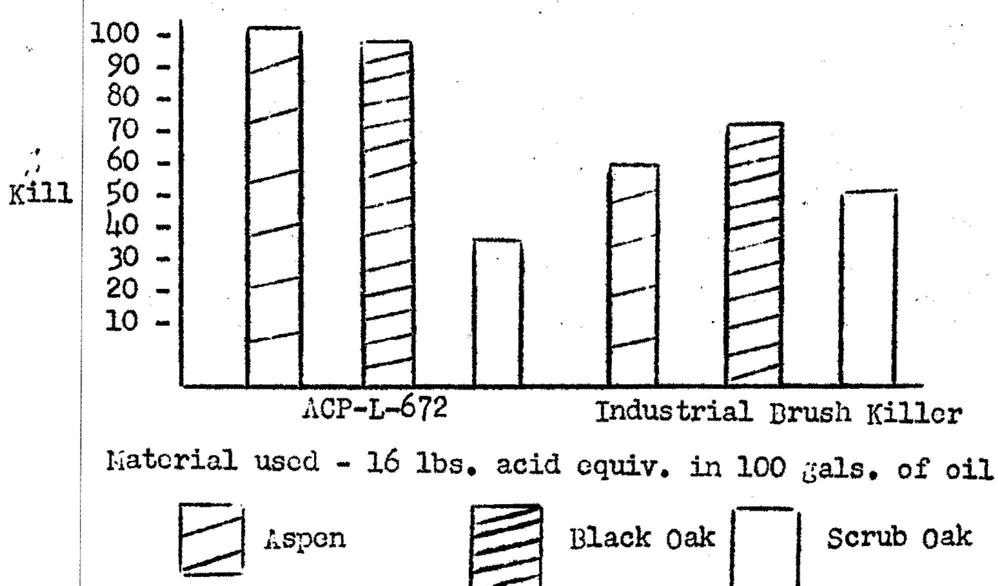
Used As a Foliage Spray



Material used - 4 lbs. acid equiv. in 100 gals. of water

Table II - Effect After Two Years of 2,4-D plus 2,4,5-T (50-50) Butoxy Ethanol Ester Formulations

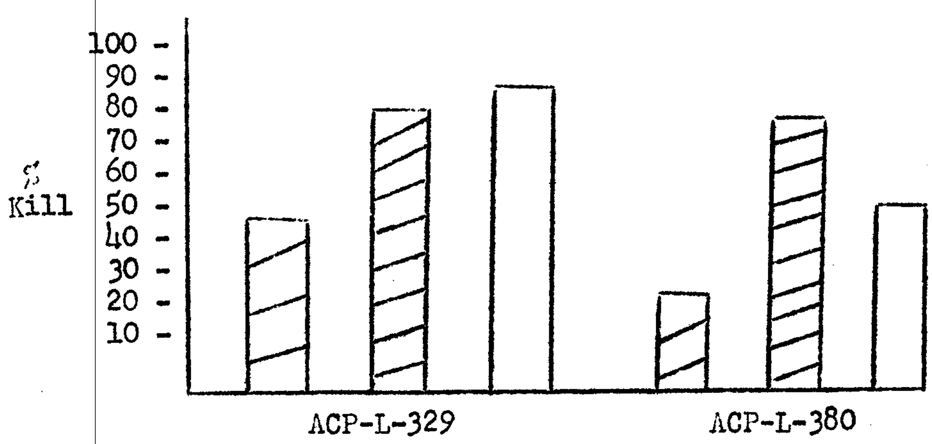
Used As a Basal Spray



Material used - 16 lbs. acid equiv. in 100 gals. of oil

Table III - Effect After Two Years of 2,4,5-T Butoxy Ethanol Ester Formulations

Used As a Basal Spray



Material used - 16 lbs. acid equiv. in 30 gals. of oil and 70 gals. of water

DISCUSSION

By comparing the three materials shown in Table I, we can readily see that there is a great difference in effectiveness. Per cent kills may vary tremendously with a species and be relatively the same in the case of another species. For example, red maple shows an increase in kill from a low of 7% with standard Weedone 2,4,5-T to a high of 45% with ACP-L-329, a gain of 38%. Using the same material, we also show a gain of 35% on white oak. It should be pointed out here that red maple and oak are two problem species with our present foliage sprays. Increasing the kill of these species increases the effectiveness of our initial spray. Percentage kill on black birch varied only 2% among the three materials used. However, in all cases, we got as high as 95% on this plant which, in our opinion, is excellent control and one does not expect differences on these easy-to-kill species.

Since these three materials in Table I were applied on the same date, at the same rate on adjoining areas, and had the same amount of 2,4,5-T acid equivalent per gallon, the difference in kill must be attributed to formulation differences in the case of hard-to-kill species.

The basal spray plots showed the same trend in variation of kills in relation to formulation as did the foliage spray tests. This is further evidence of the effectiveness of these new formulations. The material is not only increasing the kill as a foliage spray where penetration and translocation are most important but is also increasing the kill on our basal plots. We feel that we are getting more of the active ingredient into the plants with these new formulations. Both Table II and Table III illustrate this trend. In Table II, aspen responded to the treatments with a 100% kill with ACP-L-672 and a 59% kill with Industrial Brush Killer.

In Table III, the kill of white oak varied from 48% to 20% depending on the formulation used as a dormant basal spray. The 48% kill was obtained with ACP-L-329 in an oil-water vehicle. The 20% kill was obtained with ACP-L-380 in an oil-water vehicle.

CONCLUSION

1. Based on the above data and the experience we have obtained over the past eight years in applying various phenoxy acid formulations to woody plants, we conclude that there are differences in the kill of woody plants when different formulations are used even though the formulations have the same amount of acid and the same esters.

2. There is a significant difference in kill of red maple, white oak using ACP-L-329 over Weedone 2,4,5-T, both formulations containing the same amount of 2,4,5-T acid as the butoxy ethanol ester.

3. ACP-L-329 showed significantly better kill of white oak over ACP-L-380 when used as an oil-water dormant basal spray even though both sprays contained the same amount of acid.

Work will be continued along this line. We bring it to your attention so that in future work on woody plants differences in kill of woody plants should not always be contributed to the esters used but one in research work must be careful in his evaluation, making sure that the formulations are the same in both cases when comparing esters.

THE EFFECT OF VOLUME, CONCENTRATION AND POINT OF APPLICATION OF 2,4,5-T IN THE BASAL TREATMENT OF BEAR OAK

By

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Introduction

Bear Oak (Quercus ilicifolia), one of the hard-to-kill species, is characterized by vigorous resprouting from the root collar area. Early attempts to control this species by cutting or burning failed because the two or three original stems were replaced by from 10 to 50 new ones, all arising from the root collar area. Similar difficulties are encountered when using hormone brush killers.

Work on this species was initiated at The Pennsylvania State University in the winter of 1952 using 2,4,5-T butoxy ethanol ester (Weedone) applied in an oil carrier to different parts of the plant. Preliminary results of these tests were presented at this meeting in January 1953. These tests were repeated in the summer of 1952 to determine the effect of season and to see if the trends shown for the winter placement tests were true in the summer as well. Three growing seasons have elapsed since the winter tests and two since the summer tests. Additional tests to determine the effect of volume and concentration of solution were completed in the winter of 1953; these tests have passed two growing seasons.

Placement Tests

These tests were undertaken to determine if the point of application was important in preventing resprouting of Bear Oak. Weedone 2,4,5-T was used at a concentration of 4% by volume (12# acid/100 gal. spray) in kerosene. Five different applications were tested as follows using 10 plants in each test:

1. The spray material was applied with a brush so as to completely cover the basal 12 inches of the stem being careful that none of the solution contacted the root collar area.

2. The spray material was brushed on the root collar area being careful not to treat the basal portion of the stem.

3. The spray material was brushed on the basal part of the stem as in (1) and on the root collar as in (2).

4. The spray material was applied with a knapsack sprayer to the basal 12 inches of the stem, using the normal procedure of allowing an excess to run down the stem to the root collar.

5. The spray material was applied to the ground in a 2-foot circle around the plant with a knapsack sprayer being careful not to contact the stem and allowing the material to soak into the ground.

These applications made in the dormant season (March 1952) were repeated in the growing season (August 1952). The effects of the material varied greatly for the different points of application and for the different seasons as shown in Table 1.

Table 1. Summary of placement tests using Weedone 2,4,5-T, 12# acid/100 gallons spray - data taken in September 1954.

Point of Application	Date of Application	Number of Original Plants	Per cent of Original Plants Completely Top killed	Per cent of Original Plants Resprouting	Per cent of Original Plants Top killed without Resprouting
(1) Base of stem only	March 1952	10	60	100	none
	Aug. 1952	10	20	90	none
(2) Root collar only	March 1952	10	100	20	80
	Aug. 1952	10	50	20	40
(3) Base of stem and root collar	March 1952	10	100	10	90
	Aug. 1952	10	90	10	80
(4) Excess on base of stem (2.4 oz. per plant)	March 1952	20	85	70	25
	Aug. 1952	10	20	70	none
(5) On ground under plant	March 1952	10	none	60	none
	Aug. 1952	10	none	30	none

These results support the preliminary findings, that it is necessary to completely wet the root collar with the spray material to obtain the best results. This series of tests also indicates a superiority of dormant basal treatments over growing season basal treatments when treating Bear Oak. The high percentage of resprouting shown in Table 1, application 4 was due, as will be shown later, to the fact that the volume was too low to get complete top kill with minimum resprouting.

Concentration Tests

Good results had been obtained in the first placement tests when a 4% by volume (12# acid/100 gal. spray) solution was applied to the exposed root collar. In January 1953 an experiment was conducted to determine the effect of lower concentrations also applied directly to the exposed root collar. Groups of 20 plants were treated by uncovering and painting the root collars with 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 per cent by volume concentrations of Weedone 2,4,5-T in kerosene. The results of these trials indicate that low concentrations are highly effective both in causing top kill (90% or over) and in suppressing resprouting (85% or over) when applied directly to the root collar (Table 2).

Table 2. Effect of different concentrations of 2,4,5-T in oil when applied directly to the root collar.

Concentration % by Volume	Concentration #acid/100 gals.	Per cent of Original Plants Top killed	Per cent of Original Plants Resprouting	Per cent of Original Plants Top killed and not Resprouting
0.5	2	90	10	85
1.0	4	100	0	100
1.5	6	95	5	90
2.0	8	100	5	95
2.5	10	90	10	85
3.0	12	100	0	100

From the data shown in Table 2, effective treatment was not dependent upon the concentration used but upon a mininum amount of 2,4,5-T reaching the root collar. It follows, therefore, that in practical application where an excess is sprayed on stems, success is gained by getting a certain minimum amount of 2,4,5-T to the root collar. This is achieved by spraying a high volume of spray material on the base of stems. As some allowance must be made for loss of 2,4,5-T in stem flow etc., a minimum concentration should not be used. As a safety factor, therefore, concentrations as high as 12# to 16# acid/100 gal. of spray are necessary to be entirely safe.

Volume Tests

The earlier results of the placement tests showed that it is only necessary to reach the root collar with a small amount of 2,4,5-T to get adequate kill. It was reasoned that this could be accomplished by increasing the volume of solution well beyond that customarily applied so that more of the spray material would have the opportunity to trickle through the duff and soil to the root collar. An experiment to test this hypothesis was carried out in January 1953 in which different amounts of Weedone 2,4,5-T in oil solution were applied to individual plants. Two concentrations were used, a 3% by volume (12# acid/100 gal.) solution and a 1 1/2% by volume (6# acid/100 gal.) solution. Careful records were kept of the volumes applied to each of the 120 Bear Oak plants treated in the test. These plants averaged about 5 original stems per plant.

In September 1954, two growing seasons after treatment, a tally was made of plants completely top killed and of plants resprouting. This data was classified according to the volumes which were applied for each of the two concentrations as summarized in Table 3.

Table 3. The effect of volume on top kill and resprouting of Bear Oak.

	Concentrations of Weedone 2,4,5-T by Volume							
Ave. Vol.	1 1/2% (6# acid/100 gals.)				3% (12# acid/100 gals.)			
Applied per Plant in ozs.	No. Original Plants	% Original Plants Top Killed	% Original Plants Re-sprouting	% Original Plants Top Killed not Re-sprouting	No. Original Plants	% Original Plants Top Killed	% Original Plants Re-sprouting	% Original Plants Top Killed not Re-sprouting
2	21	43	67	10	22	73	68	32
5	14	93	.	43	12	84	50	42
8	11	82	45	63	9	100	11	89
11	4	100	50	50	5	100	20	80
14	1	100	0	100	6	100	17	83
17	3	100	33	67	2	100	50	50
20	6	100	0	100	4	100	25	75

It is interesting to note that 10-12 ozs. of spray material are required to insure complete top kill, while sprouting was never eliminated but could be reduced to a practical limit of 15 to 20% by applying 14 ozs. or more. The best top kill without resprouting obtained was 80 to 85%. It is probable, therefore, that to get further complete kill a higher concentration must be used. Since no consistant differences in resprouting appeared due to the difference in the concentrations used, the data for both concentrations were combined and graphs were constructed showing the top kill and resprouting for different volumes as shown in figure 1.

The practical implications of this sort of information is interesting. The amounts of solution required to treat a definite number of plants with the various volumes per plant given in Figure 1, can be calculated. Also, the number of plants per acre on any particular area can be calculated by measuring the spacing between plants or by counting the plants in a number of small samples distributed throughout the area. In plant communities dominated by Bear Oak the number of these plants per acre is likely to vary between 500 to 2000. Table 4 has been constructed to show the gallonage per acre required for various volumes per plant with different numbers of plants per acre.

Figure 1. The effect of volume of 6-12# acid/100 gal. solution of 2,4,5-T on top kill and resprouting of Bear Oak.

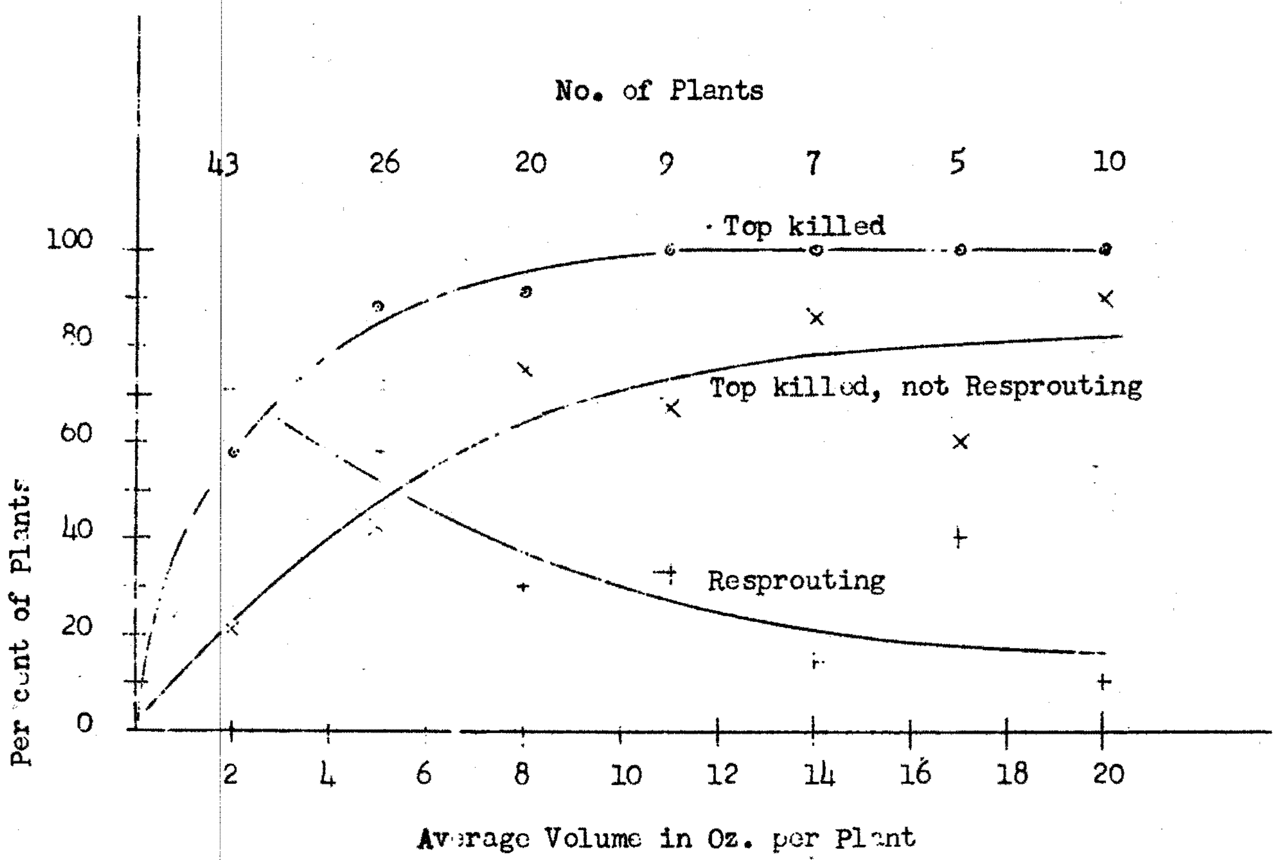

Table 4. Number of gallons of spray per acre required to treat various brush densities with a selected volume per plant.

Volume per Plant in ozs.	No. of Plants per Acre			
	500	1000	1500	2000
	gals.	gals.	gals.	gals.
8	30	65	95	125
10	40	80	115	155
12	45	95	140	185
14	55	110	165	220
16	65	125	190	250
18	70	140	210	280

The practitioner can select the volume per plant to give a level of kill desired from Figure 1 and translate this to gallons per acre for any particular case in Table 4. For example, if 14 ozs. per plant, which is about the optimum volume at 12#/100 gal., is selected, then from Table 4 it will take 110 gal. of spray per acre to treat brush with a density of 1000 plants per acre. In this way he can gain an estimate of the chemical requirements for a particular job or gain day by day control of a project already in progress.

Summary

Experiments to determine the best way to use 2,4,5-T esters in the basal treatment of the hard-to-kill Bear Oak were begun at The Pennsylvania State University in the winter of 1952. The first tests, to determine the best point of application showed that it is necessary to wet the root collar with the spray material in order to obtain complete top kill with a minimum of resprouting. These tests also revealed that dormant treatments are superior to growing season treatments when dealing with Bear Oak. This last conclusion is at variance with similar work with Aspen reported at this meeting last year in which it was shown that the early growing season is the best time to basal spray Aspen. Hence it is concluded that the best season for effective treatment with 2,4,5-T esters is different for some species of woody brush.

In a second series of tests conducted in the winter of 1953, concentrations of 2,4,5-T in oil which varied from 0.5% by volume (2# acid/100 gals. spray) to 3.0% by volume (12# acid/100 gals. spray) were applied directly to the exposed root collars of Bear Oak. Since no consistant trends were noted in the effect of the different concentrations it is believed that the amount of active 2,4,5-T ester reaching the root collar is the critical element in the success of basal treatments of Bear Oak.

The volume of spray material applied per plant was varied in the third and last series of tests reported. This was sprayed to as near the base of the plant as possible. A graphical analysis of this data is presented which shows a marked increase in the effectiveness of the spray to about 14 fl. oz. per plant, at which point 80 per cent of the plants treated were top killed and failed to resprout after 2 growing seasons. A table is presented which translates this information into gallons of spray material per acre required for different numbers of plants per acre. Finally these experiments lend strength to the contention that a high volume, low concentration technique is superior to the low volume, high concentration approach.

EFFECT OF ATA ON WOODY PLANTS

W. A. Meyers, W. W. Allen and R. H. Beatty[1]

Amizol (3-amino-1,2,4-triazole) has shown a great deal of promise as a selective herbicide in the field of woody plant control. It affects plants through its growth regulatory properties which cause it to be translocated to the growing points, producing inhibition and albinism in some species. Death of the treated plant results where concentrations are high enough.

A series of summer foliage sprays and dormant basal sprays were put down during the early spring and summer. I would like to give you a picture of the manner in which Amizol has affected the various species of plants found on these test sites.

FOLIAGE SPRAYS

The first series of plots were laid out on the right-of-way of the Philadelphia Electric Company near Dreshertown, Penna. Rates of 3, 9 and 12 pounds of Amizol per 100 gallons of water were applied to mixed brush in July. Density of the brush averaged about 8,000 stems per acre and the height of the brush was 4 to 6 feet. All foliage and stems were wetted to the point of run off. Approximately 150 gallons per acre were applied. Species reactions to the treatments were as follows:

White ash (Fraxinus americana) was seriously affected by all rates of Amizol. The material showed a marked selectivity in its relation to this plant. During the summer following treatment, a slight browning of the leaves resulted but no die back was noted. A few dormant buds were induced to put forth leaves in late fall which were of the characteristic white color. However, it was not until the following spring that the full effect of the treatment became apparent. When the leaves appeared, they were completely chlorotic. No green leaves were produced during the growing period. Several sets of white leaves were produced by the plant only to die back and be replaced by another set. By September the plants were no longer producing leaves and most were dead at least to the ground line on the plots receiving the 9 and 12 pound rates. No basal sprouts were produced on any of the treated **plants**.

[1]American Chemical Paint Company, Ambler, Pennsylvania

Black oak (Quercus velutina) reacted in much the same manner as did white ash. The new growth which appeared the spring following treatment was of a light tan color and bore only vestigial leaves. They persisted well into the summer and then died and became dessicated. The cambium remained green until the early part of September when the stems of plants treated with 9 and 12 pounds became dry and brittle. No basal shoots appeared on any of the treated plants. Some plants on the plots receiving the 3 pound rate appear to be recovering.

Mockernut hickory (Carya tomentosa) produced chlorotic shoots up to five inches in length the summer following treatment. The leaves on these shoots were undersized and of a pale yellow color. During August, these sprouts turned brown. The stems remained green but no new leaves appeared. The cambium layer was still alive when the plots were last checked in October. No shoots were produced from the root collar.

In tests at the American Chemical Paint Company research farm, poison ivy has been completely eradicated with a foliage spray at rates as low as one pound per acre used as a summer spray. The plants were treated in July and were completely brown and dessicated within a few weeks. No subsequent regrowth has appeared to date in any of the plots. Poison ivy does not show the characteristic chlorotic symptoms after being treated with amino triazole as do other woody plants. A rapid dessication of the leaves and stems takes place after spraying, with the effects spreading rapidly to the underground parts.

A series of plots were laid out in a pure stand of scrub oak (Quercus ilicifolia) on the United States Government Experimental Station Forest near Effort, Penna. Rates of application were 3, 6, and 15 pounds of Amizol per 100 gallons of water. The application was put on in July. All plants and ground cover were sprayed to the point of run off with approximately 250 gallons of spray material per acre being applied. No reaction to the treatment was noted during the remainder of the summer.

In the spring following treatment, scrub oaks on all treated plots produced flowers. However, no leaves were formed until July and then only on the plants in the plots receiving the 3 pound rate. These leaves were stunted and chlorotic, but persisted during the balance of the summer. Scrub oak on the plots treated at the 6 and 15 pound rate produced no leaves during the entire growing season. No leaf buds broke dormancy. Immature acorns present during the initial spraying matured during the following summer. These acorns were somewhat stunted but otherwise appeared normal. No acorns developed from the aments produced the season following treatment.

There were a number of other species present in the plots in varying degrees of density. It may be of value to look at just what the effects of the treatments were on them. Blueberry (Vaccinium spp.) was affected very little by any rate of application. Some chlorosis was apparent when the plants began growth in the spring but they subsequently recovered as the season progressed.

Sassafras (Sassafras variifolium) is outstanding in its almost complete resistance to foliage sprays of Amizol. Even at rates up to 15 pounds per 100 gallons of water, the only visible effect was a slight die back of the ends of the twigs the winter following spraying. All new growth was apparently normal and no stunting or chlorosis has occurred.

Smooth sumac (Rhus glabra) did not give the characteristic white appearance when it leafed out in the spring. The only apparent effect was that the plants were late in beginning growth the spring following spraying and were definitely stunted. None of the treated plants produced flowers.

Red maple (Acer rubrum) leafed out a pale pink color the season following treatment with Amizol at rates up to 12 pounds per 100 gallons of water. The plants were killed back from the tips and stunted, but recovered as the season progressed. Once recovery began, it was very rapid.

Sweet fern (Comptonia peregrina) was totally unaffected by rates of Amizol up to 15 pounds per 100 gallons of water used as a drenching spray. The few plants treated leafed out normally and produced flowers and seed the year following treatment. No dieback of the ends of the stems was noted.

Dogwood (Cornus florida) was killed to the ground line by rates of 6 pounds of Amizol in 100 gallons of water. The leaves that appeared were tiny pink. The plants gradually died back during the summer.

Viburnum (Viburnum prunifolium) was killed back by the spray but the plants showed recovery the following season. The leaves were stunted but did not show the chlorotic conditions that usually exist in treated plants. The leaves that were formed later in the season gradually grew to normal size.

Spicebush (Lindera benzoin) seemed totally unaffected by rates up to six pounds of Amizol per 100 gallons. The plants leafed out normally and grew in a normal manner during the summer following treatment.

A second series of plots were put down on mixed oak on the right-of-way of the Atlantic City Gas and Electric Company near May's Landing, New Jersey. These plots were sprayed with Amizol at the rate of 15 pounds of ATA per 100 gallons of solution. The area was treated in September. All plants were cut at ground line two weeks after treatment. During the following spring, all shoots of scarlet oak (Quercus coccinea), scrub oak (Quercus ilicifolia), and black jack oak (Quercus marilandica) which appeared were stunted and chlorotic. Approximately 50% of the shoots of white oak (Quercus alba) were also affected.

A rather dense growth of seedling pitch pine (Pinus rigida) was present as an understory on the right-of-way. These seedlings were sprayed as thoroughly as possible. All new growth on the treated pines was completely white and needles on the new candles were stunted. Unfortunately these oak and pine plots in New Jersey were disced up in August, so no later data was available.

BASAL SPRAYS

Amizol was put down basally on mixed brush on the right-of-way of the Philadelphia Electric Company near Dreshertown, Penna. The material was put down in February in a water carrier at the rate of 20 pounds of active ingredient per 100 gallons of water. Approximately 100 gallons per acre of spray material was applied. The area had a stand of mixed hardwood sprouts averaging 4 to 6 feet in height. Each stem was sprayed to the height of 12 inches with enough material being applied to cause considerable run down to the ground line. No attempt was made to spray the ground.

The species present on the test area varied in their reaction to the treatment. The greatest mortality occurred among the sprouts of black oak and hickory. All individuals of these two species showed the characteristic chlorotic symptoms when the plants commenced growth in the spring. Approximately half of them were completely dead by the end of the first growing season. However, the other 50% recovered and showed normal growth during the following summer.

Other species such as aspen, wild azalea, sassafras and white oak were only mildly affected. Aspen and white oak were chlorotic and stunted the summer after spraying but had recovered before the growing season was over. Sassafras and wild azalea showed practically no effects of the treatment.

SUMMARY

A variety of plants were treated with varying rates of Amizol as a foliage spray in the summer of 1953. The plants most affected by rates of 6 pounds and above per 100 gallons of water applied to run off were poison ivy, white ash, black oak, scrub oak, and hickory. Poison ivy reacted most rapidly to the treatments. Rates down to one pound per acre in water gave complete control.

Other species such as sumac, red maple, blueberry, dogwood and viburnum were affected at the higher rates of treatment but most are showing signs of recovery.

Sweet fern, sassafras and spicebush were not injured to any appreciable extent by the foliage sprays and made normal growth the season following spraying.

Dormant basal sprays of 20 pounds Amizol per 100 gallons of water gave 50% kill of black oak and hickory, but relatively little control on white oak and aspen and no control on sassafras and wild azalea.

COMPARATIVE USE EFFICIENCY OF THE SUBSTITUTED UREA HERBICIDES FOR INDUSTRIAL WEED CONTROL

G. L. McCALL [1]

Abstract

A large number of substituted urea compounds have been tested for herbicidal efficiency. To the present, for various reasons, only two of these, 3-(p-chlorophenyl)-1,1-dimethylurea and 3-(3,4-dichlorophenyl)-1,1-dimethylurea, have shown sufficient merit to be used commercially as industrial weed killers. They are offered for sale as 80% wettable powder formulations under the names "Telvar" W and "Telvar" DW respectively.

In addition to being closely related chemically, both compounds are non-flammable, non-volatile, non-corrosive, and have a low order of toxicity to warm-blooded animals. Their basic phytotoxicities are of the same order of magnitude and quite high.

Perhaps the most important difference between the two is that of water solubility; 3-(p-chlorophenyl)-1,1-dimethylurea being approximately six times as soluble as the 3-(3,4-dichlorophenyl)-1,1-dimethylurea.

The rates of application recommended for "Telvar" W and "Telvar" DW generally are the same for a given weed problem but, because of the differences in solubility, the variation in effectiveness and performance of the two products is most marked under extreme rainfall conditions.

In regions of low rainfall (20 inches per year and less), "Telvar" W has given much quicker and often more satisfactory weed control than has "Telvar" DW. The latter is not recommended for use in arid areas.

On the other hand, when applied in regions of comparatively high rainfall (30-80 inches per year), "Telvar" DW has given much longer periods of weed control than "Telvar" W. Differences in the period of effective weed control are particularly great where rainfall is extremely heavy, on light sandy soils, and where late fall treatments are made. Fall treatments are important in many areas to take advantage of winter rains, favorable conditions of application and weed growth, and to minimize seasonal work load periods.

[1] E. I. du Pont de Nemours & Co.

HERBICIDE SPECIFICATIONS AND LABORATORY EVALUATION PROCEDUTRES

J. W. Suggitt[1]

Within the past eight years, the increasing volume of herbicides used in vegetation control has induced many chemical companies to market suitable formulations. Large scale brush control operations by public utilities, the railroads and government agencies has required the purchase by tender of considerable quantities of material. It has become the users problem to discern between well formulated and efficient products and those where satisfactory performance may be lacking. As a result, methods of determining the suitability of commercial herbicide formulations has presented a new set of evaluation problems for the consumer laboratory.

Since the esters of the chlorophenoxyacetic acids have exhibited greater herbicidal effectiveness against woody growth than amine and alkali salt forms, esters have found the widest use as herbicides in brush control. Subsequently, literally dozens of different esters of 2,4-D and 2,4,5-T have been formulated into commercial products.

The ultimate evaluation of any herbicide is not found without an adequate field test, but thorough field tests are costly and subject to disputable variables, thus the preliminary laboratory examination of formulations by chemical analysis and physical evaluation procedures is becoming an important supplementary guide in the purchase of materials.

Specifications for Purchase Acceptance

In developing herbicidal evaluation procedures, the first consideration was the requirements of herbicides for field use. Such immediate requirements as low volatility, suitable emulsion characteristics, storage stability - particularly under winter conditions, oil compatibility, and flash point come to mind. Out of these requirements arose certain minimum specification values which act as a guide in purchase acceptance. Backing up specifications are investigations which limit the requirements and indicate suitable testing procedures.

Consumer purchase evaluation of ester herbicides is properly based on performance type tests. These logically fall into two classes: chemical, and physical properties of the formulation as an aqueous emulsion.

Chemical Requirements

The most important chemical tests are the determination of the amount and nature of the chlorophenoxyacetic acids present. Many procedures have been used to convert the organic chlorine

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to an alkali chloride salt which can be titrated in aqueous solution. Such variations as the Parr Bomb method, refluxing the sample with alcoholic potash, reducing the material in liquid ammonia, or the combustion of the sample in a bed of calcium hydroxide vary only as refinements in technique. These methods generally conclude with the Volhard thiocyanate titration, although some authors report the use of potentiometric titration procedures for chloride determinations. Probably such refinement should be regarded as a research tool and is not required in routine checking. In case of dispute, the referee method (1) should be the most recent procedure described by the AOAC based on extracted chlorophenoxyacetic acids.

From the percentage of chlorine and the specific gravity of the sample can be calculated the weight of 2,4-D or 2,4,5-T acids per gallon of formulation. Provided the formulation is only 2,4-D or 2,4,5-T and not a mixture of these acids, the calculation is simple and accurate. However, with varying mixtures of 2,4-D and 2,4,5-T the analysis becomes quite complex. Recent work (2) has indicated that partition chromatographic methods, with a recovery accuracy of within five per cent, can be used to obtain satisfactory separations, or infra-red spectrophotometers can provide graphic records of the proportions of the mixed acids present (3). Infra-red techniques can be used for the rapid identification and analysis of herbicidal mixtures of 2,4-D and 2,4,5-T. Thus far, the alcoholic components of the esters used in commercial formulations have not interfered with the determination of the acid content. No preliminary chemical preparation is required for qualitative analysis. The 2,4-D configuration can be identified by infra-red absorption in the region of 12.4 to 12.6 microns, while the 2,4,5-T is characterized by an absorption at 14.7 microns. In the quantative analysis of commercial 2,4-D and 2,4,5-T, either singly or in mixtures, suitable cyclohexane dilutions are examined at 15.46 or 12.54 microns for 2,4-D absorptions, while for 2,4,5-T the absorptions at 13.68 or 14.70 microns have proved most useful. An analysis accuracy of within ± 5 per cent has been confirmed. For routine acceptance, the total acids determined in pounds per gallon must meet the requirements of the purchase order or be in agreement with the quantity specified on the manufacturer's label.

<u>General Physical Requirements</u>

The delivered formulation in new, factory-sealed containers, is required to be clear, homogeneous and free of sediment or crystalline solids. Further, it should not be of such pH, either in the concentrate form or in water dilution that any corrosion of equipment may occur.

A flash point requirement on the finished formulation of 140°F, using the Pensky-Martens Closed Tester (4), has been a requirement suggested by the Fire Marshal's office for stored materials. When herbicide stocks are stored for any length of time before use, a fire hazard would exist with materials of low flash point.

The oil compatibility of the herbicide is evaluated by dilution with various types of low-cost oils such as are used as diluents in winter spraying. The most general dormant basal spray diluents are fuel oil, stove oil or kerosene, all of which when obtained from Canadian sources have been found to be principally aliphatic in nature with fairly low (5025%) aromatic content.

Since dilution of the stock formulation may be necessary under the cold conditions of dormant season spraying, it is required that the commercial material have a maximum pour point (5) of at least ±10°F. If the herbicide becomes solid at below freezing temperatures, then the hard mass is of little value for workmen making dilutions in the field.

Storage Tests

Storage stability tests simulate the conditions of storing purchased material. A formulation should be stable under warm summer conditions, as for instance when a container of the material is held in a hot storage shed, or left on a right-of-way under the summer sun. A small quantity held for 24 hours at 125°F in a laboratory oven should show no separation of the herbicide components or fail to pass subsequent emulsion stability tests.

Cold storage evaluation is a more difficult problem. Early types of ester formulations did not winter well. Material that was purchased and stored, even under protected conditions, was often found to have solidified during the winter when examined the following spring. Some materials could be warmed and reclaimed, but others did not form satisfactory spraying emulsions. In the laboratory this "wintering" ability is checked by a series of freezing-thaw cycles (6). The herbicide is placed in a one quart tin can and taken to ±60°F for 20 hours, then allowed to thaw for four hours. This cycle is repeated on four successive days, then, if the material still shows no signs of separation, or crystallization, the formulation is held continuously at -60°F for ten days and again examined for any deterioration after thawing.

Emulsion Properties

The physical properties of the oil-in-water emulsion formed when the herbicide is added to water is an important practical requirement. The ease and spontaneity of emulsification, homogeneity of the emulsification, homogeneity of the emulsion, hard water dispersion, emulsion stability, surface tension, break time and re-emulsification ability are carefully evaluated.

Despite the considerable literature on the evaluation of emulsions, there are no simple laboratory tests which will invariably indicate the field performance of an emulsion. The first step in evaluating a herbicide for emulsion properties consists of establishing as a standard a herbicidal formulation that is of proven merit - one on which there are field data regarding its actual performance in commercial sprayers. Next it is necessary to establish a uniform testing procedure for evaluating other formulations in reference to the standard. Finally, this performance must be capable of graphical presentation so that critical comparisons can be made

Test procedures similar to those described by Kelly (8) and Selz (9) can be easily followed and give the data required. A review of the reproductibility of the different emulsion tests is presented by Behrens and Griffin (10)(11). For routine evaluation the simpler procedure of comparing the results obtained against a standard formulation is more rapid and meaningful than any absolute method.

Surface tension measurements of a one per cent by volume herbicide in water emulsion are made with a Du Nuoy tensiometer (7) to determine whether adequate wetting of the leaf surface without excessive run-off will be obtained. Experience has shown that a surface tension value of between 30-35 dynes per cm will give good field performance.

The "breaking time" of a herbicide-water emulsion is of value. The length of time after application before the emulsion breaks is important in depositing the herbicide on the leaf surface. Certain manufactured formulations have produced emulsions which were still stable after 24 hours. Earlier fast-breaking types separated within a few minutes. Very stable emulsions are disadvantageous in brush spraying, because they will not "break" in a reasonable time and will tend to drain off leaf surfaces and be lost to the plant. On the other hand, fast-breaking emulsions will demand constant agitation in the mixing tank before spraying, and will tend to layer out before adequate leaf wetting is obtained. For knapsack spraying where constant agitation of the spray solution is impractical, fast-breaking emulsions may settle in the spray tank and give uneven application of the chemical. The requirement for emulsion stability which summarizes these limits is that one per cent by volume of the herbicide formulation in water at 60°F shall be immediately dispersed to form a homogeneous stable emulsion, and shall show no creaming or separation within the first half-hour after emulsion formation, and that the emulsion will be completely broken two hours after emulsion formation. The hardness of the water, up to 500 ppm total hardness expressed as calcium carbonate shall not effect the emulsion stability.

Volatility Tests

The volatility of herbicidal esters has been the cause of concern for both consumers and manufacturers. While undoubtedly, it is true that the lower alcohols when esterified with 2,4-D acid form products with measurable vapour pressure and volatility, it is more than likely that spray drift has been the basic cause of most "volatility" damage claims. However, herbicide manufacturers now market "low-volatile" esters of high molecular weight alcohols and 2,4-D which have satisfactory herbicidal effectiveness and which minimize any effect of "volatility". With the marketing of low-volatile esters of herbicidal acids and their immediate acceptance by consumers, the necessity for routine determinations of the volatility of commercial formulations by tedious botanical tests has almost disappeared.

It is agreed that plant survival tests are the best criterion of herbicide volatility (12). Many workers have considered volatility tests and various procedures have been developed (13)(14)(15). In our own laboratory, the volatility of a herbicide has been determined by exposing three-week-old bean plants grown in individual jars to 3500 ppm solutions of the formulation. An open dish of the dilute herbicide, warmed to 100°F, was placed under a bell-jar with two or three bean plants for one-half hour. The bean plants were then removed and allowed to grow normally. Isopropyl and butyl esters show their volatility under these conditions, and the young bean plants are dead within a day or two. Low-volatile types of esters meet this test quite well, and bean plants continue to grow quite normally after exposure with no signs of epinasty.

The procedure described by Zimmerman (16) has also been used, substituting the more easily grown bean plants for tomato seedlings. The United States Department of Agriculture are now publishing annual listings of tested "low-volatile" esters. These are forming a useful reference source of independent data on the volatility of new formulations.

Summary

Analytical chemical and performance type physical evaluation procedures are described for ester herbicides. Suitable specification limits and purchasing requirements are included.

BIBLIOGRAPHY

Determination of the Amount and Nature of the Chlorophenoxyacetic Acids

1. Official Methods of Analysis of the Association of Official Agricultural Chemists. Seventh Edition, 1950.

2. Gordon, N. Spectrophotometric Determination of Small Quantities of 2,4-D Acid and 2,4,5-T Acid Using Partition Chromatography. Anal. Chem. 24, 1968-71 (1952).

3. Takahashi, S. Infra-red Analysis of 2,4-D and 2,4,5-T Herbicides. Progress Reports Nos. 1 and 3. HEPC Research Division Report Nos. C54-82, November 30 and C54-84, November 30.

General Properties

4. Method of Test for Flash Point by Means of the Pensky-Martens Closed Tester. ASTM D93-52 (1952).

5. Test of Pour Point of Oils. ASTM D97-47 (1952).

6. Freeze and Thaw Test for Emulsified Asphalts. ASTM D244-49 (1952).

7. Tension of Solution of Surface Active Agents. ASTM Proc. 52, 447 (1952).

Testing Emulsion Properties

8. Kelly, J. A. Present Methods of Formulation. Ag and Food Chem. 1, (3), 254-257 (1953).

9. Selz, E. Liquid Concentrates Problems. Ag and Food Chem. 1, (5), 381-386 (1953).

10. Behrens, R. S. and Griffin, W. C. A Basis for Tests for Emulsifiable Concentrates of Agricultural Chemicals. Ag and Food Chem. 1, (11), 720-724 (1953).

