VARIABLE DOSAGE SPRAYING

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The new technique of variable dosage spraying developed by Fisons Pest Control Ltd., England, was first described in the United States at the 1956 meeting of the New York State Insecticide, Fungicide and Application Equipment Conference.

At that time the only machines capable of spraying a decreasing dosage along an experimental plot were a small number of prototype machines manufactured in Fisons Pest Control Ltd.'s own workshops for use within their own organization.

Since the last Conference machines have been used at the U.S.D.A. Experimental Station, Beltsville, and also in Canada at the Universities of Manitoba and Saskatchewan. The work carried out with the machines in Canada during 1957 was reported at the Canadian Weed Control Conference, Western Section, in Victoria, B.C., and Dr. Danielson will be reporting on the work carried out at Beltsville at this Conference.

Perhaps to refresh the memories of those of you who have heard of the Chesterford Logarithmic Sprayer, and for the benefit of those who have not, I may briefly describe the machine and its application.

As most of you will appreciate, the normal method of carrying out field experiments with agricultural chemicals, using small randomized plots, is a laborious and time-consuming business. A large number of solutions of varying degrees of concentration are required, marking out of plots takes a considerable amount of time, and the spraying apparatus, usually a knapsack sprayer, requires thorough washing out after each chemical has been applied.

It was considered that the research workers' task would be immensely simplified if a machine could be designed which would spray a continuously decreasing dosage of a chemical as it moves along a plot. The machine developed, a logarithmic sprayer, sprays a dosage which decreases as an exponential function of the distance travelled. This form of variation is the most useful biologically and the one which can be most reliably achieved mechanically.

The method of operation of the machine is shown in the accompanying diagram.

The machine consists of a 20 gallon water tank equipped with a three-way valve; a completely closed circuit concentrate tank provided with an efficient agitator; a 3/4" gear pump feeding to a distributor, from which 20 equal length narrow bore polythene tubes lead to nineteen specially matched ceramic nozzles, and a pressure gauge.

The two-way valve on the concentrate tank is to open the tank for filling and to seal to the atmosphere for spraying.

The three-way valve on the water tank provides positions for draining the tank, by passing the tank if using an alternative tank, and normal spraying.

The pump is driven by a 1:1 chain drive from the splined shaft of the vehicle power take-off, and the agitator is driven by a 1:1 chain drive from the pump shaft.

Filtration is provided by:

(a) Filter basket in water tank.
(b) Line filter on diluent feed.
(c) Filter in chemical filling funnel.
(d) Individual filters in each nozzle body.

The boom width is 14' 6" extended, and 5' when in the travelling position.

For a normal experiment the spray solution, at a higher concentration than is expected to be of biological interest, is contained in the concentrate tank which should be completely filled Meanwhile the water tank should contain at least six gallons of water.

As soon as the concentrate tank is completely filled, the air outlet is closed and the sprayer is ready for operation.

When the vehicle moves forward at a governed speed, the sequence of events is as follows:

(1) Spray solution is extracted from the concentrate tank and pumped through the polythene tubes, first forcing air out of the tubes.

(2) Spray solution extracted from the concentrate tank is continually replaced by water from the water tank, thus effecting a continual decrease in the concentration of the spray solution.

As the rate of extraction, and consequently the rate of dilution, is directly related to the engine speed of the vehicle, which in turn controls the land speed of the vehicle, a simple formula will permit the determination of the exact dosage applied at any point along the plot.

Fitting.

The machine was primarily designed for attachment to a standard Land Rover or Jeep equipped with a rear power take-off. Only four securing points are used and it should be a comparatively simple matter to fabricate a special bracket for use with a tractor. The two essentials are a rear power take-off and an efficient governor.

Calibration.

Before the machine can be used for an experiment it is necessary to establish two factors which are specific to each individual machine. It is inevitable that the standard gear pumps used will differ slightly in output at the controlled speed of operation and for this reason the dosage at the start of the plot and the distance from the start of the plot at which the dosage will be halved must be established for each individual machine.

With earlier machines a somewhat complicated procedure was recommended for each machine to determine the rate of dilution using elutable red dye and a colorimeter.

Subsequent experiments with the latest machines have indicated that this procedure was unnecessarily complicated and all that is now necessary is to determine the time taken to spray a given quantity of solution at the operating speed of the power take-off and the corresponding speed of the vehicle over the ground. Given this information then the two essential factors for determination of the dosage at any point along the plot for each machine can readily be calculated:

(a) half dosage distance 0.0717 vt yards

(b) dosage 5 yards after start (expressed in terms of gallons of original concentrate per acre)

$$\log_{10} D = 3.756 \log_{10} vt \frac{21}{vt}$$

v = land speed of vehicle
t = time to spray 2 gallons

The plot is taken as starting 5 yards after starting spraying. This distance is quite arbitrary but experiments have confirmed that it is sufficient to allow for the variable application rate immediately after starting due to air in the leads and that dosage will be decreasing logarithmically after five yards with all machines.

Given these two factors the exact dosage applied at any point along the plot may be determined either with a simple slide rule, which comes with the machine, or using a nomogram printed in the Instruction Book.

Uses of the Machine.

The machine was developed with the object of simplifying experimental procedures with herbicides, but although we have had little or no experience in its application in work with insecticides and fungicides, it is probable that it could be used with minor modifications.

1. The normal use of the machine is to assess the optimum dose of a given herbicide, the selectivity factor and percentage reliability of the optimum dose under varying soil and climatic conditions. The selectivity margin we define as the ratio between the highest dosage of a herbicide which the crop can tolerate without damage, and the lowest dosage at which the weed is still satisfactorily controlled. For example, a selectivity factor of 3.5 means that the crop can tolerate 3.5 times more of a herbicide than is necessary to control the weed sufficiently.

The machine normally operates at a controlled speed of around 3 1/2 miles per hour coupled with a power take-off speed of 500 r.p.m. Under these conditions the half dosage distance will be around 7 yards and the length of plot will depend on the range of dosages thought to be of interest, e.g. if it is decided to spray the equivalent of from 8 - 1 lb. active ingredient per acre it will be necessary to spray a plot 21 yds. long.

A number of sites should be chosen to cover the probable range of climate and soil conditions for the required crop, and replicated logarithmic plots should be sprayed. Subsequent observation will permit the establishment for each site of the minimum dose controlling the pest and the minimum dose causing damage to the crop. For each site the optimum dose can be calculated as the geometric mean of these two limits. This is situated mid-way between these limits on the plot. If the results for all sites are then tabulated, it will be possible to determine a mean optimum dosage and a percentage reliability for that dosage. The following table shows an illustration of the results of such an experiment:

Mean opt. dosage and % reliability of a treatment

Exp. No.	Optimum Dosage	Highest Dosage Tolerated by Crop	Lowest Dosage for Good Weed Control	Selectivity Factor
1	2.8	4.0	1.9	2.1
2	2.3	3.9	1.6	2.4
3	1.9	2.6	1.6	1.6
4	2.2	2.9	1.7	1.7
5	2.4	3.0	2.0	1.5
6	3.0	4.1	2.8*	1.5
7	1.4	2.0*	1.1	1.8
8	1.9	2.8	1.2	2.3
9	2.0	2.8	1.5	1.9
10	2.2	2.9	1.7	1.7
Mean	2.2	3.1	1.7	1.9

The mean optimum dosage of 2.2 lb/acre was both safe, and efficient in eight out of ten trials. In one trial (No. 6) the mean optimum dosage would have given unsatisfactory weed control. In one other trial (No. 7) the mean optimum dosage would have affected the crop. The % reliability was therefore 80% and the % risk of failure was 20%. You can see from this example with the variable dosage technique that a minimum of effort can give most valuable information.

2. For normal operation a volume rate of approximately 35 gallons per acre is applied. This rate may be altered in any one of the following ways or a combination of them:

(a) By folding both booms back into the travelling position a plot 5 feet wide will be sprayed at approximately 100 gallons per acre.

(b) By increasing the land speed of the vehicle while keeping a power take-off speed of 500 r.p.m. a proportionate reduction in volume will be effected. This will involve a proportionate increase in the length of plot to achieve the same decrement, and this may be of interest for experiments with insecticides and fungicides.

(c) By disconnecting half the nozzle holders and then spraying them into a container in the vehicle the volume of application at any given speed will be halved. By a combination of these methods a minimum volume of about 8 gallons per acre can be sprayed.

3. The machine can be used to determine the optimum admixture of one chemical to another for a specific pest control problem. In this case either the water tank should contain a spraying solution to be sprayed at a constant rate, or use should be made of the bypass valve provided to connect an additional tank to the sprayer. The concentrate tank should then be filled with the same chemical with the addition of a given quantity of the second chemical. Spraying should then be carried out as for a normal experiment with a single chemical solution and the added chemical will be sprayed at a logarithmically decreasing rate. Determination of the exact amount of the second chemical at any point along the plot by use of the calculator, which comes with the machine, or nomogram is then a simple matter.

4. If, having determined the mean optimum dosage of a given chem cal, it is desired to carry out large scale experiments at that dosage, the same machine can be used for normal field spraying. In this case both the water tank and the concentrate tank are filled with the spray solution and the latter operates merely as an efficient mixing vessel.

This represents a very short outline of the uses of the Chesterford Logarithmic Sprayer. As mentioned before, it has been used experimentally this year in a number of Research Stations in the United States and Canada, and the technique aroused a considerable amount of interest at the recent International Plant Protection Congress in Hamburg, Germany.

As we see it, the main advantages of the logarithmic technique are:

(1) Considerable increase in productivity of research work. Only one solution is required to be made up for each experimental plot, only the most elementary marking out is required, and the machine, being self-washing, is immediately ready for a further experiment on completion of each plot.

(2) Each experimental plot provides a complete picture of dosage response as it includes all dosages within the range of interest.