11. Griffin, W. C. and Behrens, R. W. Agric. Chemicals 7, 65 (1952).

Volatility Testing

12. P. W. Zimmerman in a recent book review, (Ag and Food Chem. 2, April 28, 1954, page 485), states that the tomato plant is far better for testing substituted phenoxy acids than the standard Went "Avena" test. In fact, he states, hormone herbicides could not have ever been discovered without plant survival procedures.

13. Hitchcock, A. E., Zimmerman, P. W. and Kirkpatrick, H., Jr. A Simple Method for Determining the Relative Volatility of 2,4-D and 2,4,5-T. Contributions Boyce Thompson Institute, Vol. 17, (3), 243-263, April-June, 1953.

14. King, L. J. and Kramer, J. A. Studies on the Herbicidal Properties and Volatility of Some Polyethylene and Polypropylene Glycoesters of 2,4-D and 2,4,5-T. Contributions Boyce Thompson Institute, Vol. 16 (6), 267-268, April-June (1951).

15. Tafuro, A. J. Van Geluwe, J. D., and Curtis, L. E. Drift and Volatility Comparison of an Amine Salt and Ester Form of 2,4-D Under Field Conditions. Proc. Northeastern States Weed Control Conference, New York City, 1950, pp 31-35.

16. Zimmerman, P. W. Methods for Determining Relative Volatility of Esters of 2,4-D and Other Growth Regulants Based on Response of Tomato Plants. Proceedings of the Northeastern Weed Control Conference, January 1953, page 39.

HERBICIDE RESEARCH AT THE CONNECTICUT ARBORETUM

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INTRODUCTION

The Connecticut Arboretum, located at Connecticut College in New London, comprises 250 acres. Part of this area is devoted to collections of trees and shrubs native to Connecticut. Another sector of 100 acres has been established as a Natural Area where long-term research is in progress. The remaining tracts are either in evergreen plantations or native vegetation where a considerable part of the herbicidal research is in progress.

In the Arboretum, herbicides are being used in general maintenance and as a tool for manipulating vegetation. They are being used to control the weed species in the native tree and shrub collections, evergreen plantations, upland forest and to retrogress the late stages of old field succession to thicket and grassland stages. The latter is being done to maintain as many different wildlife habitats as possible throughout the Arboretum. By this technique, areas are also being landscaped with native species by leaving ornamentally desirable shrubs and low trees and eliminating those which are undesirable. In addition, a demonstration area has been established on a 1500 foot sector of the Connecticut Power Company easement crossing the Arboretum. Here various spraying techniques are being used in order to create a desirable type of vegetation under the lines.

The chemicals are being furnished by American Chemical Paint Company (ACP 977 2,4-D-2,4,5-T; Weedone Brush Killer 64; Weedone 2,4,5-T; Weedone LV 4 2,4-D), Dow Chemical Company (Esteron 245 2,4,5-T; Esteron 10-10 2,4-D) and E.I. Dupont de Nemours and Company (2,4-D-2,4,5-T ester Brush Killer; 2,4,5-T 57% Amine Brush Killer; 2,4-D Amine Weed Killer; Ammate.

MAINTENANCE

In the native tree and shrub collections, woody weed species such as poison ivy (Rhus radicans), Japanese honeysuckle (Lonicera japonica), Oriental bittersweet (Celastrus orbiculatus), and greenbrier (Smilax rotundifolia and glauca) are most troublesome. Although current chemical formulations are designated to control or eradicate these species some appear more resistant than others. Therefore, it is desirable to find the most effective chemical, carrier, concentration and time of application. Different chemicalconcentrations were applied in carriers such as kerosene, fuel oil, water and emulsions (mixtures of oil and water) at different seasons of the year. In all treatments during the vegetative season, special effort is made to spray the stems as well as the leaves.

Although after a year and a half the results are still very preliminary, certain trends are evident. Of the four species, poison ivy and greenbrier appear most easily controlled by standard formulations. However, Smilax glauca appears more resistant than Smilax rotundifolia. This may be correlated with its glaucous leaves and stems. Oriental bittersweet is most susceptible during the vegetative season. The most difficult species is Japanese honeysuckle in which all aqueous treatments have been ineffectual. However, high concentrations in oil applied in the spring appear promising.

In all treatments, it appears that wetting the stems may be more, or at least equally as important as covering the leaves. This is indicated by the rather effective nature of the oils and emulsions in which case the chemical adheres more readily to the stems and therefore is active after the leaves have turned brown and fallen off as a result of the spraying. Further work during the vegetative season will emphasize stem coverage using emulsions.

FORESTRY PRACTICES

In the evergreen plantations a competitive species, black cherry (Prunus serotina) 3-6" dbh, has been readily eliminated either by basal bark treatment or Ammate crystals placed in basal notches. Techniques to eliminate tree of heaven (Ailanthus altissima) are under way. In a young sprout oak forest selective thinning is in progress using the basal bark technique.

MANIPULATION OF VEGETATION FOR LANDSCAPING AND WILDLIFE

Areas in shrubland and late stages of old field succession are being manipulated for landscaping and wildlife values. This is accomplished by maintaining the existing vegetation, if desirable, or retrogressing it to a desirable type. Natural landscaping involves eliminating the undesirable species by basal bark spraying and leaving ornamentally desirable species such as high bush blueberry (Vaccinium atrococcum), common barberry (Berberis vulgaris), mountain laurel (Kalmia latifolia), flowering dogwood (Cornus florida), gray birch (Betula populifolia), red cedar (Juniperus virginiana) and others in a grassland matrix. For wildlife, the above as well as blackberry (Rubus spp.) and greenbrier are maintained. Actually these areas serve a dual purpose since many of the ornamentally desirable species also provide excellent food and cover for wildlife and song birds. By this technique it is also possible to observe vegetational changes. Does the man-initiated thicket rapidly return to forest? There are indicationsthat it does not. (Egler, 1954)

RIGHT OF WAY DEMONSTRATION AREA*

Another phase of the research involves a 1500' power easement demonstration area established during the winter of 1953. Here the vegetation will be maintained in accordance with the requirements of the Utility Company, but with maximum emphasis on wildlife benefits as well as the greatest stability for the longest number of years.

The vegetation now covering the easement includes several distinct types. A considerable area is covered with greenbrier which forms a dense imprenetrable thicket 2-3' high. Scattered trees and numorous low shrubs and vines such as bayberry (Myrica pensylvanica), Japanese honeysuckle, sumac (Rhus copallina) and blueberry form an admixture with the greenbrier. In the wetter areas red maple (Acer rubrum) sprouts and shrubs such as arrow-wood (Viburnum dentatum), sweet pepper bush (Clethra

*Conducted in conjunction with Committee for Brush Control Recommendations for Rights of Way of American Museum of Natural History.

alnifolia) and alder (Alnus rugosa) are dominant. On the remaining upland sites continuous stands of oak and sweet birch (Betula lenta) sprouts 8-12' high are characteristic. Within this complex the shrub layer includes greenbrier, low bush blueberry (Vaccinium angustifolium), huckleberry (Gaylussacia baccata), sumac, bayberry, mountain laurel and witch hazel (Hamamelis virginiana).

In manipulating the vegetation, current techniques now being utilized on rights of way will be evaluated. However, those which best fulfil the long-range objectives will be emphasized. Immediately under the easement, a road will be maintained so the lines are readily accessible for repair. Those trees which will eventually grow into the lines will be eliminated by various treatments. Shrubs previously enumerated except for greenbrier will be left under the lines as long as they do not impede access to fallen lines. They are of maximum wildlife value and there is evidence that they prevent the rapid reinvasion of tree species (Pound & Egler, 1953). Beyond the lines toward the forest, a shrub complex with scattered low understory trees such as witch hazel and flowering dogwood will be maintained. In the forest bordering the lines, those trees which are sufficiently close to fall into the lines will be treated before they attain a height higher than the wires. Several sample plots have already been sprayed using basal bark and commercial foliage spraying. In the latter, an effort was made to cover the upper branches as well as the leaves.

It is anticipated that this demonstration area will eventually exhibit results which will be of value to all those interested in power easement maintenance. Here it will be possible to see the effects of various techniques in manipulating and ascertaining the most desirable type of vegetation with the highest wildlife values and greatest stability.

LITERATURE CITED

Pound, C.E. & F.E. Egler 1953 Brush control in southeastern New York: fifteen years of stable tree-less communities. Ecology 34: 63-73.

Egler, F.E. 1954 Vegetation management for rights of way and roadsides. Smithsonian Report 1953 pp. 299-322.

HERBICIDE WORK ON NEW YORK STATE HIGHWAYS

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Edward Secor and Donald Ward

BROAD LEAF WEED CONTROL

The control of dandelion and broad leaved plantain in a turf predominantly red fescue by one application of 2,4-D has been found to materially reduce the amount of mowing necessary on state highways on Long Island. To determine the relative effectiveness of different volumes of spray mixtures applied, test treatments were made near Babylon on April 29, 1954.

Two pounds of the acid equivalent of 2,4-D in the ester form were applied with water on each acre treated. Two rates of application were used, 35 gallons of mixture being used on each of about five acres and 15 gallons of mixture on each of about 70 acres. The spraying was done with a small pump operating at 30 psi using OC tips, at a rate of travel of five or ten miles per hour.

Results were satisfactory with both treatments.

Control of broad leaved weeds by hormone spraying was started on June 22, 1954 in the Hornell area on 185 miles of highways. A portion of this mileage was not sprayed because of the proximity of nearby susceptible plants and crops. Two pounds of the acid equivalent of 2,4-D in 15 gallons of water were applied to an acre with a small pump operating at 30 psi using OC tips at a speed of travel of about eleven miles per hour. A swath approximately ten feet wide was sprayed.

Chicory, which was almost in the flowering stage, and ragweed were satisfactorily controlled. A later spraying was required to control Queen Ann's Lace.

Cost of the work was found to be $5.04 for material, $1.14 for labor, a total of $6.18 for each mile (both sides) treated. One mowing was eliminated in the areas treated.

BRUSH CONTROL

In Westchester, Dutchess and Putnam counties poison ivy was sprayed along 207 miles of highways in 1949 and 1950 using 2,4-D ester and fuel oil #2 in the proportion of 1:22. All leaves were thoroughly wetted with the mixture. Over 90 percent kill was obtained. No retreatment has been necessary.

In eastern Dutchess county poison ivy was sprayed with 2,4-D ester in water or oil in the proportion of 1:22 in July and August 1951. Oil was used as the carrier on about twelve miles of highway and water as carrier on about seven miles. All leaves were thoroughly wetted with the mixture. Over 90 percent kill was obtained and no retreatment has been necessary.

In Orange county poison ivy was sprayed with 2,4-D ester in water in the proportion of 1:22 in the summer of 1953. All leaves were thoroughly wetted with the spray. Over 90 percent kill was obtained.

In western Orange county poison ivy was sprayed in August and September 1954 with 2,4-D and water in the proportion of 1:200. A top kill of over 90 percent was observed in October. Further observations will be made to determine root kill.

From July 6th to July 30th, 1953 heavy growth of poison ivy along about 20 miles of highway on Long Island was sprayed using knapsack equipment. Three different mixtures were used, each in about the same total area and in sufficient amounts to wet all leaves.

Mixes Used

	Fuel Oil #2	Water	Ester of 2,4-D	Ester of 2,4,5-T
Mix 1	48 gal.	- -	1 gal.	1 gal.
Mix 2	- -	48 gal.	1 gal.	1 gal.
Mix 3	- -	48 gal.	2 gal.	- -

Both hormone materials contained four pounds of the acid equivalent per gallon. On August 10, 1954 the effect of Mix 1 was judged to be satisfactory and effect of Mixes 2 and 3 unsatisfactory. Additional treatment was required even in the area treated with Mix 1.

This job required 58 man days of work. A similar job done July 15, 1954 with relatively poor motorized equipment on about four miles of highway required two man days of work. From these figures it may be judged that knapsack equipment type of spraying requires almost six times as much labor as spraying with motorized equipment. However, selective spraying can more readily be done with the knapsack equipment.

There has been no satisfactory explanation of why poison ivy control by herbicides has been so effective in Westchester, Dutchess, Putnam and Orange counties as compared with the control on Long Island over a period of several years. Materials, mixtures, methods and quality of work were similar to the best of our knowledge.

In the Watertown area of New York, control of brush along highways is desirable to prevent snow drifting. In the past seven years the brush problem along 75 miles of highways has been practically eliminated. Two typical treatments are described as follows:

Test treatments of brush were made near Cranberry Lake in 1949. About 17 acres of heavy brush had been cut during the summer months and the stumps and stubble were sprayed during mid-October. Every effort was made to completely saturate each brush stump. The material used was the ester form of 2,4-D in fuel oil. The amount of 2,4-D applied to an acre was varied, the least amount being 1.45 gallons per acre and the greatest amount 4.70 gallons per acre. Using a small pump giving pressure of 30 psi on a truck, two men sprayed about 1.75 acres in a day using 50 gallons of spray mixture.

There was little apparent difference in results due to the different treatments. All were considered unsatisfactory. The predominance of red maple which is resistant to 2,4-D was considered responsible for the unsatisfactory results.

Northwest of Watertown a heavy stand of brush and small trees consisting of choke cherry, gray dogwood, staghorn sumac, arrowwood, elm, sugar maple, ash and thornapple was cut along five miles of road during February and March of 1953. This brush was about 25 feet in width on each side of the road. The stumps were sprayed in April of that year using twelve gallons of 2,4,5-T ester, 26 gallons of 2,4-D ester and 760 gallons of fuel oil. A foreman, truck driver and four laborers accomplished the job in five working days using knapsack sprayers.

There was complete kill of 50 percent of existing stumps and some effect on the remainder was evident. The effect on staghorn sumac was unsatisfactory due to root sprouting. Repeated applications are necessary to control it.

Based on the work done in this area on brush control the following conclusions are drawn:

Follow-up foliage spray treatments were found to be essential to obtain satisfactory control.

Control of such susceptible species as choke cherry, especially when applied to foliage can be obtained with 2,4-D and fuel oil in the ratio of 1:20, but for average brush control in the area equal parts of 2,4,5-T and 2,4-D are required for basal dormant and stump treatment. Stump treatment may be made immediately after cutting or at any time before sprout growth starts.

Brush cutting followed by stump treatment is preferred to avoid "brownouts". However, this method and basal treatment require more materials and more expensive materials, more labor and care in application and seem to have been less effective than the foliage spraying method.

Foliage spraying is effective from the time leaves are fully developed until late August with best results from May and June treatments. All leaves must be thoroughly wetted. The hazard to vegetable gardens in the Watertown area is at a minimum in May.

A mixture of two parts 2,4-D and one part 2,4,5-T with 20 parts of carrier is apparently as effective as equal parts of the two materials for average brush control by foliage spraying. Water mixtures have not been quite as effective as oil mixtures.

Less material is used in spraying spotty or intermittent growth with knapsack sprayers than by blanket treatment by power equipment. Labor costs are higher. Selective control is possible with knapsack sprayers.

CHEMICAL MOWING

This term is used to mean the reduction of top growth or kill by chemicals or all vegetation to reduce or eliminate mowing by hand or equipment. Tests by the Department of the chemicals available at the time for this purpose were reported to the Northeastern Weed Control Conference in 1950 and 1951.

Weedkiller 7B

In the Babylon area, Weedkiller 7B and oil, the material found to be most satisfactory in those tests, has been used each subsequent year to control vegetation along guard rails, posts and similar structures. Two treatments each year have been required, the first being made about the first of May, before top growth had developed very far, and the second treatment about the first part of July as required by regrowth or new growth.

This material, manufactured by General Chemical Company, is an aromatic oil containing five pounds of trichloroacetic acid and 0.75 pounds of pentachlorophenol. The standard treatment was five gallons of this material mixed with 35 gallons of fuel oil applied to an acre. A three foot swath along structures was sprayed. A light vehicle with a small pump providing about 30 psi pressure was used to permit sharp turns necessary to spray signs at intersections. The speed of operation while spraying was generally about 15 mph although successful results were obtained at 30 mph, a speed considered too fast for safety.

Control has been satisfactory* in the treated areas for the four years of chemical treatment except in areas of silt loam first treated in May 1954 and except that Weeping Lovegrass was found to be very resistant. Cost of the material and labor has been about $25 per treated mile per season. Hand mowing to provide comparable results would have cost about $100. No complaints have been received about the temporary unsightly appearance of the brown vegetation immediately following treatment.

In July 1954 three different treatments of the silt loam areas were tried as follows:

Amounts Per Acre

Gal. 7B	Gal. fuel oil #2	Gal. Mix
10	10	20
10	20	30
10	30	40

Control was satisfactory with each treatment.

Weedkiller 7B was used in the Buffalo district in 1954 along about 90 miles of highways. The mixture consisted of one part of 7B, seven parts of fuel oil and one and one-half pounds of the acid equivalent of 2,4-D and was applied at about 40 gallons per acre and at a speed of about 15 miles per hour. The first application was made on May 17th and 18th and gave satisfactory control until the last part of June when the second application was made to control regrowth which had reached an average of six to eight inches in height. In the second treatment, 2,4-D was not used and the mixture was applied at about 47 gallons per acre. The second treatment gave satisfactory control for the remainder of the year. No mowing was necessary except where the dead tops of Orchard Grass which were higher than eight inches at the time of the first spraying were considered unsightly.

During this work, a study was made of the number of guide rail postsper mile on two different types of highways. It was found that highways on flat topography with few embankments and long radius curves had approximately 50 to 100 guide posts per mile, requiring about one and one-half to two gallons of herbicide mixture per mile and that highways characterized by rougher topography with high embankments, sharp grades and many sharp radius curves had approximately 400 to 600 guide rail posts per mile, requiring eight to ten gallons of spray mixture per mile.

* Satisfactory - Vegetation eliminated or top growth inhibited to less than about ten inches with very few exceptions.

Staklor

On December 8 and 9, 1953, Staklor was applied at rates of 100, 200 and 430 pounds per acre in the vicinity of Jericho, Long Island, to test its value for chemical mowing. On April 30, 1954 and during the following summer, results were judged unsatisfactory.

Staklor was applied at rates of about 100, 200 and 430 pounds per acre in the vicinity of Roslyn, Long Island, on April 30, 1954 and in the Hornell area on April 28, 1954. At the end of September, control was judged unsatisfactory in both areas.

Telvar W (CMU)

Telvar W was applied at rates of 10 and 20 pounds per acre in the vicinity of Jericho, Long Island on December 8 and 9, 1953 and at about the same time in the Hornell area. Considerable difficulty in application was experienced in the Hornell area because of the low temperature at that time. Control at the higher rate was judged satisfactory in both districts in the spring and during the following summer. Control at the lower rate was unsatisfactory.

Telvar W was applied at rates of 10 and 20 pounds per acre in the vicinity of Roslyn, Long Island, on April 30, 1954 and in the Hornell area at about the same time. At the end of September 1954, control at the higher rate was judged satisfactory. Control at the lower rate was unsatisfactory in both areas.

From July 6 through 9, 1953, Telvar W was applied around 650 traffic signs on 100 miles of road in the Hornell area at the rate of about 50 pounds per acre. In the spring of 1954, the result was still satisfactory and an additional 1940 signs on over 400 miles of highway were treated at a similar rate. During the summer of 1954 a few weeds like dandelion began to come into the 1953 treated areas but the control was still satisfactory. Control by the 1954 treatments was satisfactory.

Cost data using Telvar W has not been obtained, but it is believed that this material might prove practical because only one spraying operation a season is required. Therefore, an overall saving might result even though the cost of material at the 20 pound rate would probably be about $60 for each acre treated.

Dalapon

Dalapon was applied at rates of about 3, 6, 9 and 18 pounds together with two pounds of the acid equivalent of 2,4-D an acre in the Babylon area on June 15, 1954. The turf which had been mowed shortly before treatment consisted for the most part, of red fescue. Unfortunately, in error some mowing was done subsequently within the test area, but on September 28, 1954, the topgrowth of vegetation in the area treated with 18 pounds of Dalapon per acre was still brown and no high regrowth had occurred. Therefore, the results of this treatment were considered satisfactory.

Dalapon was applied at rates of 3, 6, 9 and 18 pounds an acre in the Hornell area on June 21, 1954. These areas had been mowed on June 7 and 8. The grass population included orchard grass, red fescue, Kentucky blue, redtop and quack grass. Browning of the grass leaves occurred soon after treatment at all rates. At the lowest rate the tips of leaves seemed to be affected and recovery was apparent ten days later. At the 18 pound rate, practically all of the topgrowth seemed to be killed.

Two subsequent treatments with 2,4-D were made to control broad leaved weeds.

Forty-three days after application, red fescue was still completely brown, but appeared to be alive. Kentucky blue and redtop had not been affected as severely. Orchard grass was affected the least and appeared to be two-thirds of the way back to normal.

At the end of September, about 100 days after treatment with Dalapon, the results from treatments at three and six pounds per acre were unsatisfactory, while the results from treatments of 9 and 18 pounds per acre were satisfactory. The areas treated at 9 and 18 pounds per acre were still browned in appearance. All grasses were recovering in the area of the 9 pound treatment, while only Orchard grass and Timothy were recovering in the area of the 18 pound treatment.

Since these tests were installed late in the season, comparison with the results of the treatment with Weedkiller 7B and Telvar W cannot be made, but the satisfactory results obtained, together with the low cost for material indicate the desirability of further study with Dalapon. Even at the rate of 18 pounds per acre, the cost of material would be only $9 an acre at present prices.

The fact that Dalapon is soluble in water is a definite advantage in the practical application of this material as a spray.

<u>Maleic Hydrazide</u>

Maleic hydrazide (40%) was applied at rates of six and ten pounds per acre, together with two and three pounds of the acid equivalent of 2,4-D per acre on April 23, 1952 in the Babylon area. On May 13, 1952, another treatment at rates of 10, 20 and 30 pounds per acre was made on a nearby highway. Mowing on these highways had been done when topgrowth of turf had reached a height of about six to eight inches, and the height of cut had been three to four inches. There was no reduction in the number of mowings due to the reduction in growth of grass. However, where 2,4-D had been used, the control of broad leaved weeds did result in a reduction in number of mowings required.

Maleic hydrazide (40%) was applied at rates of 18, 36 and 72 pounds per acre in the Hornell area on April 14 and 15, 1953. It had been customary to mow about two or three times a year. The vegetation was predominantly red fescue with some Kentucky blue, redtop and clover. Temporary browning of the grass was caused by the 72 pound rate. A very wet spring followed. Weeds and alfalfa growth became so high that mowing was required. Subsequently there was some retarding of grass growth but this was so slight that it did not reduce the number of mowings required.

Borascu
Polyborchlorate

In the Hornell area, test installations of Borascu and Polyborchlorate were made in July, 1954. Although results were satisfactory, the large amounts required made application impractical with the equipment available in the district. Costs of the treatment would be excessively high when compared with the use of other materials reported.

THE EFFECT OF SPRAY VOLUME ON REDUCTION OF RESPROUTING OF RED MAPLE FOLLOWING STUB TREATMENT WITH 2,4,5-T

M. F. Trevett[1]/

Coulter (2), Bramble (1), and Suggitt (4) have reported that in basal bark spraying of woody plants high spray volumes are more effective than low spray volumes.

The test reported in the present paper was designed to study the volume relationships for stub applications of an oil-herbicide spray.

Procedure

Red maple (Acer rubrum) clumps were mowed the first week in April 1952, and the stubs immediately treated. Stubs averaged 4 inches in height, and ranged in diameter from 3/8 inch to 1.5 inches -- 85% of the stubs were 3/4 inch to 1 inch in diameter. Clumps contained an average of 17 stubs. Treatments were replicated 10 times, with a single clump serving as a replicate.

Oil-herbicide solutions were applied at three volume rates per stub: 1.9, 3.8, and 7.6 cubic centimeters (cc.). Solutions applied were: kerosene, and kerosene containing 2, 4, and 8 pounds of 2,4,5-T acid[2]/ (ester formulation) per 100 gallons of solution. A summary of the treatments and the number of milligrams (mg.) of 2,4,5-T acid applied per stub at the various volume rates and concentrations (pounds of 2,4,5-T acid per 100 gallons of solution) are found in Table 1.

Plastic measuring spoons were calibrated for the different volumes. Before treatments were applied, loose leaf litter and other debris were brushed away from the base of the stubs. Solutions were poured over the cut surface and around the base and lower two thirds of the stub.

1/ Associate Agronomist, Maine Agricultural Experiment Station, University of Maine, Orono, Maine. Statistical analysis was made by Mildred Covell, Technical Assistant, Departments of Agronomy and Horticulture.

2/ "Esteron 245", supplied by the Dow Chemical Co., Midland, Michigan.

TABLE 1. VOLUME RATES, CONCENTRATIONS, AND MILLIGRAMS OF 2,4,5-T ACID APPLIED PER STUB

cc. Solution Applied Per Stub	Pounds 2,4,5-T Acid Per 100 Gallons Kerosene			
	Kerosene Only	Herbicide Solution		
		2 Lbs.	4 Lbs.	8 Lbs.
	Milligrams of 2,4,5-T Acid Per Stub			
1.9	0.0	4.54	9.1	18.2
3.8	0.0	9.1	18.2	36.4
7.6	0.0	18.2	36.4	72.8

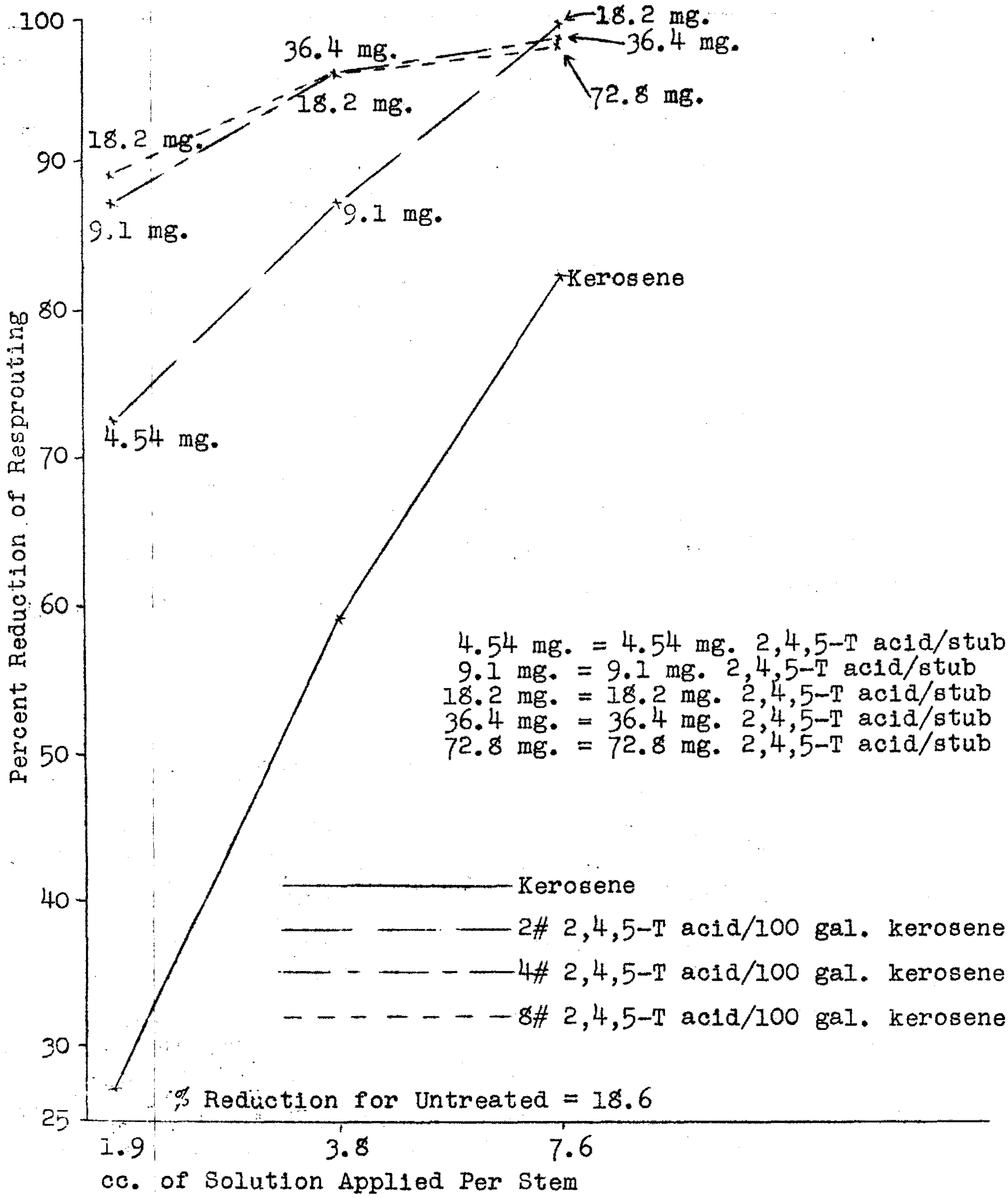
Treatments were applied the first week in April 1952. Final counts of living resprouts were made in late October 1954. Data were subjected to analysis of variance.

Results and Discussion

The effect of the various treatments on percent reduction of resprouting is summarized in Figure 1 and in Table 2.

The two most striking features of the data, as graphed in Figure 1, are the distinct phytotoxic effects of kerosene and the marked reduction in resprouting following treatment with small amounts of 2,4,5-T. For example, in the 1.9 cc. per stub series, while 18.2 mg. of 2,4,5-T gave the most satisfactory percent reduction (89.4%), 4.5 mg. suppressed resprouting to the extent of 72.9%. It is also obvious, Figure 1, that approximately the same percent reduction of resprouting can be obtained from either low volume, high concentration stub spraying (1.9 cc. per stub of a kerosene solution containing 8 lbs. 2,4,5-T acid per 100 gallons) or from high volume, low concentration spraying (7.6 cc. per stub of a 2-lb. per 100-gallon solution). Thus, high volume spraying, 7.6 cc. per stub, in which 18.2 mg. of 2,4,5-T were applied per stub, did not result in a significantly higher percent reduction than 18.2 mg. applied in 1.9 cc. of solution per stub. The apparent reason for this situation is that for both volume rates the sum total of toxicants (2,4,5-T acid plus aromatics, or other components, from kerosene) accumulating per unit area in the shoot initiating zone was at or above a minimum lethal concentration, even though absolute amounts or concentrations in the initiating zone may have differed.

FIGURE 1. THE EFFECT OF VOLUME OF KEROSENE AND AMOUNT OF 2,4,5-T ACID (ESTER FORMULATION) APPLIED PER STUB 1/ ON PERCENT REDUCTION OF RESPROUTING OF RED MAPLE



1/ Stubs 3/8 to 1.5 inches in diameter, 4 inches in height.

TABLE 2. THE EFFECT OF VOLUME OF KEROSENE AND AMOUNT OF 2,4,5-T (ESTER FORMULATION) APPLIED PER STUB[1] ON PERCENT REDUCTION OF RESPROUTING OF RED MAPLE

cc. Solution Applied Per Stub	Concentration of Kerosene Solutions: Pounds of 2,4,5-T Acid Per 100 Gallons of Solution; and Milligrams of 2,4,5-T Applied Per Stub			
	Kerosene Only	2 Lbs.	4 Lbs.	8 Lbs.
1.9	27.2%	72.9% (4.54 mg.)[2]	87.4% (9.1 mg.)	89.4% (18.2 mg.)
3.8	59.4	87.3 (9.1 mg.)	96.3 (18.2 mg.)	96.3 (36.4 mg.)
7.6	82.4	99.6 (18.2 mg.)	98.4 (36.4 mg.)	98.3 (72.8 mg.)

Percent reduction for cutting only = 18.6%

LSD 5% = 15.0%

1/ Stubs 3/8 to 1.5 inches in diameter, 4 inches in height.

2/ Figures in parentheses are milligrams of 2,4,5-T acid applied per stub.

However, while it is possible under ideal conditions to obtain satisfactory control of resprouting with low volume stub spraying, in commercial field operations high volume stub spraying is more likely to result in consistently satisfactory control than low volume spraying. In fact, under all spraying conditions, high volume spraying should be more effective, since as suggested by Bramble (1), for basal bark treatments, high volumes of solution aid in getting "the spray past obstacles such as leaf litter, soil, or irregular contours in the root collar".

The efficiency of either high or low volume spraying can perhaps be enhanced by scraping away debris from the base of stubs, as suggested by Coulter (2), and by applying the spray solution to the base of the stub, as suggested by Bramble (1) for basal treatments. Ground-level spraying of stubs in any case will be no less effective than over-all stub spraying, since the application of 2,4,5-T to cut stub surfaces and to the total bark surface apparently are not essential requirements for satisfactory suppression of resprouting of red maple. This surmise is substantiated by data obtained from a test accompanying the one reported in this paper. Kerosene containing 2 lbs. of 2,4,5-T acid per 100 gallons of solution was applied during the first week of April 1952 at volumes of 1.9, 3.8, and 7.6 cc. to the base (a ground-level application) of red maple stubs that were 4 inches tall and 3/4 to 1 inch in diameter. The percent reduction in resprouting after three growing seasons, and milligrams of 2,4,5-T acid applied per stub for each volume follow:

cc. Applied Per Stub of Solution Containing 2 Lbs. 2,4,5-T Acid Per 100 Gallons Kerosene	Milligrams 2,4,5-T Per Stub	Percent Reduction in Resprouting After Three Growing Seasons
1.9	4.54	82.3
3.8	9.1	85.6
7.6	18.2	100.0

In Table 3 are found the material costs (kerosene and herbicide) for the preparation of a sufficient quantity of solution to treat 1000 red maple stubs at the volumes and concentrations employed in the current test. A 16-pound 2,4,5-T acid per 100-gallon concentration is also included in the table. It is recognized that these values cannot be used to arrive at acre costs for commercial field spraying. However, while the magnitude of field costs will differ from those of the test, relatively, field costs should be in the same general order, whether for stubs of the size treated in the test or for stubs of larger diameter.

It is obvious from costs in Table 3, and percent reduction of resprouting in Table 2 that high volume spraying with solutions of high concentration is not economical:

	Concentration: Pounds 2,4,5-T Acid Per 100 Gallons of Solution			
	16	8	4	2
cc. per stub	7.6	7.6	7.6	7.6
mg. 2,4,5-T per stub	145.6	72.8	36.4	18.2
Percent reduction of resprouting	—	98.3	98.4	99.6
Material cost for 1000 stubs	$1.396	$0.860	$0.592	$0.456

TABLE 3. COST[1] OF MATERIALS TO PREPARE SUFFICIENT 2,4,5-T-KEROSENE SOLUTION TO TREAT 1000 RED MAPLE STUBS 4 INCHES TALL AND 3/4-1 INCH IN DIAMETER FOR 3 VOLUMES AND 4 CONCENTRATIONS

cc. Solution Applied Per Stub	Pounds of 2,4,5-T Acid (Ester Formulation) Per 100 Gallons Kerosene-Herbicide Solution				
	Kerosene Only	2 Lbs.	4 Lbs.	8 Lbs.	16 Lbs.
	Dollar Cost for Quantity Sufficient to Treat 1000 Stubs				
1.9	$0.081	$0.114 (4.54)[2]	$0.148 (9.1)	$0.215 (18.2)	$0.349 (36.4)
3.8	0.162	0.228 (9.1)	0.296 (18.2)	0.430 (36.4)	0.698 (72.8)
7.6	0.324	0.456 (18.2)	0.592 (36.4)	0.860 (72.8)	1.396 (145.6)

1/ Average prices quoted at Bangor, Maine, November 1954:
Kerosene at $0.162 per gallon.
2,4,5-T acid (ester formulation) at $3.38 per pound (4 lbs. acid equivalent per gallon).

2/ Figures in parentheses = milligrams of 2,4,5-T acid applied per stub.

Conclusion

For high volume spraying of red maple stubs of small diameter, a concentration of 2 to 4 pounds of 2,4,5-T acid per 100 gallons of kerosene is as effective in suppressing resprouting, and obviously is more economical, than the commonly recommended (3) concentration of 8 to 16 pounds of 2,4,5-T acid per 100 gallons of solution.

References

1. Bramble, W. C. Effect of Placement of Dormant Basal Spray on Top Killing and Sprouting of Scrub Oak. Proceedings of Seventh Annual Meeting of the Northeastern Weed Control Conference. Pages 309-311. 1953.

2. Coulter, L. L. Two Primary Factors Influencing Results in the Control of Oak During the Dormant Period. Down to Earth, Vol. 7 (4):2-3. 1952.

3. Research Committee of the Northeastern Weed Control Conference. Control of Woody Plants. Supplement to the Seventh Annual Proceedings of the Northeastern Weed Control Conference. Page 34. 1953.

4. Suggitt, J. W. Basal Bark Dormant Season Treatments on Resistant Woody Plant Species. Part I: The Effect of Timing, Chemical, Concentration, and the Aromatic Content of the Oil Carrier. Proceedings of the Northeastern Weed Control Conference. Mimeo paper, 9 pages. 1952.

WEED CONTROL IN CROPS, A BENEFIT TO AGRICULTURE AND HEALTH

Donald A. Schallock[1]

The control of weeds between the rows and among the plants of desirable species is the chief objective of an agricultural weed program. Field crops, garden crops, lawns, nursery and greenhouse plants, are being grown with less effort, less expense, with greater attractiveness, and usually with greater yield or better quality.

Our weed control program in New Jersey is not limited to those crops. Brush control, soil sterilization around buildings and industrial sites, weed control along highways and other rights-of-way, are examples of other weed control problems that fall within the scope of our recommendations. Due to this centralization of responsibility for disseminating weed control information, we are in a very favorable position to effect a widespread control or possible eradication of weeds that affect agriculture, industry, public utilities, municipalities, and the public health.

I do not mean to imply that any extension or research group would be able to operate without the cooperation of all groups involved. The fact that this conference of weed control workers is organized with sessions devoted to weed problems as they affect health, forestry, aquatics, industry, and highways, attests to the cooperative approach we must take to achieve our goals in weed control work.

The education of the farm population in the principles and practices of weed control is not complete. Even with 2,4-D it is necessary to emphasize the conditions under which this material may be used to best advantage. The promising new chemicals being developed by colleges and by industrial researchers, guarantee full employment for anyone engaged in dissemination information concerning chemical control of weeds.

Those farmers, home owners, and others who have learned to use weed control as a tool in producing crops, are already making contributions to the general health and welfare of the public. These same people can expand their program to encompass the entire farm from border to border, including the fence rows, stone walls, and roadsides. The equipment and know-how are there, the chemicals are available, and the incentive for such a program is apparent. The reinfestation from neglected field borders; the unsighty appearance of weed growth along roads, fences, stone walls, and buildings; and the health and comfort of the public are sufficient motives to engender a package program of weed control wherever weeds are found on a farm, home, or commercial property.

Extend these areas of "total" weed control through a county, and link them together with more farms, roads, and recreational areas that are weed-free; then our agricultural weed control program will have reached its full potential. The benefits will not be restricted to crop production, but will improve the general welfare of our entire population.

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THE CONTRIBUTION OF AEROBIOLOGY TO WEED CONTROL

by: Oren C. Durham *

The pollution of the air with allergenic pollens and other air-borne spores is obviously a public health problem. It is just as truly the concern of public health authorities as is the pollution of the air with dangerous bacteria, or poison gases -- just as much as the bacterial pollution of our city water or of the milk delivered to our doors.

But in dealing with such problems we cannot step immediately from the recognition of the social menace to a satisfactory solution. The first task is necessarily one of local and general assay and evaluation. Inspection of dairy barns and tasting of milk are not sufficient. Bacterial counts must be made and standards of purity set up. Only then are we ready to regulate dairy practices. Similarly, the evaluation of the pollen hazards of a single community or a region cannot be accomplished even by the most careful inspection of fields, roadsides and vacant lots. While this is a vital part of the job it must be remembered that pollen contact by the individual pollen victim comes only from inhaling air-borne pollens. It is, therefore, necessary to sample the air in order to determine how many pollen grains each citizen in a particular locality is forced to inhale in a unit volume of air or in a given length of time. Present methods for statistical study of pollen contamination of the air as developed by allergists and their cooperating aerobiologists during the last forty years are the outgrowth of pioneer work in this field begun nearly a hundred years ago in England.

Prevention

Preventive measures against pollen disease are essentially the same as have long been used for combating infectious diseases: immunization, sanitation and isolation. Prevention is certainly preferable to cure when dealing with a disease like pollen allergy for which there is, as yet, no known cure.

Prevention of hay fever suffering in the individual pollen victim by means of preseasonal prophylactic injections of pollen antigen is reasonably successful in the hands of a skillful physician, though protection is not always complete. Effective sanitation for the individual victim is limited to the removal of pollen from indoor air, which, though temporarily more satisfactory than immunization, cannot protect the sufferer while he is out of doors, where most of us prefer to be as much as possible during the season of plant pollination. Complete isolation of the hay fever sufferer is possible only for certain plant species of definite regional distribution, for example; Russian thistle, hemp (Cannabis) and the ragweeds; and impossible for such plants as the ubiquitous grasses and shade trees. But the expense of travel and loss of work time is considerable even if one makes certain that his chosen vacation spot offers sufficient protection for his own type

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and degree of sensitivity. Ragweed victims have been fleeing to the seashore and mountains during August and September for a hundred years, all too often with disappointing results.

At the public health level sanitation by plant destruction is necessarily limited to the wind-pollinated weeds. The economically useful and decorative trees as well as the economic grasses must not be molested even though they do discharge abundant amounts of active pollen. In some parts of the Southwest the planting of sugar beets (cultivated for seed) has been outlawed within a specified distance from populous centers because of the large quantity of toxic pollen released from this field crop. (Sugar beets are blood cousins of Russian thistle whose pollen is extremely toxic.)

Weed Pollen Control

Theoretically it should be possible to completely control hay fever caused by weed pollen by destroying or discouraging the growth of wind-pollinated weeds. But even our highly effective herbicides are still in most areas no match for our present agricultural practices, for our neglect of waste land in urban, suburban and rural areas, and for our thoroughly weed-seed-saturated soil. Turn over a shovelful of dirt almost anywhere in these United States and you will cause a hundred ragweeds to spring up. I have counted more than two hundred young ragweed plants on a square foot of fallow wheat land. Ragweed seeds buried in dry sand have been known to remain viable for forty years. Our standards of clean crop practice in the corn and wheat belt, which have risen noticeably in recent years and which are doubtless adequate from the standpoint of agriculture, are still far too low to effectively reduce ragweed pollen air pollution in the Great Mississippi Valley.

Legislation against ragweed in this same area is about as effective in clearing the air of pollen as legislation in Massachusetts would be against the splashing of waves on the shore. Actually it is now possible to completely control air contamination from ragweed only in areas where the weeds are naturally absent or rare, and where in addition there are natural barriers to the inflow of polluted air from adjacent weedy regions. The only effective barriers to such inflow of pollen are: broad, dense forests and deserts, high mountain ranges and oceans. Prevailing winds from the ocean are sometimes of direct value as a one-sided protection. A good example of naturally free and naturally protected areas is the region west of the Cascade Mountains in western Washington and western Oregon.

The long distance aerial transport of toxic quantities of pollen--a factor that can be evaluated--emphasizes the basic importance of persistent research on pollen sources, pollen production and dispersal, pollen ceilings and relative pollen incidence in all parts of the country. It is axiomatic that we should perfect and adopt reliable standard procedures for studying aerial dispersal of pollen as well as for the evaluation of our weed control programs, and our supposedly pollen-free areas. Only thus can our individual or even area-wide efforts add up to a meaningful total.

Standard Methods in Aerobiology

For those unacquainted with the method used for routine air sampling and counting it must be said that we aerobiologists do not actually count the pollen removed directly from a cu. yd. or any other measured quantity of air. Rather we allow air-borne pollens to settle for twenty-four hours on an oil-coated slide and count the "gravity" deposit per sq. cm. Then we multiply the sq. cm. figure by a factor which gives a roughly approximate equivalent volumetric figure. This indirect method is used, not because it is strictly accurate, but because no simple practicable volumetric sampler has yet been made available.

But the present standard gravity technic is a decided improvement over any of the various methods used two decades ago when each pollen investigator was a law to himself, not only in sampling and counting but in his method of stating results. As an example of the basic need of a standard for statement of data, take the case of the state-wide ragweed pollen survey carried on during three seasons (1940-1942) by the Michigan Department of Health. A unit of statement was adopted which was nearly four times as great as that which was being used in nation-wide coordinated studies. Thus the state's own health department's data caused even its best ragweed resort areas to appear bad by comparison with ragweed refuges in all other parts of the country.

The details of basic research carried on between 1935 and 1945 on the specific gravity and experimental rate of fall of pollen grains in still air need not be detailed here. Nor is it necessary to dwell on the results of numerous gravity test runs against two different types of volumetric samplers. This work resulted not only in a standarized method, which has been widely adopted, but in a frank evaluation of the inaccuracies of the method which we must still use for want of a better one. Meanwhile, only one investigator has followed my suggestion of doing parallel tests with still different types of volumetric air samplers. Nevertheless, much valuable fundamental experimental work such as that of Ruskin in Detroit has been carried on during the last decade.

In dealing with the varying degrees of pollen concentration from place to place, from hour to hour and from day to day, extreme accuracy will probably never be achieved. Air turbulence is an untamed factor. Even when more suitable and more refined instruments and technics are perfected the resulting data will almost certainly be too cumbersome and tedious to be of practical value.

Upper Air Research

Any sampling device suitable for pollen sampling at ground levels is useless in upper air research. So far, most upper air samples have been secured by direct impingement of pollen on glass slides held in the slipstream of an airplane. Correlation of such data with that obtained on stationery slides is practically impossible. Here is a wide-open three-dimensional field for pollen research. We know a little about pollen ceilings for ragweed, something about the effects of thermal air currents and temperature lapse rates on the behavior of free-flying pollen, but the basic practical pollen problems of the upper air have scarcely been touched.

Evaluation and Guidance in Ragweed Control Operations

The idea of ragweed destruction as a method of solving the fall hay fever problem was first tried out on an ambitious scale in Chicago in the early thirties under the sponsorship of the Woman's Club and the encouragement of the City Board of Health. It was assumed that the presence of Lake Michigan on the east side of the city was a guarantee that Chicago's ragweed pollen problem was half solved before "operation ragweed" began, and that with persistent weed cutting and pulling there would be no difficulty in realizing the objective stated in the slogan "make Chicago hay fever free by 1933". The cost per acre for cutting and pulling was high so not nearly all of the waste areas within the city limits were ever covered. The money spent amounted to an average of $5.00 per acre of all waste land for the three seasons.

Those who promoted the campaign did not realize that Chicago's prevailing, pollen-carrying winds come from the southwest. They also forgot about the thousands of acres of ragweeds in the southwest suburbs and the millions of acres of weed producing farmland beyond the suburbs. At that time we could not tell them from experience that almost every day during the ragweed season the upper air above the city carries a heavy load of pollen reaching to a ceiling nearly a mile high, and that the upper air concentration thirty miles out over the middle of Lake Michigan is almost as high as it is at corresponding levels over the city and adjacent farmland.

Fortunately we had been carrying on pollen counting in the center of the "loop" for several years and continued these tests through the three years of the campaign, so when our total annual count in the "loop" <u>increased greatly for each of the three years of the campaign--not because of the efforts</u> of the Woman's Club but in spite of them--we could at least be sure that no great general benefit had resulted to Chicago hay fever sufferers. Indeed, the cause of ragweed pollen control and public health was actually harmed because of the publicity that had been given to promises that could not possibly be realized. However, no better opportunity could have been desired to demonstrate the value of pollen counting in checking the effectiveness of weed control efforts. In later such metropolitan campaigns in other cities less glowing promises have been made. One hundred percent results have not been expected nor achieved. Justification of the expense of city-wide campaigns must necessarily be based partly on esthetic considerations. The benefit of partial reduction of air pollution cannot be assessed accurately at present.

In New York City atmospheric sampling by ourselves for many years, and in the last decade by Dr. Matthew Walzer and his associates has showed that at least half of New York City's ragweed pollen comes from the west side of the Hudson river. Thus, even with greatly improved methods of weed destruction, New York City can never be turned into a hay fever haven. Unless New Jersey and east Pennsylvania work some miracles hundreds of New York allergists will continue to treat thousands of hay fever patients and trainloads of ragweed refugees will roll out of the city every August.

Currently one of the most interesting ragweed control projects in the country is being started on the North Pacific coast. Twenty-five years ago we could expose slides all through August and September in Seattle and Portland and not catch a single grain of ragweed pollen. The Seattle count is still almost as good, but last year Dr. Frank Perlman, a Portland allergist, caught thirty-six ragweed pollen grains in one day. Several areas of infestation in the Willamette Valley and in the southwest corner of Oregon are being watched and checked by Dr. Perlman, but it is most difficult to arouse public interest and promote real control efforts in that area where fall hay fever is still almost unknown. Rotation of row crops with grass (grown for seed) seems at present to be the ideal method of control though spraying is also very effective. In western Oregon grass will choke out ragweed in one season.

Meanwhile a real allergy tragedy has occurred under our very eyes in Wenatchee Valley in central Washington. Common ragweed was unknown fifteen or twenty years ago in that irrigated orchard valley. On the surrounding hills the rainfall is not sufficient to support ragweed. About five years ago someone reported to the Pollen Survey Committee that the orchardists in Wenatchee Valley were or had been using common ragweed as an orchard cover crop! Tests made in the town of Wenatchee and on the State Experimental Farm on the edge of town in 1950-1951 revealed a degree of air pollution greater than at any point yet tested west of the Rockies, and as high as almost any place east of the Appalachians--almost twice that of New York City. This summer I had my first opportunity to observe the havoc that has resulted to the area. The infestation is spreading from Wenatchee Valley into adjacent orchard districts of central and southern Washington. As yet, I have not heard of anything being done about the situation, except talk.

Hay Fever Havens

Our attention was accidently turned to the possibility of evaluating popular hay fever resorts some twenty years ago because of the extravagant claims being broadcast by the Chamber of Commerce of Duluth, Minnesota. This city at the extreme western tip of Lake Superior had evidently deserved its good reputation at sometime in the far distant past, but I happened to know by personal investigation that for at least ten years it had been badly infested with ragweed. I had observed that all too many of the fall visitors carried their handkerchiefs in their hands. So, without consulting the Chamber of Commerce we set up a sampling station under the supervision of the local weather observer. The first season's testing proved that the city had more pollen in the air than is found in some of the large cities of the eastern seaboard from which thousands of ragweed victims regularly retreat to the resort areas. Of course, the Chamber of Commerce protested, claiming that we had not made our tests in the area where the visitors were accustomed to congregate. So we changed the location of the sampling apparatus to a place of their choice down by the lake shore. Here the slides caught even more pollen.

Nowadays, resort owners, concessionaires in National Parks and other recreational areas as well as transportation companies serving such areas usually follow the policy of first financing an investigation by disinterested and experienced technicians, then launching their advertising--providing the results of the investigation justify the statements they wish to make. The ragweed index figures in the now well known "Hay Fever Holiday", sponsored and revised annually by the Pollen Survey Committee of the American Academy of Allergy are regarded as valid, perhaps because it is evident that the allergists who sponsor this work have no financial or political axe to grind in encouraging their patients to leave town and thus avoid taking medical treatment.

Public Health Cooperation

Allergists might have gone on counting pollen in the large cities for a long time without the cooperation of public health agencies if it had not been for the publication of pollen counts in the newspapers and the release of index ratings for hay fever resorts. Statistical comparisons were in some cases odious. The tourist bureau of Canada caught the ball on the first bounce, but instead of tossing it to their Canadian allergists, who were already hard at work locally, or to their Canadian Department of Health they passed the ball immediately to the Dominion Department of Agriculture. Pollen counting was begun in Quebec two years before the New York State Health Department and the Michigan State Health Department were alerted. During the past seventeen years Canadian botanists and aerobiologists, usually subsidized by the Dominion Department of Agriculture, have reported pollen studies in 137 cities, towns and recreational areas from British Columbia to Newfoundland with their most thorough coverage in Quebec. The New York State Health Department has furnished us with records from nearly 100 places. The New Hampshire State Health Department has also done an excellent job of pollen survey and aerobiologic control of weed destruction and ragweed resort evaluation. The New Jersey State Health Department has been active but evidently too busy to send in very many figures, so most of our New Jersey standard data have resulted from studies carried on by Dr. Matthew Walzer and his associates working in New Jersey areas adjacent to Greater New York.

The Florida State Health Department has sponsored pollen counting in fifteen cities, mostly in the coast resort areas from Pensacola and Jacksonville to Key West. City health departments are active in a number of the larger cities scattered from Boston to Denver. It was left for Maine to come up with a model state-supported pollen survey. This particular project was not carried out by the State Health Department but by medical and botanical personnel at the University of Maine. It consists of field work and sampling in 25 counties, and covers not only ragweed but all types of airborne pollens as well as the larger fungus spores. So far the United States Department of Public Health has contributed only a few local pollen studies but the personnel of this department are engaged in basic studies on air pollution. It is entirely possible that during 1955 joint research projects both at ground levels and in the upper air will be started. We are looking toward more work on volumetric sampling.

Educational

According to our latest records, ragweed data are now available for more than 600 localities in North America from Alaska and Newfoundland to the Virgin Isles and southern Mexico. Allergists and their cooperating aerobiologists have not contributed even half of the labor involved, but they have sparked the effort and are still in close touch with most of the studies being made. The nation-wide publicity given to pollen counts and pollen index ratings for hay fever resorts and recreational areas may well be regarded as part of the educational contribution of the allergists themselves. Ten thousand copies of the booklet "Hay Fever Holiday" are being distributed each year to hay fever sufferers. Our data are being copied widely by newspapers, magazines and by book publishers. Health museums look to us to help plan their hay fever exhibits, for example, Cleveland and Dallas. The Chicago Museum of Science and Industry has used a large exhibit of ours during the past two seasons. If John Doe writes to the United States Department of Agriculture, the United States Weather Bureau, the United States Department of Public Health or the American Medical Association for information about pollen distribution he is either referred directly to us or to the records we have gathered and compiled.

In each annual report of the Pollen Survey Committee full credit has been given to all collaborating public health officials and institutions. This is our first opportunity to publicly offer our cooperation, not only to the technicians carrying on aerobiologic work, but to those interested primarily in weed control.

REFERENCES

Campagna, Elzear: Air-Borne Pollen and Fungus Spore Survey in Prince Edward Island for 1952, Proceedings of the Seventh Meeting, Eastern Section, National Weed Committee, p 37, 1953.

Cocke, E. C.: A Method for Determining Pollen Concentration of the Air, J. Allergy 9: 458, 1938.

Dahl, A. O., and Ellis, R. V.: The Pollen Concentration of the Atmosphere, Public Health Reports 57: 369, 1942.

Durham, O. C.: An Unusual Shower of Fungus Spores, J.A.M.A. 3: 24 1938.

Durham, O. C.: The Volumetric Incidence of Atmospheric Allergens, J. Allergy 14: 455, 1943.

Durham, O. C.: The Volumetric Incidence of Atmospheric Allergens. II. Simultaneous Measurements by Volumetric and Gravity Slide Methods. Results with Ragweed Pollen and Alternaria Spores, J. Allergy 15: 226. 1944.

Durham, O. C.: The Volumetric Incidence of Atmospheric Allergens. III. Rate of Fall of Pollen Grains in Still Air, J. Allergy 17: 70, 1946.

Durham, O. C.: The Volumetric Incidence of Atmospheric Allergens. IV. A Proposed Standard Method of Gravity Sampling, Counting and Volumetric Interpolation of Results, J. Allergy 17: 79. 1946.

Durham, O. C.: The Volumetric Incidence of Atmospheric Allergens. V. Spot Testing in the Evaluation of Species, J. Allergy 18: 231, 1947.

Durham, O. C.: Statistical Report of the Pollen Survey Committee of the American Academy of Allergy for the Seasons of 1950-1951-1952-1953. Distributed by the Aeroallergen Committee of the American Academy of Allergy.

Durham, O. C.: Pollen Prevalence and Pollen-Free Areas, J.A.M.A. 148: 716 1952.

Durham, O. C.: What the Pollen Count Means to You, Today's Health 32: 20 1954.

Frankton, C. and Bassett, I. J.: Canadian Havens From Hay Fever, Canadian Government Travel Bureau, Ottawa, Ontario, 1952.

Gilbert, Gareth E.: Volumetric and Gravity Slide Tests for Air-Borne Ragweed and Oak Pollens at Columbus, Ohio, Ohio Journal of Science 50: 60, 1950.

Grigsby, B. H.: Pollen Survey of Michigan to be Repeated This Year; 1940 Study Probably First Made of a Whole State, Michigan Public Health 29: 83, 1941.

Hawes, R. C., Small, W. S., and Miller, H.: An Apparatus for Determing the Pollen Content of Air and Notes on Pollen Survey Methods, J. Allergy 13: 474, 1942.

Hyland, Fay, Graham, B. F. Jr., Steinmetz, F. H. and Vickers, Martyn A.: Maine Air-Borne Pollen and Fungous Spore Survey, University of Maine, Orono, Maine, 1953.

Perlman, Frank: Ragweed Invasion of Oregon, J. Allergy 23:452-457, 1952.

Schueneman, J. J.: A Study of the Incidence of Atmospheric Ragweed Pollen in Metropolitan St. Louis During August and September 1949, St. Louis Health Division, Industrial Hygiene Section, 1949.

Shapiro, Richard S., and Rooks, Roland: The Accuracy of the Reported Ragweed Pollen Count as a Measure of the Actual Pollen Exposure of Individuals in That Community, J. Allergy 22: 450-460, 1951.

Spiegelman, Jay, and Blumstein, George I.: Pollen Counts: Variability and Percentage Error in a Given Location under Standard Conditions, J. Allergy 22: 536, 1951.

Velz, C. J.: Sampling and Measurement of Pollen Pollution of Air, Public Health News, New Jersey State Department of Health 31: 171, 1950.

Wiseman, Richard D., Sack, S. Senior, Siegel, Bernard B., Glazer, Israel and Walzer, Matthew: Studies on Factors Influencing Ragweed Pollen Counts in the New York Metropolitan District, J. Allergy 25: 1-11, 1954.

Report on the New York City program and Recommendations for a Metropolitan Program.

William M. Hawksby, Division Chief of Specialized Units, and Alton A. Smahl, M.D., M.P.H., District Health Officer, New York City Health Department.

BACKGROUND

Ragweed hay fever is a fairly common illness since it has been estimated by the U. S. Public Health Service that between 2 and 3 percent of the population east of the Rocky Mountains have symptoms of ragweed hay fever. In 1915, the Board of Health of New York City recognized ragweed pollen as a public health problem. It enacted Section 221 of the Sanitary Code which prohibits the growth of ragweed on any premises within the City of New York. For the next 31 years, the Health Department's effort to control ragweed was based on the enforcement of this section. The time of the year that this section was to be used is a handicap for proper enforcement. There are many other programs that become activated in the summer season, i.e., inspection of vacation areas, day camps, summer colonies, bathing beaches and outdoor swimming pools - all added to the work of the field force. All of these summer activities drained off the personnel that could otherwise participate in a planned drive for ragweed control.

Another factor that prevented proper enforcement was the problem of prosecuting the owners of areas where the ragweed was found to be growing. First, it is difficult for anyone without proper equipment to establish property lines on large undivided tracts of land in outlying areas of the city. Second, it is a tedious and complex job to make hundreds of title searches in order to properly locate the owners of vacant lots and property undeveloped and neglected for many many years. Finally, when the owners are located, it is found that many of them live outside city limits - in other cities, states and, in certain instances, in foreign lands. To properly serve notices on them and, as a last resort, to prosecute them in court is, in most cases, impossible. These are some of the reasons that Section 221 was never found to be effective.

Sporadic campaigns, including a W.P.A. project, were initiated by the Department of Health in order to eradicate ragweed by cutting, grubbing and treating with caustic chemicals. The reason that these campaigns proved a failure was the high cost of man-power and materials. Small benefits were derived from these efforts because cutting of the plants permitted new growths to glossom from the cut stems. Grubbing disturbed the soil and uncovered dormant ragweed seeds, thus giving them a chance to germinate into plants the following year.

In 1945, the herbicide 2,4-D was made available. This [illegible] not affect [illegible]. [illegible] found that [illegible] chemical, a hormone, is selective in its action. While it kills many broad-leafed plants, it generally does not affect grasses. It was found that ragweed plants are readily killed and the pollination of ragweed is prevented when a one-tenth of one percent solution of this herbicide is sprayed on the plants during the period of active growth. The Department of Health decided, after investigation, that ragweed could be controlled economically with the use of 2,4-D.

"OPERATION RAGWEED"

In 1946, under the direction of Health Commissioner Israel Weinstein, "Operation Ragweed" was inaugurated for the purpose of reducing ragweed pollen in New York City during the hay-fever season. This work was organized and started under the leadership of Alfred Fletcher who was then Director of the Bureau of Sanitary Engineering of the New York City Department of Health. Prosecution of this program was legally strengthened in 1946 by an amendment to the Administrative Code which gave the Department of Health authority to enter private property in order to eliminate ragweed without serving legal notice personally or posting each property individually. A Weed Control Unit was established in the Division of Specialized Activities of the Bureau of Sanitary Inspections to carry out this activity. The unit is still carrying out this program effectively.

This project requires the cooperation of several official municipal agencies. The Health Department has the authority to plan the program, prepare the budget, secure funds, procure equipment and supplies, train personnel participating in the program, promote educational and public relations programs, and coordinate the work of other departments and agencies participating. The five borough presidents' offices are responsible for the procurement of operating personnel, and for the field spraying operations on public and private property. Laborers assigned are paid by the Department of Health. The borough presidents' offices also supply trucks and drivers for the mounted power spraying units. The Department of Sanitation supplies street flushers and chauffeurs to drive them. In addition, the borough presidents' offices provide garage facilities and emergency repairs for all the equipment.

The Department of Parks eliminates all ragweed from park property and, since the public parks of New York City cover 27,000 acres, this is quite a problem. It has been accomplished effectively and with good results. The Park Department reports periodic progress of their operations to the Department of Health. During 1954 they sprayed 200 acres of ragweed. The Department of Purchase is responsible for the procurement of equipment and supplies. In 1946 and 1947 the Police, through their various police precincts, were responsible for the mapping of the ragweed infested areas in the city. The Brooklyn and New York Botanical Gardens supplied the botanical information, and the Weather

Bureau furnished meteorological information. The Allergy Laboratory of the Brooklyn Jewish Hospital maintains 10 pollen collecting stations throughout the metropolitan area. Dr. Matthew Walzer of their Allergy Clinic has been most helpful to our program by reporting the daily pollen count in the metropolitan area.

During the past 9 year period from 1946 to 1954, "Operation Ragweed" was carried on as one of the specialized programs of the Department of Health. An approximate estimate of the annual cost to the city is about $85,000. This includes the cost of labor, chemicals, automotive supplies, spraying equipment, administrative and clerical personnel, and rental values of trucks used. A table is attached showing a comparative summary of data relating to the program during this period, and includes estimated acreage of ragweed infested areas prior to spraying and acres sprayed by the Department of Health.

EVALUATION OF RESULTS

It has been found that the control of ragweed in New York City by spraying the infested areas with solution containing 2,4-D is a more effective and economical method than any of the other attempts made in the past. Mapping surveys and other observations indicate that the total ragweed infestation in New York City has thus far been considerably reduced since the spraying program was inaugurated in 1946. As a result of the apparent success of this program in New York City, many adjacent communities have initiated similar campaigns to reduce their ragweed growth.

DIFFICULTIES ENCOUNTERED

As in any other large cooperative program, difficulties are bound to arise. It is pertinent to note at this time that the program is inadequate. At its best, we can only hope for the destruction of a portion of the ragweed in the city in any one season. The number of trucks, spraying crews, and supervisors are insufficient to properly spray the entire area assigned to them.

To judge what might be accomplished if all the boroughs were properly covered, let us consider the Borough of Manhattan. In 1946, control spraying in this borough was done over an area of 254 acres. This covered all the ragweed areas then growing in Manhattan. In 1954, eight years later, only 36 acres of ragweed were found in this borough. This was mostly scattered growth and sparse tufts on vacant land. Whereas in 1946 it took 13 weeks to fully spray ragweed infestation in Manhattan, at present complete coverage is effectuated by one spraying team in less than 3 working weeks. It can be expected that working time will decrease next year.

When the program was inaugurated, the intention was to spray areas of ragweed in each borough in accordance with a predetermined master plan. In this way it was thought that the maximum acreage would be covered in the time alloted. As the program developed, the public became increasingly aware of its operation. More and more citizens' complaints are received and are being given priority. This interferes with the planned borough spraying program, and it reduces the number of acres sprayed. The reason for this is quite apparent.

Another problem has been equipment. Our Power Sprayers, Bean Sprayers and Knapsack Sprayers, purchased in 1946 from war surplus materials, are in poor mechanical condition. When a part on the power sprayers must be replaced it is necessary to send out of town for it. This causes, under favorable conditions, a loss of several days spraying time. The spraying units have deteriorated so much, that it was found necessary to discard one of them for salvage in 1953. The Department of Sanitation sprinkling trucks used for the program were designed for street sprinkling with water. While leaking sprinkler trucks present no problem to them, when using chemical solution, leaking must be controlled and there is need for constant repair and caulking of sanitation trucks throughout the ragweed spraying season.

Laborers used for the program also pose a personnel problem. They are hired by the Borough Presidents' office, and it is questionable whether most of them are interested in the program, or whether they are physically capable of doing a good job. In order to maintain good relations with the staff of the various borough presidents' who hire them, Department of Health supervisors register little complaint about the laborers. The result has been a constant pressure on these supervisors to do an effective job, and still maintain good human relations with the central office, the borough presidents' office and the laboring force.

A review of the work done during the past few years indicates the need for a careful evaluation of the entire program. Consideration might be given to contracting the entire job to private interests, under Health Department supervision.

For the effective prosecution of this program or any similar program, there are several basic requirements which must be considered.

1. Adequate and efficient mechanical equipment should be supplied.

2. Proper surveys should be made prior to and after the spraying program is completed.

3. Accurate mapping and planning for elimination of ragweed

infestations should be completed priorto the beginning of the spraying season. The planned spraying program must be strictly followed. Complaints should play a minor part in the program, and should be abated within the final period of the season's work.

4. Sufficient supervisory personnel is a basic requirement.

5. All cooperating municipal agencies should be alerted to the necessity for expediting all necessary mechanical repairs to the spray equipment and motor vehicles during the spraying season.

6. Good relations and improved liaison should be established with all other private agencies interested in ragweed control, such as Hay Fever Prevention Society, Allergy Clinics, etc. It is also recommended that responsible civic groups be supplied with 2,4-D where they are found to be anxious and willing to participate in ragweed elimination in areas that will not be reached by the program spraying trucks. These groups should be instructed in the use of 2,4-D and given token supervision.

7. In addition to this, it is felt that we should endeavor to create a real interest toward participation in the ragweed control campaign by public agencies in surrounding localities where either limited or no ragweed control work is being done.

Our present ragweed control program has given us a positive approach to what was previously a hit-or-miss method. We can look forward to a steady decrease in ragweed pollen in the metropolitan area. With the limited facilities available, an effective job has been done by the unit assigned. New knowledge about the ecology of these plants may provide a fresh approach in attacking this problem.

* * * * * * * * * * *

The necessity for a coordinated ragweed project of the Metropolitan area is clearly shown by the studies and investigations of Walzer and his co-workers.

R. P. Wodehouse, probably the best informed botanist on the subject of ragweed and its control, expresses his feelings as follows:

"Hay Fever can be cured by treating the environment instead of the patient. In fact, it is the only way that it ever will be cured.

Little is known of the ecology of the ragweed plants. Ragweed plant ecology is as important to the future ragweed control programs as entomology has been to programs to control insects.

Since 1936, Dr. Matthew Walzer and his co-workers of the Allergy Division of the Jewish Hospital of Brooklyn have been making daily estimates of the ragweed pollen content of the air in and about New York City. During the first ten years, the air was sampled by the exposure of greased slides in a crude shelter on the roof of the hospital. The adoption, in 1946, of the Durham Shelter as a standard instrument of exposure and the standardization of counting techniques by the Pollen Committee of the research Council of the American Academy of Allergy made more intensive studies of New York City's pollen problem feasible.

Since 1946, surveys have been made during the ragweed pollinating seasons in about 10 localities in the city and its environs. At the same time, meteorologic data from weather stations in these areas were analyzed in an attempt to correlate weather factors with pollen counts. Almost with the start of these surveys, the New York City Department of Health initiated a program of ragweed plant eradication within the city. This prompted considerable speculation as to the extent to which such an intramural campaign would influence pollen counts in the city and benefit its hay fever sufferers. It was common knowledge that ragweed pollen was wind-borne and could be carried from distant regions of heavy pollination into areas where ragweed growth was scant or absent. Durham, more than 20 years ago, had suggested that New York City was probably receiving much of its pollen from the large ragweed beds in New Jersey. However, concrete data on these questions were lacking and this prompted Walzer and his coworkers to undertake more extensive studies of these problems.

In 1947, a study was made of ragweed pollen conditions at Fire Island, New York. This island was relatively free of ragweed plants and was situated in the Atlantic Ocean several miles south of Long Island. It was frequently mentioned by the laity as a haven for hay fever patients sensitive to ragweed. Their studies revealed that while Fire Island tended to show daily ragweed pollen counts somewhat lower than the daily average for Greater New York, there were several days early in September, 1947, when readings on the island exceeded the city averages. Although the seasonal total of 298 at Fire Island was relatively low, it exceeded the seasonal total of 271 for the borough of Brooklyn in New York City for that year and was about 70 percent of the average total of 423 for New York City.

In 1948 and 1949, the study of this problem was continued by a survey of ragweed pollen conditions at Sandy Hook, New Jersey. This area is a narrow peninsula, not more than a few hundred yards wide, extending several miles into the ocean with only a scant growth of ragweed plants. Instead of the expected low counts, the seasonal total for Sandy Hook in 1945 was 563, as compared to an average total of 530 for New York City. In 1949, the average seasonal totals for Sandy Hook and New York City were 494 and 550, respectively.

The data obtained in the Fire Island and Sandy Hook surveys clearly indicated that the peak counts in these areas of scant ragweed growth occurred on those days during the active pollination period when winds blew briskly from the west. In this direction, according to previous surveys, were located the areas of densest ragweed growth in and around the New York Metropolitan area.

The study of wind as a factor in New York's pollen problem continued during the summers of 1949 and 1950 when pollen counts were made at Ambrose Lightship, anchored far out in the bay at the entrance to New York Harbor. Here the absence of ragweed plants were complete and all pollen granules appearing on the exposed slides were incontrovertibly wind-borne from neighboring land areas. These surveys yielded striking evidence that wind direction and velocity were the most significant meteorologic factors influencing the city's daily ragweed pollen counts.

The lowest seasonal total of the 1949 ragweed survey was 256 at the Ambrose Lightship. This figure was 46 percent of the average seasonal total of 550 for all the New York City stations. During the 1950 ragweed season, the seasonal total for Ambrose Lightship was 249, which was about 60 percent of the average seasonal total of 420 for New York City.

The investigators concluded that:

1. On the basis of the Lightship studies, New York City probably receives in the course of an average ragweed season as much windborne ragweed pollen as it raises within its own city borders.

2. An elimination program for freeing the city of ragweed pollen will only be completely successful when ragweed plants are completely and permanently eradicated from wide areas in every direction from which winds may carry pollen into the city. In New York City's planning, ragweed areas to the west of the city are its greatest problem.

NEW YORK CITY

RAGWEED ELIMINATION CAMPAIGNS

Sheet No. 1

Year	Estimated Acreage Ragweed Prior to Campaigns	Acres Ragweed Eliminated						Pounds 2,4-D Used	Man Days (Laborers)	Trucks Used
		Manhattan	Bronx	Brooklyn	Queens	Richmond	TOTAL			
1946	10,000	253.6	1073.5	422.5	1042.6	356.9	3149.1	8067	*	7
1947	8,000	146.1	1146.1	719.3	1694.2	1094.0	4795.2	5785	3814	18
1948	6,000	251.2	758.0	664.5	1537.0	733.7	3944.4	6312	2904	15
1949	4,000	89.4	769.6	406.9	1231.8	799.6	3297.3	5871	2953	16
1950	5,000	177.7	615.1	648.9	1199.0	517.0	3157.7	4277	2841	14
1951	5,500	126.6	910.0	705.3	1305.6	633.2	3680.7	7530	3177	15
1952	5,000	188.8	460.3	624.5	1301.4	622.3	3197.29	6087	2853	14
1953	5,000	44.	292.92	207.27	1365.6	440.	2350.28	4595.4	2874	15
1954	4,500	35.9	333.4	498.1	1380.	756.	3004.5	5825	2915	15

* Figure Not Available

Approximation of borough weed - 1954

1954		100	600	1000	1600	1200	4500			

"NATIONAL HAY FEVER FUND PROSPECTS"

Herbert W. Kip, Director of Public Relations,
Hay Fever Prevention Society, Inc.

On April 1st, 1954, the first effort to benefit hay fever sufferers by raising funds on a national scale was launched by the establishment of the National Hay Fever Fund.

The Hay Fever Prevention Society, Inc., the sponsor of this effort, inaugurated the Fund at a dinner at the Hotel Madison, New York City. Some persons attending this conference today participated in the inauguration. It was a modest affair, but its implications were far-reaching.

The Fund is for the purpose of research, education, and ragweed eradication legislation and enforcement. It is contemplated that about half of any funds collected by public subscription will go to research projects.

We were fortunate in obtaining real interested persons to serve on the Board of Trustees of the Fund. The Board consists of Eddie Dowling, actor and producer; Mrs. Emil Morosini, Jr., prominent and active member of other health funds; John E. Sloane, Director of Thomas A. Edison, Inc.; Emil Morosini, Jr., attorney; Kenneth D. Lozier, Vice President of St. Regis Paper Co.; Professor Gilbert H. Ahlgren, Chairman, Farm Crops Department, Rutgers University; Walter Shirley, former Commissioner of Commerce of New York City, and three prominent allergists - Abner Fuchs, M.D. of New York City; G. Everett Gaillard, M.D. of White Plains, New York, and Merle M. Miller, M.D. of Germantown, Philadelphia, Pa.

It is anticipated that local chapters of the Society will be established in various communities throughout the nation. These chapters will be of permanent status and will initiate and organize ragweed eradication programs in their community. Once a year, during the month of June, which will be declared Hay Fever Prevention Month, the chapter will make a concerted effort to raise money for the National Hay Fever Fund. Out of every dollar that is raised, however, seventy-five cents will remain with the local chapter for its own community program. The remaining twenty-five cents will be forwarded to the headquarters of the National Hay Fever Fund for the established purposes of the Fund.

No great fanfare surrounded the inauguration of the Fund for two reasons; funds were not available to promote the event on T-V, radio, advertising, etc., and it was decided by the Society management that a sound program of education was needed to acquire public acceptance of hay fever as a national health problem. The United Press and the NEA News Service did cover the event, however, and articles about the establishment of the Fund appeared in newspapers in several cities. The Society also concluded that since hay fever is not as dramatic a subject as polio, cancer, heart disease and muscular dystrophy, the foundation must be laid solidly if the public is to recognize the seriousness of hay fever and its possible complications. This program will take time and a major effort in sound but imaginative educational activities.

No organized drive has been made for funds to date, and no local chapters of the Society have been established. That declaration will immediately evoke a reaction that the Fund is dormant and has run into snags that could not be unravelled. Nothing could be farther from the truth. The Society has faced up to reality and is preparing the necessary groundwork to interest federal, state, community, civic and industrial agencies. When this is done, with the proper education and nurture of apparent interest, the chapter and fund raising features of the plan will follow with a maximum chance of success. What is also important is the fact that this approach will reduce the expense of promotion to a minimum and establish a grass roots acceptance of the program. For a program to be successful that is based on community action a grass roots acceptance is most necessary.

In the past six months, through extensive field trips, a representative of the Society has contacted staff members of several state and city Health Departments. Conferences have also been held with the Public Health Service and the Department of Agriculture in Washington, D. C. Through discussions and correspondence, contacts have been made with Chambers of Commerce, State Development agencies, hotel associations and resort owners, railroads, airlines, farm groups, civic organizations and pharmaceutical, air-conditioning and chemical companies. Most of these contacts have been of an exploratory nature, but nine out of ten of those contacted have shown a decided interest in the hay fever problem and acknowledged a responsibility in a program to alleviate hay fever suffering. Many of those approached had never realized the seriousness of hay fever and, therefore, made no investigation into the subject.

Since the inauguration of the Fund, the Society has received hundreds of inquiries for information from all over the country, and these inquiries have been carefully answered and screened for possible organizers of local chapters or volunteer workers.

At the very beginning, the Fund was registered with the National Information Bureau, Inc., Better Business Bureau of New York City and National Better Business Bureau. When New York State passed the new fund raising law last year, the Society registered as an agency raising funds.

As an additional instrument to help educate the public as to the need for a Fund, the Society changed the format of its quarterly house organ, the "Hay Fever Bulletin", from a two-page pamphlet to a magazine of several pages. It also solicited articles for the periodical from men who are recognized as specialists in various phases of the hay fever problem.

For the inauguration of the Fund, an artist was engaged to design an appropriate character to depict ragweed pollen as the Public Enemy #1 of the hay fever sufferer. The character, "Peter Pollen", was born. He is copyrighted and it is the plan of the Society to use him in its educational program as well as a visual aid to stimulate interest in the Fund. He might well become a national symbol to rally all hay fever sufferers to action.

While on a recent field trip through the South, I visited Dr. Justin M. Andrews in Washington, D. C. He is an Assistant Surgeon General and Associate Chief for Program, Bureau of State Services, Public Health Service. Dr. Andrews said that if enough of the State Health Boards would request assistance from the Public Health Service on the hay fever and ragweed problems in their states, some action might be taken on a subject that has received little official recognition heretofore. He said there have been some sincere efforts to eliminate ragweed, here and there, which have been of some help. He stated, however, it was his belief that until the government in Washington gives the problem some official recognition and assistance it will remain an isolated cause.

The Society has received pledges of support for its program, whenever possible, from the Girl Scouts of America, Boys Clubs of America, National Association of Gardeners, 4-H Club leadership in Washington, D. C., and the National Agricultural Chemicals Association.

Membership in the Society is now close to 300 and, though most of its members reside in the Eastern part of the country, there are some as far West as California and a few in Canada. As the influence of the Society increases, a sharp gain in membership is expected, particularly when chapters are organized in various communities.

After a six month's study of the possibilities of the Fund, we are firmly convinced it can be successful, provided the public is properly educated to its need. If only hay fever sufferers responded to a call for donations, the Fund would be overwhelmingly successful. Is this too much to ask of those who suffer the torments associated with hay fever?

We are also convinced that the hay fever sufferer must be advised of the latest information regarding the ailment. Some sufferers do not realize the possible consequences of treating their hay fever without the proper medical advice and attention. Others shrug it off as an inevitable seasonal affliction that must be accepted and endured. This creates an obstacle to any forward-looking hay fever program.

Last July a representative of one of the railroads approached the Society and proposed that if we would give them the ragweed pollen counts for cities they served, they would be glad to reproduce them and make them available to passengers at station information desks. Some airlines have also indicated a desire to know the ragweed pollen counts of areas they serve. I fully believe that a few years ago they would have paid little attention to pollen counts, much less the welfare of their patrons who have hay fever. I am not arguing the point that such information, in some areas, would be an accurate guide to a sufferer's "hay fever heaven", but it is a definite indication that various agencies are aware at last that hay fever sufferers deserve some consideration. That is a very big step forward.

In the over-all picture of weed control attempts, the effort to control ragweed has the most sympathetic audience, once the facts are known, and this should help to enhance the program of other weed control projects, whatever their goal.

When will the Fund produce results? That is the question that is running through all of your minds. Not having looked into my crystal ball lately, I cannot tell you. This is certain, however. Every effort will be made, every idea explored, and every action will be taken as soon as possible that will induce donations to the Fund. Every move that is made will have one final goal as its end result -- the elimination of hay fever from our national health picture. It will mean putting on the gloves and fighting every inch of the way. We cannot live in a "Brigadoon", where we only face the realities of life one day out of each hundred years. I am sure if that were possible the hay fever sufferer would select a day in February.

We are continuing to explore the possibilities of getting governmental and private agencies to cooperate, State Health Department with State Health Department, city with city, and town with town. We shall interest civic minded citizens into organizing local chapters. We expect industry as well as the farmer to cooperate. We want the cooperation of the press, radio and television. We cannot afford a stalemate and we are prepared to achieve the impossible when we are told it cannot be done.

There is no easy road for any health fund, even those that are dramatic and have a great deal of support on a national scale. Surely then, hay fever presents a greater challenge to those dedicating their efforts to eliminate it. It will take more than the thousands of words uttered at this Conference to spell its doom.

We can all help by employing the talents we possess to arouse many of our complacent communities to action. This may sound like beating the drum. If we face the fact squarely, however, we must realize that the only way the job can be done is by the hard work of those who are dedicated to the task and have the experience to advise others of its value. With a concerted effort by those who care, we could report progress in our Fund operations at this Conference in 1956. That is a certainty.

The Society organized the Fund because it believed it was long overdue. The Fund can be the instrument for providing much needed money for research. It could be the humanitarian godfather of all hay fever sufferers.

Most important at present, however, is the fact that the Society intends to stay in the fight until the job is done.

Thank you.