(3) Experiments are exactly reproducible as the dosage applied is controlled mechanically, and possible errors due to the human factor are reduced to a minimum.

(4) Owing to the simplicity of operation comparatively unskilled personnel can be employed on accurate experimental work.

We, as a company, are actively engaged in the comparative assessment of agricultural chemicals in field experiments and in the rapid development of new chemical compounds to the stage of commercial marketing. We are convinced that the technique of variable dosage spraying represents a considerable advance on more orthodox methods, and we anticipate that when the advantages are fully appreciated, it will become increasingly widely adopted by agricultural research stations throughout the world.

EXPERIENCES WITH THE LOGARITHMIC SPRAYER[1/]

L. L. Danielson[2/]

Abstract

The usual methods of performing the initial evaluation of any number of herbicides in the field on a wide range of vegetable crops is extremely time consuming and requires large experimental areas. A new research tool known as the logarithmic sprayer offers the possibility of greatly reducing the time and space required for these evaluations. This sprayer, as suggested by its name, applies a logarithmic rate pattern over a predetermined distance in the field. In the present instance, this equipment was mounted on a Willys jeep equipped with a governor and wheel speedometer.

The initial series of evaluations in which this equipment was used was concerned with 15 vegetable leaf, salad, and cole crops. These involved the pre-emergence applications of ethyl N,N-di-n-propylthiolcarbamate (EPTC)using a maximum rate of 10 pounds per acre. Subsequent pre-emergence and post-emergence evaluations of this chemical were made on a selected series of these crops. The sprayer as used in these evaluations provided an infinite number of rates of application of a single chemical. The number of rates which may be considered is only limited by the plant population of each crop under consideration.

The logarithmic sprayer was also used to determine the correct ratio of isopropyl N-(3-chlorophenyl) carbamate (CIPC) to one pound of 2-chloro-allyl diethyldithiocarbamate (CDEC) as pre-emergence applications on these crops.

From these experimental applications with the logarithmic sprayer it was possible to select an optimum rate to be used for subsequent small scale yield evaluations on the tolerant crops. This optimum rate was determined by selecting the mid-point between the lowest rate that gave satisfactory weed control and the highest rate that did not cause injury to the crop.

Data from these initial trials with the logarithmic sprayer suggest that this equipment will prove to be a valuable research instrument for herbicide investigations in the field. We are suggesting the use of the symbol "(" to indicate a logarithmic application. Thus, a herbicide applied logarithmically at a maximum rate of 10 pounds per acre would be expressed as 10 lb/A (.

1/ To be presented at the Northeastern Weed Control Conference, January 8-10, 1958, in New York, New York, as an invitational paper. Data to be published in extensia by L. L. Danielson and R. E. Wester in the Journal of the Weed Society of America.

2/ Plant Physiologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

Some Residue and Metabolism Findings in the Development of 3-Amino-1,2,4-triazole

By J. F. Yost and E. F. Williams

One of the promising new herbicidally active materials to appear on the market is 3-amino-1,2,4-triazole. This compound, sold under the trade names Amino Triazole(1) and Weedazol(2), not only produces the characteristic physiological response of chlorosis in the new growth of plants but is also readily and rapidly translocated within the plant. Translocation occurs either by uptake through the roots or intake when applied on the foliage(3).

In many cases only minute amounts of the compound are required to induce a physiological response in the growing plant. Tomato seedlings, for example, show effects when grown in solutions containing 1 to 2 ppm aminotriazole. With poison ivy, control of growth has been obtained using rates as low as 1/4 to 1/2 pound active material per 100 gallons of water, although higher rates in the range 3/4 to 2 pounds per 100 gallons are recommended commercially(4).

Aminotriazole shows promise and is used commercially at economical rates on a great number of weed species(5). While the compound does have a broad spectrum of activity against both annual and perennial plants, some species are quite resistant to the action of the compound. Among the weed species included on the aminotriazole label are Canada thistle, sow thistle, quack grass, nut grass, cattails, tules, Phragmites, horsetail rush (Northwest), Russian knapweed, leafy spurge and Bermuda grass. Among the woody plants and vines poison ivy, poison oak, white ash, red, white and scrub oak, prickly ash and buck brush are controlled. On the other hand, sassafras, cranberries, asparagus and corn in the early seedling or 2 to 4 leaf stage are quite resistant to the action of aminotriazole.

Use of cultural practices such as treatment of weeds prior to planting followed by cultivation, directional sprays on small weeds among larger crop plants, also serve to enhance the selective herbicidal action of aminotriazole.

Another interesting property of aminotriazole is its defoliation and second growth inhibiting action on cotton.

While aminotriazole has been registered for control of various weed species on non-cropland, the only cropland use registered to date is for control of Canada thistle in corn. Here, the thistle is treated 10 to 14 days before planting time, using a rate of 4 pounds actual aminotriazole per acre. The crop is planted after normal soil tillage and cultivation.

As with insecticides and fungicides, Federal registration of a herbicide implies completion of a considerable variety and amount of research. To register any pesticide, and this definitely includes herbicides, two cardinal points must be established. These points, outlined in Public Law 518, delegate to the U. S. Department of Agriculture the responsibilities (a) certification as to usefulness of each pesticidal chemical for which a tolerance is sought, and (b) an opinion as to residue likely to remain on a specified crop at harvest whan the chemical is used according to labeling directions. Tolerances themselves are set by the Food and Drug Administration. In all cases hazards must be absent both to the consumer of the raw agricultural commodity involved and to the public using the pesticide.

Registrations are greatly simplified if a material is relatively nontoxic and is not translocated. However, for moderately or highly toxic materials or materials forming toxic metabolites much research is required for registration. Ready translocation further complicates registration requirements. Various toxicological studies, including prolonged chronic toxicity studies on two animal species, are needed to determine safe residue levels and to permit the setting of a tolerance or practical zero. Highly sensitive analytical procedures are required for each crop to permit analysis of residues not only for the chemical itself but for any toxic metabolite formed. These procedures must often be sensitive to the 0.1 to 0.01 ppm range. Studies must, of course, be made to identify the metabolites formed. Paper and column chromatography and radio tracer techniques have proven to be most successful special tools for use in residue determination and metabolism studies.

The various techniques just mentioned were used to obtain residue and metabolism data in support of the registration of aminotriazole for corn cropland use. Since toxicological studies had not proceeded far enough to permit setting of a tolerance, residue levels less than the practical zero value had to be established in the raw agricultural commodity at harvest to permit registration of aminotriazole for this use. Early work on translocation and fate of aminotriazole in plants by Dr. B. J. Rogers of Purdue University(3) showed ready and rapid movement of the compound in soybeans, Canada thistle and Johnson grass. Using tagged aminotriazole and paper chromatography separation techniques, three peaks, representing aminotriazole and two metabolites, were found for soybeans. Similarly, two peaks, representing aminotriazole and one metabolite, were found for Johnson grass. The developing solvent used in the chromatography studies was liquified phenol. In the chromatograms obtained, aminotriazole had the greatest Rf value. One of the metabolites formed was believed to be a sugar adduct of aminotriazole; it had an intermediate Rf value. The third metabolite, not yet identified, moved only slightly in the phenol solvent system.

In studies at our own laboratories tagged aminotriazole was added topically to young growing soybean and corn plants. Each plant was treated with 0.15 ml. of 0.1% aminotriazole solution, 10% of which was tagged compound having a specific activity of 13.4 mc/mgm. Surface residues were obtained by a simple water wash repeated three times. The washed plants were extracted with methanol and the tagged material concentrated on an Amberlite IR-120 (H+) resin and then eluted with aq. ammonia. The

The solvent systems n-butanol-ethanol-water in the ratio 4:1:1 and n-propanol-ethyl acetate-water in the ratio 6:1:3 were used for development. After the paper chromatograms were developed they were scanned and the concentration of tagged material present in the various sections of the paper recorded. A Model C 100 actigraph and Model 1615 B rate meter were used in this work.

In the soybean experiment plant samples were investigated during a period covering three weeks after treatment date. As found by Rogers in the studies previously mentioned, unchanged aminotriazole and an unidentified major metabolite were present. Based on counts found, the metabolite reached a maximum concentration after about two weeks and then began to decrease. The aminotriazole content decreased steadily throughout the three-week period. The experiment had to be terminated at this point due to exhaustion of available plant samples.

In the experiments with corn more than 90% of the total count was present as unchanged aminotriazole throughout the three-week period observed after treatment. Only trace amounts of metabolite were formed. In addition, total counts (substantially aminotriazole) disappeared rapidly, going from approximately 8 ppm initially to about 2 ppm during the three-week period.

Table I shows the concentration of free and combined aminotriazole found in and on the plant at various time intervals after treatment for both soybean and corn seedlings.

Table I

Soybeans

Activity Expressed as Aminotriazole in ppm

Time Interval	Residue Within the Plant		Total Residue	
	Free	Combined	Free	Combined
3-day	2.7 ppm	4.0 ppm	9.4 ppm	4.0 ppm
6-day	0.5	11.2	3.6	11.2
14-day	<0.25	4.3	1.2	5.8*

*Tissue contained chlorotic areas; some leaching of combined aminotriazole from the plant tissue may have occurred.

Corn

Activity Expressed as Aminotriazole in ppm

Time Interval	Residue Within the Plant		Total Residue	
	Free	Combined	Free	Combined
3-day	3.53 ppm	0.41 ppm	7.43 ppm	0.41 ppm
6-day	1.85	0.46	5.03	0.46
11-day*	0.29	0.11	1.94	0.11
17-day	0.77	0.45	3.35	0.45
21-day	0.85	0.09	1.93	0.09

*Residue values for this sampling are unexpectedly low; experimental difficulties may have been responsible.