SUSSEX COUNTY'S HIGHWAY WEED-CONTROL PROGRAM

By: Lester N. Price
Director,
Board of Chosen Freeholders
Sussex County, New Jersey

Gentlemen:

As a farmer I have had for many years a compulsory and vital interest in weeds; as an elected representative of the people of Sussex County, New Jersey, I have had a like interest in public health, in public safety and in the wise expenditure of public funds -- -- -- and as a human I have had a natural and pleasant interest in beauty. Thus, when it was first proposed that all of these separate interests could be well served by the single act of spraying roadsides with herbicide, I was bent towards adding the notion as a new interest; though it struck me as one that was being at least mildly exaggerated. Even in this age, when the youngest one of us here today can recall, as fantastic, the notion that we might one day sit in our livingrooms and see things happening a thousand miles away, it seemed that too much was being attributed to this chemical cure-all.

But, as our Board and Supervisor of Highways began to examine the idea more closely, to take each of the suggested benefits and hold it up to the light of the known power of the chemical itself, it became increasingly clear that it deserved a try.

It might be of interest to you to know what benefits were suggested and how we eventually examined them.

The proposals were simply these:

1. Chemical weed-control will cut mowing and other roadside maintenance costs.

2. It will greatly decrease the number of cases of poison ivy among highway maintenance personnel and among other citizens and their children.

3. It will eliminate ragweed from the roadsides and thereby decrease the possibility of hay fever attack among all citizens.

4. It will stop the growth of plants that obscure the the highways themselves and render the roadsides inaccessible to pedestrians and motorists in trouble.

5. It will aid agriculture by eliminating the highway weeds that may reinfest crop areas.

6. It will decrease mosquito breeding by creating weed-and-brush-free roadsides, thus permitting ditches to drain and dry more readily.

7. It will create a beauty heretofore unseen on most rural roads.

8. It will aid in the removal of snow.

9. It will conserve wild life by eliminating the cover that lures animals to the roadside area.

10. The complete service may be bought for less money than is now being expended on the unnecessary portion of the moving operation alone.

Now, if you will go back in mind to the time when you were not aware of any of these virtues of chemical spraying, you will be able to appraise our suspicion upon hearing this barrage of wonders that was to be ours for the mere willingness to save money.

But, when each feature of the proposed spraying program was separately and seriously examined in face of the known fact that these chemicals kill weeds and woody growth, while actually encouraging the growth of grasses, each feature became a simple, logical conclusion; provided, of course, the spraying program was reasonably conceived and carefully executed.

This latter consideration was very important to us, since whatever we lacked in information on the particular virtues of roadside spraying was, you may be sure, more than compensated for by an abundance of misinformation on the evils of such a program.

The program proposed called for three sprayings during each of three seasons to permit the most rapid development of sound turf by way of the persistent destruction of the ever-invading weeds and woody plants. When the nature of various plants in our area was examined, that program seemed to be sound. It left no opening for anyone's being deceived, disappointed or subject to public criticism. It consisted of blanket spraying of the entire roadside areas back to the fence lines or to the lines at which the roadsides are generally maintained.

We have completed our first year of the program and have enjoyed a fascinating operation.

The chemical is applied from a moving vehicle, having a right-hand drive and four remote-control nozzles mounted vertically at the right front end. This equipment is called the "Multifix". It is produced by McMahon Brothers at Binghamton, New York, and is operated by one man who is both driver and operator of the spray equipment. The vehicle carries 1000 gallons of finished spray and

and several day's supply of chemical. It operates a low pressure in the spraying operation and at high pressure for refilling the main tank from any roadside stream. It is well-engineered for maximum safety and economy and is most surely responsible for the low cost at which this service is brought to our highways.

The results of the first year's work have been most gratifying. We had relatively weedless roadsides from the very first spraying and greener and healthier grasses than we had bargained for. The single mowing after the grass went to seed in the spring was all that was required during the entire growing season; and that one mowing was accomplished in one-third the time it would normally have taken, had the weed bulk not been eliminated.

On the roads that were sprayed, there was not a single case of poison ivy or hay fever reported among our maintenance personnel, though in a normal season we would experience eight to twelve cases of such disability, each lasting from one to two weeks.

Incidently, you will probably be interested in knowing that one section of road that was sprayed in our experiment is the the oldest travelled road in the United States. It is the old Delaware Mine Road running along the Delaware River in Sussex County and is a part of the old road between Kingston, New York and Pahaquarry mines in Warren County, N. J. It was built by early Dutch settlers to transport copper with horses and mules from the mines to Kingston.

As for conservation, only occasional small game, such as rabbits and woodchuck could be observed on the roadsides, and these could be clearly seen on the grassy areas in plenty of time for motorists to guard against their sudden actions. The very same might be said of children.

The work was neatly done. The line of spray was sharply cut at the far edges of the rights of way and left no unwanted appearance.

There were three reports of damage to private property, none of which was serious or cause for criticism of the operator. Each case involved hidden or informal plantings within the highway right of way. Two of these occurred in our very beautiful lake resort area where most plantings are informal and spraying most exacting. The contractor investigates each report and repairs the damage to the satisfaction of the owner. It is understood that the contractor's experience to date shows less than one report of damage per thousand miles of spraying operation.

Such facts are of vital importance to anyone contemplating a spraying program. For the whole matter seems to require assurance of good results and of public acceptance.

In Sussex County, the general reaction has been more than gratifying. Representatives of State and local governments, of universities and agricultural agencies have visted our County to inspect the work. As far as I know, all have been favorably impressed with one or another phase of it; such that it is difficult to say which of the many virtues I have listed for this highway spraying program is of paramount importance.

The Highway Supervisor sees in it the elimination of many of his nuisance problems and a substantial saving in maintenance expenditures.

The conservationist sees benefits to game, soil, water and forests.

The agriculturalist sees in it benefits to crops and, more especially, in educating the farmer in the further use of these chemicals in the fields and hedgerows.

Commerce officials see in it an opportunity to advertise all of its virtues for their State.

Health officials see the end of plant poisonings along that great expanse of roadside acreage that marks the responsibility of all public officials.

It need not be called a highway program. It can be justified as well as a conservation, farm, commerce or health program. In any case, the cost to the taxpayer is nothing. One benefit cannot be had without accepting all others; and all are available at a definite saving of public funds.

Since my purpose here, however, is to report the work in Sussex County from the standpoint of Public Health, I shall now try to stay on that subject.

Anyone who has travelled the rural highways of New Jersey knows well that we grow more than our fair share of poison ivy and ragweed. We could very well be famous for them were it not for the fact that we have already an overshadowing fame for mosquitoes. As regards Sussex County, however, we do not contribute much to our State's mosquito fame, and are determined that we shall no longer be in the position of contributing in any appreciable way to its potential fame in the matters of poison ivy and ragweed.

We have altogether too much natural beauty in our lakes and hills in Sussex County to permit to persist any such controllable ills; and since these plants are now most surely controllable we look upon it as a duty to control them.

I should like to say, too, that I would certainly avoid saying anything at all about the abundance of these plants throughout the State of New Jersey if I did not feel quite certain that our entire State will soon take hold of the problem in much the same way as has Sussex County. In fact, if I might burden you with an opinion in the matter, I believe, after witnessing at first hand the work in our County, that this process of destroying poison ivy and ragweed will spread rapidly throughout every State in our Union to the end that they will be eliminated along all highways and even other areas that are within the general public charge.

Taking a backward glance at t he problem, it seems most strange that we should only now be looking forward to the attack on these plants when in fact the chemical sword has been hanging in its sheath, well within our reach, for the past ten years.

We have known ragweed to be the cause of hay fever since 1854 --- a hundred years! Yet, for ten years we merely ponder the use of its virtual destroyer while at the same time we crusade to gather millions upon millions of dollars to be spent in study to learn just the causes of other ailments that do not affect nearly so many of our people.

Such study is good. But we might pause in the process of study and ask ourselves when we are going to stop being students and go to work. If the answer is, that in the public interest some must always be students and some always workmen, then we cannot escape the conclusion that those of us who are the workmen should most surely get about our jobs and finish them.

Actually, where there has been any slowing down in the process, it might well be attributed to neither the student nor the workman, but to that overcautious intermediary, the public official. The chemist has long ago completed his work and the contractor stands ready for his. All is in readiness; but the generals have not given the orders to proceed.

Indeed, when it comes to the application of these chemicals on roadsides and other public places, that is exactly the situation. The order is all that is needed. I believe there may still exist unfounded fears of wholesale destruction of desirable plants, ugly, scarred foliage and wide public resentment.

I assure you there need be none of these. Or, even if there were, there would still be great doubt that these plants should continue to increase year after year when there exists no other practical way of destroying them.

But, actually, these are idle words. For it has already been determined that one of the virtues of the program we are discussing is the beautification of our highways not their disfiguration. In the very first year ours were made so, and we look to ever-increasing beauty along their borders.

Of greater interest to you are the facts that our poison ivy is being gradually eliminated and that ragweed seems simply not to appear at all.

Perhaps no State has done so much in coordinated research into the problems of highway weeds as has New Jersey. A great amount of data is available in several pamphlets issued on the subject by our State Health Department at Trenton. The subject is quite adequately covered and nothing appears that does not in one way or another confirm the facts that I have expressed here. Accordingly, I repeat, we can surely expect statewide action in the manner of roadside spraying.

We are, of course, aware of a few lingering objectionists in the matter of chemical treatment of our roadsides; but their objections seem no longer to be honored as substantial or even valid.

One day during the summer, Mr. Leon McKeon, our Supervisor of Highways, who is really responsible for instituting the spraying program, received a phone call from one of our more mature citizens who insisted that Leon come out immediately to see him regarding "this spraying business". He refused to clarify the matter further, so it was natural for Mr. McKeon to assume he was about to run into his first bit of trouble with this new project. Upon arriving at the "scene of the crime", he was escorted up the road and invited to observe a very old and picturesque stone fence from which a great amount of foliage had obviously been chemically removed.

"See that old stone fence?", said the man.

"Yes," said Leon, waiting for the next blow.

"Remember when you saw it last?"

As Leon searched his troubled mind for an answer, his old friend relented and proceeded to point out that both of them had once admitted a fondness for the fence; that both had surely forgotten it was there, because neither had seen it in over twenty years for the solid mass of poison ivy on it, and that he just wanted to bring back old times and congratulate Leon on the fine job he was doing with the spraying of the County.

I relate that incident as typical of the acceptance of the program by our citizens. There has been a good deal of enthusiasm for the results obtained; and many of our municipalities are not planning local programs of the same general pattern.

On November 28, 1954, the New York Times carried an article reporting that Dr. Ross A. MacFarland of the Harvard School of Public Health viewed accident prevention on our highways as a vital part of preventive medicine that should be the subject of regular courses in all Public Health schools. "Health Officers", said Dr. MacFarland, "have to know how to carry out an active and aggressive safety campaign".

To Dr. MacFarland, and to all Health Officers, I recommend an expert highway spraying program as an immediately available starting point in any health or highway safety program. It will cure many ills at no cost. It makes safer and better highways and provides substantial bonuses to agriculture, conservation and health.

It may seem to you that I am perhaps over enthusiastic about this chemical attack on our roadside problems -- -- that I am perhaps oversold. But, if it be called to my attention that the moon is blue, and I see that it is, I must, when asked to report on it, say that indeed the moon is blue, though millions who have not looked at it say it must be orange.

WEED CONTROL IN MARSHES

John H. Steenis, Fish and Wildlife Service,
United States Department of the Interior

Marshes have commonly been regarded as wastelands by farmers, engineers, and industrialists. Actually, wetlands constitute a valuable natural resource that makes important contributions to the American standard of living. Besides the possible effects which extensive drainage may have upon ground water levels, drouth and dust bowl conditions, it must be remembered that destruction of marshes is a major threat to wildlife, such as ducks, geese, and muskrats.

In many places marshes, like farms, can be managed to yield profitable crops. In the State of Delaware where tidal marshes and fresh water tributaries comprise 8% of the total area, returns from muskrat trapping have averaged seven to nine dollars per acre on well-managed marshes and in some cases as much as fifty dollars (2). Hunting concessions in such areas provide additional sources of income. Because of the ever-increasing recreational demand for hunting, it is becoming essential that remaining marsh habitats be preserved and improved.

Objectives of Marsh Weed Control

Controlling marsh weeds can be important in improving marshlands for wildlife. Investigations on how to accomplish this involves two distinct steps: (1) finding how to control objectionable plants, and (2) learning how to apply control procedures for improving wildlife habitat.

Complexity of the Problem

In some respects, controlling marsh weeds is a more difficult and complex problem than destroying weeds on farm lands. Though some marsh weeds are annuals, most of them are perennials that require studies for each species to develop methods and materials for control. There is considerable variation among marsh weeds as to the stage of growth most vulnerable to control operations. In some species like arrow-arum (*Peltandra virginica*) and needlerush (*Juncus roemerianus*) this vulnerable period occurs during flowering and in others such as rosemallow (*Hibiscus* spp.) and cattail (*Typha* spp.), at time of early fruiting. Giant cutgrass (*Zizaniopsis miliacea*) is killed most easily during maximum runner growth, waterwillow (*Decodon verticillatus*) at the period of extensive leaf production, and most other woody species in late summer or early fall when in maximum foliage.

Vulnerability of marsh weeds differs not only with the species but also according to geography. In North Carolina, needlerush can be controlled successfully in April whereas in eastern Maryland, greatest susceptibility begins in the latter part of May or early June (1). About half again as much herbicide is required for control of needlerush in North Carolina as compared to Maryland, near the northern limits of the plant's range.

The duration of vulnerability is another variable, depending on the species. The ideal period for attack is considerably longer for some marsh weeds than others. For reeds (Phragmites communis), vulnerability is limited to two or three weeks, whereas for swamp willow, eight or nine weeks are available.

Variations in habitat also affect results of control procedure. For example, reeds can be controlled fairly readily by herbicides or mechanical means in non-flooded areas. However, when the plants are growing in water they are much more resistant to control. Giant cutgrass is just the opposite; treatments have been successful in flooded sites, but not where stranded. Similarly, suckers of green ash (Fraxinus lanceolata), persimmon (Diospyros virginiana), and sweet gum (Liquidamber styraciflua) have been killed by 2,4-D in flooded areas but not in terrestrial sites.

Several methods other than use of herbicides can be employed for controlling marsh vegetation. They include water-level management, mechanical control (cutting, disking, etc.), burning and combinations of these practices. Of these, adjustment of depth of water can be of considerable importance in promoting growth of desired plants and discouraging pest species. For example, flooding of mud flats at time of germination kills seedlings of reed (Phragmites communis), rosemallow (Hibiscus spp.), and swamp dock (Rumex verticillatus) providing they have not become established with an extensive root system. The more tolerant seedlings of duck food plants, such as Walter's millet (Echinochlos walteri), smartweeds (Polygonum spp.), fall panicum (Panicum dichotomiflorum), and tidemarsh waterhemp (Acnida cannabina) continue growth despite the changes in water level. In some instances, combination treatments can be successfully employed. Needlerush has been killed by burning or cutting when such practices are followed immediately by flooding (3). Cutting brush and flooding the cut stems yields good control. Spatterdock and pickerelweed have been controlled by double treatment involving 2,4-D at time of maximum flowering, followed four to six weeks later by an application of Ammate.

Plant control in marshes is complicated by the need to consider the role of so-called weeds in different situations. Often the objective of marsh management is to furnish a balanced combination of food and cover. Frequently, the so-called weeds contribute to this balance. In some places the aggressive growing reed or Phragmites is useful by giving protection to the marsh turf at time of severe storms and providing excellent cover for the hunted and the hunter. On the 1000-Acre Marsh in Delaware, Phragmites helps make this location one of the best duck hunting areas on the Atlantic Coast, but if the plant is not properly managed it could ruin this marsh. Complete elimination of pest plants is, therefore, not always desirable. In the case of a small local infestation by an aggressive weed, complete eradication should be carried out. Often, however, the purpose of control is to release valuable suppressed vegetation to replace weeds.

Experimental Procedure

In view of the complexity of applying plant control measures in marshes, it is necessary to accumulate local phenological data on both the weeds and associated species that are valuable to wildlife. Information is also needed on how the plants spread; that is, whether by runners, seeds or other means, and also how they react to changing water-levels and competition from other species.

Studies on Phragmites may serve as a good example of the nature of the problem involved in research on marsh weeds. This plant is one of importance not only to wildlife but also to industry. In the vicinity of New York, Phragmites is a serious fire hazard near oil storage tanks, refineries and other installations. In addition, railroad, telephone, and power companies have found it necessary to control this plant along right-of-ways. Accordingly much cooperation on Phragmites control research has been received from various industrial organizations.

Phragmites has been one of the more difficult plants to control. To date, over 300 plots have been treated with twenty-seven different herbicides being tried. In addition to experiments with herbicides, underwater cutting, crimping and combination treatments on dry sites, mowing, burning and disking have been employed. In the initial stages of the study, cutting (underwater where possible) and spray treatments with graded concentrations of herbicides were made at weekly intervals throughout the period of plant growth. These treatments were duplicated in dry, flooded and tidal sites. The vulnerable period for treating Phragmites was determined and procedures showing promise were tried on a more extensive basis. Recent studies have been made on an even larger scale with a small power spray unit that simulates commercial operations.

The results of these studies show that the period of vulnerability for Phragmites occurs during the flowering or pollination period and lasts for approximately three weeks. Within this period, mowing, burning, and then disking results in sufficient control on terrestrial sites to enable planting of row crops, such as corn in the following season. At this vulnerable stage underwater cutting yielded up to 100 percent control. However, at present, this is not a very practical method of killing Phragmites.

Of the herbicides used, the few that were effective are discussed below.

TCA: Treatments with this chemical have been made at different rates and also in mixtures with 2,4-D. The latter herbicide used alone on reeds yields an initial set-back but no permanent results. Since only slight effects have been noted from treatments with mixtures of TCA and 2,4-D, the more recent tests were made without 2,4-D.

TCA applied at the rate of approximately 120 pounds acid equivalent to an acre has yielded excellent control in terrestrial sites, but has not been effective in flooded or tidal areas, even when increased poundage was used. This seems to indicate that some ground sterilization takes place in dry sites, but in flooded areas the chemical dissolves and becomes too diluted to be effective.

CMU: This material has been found effective when it contacts or enters the plant roots. When applied at rates of 20 to 40 pounds (active) per acre, good results were attained in areas having saturated soils. Similar applications were not successful on dry or flooded sites. Combined disking and ground treatments with CMU were tried in 1954, but results from these experiments will not be available until next year.

Dalapon: Small pilot tests with Dalapon, made last season, indicate that of all herbicides used on *Phragmites* to date, this has shown the most promise. Effective control was noted in a terrestrial site from applications of over 25 pounds (acid equivalent) per acre, and some control was effected in flooded habitats at increased applications of 60 pounds or over per acre. However, in the latter sites effective control was obtained only on mature stands. Young growth from runners was set back but not completely killed. Because Dalapon has shown considerable promise, a series of tests were made in 1954 on 40th-acre plots in dry, tidal and flooded areas.

New Pilot Tests: In 1954 a series of 20 treatments were made, during the pollination period, with eight new herbicides. These new chemicals are the most promising ones from a series of more than 400 given preliminary screening by Dr. C. Warren Shaw of the Department of Agriculture. Results that become evident next season will indicate what further tests with them will be justified.

Acknowledgements

In conjunction with the investigations, the Dow Chemical Company, through Penn Line Service, Inc., has treated five quarter-acre plots along the Delaware and Chesapeake Canal with graded concentrations of TCA and Dalapon. In addition, the Dow and Dupont companies have cooperated by furnishing supplies of chemicals as well as by offering advice and participating in field inspections. Additional cooperators, making herbicides available for screening tests, include the American Chemical Paint Company, Heyden Chemical Corporation, American Cyanamid Company, U. S. Industrial Chemicals Company, W. A. Cleary Corporation, B. F. Goodrich Chemical Company, and General Chemical Division.

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Literature References

(1) Barber, Yates. Experimental control of *Juncus roemerianus* with herbicides in North Carolina. Mimeo. report. North Carolina Wildlife Resources Commission. 1952.

(2) Steenis, John H., Norman G. Wilder, Henry P. Cofer and Robert A. Beck. The marshes of Delaware, their improvement and preservation. Pittman-Robertson Bul. No. 2, Delaware Board of Game and Fish Commissioners. June 1954

(3) Wilson, Kenneth A., P. R. Quarterly Report on 6 R-F. 1951.

11/30/54

AQUATIC WEED CONTROL STUDIES IN NEW JERSEY

A PROGRESS REPORT

Robert K. Huckins[1]

INTRODUCTION

The New Jersey Division of Fish and Game has, during the past three years, undertaken a study of the possibilities of aquatic weed control in its lakes and ponds. This study has been undertaken with Federal Aid to Fish Restoration funds under the Dingell-Johnson Project Number F-1-R.

The aim of the project has been to evaluate known aquatic herbicides and to develop practical uses of new and, as yet untried materials.

Ideally, it had been hoped that an inexpensive aquatic herbicide could be found that would be nontoxic to fish and other aquatic life, harmless, or reasonably so, to Man so as to insure safety of application and, of course, effective as an herbicide to the extent that treatments could be limited to one application a season.

In aquatic weed control work, the plants are usually placed into one of the following three groups: Marsh and swamp, waters edge or emergent, and water proper or submersed. The project has dealt mainly with the latter group.

PROJECT DEVELOPMENT

The first year of the project was spent in evaluating the effects of a variety of known aquatic herbicides on submersed aquatics. The work was carried on in small ponds at the New Jersey State Fish Hatchery at Hackettstown.

On the basis of results so attained in these situations of small ponds and limited numbers of plant species, a state-wide testing program was inaugurated for the 1953 season. Some fifteen test ponds were selected covering the state from its southern-most pond at Cape May Point to a pond in the Stokes Forest, only a few miles from the New York-New Jersey and Pennsylvania borders.

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This testing covered a variety of physical and chemical situations and plant species. Many of these ponds had excessive growths of water milfoil, Myriophyllum sp., a plant which has proved to be resistant to all our control efforts. This past year has seen our work largely restricted to the attempted control of this aquatic which we have labeled, perhaps somewhat facetiously, Public Enemy No. 1.

SUMMARY OF RESULTS AND PROCEDURES OF FIELD TESTS

A. Submersed vegetation treatments

1. 2,4-D

Applications of Chipman 2,4-D, Ester 44%, were made on Anacharis Canadensis, at 10, 15, 20 and 25 ppm., Ranunculus trychophyllus, at 10 ppm, and Sparganum angustifolius, at 10, 15 and 20 ppm, and Najas flexilis at 15 ppm. The only plant controlled was the Ranunculus.

It is interesting to note that bluegill sunfish, Lepomis m. macrochirus, which were caged in the test plots died at all concentrations in three to four hours. Other fish present moved out of the treated area and were not harmed. These returned to the treated area within six hours or as soon as the 2,4-D emulsion had settled out. It is believed that the carrier and not the 2,4-D itself is responsible for this toxicity.

2. Telvar P. Pellets-3(p-chlorophenyl)-1,1-dimethylurea[2/]

In the initial hatchery pond testings four ponds each of about 6,250 square feet in area,(25'x250'x2') were used; three as test ponds and one as a control. All had a common source of water. The vegetation present included Anacharis canadensis, Potamogeton crispus, P. pusillus, Sparganum angustifolium, Najas flexilis and Sagittaris latifolia. The test ponds were completely treated at rates of 25, 50 and 100 lbs/surface acre - (4.6, 9.2 and 15.4 ppm) in late May and early June.

At 25 lbs/acre there was a kill of all but the P. crispus and the Anacharis. A high degree of control of these two plants resulted, however, and

2/ The Telvar P. used in the tests was a 25% active weight pellet. All concentrations mentioned are for the active weight of the ingredient.

what growth remained by late September had a density of 26 stems/square meter. At 50 lbs/acre all plants were killed. By late September there were some *Sparganium* and *Anacharis* seedlings evident at a very low density of less than 1/square meter. At 100 lbs/acre control was complete, and there was no new growth by late September. At this time the control pond had a mass of vegetation with a stem density of approximately 300 stems/square meter.

There was no flow of water through these ponds during the test period. Water levels were maintained at a constant depth.

Each of the ponds were stocked with 100 largemouth bass I's, 40 adult bluegill sunfish, and 30 fingerling northern brown bullheads at the start of the tests. No excessive mortality was noted. The bluegills, however, did not spawn in the test ponds but did in the control. This may probably be attributed to the low O_2 values which persisted below 3 ppm. for 28 to 40 days, due to plant decomposition.

In our statewide testing program and later in our concentrated efforts to control *Myriophyllum* we have restricted our testing to plots. Plot sizes have varied from 10'x25' to 50'x50', the latter being the usual size. With few exceptions the Telvar P. 25% pellet has been used.

The physical conditions of the waters so treated have varied from very soft, acid water to water of moderate hardness and fairly alkaline pH. To date we have been unable to attribute water quality as a limiting factor to Telvar P. effectiveness.

Table I lists those plants found to be reasonably susceptible to Telvar P. in standing water situations and the rates of application necessary for their control. No obvious differences were noted between the rate of application and the percent of control that was obtained during the first season.

TABLE I. Plants controlled with Telvar P. in plot tests

Plant	Number situations	Rates of application (active weight) (lbs/acre)	% control
Sparganium spp.	4	50, 75, 100, 125	95
Nuphar spp.	3	100	90
Pontederia cordata	2	50, 75, 100, 125	95
Decodon verticillatus	2	75, 100, 125	95
Potamogeton Robbinsii	2	75, 100	95
P. Vaseyi	1	75, 100	95
P. crispus	1	50, 75, 100	95
P. pusillus	1	75, 100	95
Anacharis canadensis	1	75, 100	95

Table II lists those plants found to be resistant to Telvar P. at the rates used in standing water situations and the range of the rates of application:

TABLE II. Plants resistant to Telvar P. in plot tests

Plant	Number situations	Rates of application (active weight) (lbs/acre)
Myriophyllum spp.	7	50, 100, 125
Potamogeton pectinatus	3	50, 75, 100
Cabomba caroliniana	2	50, 75, 100
Eleocharis acicularis f. inundata	3	75, 100
Brasenia Schreberi	2	75, 100
Vallisneria americana	1	75, 100

The depth of water in the plots listed above ranged from eighteen inches to five feet. Applications were made from mid-May through July.

3. Copper Sulphate ($CuSO_4$)

Realizing the potential phytotoxic properties of copper sulphate, an attempt was made to use this compound in such a way as to produce concentrations of copper sufficiently strong to kill the aquatic plants and at the same time not be toxic to fish life.

When copper sulphate is applied to a pond in the conventional manner employed by water supply people, (dragging the surface with bagged copper sulphate) the copper sulphate goes into solution at the surface level and sinks with a cloud-like effect to the bottom. When used in this manner it may be toxic to fish life. A technique of broadcast sowing of copper sulphate crystals over the water surface was developed. When thus applied the copper sulphate crystals sink rapidly to the pond bottom before any appreciable amount can go into solution. Upon the dissolution of the crystals two things happen: part of the free copper is bound up almost immediately by the bottom soils and some remains in solution close to the bottom. Its weight prevents it from mixing readily with the waters not closely adjacent to the bottom. Concentrations of 400 lbs/acre have been so applied to areas up to five acres at a time without harmful effects to fish life being noted. In all cases, not more than 8% of the total pond area was treated.

Most of the areas treated consisted of small plots of about 1/16 acre. (50'x50') The results shown in the following table are based on plot tests of this size:

TABLE III. Aquatic plants found susceptible to copper sulphate at the rates tested:

Plant	Number situations	Rates of application 3/ (Commodity weight) (lbs/acre)	% control
Anacharis canadensis	2	400	90
Potamogeton crispus	1	400,500	90
P. pusillus	2	300,500	90
P. Richardsonii	1	300	90
P. Vaseyi	1	400,500	90
P. natans	1	500	90
P. Robbinsii	1	400,500	90
Najas flexilis	1	500	90
Vallisneria americana	2	300,500	90

3/ These rates may possibly be reduced when larger areas are treated because of decreased dilution per plot area.

TABLE IV. Aquatic plants found resistant to copper sulphate at the rates tested

Plant	Number situations	Rates of application (commodity weight) (lbs/acre)
Myriophyllum spp.	7	300,2000
Sparganium spp.	4	300,500
Potamogeton pectinatus	3	300,500
Nuphar spp.	2	400,500
Cabomba caroliniana	3	400,500
Pontederia cordata	2	300,500
Eleocharis acicularis f. inundata	1	400,500
Brasenia Schreberi	1	400,500

The Water Milfoil has been treated unsuccessfully in plots up to one-half acre at rates of 2,000 lbs/acre. The amount of free copper in solution (up to 20 ppm. $CuSO_4$), at this rate would be definitely harmful to fish life if large areas were to be treated.

4. Delrad, Rosin Amine D Acetate

Delrad, a product of the Hercules Powder Company, was another of the materials used in an attempt to control *Myriophyllum*. A plot with this material was established at an active weight concentration of 12 ppm. Phytotoxic response from this application was negative, and there was a slight fish kill observed. It is felt that further testing should be undertaken as it may well be that other plant species are less resistant to this material than is the *Myriophyllum*.

5. Phygon XL

Phygon XL (2,3-dichloronaphthaquinone), a product of the Naugatuck Chemical Division of the U.S. Rubber Company, has been used this past season with somewhat favorable results. Plots of *Myriophyllum heterophyllum* were treated at commodity weight rates of 10, 15, 16, 32 and 40 lbs/acre. In all cases there was decided damage to the foliage and upper stem areas. The kill did not penetrate to the root level and subsequent observations found new sprout growths emerging from the root collar and from buds on the lower stems.

It is felt that further work with this material should be carried out another year. Perhaps spring or early summer treatment will be more effective when the plant growth is more vigorous.

B. Emergent vegetation treatments

While the principal objective of the project has been that of the control of submersed aquatics, some limited work has been undertaken attempting to control the Cattail, Typha latifolia.

1. Telvar P.

Eight plots, 10'x10' of Cattail were treated on May 28, 1952, with Telvar P., 25% pellets, four at 50 and four at 100 lbs/acre, active weight. The substrate was wet and marshy. After twelve days of no noticeable change, the tips of the leaves began to turn brown. This "dying" from the tip down continued rapidly for the next ten days, resulting in a 50% kill. From then until late September, the kill continued slowly and equally at both concentrations. By this time there was an 80% kill. These plots were located at the Hackettstown Hatchery. Expansion of the Hatchery made it necessary to bulldoze the plots, thus preventing any second-year observations.

2. Karmex W - 3-(p-chlorophenyl)-1,1-dimethylurea
and
Karmex DW - 3-(3,4-dichlorophenyl)-1,1-dimethylurea

Four plots of Smartweed, Polygonum hydropiperoides, were established in July of 1954. Two were treated with Karmex W at 24 and 48 lbs/acre, active weight, and two with Karmex DW at the same rates.

The Smartweed was growing in a dense mat along a shallow bank so that the roots and lower stems were well submerged, but the foliage fully emergent. The Karmex was mixed with water and applied with a hand pump to the foliage.

The treatment prevented flowering in all plants and by August there was considerable browning of the foliage in all plots. Observations made September 13th indicated various degrees of control. (Table V)

TABLE V. Percent control of Smartweed, *Polygonum hydropiperoides*

Material	Rate of application (lbs/acre) (active weight)	percent control
Karmex W	24	50
	48	75
Karmex DW	24	75
	48	95

4. Chipman Chlorax Liquid

Chlorax Liquid, a Sodium Chlorate-Metaborate compound manufactured by the Chipman Chemical Company, has been used with good results for the control of Cattail. Plots were established on August 6, 1953, as follows: Chlorax Liquid, at a rate of 2 pounds, active weight of material, (1 gallon) to 200 square feet of surface area; Chlorax Liquid, plus 0.02% MCP at 2 lbs/200 sq. feet; Chlorax Liquid, plus detergent at 2 lbs/200 sq. feet; Chlorax Liquid, plus detergent at 2 lbs/600 sq. feet; and Chlorax Liquid, plus 0.02% MCP at 2 lbs/800 sq. feet. Special care was taken to spray the entire stems of the plants.

At least 99% control resulted in all cases. The following year those plots treated at 2 lbs/200 sq. feet also showed complete control, while those treated at the lower rates came back fully. Those showing second year control were situated in both marsh and standing water locations. There was no measurable difference in the control that resulted from either the straight Chlorax Liquid or the

Chlorax Liquid plus MCP or detergent, and it is believed that these additives were present in such small amounts that their effects may be generally disregarded.

C. Drained situations

Certain types of herbicides are so water soluble that their use must be restricted to treatment of exposed weed beds. This project has done limited work using Chlorax Spray Powder, a Sodium Chlorate-Borate compound manufactured by the Chipman Chemical Company. Vegetation so treated has been limited to two species. *Potamogeton crispus* has been successfully controlled at rates as low as 2 lbs/100 square feet, (commodity weight). Results on *Anacharis canadensis*, while inconclusive, show promise.

More comprehensive work employing this technique is indicated. Many lake situations requiring weed control may readily lend themselves to at least partial drainage. This method would then by-pass nicely the problem of herbicidal dilution which is ever present when standing water situations are encountered.

COMPLEXING AGENTS AND CHELATED HEAVY METALS AS POSSIBLE AQUATIC HERBICIDES

As a result of the studies with copper sulphate, the possibility of employing other heavy metals as aquatic weed control agents was investigated. At the same time the potential use of chelated forms of heavy metals was considered. It was reasoned that small amounts of the more soluble chelated forms of these metals would be more readily absorbed by the plant tissues to an extent that minor element antagonism or, possibly, protein hydrolysis would occur. The testing of these theories was conducted in aquaria in the laboratory.

The complexing agent and chelated metals used in these tests are the products of the Bersworth Chemical Company and are known commercially as Versenes. Tested were the Disodium Versenate, Zinc Disodium Versenate, Copper Disodium Versenate and Versene Acid. The plants so treated included *Anacharis densa*, *Myriophyllum heterophyllum* and *Cabomba caroliniana*. Results of these tests showed that at least 500 ppm, (commodity weights) would be needed to five satisfactory results. The materials used are acid to the extent that pH values of below 3.8 were generally recorded at the concentrations that gave satisfactory phytotoxic results. Incidentally, tests using acetic acid to give comparable low pH values gave the same herbicidal results. On the basis of these experiments no practical field value for these compounds was indicated.

PROBLEMS IN TESTING POTENTIAL AQUATIC WEED CONTROL AGENTS

1. Aquaria testing

Aquaria represent a total situation of definite limitations. Field testing is generally restricted to small areas within the total situation and in a much more complex media. Because of these differences caution should be exercised when applying results of aquaria tests to general field situations. At best, such tests give a bare minimum indication of what will transpire in the field.

Most of the compounds discussed in this paper have been tested in the laboratory for phytotoxic and zootoxic properties. The aquaria used were of 2 gallon capacity. Each had a bottom covering of washed aquaria sand. It was found necessary to illuminate the aquaria with a 25 watt frosted bulb. Greater intensities of light produced algae growths which interfered with the experiments. The aquaria were generally aerated lightly.

2. Field testing

Ponds and lakes may be considered much the same as fingerprints - there are no two alike. The various factors that make up the chemical composition of dissolved matter in water varies infinitely, depending principally on the chemical composition and soil type of the basin and on the watershed. Consequently, what may work in one situation may be a complete failure in another. For this reason as many field situations as possible must be tested. For example, it may be of interest to note some of the absorptive effects of various bottom types on copper sulphate. (Table VI) These checks were made in glass hatching jars using spring water that has a pH of about 7.0 and a total carbonate hardness of 175 ppm. It is easily seen that the phytotoxic properties of this compound were greatly altered and, in some cases, rendered ineffective as an herbicide or algacide. A similar effect is indicated when using water from various sources. (Table VII)

TABLE VI Absorption of Copper Sulphate by different soils and plants as shown by amounts of measurable $CuSO_4$ remaining in solution

	ppm. $CuSO_4$		
Time:	3 hours	3 days	4 days
Control	2.4	2.4	2.4
Clay	2.4	2.0	2.0
Shale	2.0	0.4	0.1
Sand	2.4	1.4	0.5
Muck	2.0	0.3	0.1
Anacharis canadensis	2.0	1.0	0.3
Potamogeton crispus	2.4	1.0	no test

TABLE VII. Effects of different waters on equal amounts of copper sulphate

Water source	Hardness as $CaCO_3$ (ppm)	pH	Temp. F.	Units of $CuSO_4$ added	$CuSO_4$ ppm.
Old distilled	4	5.2	52	3 5	1.2 2.0
Old distilled, plus NH_4OH	4	8.6	52	3 5	1.2 2.0
Rain water	2.7	6.4	57	3	1.2
Tap (town)	28	7.0	60	3	1.0
Bear Pond	35	6.4	46	3	1.0
Lake Hopatcong	28	6.9	28	3	1.0
Spring	175	7.2	50	3 5	0.8 1.6

Such interactions within the aquatic ecosystem may be of prime consideration in many situations and can well explain why a given compound which is effective in one lake and useless in another. For instance, in one lake, a sodium arsenite treatment of 10 ppm. proved ineffective because of the precipitation reaction with ferrous iron, present in solution at a concentration of about 40 ppm. Such interrelated factors are not well understood or as yet identified, and may vary seasonally.

An infinite variety of physical factors may also be encountered that can influence the degree of effectiveness of certain herbicides. Water flow and the rate of water exchange in standing water must certainly be a consideration. Currents set in motion by inlet and/or outlet streams, springs, surface runoff and wind action may cause excessive dilutions. Such factors may well limit the size of any area that can be treated successfully. The work in Wisconsin (Mackenthun, 1950) using sodium arsenite at different concentrations under different degrees of treated area exposure is a good example of how such factors may effect the results of any treatment.

We have often wondered what size test plot would be ideal. Apparently physical factors may have a direct bearing here. For example, the amount of copper sulphate in solution in two different size plots in the same pond after equal treatment with copper sulphate crystals (Table VIII) may be cited.

TABLE VIII Amount of $CuSO_4$ in solution during a 96 hour period above two plots treated in the same manner

	Plot A			Plot B		
Size	150'x150'			25'x25'		
Rate	2,000 lbs/acre (commodity weight)			2,000 lbs/acre		
Depth of sample	6 ft.			6 ft.		
Hours after treatment	24	48	96	24	48	96
Concentration of $CuSO_4$ in solution (ppm)	20.0	2.0	0.4	0.3	0.1	trace

These considerations are only a few of the many that will have to be fully explored and worked out before any concrete rules for adequate plot size may be laid down. In all probability the nature of the herbicide will be as important a consideration as the physical, chemical and biological characteristics of the area to be treated, and the techniques will vary accordingly.

Certainly not the least of the factors to be considered is the inherent differences of any given plant species to a given concentration of herbicide. For example, CMU, at a rate of 400 lbs/acre, active weight, is apparently not toxic to Vallisneria americana, whereas Potamogeton crispus is controlled by an application of less than 100 lbs/acre. Seasonal differences of growth and plant conditions may affect the results of treatment. Knowledge of aquatic plant physiology is generally lacking, making it rather difficult to spot the potential weakness of the plants.

Even the evaluation of results poses unique problems. One cannot as readily count stems accurately in six feet of water as one can on his hands and knees on terrestrial test plots. Aquatic plants are continually breaking off under natural situations, and may lodge in a test plot, thus further confusing the issue. The problem of visibility is often great, especially where water "blooms" occur. Wind, waves and cloudy days are a hindrance.

THE PLACE OF INDUSTRY AND UNIVERSITY IN AQUATIC WEED CONTROL WORK TO-DAY

The chemical industry, as shown by their ever increasing cooperation with field testing agencies, is becoming more and more aware of the problem of aquatic weed control. It should be their function to develop new herbicides, or to modify present herbicides, to meet the requirements set forth at the beginning of this discussion.

The University is the logical place to conduct life history and physiological studies of aquatic plants. Such work is seriously needed. The University should also do "aquaria screening" of potential herbicides and industry could aid this program by the establishment of research fellowships.

THE ROLE OF STATE AGENCIES

In general, state health departments and fish and game agencies are the logical ones to field test potential aquatic herbicides. States have health and/or fish and game laws regulating the kinds and quantity of chemicals that may be introduced into public waters. Such materials, as a rule, must be harmless to humans and livestock, and non toxic, to fish and other aquatic life. In order to eliminate the possibilities of legal complications most industries have found it generally advisable to have their products field tested by state or federal agencies, or at least under the supervision of personnel from agencies that may have a direct interest in the matter.

CONCLUSIONS

The problem of controlling aquatic vegetation has attained major proportions in many sections of the country. It has become the concern of groups with many varied interests; for not only is it important from a recreational point of view, but it is a major consideration with water supply and health agencies, industry, farmers and real estate interests in suburban areas. One need only consider the expense involved and extreme measures taken in an attempt to alleviate this problem in certain areas to realize that the problem is, at times, an acute one.

The fact remains, however, that the problem is far from solved. Much yet remains in the research and development phase before those who are plagued with the problem can hope to find permanent relief.

Even when completely satisfactory measures for aquatic weed control are developed it is very likely that they will be expensive. This means, for the most part, that the cost of such work will have to be borne by private or municipal agencies, for, without additional legislative appropriations, very few state agencies are presently able to finance any extensive weed control program on the management level.

Even though the state may not enter into much management work it will be necessary for certain controls and restrictions to be adopted. This will very likely mean that most weed control work will be undertaken by qualified commercial operators who will be licensed by the state. Not only will this insure adequate protection to the state's public waters but it will also protect the public from "fly by night" operators out for a fast buck and who, even now, are cropping up.

SUMMARY

1. A three year study on the effects of a variety of chemicals as aquatic weed control agents has yet to yield any definite management recommendations for the general control of submersed aquatics.

2. The use of Chipman's Chlorax Liquid for the control of Cattail, Typha latifolia, was found to be effective.

3. Aquaria testing of potential herbicides has proven to be of limited value insofar as field testing application is concerned.

4. The intricacies of, and variations in, aquatic plot testing leave many important questions unanswered which calls for further experimentation and study.

5. Industry and University can contribute materially to future aquatic weed control studies by the development of new herbicides and the expansion of life history and plant physiological studies.

6. Developmental studies on weed control chemicals and techniques should be undertaken by and/or with state and federal agencies.

7. While the advent of commercial operators will undoubtedly follow the successful development of aquatic herbicides state regulation will be necessary to control these activities for reasons of conservation and health.

8. Unless additional public funds are made available for this work, few state agencies will be able to carry the financial burden of aquatic weed management. For the most part private or municipal funds will have to support these activities.

ACKNOWLEDGMENTS

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SELECTED BIBLIOGRAPHY

Crafts, Alden S. 1949	Control of aquatic and ditchbank weeds. Calif. Agri. Extens. Serv. Coll. of Agri. University of California, Berkley, Circular #158.
Fassett, Norman C. 1940	A manual of aquatic plants. McGraw Hill Co. Inc. New York.
Mackenthun, Kenneth M. 1950	Aquatic weed control with sodium arsenite, sewage and industrial wastes. Vol. 22, No. 8. August, 1950.
Speirs, J. Murray 1948	Summary of literature on aquatic weed control. Reprint: Canadian Fish Culturist, 3:(4):20-32, August, 1948.
Surber, Eugene W. 1949	Control of aquatic plants in ponds and lakes, U.S.D.I. Fishery Leaflet #344, July, 1949, Washington, D.C.

THE EFFECT OF HERBICIDES

ON A SERIES OF AQUATIC PLANTS

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Although considerable literature is available on herbicidal treatments of aquatic plants in the field, little is known of the specific effects of a herbicide on any one species. The aim of this study has been to determine these specific effects on a series of aquatic plants. As aquatics vary considerably in their general morphology, a series was chosen to cover as wide a range of forms as possible. The plants included forms with floating leaves; those with submerged leaves; and those with completely dissected leaves. Some of the species had roots and root hairs; some roots but no root hairs; some water roots; some no roots at all and some only rhizoids.

The herbicides selected included organic and inorganic contact and translocated compounds, two of which have been used successfully against aquatics in field trials.

The objects have been to determine

1) dosage/response effects, up to a lethal concentration of the herbicide, on external and internal parts of the plants;

2) differential effects on the different plants;

3) points of entry of the herbicide;

4) if translocation takes place in plants having the reduced vascular systems, characteristic of aquatic plants;

5) whether the herbicides accumulate in any region of the plant; and

6) what percentage of a herbicide remains in the water after the death of the plants, and how much is present in the soil.

METHODS OF INVESTIGATION

Characteristics of the six species used are given in Table 1. For the most part the plants were collected from local waters in Dutchess County, the rest being purchased from a commercial supply house.

The three herbicides selected were sodium arsenite, ammonium thiocyanate and 2,4-D. These three compounds cover all types of herbicidal action and represent both inorganic and organic substances.

Table 1
Anatomical Features of Plants Used in Dosage / Response Trials

Plant	Leaf	Xylem	Stem	Xylem	Root	Xylem
Monocotyledons						
Elodea canadensis	Submerged Small	1 or 2 vessels	Elongated	Lacuna	Fibrous roots with root hairs-Adventitious water roots	Lacuna
Lemna minor	Floating	Undifferentiated	None	---	Adventitious water roots	None
Dicotyledons						
Nymphaea odorata	Floating Long peticle	Several vessels Lacunae	Rhizome	Several vessels	Adventitious roots with few root hairs	Several vessels
Myriophyllum verticillatum	Submerged Dissected	Several vessels	Elongated	Several vessels	Fibrous roots No root hairs	Lacunae 1 or 2 vessels in young roots.
Ceratophyllum demersum	Submerged Dissected	None	Elongated	1 or 2 vessels	None	-----
Algae						
Chara sp.	Cylindrical whorled branches				Rhizoids	

Table II. MODE OF ACTION OF HERBICIDES ON TERRESTRIAL PLANTS

Herbicide	Contact		Translocated	Soil Sterilization	
	Non-selective	Selective		Temporary	Permanent
Sodium arsenite	+		+		+
Ammonium thiocyanate		+	*	+	
2,4-D		+	+	+	

Of the three, two (sodium arsenite and 2,4-D) have been used extensively in attempts to control aquatic vegetation.

Elodea, Myriophyllum, Ceratophyllum, Lemna, Chara and Nymphaea were transplanted during October into stone crocks and galvanized tubs in the greenhouse (Slide I). All rooting types were rooted in soil to insure favorable growth conditions and good development of root systems. During the months of November, December and January, the plants were kept under continuous illumination. This, while encouraging the growth of these aquatics, also encouraged the growth of algae. The resulting algal growth was kept under partial control by administering a o.02% copper sulphate solution at frequent intervals; by renewing the water in the crocks and by the use of a filter pump. When added illumination seemed no longer necessary, the algal growths gradually disappeared.

With the exception of Nymphaea and Chara, equal quantities of each plant were placed in each of ten crocks. In February, each herbicide (sodium arsenite, ammonium thiocyanate and 2,4-D) was administered in a range of three concentrations (three crocks at each level), the last concentration being a lethal dose. The tenth crock was kept as a control.

Rhizomes of Nymphaea were planted in each of four galvanized tubs. The herbicides were initially added at a concentration of 10 p.p.m. This did not prove to be a lethal dose with sodium arsenite and ammonium thiocyanate. Accordingly, the concentration was increased over a period of time. Similarly, a cluster of Chara, was placed in each of four crocks and the herbicides administered as with Nymphaea. Again concentrations were increased in an effort to attain a lethal dosage.

In all cases observations were made over a period of six weeks.

It became apparent that an increase in algal growth resulted after the application of certain concentrations of herbicides. In order to determine whether this was due to the breakdown of the plants or to the herbicides themselves, a check trial was run. This consisted of four crocks inoculated with the algae. Glass wool was suspended in each crock to provide a "support" for their growth. Three crocks were then treated with the herbicides and the fourth left as a control.

Elodea and Myriophyllum were used in an attempt to discover main regions of entry and possible translocation paths of the herbicides. Plants were rooted in soil in one container and their shoots allowed to trail over into another. Roots and the lower stems were treated in one pair, the shoots in another (Slide II). Sodium arsenite and 2,4-D were both used. The plants were kept in a humid chamber throughout the experimental period.

After the death of Myriophyllum and Elodea plants, following an application of 10 p.p.m. of sodium arsenite, chemical analyses were done on the water and the soil. The analyses were carried out for arsenite, in an attempt to determine how much of the herbicide remained in the water and how much in the soil. Methods for the analyses followed those given by Polyakov and Kolokolov (1) and described by Scott (2).

EXPERIMENTAL RESULTS

It has been mentioned that algal growth appeared to increase following applications of herbicides. Results of tests to see whether this was due to the actual herbicide are given in the following table.

Table 3

Effects of Herbicides on Algal Growth

Time after treatment in days	10 p.p.m. Sodium arsenite	25 p.p.m. Ammonium thiocyanate	10 p.p.m. 2,4-D	Control
0	1	1	1	1
2	1	3	2	3
4	2	4	3	5
9	3	5	4	6
11	4	7	5	7
13	5	8	6	7
18	6	9	7	8
23	8	10	7	8
28	Algae brown, dying	12	8	8

(Estimated Growth of Algae: 1-12 Scale)

Only the ammonium thiocyanate appeared to favor the growth of algae, and that only after a period of two weeks. The algae taken from the crocks included Ulothrix, Stigeoclonum, Chaetophora, Oedogonium, Hydrodictyon, Chlorella, Scenedesmus, Zygnema and some unidentified genera.

A summary of the effects of the herbicides used in the dosage/response trials are given as follows:

Sodium arsenite

This compound was the most effective herbicide against the plants chosen. 10 ppm proved to be a lethal dose for Elodea canadensis after 13 days, and for Myriophyllum verticillatum and Ceratophyllum demersum after 10 days. 50 ppm was partially effective against Nymphaea odorata after 42 days, while 100 ppm killed Lemna minor after 14 days. Chara sp., however, was uninjured when treated with sodium arsenite.

Elodea canadensis became chlorotic with brown areas on the leaves (Sl.111, fig.8). The stems often fragmented. At sublethal concentrations stem bases were blackened but were still able to produce laterals (Sl.IV). When viewed microscopically, the root meristematic region appeared brown. Root hairs were unaffected. Leaves were more heavily damaged than stems. Cells became chlorotic and plasmolyzed, while the cell walls, especially those of the epidermis and air chambers, became brown (Sl.V, figs.1,3,4). No translocation or accumulation of sodium arsenite seemed to occur.

Lemna minor leaves became chlorotic, and the roots black. Vegetative reproduction was inhibited.

Areas of tissue on leaves of Nymphaea odorata became blackened. The lower epidermis and the conducting tissues, including the lacunar walls of the petiole, appeared brown (Sl.VI, figs.13,14). Starch reserves in the rhizome were exhausted. Only epidermal hairs in the rhizome and epidermal cells in the root appeared brown. Downward translocation of the compound took place.

Brown spots appeared on the stems of Myriophyllum verticillatum. The leaves became brown and finally disintegrated. Stems sometimes fragmented and the undergrowth was usually black. Plasmolysis and browning of cells occurred first under the epidermis and finally spread to the rest of the tissues, including the xylem (Sl.VII, figs.16,17,18, 20). Upward translocation of the compound appeared to take place. Injurious effects spreading down through the plant were apparently due to absorption if the compound onto the epidermis and walls of the air chambers.

Sodium arsenite with Ceratophyllum demersum caused fragmenting of stems, chlorosis and finally blackening of the stems and leaves (Sl.VIII,figs.22,23). Browing occurred first in the epidermal cells and then spread inward (Sl.V111,fig.21).

No injurious effects were produced with Chara sp.

Sodium arsenite appeared to be an efficient contact killer on leaf cells where there was virtually no cutin. Maximum absorption seemed to take place near the soil level with both E. canadensis and M. verticillatum. It was translocated only in those plants containing xylem vessels. The compound appeared to be absorbed onto free surfaces such as the cuticle and epidermal walls of stems and the walls of air chambers and xylem lucunae. It proved to be lethal to both Monocotyledons and Dicotyledons but was more effective against plants with submerged leaves than those with floating leaves.

Ammonium thiocyanate

Relatively unsatisfactory results were obtained with the concentrations used. 100 ppm proved to be lethal with E. canadensis after 21 days. M. verticillatum after 28 days, and Chara sp. after 18 days. It was obvious that the compound broke down after a period of about two weeks, rendering available increased amounts of nitrogen. This was evidenced by the bright green leaves of N. odorata and the rich algal growth following applications of the compound. When used against E. canadensis, root hairs as well as stem bases and roots became brown. The plants became chlorotic, brown, leaves were shattered and the stems fragmented at the base. No injury occurred in meristematic regions. Similar to the effects produced by sodium arsenite, cells became plasmolyxed, and walls became brown, with the injuries spreading inward from the epidermis. Sometimes cells exhibited a very prominent nucleus (Sl.IX, figs.5,6).

Some but not all L. minor plants became chlorotic and brown when treated with 100 ppm of the compound. Vegetative reproduction was inhibited. Cells at the region of root origin in the leaf most often showed browning.

N. odorata leaves initially showed blackened edges, especially at the apical notch after treatment with 100 ppm of ammonium thiocyanate. Upper epidermal cells appeared to be the only ones injured, "burnt" areas of tissue appearing on the leaves. Little damage occurred in the rhizome.

No injury to meristematic cells was found in M. verticillatum. Epidermal cells became plasmolyzed and brown, followed by internal tissues. Nodal cells were more severely damaged than other cells of the stem.

Only epidermal cells at the nodes became brown in C. demersum stems after an application of 100 ppm. Leaves became brown, some disintegrating from the stem, which fragmented. Shoot tip fragments, however, were capable of recovery.

Filaments of Chara sp. became chlorotic and plasmolyzed.

Ammonium thiocyanate appeared to act as a contact killer against those plants with submerged leaves or filaments, which were rooted in the soil. No differential effects were observed between Monocotyledons and Dicotyledons. Cellular effects were similar to those produced by sodium arsenite, namely, browning of cell walls and plasmolysis followed by browning of cell contents. Like sodium arsenite, maximum absorption appeared to take place near the soil. It is doubtful that translocation of the compound took place.

2,4-D

This compound was lethal at 5 ppm after 42 days, and at 10 ppm after 10 days against M. verticillatum. Against C. demersum it was lethal at 5 ppm after 14 days, and at 10 ppm after 11 days. It would be lethal at 10 ppm against N. odorata if reapplied at intervals until the reserve foods in the rhizome were completely exhausted. It appeared to have slight effects against Chara sp. at 100 ppm after 20 days. Against E. canadensis it was ineffective at 25 or even 50 ppm after 56 days, and against L. minor was ineffective at 100 ppm for 20 days.

E. canadensis plants were killed but new laterals were always produced. Plants became chlorotic and epinastic, basal growth became brown and the stems fragmented. The stem meristem became brown but the root meristem did not. As with the other herbicides, cell walls became brown and the contents plasmolyzed. (Sl.X, fig.2). However, an initial increase in the rate of cyclosis was observed following absorption of the 2,4-D. At low concentrations, prolific root hair development occurred. Slight upward translocation appeared to take place as seen by stimulation of flowering and possible accumulation of the compound in the meristem.

L. minor leaves became chlorotic, epinastic and brown. Epidermal cells of the root cap became brown. A proliferation of tissue appeared to occur in the root tip and in the conducting tissue of the leaf (Slide XI, Figs.10, 12). Vegetative reproduction was slowed down but not totally inhibited.

With N. odorata, leaves became brown, the browning spreading to and down the petioles. Petioles were first yellow and epinastic. In the leaf, the palisade tissue, lower epidermis and vascular tissue became brown. Downward translocation appeared to occur in the petiole and upward translocation from the rhizome to embryonic shoots. Absorption and translocation also appeared to take place in the roots (Slide XII, Fig.15).

When used against M. verticillatum, prompt and drastic effects occurred. Black spots appeared on stems which became epinastic. Basal growth became brown, followed by a general browning of leaves and stems. Cells became plasmolyzed and brown, the browning extending inward from the epidermis to the xylem (Slide XIII, Fig.19). At low concentrations, prolific development of branch roots occurred. Upward translocation of 2,4-D took place and also, apparently, a slight amount downward.

Similar cellular effects were produced in Ceratophyllum demersum. The central stele was brown and a greater degree of injury occurred in the apical cells of leaves, suggesting a possible area of accumulation, although no browning was observed in the meristem (Slide XIV, Fig.24). Plants became slightly epinastic, chlorotic, brown and finally fragmented.

Chara sp. became brown due to the browning of the mucilage covering the filaments. Branch filaments became plasmolyzed and chlorotic, but cytoplasmic streaming was still active in many cells.

2,4-D was most effective as a contact and translocated herbicide against the Dicotyledons. Its value against the Monocotyledons and algae appeared to be slight. When used in sublethal concentrations, it stimulated growth. Cellular effects such as browning of cell walls, plasmolysis and browning of cell contents were the same as with the other two compounds. Differences were observed in the effects on cyclosis, proliferation of various tissues and the occurrences of epinasty.

Chemical Analyses

From the results of the limited chemical analyses (see Table IV) it appears that plants rooted in soil take up a considerable proportion of the sodium arsenite.

Table IV. Chemical Analyses

	Sodium arsenite in p.p.m.	
	Water	Soil
E. canadensis	3.0 p.p.m.	0.5 p.p.m.
M. verticillatum	3.0 p.p.m.	Trace

In both cases, approximately 3 p.p.m. of the compound remained in the water after the removal of the plants. At sub-lethal dosages of sodium arsenite, the low percentage in the soil could well account for the ability of E. candensis to produce laterals at the soil level.

DISCUSSION

In all cases of herbicidal treatment a relationship was noticed between the breakdown of plant tissues and the growth of algae. Initially, the normal population of epiphytic algae facilitated the entrance of the herbicide into the host plant. It is assumed that the wall area to which algal filaments were attached was weakened, allowing a quick penetration of the herbicide. Once absorbed, the herbicide affected the cell walls first, presumably by altering their composition. Algal threads were then able to ramify along these lines of weakness and finally penetrate the cells. Final penetration, however, was not possible until the cells had been materially affected by the herbicide. As endophytic algae established themselves, breakdown of the plant proceeded at a rapid rate with an accompanying increase in algal growth. (Slide XV., Figs.5, 7,8).

It would be of interest to determine which species of algae are important in hastening the breakdown of the plants and which species are killed by an herbicide.

Cellular effects produced by each of the three herbicides were the same. The cell walls were broken down, followed by plasmolysis and chlorosis of the cell contents. However, the plant species killed by each herbicide varied.

Sodium arsenite, which is both a contact and translocated herbicide against terrestrial plants, was only translocated in those aquatics with xylem vessels. It was a more effective contact killer against plants with submerged leaves than those with floating leaves. Ammonium thiocyanate, which is a contact terrestrial herbicide, was also most effective against submerged plants, and those plants which were rooted in the soil. Maximum absorption of both these inorganic compounds took place near the soil level. The fact that some aquatic plants appear to absorb sodium arsenite near the soil level differs from the recorded results for terrestrial plants, where it is believed the arsenic is transported through the stems to the roots causing their death. (Wilson (3)). Both compounds were effective against Monocotyledons and Dicotyledons.

The organic compoun 2,4-D, which is both a contact and translocated herbicide against terrestrial plants, and more effective against Dicotyledons, gave similar results against aquatics. However, at sublethal concentrations, especially when applied to Monocotyledons, it produced stimulatory effects. Invigorated plant growth following such sublethal dosages of 2, 4-D may be a considerable problem. Consequently, the effective use of 2,4-D for the control of aquatic plants appears to be limited.

It is of interest that the herbicides were commonly adsorbed onto the free wall surfaces of the epidermis, the air chambers and the Xylem lacunae. The fact that adsorption was able to take place on the walls of the air chambers suggests that diffusion of the compounds through the plant may take place in these chambers. Diffusion presumably took place from the epidermis through the cortex into the chambers, where the herbicide accumulated, finally causing injury to the cell walls.

The series of plants chosen for their varying morphology did not seem to vary in susceptability to herbicidal effects as much as might be expected. Differences in root anatomy could not be correlated with differences in herbicidal action, except in the case of ammonium thiocyanate which was more effective against plants with absorbing organs in the soil. Submerged leaves having little cutin and very reduced tissues were quickly affected by the herbicide in contrast to the stems or floating leaves with more cutin and more complex anatomy. The one exception to this was Nymphaea odorata which, though having a succulent floating leaf, was rapidly affected by 2,4-D.

Lastly, the tremendous regenerative power of aquatic plants must be considered. Unless a complete kill can be obtained in a relatively short time by a given herbicide, the plants will vegetatively reproduce and render any application useless. It might be of value to determine those concentrations of herbicides which are necessary to prevent any such regeneration rather than those concentrations necessary for an initial kill.

CONCLUSIONS

From the experimental results obtained the following conclusions may be drawn:

1) Breakdown of plant materials following applications of toxic compounds is partly due to the herbicides and partly due to the growth of algae.

2) Sodium arsenite and 2,4-D proved relatively satisfactory herbicides at a concentration of 10 p.p.m. Sodium arsenite was effective against Elodes canadensis, Myriophyllum verticillatum and Ceratophyllum demersum.
   2,4-D was effective against Myriophyllum verticillatum, Ceratophyllum demersum and Nymphaea odorata.
   Ammonium thiocyanate was ineffective at concentrations up to and including 100 p.p.m.

3) The regenerative power of aquatic plants renders many applications of herbicides useless.

4) Penetration of herbicides into plant tissue breaks down the cell wall and causes plasmolysis and chlorosis of the cell contents.

5) Translocation of inorganic compounds such as sodium arsenite takes place only in xylem vessels.

6) Translocation of 2,4-D takes place only in Dicotyledons.

7) Downward translocation of the herbicides may be due to adsorption of the herbicides onto free wall surfaces.

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REFERENCES

(1) POLYAKOV, A and KOLOKOLOV, N. (1929). Method for the Colorimetric Determination of Arsenic. Biochem, Z. 213: 375-379.

(2) SCOTT, W.W. (1939). Standard Methods of Chemical Analysis. Vol.I (116). Fifth Edition. New York: D. Van Nostrand.

(3) WILSON, H.F. (1944). Control of Noxious Weeds. Bot.Rev. 10: 279-326.

THE CONTROL OF SUBMERGENT AQUATIC VEGETATION THROUGH THE USE OF SODIUM ARSENITE

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Introduction

Man derives some of his greatest recreational pleasures from an association with water. Recreation has become an essential part of our way of life, and water areas as a part of the recreational concept have a special appeal to man. Fishing, swimming, boating, competitive water sports, camping, picnicking, nature study, hiking, and pleasure driving are either dependent directly upon water or are much enhanced when they can be pursued in the vicinity of clean water. To foster these recreational pursuits, stream sanitation activities have been developed to keep natural waters from becoming a public liability. Purity of water, along with freedom from nuisance-creating substances and offensive aquatic growths, is being recognized as an important asset especially in areas extensively used for recreational purposes.

Wise use of natural waters is developed to a large extent through the installation of wise management practices. The latter can only be based upon the concept of total management of water which encompasses all legitimate uses of inland waters. Total water management is an attempt to manipulate all of those chemical, biological, and physical factors which lend themselves to human control so as to secure the maximum legitimate utilization of the water for the benefit of the greatest number of people, thus water management must include not only recreational hunting and recreation and commercial fishing, but also the conservation of aquatic areas of natural beauty which lend themselves to the relaxation of man. Management must begin with an evaluation of the use to which a given body of water is put, and must foster, develop, expand, and improve those uses to meet the increased demands of civilization. The ultimate goal of wise aquatic management is never achieved; it does, however, aspire to the greatest and most diversified utilization to which a given water is suited.

Along with the increased general interest in weed control in recreational areas, there is developing a changing philosophy regarding the use of chemicals to control these aquatic plants. Fish management men and well informed sportsmen are becoming concerned over the correlation of poor fishing and prolific growths of submergent aquatic vegetation in small lake areas. For several years, general observ ons have indicated that fishing has become poor in lakes which have big weed populations. Stunting of the pan-fish population exists and the catch of the larger species has been poor because of poor fishing conditions. Many people are becoming increasingly aware of this general philosophy of the possibility of chemical weed control as a fish management tool. Weed control is now being recommended by fisheries' biologists as a means of improving fishing within localized areas.

The concentration of a greater population density upon the shores of inland waters has created new problems in the concept of aquatic management. Through pollution, siltation, and the inflow of nutrients from surface runoff, increased water use and increased water fertility have, in some instances, created severe nuisances which are due to excessive weed and algae growths in water. Although nuisances occur in many different types of aquatic environment, they most commonly occur in lakes or stagnant water areas. Such nuisances may eliminate almost all recreational uses of a lake, create disagreeable odors and appearances, lower property valuations, and kill fish or jeopardize fish populations.

One could hardly deny that aquatic nuisances which affect the health and welfare of fellow man should be controlled. Such controls would logically fall into the concept of wise total management of water, and should be approached with a definite goal based upon the overall effect on the body of water in question.

History of Wisconsin's Weed Control Program

A solution of sodium arsenite has been used for many years in aquatic weed control. In Wisconsin, Domogalla (1929) reports the use of sodium arsenite for the control of weeds in the Madison Lakes in 1926. This is the first indication that sodium arsenite had been used for the control of a nuisance and the enhancement of the recreational value of an area. Surber (1929) was the first to adopt this means of control in fish management work, stating that preliminary experiments with sodium arsenite during the summer of 1929 indicated that this chemical may be used effectively at low cost in controlling submerged aquatic plants without doing apparent injury to either large or small fish, and without exterminating or seriously diminishing the supply of natural fish food.

During 1938, a controversy arose between sportsmen and property owners over the chemical treatment of a particular lake. Following this controversy, an executive order established a committee to review the problem of algae and weed control in streams and other bodies of water within the state. This inter-departmental committee is still in existence and consists of the State Sanitary Engineer of the State Board of Health, the Chief Chemist of the State Laboratory of Hygiene, and the Assistant Director of the Wisconsin Conservation Department. The principal functions and aims of this committee are:

1. To investigate the technical aspects of the use of chemicals in order to determine whether or not, and to what degree, the practice of treatment is detrimental to lakes.

2. To disseminate information on the subject as an educational service toward resolving controversy, and particularly that surrounding proper proposals for chemical treatment.

3. To supervise nuisance control activities wherever conducted in the state.

Soon after the formation of the original committee, a permit system was devised, making it necessary for the filing of an application with the Committee on Aquatic Nuisance Control.

In 1941, the legislature passed an act calling upon the Committee on Water Pollution "....to supervise chemical treatment of waters for the suppression of algae, aquatic weeds, swimmers' itch, and other nuisance-producing plants and organisms. To this end the Committee may conduct experiments for the purpose of ascertaining the best methods for such control. It may purchase equipment and may make a charge for the use of same and for materials furnished, together with a per diem charge for any services performed in such work. The charge shall be sufficient to reimburse the Committee for the use of equipment, the actual cost of the materials furnished, and the actual cost of the services rendered, plus 10% for overhead and development work."

State-owned equipment was purchased in 1941 and operated on a rental basis for the chemical control of aquatic nuisances. The growth of the early program was governed by the ability of the crew operating the state-owned equipment to treat as many of the proposed projects as possible at a time when treatment was biologically necessary for best results. It was soon found that this procedure could not keep abreast of the demands for control. Therefore, in 1949, the use of state-owned equipment was discontinued. Sponsoring organizations were given the opportunity to select one of two options in conducting the work -- that is, they might enter into private contract with a commercial operator or they might apply the chemical by using their own equipment.

The state-wide program of chemical control of submergent aquatic vegetation had its beginning in 1939 with one treatment project. In 1940, four projects were supervised, and in 1941, the number had risen to six. The year 1945 saw the beginning of an accelerated program until at the present time, some forty lakes throughout the state receive some sodium arsenite for aquatic weed control. During the past five years, a total of 76,740 gallons of a commercial solution of sodium arsenite has been used for the control of submergent aquatic vegetation in the lakes of Wisconsin.

Present Administrative Organization of Wisconsin's Aquatic Nuisance Control Program

Private individuals, associations, communities, or town sanitary districts may sponsor aquatic nuisance control projects. The present permit system requires the filing of duplicate application forms for chemical control with the Committee on Aquatic Nuisance Control. A detailed map of the proposed treatment project must be submitted with the application forms. If it is deemed necessary, the proposed project is inspected by the biologist, since it is a function of the Committee on Water Pollution to determine that conditions existing in the area actually constitute a nuisance, as chemical treatment must be authorized on the basis of such findings. The application is then reviewed by the Committee, and, if approved, the sponsoring organization is given the choice of two options for the completion of the project. Under one option the sponsor shall obtain the services of a commercial operator who will carry out treatment in accordance with a specified plan submitted to, and approved by, the Committee. The Committee is not a party to any financial arrangements between prospective sponsors and commercial operators, and assumes no responsibility in such financial arrangements. At the present time, there are three commercial operators who do this type of work in Wisconsin. Under the second option, the sponsor shall provide suitable equipment and all of the necessary materials and labor for the private application of the chemical. Descriptive information on types of suitable equipment, as well as aid in planning the project, is supplied by the state.

Under either option, the actual treatment must be supervised by a representative of the Committee on Water Pollution. The statutes provide that a charge must be made for this supervision, and at the present time this charge is at the rate of $8 per hour, or fraction thereof, of supervisory service. A minimum seasonal charge of $20 is made for supervision on those projects whose seasonal supervision requirements do not exceed two hours of supervisory service. Supervision begins at the time so designated or agreed upon by the operator or sponsor and the supervisor. All preparatory work, with the exception of the pre-treatment inspection and supervision, is considered fundamental for proper supervision and no separate charge is made for this service.

The duties of a supervisor are two-fold. Careful calculations are made prior to supervision to insure that just the right amount of chemical is sprayed on the water to control the nuisance and yet not prove deleterious to the fish population or fish food organisms. The supervisor has an obligation to the sportsmen to see that the proper amount of chemical is applied and that aquatic life is in no way harmed. He has an additional obligation to the sponsor to see that the application of the chemical is accomplished in the best possible manner to abate the nuisance.

Control Methods

Sodium arsenite is applied as a solution spray over the surface of the area to receive treatment. It is believed that the action of the chemical involves absorption by the roots as well as exposed parts, translocation to all parts of the plant body, followed by toxic action upon the protoplasm. Within a period of one or two days following treatment, the tips of the plants are visably burned and assume a brownish color. The dying process progresses until about the fifth day when the entire plant is dead and sinks to the bottom, continuing its decomposition. On rare occasions it has been noted that plants, although dead, will remain standing until there is sufficient agitation in the water, produced either by wind and wavesor motor-boat traffic, to knock all of the vegetation down at one time. This phenomenon is the exception rather than the rule.

Sodium arsenite has been found efficacious in controlling most of the types of submergent aquatic plants, as well as those types of algae producing a floating pond scum. A partial list of rooted weeds which may be controlled by treating with sodium arsenite includes waterweed, coontail, water milfoil, buttercup, members of the pondweed family, water-stargrass, water-purslane, and bladderwort. As a general rule, the chemical may be said to be effective against a rooted submerged or floating plant except those which have a coating of wax on their leaves. Water-lilies and lake bulrushes cannot be destroyed with a reasonable amount of sodium arsenite solution in hard water. This is also true for watershield, the duckweed family, and the stoneworts and musk-grass.

The application rate for sodium arsenite varies somewhat with the nature of the project, the area of the project compared with the total area of the body of water, the shape of the treated area, the depth, and the location of the treated area as it is affected by the physical forces of wind and waves. A small pond of two acres or less would doubtless have to be treated in its entirety. The amount of chemical required for the adequate control of the rooted vegetation in a pond of this size should be calculated at a rate of 4 parts per million arsenic trioxide equivalent for the quantity of water contained therein. For ponds larger than 2 acres and less than 10 acres in area, which are treated in their entirity, a dosage rate of 5 parts per million arsenic trioxide equivalent is recommended. Fish management ponds containing wall-eye fry have been effectively treated at this concentration in Wisconsin. In treating the ponds containing these sensitive fish, the ponds were divided into two equal portions which were treated one week apart.

In larger lakes it is often desirable to clear localized areas along the shoreline, cut channels through weed beds so that boats will have access to deeper water, and control vegetation around piers and swimming areas. The best results are obtained from the treatment of the shoreline areas because currents and wave actions are usually minimized and the diffusion of chemical can only take place in one direction; i.e., outward into the lake. There are minimum limitations below which it is not feasible to attempt chemical control. The treatment of very small areas permit the diffusion of chemical on three sides, thus reducing the concentration of chemical within the area to a point below the toxic level for rooted plants. The recommended minimum dimensions of an area suitable for treatment are 200' x 200'. An exception to this recommendation might be a small slough, bay, or stagnant channel with an area of less than 40,000 square feet.

In the treatment of a shoreline area on a large body of water protected from wind and wave action, and having an average depth not exceeding 5 feet, and a maximum depth not exceeding 8 feet, a dosage of 7.5 parts per million white arsenic equivalent is recommended. A dosage of 10 parts per million white arsenic equivalent has been found effective against submergent vegetation in the treatment of a shoreline area of a large body of water unprotected from wind and wave action and having an average depth not exceeding 8 feet and a maximum depth not exceeding 10 feet. The majority of large lake treatment projects will be most effectively treated at this concentration. It has been our experience that the treatment of shoreline areas which exceed these limits as far as the physical dimensions of the area, will be costly, difficult to treat, and will not be dependable. Success of the operation depends upon an even distribution of chemical over an area of known dimensions within the limits stated above.

To calculate the quantity of sodium arsenite required to treat a body of water, the volume of water covering the area should be accurately measured. This necessitates the determination of both surface area and average depth. After this information is obtained, the formula, length x width x average depth x 62.4 (wgt. of a cu. ft. of water) divided by 1,000,000 equals the pounds of arsenic trioxide needed to give a 1 part per million concentration. This figure multiplied by the required parts per million for effective treatment equals the pounds of As_2O_3 needed for treatment. Various formulations of the compound may be purchased. One formulation contains 4 pounds of arsenic trioxide per gallon of solution and thus the pounds of arsenic trioxide needed for effective treatment divided by 4 would equal the gallons of commercial solution required to control the nuisance.

An easy method may be employed when the calculation is more readily based upon the acreage basis. The number of acres multiplied by the average depth, multiplied by 0.7 gives the required gallons of commercial 4 lb. arsenic trioxide per gallon solution for a 1 part per million concentration in the treated area. A graphic method (Fig. 1) of calculating the chemical requirements for a particular treatment project has also been devised. By knowing the width of the treatment area and the average depth, one is able to determine the gallons of chemical for each 100 feet of shoreline that is treated. The dosage chart is based upon a 10 part per million concentration of the commercial 4 lb. As_2O_3 per gallon formulation. In figuring concentrations other than 10 parts per million, it is necessary only to divide by 10 and multiply by the desired concentration. A brief study of the dosage chart will illustrate the importance of accurate dimensions, especially the average depth, of a proposed treatment area. An error of 1 foot in the average depth of a treatment area 300 feet wide will make a difference of nearly 5 gallons of chemical for each 100 feet of shoreline treated. This difference may be enough to determine the success or failure of the particular operation.

In applying the chemical on smaller areas, a tree sprayer and pressure tank or similar apparatus may be used. A gun-type sprayer such as is used in apple orchards for spraying individual trees, connected with a 30-gallon pneumatic tank, has been successfully used. Smaller types of pressure spraying devices might be used on very small areas. It is well to remember that the chemical should be diluted sufficiently to obtain good coverage and good distribution over the entire pond.

Ponds of any appreciable size, and small shoreline areas of large bodies of water, should be treated with equipment similar to a 1½ inch pump with appropriate spray nozzle and connection hose (Fig. 2). In general, a 1 or 1½-inch self-priming centrifugal or gear pump is used with a 3/8-inch smooth fire hose nozzle and the required amount of pressure hose and valve connections. A good quality of pressure hose or steam hose should be used for all hose connections in assembling the equipment. Appropriate steam hose fittings and clamps are used for all hose connections. Beginning on the suction side of the pump, a 1½-inch suction hose complete with strainer and foot valve must reach from the lake to the pump for the dilution of the chemical with the lake water. Usually about 7 feet of suction hose is required for this purpose. A valve is placed at the end nearest the pump to control the volume of dilution water. This valve is then connected to a 1½-inch 45° Y-bend and the unit is connected to the suction side of the pump by the proper union. Depending upon the sea-worthiness of the craft, a suitable iron container is provided for the concentrated sodium arsenite solution. In the event that a barrel is used, a 3/4-inch pipe, long enough to reach to the bottom of the barrel, is inserted into the bung to draw out the chemical. A 3/4-inch right-angle elbow is attached to the top end of this pipe and to this is connected a sufficient length of pressure hose to reach to the gate valve and connection with the 45° Y-bend. It may now be seen that the desired dilution of the commercial formulation can be accomplished through the adjustment of two valves. The discharge side of the pump is reduced to a 3/4-inch line and equipped with sufficient 3/4-inch pressure hose to allow freedom of movement. To this is attached a smooth fire hose nozzle with a 3/8-inch opening to permit the discharge of a stream of solution which breaks into droplets at the end of the stream.

The principal adaptation for use in large-scale operations in the type of equipment just described lies in the type of conveyance which is used to transport the equipment while on the water. For very small operations, such equipment can be readily adapted for use in two row-boats that are lashed together with ropes. One boat is used to carry the chemical and the pump, while the other boat transports one man at the spray nozzle and one running the outboard. A slight modification of this principle permits a more sea-worthy craft if one constructs a platform out of two-by-fours which is suspended between and attached to two row-boats of equal size. The chemical and the pump are placed on the platform and attention may be given to the valves and spray nozzle from either side.

The biggest time saver in large-scale operations lies in the ability of the vehicle to support a sufficient quantity of chemical so that one does not have to make long time-consuming return trips to the base of supply. Perhaps the most satisfactory type of conveyance in this regard is an all metal barge which is sufficiently large to permit freedom of movement as well as the transportation of large quantities of chemical. An all steel barge applicable for the "average" weed project might be 20 inches high, 7 feet wide, and 12 feet long. It could be constructed from 1/8-inch steel and have sufficient reinforcements to prevent failure of joints or distortion from hard use. Such a barge would carry a distributed load of about 5,000 pounds.

A slightly larger pump may be used if a greater volume of discharge is desired. A self-priming, high-pressure pump with a 2-inch suction and a $1\frac{1}{2}$-inch discharge has been successfully used in Wisconsin. This pump was powered by a 5 h.p. gasoline engine and used with a 1/2-inch smooth fire hose nozzle.

A time-saver in large operations is found in altering the equipment to provide for the use of two alternate chemical intake lines connected with the clear water suction line from the lake (Fig. 2). The purpose of the two lines is not to draw on two drums of chemical at one time, but to facilitate continuous spraying with the same concentration of chemical when one is changing from a drum that is nearly empty to one which is full. This modification of the equipment which appears on the diagram is not necessary for the smaller projects.

Application Details

When should the chemical be applied to obtain the best results?, is a question which is often asked by those interested in aquatic weed control. Field experience has indicated that chemicals should be applied before the fruiting stage of the plant, and that the best time is in the spring when the plants are young and growing vigorously. At this time, the weeds are young and tender, absorb the most chemical, and the most weeds are killed with the least amount of chemical.

There are a few application details which should be kept in mind during the actual spraying of the chemical. It has been found advantageous, for example, to sub-divide a large area to be treated into a convenient number of small sub-areas and to accurately determine the volumes of water which they contain. Since the quantity of chemical used is proportionate to the water volume to be treated, it is then a simple matter to properly adjust the mixing valves with the speed of the boat and evenly distribute the correct amount of chemical into the sub-area. This procedure is then repeated in successive sub-areas.

The actual procedure of applying the chemical is rather routine. After the pump is operating and the valves have received proper adjustment, the operator swings the spray nozzle from left to right, distributing the spray uniformly in the area covered as the boat or barge is propelled through or along the weed area to be treated. For reasons which will be discussed later, the spray is directed with the wind or in such a manner that it will not drift back upon the operator or upon the other workers on the unit. Generally speaking, three or more parallel trips are required to cover a shoreline treatment area. These are completed and one sub-area is finished before advancing to the next sub-area. The shoreline area is treated first and subsequent trips are directed outward until the entire width of the area receives its allotment of chemical. It should be possible to distribute about 85 gallons of commercial sodium arsenite solution on a given lake in a one-hour period.

Arsenical compounds are recognized poisons. In the hands of untrained and irresponsible individuals, the use of sodium arsenite in treating water could become an activity extremely dangerous to the operators who apply it, to those who use the water, and to all forms of life that it contains. However, with proper precautions, no danger is experienced either to humans or animals. Children and animals should not have access either to the chemical or empty containers. Containers should be thoroughly washed and rinsed with water when emptied. It is considered good practice as a safety measure to advise against bathing in a treated area or using the water for watering lawns, for livestock, or for any other purpose for a period of two days following treatment. It is important also that pets of all kinds be kept from the water for the same period. At the end of that time, the chemical should be sufficiently dissipated by dilution and absorption to make similar precautions no longer necessary. Cattle and other grazing animals should be excluded from the treated area until rains have washed the shoreline vegetation. Although domestic animals would probably not drink enough of the treated water to be injured, it is almost impossible to spray a pond or similar area thoroughly and not leave a certain amount of poison on the shore plants. Stock may be attracted by the salty taste and eat enough of the treated shoreline vegetation to be poisoned.

Sodium arsenite is a caustic compound and may cause a burn if it comes in contact with the skin and is not washed off with water. As a result there are a few precautionary measures which should be given consideration by the men operating the equipment and applying the chemical. As pointed out earlier, the spray should be directed away from all people and should be applied in such a manner that wind currents will not carry large particles of the chemical onto the operator or others connected with the operation. In this regard, it is often desirable to carry a clean cloth dampened with fresh water to be used in wiping off any chemical which might accidently have been deposited upon the face or neck. It has been found helpful to wear some type of protective covering for the face such as a welder's face mask. Face cream may be applied as an additional protective agent. The region of the chin and neck are especially vulnerable to burns caused by the fine, chemical-laden mist which is sometimes carried back upon the operators by air currents during the application of this chemical. The hands of the operator may be protected with rubber gloves to avoid getting the sodium arsenite solution on the skin. In the event of skin contact, the chemical should be washed off immediately.