Examination of the above data showed that while aminotriazole disappears rapidly from young corn plants, any metabolites that may be formed are not concentrated by the plant itself. On the other hand, with soybeans a major and unidentified metabolite forms at the expense of the uncombined aminotriazole. This metabolite also decreases in concentration with time. Extrapolation of the corn residue data using a semi-log plot shows that under the conditions used in this experiment total free and combined aminotriazole approaches zero about six weeks after application. Further, the residue contained in the plant requires about one month to approach zero concentration. This means that the half-life of aminotriazole residue in toto for young corn plants is approximately 8 days.

Corroborative evidence on disappearance of aminotriazole residues in plants was also obtained from soil treatment experiments with tagged aminotriazole in which corn and soybeans were planted at various time intervals after soil treatment, the plants subsequently harvested, and total counts made. Results again showed virtually complete disappearance of any tagged aminotriazole or metabolite thereof in about 4 to 6 weeks (unreported work done by Dr. B. J. Rogers, Purdue University).

Further evidence on the behavior of aminotriazole in both corn and soil was obtained using ordinary chemical techniques. Based on the nitroprusside reagent developed by Sund(6) for analysis of aminotriazole in soil, analytical procedures have been developed in our laboratories for the analysis of trace amounts of aminotriazole and aminotriazole sugar adducts in several plants. The lower limit of sensitivity for the method is 0.1 to 1.0 ppm depending upon the crop in question. Some of the results obtained by the chemical method are given in Table II.

Table II

Rate of Disappearance of 3-Amino-1,2,4-triazole Applied to Greenhouse Grown Corn Plants at Four-Leaf Stage

Location	Rate/A 3-amino-1,2,4-triazole	Application Date	Sampling Date	Analytical Results	Estimated Limit of Sensitivity
American	0.5 lbs.	12/21/56	12/26/56	8.5 ppm	1.7 ppm
Cyanamid Co.	check		12/26/56	0.9 ppm	
Stamford Lab.	0.5 lbs.	12/21/56	12/31/56	3.5 ppm	1.0 ppm
Stamford, Conn.	check		12/31/56	0.5 ppm	
	0.5 lbs.	12/21/56	1/7/57	1.5 ppm	0.5 ppm
	check		1/7/57	0.7 ppm	
	0.5 lbs.	12/21/56	1/14/57	<0.5 ppm	0.5 ppm
	check		1/14/57	1.0 ppm	
	0.5 lbs.	12/21/56	1/21/57	<0.5 ppm	0.5 ppm
	check		1/21/57	1.0 ppm	

(Results corrected for check value readings)

The data obtained in the above experiment again show that aminotriazole does not persist in corn. Extrapolation of the data on a semi-log plot also shows that under the conditions of this experiment zero concentrations of the compound are approached after about 4 weeks.

In Table III results are given on analysis of field samples of corn from Ohio and Illinois.

Table III

Results of Analysis of Field Corn for 3-Amino-1,2,4-triazole Residues

Pre-planting Applications 1956

Location	Rate/A Aminotriazole	Application Date	Planting Date	Sampling Date	Analytical Results
Columbus, Ohio	8 lbs.	5/21/56	6/29/56	8/27/56	<0.25 ppm
	check		6/29/56	8/27/56	1.2 ppm
	8 lbs.	5/21/56	6/29/56	9/6/56	<0.25 ppm
	check		6/29/56	9/6/56	1.0 ppm
	8 lbs.	5/21/56	6/29/56	9/17/56	<0.25 ppm
	check		6/29/56	9/17/56	0.8 ppm
Urbana, Ill. (Field 1)	8 lbs.	8/23/56	8/23/56	9/10/56	<0.25 ppm
	4 lbs.	8/23/56	8/23/56	9/17/56	<0.25 ppm
	8 lbs.	8/23/56	8/23/56	9/17/56	<0.25 ppm
	4 lbs.	8/23/56	8/23/56	9/24/56	<0.25 ppm
	8 lbs.	8/23/56	8/23/56	9/24/56	<0.25 ppm
Urbana, Ill. (Field 2)	4 lbs.	5/15/56	5/30/56	8/12/56	<0.25 ppm
	8 lbs.	5/15/56	5/30/56	8/12/56	<0.25 ppm
Gibson City, Ill.	4 lbs.	5/10/56	5/20/56	7/30/56	<0.25 ppm
	8 lbs.	5/10/56	5/20/56	7/30/56	<0.25 ppm
DeKalb, Ill.	4 lbs.	5/21/56	5/30/56	8/16/56	<0.25 ppm
	8 lbs.	5/21/56	5/30/56	8/16/56	<0.25 ppm

(Results corrected for check value readings)

As can be seen by inspection of the above data, negative results for aminotriazole content were obtained in all cases. In these studies the herbicide was applied to the ground cover (predominately Canada thistle) and the field plowed and planted at various time intervals after treatment.

The data presented, along with additional evidence on residue and metabolism characteristics of aminotriazole in related crops and various soil types, plus considerable evidence on the toxicological behavior of aminotriazole, formed the basis for the first cropland registration of the product. While pre-planting treatment of corn cropland represents an important use for aminotriazole other uses, such as pre-planting application for soybean cropland, post-emergence application on corn, control of weeds in orchards, cranberry bogs and vineyards, particularly poison ivy, and spot treatment of pastures, grain and pea stubble are also of considerable importance and immediate concern. Research is now in progress at our own laboratories and in various other laboratories around the country to further elucidate the behavior of aminotriazole in soil and

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WEEDS IN ALASKA AND SOME ASPECTS OF THEIR CONTROL

C. H. Dearborn, Horticulturist

Abstract

Weed problems in Alaska are relatively new because mans agricultural activities in this region have been limited until very recently to isolated clearings in widely separated localities. With the expanding population, new clearings are coalescing with former clearings. Weeds are spreading rapidly from the old to the new lands.

Practically all of the seeds used in Alaska except potato are imported. This provides an avenue for weed seeds to get into the Territory. Other potent sources of weed seeds are imports of seeds for bird food, baled hay, baled straw, baled peat, potted plants and nursery stock.

Regulations that govern the tolerance of weed seeds in interstate commerce apply also to Alaska. This is most unfortunate because these regulations permit the shipment of seeds of noxious weeds which have not yet been observed in Alaska. The most troublesome weeds in Alaska are chickweed, lambsquarters, quack grass, mustard and climbing buckwheat. These are included among the 35 species listed as present in Alaska.

Canada thistle and perennial sow thistle, still not generally distributed over the Territory, are persisting in spite of chemical treatments. Climbing buckwheat, knotweed, Pennsylvania smartweed and wild chamomile are examples of weeds that are increasing because of new cultural practices. Commercial control of quack grass has been affected in potato fields within the year of cropping.

Thirty-five weeds are listed that are common on the East coast of the United States that have not been observed in agricultural areas of Alaska. Some weeds that should be prevented from entering Alaska are bindweed, common mallow, Devils paint brush, foxtail, Galinsoga, King Devil, peppergrass, purslane, ragweed and redroot. Three weeds new to Alaska have been observed since 1950.

Alaskans will be confronted with most of the noxious weeds of the States by the turn of the century unless the screening of imports becomes more effective.

LONGEVITY OF SEVERAL HERBICIDES IN SOILS

by
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There has been little or no trouble reported from carry-over of toxic residues from one growing season to another with selective usage of common herbicides. Most troubles have arisen from re-planting fields with a sensitive crop much sooner than is normally practiced. For example, a crop such as corn may be treated with 2,4-D and then be hit by a severe hail storm. The grower may replant to a sensitive crop like snap beans with a minimum of tillage and the 2,4-D cause moderate to severe symptoms on the beans. This type of trouble can never be completely avoided because it involves a human error.

On the other hand, some of the newer chemicals are "unknowns" as far as their longevity in soils is concerned. Also some chemicals have not been studied under the relatively cool moist conditions that prevail in the Northeast. The primary purpose of the studies reported here was to investigate the longevity in soils of chemicals that might be used for irradicating perennials such as quack grass. Observations from tests not designed for longevity studies will also be noted.

Experiment No. 1

At the Geneva Experimental Farm in 1956 a series of chemicals were applied August 1 to an actively growing quackgrass sod. The soil was a poorly drained area of silt loam. Two series of plots were plowed two weeks following spraying. On August 23, one of the plowed areas was disked and seeded to snap beans, cucumbers and sweet corn. A third series of plots was left undisturbed until the following season. Each of the three series of plots contained two replications of the treatments listed in Table I.

Results from Experiment 1 were recorded six weeks following planting the test crops. The ratings are given in Table I. A rating of 9 indicates normal growth.

From Table I it can be seen that residues from TCB, TCA, and the high rate of dalapon were present at toxic levels. It is questionable as to whether field variability or toxic residues account for the other ratings which fall below the check.

In 1957 the entire area, all three series, was plowed July 16 and disked two days later. On August 6, the area was again disked and seeded to snap beans, sweet corn, and squash. Due to dry weather irrigations were applied August 8 and August 14. Results of these plantings are reported in Table I.

Paper No. 418, Department of Vegetable Crops

Table I. Crop response when planted three weeks and again about one year following soil treatments. Poorly drained silt loam.

	Material	Rate	1956 Plowed and disked Beans	1956 Plowed and disked Corn	1956 Plowed and disked Cucumber	1957 Beans, corn & squash Plowed	1957 Beans, corn & squash Plowed & Disked	1957 Beans, corn & squash None
1.	Oil (Carter)	100 gal.	8.0	6.5	9.0	8.5	9.0	8.0
2.	" "	200 "	8.0	8.0	9.0	8.5	8.5	8.0
3.	Oil (Esso)	100 "	9.0	8.5	9.0	8.5	9.0	8.5
4.	" "	200 "	9.0	9.0	4.5	7.5	9.0	7.5
5.	2,4-D Amide	2.5 lbs.	8.5	9.0	7.5	8.0	8.5	8.0
6.	" "	5.0 "	6.0	8.0	6.0	6.0	9.0	6.0
7.	TBA (1281S)	2.5 "	3.0	9.0	*	9.0	8.5	7.0
8.	" "	5.0 "	1.5	7.0	*	7.5	8.5	6.0
9.	CDAA	5.0 "	7.0	6.5	9.0	8.5	8.5	8.5
10.	"	10.0 "	7.0	5.0	8.5	9.0	8.5	6.5
11.	ATA	2.5 "	7.0	7.5	8.5	8.0	8.5	7.5
12.	"	5.0 "	9.0	6.5	7.0	7.5	8.5	7.5
13.	Dalapon	10.0 "	7.0	9.0	9.0	9.0	8.5	7.5
14.	"	20.0 "	8.5	3.5	8.0	8.5	8.5	7.5
15.	TCA	20.0 "	7.5	4.5	5.0	8.5	7.0	7.5
16.	"	40.0 "	5.0	2.5	5.0	6.5	8.0	8.5
17.	Check	-	8.0	8.5	9.0	6.0	8.5	9.0
18.	Simazin	5.0 "	-	-	-	-	-	**
19.	"	10.0 "	-	-	-	-	-	**

* Hormone-type leaf symptoms plus elongated stems.
** Normal size but typical triazine symptoms

Crop response was commercially acceptable in all plots except those which received simazin. Here there were definite leaf symptoms on beans, squash and tomatoes. There was no definite effects of TBA 1281S. This is in direct contrast to results obtained in other tests reported later in this paper.

It is interesting to note that in the spring quack grass control in the undisturbed area was very poor with TCB and ATA, as compared to the plowed plots that received the same chemicals. There was no consistent trend with dalapon, but with the oils at high rates better control was obtained from undisturbed plots. Later that fall, however, the quack grass was becoming rapidly re-established in all plots except Simazin. This indicates that the chemicals were essentially all dissipated and further that with most chemicals, plots with apparent complete kill in the spring may not remain free of quack grass throughout the next growing season.

Quack grass ratings are presented in Table II.

Table II. Quack grass response 9 and 13 months following treatments made Aug. 1, 1956

Material	Rate	April 1957			September 1957		
		Plowed	Plowed & Disked	None	Plowed	Plowed & Disked	None
1. Oil (Carter)	100 gal.	2.0	3.5	5.0	4.0	5.5	3.5
2. " "	200 "	2.5	5.5	6.5	5.0	6.0	5.0
3. Oil (Esso)	100 "	6.5	5.0	5.0	6.5	6.5	3.0
4. " "	200 "	3.0	3.5	7.0	5.5	5.0	6.0
5. 2,4-D Amide	2.5 lbs.	2.0	3.5	1.0	5.0	7.0	4.5
6. " "	5.0 "	3.5	2.0	1.5	4.5	4.5	3.5
7. TBA (1281S)	2.5 "	3.5	3.0	1.0	5.5	4.5	7.0
8. " "	5.0 "	7.0	7.5	1.0	6.5	6.5	5.0
9. CDAA	5.0 "	1.5	5.0	2.5	5.0	5.0	5.0
10. "	10.0 "	3.5	3.5	2.5	3.5	4.5	5.5
11. ATA	2.5 "	3.5	5.0	1.0	7.0	5.5	4.0
12. "	5.0 "	4.5	6.0	1.0	6.5	5.5	7.0
13. Dalapon	10.0 "	6.5	8.5	9.0	7.0	7.0	5.0
14. "	20.0 "	8.5	9.0	9.0	7.0	7.0	6.0
15. TCA	20.0 "	7.0	6.5	7.5	6.0	7.0	4.5
16. "	40.0 "	8.0	8.5	8.5	7.0	7.5	5.0
17. Check	-	3.5	3.5	1.0	5.0	4.5	2.5
18. Simazin	5.0 "	-	-	9.0	-	-	9.0
19. "	10.0 "	-	-	9.0	-	-	9.0

Experiment 2

In 1956 another series of plots were started at Ithaca on a well-drained stony silt loam to help determine the possible carry-over of certain herbicides. In this test a series of chemicals were applied September 3 on fallow soil. Duplicate treatments were applied May 2, 1957 to another series of plots in the experiment. Both series were plowed in late May and planted to sweet corn and snap beans. Plantings were made on one-half of each plot June 5. Duplicate plantings were made June 26 on the other half of each plot. Results were recorded on the basis of crop response, and are presented in Table III.

When inspecting the data in Table III it should be kept in mind that the fall of 1956 was relatively open and wet. Any materials subject to leaching would undoubtedly have been substantially influenced. Furthermore, the spring of 1957 was relatively open and the soil warmed early in spite of a cold winter and in spite of sharp freezes in May. This situation favored chemicals which might be dependent on microbial action for breakdown.

Table III. Treatments and crop response ratings in Experiment 2

Chemical	Rate	Time	Crop Response: Sweet Corn 1st pl.	Sweet Corn 2nd pl.	Snap Beans 1st pl.	Snap Beans 2nd pl.
1. Dalapon	10 lbs.	F	S	S	S	S
2. "	10 "	Sp	S	S	7	7
3. "	5 + 5 "	F + S	S	S	S	S
4. TCA	40 "	F	S	S	S	S
5. "	40 "	Sp	S	S	S	S
6. "	80 "	F	S	S	S	S
7. "	80 "	Sp	S	S	S	S
8. TCB (103A)	5 "	F	S	S	5	5
9. " "	5 "	Sp	S	S	3	3
10. " (1281S)	5 "	F	S	S	3	3
11. " "	5 "	Sp	S	S	2	2
12. ATA	6 "	F	S	S	S	S
13. "	6 "	Sp	S	S	S	S
14. Esso 180	100 gals.	F	S	S	S	S
15. " "	100 "	Sp	S	S	S	S
16. " HB	100 "	F	S	S	S	S
17. " "	100 "	Sp	S	S	S	S
18. Carter Oil	100 "	F	S	S	S	S
19. " "	100 "	Sp	S	S	S	S
20. Check	-	Sp	S	S	S	S

S = satisfactory growth with no symptoms

7 = " " " slight "

2 = severe stunting, but plants still alive

The data indicate that only the two TCB formulations gave definite carry-over symptoms on the test crops. It is interesting to note that under the warm moist soil conditions that prevailed, even the spring applications of 80 pounds of TCA were not toxic when planted only about one month later.

Experiment 3

Reports vary as to the length of residual activity from dalapon under field conditions. However, Holstun and Loomis (1956) showed that temperature and soil moisture greatly influenced the rate of dalapon breakdown and disappearance. Temperatures of 70° resulted in considerable breakdown in two weeks, i.e., reductions from 120 ppm to about 40 ppm when moisture was at field capacity. On the other hand if the moisture level were maintained at the more nearly normal level of only 50% of field capacity instead of an abnormal 100%, it required eight weeks at 80° F. to bring the levels down from 120 to 40 ppm and required 16 weeks to complete the disappearance.

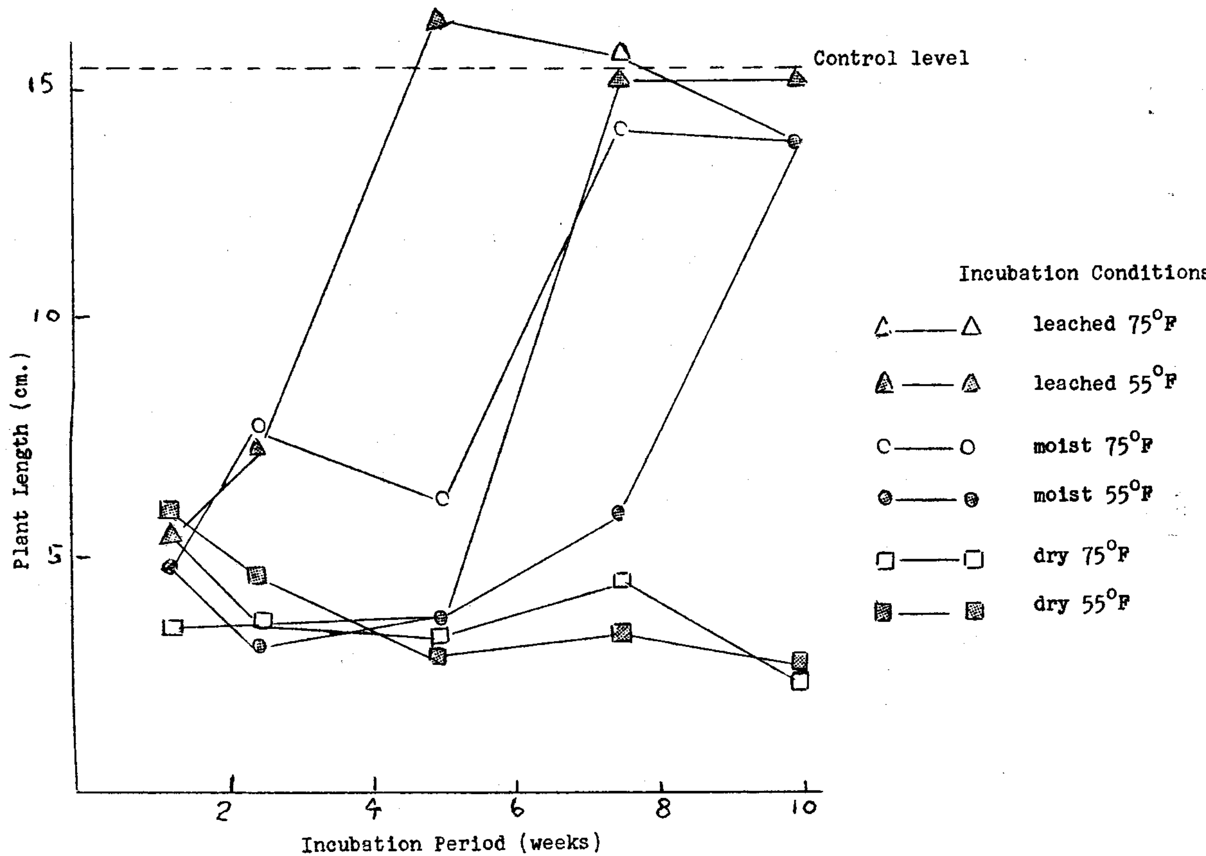
From the above research, the prospect of using dalapon safely on crop lands looks rather dim for New York and similar areas where soil temperatures do not reach the 80° range except for a few weeks in the middle of the summer. However, the interaction of leaching, rate, temperature, and time was not studied by Holstun and Loomis. Conceivably with the degree of leaching which could be expected under average field conditions in the Northeast the time required for disappearance under cool soil conditions might be shortened. Low rates also might show a decidedly shorter period of activity. To test this possibility a greenhouse experiment was conducted in which rate of chemical, temperature, soil moisture, and leaching were studied as to effects of dalapon disappearance.