Trees, shrubbery, grass and flowers will be burned or killed if they receive enough of the spray. Therefore, extreme caution should be used in handling the spray nozzle around valuable plants. Most burning or killing of terrestrial shrubbery and flowers takes place because of carelessness in the handling of the nozzle or because of winds or air currents which carry the spray solution shoreward. Difficulty has also been experienced on cloudy, mist-laden days when the saturated atmosphere seems to combine with a portion of the chemical in the spray and cause severe burning of surrounding foliage. Caution should also be exercised around loading piers and loading sites to prevent spillage of the concentrated chemical on lawns, shrubs, trees, or in the water where tree roots may absorb the chemical. Accidents of this nature have been known to kill willows, shrubs and grass.

Effect of Treatment

The ultimate effect of a sodium arsenite treatment upon susceptible aquatic plants results in the death of the plant. The length of time required for the death and decomposition of the plant depends somewhat upon local conditions, however, about five days is required for the plant to sink to the bottom and a total period of ten days to two weeks or longer is required for the vegetable material to be returned to the water in soluble form. This varies somewhat according to the total bulk of the plant tissue, the water temperature, and the oxygen supply. Within a period of seven to ten days following the destruction of the rooted vegetation, a growth of algae is likely to appear in the treated area. This is brought about by the nutrients liberated in the immediate area by the decomposing, rooted vegetation. As a general rule, the algae bloom persists for only a short time and need not be reckoned with. If the area is extensive, however, and the algae bloom appears serious, a single application of copper sulphate or similar algicide should eradicate the nuisance.

The effect of weed treatment upon the growth of weeds in a particular area should be considered as a temporary measure. A single application of sodium arsenite should control the rooted vegetation within a treated area for the period of one summer. It does not, however, kill the weed seeds which are deposited in the bottom muds, nor does it kill any seeds which may infiltrate the area from adjacent or surrounding weed beds. Thus, treatment is likely to be necessary in a given area for at least two successive years and possibly longer. After two or three years of successive treatment, however, the weeds most probably will become thinned to a point where they no longer present a nuisance, and the extent of treatment may be reduced or eliminated for a period of time. After a short time, however, it will probably be necessary to re-treat the entire area. The lasting qualities of the control measures are dependent principally upon the influx of weed seeds from adjacent weed beds.

There is no reason to suspect a deleterious effect on fish life because of the use of sodium arsenite solution for weed control. Tests by the Wisconsin Committee on Water Pollution showed that large-mouth bass were unaffected by a concentration of 6 parts per million arsenic trioxide in a 10-day period. A concentration of 10 parts per million killed 13% of the fish in the same length of time. Blue-gills and crappies were found to survive 12 parts per million arsenic trioxide for six days. A similar test in distilled water indicated that sodium arsenite has the same effect on fish in either hard or soft water. Wiebe, in 1930, found that 7 parts per million arsenic trioxide in Mississippi River water did not injure the fingerling stages of small-mouth bass, large-mouth bass, white crappies, golden shiners, blue-gills, bull-heads, and goldfish upon exposure for 148 hours. Schaut (1939) found that a concentration of 17.1 parts per million arsenic trioxide was not fatal to fresh-water fish within a one-hour period. Direct toxicity to invertebrate fish-food organisms has also proven not to be of too serious a concern in the use of sodium arsenite within the recommended concentrations. There is, however, a wider range of sensitivity among the invertebrate fauna. Surber and Meehean (1931) found that chironomids, mayfly nymphs, and fresh-water shrimp appear to be the most sensitive to the treatment with relatively high mortality rates following exposure to 2.5 to 4.0 parts per million white arsenic equivalent. Damsel-fly and dragon-fly nymphs, sow-bugs and water mites survived concentrations of 10.5 to 21 parts per million. Safety factors are in operation following the treatment which reduce the concentration of the chemical to which fish and aquatic organisms are exposed. Almost immediately following application, a portion of the chemical is absorbed by the plants, there is a diffusion of the chemical into surrounding untreated areas, and an absorption by the mud and other debris on the bottom. The original concentration within a treated area is much reduced within a short period of time.

In discussing the effects and results of treatment upon plants, fish, and fish-food organisms, it seems wise to continue with a brief discussion of the causes of treatment failure. The chief cause of failure lies in the use of inaccurate dimensions, especially average depth, in the calculation of the amount of chemical required to treat a given area. Good results are dependent upon sufficient chemical to do the job, and this can only be arrived at through the use of accurate dimensions for the proposed treatment area. Poor or inadequate equipment is also a common cause for failure. Good pressure hose should be utilized, hose connections should be tight, and the pump and nozzle should be of a suitable combination to assure an even distribution of the chemical over the area to be treated. Time of application also enters into the failure picture. The most economical and efficient control necessitates that the chemical be applied before the plants have developed seed. If the season has advanced too far, the weeds become tough and as a result, the treatment might not meet expectations. Water currents of inflowing streams exert a great influence upon particular treatment areas. It has been found very difficult, if not impossible, to get good consistent results following the treatment of areas subjected to the influence of water currents. Another cause may be attributable to the technique of applying the chemical. Once treatment is instigated on a given area, it should be continued and concluded in the most rapid and efficient manner. Any delay in the treatment operation will cause some decrease in the concentration of the chemical already applied to the water which may influence the final results of treatment.

Bartsch, A. F. - Aquatic Nuisance Control in Wisconsin. Wisconsin Committee
1946 on Water Pollution, Madison, Wisconsin. 35 pp.

Domogalla, B. P. - Treatment of Algae and Weeds in Lakes at Madison, Wisconsin.
1926 Eng. News-Record, 97, 850.

Grindley, J. - Toxicity to Rainbow Trout and Minnows of some Substances known
1946 to be present in Waste Waters Discharged to Rivers. Ann. Appl. Biol. 33, 103.

Mackenthun, Kenneth M. - Aquatic Weed Control with Sodium Arsenite. Sewage
1950 and Industrial Wastes, 22(8) 1062.

Mackenthun, Kenneth M. - Cleaner Lakes can be a Reality. Wis. Cons. Bull.
1952 17(1) 1-4. Madison, Wisconsin.

Schaut, G. G. - Fish Catastrophies during Drouths. Jour. A.W.W.A. 31(5) 771.
1939

Surber, E. W. - The Utilization of Sloughs in the Upper Mississippi Wildlife
1929 and Fish Refuge as Ponds. Trans. Am. Fish. Soc., 59, 106.

Surber, E. W., and Meehean, O. L. - Lethal Concentrations of Arsenic for
1931 Certain Aquatic Organisms. Trans. Am. Fish. Soc., 61, 225.

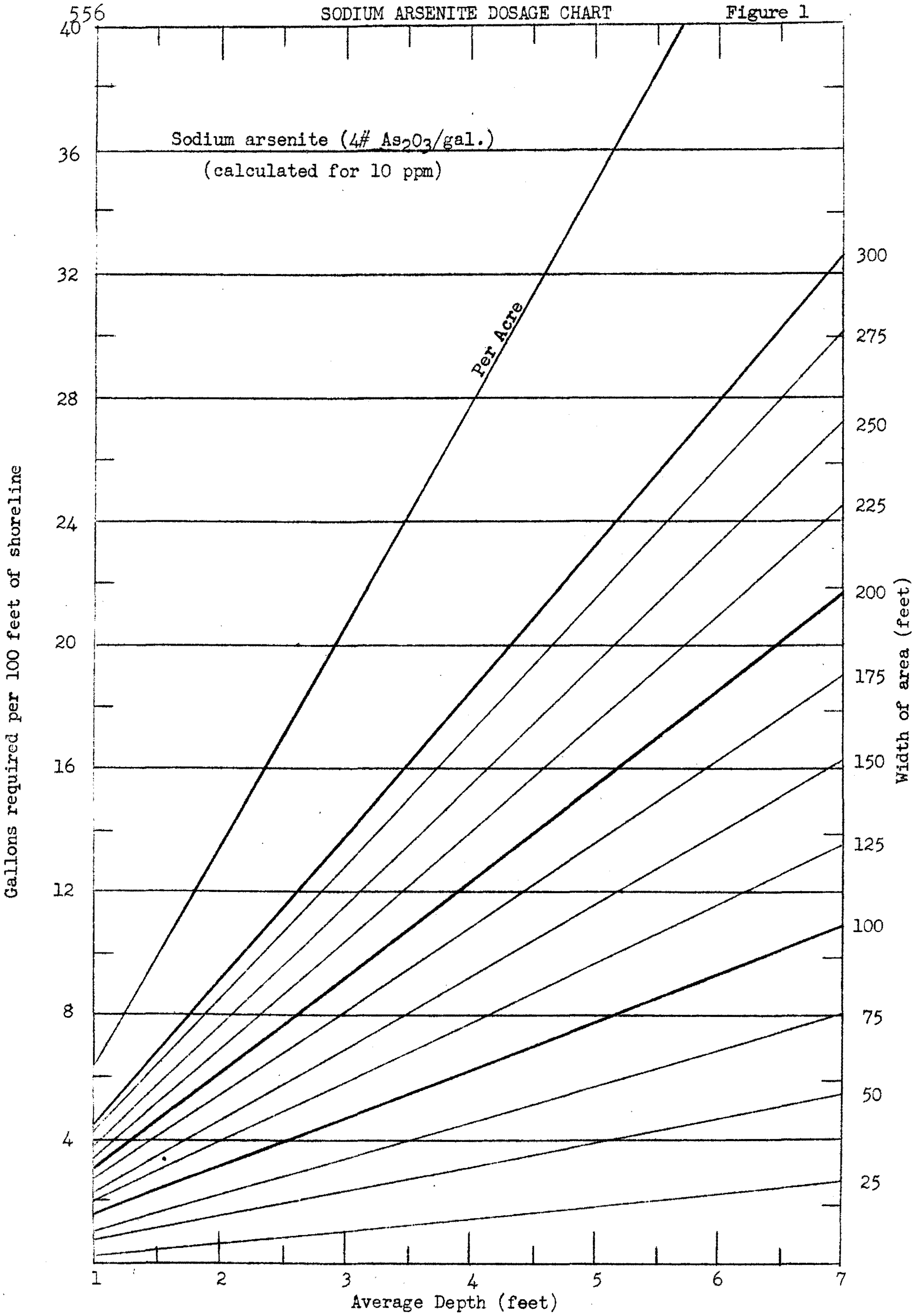
Surber, E. W. - Weed Control in Hard-water Ponds with Copper Sulphate and
1943 Sodium Arsenite. Trans., 8th N.A. Wildlife Conf., pp.132-141.

Surber, E. W. - Control of Aquatic Plants in Ponds and Lakes. Fish. Leaf. 344,
1949 U. S. Fish and Wildlife Serv. 20 pp., 6 Figs.

Wiebe, A. H. - Notes on the Exposure of Young Fish to Varying Concentrations
1930 of Arsenic. Trans. Am. Fish. Soc., 60, 270.

Wisconsin Committee on Water Pollution - Chemical Treatment of Lakes and
1939 Streams with Special Reference to the Origin and Control of Swimmers' Itch. Mimeo.

SODIUM ARSENITE DOSAGE CHART Figure 1



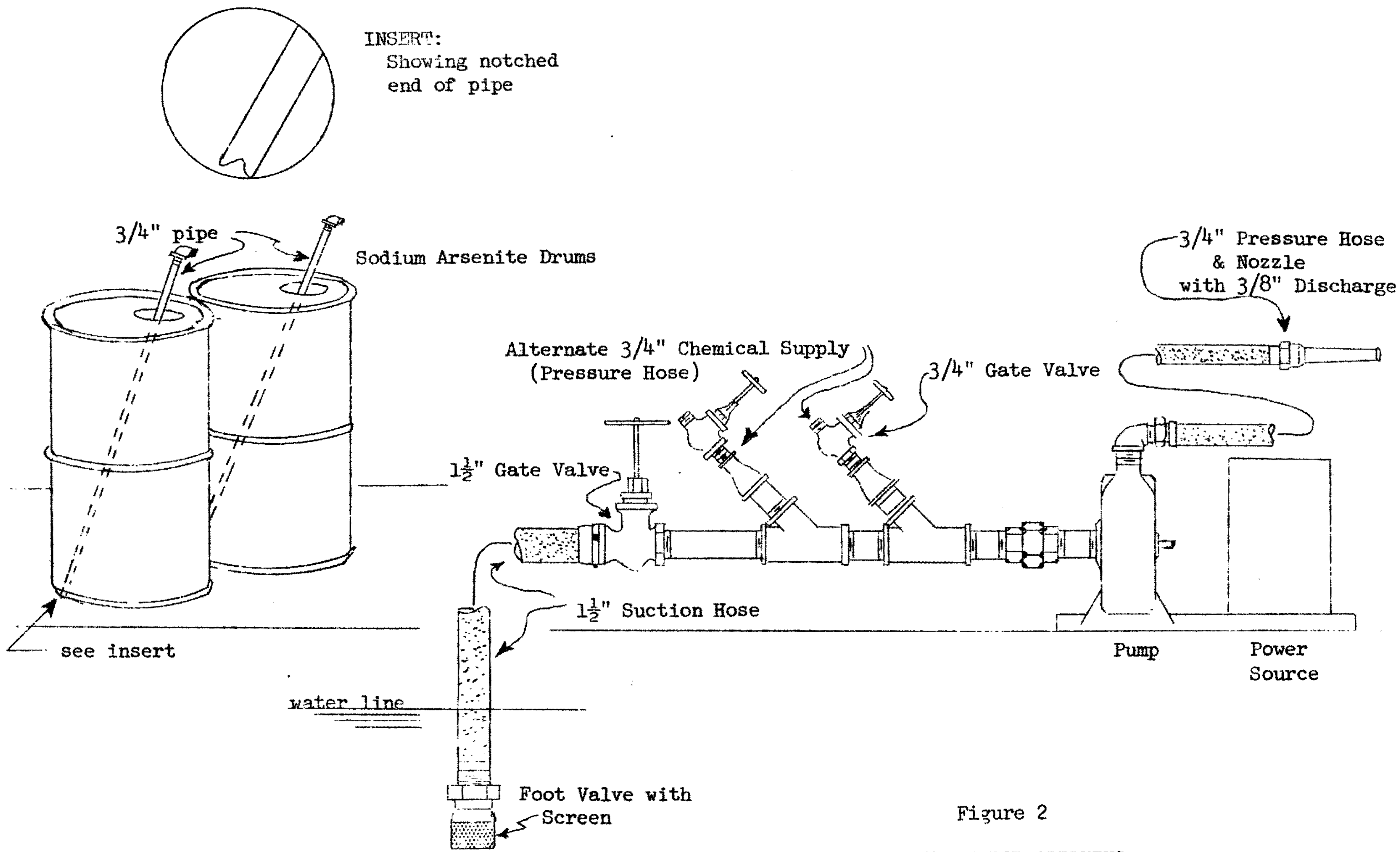


Figure 2

EQUIPMENT FOR APPLYING
SODIUM ARSENITE FOR AQUATIC WEED CONTROL

2/54

A Case History of a Misapplication of CMU for Aquatic Weed Control

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This first special session on aquatic vegetation control is evidence that a better understanding of the subject is needed. Persons so engaged, have found that the control of aquatic weeds is different, often more difficult and not infrequently more complex than terrestrial weed control.

In order to contribute to an understanding of the various factors involved in aquatic weed control, the following case history is presented for discussion.

The place is a privately owned recreation park in Dayton, Ohio. The problem was to control the common water weeds that interfered with boating. After mediocre efforts in controlling these weeds, CMU was recommended as a candidate control measure.

The area of the park consists of several hundred acres and the lagoon is more than a mile in length and completely surrounds the main part of the park. The diagram is a sketch of the affected area only.

The time of application was early March 1953 but before application, the water level was lowered to a level which exposed a band of weeds about 10 feet wide along each bank. The herbicide was applied to this band of weeds at the rate of 60 pounds per acre. Some of it undoubtedly washed into the water.

There still were weeds in the center of the lagoon under the water and to kill these weeds, an additional amount of herbicide was applied on the surface of the water between points A and B at the rate of 80 pounds per acre. The total amount of herbicide applied in the lagoon was 1200 pounds.

All of the weeds were killed and the water was again brought up to summer level which was from 3 to 5 feet below the top of the retaining bank.

There is very little current in the lagoon, but motor boats do produce considerable wave action. The general drainage of the area is in a southerly direction with a "static head" existing on the north side.

In August 1953 large trees, 20 to 40 inches in diameter were observed to shed leaves, and produce yellow malformed leaves. The symptoms were characteristic of CMU toxicity. The first trees affected were: cottonwood (Populus deltoides marsh), followed in order by sycamore (Platanus occidentalis L.), box-elder (Acer negundo L.), elm (Ulmus sp.), ash (Fraxinus sp.).

Except on the water's edge where all trees died, ash appeared to be more tolerant to the toxin than the others. Cottonwood, on the other hand, was very susceptible. By late fall approximately 80 trees were dead and others were partially dead. The turf, however, showed no symptoms of toxicity.

Because most of the dead trees were along the bank, it was assumed that their roots extended to the edge of the lagoon and thereby absorbed the toxin. The only irregular aspect of the then existing pattern of dead trees was the occasional occurrence of affected cottonwood trees at distances of 60 - 120 feet from the lagoon. Nevertheless, it was considered that most of the damage was done and that the toxin had been dissipated to a safe level of concentration.

However, by mid-summer of 1954 about 100 more trees had died in an area extending several hundred feet back from the edge of the lagoon. The distance was far beyond any logical assumption that roots could have absorbed it from the edge of the lagoon.

To understand this pattern of toxicity, two theories were considered. The first theory was that the interlocking of root systems carried the toxin to trees inland much as Oak-Wilt passes from tree to tree through inter-grafting of root systems.

The second theory considered the substrata of the island. This island was formerly a partial swamp that had been filled and graded more than ten years ago, to provide the usual recreation facilities. Underlying the island at a depth of from 5 to 8 feet is a coarse gravel substrata quite permeable to water.

Considering the position of the "static water head", the pattern of movement of toxin response across the island, and low requirements of toxin to kill trees it would appear that underground drainage was responsible for the movement. This was confirmed by soil analyses which found toxic quantities of CMU at the locations indicated on the map.

It was also observed that the larger trees were more susceptible to CMU than smaller trees.

In light of the above experience, it would seem important that one consider not only the dosage rate of toxin required to kill weeds and prevailing current of a stream, but also to be considered are:

1. Known residual life of the toxin which include water solubility and rate of bacterial decomposition.

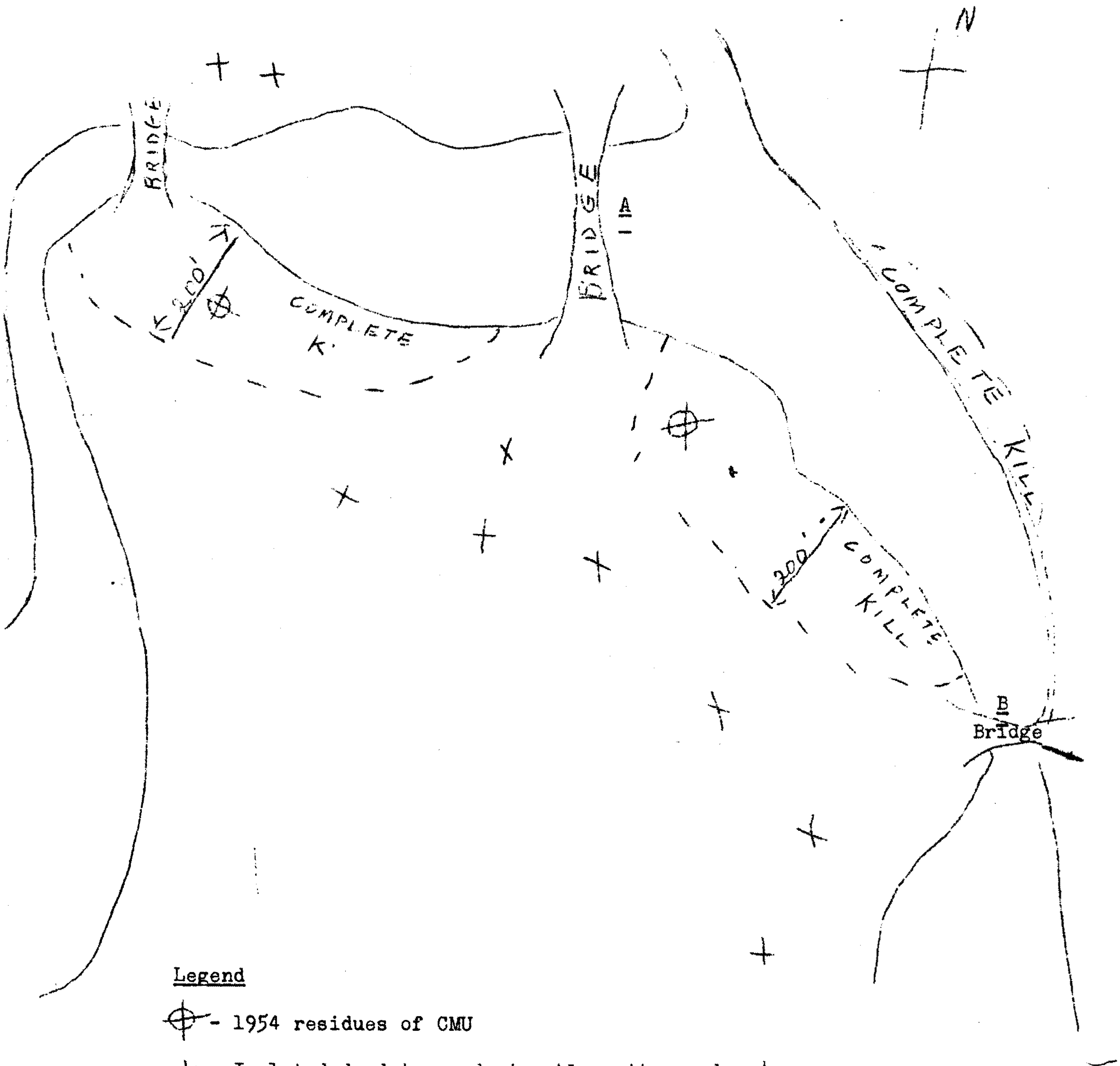
2. Nature of the substrata below the area of application.

3. Nature of water permeability of soil on retaining banks and bottom of water area.

4. Physiographic features which influence drainage of general area.

5. Presence of trees, their size, and their tolerance toward the toxin used.

Diagramatic Sketch of Recreation
Area Showing Extent of CMU Damage



Legend

⊕ - 1954 residues of CMU

+ - Isolated dead trees dominantly cottonwood

AUTHOR INDEX

AUTHOR INDEX

SUBJECT INDEX

NORTHEASTERN WEED CONTROL CONFERENCE

MINUTES OF THE BUSINESS MEETING

January 6, 1955

The meeting was called to order by President Kuhn who then introduced guests at the head table, namely, Dr. M. W. Parker, Head of the Weed Investigations Section of the U. S. Department of Agriculture and Dr. C. J. Willard, Professor of Agronomy at Ohio State University and Past President of the American Society of Agronomy.

The Secretary indicated that G. L. F. was due a vote of thanks for transporting the equipment and records of the Conference from Ithaca, New York to New Brunswick, New Jersey at the time the position of secretary changed.

The report of the Treasurer was given in brief form and it was indicated that the complete report would appear in the Supplement.

Mr. Beatty reported on the meeting of the Association of Regional Weed Control Conferences held at Fargo, North Dakota December 8, 1954. The Weed Society of America was formed on that date. Membership dues of $6.00 for 1955 include a subscription to the journal, WEEDS. Dr. K. P. Buchholtz of the University of Wisconsin was named editor of WEEDS and Dr. W. C. Jocob of the University of Illinois was named business manager.

A discussion was held concerning the Charter Meeting of the Weed Society of America to which the Northeastern Weed Control Conference will be host January 4 and 5, 1956. It was indicated that the National Meetings make it necessary to omit oral presentation of papers at the 1956 Northeastern Weed Control Conference. A Proceedings will be assembled as in previous years. A business meeting will be held and the Coordinating Committee will report January 6, 1956

President Kuhn indicated that progress has been made in developing a Constitution and By-laws of the Conference. It is planned to make the proposed Constitution and By-laws available to the members for consideration sometime during 1955.

The Awards Committee reported that the paper entitled "A Comparison of MCP and 2,4-D For Weed Control In Forage Legumes" was chosen as being outstanding. Mr. Marvin Schreiber, author of the paper, was presented with a one hundred dollar check and will receive a certificate of his achievement at a later date.

The nominating committee presented as their slate of officers; for President, J. G. VanGeluwe; for Vice-President, L. L. Danielson; for Secretary, R. J. Aldrich; for Treasurer, D. A. Schallock. No further nominations were made from the floor and the secretary was instructed to cast an unanimous ballot for each nominee of the slate.

Dr. Kuhn expressed his appreciation for the help of those who contributed to the success of the Conference during the year before turning the meeting over to the new president, Mr. VanGeluwe. Mr. VanGeluwe adjourned the meeting after he had indicated that committee appointments would be made later during the meeting.

The following committee appointments were announced by the President on Friday:

Program Committee Chairman - C. L. Hovey

Coordinating Committee Chairman - R. A. Peters

Publications Committee Chairman - R. J. Aldrich

Sustaining Membership Chairman - L. E. Cowart

Public Relations Chairman - E. M. Rahn

Awards Committee Chairman - A. O. Kuhn

Richard J. Aldrich

Richard J. Aldrich, Secretary

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NORTHEASTERN WEED CONTROL CONFERENCE
Treasurer's Report
February 15, 1955

Receipts

Cash on Hand 2/1/54		$3081.51	
Sustaining Membership		1575.00	
Sale of 1954 Proceedings & Reprints		840.75	
Sale of 1955 Proceedings		1016.00	
Registration at 1955 Conference		769.50	
Luncheon		584.00	
Miscellaneous		6.80	
	Total Receipts		$7873.56

Expenses

General		
Travel of Exec. Committee	$ 543.63	
Old Bill - Agent Award Cert.	73.25	
Letterheads	79.80	
Electric Typewriter	397.50	
Award for best paper	100.00	
Brochure	39.35	
Miscellaneous	129.76	
General Communications	386.86	
Total		$1750.15
Publications		
1954 Supplement	641.95	
1955 Coordinating Reports	312.75	
1955 Proceedings	1830.61	
1955 Supplement (partial)	299.46	
Newsletter	174.66	
Total		$3259.43
Meeting		
Programs	216.35	
Clerks	86.44	
Public Stenographer	12.00	
Pictures	46.00	
Tickets for Luncheon	7.50	
Banner	48.00	
Publicity	16.07	
Mixer	175.00	
Flowers	10.00	
Luncheon	603.28	
Travel	257.08	
Miscellaneous	6.00	
Total		$1483.72

Total Expenditures	$6493.30
Cash on Hand February 15, 1955	1380.26
Total	$7873.56

Donald A. Schallock
Donald A. Schallock, Treasurer

We have examined the foregoing financial statement of the Northeastern Weed Control Conference and find it correct as submitted.

M. A. Sprague — Margaret Greenwald

M. A. Sprague — Margaret Greenwald

REPORT OF THE RESEARCH COORDINATING COMMITTEE OF THE NORTHEASTERN WEED CONTROL CONFERENCE FOR 1955

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The preliminary draft of this report was prepared and distributed prior to the annual meeting. Opportunity for discussion and amendments of the report was provided during the oral presentation of the individual reports by the members of the Research Coordinating Committee in their respective sections of the Conference Program and in the general discussion on the final day of the meetings. The revised report based on these discussions is presented here as the consensus of opinion of the conference membership.

The materials, rates, and methods given here are not recommendations of this Conference for general local use and shall not be construed as such. The report represents a compilation of experimental and practical trial results which may be used as a guide in establishing methods and rates for local practical and experimental trials.

L. L. Danialson, Chairman
Virginia Truck Experiment Station
Norfolk, Virginia

VEGETABLES GROUP I
Carrot Family, Cole Crops, Salad Crops, and Green Crops

W. H. Lachman
Olericulture Dept.
Univ. of Mass.
Amherst, Mass.

Carrots (9 reports)

For Extensive Use

1. Stoddard Solvent - 75-125 gals after 2 true leaves are formed on a cool, cloudy day. (9 reports)

Problems Needing More Work

1. Better herbicide for control of Galinsoga.
2. Pre-emergence herbicide for carrots.
3. More economical herbicide than Stoddard Solvent.

Parsnips, Parsley, Dill

Same as for carrots.

Celery

For Extensive Use

1. Stoddard Solvent - Seed Beds only. (3 reports)

Problems Needing More Work

1. Herbicide for use after transplanting.

Cole Crops

For Trial Use

1. Chloro IPC - 2 lbs. in warm weather, 1 lb. in cool weather immediately after seeding. (3 reports)
2. Natrin - 3 lbs. applied to transplants.

Problems Needing More Work

1. Relation of temperature, soil type and moisture of activity of Chloro IPC.
2. Herbicide for use after transplanting.

Spinach

For Extensive Use

1. Chloro IPC - 2 lbs. warm weather (above 60°F), 1 lb. cool weather (below 60°F) immediately after planting. Injury may result on sandy soils. (3 reports)

For Trial Use

1. Chloro IPC - 2 lbs. warm weather (above 60°F), 1 lb. cool weather (below 60°F) immediately after planting. (7 reports)
2. Granular Cyanamid - 400 lbs. 7 days before planting. seed for over wintered spinach. (1 report)
3. Endothal - 3 lbs. - Pre-emergence.

Problems Needing More Work

1. Selective herbicide for control of henbit and lamb's quarters.
2. Effect of Chloro IPC on spinach maturity.
3. Karmex W 1-2 lbs. per acre promising in Va. but information needed on soil type and response.

Lettuce

For Extensive Use

1. Chloro IPC - 1½ lbs. one week after transplanting in field on mineral soil. Delays maturity 10 days. (1 repor
2. Chloro IPC - ½ lb. pre-emergence immediately after seeding on mineral soil. (1 report)

For Trial Use

1. Chloro IPC - ½-3 lbs. pre-emergence immediately after seeding. Low rate on mineral soil. High rate on muck soil. (4 reports)
2. Chloro IPC - 1 lb. Granular either pre or post emergence. (1 report)

Problems Needing More Work

1. Herbicide for use after transplanting.

VEGETABLES GROUP II
Tomatoes, Peppers, Asparagus, and Sweet Corn

E. M. Rahn
Hort. Dept.
Univ. of Dela.
Newark, Dela.

Asparagus Cutting Beds

For Extensive Use

1. CMU (Karmex W) - Pre-emergence 1 lb. (1 report); 1-1½ lbs. (2 reports); 1-2 lbs. (4 reports); 1½-2 lbs. (4 reports) 3 lbs. (1 report)
2. SES (Crag Herbicide 1) - 2½-3 lbs. Pre-emergence (2 reports).
3. Cyanamid Granular - 200-400 lbs. concentrated over row when weeds are small (2 reports).
4. Cyanamid Dusting Grade - 70-100 lbs. during cutting season (2 reports).
5. 2,4-D - 1 lb. pre-emergence (1 report).
6. NaPCP - 20 lbs. pre-emergence (1 report).
7. DNOSBP - 5 lbs. pre-emergence (1 report).
8. KOCN - 3% directed spray after cutting season (1 report).
9. CIPC - 6 lbs. pre-emergence (1 report).

For control of winter weeds while asparagus is dormant:

10. CIPC, 1 lb., plus SES, 2 lbs., after discing (1 report).
11. CMU (Karmex W) - 1 lb. after discing (1 report).

For Trial

1. CMU (Karmex W) - 1 lb. (1 report).
2. Alanap-1 - 4 lbs. (1 report).
3. For control of quackgrass and annual weeds. CMU, 2 lbs., plus Dalapon, 10-20 lbs., after cutting when quackgrass is at least 6 inches high. (1 report)
4. Fall treatment with 15-20 lbs. Dalapon per acre to control perennial grasses in fields to be planted to asparagus in the following spring.

For control of winter weeds while asparagus is dormant:

3. DNOSBP - 3 lbs after weeds have emerged (1 report).

Problems Needing More Work

1. CMU - effect on quality, persistence in soil, effect on crops planted after asparagus, how to clean spraying equipment following use.
2. Control of volunteer asparagus seedlings, plantain, foxtail, milkweed, bindweed, quack grass, witch grass, and chickweed.
3. Value of cultivation other than for weed control.

Asparagus Seed Beds

For Extensive Use

1. PCP (10% Emulsifiable) - 6 gals. in 60 gals. just before crop emergence (3 reports).
2. CMU (Karmex W) - 1½ lbs. pre-emergence (1 report).
3. NaPCP - 20 lbs. pre-emergence (1 report).
4. DNOSBP - 3 lbs. just before asparagus emerges (1 report).
5. Stoddard Solvent - 80 gals. when seedlings are less than 4" tall (1 report).
6. Young geese (6-8 wks.) when asparagus is 1" high (1 report).

For Trial

1. CMU (Karmex W) - 1½ lbs. within 7 days of seeding (1 report).
2. CMU (Karmex W) - 1½ lbs. post-emergence after clean cultivation (1 report).
3. Alanap-1 - 4 lbs. post-emergence after clean cultivation (1 report).

Sweet Corn

Pre-emergence

For Extensive Use

1. DNOSBP - At planting - 3-4½ lbs. (4 reports); 3-6 lbs. (3 reports); 4½-6 lbs. (2 reports); 6 lbs. (2 reports). Just before emergence - 3-4 lbs. (2 reports); 3-6 lbs. (2 reports); up to 5% of corn emerged - 3-4½ lbs. (1 report); up to 50% emerged - 3-4½ lbs. (1 report).
2. 2,4-D amine- 1¼-1½ lbs. on other than sandy soils (6 reports).
3. 2,4-D ester - 3/4 - 1 lb. (3 reports).
4. NaPCP - 15-25 lbs. at planting or 9-12 lbs. just before emergence (2 reports).
5. Cyanamid Granular - 300 lbs. at planting or just before emergence (1 report).

For Trial

1. CMU (Karmex W) - ¼-3/4 lbs. at planting (2 reports).
2. Trichlorobenzoic acid - ½-2 lbs. (1 report).
3. DNOSBP - 6 lbs. (2 reports).
4. NaPCP - 10-16 lbs. (2 reports).
5. Natrin - 2 lbs. (1 report).
6. Sesin - 2 lbs. (1 report).
7. SES - 2 lbs. (1 report).
8. Fall treatment with 15-20 lbs. Dalapon per acre to control perennial grasses in fields to be planted to sweet corn the following spring.

Post-emergence

For Extensive Use

1. 2,4-D amine - ½ lb. (9 reports). Use drop pipes after 6" (4 reports), after 12" (5 reports).
2. 2,4-D amine or ester - ½ lb. at emergence or ¼ lb. after corn is 4" high, (3 reports).
3. DNOSBP - 1½-3 lbs. in spike stage (3 reports).
4. NaPCP - 4-6 lbs. in spike stage (1 report).

For Trial

1. DNOSBP - 1½-3 lbs. at come-up. Weeds should have emerged (3 reports).

Problems Needing More Work

1. Control of annual grasses, quack grass, milkweed, smartweed, horsenettle.
2. Proper cultural practices following pre-emergence treatments.
3. A material as economical as 2,4-D without the residue problem.
4. Satisfactory pre-emergence chemical.

Tomatoes

For Extensive Use

No suggestions.

For Trial

1. Natrin - 2-5 lbs. after tomatoes become established and after clean cultivation (4 reports).
2. Natrin - 3-5 lbs. after last cultivation or at "lay-by" (5 reports).
3. Carbide and Carbon Compounds 7977 (3-4 lbs.) and 6711 (2-3 lbs.) after last cultivation (1 report).
4. DNOSBP - 9 lbs. before transplanting (1 report).
5. CMU (Karmex W) - 3/4 lb. at transplanting (1 report).

Problems Needing More Work

1. Herbicides that are more selective for tomatoes.
2. Place of Carbide and Carbon Compounds - Natrin, No.7976, and No. 7977, and derivatives - for control of late germinating weeds.
3. Control of late season grass on light soil.

Peppers

For Extensive Use

No suggestions.

For Trial

1. Natrin or Sesin - 2 lbs. after first cultivation (1 report).
2. DNOSBP - 9 lbs. before transplanting (1 report).

Problems Needing More Work

1. Herbicides that are more selective for peppers.
2. Control of late season grass on light soil.

VEGETABLES GROUP III
Vegetable Legume and Bulb Crops

Stewart Dallyn
L. I. Vegetable Research Farm
Riverhead, L. I., N. Y.

Peas (10 reports)

Pre Emergence (5 reports)

Recommended: (3 reports)

1. Dinitro (DNOSBP) - 4.5 - 6.0 lbs./A. in 30-40 gals. water at planting; 3.0 - 4.5 lbs./A. in 20-40 gals pre-emergence; 1.5-3.0 lbs. at emergence.

For Trial

1. 15-20 lbs. NaPCP in 30 gals water
2. Granular Calcium cyanamid 300 lbs./A. broadcast 1-3 days after planting.

Post Emergence (6 reports)

Recommended:

1. Dinitro. State recommendations vary on form and amount of dinitro, amount of water, temperature considerations, etc. In general -- 3/4-1¼ lbs./A. (DNOSBP) in 30-60 gals. water applied when peas 3-8 inches tall. Use lower rates when temperature high and do not treat if temperature over 80-85°.

Problems Needing More Work

1. Grass control in peas for processing.
2. Minimum gallonage needed - possibility of airplane application to reduce damage from ground equipment.
3. Effects of heavy rain following pre-emergence application.
4. Possibility of MCP where seedings involved.

Beans (12 reports)

In general, reports did not differentiate between types of beans and the treatment recommended.

Pre-emergence (12 reports)

Recommended:

1. Agreement on water soluble Dinitro applied pre-emergence. Some differences between States on actual amounts and time to be applied, precautions listed, etc. In general 3-6 lbs./A. in 30-50 gals. water; the lighter rates to be used on sandy soil or as application delayed until near come-up. On late planted beans where germination and emergence are rapid, application of the herbicide should be at planting or immediately after.
2. NaPCP (2 reports) 16-25 lbs./A. on light soils--safer than dinitro.

For Trial

1. NaPCP 15-20 lbs./A.
2. 3-CIPC 2-4 lbs. immediately after planting--grass control.
3. Combination 3 lbs. CIPC plus 3 lbs. DN for lima beans.
4. Fall treatment with 15-20 lbs. Dalapon per acre to control perennial grasses in fields to be planted to beans the following spring.

Problems Needing More Work

1. Control of grasses and late weeds that come in after last cultivation.
2. Quackgrass control and barnyard grass.
3. Demonstration of band spraying equipment to reduce cost of treatment.
4. Cultural requirements following pre-emergence treatment.

Onions (10 reports)

No reports received on other vegetable bulb crops.

Pre Emergence

Recommended:

1. 75 lbs./A. pulverized aero cyanamid (5 reports).
2. 2 lbs./A. CIPC on set onions (1 report).
3. 4-6 lbs./A. CIPC on set onions (1 report).
4. 4-6 lbs./A. CIPC on seed or sets (1 report).
5. 2-8 lbs./A. CIPC on seed (2 lbs. on mineral and 8 lbs. on muck).

For Trial

1. CMU 1 lb./A.
2. NaPCP 20 lbs./A.
3. 2 lbs. CIPC for seed and sets on mineral soil.
4. PCP, 2 lbs./A. shortly before harvest to control late weeds.

Post Emergence

Recommended:

1. KOCN - 1-2%, 100 gals./A. at emergence or after flag stage. 2% on larger onions (some say 6" high or above) (6 reports).
2. 2% KOCN on set onions after 6 inches in height (2 reports)
3. CIPC - 2-8 lbs./A. 2 lbs. on light mineral soils, 4-8 lbs. on muck soils. (4 reports; 2 of them stated wait till onions 6" high) Directed application preferable.

Problems Needing More Work

1. Combinations of pre and post treatments.
2. Improved methods for weeds in seeded onions on light mineral soil.
3. Control of CIPC tolerant weeds such as lambs quarters, redroot, etc.
4. Rates of CIPC for seed, set, and transplant onions grown on mineral soil.
5. More effective safe grass killer.

VEGETABLES GROUP IV
Cucumber, Squash, Pumpkin, Cantaloupe, Watermelon, and Sweet Potatoes

A. W. Feldman
Naugatuck Chemical
Naugatuck, Conn.

Cucumber, Squash, Pumpkin, Cantaloupe, and Watermelon

Total Reports (11)

For Extensive Use

1. Alanap-1, 2-6 pounds pre-emergence for cucumber, cantaloupe, and watermelon. (7 reports) For post-emergence to extend period of weed control, 2-4 pounds

Alanap-1 applied 4 to 6 weeks after pre-emergence treatment. (2 reports).