In any laboratory study designed to simulate field conditions one must make arbitrary choices of treatments and techniques. An attempt was made here to represent conditions where heavy but intermittent showers occurred. This would allow for some drying out of soil between treatments. The heaviest watering treatment or "leaching" consisted of placing the flats in a container of water for several minutes until the entire soil was flooded. The flat, however, was not completely submerged. It was then removed and the excess water allowed to drain away. This treatment was given at weekly intervals. A second moisture treatment was surface watering as needed to keep the soil moist and at a sufficiently high level to assure an adequate supply for normal growth. A third moisture level permitted the soil to become air dried with no renewal until the flats were scheduled to be planted.

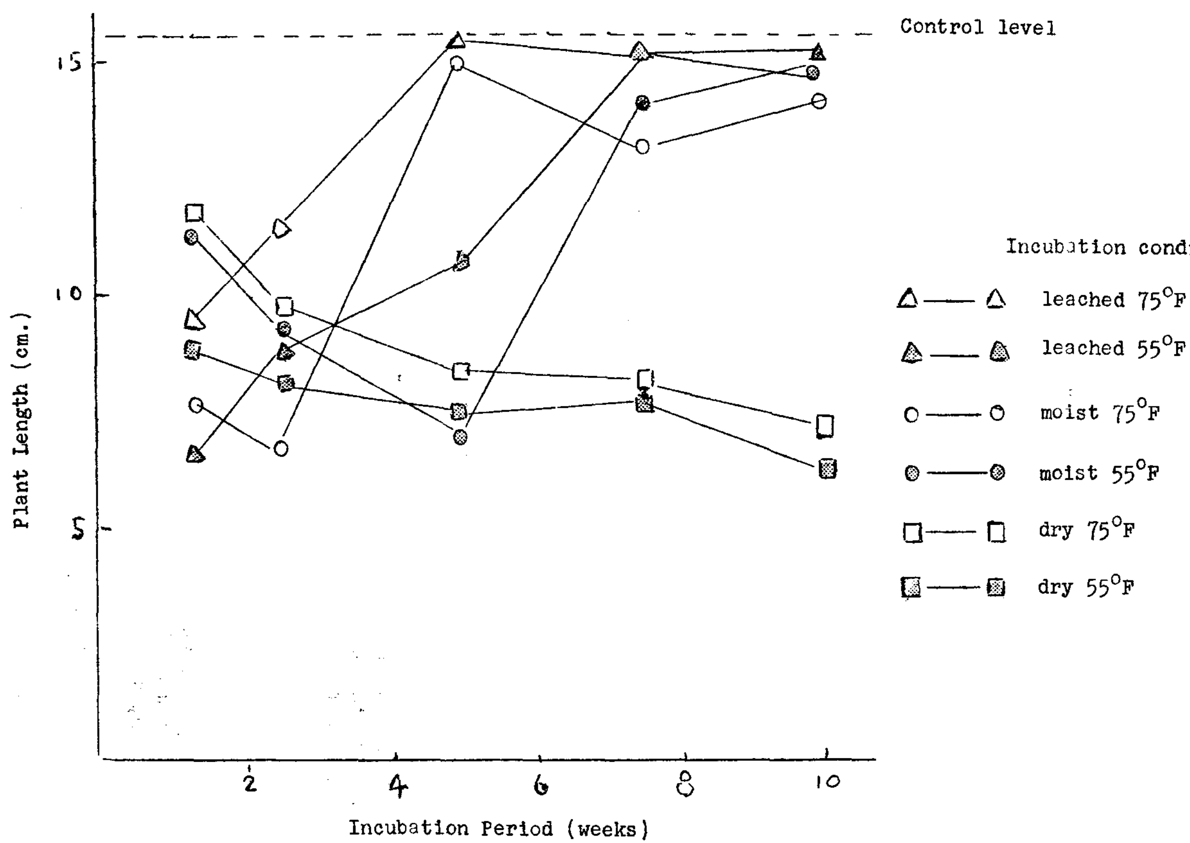
A series of flats were filled with greenhouse potting soil to a depth of 2 inches. They were divided into 3 groups receiving 0, 7, and 21 pounds of active dalapon per surface acre. One-half of each chemical level were placed in a warm headhouse, the others were placed in a cool greenhouse. At intervals of two weeks, flats were removed from these locations, planted to test crops of oats and corn, and then placed in a moderate temperature greenhouse. The temperatures fluctuated a few degrees in the several locations but the soils averaged 14° C. and 24° C. in the cool and warm locations respectively. During the growth of the test crop, the soil ranged between 18° and 21° C.

Growth of oats and corn at five planting dates at 2 week intervals following treating gave good information on the interaction of rate, time, moisture level, and temperature on dalapon disappearance. The results as presented in the graphs demonstrate clearly the importance of soil moisture level. In dry soil dalapon does not disappear. The leaching technique employed in this test was not severe and only had a modest influence. The results indicate that rate of chemical also has only a slight effect. Roughly 2 weeks longer were required to achieve an equal degree of disappearance of 21 pounds of dalapon as were required for 7 pounds. Warm temperatures also speeded dalapon disappearance.

From these tests it appears that even with the most favorable conditions i.e., warm, moist soil, and low rates of chemical, it would not be safe to plant sensitive crops sooner than 5 weeks after treating with dalapon.



RESIDUAL EFFECTS OF DALAPON ON OAT GROWTH - 21 lbs. per acre Rate



RESIDUAL EFFECTS OF DALAPON ON OAT GROWTH - 7 lbs. Per Acre Rate

Observations with TCB Formulations

In 1955 extensive field investigations on sandy loam soil were made with several TCB formulations supplied by the Heyden and the Hooker Chemical Companies. These formulations were applied at 1, 2, and 4 pounds active ingredient to the acre. In 1956 beans and tomatoes were grown for other purposes in the 1955 test areas. Both crops showed typical TCB symptoms from only the 1281S formulation, which is the sodium salt form of a mixture relatively high in the 2,3,6, isomer. The dispersible acid of the same material did not carry over. In 1957 part of the area was again planted to red kidney beans. The beans showed serious symptoms and reduced yields in the 2 and 4 pound plots of the 1281S material. Again there were no apparent symptoms from the dispersible acid formulation of this material or from formulations of the other TCB isomers. The above observations indicate that certain TCB materials can be one of the worst offenders from a carryover viewpoint of any of the herbicides tested.

Summary

When used at selective dosages most common herbicides cause little difficulty from carryover of toxic residues. However, certain TCB formulations even at low dosages are extremely dangerous for succeeding crops. There is a very marked difference between the various TCB materials and of those tested 1281S of Heyden, a sodium salt high in the 2,3,6, isomer, was the most persistent.

Dalapon is likely to remain a minimum of five weeks even when the soil is warm and moist. Sensitive crops cannot be safely planted in a shorter period.

Simazin at 5 and 10 pounds has remained in some soils at toxic levels for 2 growing seasons.

A COMPARISON OF GRANULAR AND LIQUID CARRIERS FOR HERBICIDES.[1]

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Several investigators, particularly Chappell and Danielson have reported the value of vermiculite and atta-clay as carriers for herbicides. The work reported here emphasized three aspects: (A) comparisons of vermiculite, clay, and water as carriers for common herbicides, (B) studies on the amount of vermiculite carrier needed to give good field results, (C) comparisons of the two sources of vermiculite.

In addition to the experiments specifically designed to test vermiculite as a carrier, a few such treatments were included in screening work where many chemicals were being investigated on a given crop.

There were two locations in the vicinity of Ithaca for the test plots. One site had sandy loam and the other silt loam soil. In general, the experiments were duplicated as nearly as possible at the two locations.

Part A

Comparison of Vermiculite with Water and Clay

Test No. 1.

On sandy soil a test was designed to give direct comparisons between vermiculite, clay, and water as carriers of several herbicides important in vegetable production. The treatments were three and six pounds of active ingredient of each of the following: DN (Premerge), CIPC, EPTC, and CDEC. Each rate of each chemical was applied with vermiculite, clay or water as the carrier. The soil was worked, seed sown and treatments applied on consecutive days. There was a heavy rain of 1.86 inches the day following treating. This caused poor germination and uneven growth in a few plots.

The test area was divided into three separate but adjacent blocks and oats, buckwheat, and sweet corn were sown as test crops. There were two replications of each treatment on each crop. Statistically these should be considered the same as three experiments.

Since there was very limited weed growth, crop response was used as the measure of treatment activity. After about one month crop growth was rated one to nine. The higher the number, the better the growth. Any value below seven indicates growth to be substantially below commercial acceptability. A rating of one means complete kill. Results are presented in Table I.

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1. Paper No. 419 of the Department of Vegetable Crops.

Table I. A comparison of clay, vermiculite and water as carriers of certain herbicides as indicated by crop response. (Sandy Soil)

Chemical	Pounds	Clay	Water	Vermiculite
		Oats		
DN	3	5.0	7.0	5.0*
	6	4.5	4.5*	5.0
CIPC	3	1.0	1.5	1.5
	6	1.0	1.0	1.0
EPTC	3	1.0	1.0	1.0
	6	1.0	1.0	1.0
CDEC	3	1.5	2.0	2.0
	6	2.0	2.5	2.0

* Water damage one replication.

Chemical	Pounds	Clay	Water	Vermiculite
		Buckwheat		
DN	3	5.5	5.5	5.5
	6	3.0	4.0	3.5
CIPC	3	1.5	1.0	1.0
	6	1.0	1.0	1.0
EPTC	3	2.0	3.5	2.5
	6	1.5	2.5	1.0
CDEC	3	3.0	4.5	4.0
	6	3.0	4.0	3.0
		Sweet Corn		
DN	3	6.5	7.0	6.5
	6	5.0	6.0	5.0
CIPC	3	1.0	2.5	1.5
	6	1.0	1.0	1.0
EPTC	3	4.0	6.0	5.0
	6	4.5	6.0	4.0
EDEC	3	5.5	7.5	6.5
	6	5.5	6.0	5.5

It can be seen in Table I that wherever there was a differential response between carriers, water was somewhat inferior. It is interesting to note that there was no interaction between type of chemical and type of carrier; DN and carbamates each responded in the same general pattern. Clay and vermiculite were essentially equal as carriers.

Test No. 2.

On a silt loam soil an experiment similar to No. I was conducted. In this case buckwheat was not included, only oats and sweet corn were tested. Again crop response was used as the indicator of chemical activity. The ratings are presented in Table II.

Table II. A comparison of Clay, vermiculite and water as carriers of certain herbicides as indicated by crop response. (Silt Soil).

		Clay		Water		Vermiculite	
Chem.	Pounds	Oats	Corn	Oats	Corn	Oats	Corn
DN	3	8.5	7.0	8.5	7.0	8.5	6.5
	6	6.0	4.0	7.0	4.0	7.5	4.0
CIPC	3	2.0	3.0	3.0	4.0	3.5	3.5
	6	1.0	4.0	1.5	4.0	1.5	3.0
EPTC	3	3.0	6.5	6.0	7.5	5.0	6.5
	6	1.0	6.0	2.0	6.5	1.5	6.0
CDEC	3	7.0	8.0	7.5	8.0	7.0	7.5
	6	8.0	7.5	7.5	7.5	7.5	8.0

It will be noted that in this test there was less influence of carrier on activity of DN than in the previous test. This may be due to the fact that in the second experiment no heavy rains occurred. Irrigation, however, was applied at weekly intervals to assure good crop growth. No irrigation was given until about one week following planting.

In spite of the difference in soil type and in rainfall, there was a trend in favor of the dry carriers. With EPTC at three pounds there was a marked advantage of clay. This is the only place where this superiority occurred and may have been due to some other factor not apparent.

Part B

Amount of Vermiculite Carrier

In much of the work with vermiculite as a carrier for herbicides there have been good results with rates ranging from 20 to 40 pounds on an acre. Relatively little work has been done with less than 20 pounds. A series of comparisons was set up in which certain standard herbicides at specified rates were applied with various amounts of vermiculite carrier. These tests were conducted on both sandy and silt soils.

Test No.3

Water soluble DN and 2,4-D Amine were used as test chemicals. They were each applied at two rates. Each rate of chemical was supplied by vermiculite carrier at 10, 15, and 20 pounds an acre. Radishes were used as a test crop. The chemical treatments were applied the day following planting. The lowest rate of vermiculite was diluted with sand to enable more even distribution. Results are reported in Table IV.

It can be seen in the table that consistently there were slightly higher ratings (less effectiveness) in the lowest rates of vermiculite.

Table III. The influence of several rates of vermiculite carrier on the Activity of Premerge and 2,4-D Amine.

Chemical	Pounds Per Acre	Amount of Vermiculite	Rating (Repl.) 1	2	3	4	(Ave.)
2,4-D Amine	$\frac{1}{4}$	10 lbs.	4	5	3	4	4.0
" "	$\frac{1}{4}$	15 "	4	5	4	3	4.0
" "	$\frac{1}{4}$	20 "	4	4	2	2	3.0
" "	$\frac{1}{2}$	10 "	4	2	2	2	2.5
" "	$\frac{1}{2}$	15 "	3	2	1	2	2.0
" "	$\frac{1}{2}$	20 "	2	2	1	2	1.7
DNOSBP	2	10 "	4	4	4	3	3.7
"	2	15 "	3	3	2	2	2.5
"	2	20 "	2	4	2	2	2.5
"	4	10 "	2	2	1	3	2.0
"	4	15 "	2	2	1	2	1.7
"	4	20 "	2	2	1	1	1.5

Test No.4.

Another test similar to number four was initiated. Treatments were identical. In this test, however, both radish and spinach were

TableIV. The influence of varying amounts of vermiculite on response of radish and spinach.

Chemical	Pounds per Acre	Amount of Vermiculite	Rating Spinach	Rating Radish
2,4-D Amine	¼	10 lbs.	4.25	3.25
" "	¼	15 "	4.25	4.00
" "	¼	20 "	3.75	2.50
" "	½	10 "	3.75	1.50
" "	½	15 "	2.50	2.75
" "	½	20 "	2.25	1.75
DNOSBP	2	10 "	2.25	3.00*
"	2	15 "	2.25	2.50
"	2	20 "	2.00*	2.50
"	4	10 "	1.00	1.25
"	4	15 "	1.00	1.25
"	4	20 "	1.25	1.00

* Three instead of four replications.

It is interesting to note that when the chemical rate was high enough to give almost complete kill of the test plants, there was no effect of amount of carrier. However, at all but the four pound rate of DN 20 pounds of vermiculite was better than 10 pounds.

Test No 5.

On silt soil an experiment practically identical with Test No. 4 was conducted. Radishes were the test crop. Results are presented in Table VI.

Table V. The effect of amount of vermiculite on activity of water-soluble DN and 2,4-D Amine. Silt soil, radish for test crop.

Chemical	Pounds	Amount of Vermiculite	Rating
2,4-D Amine	¼	10 lbs.	7.0
2,4-D "	¼	15 "	7.0
" "	¼	20 "	6.5
" "	½	10 "	3.75
" "	½	15 "	3.75
" "	½	20 "	3.75
DN	2	10 "	2.50
"	2	15 "	1.00
"	2	20 "	1.75
"	4	10 "	1.0

In test No. 6 there was no consistent trend regarding performance and amount of carrier.

Test No. 6.

A test similar to number 5, using radishes and spinach, was conducted on silt soil. The results of this test are reported in Table VII.

Table VI. The effect of amount of vermiculite on activity of water-soluble DN and 2,4-D Amine. Radishes and spinach are test crops grown on silt soil.

Chemical	Pounds	Amount of Vermiculite	Ratings Radishes	Ratings Spinach
2,4-D Amine	¼	10 lbs.	6.5	3.25
" "	¼	15 "	6.25	4.25
" "	¼	20 "	5.75	2.25
" "	½	10 "	4.0	2.25
" "	½	15 "	4.50	3.00
" "	½	20 "	6.00	3.00
DN	2	10 "	3.25	1.00
"	2	15 "	1.50	1.00
"	2	20 "	1.00	1.00
"	4	10 "	1.25	1.00
"	4	15 "	1.00	1.00
"	4	20 "	1.00	1.00

In this test there was no significant trend in performance in relation to amount of vermiculite.

SUMMARY

In several tests there were indications that 15 or 20 pounds of vermiculite were better than ten. This was not consistent in all tests. In several 10 was as good as 20. However, it should be kept in mind that with the low rates it was necessary to dilute the carrier with sand in order to get even distribution with the equipment we were using.

Part C

Sources of Vermiculite

Since vermiculite is available from two different mining operations and since it is known that somewhat different characteristics pertain to these sources, it was decided that the two should be evaluated as herbicide carriers.

Test No. 7.

For purposes of these tests three standard herbicides were used; 2,4-D Amine, Monuron (KW), and Water-soluble DN. (CIPC not available in time). Each was used at two rates, with two sources of vermiculite as the carrier at 20 pounds to the acre. The soil was fitted, planted and treated on successive days. Snap beans and radishes were the test plants. There were no differences in crop growth between treatments in this experiment.

Test No. 8.

A second test on sources of vermiculite was conducted on sandy soil. Due to space limitations only six treatments were included. These were two rates of 2,4-D Amine and one rate of Monuron, each with A and B sources of vermiculite as the carrier. The results are presented in Table VII.

Table VII. The influence of A & B sources of vermiculite on the activity of 2,4-D Amine and Monuron. Sandy Soil - radishes and snap beans as test crops.

Chemical	Pounds	Source	Beans	Radish	Lamb's Q. I
2,4-D Amine	$\frac{1}{4}$	A	7	6	7
" "	$\frac{1}{4}$	B	7	5	7
" "	$\frac{1}{2}$	A	8*	4*	4*
" "	$\frac{1}{2}$	B	6	3	5
Monuron	$\frac{1}{2}$	A	8*	4*	2*
"	$\frac{1}{2}$	B	7.5	4	2

I. Lamb's Quarters was the important weed species present.
* Data from only three replications in these treatments, four replicates in the others.

In the table it can be seen that there was little difference in source of vermiculite. However, there was a suggestion that "B" might be giving slightly better activity, i.e., lower ratings in a few instances.

Test No. 9.