2. Water Soluble DN 2-3 pounds per acre pre-emergence for cucumber, squash, and pumpkin. (2 reports)

For Trial Use

1. Water soluble DN 2-3 pounds pre-emergence for musk-melon and cucumber. (1 report)
2. Alanap-1 1-4 pounds per acre pre-emergence, especially on squash and pumpkin. (5 reports)

Problems Needing Further Work

1. Effect of Alanap on yield and earliness of vine crops when applied post-emergence. Effect of rates, frequency, and stage of crop need to be included.
2. Varietal response of vine crops to Alanap, especially squash.
3. Selective herbicide for all vine crops.
4. Effect of soil type and moisture on results with Alanap.
5. Effect of environment, particularly soil temperature and moisture content on the effect of Alanap.
6. If replanting is necessary, should herbicide be reapplied?

Most Serious Weed Pests

Crabgrass, purslane, pigweed, lambsquarter, goosegrass, chickweed.

Promising New Chemicals

None

Sweet Potato

Report (1)

For Extensive Use

None.

For Trial Use

Alanap-1, 3 pounds per acre applied immediately after setting plants.

VEGETABLES GROUP V
Irish Potatoes, Beets, Turnips, and Rutabagas

M. F. Trevett
Maine Agr. Expt. Sta.
Orono, Maine

Turnips

For Trial Use

1. 3 chloro IPC: 1-2 lbs. per acre at planting.
   Remarks: For turnips for greens only.

Rutabagas

No reports.

Irish Potatoes

For Extensive Use

1. DNOSBP from amine salts: 1½-6 lbs. DNOSBP in 30-50 gals. H_2O per acre, pre-emergence or at emergence. (6 reports)
   Remarks: Not for muck. (1 report)
2. DNOSBP from "generals": 3-5 lbs. DNOSBP in 50-60 gals. of oil-water emulsion per acre, pre-emergence. (2 reports)

For Trial Use

1. Crag Herbicide 1 (SES): 3 lbs. per acre immediately after last cultivation. (1 report)

For Further Testing

1. CMU: ½ lb. per acre, pre-emergence or at last cultivation. (2 reports)
2. SESIN 50W: 2 lbs. per acre, at last cultivation. (1 report)
3. Amino triazole: 2-8 lbs. per acre, pre-emergence. (1 report)
4. SES at layby.
5. Dalapon, pre-emergence.
6. TCA for fallow treatment of *Agropyron repens*.

Problems Needing More Work

1. Continued evaluation of cultivation for purposes other than weed control.
2. Control of late emerging weeds.
3. Control of various perennial weeds.
4. Evaluation of band compared to over-all spraying.
5. Evaluation of combinations of contact - and residual - type herbicides.

Red Beets

For Extensive Use

1. NaCl: 2 lbs. per gallon of water, 100-200 gallons per acre, 4 to 5 leaf stage of beets. (4 reports)
   Remarks: Not effective against *Chenopodium album*.
2. 1 lb. per gallon NaCl plus 1 lb. per gallon $NaNO_3$, 200 gallons per acre at 4 to 5 leaf stage of beets. (1 report)
   Remarks: Not effective against *Chenopodium album*
3. Stoddard solvent type oil: 75 gallons per acre, pre-emergence. (1 report)
4. TCA for grass control: 8-12 lbs. per acre, pre-emergence. (2 reports)

For Trial Use

1. Chloro IPC: 1-4 lbs. per acre at planting. (2 reports, 1 report suggested use only for beets for greens)
2. Endothal: 10-25 lbs. per acre, pre-emergence. (1 report)

For Further Testing

1. Chloro IPC.
2. Endothal.
3. Substituted ureas.
4. Dichloroproprionic acid.

STRAWBERRIES

R. F. Carlson
Hort. Dept.
Michigan State College
East Lansing, Mich.

This summary report includes recommendations and suggestions of 23 persons from Experiment Stations and commercial concerns in the Northeast.

General Agreement:

New planting:

1. SES, 2 to 4 pounds per acre - higher rate on heavy soil - applied to weed-free planting as needed.
2. 2,4-D (amine form), ½ pound per acre on small weeds.
3. Combination of 2 pounds each of SES and CIPC at the following times: 10 days after planting, in June, and in October.

Established planting:

1. Same as 3 above, used after picking and again in October.
2. SES, 2 to 4 pounds in early spring before strawberry flower clusters appear.
3. 2,4-D, 1 to 1.5 pounds per acre immediately after harvest.

Dormant planting (Late fall):

1. DNOSBP (amine salt), also know as "Dow Premerge" and "Sinox PE", at 2 pounds per acre when temperatures are above 70°F and 4 pounds at lower atmospheric temperatures.
2. DNOSBP (ammonium salt or other emulsifiable forms), also known as "Dow General" and "Sinox W", at 1 pound per acre. For hard to kill weeds, use 1 pound DNOSBP (ammonium salt), 10 gallons fuel oil, and 90 gallons of water per acre.
3. CIPC at 1.5 to 2 pounds per acre (selective for common chickweed).

Application notes:

1. Avoid using herbicides when strawberry plants are initiating flowers, flowering and fruiting, and producing runners.
2. SES and 2,4-D should be used when the soil is moist.
3. DNOSBP should be used in 50 to 100 gallons of water per acre.
4. Pounds per acre means covered with the spray - for example, one pound of 2,4-D per acre used as a row application might cover 2 acres of strawberries depending on row spacing.

Herbicides recommended for trial only:

1. CIPC and SES at 2 pounds each per acre.
2. Dalapon, 15 pounds per acre as a pre-planting treatment in fall prior to spring planting for control of quack-grass.

Herbicides for experimental use only:

1. Sesin (2,4-Dichlorophenoxyethyl benzoate), 2 to 4 pounds per acre.
2. Natrin (sodium 2,4,5-trichlorophenoxyethyl sulfate), 2 to 4 pounds per acre.
3. Combination of granular Sesin and CIPC at rates of about 2 pounds each per acre.
4. Fall treatment with 15-20 lbs. Dalapon per acre to control perennial grasses in areas to be planted to strawberries in the spring.

Problems needing more work:

1. Distribution equipment for granular materials.
2. Varietal response of strawberry plants to various herbicides.
3. Influence of herbicides on bud development and on storage materials in the stem and roots.
4. Information on selective mechanism of strawberry plants and weeds.
5. Effects of irrigation used on plants before and after application of herbicides.
6. Selective chemicals for:
   a. Grasses - quack-grass, crab-grass, June-grass, and wire grass.
   b. Broad-leaved weeds - sand spurry (*Spurgularia rubra*), common groundsel (Senecio vulgaris), low cudweed (*Gnaphalium uliginosum*), field sorrel (*Rumex acetosella*).

GRAPES

R. F. Carlson
Michigan State College
East Lansing, Michigan

This report was obtained by visiting with several research persons at the annual conference. Control of weeds in the grape row by mechanical means without injury to the grape vines is difficult. Chemical control is now practical.

Chemicals Recommended for Extensive Use

1. DNOSBP - two pounds, fuel oil - 15 gallons, and 85 gallons of water with a emulsifying agent. Use this amount as a directional row application on two acres of grapes of standard spacing. Two applications, one in early spring and another in mid-summer is usually enough. Avoid contacting foliage and do not use this mixture in newly planted vineyards.

Chemicals Recommended for Trial

1. CIPC at 8, 12, and 16 pounds per acre as row applications in the spring and in the fall.
2. CMU at 2, 4, and 6 pounds per acre as row applications in established vineyards. Low rate in new vineyards.

Chemicals for Experimental Use

1. Dalapon at 3, 5, 8, and 10 pounds per acre as row applications. The low rate should be repeated two or three times during the growing season.
2. Other materials such as MH-40, Natrin, and Sesin should be tried on a limited scale at rates of 2, 4, and 6 pounds per acre.

NOTE: 2,4-D and similar herbicides should be kept out of the vineyard since the grape vines are very sensitive to them.

RASPBERRIES, BLACKBERRIES, AND BLUEBERRIES

John S. Bailey
Cranberry Experiment Station
University of Massachusetts
East Wareham, Mass.

Raspberries

Recommended for Extensive Use

1. DNOSBP, amine salt, 4-6 lbs. in 50 gals of water per acre before new shoots emerge. DN at 2-4 lbs. in 50 gals. of water per acre when new canes are tall enough so new tips will not be hit.
2. SES 3-4 lbs. per acre applied to clean plantings except when new canes are emerging.
3. 2,4-D amine 1 lb. per acre for broad leaf weeds during growing season except when new canes are emerging.
4. No. 2 Fuel Oil at 40 gals. per acre. Spot spray for grasses except when new canes are emerging.
5. CIPC at 6 lbs. per acre October 15 to November 30 to control grass and common chickweed.

Recommended for Trial

1. Dalapon at 3-5 lbs. per acre to control grass.

2. DNOSBP 2 pts. of 55% plus 10 gals. of diesel fuel oil plus water to make 100 gals per acre applied in Nov.

For Experimental Use Only

1. Dalapon at 3, 6, 8, 10, and 12 lbs. per acre fall and spring. Raspberries show good tolerance.
2. CMU 2, 4, 6, and 8 lbs. per acre fall and spring.
3. CIPC at 6, 10, and 14 lbs. per acre fall and spring.

Problems Needing More Study

1. Combination sprays with, for example, Dalapon and SES, or 2,4-D for complete control of broadleaf and grassy weeds.
2. Test new materials.

Blackberries

Recommended for Extensive Use

1. SES at 3-4 lbs. per acre applied to a clean soil except when suckering.
2. 2,4-D at 1 lb. per acre for broad-leaf weeds except when suckering.
3. Fuel Oil at 40 gals. per acre as a spot spray for temporary grass control. Avoid too much contact with canes and leaves.

Recommended for Trial

1. CIPC at 6 lbs. per acre applied October through November for grass control.
2. Dalapon at 5 lbs. per acre applied October through November for grass control.

For Experimental Use Only

1. CIPC at 6, 10, and 14 lbs. per acre applied fall and spring for grass control.
2. Dalapon at 3, 5, 8, 10, and 12 lbs. per acre applied fall and spring for grass control.
3. CMU at 2, 4, and 6 lbs. per acre fall and spring for grass control.

Problems Needing More Study

1. Combination of chemicals for control of all weeds.
2. Test new materials.

Cultivated Blueberries

Recommended for Extensive Use

1. SES at 3 lbs. per acre applied to clean soil.

2. DN as Dow Premerge or Sinox PE 3 lbs. in 40 gals of water per acre used as directed spray for small weeds in early summer and after harvest.
3. Use of Friday rotary hoe.

Recommended for Trial

1. CMU at 1 lb. per acre in April and July to weed-free soil.

For Experimental Use only

1. CIPC at varying rates to 50 lbs. per acre fall and spring.
2. Dalapon at 3 to 30 lbs. per acre fall and spring.
3. CMU at 2, 4, 6, and 8 lbs. per acre fall and spring.

Problems Needing Further Study

1. Combinations of chemicals.
2. Test new materials.
3. Effect of soil type on action of weed control chemicals on crops and weeds.
4. Effect of organic matter and mulches on action of chemicals on crops and weeds.

Wild Blueberries

Recommended for Extensive Use

1. Spot or patch spraying of foliage, during growing season:

   For weeds easily killed by 2,4-D (alder, birch, pin cherry, willow, sweet fern), apply a 2000 parts per million water solution of 2,4-D acid from amine formulations.

   For weeds moderately resistant to 2,4-D (poplar, choke-cherry, bush honeysuckle, hardhack, Rhodora), apply a 4000 parts per million water solution of total acids from a mixture of 2,4-D and 2,4,5-T amine formulations.

   For weeds very resistant to 2,4-D (Bayberry), apply a 4000 parts per million water solution of 2,4,5-T acid from amine formulations.

   For Red maple, use one pound of Ammate per gallon of water, with a sticking agent added.

2. Stub treatments, applied as soon as possible after cutting bushes:

   For weeds easily killed by 2,4-D, apply kerosene or fuel oil that contains per 100 gallons of oil, 4 pounds of 2,4-D acid, or 4 pounds of total acids from a mixture of 2,4-D and 2,4,5-T ester formulations.

For weeds moderately and very resistant to 2,4-D, apply kerosene or fuel oil that contains per 100 gallons of oil 8 pounds of total acids from a mixture of 2,4-D and 2,4,5-T ester formulations.

3. Follow-up treatments to eliminate skips or misses after Chemical treatment:

   Use the chemicals suggested above, or hand pull or mow survivors during July of following years.

4. Brake fern:

   Mow two or more times per year at intervals of 4 to 6 weeks. Cut just as leaves (fronds) reach full size.

Recommended for Trial:

1. 2,4,5-T at 4000 ppm low volatile ester in water applied as a spot treatment in mid-June to early July for bayberry control where they are not numerous.
2. 2,4,5-T ester in water at 4000 ppm as spot treatment in the fall preceding the spring of burn where bayberry is widespread.

For Experimental Use Only:

1. CMU at 5-15 lbs. per acre, fall and spring.
2. Polyborchlorate 400-600 lbs. per acre fall preceding burn especially for control of brakes.

Problems Needing Further Study

1. Control for poplars.
2. Control for herbaceous weeds.
3. Control of blackberry bramble following burning.

ORCHARDS

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The recommendations for control of poison ivy and honeysuckle in orchards presented in the Supplement of the Proceedings of the 1954 Conference still hold good.

CMU and PDU at 11.2 grms. per 10 ft. square were found to be effective in reducing the stand of quackgrass, while CMU suppressed under tree growth if applied after cultivation or following dinitro contact sprays.

BHC at 0.2 lbs. per 10 square ft. gave nearly complete control of weeds around newly planted apple, cherry, peach, and plum trees.

There is still a need for safer and more effective materials to control weeds around trees in order to aid in the rapid establishment of new plantings and the more economical maintenance of older ones.

Trial use of 2,4-D and 2,4,5-T has been suggested to check weeds, poison ivy, and to prevent root suckering of trees. Spray mexture suggested is 1% oil and 2 lbs. of combined esters in 100 gallons of water.

It has been suggested that mouse damage to trees can be reduced by spraying grass under trees to destroy cover which harbors the mice. Experimental rates for use of Dalapon for this purpose would be 3 to 20 lbs. Apple and pear trees older than 10 years tolerate the higher rates when applied to areas 10 feet by 10 feet around trunks of trees. Least possibility of injury to trees occurs when spray volume is kept to minimum required to wet grass foliage. Spring and fall applications of 3 to 5 lbs. per acre around trees younger than 10 years and around stone fruit trees were suggested for experimental trial.

Experimental use of 15 to 20 lbs. per acre of Dalapon in September or October for control of perennial grasses where new orchards are to be set in the spring have looked promising. Further trials are suggested.

FIELD CORN AND SOYBEANS

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Field Corn

General Agreement - Pre-emergence

1. Use 2,4-D, 1-2 pounds acid equivalent per acre.

Remarks - In general esters were preferred over amines for pre-emergence treatments. Several reports mentioned a preference for low volatile esters because of the safety factor. The high rates were preferred on heavier soils, and caution was suggested in recommending 2,4-D on sandy soils.

2. Use amine dinitros, 3-6 pounds per acre.

Remarks - Preferred on light soils where 2,4-D injury is common and where corn is grown near 2,4-D sensitive crops. One report recommends the use of 6-9 pounds where soils are heavy. It is best to treat as near to the time of emergence as possible.

General Agreement - Post-emergence

1. Use ¼-½ pound 2,4-D acid equivalent per acre. Use drop nozzles after the corn is 10 inches high.

Remarks - Some reports preferred amine only, others either amine or low volatile esters. Some reports recommended no cultivation for at least 10 days after spraying.

For Trial Use

Pre-emergence

1. Calcium cyanamid, 300-500 pounds per acre.

Remarks - Moisture essential for good results. Lower rates preferred on sandy soil.

2. CMU, ½-2 pounds per acre.

Remarks - More research needed. Two reports indicated good results this past year.

Emergence

1. Amine dinitro, 3-6 pounds per acre applied at or just before the time that the corn breaks through the ground.

Remarks - Three reports mentioned that this looks very promising, but further study is needed. Good control of grass seedlings was obtained.

Post-emergence

1. Amine dinitros, 3-6 pounds per acre.

Remarks - This is usually applied at the coleoptile stage or 1 to 2 leaf stage of growth. More work needed.

General Remarks

1. Some cultivation in addition to chemical treatment appears necessary for maximum yields. This may be only 1 cultivation.

2. The most serious weed problems mentioned in order of importance were: annual broadleaved weeds, quack grass, Johnson grass, and annual grasses.

Materials Tested Recently

1. Dalapon -- Preferred use as a directed spray, post emergence. Two reports indicated severe injury to corn.

2. Amino triazole -- Two reports mentioned this chemical. Use pre-planting on quack grass at 2 to 4 pounds per acre. One report mentioned its use pre-emergence.

3. CIPC -- One report indicated the use of this post-emergence when the corn was 25-30 inches tall to control annual weedy grasses.

4. Silvex -- Two to three pounds per acre pre-emergence. Did not injure corn and results have been good.

5. PCP -- 16-20 pounds pre-emergence. One report indicated that this has looked good for two years.

6. Tri-Chloro Benzoic Acid (HC 1281) -- Used pre-emergence at ½-1½ pounds per acre. One report indicated good weed control with no injury to corn. Use higher rates on organic soils.

7. Maleic Hydracide -- No comment given.

8. Alanap 5 -- No comment given.

9. Sesin -- Used post-emergence at 2-4 pounds per acre.

10. Natrin -- Use post-emergence at 2-4 pounds per acre.

11. Crag 1 -- 2-4 pounds per acre post-emergence.

12. Fall treatment with 15-20 lbs. Dalapon per acre to control perennial grasses in fields to be planted to corn the following spring.

Problems Needing More Work

1. Pre-emergence weed control on sandy soils.

2. Control of Johnsongrass and quackgrass.

3. Control of annual weeds, particularly grasses.

4. Factors influencing dinitro injury to corn.

5. Value of cultivation where weeds are chemically controlled and timing of cultivation and chemical treatments.

6. Control of problem weeds such as wild morning glory after the last cultivations.

7. Pre-planting applications of Maleic Hydrazide, TCA, Amino Triazole, or Dalapon to suppress quackgrass growth during the season.

8. Mechanics and economics of band application of herbicides at planting or post-emergence.

Soybeans

Note: The following summary is from a rather limited number of reports. Several states reported soybean weed control to be a negligible problem with them.

General Agreement - Pre-emergence

1. Amine dinitros, 3-6 pounds per acre.

Remarks - One report indicated that delayed applications were better. Results may be erratic, particularly following heavy rains.

For Trial Use - Pre-emergence

1. PCP - 16-20 pounds per acre. One report indicated excellent results for four years.

2. CIPC - 6-8 pounds per acre.

Remarks - Rather selective on weeds controlled. Relatively ineffective in hot weather.

3. Alanap - 2-6 pounds per acre.

Remarks - Use low dosage on light soils. May cause moderate injury to leaves.

4. Silvex - 2 pounds per acre. May cause moderate injury to leaves.

5. Other materials tested as pre-emergence treatment were: Sesin 25, Crag 1, Natrin, Amino Triazole, CMU, and 3,4-D.

6. Fall treatments with 15-20 lbs. Dalapon per acre to control perennial grasses in fields to be planted to soybeans the following spring.

Problems Needing More Work

1. A chemical for selective post-emergence spraying to control weeds such as Morning Glory and Cocklebur, that come in at the last cultivation.

2. A more residual and fool-proof pre-emergence spray.

WEED CONTROL IN SMALL GRAINS

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The control of weeds in cereal grains is a comparatively simple procedure where the grain is grown alone. However the production of cereal grains in the Northeastern States is closely aligned with the production of forage crops since the grains are often grown as a companion crop in the establishment of grasses and legumes. This complicates the weed control problem since the legume seedlings are more sensative than the cereals to chemicals.

Agreement

Spring cereals not seeded.

1. Use of 2,4-D amine at ¼ to ½ pound per acre after stooling but before jointing.

2. Use of MCP at ¼ to ½ pound per acre after stooling but before jointing.

Spring grains under-seeded to grasses and legumes

1. Use of Dinitro amine at the rate of 3/4 to 1.5 pounds per acre in 30 to 75 gallons of water. Use when weeds are small and grain not over 6 inches high.

2. Use MCP or 2,4-D amine at the rate of ¼ to ½ pound per acre on grain over 6 inches where weeds are severe or where weeds and grain form a canopy over legumes. Use MCP on red clover.

Winter cereals not seeded

1. Use 2,4-D amine or MCP at the rate of ¼ to ½ pound per acre in spring after stooling but before jointing.

Winter cereals seeded to legumes and grasses

1. Use of 2,4-D amine at the rate of ¼ to ½ pound per acre in early spring when weeds are small.

2. Use of Dinitro amine at the rate of 1 pound per acre to control chickweed.

The use of MCP is suggested for the control of wild garlic or onions in winter grain, applied at the rate of ½ to 3/4 pound per acre.

Spraying grain underseeded with legumes and grasses is still not a sure proposition, there is considerable danger of injuring the seeding.

Problems Needing More Work

1. Control of wild garlic in fall seeded grain.
2. Control of Canada Thistle.
3. Study of the factors influencing the effect of dinitros.
4. A weed killer less injurious to alfalfa.
5. More work on grains underseeded to legumes.
6. Re-evaluation of effect of any herbicides on viability of seed and production from seeds coming from treated plants.

PASTURE AND HAY CROPS

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General Agreement (No change for 1954)

Permanent Pastures

Problem 1. Summer annual broadleaf weeds.
Control -- One pound of 2,4-D amine or MCP per acre in early spring. Repeat if new weeds appear.

Problem 2. Brambles and woody plants.
Control -- Spot treat with 2,4,5-T ester or a combination of the 2,4-D and 2,4,5-T esters in early summer or in the dormant season.

Problem 3. Wild garlic.
Control -- 2,4-D ester at 1 to 1.5 pounds in early spring. Repeat yearly until control is effective.

Problem 4. Horse nettle.
Control -- 2,4-D, 2,4,5-T ester mixture at 1.5 to 2.0 pounds applied about blossoming time. Clovers will probably need reseeding after the treatment. A single treatment may not give complete control and it should be repeated.

Problem 5. Perennial and winter annual broadleaf weeds.
Control -- Frequent mowing and adequate fertilization will greatly reduce weed population. Use of 2,4-D or MCP at .5 to 1.5 pounds depending on susceptibility of weed species present.

Semi-permanent pastures, legume or grass legume mixtures

Problem 1. General weeds.
Control -- Rotational grazing, fertilization and mowing, are of primary importance.

Alfalfa and clover, seedling stage

Problem 1. Chickweed.
Control -- Water soluble dinitro 1 - 1.5 pounds. Chloro IPC at 1-2 pounds in the absence of grass seeding.

Alfalfa, established stands

Problem 1. Chickweed.
Control -- Chloro IPC at 1-3 pounds in late fall or early winter in warmer areas in the absence of grass seeding. DN at 1-3 pounds.

Problems Needing Further Study

1. Use of Dalapon and CIPC for control of weedy grasses in legume hay fields.
2. Use of 3 amino 1,2,4-triazol for control of horsenettle, thistle and curled dock.
3. Preplanting treatments of cyanamide or dinitro for legumes.
4. Weed control in birdsfoot trefoil. Dalapon looks promising for bedstraw and quackgrass.
5. Pre-emergence treatments for legumes.
6. Control of conifers.
7. Complete sod kill prior to reseeding. CMU, Dalapon plus 2,4-D; 3 amino 1,2,4-triazol and mixtures of Dalapon and amino triazol at reduced rates look promising.
8. Indicator crops for use in determining dessipation of chemicals from soil prior to reseeding.

TURF

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The following states offered recommendations on control of turf weeds: Delaware, Maine, Maryland, Massachusetts, New Jersey, Rhode Island, Vermont, and West Virginia.

Agreement

1. The chemical 2,4-D was recommended for control of broad-leaved weeds (dandelion, plantain, and buckhorn) by all eight states. The rates of application ranged from ¼ to 1½ pounds of actual 2,4-D per acre. Six of eight reports specified amine.

2. Four of eight reports recommended phenyl mercury acetate spray applications for crabgrass control. Rates of application for lawn turf varied from 1 to 2½ ounces of 10 percent active material per 1000 square feet. Three to five treatments were recommended at 5 to 10 day intervals.

3. Five of eight reports recommended potassium cyanate at a rate of 8 to 16 pounds per acre. Two to three treatments were recommended. Two reports specified potassium cyanate for Kentucky bluegrass lawns.

4. No agreement was expressed on a chemical control for chickweed as listed by four states. Potassium cyanate, arsenate of lead, sodium arsenite, and DNOSBP were suggested.

5. Two states recommended 2,4-D at the rate of 1½ pounds per acre for wild garlic and onion. Early spring treatment recommended and ester formulations were preferred by some.

6. Good management that encouraged a better turf was recommended in all reports. The common recommendations were high cut, lime, and fertilizer. Two listed hand-weeding as still important for some situations.

Problems Needing Further Study

1. Methods of control for such common weeds as *Poa annua*, clover, chickweed, muhlenbergia, pearlwort, and goosegrass.
2. Two reports desired work on pre-emergence control.
3. Two reports desired more work on fundamentals.
4. Continued evaluation of chemicals for crabgrass control.
5. Continued evaluation of di-sodium methyl arsonate and other new chemicals.
6. Better equipment for application of chemicals.

HIGHWAYS AND HERBICIDES

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Greater efficiency is being demanded of responsible highway personnel today. This is due to increasing labor costs and to the enormous increase in roadside areas on our constantly growing highway systems, most particularly in the construction of modern primary highways with wide rights of way. The development of chemicals to control vegetation in recent years has provided the means for more efficient roadside maintenance. Use of these chemicals by state highway departments in the northeastern section of the United States has not, however, kept pace with their widespread use in agriculture and industry.

In considering the use of chemicals to control vegetation on roadsides, highway officials are concerned about three factors - safety, economy and appearance. Of these, the safety of not only the traveling public, but also of personnel is of primary importance and warrants greater rather than less expenditure for any specific improvement. Highway safety can be improved by efficient control of vegetation interfering with sight distances on horizontal curves, by efficient control of vegetation to assure continuing visibility of signs and guard rails and by control of poisonous plants.

Considerable cost data indicating the economies made possible by the proper use of chemicals for roadside maintenance have been published (1,2,3)*.

Mowing is a continuing and costly operation. One excellent cost study (1) reports 4.3 acres mowed in a nine hour day by a sickle bar tractor mower and 1.75 acres by a small power mower. At $1.50 per hour for labor, this would be a cost of over $3 per acre for the former and over $7 for the latter for labor alone. One spraying of 2,4-D has been done for less than $3 an acre for labor and materials (2,3). The effect of this treatment which materially reduced the number of mowings necessary lasted more than one year.

Brush can be controlled by chemicals at a cost comparable to that for one or two cuttings by hand, the cost of subsequent control being negligible when chemicals are used and continuing when cutting is practiced (3).

Mowing of vegetation around structures such as guard rails and posts whether by hand or by equipment is expensive. Hand mowing has cost almost $100 an acre (1) or $35 for a swath three feet wide along one mile of guard rail. At least three such mowings at a labor cost of over $100 for one season would be required to give results comparable to those obtained with chemicals (2,3). Since reporting tests of several materials for this purpose to the Northeastern Weed Control Conference (4), one agency has used the highest

* Figures in parenthesis refer to references given.

rated material during the past four years at a cost of less than \$25 a season for labor and materials for each mile treated (3). Additional study is needed in this field due to the development of new materials such as Telvar W, Telvar DW and Dalapon.

Appearance, although least important, is actually improved by intelligent use of the available chemicals for improving safety and reducing costs. "Brownouts" are not necessary.

Recent reports from the state highway departments of 12 of 13 states included in the Northeastern Weed Control Conference area indicate that nine of those reporting have a herbicide control program, that four have programs embracing broad-leaf weed control, brush control and chemical mowing. Five report investigational work.

In one of the states included within this conference a board of water supply has forbidden the further use of 2,4-D to control broad leaved weeds within a water shed area because of the hazard of water polution. It is believed that such an objection to the use of plant hormones is similar to the objections voiced by bee keepers and some conservationists to the control of roadside vegetation with herbicides. An authoritative statement of policies on these subjects is needed.

There is at present a lack of agreement on necessary procedures. One agency has used 100 gallons of water an acre as a carrier for two pounds of 2,4-D acid equivalent for the control of broad leaved weeds while another agency has reported satisfactory control with as little as 12 gallons of water an acre. There is also a lack of suitable inexpensive equipment for use on the various phases of herbicide work along highways.

There appears to be need for an agressive educational program to acquaint highway officials with the value of intelligent use of herbicides on roadsides. Tests have been made and work has been done on a large scale which can be used to show that safety can be improved, maintenance costs lowered subsequently and appearance improved. There is need for continued study of new materials and for the development of more efficient methods and equipment.

REFERENCES

1. "Connecticut Highway Maintenance Production Study"; Highway Research Board Special Report 8 (1952).
2. "Roadside Vegetative Cover Research Project", Progress Report; Landscape Bureau, New York State Department of Public Works (March 1954).
3. "Roadside Vegetative Cover", Final Report; Landscape Bureau, New York State Department of Public Works March 31, 1954. (In press.)
4. "Progress Report on the use of herbicides to eliminate hand-mowing under guard rails and around traffic signs along New York Highways", Iurka and Pridham. "Proceedings" Fifth Annual Meeting, Northeastern Weed Control Conference (January 1951).

AQUATIC WEED CONTROL

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Chemical control of aquatic weeds is, at the moment, in a very disorganized state. In an effort to determine the situation, as regards aquatic weed control a questionnaire was sent to about thirty people, mostly in the northeast. These questionnaires were sent to persons connected with Industry, Colleges, the Fish & Wildlife Service and Divisions of Fish & Game. Twenty-two replies were received and of these fifteen were engaged in some sort of work on aquatic weed or algae control.

Most of the work is being done on an experimental or trial basis, although about half of these concerned have done some work on what might be called a production basis.

About twenty different chemical compounds have been tried experimentally. However, sodium arsenite, copper sulphate and the 2,4-D compounds seem to have been used most frequently.

Tests were conducted on over twenty species of aquatic and semi-aquatic plants. And in addition to these tests there were several workers who were concerned with algae.

Late Spring and Summer are generally felt to be the best time to treat aquatic weeds.

It is evident that all people interested in aquatic vegetation control are very anxious to have available a "clearing house" for information on this subject.

The following are some of the suggestions for research programs:

1. We need more work on physiology of aquatic plants - their nutritional and light requirements.
2. University level screening of potential herbicides and a State and Federal Fish & Game Agency field testing program of those showing promise.
3. Research on methods of application.
4. We need a compilation of all existing information on chemical control o f aquatic vegetation.
5. We need to ally ourselves with those interested in water pollution and sanitation.
6. We need a program whereby the states in the northeast divide the experimental load amongst them.

PUBLIC HEALTH

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Ragweed

Agreements

1. Approximately 5% of the persons living in the Northeast

have pollen hayfever. It is estimated that 70-80% of these are sensitive to the ragweed pollen and a large percentage of these develop asthma after repeated attacks of hayfever.

2. A few people develop a dermatitis when they come in physical contact with the ragweed plant.

3. The effective control of ragweed depends primarily on the prevention of seed production and fertilization.

4. The low pressure aqueous foliage spray application of 500-1000 parts per million or about ½ to 1 pound per 100 gallons of water of acid equivalent of 2,4-D of non-volatile formulations such as the sodium or amine salts of 2,4-D have been shown to be effective, practical and safe when applied as coarse foliage drenching sprays at the rate of 100-300 gallons per acre, depending on size of plants. Ester formulations should not be used. Spraying should not be done on windy days because of drift.

5. Spraying ragweed not only prevents pollen and seed production, but has a cumulative effect. Future ragweed growth is discouraged through the stimulation of competing vegetation especially grasses.

6. The control of ragweed plants in urban areas, using 2,4-D has proven effective and economically feasible, as well as beneficial to hayfever sufferers within such areas. Control along highways and railroads is highly desirable to complement and supplement urban control programs.

7. The time period for spraying in any community depends on equipment and manpower available in relation to extent of weed growth to be sprayed. When spraying can be completed in a few weeks it should be done as late as possible during the growing season and still be completed by the first week in August.

8. Most municipalities find it desirable to conduct weed control programs with several departments cooperating. Such departments generally include one or more of the following: health, public works and parks.

9. Two types of programs that provide the maximum of control are:

   First, the control of the extensive and concentrated ragweed growth in urban areas where the largest number of people will benefit with the least per capita cost, and

   Second, the control of ragweed along highways and railroads where people travel between home and work.

Problems Needing More Work

1. The cooperation of specialists, including aerobiologists, botanists, statisticians, public works engineers, sanitarians, agriculturists and public health administrators, is essential in solving the problems of control and in evaluating control programs.

2. Research to determine the concentration and dynamics of pollen in the atmosphere necessary to bring about allergic reactions.

3. The botanical and meteorological factors influencing the distribution of pollen in the air from the ragweed growing areas.

4. Measuring devices to quantitatively sample pollen in air. This is necessary to determine where pollen is coming from and to measure the reduction in pollen concentrations in the air following the elimination or reduction of ragweed growing areas.

5. Field surveys of States or regional areas to determine the location, the extent and the intensity of infestations of ragweed.

6. The development of control programs on a regional basis.

7. Research is needed in plant ecology. Such research should include the effect of weed killers on plants and on the use of competitive plants to compete with or suppress ragweed growth in places where competitive plants are now discouraged by an unfavorable environment.

8. Research is needed on the life history of ragweed in order to better understand the problems of control.

9. The development of practical measures for the control of ragweed in connection with the growing of crops such as potatoes, corn, tomatoes, grain, etc. Progress has been made in developing chemical methods of weed control in the growing of potatoes.

10. The encouragement of private organizations, financed by public contributions, that are dedicated to the relief of hayfever sufferers.

Poison Ivy

Agreements

1. A substantial percent (as high as 20% to 25%) of the population in many suburban-type communities, where poison ivy has been allowed to grow unchecked, are poisoned from contact with this plant each season.

2. Poison plants killed by chemicals retain some of their poisonous quality for a considerable period of time

after they turn brown and appear dead.

3. Research is needed on the life history of poison ivy in order to better understand the problems of control.

4. Poison ivy is found in wood lots, along fence rows, in parks and school playgrounds and in other recreational areas, as well as growing on trees, poles and in orchards.

5. Poison ivy can be effectively controlled using, ammonium sulfamate, 2,4,5-T, and combinations of 2,4-D and 2,4,5-T ester formulations. Higher concentrations of the chemical are necessary to kill poison ivy growing in the shade than in the sun.

6. Borax has been successfully used at rates of 4 lbs. per 100 sq. ft.

Problems Needing More Work

1. Studies of penetration, absorption and translocation of herbicides in the poison ivy plant and the influence of time of application on the effectiveness of control.

2. Research is needed to determine uniform applications of lethal amounts of herbicide to control poison ivy and in the development of wetting and spreading agents.

3. The cooperation of several specialists, including botanists, public works engineers, sanitarians, agriculturists and public health administrators, is essential to developing good control programs.

HERBACEOUS PERENNIAL AND BIENNIEL WEEDS

Prepared by Joe Antognini
Presented by H. M. Day
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Several chemicals are recommended for use but for most weeds in this class we still do not have chemical control methods which are economical for large areas.

No major changes from the 1954 recommendations are listed below. There were a large number of reports suggesting the use of Dalapon and Amino triazole and some reports recommended these chemicals.

Bedstraw (Gallium Mollugo)

Bedstraw is a problem in birdsfoot trefoil.

Agreement

Dalapon at 10 pounds per acre applied as a fall treatment.

Further work needed

1. Use of Dalapon at lower rates than above as a spring treatment. Studies to determine the effect of Dalapon on seed setting of birdsfoot trefoil.

2. Complete evaluation of water soluble dinitros as spring and/or fall applications.

Bermuda Grass (Cynodon dactylon)

One report suggests the use of sodium TCA as a spray at a rate of 2 pounds per 1000 square feet anytime active growth is occurring. The same report also suggests plowing in September followed by a winter smother crop of small grain. After harvesting the grain the ground should be plowed and planted to a summer smother crop.

Further work needed

Use of Dalapon and MH.

Chicory (Cichorium Intybus)

Agreement

2,4-D at ½ to 1 pound per acre applied in spring or fall when plants in the vegetative state.

Further work needed

Use of 4-chloro amine at a rate of 0.2 pounds per acre applied in early spring.

Chrysanthemum Weed (Artemisis Vulgaris)

One report states that Chloro IPC (4 pounds per gallon) used at a dilution of 1:25 and applied at a rate of 1 gallon per 100 feet of plant row on woody nursery stock. The treatment was applied as a basal spray in summer and winter. No injury to the woody nursery stock and root counts on the Artemisia were reduced by one-half following two treatments.

Canada Thistle (Cirsium arvense)

Agreement

1. Chemical - 2,4-D at rate of ½ to 1½ pounds acid equivalent per acre in bud stage. Treatment for more than one season needed for eradication. One report states that MCP is more effective than 2,4-D.
2. Chemical plus cultural - Mowing plus 2,4-D.

Further work needed

1. Continued evaluation of MCP.
2. Rates of 2,4-D necessary for eradication.
3. Use of Silvex - One report suggests use of Silvex at rate of 1 pound per acre.

4. Use of amino-triazole - one report recommends amino-triazole as a spot treatment at 4 pounds per acre and one report suggests use of amino-triazole at 2-6 pounds per acre. Need information on the following:
   a. Minumum rates required.
   b. Stage of growth at time of application.
   c. Effect on various types of pastures.
   d. Combinations with cultural practices.

Curled Dock (Rumex crispus)

A survey in New Jersey has shown that 12.7% of the hay contains this weed.

Work needed

Evaluation of chemicals for use at several places in the rotation system which includes hay, corn and grain.

Golden Rod (Solidago nemoralis)

One report recommends 2,4-D at 1 pound per acre before bloom for control in pastures. One report suggests amino triazole at 2 pounds per 100 gallons as a thorough cover spray applied pre-bloom or bud stage for control in pastures.

Horse Nettle (Solanum carolinense)

Agreement

2,4,5-T, 2,4-D and 2,4-D--2,4,5-T mixture at 2 pounds acid equivalent per acre in early bloom stage. Retreatment the same or following year may be necessary.

Further work needed

1. Information concerning the extent of vegetative and seed reproduction.
2. Use of amino-triazole which was suggested for use in one report at 2-8 pounds per acre applied to active-vigorous growth. Looks promising and safe for corn and other row crops planted 2-3 weeks following spraying of weeds. Need information on the following:
   a. Minimum rates required.
   b. Stage of growth at time of application.
   c. Effect on various crops.
   d. Combinations with cultural practices.
3. Use of S/V Agronyl R.

Johnson Grass (Sorghum halepense)

Agreement

1. Sodium TCA for spot treatment at a rate of 50-100 pounds acid equivalent per acre. Application should be made just prior to or at time of emergence.
2. Dalapon applied at 20 pounds per acre in 50-100 gallons per acre and ½-1 pound per gallon for spot treatment.

Make application on seedlings or after mowing.

3. For cultural control on non crop disc during hot dry weather and repeat as new growth appears. For large infested areas graze or mow closely for 1 year; following year plow shallow and work ground every 2 weeks with duckfoot shovels; following year cultivate until time to plant a smother crop such as soybeans.

Further work needed

1. More work on the use of Dalapon with emphasis on treatment of foliage prior to land preparation for cropping.

Milk Weed (Asclepias syriaca)

One report recommends CMU at 1 pound per gallon as a spot treatment. One report recommends amino triazole as a thorough cover spray at rate of 2-4 pounds per 100 gallons just before bloom.

Further work needed

1. Effect of wetting agents with some of presently used translocated herbicides.
2. Use of Silvex
3. Use of CMU.
4. Use of amino triazole with emphasis on rates of application and time of application.
5. Use of S/V Agronyl R.

Nut Grass (Cyperus esculentus)

Agreement

Sodium TCA at rates of 50-100 pounds acid equivalent per acre. Applied when nut grass shoots are 2-6 inches tall followed by discing or harrowing.

Further work needed

1. Use of Dalapon at rates of 5-10 pounds per acre.
2. Use of Silvex at rates of 1-3 pounds per acre.
3. Use of S/V Agronyl R.
4. Use of Amino triazole at rates of 2-10 pounds per acre. One report recommends Amino-triazole at 2-4 pounds per acre when shoots are 2-3 inches tall.
5. Use of Alanap as a pre-emergence treatment at 8 pounds per acre.
6. Further evaluation of cultural practices in combination with chemicals.

Quack Grass (Agropyron repens)

Agreement

Fall plowing followed by continued cultivation the following spring and summer and a smother crop the second season.

Sodium TCA at 50-100 pounds acid equivalent per acre applied on plowed soil. One report suggests discing chemical into soil. No complete agreement as to time of application although trend is toward agreement on late summer or fall applications. Repeat application if heavy rainfall occurs shortly after application.

Further work needed

1. Use of MH and amino triazole in the spring prior to plowing land for corn.
2. Use of Dalapon at 25-40 pounds per acre on the foliage followed by repeat applications of 5-10 pounds per acre.
3. Use of Dalapon at 5-10 pounds per acre on foliage 2 weeks before plowing and 4 weeks before planting of corn.
4. Use of Amino-triazole at rates of 2-8 pounds per acre to vigorous growing Quack grass and planting of crops 1 to 3 weeks later.
5. Timing of applications of Dalapon and Amino triazole in relation to stage of growth and cultural practices.
6. Use of S/V Agronyl R.

Wild Onion or Garlic (Allium spp.)

Agreement

Cultural control - clean cultivation in row crops.

Chemical control - 2,4-D ester at 1-1½ pounds acid equivalent per acre in fall and spring. Retreatment for several years needed for erradication. This method primarily for pastures.

Further work needed

1. Method of control in underseeded grains.
2. Stage of growth at time of application.

ORNAMENTALS

Arthur Bing
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Farmingdale L. I., N. Y.

This summary covers a very diverse group of crop plants. Chemical weed control has been tried on a small number of the many ornamentals that are grown commercially. Although there is considerable interest in the use of chemicals to control weeds in ornamental plantings, the acreages of most crops are too small to warrant large scale testing by chemical companies or experiment stations. Information in this field is therefore very scarce and much of the data that is available comes as isolated reports based upon a wide variety of crops and conditions. Information from New York State happens to be more readily available and is therefore used to a larger extent in this report.

Sources of Information

	Questionaires sent	Questionaires acknowledged	Information
Chemical Companies	33	13	5
Research workers	30	12	6
Nurseries and florists	66	24	16

Woody Nursery Crops

Preplanting in beds for seedlings or liners.

Agreement

1. Methyl bromide at 1#/100 sq. ft. using plastic cover (5 reports)
2. Chloropicrin (2 reports)

For trial

1. Allyl alcohol - 3 qts./100 gallon per 100 sq. yds.
2. Stauffer N 869 - 200-400#/acre with enough water to soak down 3".

   (Also very effective nematocide)

Post emergence for seedlings

Agreement

1. Salvasol for evergreen seedlings (1 report).

For trial

1. SES - 2-4#/40 gal/acre.
2. CIPC - 2#/50 gal/acre.

Liners spring and summer

Agreement

1. SES - 2-4# (6 reports)

For trial

1. Alanap 2-4#/50-100 gal/acre

Established evergreens

Agreement

1. SES - 2-4# for spring and summer (4 reports)
2. SES - 2-4# for fall (2 reports)
3. DNOSBP - 3-9# for fall (3 reports)
4. CIPC - 4-8# for fall (3 reports)

For trial

1. Pentachlorophenate for fall (1 report)
2. DNOSBP for summer (1 report)
3. Sodium ethyl xanthate 6#/50 gal/acre

Established deciduous plants

Agreement

1. SES for fall (2 reports)
2. DNOSBP for fall (3 reports)
3. CIPC for fall (3 reports)

For trial

1. SES for summer (1 report)

Herbaceous Ornamental Crops

Gladiolus pre-emergence

Agreement

1. SES - 4#/50 gal/acre (5 reports)
2. DNOSBP - 4-8#/50 gal/acre (3 reports)
3. CIPC - 4-8#/50 gal/acre (2 reports)
4. 2,4-D amine 2-3#/50 gal. (3 reports)

For trial

1. CMU - 2#/50 gal/acre on corms very likely harmful if used on cormels. (2 reports)
2. SES - 4# plus CIPC 4#
3. 2,4-D 2# plus TCA 10# (3 reports)
4. Oktone 12# in 50 gallons of oil just before emergence.

Gladiolus post emergence

Agreement

1. SES - 2-4#
2. 2,4-D amine 1-2#

For trial

1. Sodium ethyl Xanthate
2. Potassium cyanate 2% solution at 50 gal/acre - directed spray on plants over 12" tall.

For study

1. Alanap depends on weather and soil conditions (2 reports)
2. Various mixtures of SES, DNOSBP, CIPC, 2,4-D and TCA.

Perennials

Agreement

1. SES - 2-4#/50 gal/acre, depends upon species for tolerance, plants must be established (2 reports)

2. *Methyl bromide for seed beds, used commercially for pansies (7 reports)
3. Chlorpicrin for seed beds (5 reports)
4. Steam is very effective where available near greenhouses.

For trial

1. Allyl alcohol - soil treatment
2. Stauffer N-869 - soil treatment
3. Aero cyanamid 6-10#/100 sq. ft. - soil treatment
4. DNOSBP - on established plants

Annuals

Agreement

1. Soil treatments as for perennials

For trial

1. SES 2-4#/50 gal/acre depends upon variety for tolerance: zinnia and asters are not tolerant (2 reports) plants must be established, soil moist, weeds just emerging.

Comments

Moist soils greatly improved the herbicidal effect of most treatments so applications are advised after rain or irrigation when weeds are most susceptible. In dry soils older weeds have deeper roots and are hard to eleminate. Most materials do their best job if crop plants are established and weeds are very young. In nurseries it is difficult to get good coverage with herbicides if weeds grow to a large size.

We can look forward to greatly increased use of chemical weed control in nurseries.

*Do not use in soils to be planted with carnations or relatives.

SOIL STERILIZATION

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Chemicals Recommended

Chemical *	Rate of Application	Method of Application	Stage of Growth at Time of Application
Borascu Borascu 44 Conc. Borascu Tronabor Gerstley Borate	10 lbs./100 sq.ft. 7-3/4 lb./100 sq.ft. $5\frac{1}{2}$lbs./100 sq.ft. $7\frac{1}{2}$-11 lbs./100 sq. ft. 10-12 lbs./100 sq.ft.	Apply dry by hand broadcast or mechanical spreader	Pre-emergence or early post-emergence. Fall, winter, or early spring. Deep-rooted perennials: Fall or winter
Atlacide	500 lb./A in 200-300 gal. water	Spray	In early growth stages
Polybor-chlorate	2 lbs./150-200 sq. ft. (annuals) 2-4 lbs./100 sq.ft. (perennials)	Spray Spray	Perennial weeds: near maturity or dormant stages, or in fall months
Polybor-chlorate-88	2 lbs./125-175 sq. ft. (annuals) $2\frac{1}{2}$-5 lbs./100 sq. ft. (perennials)	Spray Spray	
Tumble-weed 25	1 lb./100 sq.ft. in 1 gal. water (annuals) $1\frac{1}{2}$ lb./100 sq. ft. (annuals) 2-4 lbs./100 sq.ft. (2 lbs./gal.)-(perennial) 2-4 lbs./100 sq.ft. (perennial)	Spray Dry Spray Dry	Perennials- Spring application as plants approach maturity except in areas of low rainfall where late summer or fall applications are suggested
"Telvar" W "Telvar" DW "Karmex" W	20-80 lbs./acre (higher dosages for deep-rooted perennials)	Spray	On bare soil shortly before plant growth begins
"Telvar" W	$\frac{1}{4}$-$\frac{1}{2}$ cup/100 sq.ft. in $2\frac{1}{2}$ gals. water	Spray with sprinkling can or knapsack sprayer	Spot treatment
"Karmex" W	$1\frac{1}{2}$-2 lbs./1000 sq. ft.	Spray	Spot treatment of deep-rooted perennial
TCA	$\frac{1}{2}$-1 lb./100 sq.ft.	Spray	Spot treatment of perennial grasses
Calcium Cyanamide	50-75 lb./1000 sq.ft.	Pre-seeding	On lawns, pt.greens, other turf. Treat in late summer or early fall at least 3 weeks before seeding.

Chemical *	Cultural Practices Recommended
Borascu Borascu-44 Conc. Borascu Tronabor Gerstley Borate	Where practical, cut and remove all growth exceeding 4 to 6 inches in height to insure an even spread of chemical. Quackgrass, Bermuda, nut and Johnson grass should be scalped or cut very close before conc. Borascu is applied.

Chemical	Combinations of Chemical and Cultural Practices Rec.
Borascu Borascu-44 Conc. Borascu Tronabor	On bare ground, raking in will prevent material from washing away during heavy rains.
Calcium cyanamide (Granular)	On lawns, putting greens, and other turf. On fully prepared seed beds, mix cyanamid in surface ½ inch of soil. On old turf to be renovated, mow closely and aerify or scarify to bring cyanamide into contact with soil.

Chemical	Remarks
	Adequate moisture is desirable optimum results with most chemicals. With the exception of calcium cyanamid, rainfall should be at the time of treating or soon thereafter.
Calcium cyanamide (Granular)	Adequate moisture at time of treating and through seeding and growing period essential. Use low nitrogen fertilizer. Cyanamide and superphosphate may hasten waiting period between treatment and planting.
"Karmex" W	In irrigation ditches, apply "Karmex" W preceding expected seasonal rainfall, when soil in ditch is moist.

Chemical	Further Work Needed
Calcium Cyanamide (Granular)	Proper timing and methods of use are essential to success and need to be stressed in extension or educational programs.

*Chemical Names

Borascu	sodium biborate (borax) 93%
Borascu-44	boron trioxide 44%
Borascu, Conc.	anhydrous sodium biborate (borax) 89%
Tronabor	socium borate, minimum 44% B_2O_3
Gerstley Borate	A sodium calcium borate ore, a mixture of Ulexite ($NaCaB_5O_9 \cdot 8H_2O$) and Colemanite ($Ca_2B_6O_{11} \cdot H_2O$)
Atlacide	sodium chlorate 58%

*Chemical Names

Polybor-chlorate	sodium pentaborate 58%, sodium biborate pentahydrate 15%, sodium chlorate 25%
Polybor-chlorate-88	sodium pentaborate 44%, sodium tetraborate 11%, sodium chlorate 22%
Tumble weed-25	borate-chlorate, minimum 72% soluble borates
"Telvar" W	3-(p-chlorophenyl)-1, 1-dimethylurea, 80%
"Karmex"W	3-(p-chlorophenyl)-1, 1-dimethylurea, 80%
"Telvar" Dw	3-(3,4-dichlorophenyl)-1, 1-dimethylurea, 80%
TCA	sodium trichloroacetate 90%

SOIL STERILIZATION
CHEMICALS SUGGESTED

Chemical *	Rate of Application	Method of Application	State of Growth at Time of Application
Experimental Herbicide DB Granular	1-3 lb./100 sq. ft.	Apply dry by hand or fertilizer spreader directly to soil	Deep-rooted perennials: Fall applica tion. Annuals: When seedlings appear in Spring
Experimental Herbicide DB Spray Powder	1-3 lb./100 sq. ft. (1-2 lb./gal. water)	Spray	ditto Woody brush: Late fall or early spring
Chipman Chlorax Spray Powder	1-4 lb./100 sq. ft.	Spray	Submersed aquatics Spring
"Karmex" W	20-100 lb./acre	Spray or broadcast	Submersed aquatics Spring or early growth
TCA	80-100 lb./acre	Spray	Spot treatment: early Fall for Quackgrass

Chemical *	Remarks
Experimental Herbicide DB Granular	Designed primarily for control of deep-rooted perennials on non-cultivated land and/or small patches in cultivated land when temporary residual action is not objectionable.
Experimental Herbicide DB Spray Powder	For woody brush, make applications to soil and out to perimeter of foliage.
Chipman Chlorax Spray Powder	To be applied to exposed pond bottoms, ponds to remain drained for 3 days to 2 weeks.
"Karmex" W	To be applied to exposed pond bottoms, ponds to be exposed = 30 days

A Tabular Summary of the 1955 Report of the Research Coordinating Committee Northeastern Weed Control Conference

A tabular summary was presented as a part of the Research Report in 1954 and met with the general approval of the members of the Conference. It is, therefore, presented here as a regular part of the Report.

These tables are offered as a means of ready reference and summarization of the general Research Coordinating Committee Report. Reference is made to the general report in each item listed so that more complete information may be obtained by turning to the reference page. In some cases treatments suggested in previous years are carried over and are indicated in the reference page column by "Pr Yr ".

The chemicals listed in the extensive use category in these tables are subject to prior approval by the U. S. Food and Drug Administration before general use.

L. L. Danielson
Chairman

Control of Weeds in Crops

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Alfalfa (Seedling)	25	NH_2DNOSBP	(1)	1-1½	Post-E Dorm.
		CIPC	(1)	1-2	Post-E Dorm. No grass seedin
Alfalfa (Est)	25	CIPC	(1)	1-3	Dorm. Early winter for chickweed
Asparagus (Cutting beds)	6	CMU	(1,2)	1-3	Pre-E
		SES	(1)	2½-3	Before weeds emerge. Any stage asparagus.
		Gr. Cyan.	(1)	200-400	When weeds are small
		Cyan. Dust.	(1)	70-100	During cutting season
		2,4-D	(1)	1	Pre-E
		NaPCP	(1)	20	Pre-E
		DNOSBP	(1,2)	5	Pre-E
		KOCN	(1)	3% spr.	Post-H directed spray
		CIPC	(1)	1	Pre-H for chickweed
		Alanap-1	(2)	4	Pre-E
Asparagus (Seed beds)	7	PCP	(1)	6	Pre-E
		CMU	(1,2)	1½	Pre-E and Post-E
		NaPCP	(1)	20	Pre-E
		DNOSBP	(1)	3	Pre-E
		Stod Solv	(1)	80 G	Post-E at 4"
		Alanap-1	(2)	4	Post-E

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds Per acre	Time of Applications and Comments
Beans (all veg. bean crops)	10	$NH_2DNOSBP$	(1)	3-6	Pre-E Lower am't. on sandy soil
		NaPCP	(1)	16-25	Pre-E
		CIPC	(2)	2-4	Post-P
		CIPC + DN	(2)	3+3	Pre-E
Beans, Soy	22	$NH_2DNOSBP$	(1)	3-6	Pre-E
		PCP	(2)	16-20	Pre-E
		CIPC	(2)	6-8	Pre-E
		Alanap-1	(3)	2-6	Pre-E
		Silvex	(3)	2	Pre-E
Beets, Red	13	NaCl	(1)	200-400	2#/gal.at 4-5 true leaf stage
		TCA	(2)	8-12	Pre-E for grass control
		CIPC	(2)	2	Pre-E for greens only
Blackberries	17	SES	(1)	3-4	To clean soil except when suckering
		2,4-D	(1)	1	Except when suckering
		Fuel Oil	(1)	40 G	Spot for temporary grass control, avoid too much contact with canes and leaves.
		CIPC	(2)	6	October through November
		Dalapon	(2)	5	October through November
		CIPC	(3)	6-14	Fall and spring
		Dalapon	(3)	5-12	Fall and spring
		CMU	(3)	2-6	Fall and spring
Blueberries (Cultivated)	17	SES	(1)	3	To clean soil
		DNOSBP	(1)	3	40 gals. H_2O as directed, spray in early summer
		DNOSAP	(1)	3	40 gals. H_2O as directed, spray in early summer
		CMU	(2)	1	2 Applications to clean soil, one in April, one in July
		CIPC	(3)	5-50	Fall and spring
		Dalapon	(3)	5-30	Fall and spring; repeat spplication
		CMU	(3)	2-8	Fall and spring
Blueberries (Wild)	18	2,4-D	(1)	2000 ppm	Spot spray in growing sea-scn susceptible weeds
		2,4-D	(1)	4000 ppm	Spot spray in growing sea-son resistant weeds
		2,4,5-T	(1)	4000 ppm	Spot spray in growing sea-son weeds very resistant to 2,4-D
		Ammate	(1)	1/gal	Spot spray in growing sea-son red maple
		2,4-D	(1)	4	100 gals. oil, stub treat-ment of 2,4-D susceptible brush

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
cont. Blueberries (Wild)	18	2,4-D & 2,4,5-T	(1)	4	100 gals. oil, stub treatment of 2,4-D susceptible brush
		2,4-D & 2,4,5-T	(1)	8	100 gals. oil, stub treatment of brush resistant to 2,4-D
		2,4,5-T	(2)	4000ppm	Low volatile ester in H_2O in mid-June-early Jul Spot for bayberry or in fall preceding burn where bayberries are very thick.
		CMU	(3)	5-15	Fall and spring
		Polybor-chlorate	(3)	400-600	Fall preceding burn for brake control
Cantaloupes	21	Alanap-1,2	(1)	6	Pre-E
		NH_2DNOSBP	(2)	2-3	Pre-E
Carnations	30	SES	(3)	2-4	Before weeds emerge.
Carrots	4	Stod Solv	(1)	75-125G	After 2nd true leaf. Appl on cool cloudy days.
Celery	5	Stod Solv	(1)	75-125G	Seed beds only
Cereals, Spr (Not seeded	23	2,4-D	(1)	¼-½	Post-stooling, Pre-jointi
		MCP	(1)	¼-½	Post-stooling, Pre-jointi
Cereals, Spr (seeded)	24	NH_2DNOSBP	(1)	3/4-1½	Weeds small grain under 6'
		MCP	(1)	¼-½	Where weeds severe, canop over legumes, especially on red clover.
		2,4-D A	(1)	¼-½	Where weeds severe, canop over legumes
Cereals, Wntr (Not seeded)	24	2,4-D A	(1)	¼-½	Spring, post-stooling, pre-jointing
		MCP	(1)	¼-½	Spring, post-stooling, pre-jointing
		MCP	(2)	½-3/4	Control of wild onions or garlic
		2,4-D E	(2)	1	Control of wild onions or garlic
Cereals, Wntr (Seeded)	24	2,4-D A	(2)	¼-½	In early spring when weeds are small
		NH_2DNOSBP	(2)	1	Used to control chickweed

* (I) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Chrysanthemum	Pr Yr	MCP	(1)	¼-½	On canopy of weeds in spring
	Pr Yr	SES	(3)	2-4	Before weeds emerge
Clover (Seedling)	25	NH_2DNOSBP	(1)	1-1½	Post-E Dorm. No grass seeding
		CIPC	(1)	1-2	Post-E Dorm. No grass seeding
Cole Crops	5	CIPC	(2)	2	Post-Pl. Warm weather
			(2)	1	Post-Pl. cool weather
		Natrin	(2)	3	On transplants
		TCA	(2)	25-40	Pre-Pl. 60-90 days
Corn, Field	20	2,4-D	(1)	1-2	Pre-E. esters preferred
		NH_2DNOSBP	(1)	3-6	Pre-E
		2,4-D	(1)	¼-½	Post-E, Use drop nozzles when necessary
		Ca Cyan	(2)	400	Pre-E
		CMU	(2)	½-2	Pre-E
		NH_2DNOSBP	(3)	3-6	At emergence-good results reported
		NH_2DNOSBP	(2)	3-6	Post-E
		Am. Triazole	(3)	2-4	Pre-E. or Pre-plowing for quackgrass
		Silvex	(3)	2-3	Pre-E. good results reported
Corn, Sweet	7	DNOSBP	(1)&(2)	3-6	Pre-E
		DNOSBP	(1)&(2)	1½-3	Post-E, in spike stage
		2,4-DA	(1)	1¼-1½	Pre-E, not on sandy soil
		2,4-DA	(1)	½	Post-E
		2,4-DE	(1)	3/4-1	Pre-E
		2,4-DE	(1)	¼-½	Post-E
		NaPCP	(1)&(2)	15-25	Pre-E
		NaPCP	(1)	4-6	Post-E, in spike stage
		Gr Cyan	(1)	300	Pre-E
		CMU	(2)	¼-3/4	Pre-E
		TCBA	(2)	1-2	Pre-E
		Natrin	(2)	2	Pre-E
		SES	(2)	2	Pre-E
		Sesin	(2)	2	Pre-E
Cucumbers	11	Alanap-1,2	(1)	6	Pre-E
		NH_2DNOSBP	(2)	2-3	Pre-E
Cranberries	Pr Yr	Fe S	(1)	1-4T	Rate and time depend on problem.
	Pr Yr	PDB	(1)	1200	Mid Apr. - Mid Nov.
	Pr Yr	NaCl	(1)	150-200	June - July
	Pr Yr	NaAs	(1)	1½-3	Early August
	Pr Yr	Cu SO_4	(1)	20-120	Rate depends on problem
	Pr Yr	Kerosene	(1)	400-1000G	Early May

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
cont. Cranberries	Pr Yr	2,4-DA	(1)	1:2 dil	Avoid cranberry vines
	Pr Yr	NaNO3	(1)	300-500	June and July
	Pr Yr	NaAs	(1)	60-90	For shores
	Pr Yr	Ammate	(1)	75-300	For ditches and shores
Dill	4	Stod Solv	(1)	75-125G	Beyond 2 leaf stage. Apply on cool cloudy days
Fennel	4	Stod Solv	(1)	75-125G	Beyond 2 leaf stage. Apply on cool cloudy days
Gladiolus	38	SES	(1)	4	Pre-E
		NH_2DNOSBP	(1)	4-8	Pre-E
		CIPC	(1)	4-8	Pre-E
		2,4-DA	(1)	2-3	Pre-E
		CMU	(2)	2	Pre-E. Corms only. Not cormels
		SES + CIPC	(2)	4+4	Pre-E
		2,4-DA + TCA	(2)	2+10	Pre-E
		Oktone	(2)	12	In 50 gals. kerosene just Pre-E
		SES	(1)	2-4	Post-E
		2,4-DA	(1)	1-2	Post-E
		NaEx	(2)		Post-E
		KOCN	(2)	2%	50 gal/A. Directed spray after 12"
Lettuce	5	CIPC	(1)	1½	1 wk. after transpl. in field. Delays maturity 1 w
		CIPC	(1)	½	Immed. after seeding
		CIPC	(2)	½-3	Immed. after seeding
		CIPC	(2)	1	After transplanting
		CIPC	(2)	1	Granular form either Pre or Post-E
Nursery Stock (Seedlings or liners)	37	M Br	(1)	1/100 ft.^{2}	Pre-Pl. Use plastic cover
		CP	(1)		Pre-Pl
	Pr Yr	Gr Cyan	(1)	½-1T	Pre-Pl. Before weeds emerg
	Pr Yr	TCA	(1)	50	Pre-Pl. 6 mo. for quackgr.
	Pr Yr	NIX	(1)		Pre-Pl. Pre-E
	Pr Yr	KOCN	(1)		Pre-Pl. Pre-E
		Allyl Al	(2)	3 qts.	Pre-Pl. in 100 gal. water/ 100 sq. yds.
		St. N869	(2)	200-400	Pre-Pl. In enough water to soak down 3".
	Pr Yr	M Spirits	(1)	20-30G	Pre-E, Post-E on conifers except larch and spruce
		Salvasol	(1)		Post-E. Evergreen seedling
		SES	(2)	2-4	Post-E for seedlings
		CIPC	(2)	2	Post-E for seedlings
Nursery Stock (Liners, Spring and Summer)	37	SES	(1)	2-4	
		Alanap-2	(2)	2-4	

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Nursery Stock (Est ever-greens)	37	SES	(1)	2-4	Spring, summer, and fall
		DNOSBP	(1)	3-9	For fall
		CIPC	(1)	4-8	For fall
		PCP	(2)		For fall
		DNOSBP	(2)		For summer
		NEX	(2)	6	
Nursery Stock (Est decidu-ous plants)	38	SES	(1)	2-4	For fall. Directed
		NH_2DNOSBP	(1)	3-4	For fall. Directed
		CIPC	(1)	4-8	For fall. Directed
		SES	(2)	2-4	For summer. Directed
	Pr Yr	NIX	(1)	8	Directed spray
	Pr Yr	Gr Cyan	(1)	600-800	On row middles. Moist soil
Onions	10	Cyan Dust	(1)	75	Pre-E
		CIPC	(1)	2-6	Pre-E on seed or set onions
		CMU	(2)	1	Pre-E
		NaPCP	(2)	20	Pre-E
		PCP	(2)	2	Pre-H for late weeds
		KOCN	(1)	1-2%	1% Post-E at flag stage 2% Post-E after 6"ht.
		CIPC	(1)	2-8	Post-E 2 lbs. on light min. soil. 8 lbs. on muck after 6" ht.
Orchards	Pr Yr	DN Em	(2)	1-2	Directed and repeat
(Bindweed)	Pr Yr	2,4-DA	(2)	1+1	Post-H directed spray
Orchards (Quackgrass	19	CMU	(3)	11.2gms	to 10 $ft.^2$
		PDU	(3)	11.2gms	to 10 $ft.^2$
		BHC	(3)	0.2 lb.	to 10 $ft.^2$ Around newly planted apple, cherry, peach, and plum trees
Orchards (Gen. weeds)	Pr Yr	DN Em	(2)	1-2	Directed sprays & use on grasses in fence rows
	22	2,4-DE + 2,4,5-T	(3)	1+	Under trees to control poison ivy and root suckering.
Ornamentals (Herbaceous)		SES	(1)	2-4	Tolerance depends on specie
(perennials)	39	MBR	(1)		Pre-Pl for seed beds. Used comm. for pansies. Not on carnations or rel.
		CP	(1)		For seed beds Pre-Pl
		Steam very effective on seed beds. Pre-Pl			
		Allyl Al	(2)		Pre-Pl for seed beds.
		St. N-869	(2)		Pre-Pl for seed beds.
		Cyan Dust	(2)	6-10/ 100 sq. ft.	Pre-Pl for seed beds.
		NH_2DNOSBP	(2)		Pre-E directed on est. plants.

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Ornamentals (Herbaceous annuals)	39	Soil treatments as for perennials above.			
		SES	(2)	2-4	Tolerance depends on variety. Zinnia & asters not tol. On est. plants, moist soil, small weeds.
Orchards (Poison Ivy & honeysuckle)	Pr Yr	2,4,5-TLVE	(2)	1-2	Active ore dormant directed Do not use on winesap or in pear orchards. May injure stone fruits.
	Pr Yr	2,4-DLVE & 2,4,5-TLVE	(2)	2-3	Same cautions as above.
		Ammate	(2)	75-100	Directed spray. Use on trees 5-6 yrs. old.
Parsnips	4	Stod Solv	(1)	75-125G	After 2 leaf stage. Apply on cool cloudy day.
Pastures(Perm)	24	2,4-DA	(1)	1	E spr & repeat if needed
(Sum. ann. brdlf. weeds)	24	MCP	(1)	1	E spr & repeat if needed
(Brambles & Woody plants)	25	2,4,5-TE	(1)		Spot treat early sum. or dorm.
		2,4-DE + 2,4,5-TE	(1)		Spot treat early sum. or dorm.
(Wild garlic)	25	2,4-DE	(1)	$1\frac{1}{2}$	Ear. spr. and repeat as needed
(Horse nettle)	25	2,4-DE + 2,4,5-TE	(1)	$1\frac{1}{2}$-2	Blossom time & repeat if nec.
(Per and wntr ann weeds)	25	2,4-D	(1)	$\frac{1}{2}$-$1\frac{1}{2}$	
		MCP	(1)	$\frac{1}{2}$-$1\frac{1}{2}$	
Pastures (Semi Perm)	25	General weeds - Rotational grazing, fertilization, and mowing are of primary importance.			
Peas	9	DNOSBP	(1)	$4\frac{1}{2}$-6	At planting
				3-$4\frac{1}{2}$	Pre-E
				$1\frac{1}{2}$-3	At emer.
		NaPCP	(2)	15-20	Pre-E
		Gr. Cyan	(2)	300	Broadcast 1-3 days Post-Pl
		DNOSBP	(1)	3/4-$1\frac{1}{4}$	Post-E on peas 3-8" tall. Do not treat if temp. above 80-85°. Use lower rate when temp. high
Peppers	9	Natrin	(2)	2	After first cult.
		Sesin	(2)	2	After first cult.
		DNOSBP	(2)	9	Before transpl.

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Potatoes, Irish	13	DN Em	(1)	3-5	Pre-E
		NH_2DNOSBP	(1)	1½-6	PreE or at emergence
Potatoes, Sweet	12	Alanap-1	(2)	3	Immed. after setting
Pumpkin	11	NH_2DNOSBP	(1)	2-3	Pre-E
		Alanap-1	(2)	1-4	Pre-E
Raspberry	16	DNOSBP	(1)	4-6	Before new shoots emerge.
		DNOSBP	(1)	2-4	When tips of new canes will not be hit.
		SES	(1)	3-4	During growing season except when new canes are emerging.
		2,4-D	(1)	1	Amine, except when new canes are emerging.
		No. 2 Fuel Oil	(1)	40gals.	Spot for grasses, except when new canes are emerging
		CIPC	(1)	6	Oct. 15-Nov. 30, grasses and chickweed.
		Dalapon	(2)	5	Oct. 15-Nov. 30, grass control
		DNOSBP	(2)	2 pts.	55%+10 gals. diesel oil + water to 100 gals. in Nov.
		Dalapon	(3)	6-12	Fall and spring
		CMU	(3)	2-8	Fall and spring
		CIPC	(3)	6-14	Fall and spring
Spinach	5	CIPC	(2)	1	Post-Pl cool weather
			(2)	2	Post-Pl warm weather
		Gr Cyan	(2)	400	Pre-Pl 7 days for over-wintered spinach
Squash	11	NH_2DNOSBP	(1)	2-3	Pre-E
		Alanap-1	(2)	1-4	Pre-E
Strawberries	14	SES	(1)	2-4	Post Pl. 7-12 days and as needed
		2,4-D	(1)	½	For emerged brdlf. weeds
		2,4-D	(1)	1-1.5	Immediately after harvest
		SES+ CIPC	(2)	2 each	May, June, and October
		NH_2DNOSBP	(1)	2-4	Dormant Application
		NH_4DNOSBP	(1)	1-2	Dormant Application
		CIPC	(1)	1.5-2	October, November and Dec.
		Dalapon	(2)	15	Grass - fall prior to spring planting
		Sesin	(3)	2-4	General weed control
		Natrin	(3)	2-4	General weed control
		Sesin+ CIPC	(3)	2 each	Grasses and general weeds

* (1) Extensive use (2) Trial use (3) Exper. use only

Crop	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Tomatoes	8	Natrin	(2)	2-5	After tomatoes become est.
		Natrin	(2)	3-5	At "lay-by"
		C.&C.No.7977	(2)	3-4	At "lay-by"
		C.&C.No.6711	(2)	2-3	At "lay-by"
		DNOSBP	(2)	9	Before transplanting
Turf (Brdlf Weeds)	26	2,4-DA	(1)	¼-½	On small weeds
Turf (Crabgr.)	26	PMA	(1)	1-2½oz.	of 10% per 1000 ft.^{2} 3-5 treats. at 5-10 day intervals.
		KOCN	(1)	8-16	2 - 3 treatments
Turf (Wild garlic ... n on)	26	2,4-DE	(1)	1½	Spr. & fall, & repeat as needed next year
Turnips	12	CIPC	(2)	2	Post-Pl for greens only
Watermelons	11	Alanap-1,2	(1)	6	Pre-E
		Alanap-1	(1)	2-3	Applied 4-6 wks. after pre-e treatment.

Control of Herbaceous Perennial and Bienniel Weeds

Weed	Ref. Page	Chemical	Use*	Pounds per acre	Time of Application and Comments
Bedstraw (Galium Mollugo	32	Dalapon	(2)	10#	Fall treatment.
		Dalapon	(2)	2-4#	Early spring or immediately after 1st cutting.
		Water Soluble Dinitros	(2)	3-6#	Spring treatment.
Bermuda Grass (Cynodon dactylon)	33	NaTCA	(2)	86#	As a spray when active growth is occurring.
Canada Thistle (Cirsium arvense)	33	2,4-D	(1)	1-1½#	Bud stage.
		MCP	(1)	1½#	Bud stage.
		Silvex	(2)	1#	
		Amino triazole	(2)	2-6#	Bud or actively growing (6" or higher).
Chicory (Cichorium Intybus)	33	2,4-D	(1)	½-1#	Spring or fall when plants in vegetative stage.
		4-Chloro amine	(2)	0.2#	Early spring.

* (1) Extensive use (2) Trial use (3) Exper. use only

Weed	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Golden Rod (Solidago Nemoralis)	34	2,4-D	(1)	1#	Pre-bloom.
		Amino triazole	(2)	2#/100 gal.	Pre-bloom or bud.
Horse Nettle (Solanum carolinense)	34	2,4-D	(1)	2#	Early bloom.
		2,4,5-T	(1)	2#	Early bloom.
		2,4-D + 2,4,5-T	(1)	2#	Early bloom.
		Amino triazole	(2)	2-8#	Active vigorous growth.
Johnson Grass (Sorghum halepense)	34	NaTCA	(1)	50-100#	Just prior to or at time of emergence.
		Dalapon	(2)	20#	Young seedlings.
			(2)	1#/gal.	For spot treatment. Young seedlings.
Milk Weed (Asclepias syriaca)	35	CMU	(1)	1#/gal.	Spot treatment.
		Amino triazole	(1)	2-4#/gal.	Spray to runoff just before bloom.
Nut Grass (Cyperus esculentus)	35	NaTCA	(1)	50-100#	Shoots 2-6" tall. Follow with harrowing.
		Dalapon	(2)	5-10#	Shoots 2-6" tall.
		Silvex	(2)	1-3#	Shoots 2-6" tall.
		S/V Agronyl R	(2)		
		Amino triazole	(2)	2-10#	Shoots 2-6" tall.
		Alanap	(2)	8#	Pre-emergence
		Karmex DW	(2)	10#	Shoots 2-6" tall.
Quack Grass (Agropyron repens)	35	NaTCA	(1)	50-100#	Apply on plowed soil.
		Amino triazole	(2)	2-8#	Actively growing grass.
		Dalapon	(2)	25-40#	Actively growing grass.
Wild Onion or Garlic (Allium spp.)	36	2,4-D ester	(1)	1-1½#	Fall and spring.

Public Health Weed Control

Weed	Ref. Page	Chemical	Use*	Pounds per acre	Time of Applications and Comments
Ragweed	29	2,4-DA	(1)	1½-3#	Veg. Stage
		2,4-D NaS	(1)	1½-3#	Veg. Stage
Poison Ivy	31	Ammate	(1)		Active growth
		2,4,5-T	(1)		Active growth or dormant
		2,4,5-TE	(1)		Active growth or dormant
		Borax	(1)	4#/100 sq. ft.	Active growth

* (1) Extensive use (2) Trial use (3) Exper. use only

Aquatic Weed Control

Weed	Ref. Page	Chemical	Use	Rate	Time of Application
Potamogeton, sp.	29	Sodium Arsenite	This varies with State concerned, species, and body of water.	Varies with species, material, and body of water.	General concensus is that late Spring and Summer are best.
Elodea	29	Copper Sulphate			
Cerataphyllum	29	2,4-D Compounds			
Myriophyllum	29	Rosin Amine-D Acetate			
General		Aquasan	(3)	Variable depend. on growth.	During growth Irrig. ponds only. Kills fish.

This table presented as a framework for future expansion of this section.

Table of Abbreviations Used

Chemicals	
Alanap-l	N-l naphthyl phthalamic acid
Allyl Al	Allyl alcohol
Ammate	Ammonium sulfamate
Aquasan	Mixture of petroleum fractions
BHC	Benzene hexachloride
C & C	Carbide and Carbon
CIPC	Isopropyl-N-(3-chloro-phenyl) carbamate
CMU	3-(p-chlorophenyl)-1. 1-dimethylurea
CP	Chloropicrin
Cyan Dust	Calcium cyanamid dust
Dalapon	2, 2-dichloropropionic acid
DN Em	Dinitro oil emulsions
DNOSAP	Dinitro ortho secondary amyl phenol
Endo	Disodium 3,6-endoxohexahydrophthalate
Gr Cyan	Granular calcium cyanamid
Iron S	Ferrous sulfate
Karmex DW	3(3,4-dichlorophenyl) 1,1 dimethylurea
KOCN	Potassium cyanate
M Br	Methyl bromide
MCP	2,methyl 4 chlorophenoxyacetic acid
MH	Maleic hydrazide
M Spirits	Mineral spirits
NaAs	Sodium arsenite
NaPCP	Sodium pentachlorophenate
Natrin	2,4,5-trichlorophenoxy-ethyl sulfate
Na EX	Sodium ethyl xanthate
NH_2DNOSBP	Alkanolamine salts of dinitro ortho secondary butyl phenol
NH_4DNOSBP	Ammonium salt of dinitro ortho secondary butyl phenol
NIX	Sodium isopropyl Xanthate

Table of Abbreviations Use con't

Chemicals	
No. 2 F. oil	No. 2 Fuel Oil
Oktone	Octachlorocyclohexenone
PA	Phthalamic acid
PCP	Pentachlorophenol
PMA	Phenylmercuric acetate
PDB	Paradichlorobenzene
PDU	Phenyl dimethyl urea
SES	2,4-dichlorophenoxyethyl sulfate
Sesin	2,4 dichlorophenoxyethyl benzoate
Silvex	2(2,4,5-Trichlorophenoxy) propionic acid
S$N-869	Stauffer N-869
Stod Solv	Stoddard solvent oil
TCA	Trichloroacetatic acid (salts)
TCBA	Trichlorobenzoic acid
2,4-DA	Alkanolamine salt of 2,4-D
2,4-DE	Ester form of 2,4-D
2,4-DLVE	Low volatile ester form of 2,4-D
2,4-D NaS	Sodium salt of 2,4-dichlorophenoxyacetic acid
2,4,5-TE	Ester form of 2,4,5-T
2,4,5-TLVE	Low volatile ester form of 2,4,5-T

Other Abbreviations

Ea	Each
Ear	Early
Directed Spray	Directed application to base of crop
Dorm	During Dormancy
G	Gallons
Post-E	Post-emergence
Post-H	Post-harvest
Pre-E	Pre-emergence
Pre-H	Pre-harvest
Spr	Spring

These designations of time refer to crops unless otherwise indicated in the table.

Reaction of Woody Plants to Herbicides

H. C. Ferguson

(Reprinted From the 1953 NEWCC Proceedings)

Plant Species Common Name Scientific Name	Water Carrier-Foliage Appl'n 2,4-D - 2,4,5-T Comb'n*	 2,4,5-T alone *	 Ammate ***	Oil Carrier-Basal Appl'n 2,4-D- 2,4,5-T Comb'n**	 2,d,5-T alone **
Ailanthus (Ailanthus glandulosa)	S	S	M	S	S
Arrow Wood (Viburnum acerifolium)	S	R	S		M
Ash (Fraxinus Spp.)	R	R	M	M?	M
Basswood (Tilia americana)	R	M	M	R?	M
Beech (Fagus grandifolia)	M	M	S	S	M?
Birch (Betula Spp.)	S	S	S	S	S
Bramble (Rubus Spp.)	S	S	S	M	S
Buckeye (Aesculus Hippocastanum)	M	M	M	S	S?
Cucumber Tree (Magnolia acuminata)	S	S	S	S	S
Elm (Ulmus Spp.)	S	M	S	S	S
Green Briar (Smilax rotundifolia)	R	R	M?	R	R
Gum Black (Nyssa sylvatica)	M	S	S	M	M
Gum Red (Liquidambar styraciflua)	S	S	S		S?
Hawthorn (Crataegus Spp.)	M	M	M?	S	S?
Herculus Club (Aralia spinosa)	S	S	S		S
Haw (Viburnum prunifolium)	M	M	M	S	S?
Hickory (Carya Spp.)	M	S	M	M?	S
Honey Locust(Gleditsia triacanthos)	M	S	M	S	M
Ironwood (Ostrya virginiana)	S	R	S	S	M
Laurel (Kalmia latifolia)	R	R	M	S	M
Maple Sugar (Acer saccharum)	R	R	S	S	S
Maple Red (Acer rubrum)	R	M	M	S	S
Oak White (Quercus alba)	M	M	S	S	S
Oak Red (Quercus borealis maxima)	M	M	S	S	S
Locust (Robinia pseudo-acacia)	S	S	M	S	R
Paw Paw (Asimina triloba)	M	M	S		M
Persimmon (Diospyros virginiana)	R	R	M	M	M
Poplar (Populus Spp.)	S	S	S	S	S
Poison Ivy (Rhus Toxicodendron)	S	S	S	M?	S
Red Bud (Cercis canadensis)	M	M	S	S	M
Sassafras (Sassafras variifolium)	S	S	S	S	S
Spice Bush (Benzoin aestivale)	S	S	S		S
Sycamore (Platanus occidentalis)	S	S	S	S	M
Tulip Tree(Liriodendron tulipifera)	S	S	S	M?	S
Willow (Salix Spp.)	S	S	S	S	S
Witch Hazel (Hamamelis virginiana)	S	S	S	S	S

*Conc. 4# acid per 100 gal water
Best results June, July, Aug., early Sept.
Ten feet max. height controlled by chem.

***Conc. 75-100# per 100 gal. water
Best results May, June, July, Aug., early Sept.
Ten feet max. height controlled by chem.

**Conc. 16-20# acid per 100 gal. oil
Best results through dormant season
No limit to max. height controlled

R - Resistant
M - Moderately resistant
S - Susceptible
? - Opinion divided

REGISTRATION LIST

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January 5,6,7, 1955 v8

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