A test was conducted on silt loam comparing A and B vermiculite as carriers of DN, Monuron and 2-4-D each at two rates. There were four replications. Unfortunately during irrigation a faulty connection caused excessive washing on two replicates. There was no consistent trend in the other two replicates.

Test No. 10.

A duplicate of test No. 9 was set up. Beans and radishes were test crops. Weeds wereinsufficient to judge. The results are presented in Table VIII. It can be noted that there was no significant trends.

Table VIII. The effect of source of vermiculite on the activity of certain herbicides. Snap beans and radishes were test crops.

Chemical	Pounds	Source	Beans	Radishes
2,4-D Amine	1/4	A	7.5	8.0
"	1/4	B	7.0	8.0*
"	1/2	A	6.0	6.0*
"	1/2	B	5.5	4.75
Monuron	1/2	A	6.5	3.00
"	1/2	B	6.5	2.25
"	1	A	4.25	1.00
"	1	B	3.75	1.25
Premerge	2	A	6.33*	4.50
"	2	B	6.00	5.50
"	4	A	7.00	1.00
"	4	B	7.00	1.25

* 3 replicates only; 4 in other ratings.

Summary

Tests in 1957 confirmed previous work that indicated vermiculite and atta-clay are sometimes superior to water as carriers of most common herbicides when chemical activity is used as the criteria.

When as little as 10 pounds of vermiculite was used as the carrier, available equipment did a poor job of distribution. This often resulted in an inferior performance by the herbicide. On the other hand 20 pounds of vermiculite was distributed evenly by readily available commercial equipment. 15 pounds was intermediate in performance.

There were no consistent differences between the two sources of vermiculite as carriers of herbicides under favorable field conditions. No studies were made with adverse conditions.

THE INFLUENCE OF LIGHT ON THE ACTIVITY OF SEVERAL HERBICIDES[1]

by
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There have been speculations based on observation by several workers (Penfound and Minyard, 1947; Elle, 1952; Meyers, 1953; Meggit, Aldrich, and Shaw, 1956; Anderson, 1957; Olsson and Salisbury, 1957) as to the influence of light on the action of herbicides, but only a few investigations have been designed to study in detail the interactions of these variables.

Mitchell and Brown (1946) early in the work with 2,4-D showed that light, as affecting the production of substances by photosynthesis, was necessary for the translocation of sub-lethal quantities of that herbicide. Recent reinvestigation by Hay and Thimann (1956) has confirmed this. The most complete work on the influence of light on the effects of 2,4-D has been carried out by Blackman and Robertson-Cuninghame (1955a, 1955b). They showed that with Lemna minor that their highest light intensities tended to increase the effect of 2,4-D but that temperature was more important, and that reduced light prior to treatment increased the amount of chlorosis obtained at higher concentrations of 2,4-D. Their studies with sunflower plants included a number of criteria being affected by 2,4-D; and the interactions of light, 2,4-D and these various criteria appear to be rather complex. However, no important effects were observed until the light intensities were greatly reduced. Low light intensities, both before and after chemical treatment, tended to increase the effect of 2,4-D.

Datta and Dunn (1955, 1956) studied the effect of light quality on the action of 2,4-D and concluded that the action spectrum for the synergistic influence of light followed that of photosynthesis and suggested that these phenomena may be related.

Minshall (1957), working with excised bean shoots, investigated the influence of light on the action of CMU, and concluded the increased injury at higher light intensities was due to a greater accumulation of the herbicide in the affected tissue as a result of greater transpiration rate.

No recent studies of herbicidal oils have been made with respect to this factor, but Dallyn (1950) showed that light prior to treatment increased injury by oils of low toxicity in proportion to stomatal opening and light following oil sprays also increased their toxicity.

The work reported here was carried out to clarify some of these previous investigations and obtain information on the influence of light on the action of several herbicide types used commercially at the present time. That portion of the investigation included here deals with field studies with 2,4-D, CIPC, CNOSBP, and petroleum oil at normal occurring light intensities.

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1. Paper No. 414 of the Department of Vegetable Crops.

Methods

Preliminary investigations with normal light intensities and a range of herbicide concentrations were used to determine a satisfactory test plant species, a criterion of effect, and a concentration level for each herbicide. Criteria were chosen to give a somewhat linear response to serial levels of herbicide.

Each herbicide was tested in a separate experiment but the light control treatments were comparable for all of these. A split plot design was used with chemical treatment and control sub-plots within light control main plots. Light control treatments consisted of shading with one thickness of a medium weight muslin cloth supported by a frame 14 inches above the soil. The degree of shading resulting from this varied with light intensity but allowed about 25 percent light penetration at normal summer intensities. No measure of change in light quality was made. The herbicides were applied with a small plot sprayer after the test plants had reached a certain size. The shading treatments are listed in Table I.

Table I. Shading Treatments for Field Tests of Light-Herbicide Interactions.

Treatment No.	Shading Treatment
1.	From emergence to the end of experiment.
2.	From herbicide application to the end of experiment.
3.	From emergence to herbicide application.
4.	No shading.
5.	Same as 1, except removed 2 days after herbicide applied.
6.	Same as 2, except removed 2 days after herbicide applied.

The first four treatments form the complete 2 x 2 factorial of two levels of light and two times of application. The last two treatments are the complete possible modifying treatments to show the effect of removing the shades after sufficient time for the herbicide to reach the site of action. This duration of two days was chosen arbitrarily.

Further information about the procedures used in the five tests reported here are presented in Tables II and III. The statistical procedure used to evaluate the results was a split plot analysis of variance with the subplot X main plot interaction divided into five orthogonal comparisons.

Table II. Procedure Details for Field Tests of Light-Herbicide Interactions.

	Chemical	Rate/acre (active)	Test Plants	Response Criterion
est 1	2,4-D, Amine salts	1/4 lb.	Beans	Second Internode length, between node bracts (mm.)
est 2	" " "	"	"	" " " " " " "
est 3	CIPC, emulsifiable	1 "	Oats	Plant length from stem base to tip of longest leaf (cm.)
est 4	DNOSBP, amine salts	1/4 "	Radishes	Plant weight, except roots remaining when pulled(gm.)
est 5	Oil , Bayol D	100 gal.	Oats	Same as Test 3.

Table III. Summary of Temperature and Light Data During Test Periods.

		From Time of Emergence to Herbicide Application			Two Days Following Herbicide Application			Remainder of Experimental Period		
	Period	No.of Days	Ave. Temp.°F	Ave. Solar[1] Radiation	No.of Days	Ave. Temp.°F	Ave.Solar Radiation	No.of Days	Ave. Temp.°F	Ave.Solar Radiation
est 1.	Sept. 4-Oct. 6,1956	8	58.2	366	2	66.2	345	12	52.4	293
est 2.	June 27-July 16,1957	9	67.4	568	2	67.3	521	8	65.0	542
est 3.	July 16-July 31,1957	3	65.6	712	2	73.9	660	10	69.4	518
est 4.	July 31-Aug. 21,1957	12	66.1	531	2	60.6	588	7	63.6	580
est 5.	Aug.24 -Sept. 9,1957	9	62.3	365	2	69.4	389	5	58.5	493

Solar Radiation = gm cal/cm^2 (Average total accumulation / day)

Results

Table IV lists the treatment means of the responses used to measure herbicide effect as a function of concentration. Other measurements were made but are not reported here since their results do not differ appreciably from those listed.

Table IV. Treatment Means of Response Criteria for Field Tests of Light - Herbicide Interactions.

Shade Treatment		Test 1 2,4-D Beans Second Internode (mm.)	Test 2 2,4-D Beans Second Internode (mm.)	Test 3 CIPC Oats Plant Length (cm.)	Test 4 DNOSBP Radishes Fresh Weight (gm.)	Test 5 Oil Oats Plant Length (cm.)
1.	Herbicide	5.6	4.9	21.9	14.1	12.6
	No Herbicide	23.0	24.2	30.2	375.0	24.6
2.	Herbicide	5.5	5.6	13.8	23.4	12.1
	No Herbicide	16.6	19.5	28.1	515.0	24.5
3.	Herbicide	5.4	5.0	12.3	5.7	13.0
	No Herbicide	20.5	15.3	20.5	591.7	19.4
4.	Herbicide	5.4	5.8	10.5	66.3	11.8
	No Herbicide	15.8	18.8	19.9	1276.7	19.7
5.	Herbicide	5.9	5.2	17.0	11.2	13.5
	No Herbicide	15.5	17.0	21.9	546.7	21.5
6.	Herbicide	5.5	5.8	12.0	29.7	11.9
	No Herbicide	17.3	14.4	21.4	840.0	21.9

Partial analyses of variance for each of these field tests are presented in Table V. The components of the herbicide X shading interaction are given the following letter designations as used in the analyses of variance table:

A - Shaded before chemical application vs. all other
B - Shaded after chemical application, two days vs. longer
C - Shaded after chemical application, (two days + longer)/2 vs. none.
D - A x B interaction
E - A x C interaction

Table V. Analyses of Variance for Field Tests of Light-Herbicide Interactions.

Source of Variation	df	Test 1 (2,4-D) ms	Test 2 (2,4-D) ms	Test 3 (CIPC) ms	Test 4 (DNOSBP) ms	Test 5 (oil) ms
Shading Treatments	5	13.32**	9.90	95.31**	178706**	7.66*
Error A	10	3.81	15.31	4.89	7171	1.92
Herbicide Treatments	1	1423.93**	1475.84**	754.38**	3999200**	803.72**
Herbicide X Shading	5	27.20**	27.96**	11.88	139689**	8.76**
A	1	19.97**	8.90	34.22*	267806**	3.42*
B	1	18.97**	60.80**	25.42*	93126	3.45*
C	1	0.20	6.36	0.39	241374**	24.15**
D	1	27.14**	2.04	0.77	8318	1.00
E	1	3.64	24.73*	8.61	87822	0.03
Error B	12	1.06	5.10	4.00	25027	0.45

* Significant F test at 0.05 probability level.

** Significant F Test at 0.01 probability level.

Discussion

Careful consideration must be given to the data in Table IV in the interpretation of the significant effects of the variance components in Table V. It is apparent that a large portion of many of these effects is due to differences between the plants not treated with herbicides.

The two tests reported for 2,4-D were conducted because of the relatively cold weather during the first test period (Table III) and therefore offering the possibility of studying a temperature effect. However, the differences in light intensities during these periods would make such a comparison questionable. The effect of shading prior to chemical treatment in increasing the effectiveness of 2,4-D in inhibiting growth which was exhibited in the first test, was not found in the second test in which the temperature averaged more that 10°F higher. If this is a true temperature effect then a general weakening of the plant at low light intensities rather than a specific action would be suggested. Among the treatments shading the plants after the herbicide application, removing the shades two days after the chemical treatment tended to decrease the effect of 2,4-D. This effect component was highly significant in both 2,4-D tests. Since there was no overall effect of shading after the chemical application, a modification of this effect by early removal of the shades would not likely exist. Because of the direction of the effect caused by early shade removal, a general increase in plant resistance to 2,4-D effects, rather than a specific action on plant uptake or translocation of the herbicide would be suggested. The highly significant interaction between the effects of shading prior to chemical treatment and removing the shades two days after the 2,4-D was applied is largely due to differences in growth of controls. Here again the effect of removing the shades after two days on decreasing the apparent effectiveness of the 2,4-D is shown, and the interaction indicates that this is particularly true of the plants shaded prior to the 2,4-D spray. In general these results are in agreement with the findings of Blackman and Robertson-Cuninghame.

The results of the CIPC test indicate a strong response to shading the plants before application of the herbicide by decreasing its effectiveness with shading. It seems more probable that this is a result of general metabolite level resulting from differences in photosynthesis rather than a specific effect of one reaction or one plant constituent level. This would indicate a possibility of a relation between general metabolite level and CIPC entrance into the plant and translocation except for the conflicting effect by removing the shades two days after the CIPC application and the lack of an interactive response of these effects.

The plots treated with DNOSBP showed the same response to shading prior to chemical treatment as with CIPC. Here again the direction of the effect makes explanation difficult. Since DNOSBP is a contact type herbicide, translocation would not seem important and if the mode of action is associated with the uncoupling of phosphorulation, the relative amounts of phosphorulation in light and shade grown plants may be a factor. The significant effect of shading following chemical treatment in reducing the effectiveness of DNOSBP may possibly be connected with a photo chemical reaction, but DNP inhibition of phosphorulation is not generally considered light sensitive. The very large difference between weights of sprayed and control plants must be considered. The variance due to weights of sprayed and control plants in the unshaded plots is important in the calculation of these two significant effects

Although it may be questionable to use Bayol D as an herbicidal oil, it was not possible with the response criteria attempted to obtain a useful response curve with oils of higher acute toxicity such as Stoddard Solvent. For this reason there is no correlation information available for the observed effects of this test and those possible with oils of acute toxicity.

Oil showed the same effect as the other herbicides in relation to shading before the herbicide application. The significant effect of the first component of shading following the oil spray, that is removal of shades after two days, also followed the other herbicides in this respecct. The second component of shading following spraying gave a response opposite to that obtained with DNOSBP, or a reduction in effectiveness of the oil by removing the shades. Both the effects of shading prior to the oil spray and removing the shades two days afterwards are in agreement with the work of Dallyn but the overall effect of shading after treatment does not agree and may be due to temperature differences as explained later.

A notable feature in the comparison of the interactions of light with the four herbicides tested is the similarity in effects. Particularly the tendencies for shading before herbicide application and removal of the shades after two days to reduce the effectiveness of the herbicides would indicate that general growth effects rather than specific actions were being measured. Since all response criteria reported here were of a general inhibition type at near lethal concentrations this correlation between herbicides of widely varying type would probably be expected.

Another important factor to consider in these tests is temperature. Blackman and Robertson-Cuninghame have indicated that temperatures under their shades remained nearly the same as the temperature in a standard Stevenson screen. This was verified in temperature measurements made in the field tests reported here, but the temperatures of plants growing in the open varied as much as 10°F from those under shades. They may be particularly important in the vaporization and greater activity of DNOSBP and loss of activity of herbicideal oils.

Summary

Field tests were made to study the interaction effects of light with four types of chemicals used as herbicides. Shades were used for light control and various effects were extracted from the interactions with each of the herbicides. Possibly because non-specific growth inhibition was used as the response criterion for each herbicide there tended to be a similarity between chemicals in their interaction effects. This was most evident in (1) the reduction in response to herbicides by shading prior to their application and (2) removing the shades two days after herbicide application in comparison to shading for a longer period.

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THE INFLUENCE OF DEPTH OF PLACEMENT ON HERBICIDAL ACTIVITY[1] OF MONURON AND SIMAZIN.

by
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This experiment was undertaken to determine whether or not plant species which show some degree of tolerance to surface applications of Monuron can attribute part of their tolerance to a particular type of root system. Sherburne et al (1956) have shown that the movement of the highest concentration of Monuron in soils is related to: 1, amount of water applied after Monuron application, 2, soil type, 3, original soil moisture. Observations of asparagus beds, vineyards and beet fields treated with Monuron indicates that weeds having root systems that penetrate deeply into the soil are becoming the major pests. The plants showing varying degrees of tolerance are: beet (*Beta vulgaris*), dandelion (*Taraxacum* sp), lambs quarters (*Chenopodium album*), and milkweed (*Asclepias syriala*).

Simazin was included in this test because some of the same plants that have shown tolerance to Monuron are tolerant to simazin.

Procedure:

Three herbicide treatments at four depths of placement were replicated twice using a randomized block design. Monuron was used at two rates, ½ and 1 pound active / acre, and Simazin at 2 pounds active/acre. Each treatment was applied with a small plot sprayer using 40 gallons of water per acre. To place the herbicides at the 4, 8 and 12 inch depths the soil was removed from 3' x 3' areas to the desired depth, the side walls were shielded from the spray by Kraft paper and the base of the pit was sprayed. The soil was replaced, tamped and seeds of crop and weeds were sown. The herbicides referred to as being applied at the zero level were then applied. Within the next 24 hours precipitation was recorded at .22 inches. A soil sample taken from the area was classified as an Ontario sandy loam, having 4.9% organic matter and a pH of 7.2

The seeds sown in these plots were:

Green beans	-	var. Refugee
Garden beets	-	var. Detroit Dark Red
Cucumber	-	var. Burpee's Hybrid
Lamb's Quarters	-	*Chenopodium album*
Red Root Pigweed	-	*Amaranthus retroflexus*
Purslane	-	*Portulaca oleracea*
Dandelion	-	*Taraxacum* sp.

Results

Germination was uniformily good on all plots with the larger seedlings of beans and cucumbers exhibiting the first visible symtoms of contact with the herbicide. Purslane on the 4, 8 and 12" depth plots grew to various sizes depending on the depth of the herbicide. At the zero depth purslane died in the seeding stage but on the 12 inch depth purslane spread to a diameter of 6 - 8 inches before dying. The following table presents the percentage of each kind of plant remaining on the plots five weeks after treating:

% Seedlings Remaining Five Weeks After Treating

Treatment	Bean	Cucumber	Beet	Lambs Quarters	Red root Pigweed	Purslane	Dandelion
Monuron							
" ½ lb/a 0" depth	0	0	80	1-5	0	0	0
" " 4" "	0	0	0	0	0	0	0
" " 8" "	0	0	0	0	0	0	0
" " 12" "	0	0	0	0	0	0	0
Monuron							
" 1 lb/a 0" "	0	0	0	0	0	0	0
" " 4" "	0	0	0	0	0	0	0
" " 8" "	0	0	0	0	0	0	0
" " 12" "	0	0	0	0	0	0	0
Simazin 2 lbs/a depth 0"	0	0	0	0	0	0	0
" " 4"	0	0	0	0	100	0	0
" " 8"	0	0	0	0	100	0	0
" " 12"	0	0	0	0	100	0	0

The ½ lb. Monuron plots were outstanding in that the surface application reduced the beet stand by 20% and allowed a scattering of "lambs' quarters" to survive. However, placement of Monuron at any other depth completely killed all crop and weed species. Evidently beets and lambs' quarters growing in plots treated with surface applications of Monuron are not exposed to the full concentration of the herbicide.

Simazin depth placement results showed in one respect a reversal of what was obtained on the ½ lb. Monuron plots. Surface applications gave 100% control of both crops and weeds. However, placement of the herbicide at depths of 4, 8 and 12 inches favored the survival of only "red root pigweed". The seedlings of pigweed on the 4 inch depth plots grew to a height of 2 - 3 inches, showed marginal chlorosis on the leaves, and remained stunted for a period of five to six weeks. The red root pigweeds on the 8 inch depth plots were slightly taller than those on the 4" plots when they exhibited the same symptoms of chlorosis and stunting. However, the stunting and inhibition of growth was of shorter duration for these plants than those growing on the 4" depth plots. Similarly, the red root pigweeds on the 12" depth plots attained a 5" - 6" height before exhibiting chlorosis and growth inhibition and they resumed growth within three weeks. These differences in size of plant before inhibition and the duration of the inhibitory growth period is reflected in the final heights which were:

Location of Simazin 2 lbs/a - Final plant height (inches)

1.	0" depth	0
2.	4" "	14"
3.	8" "	19"
4.	12" "	27"

Examination of the pigweed plants' root system at maturity on the Simazin plots showed that the lateral extension and vertical penetration was not visibly different from the root systems of pigweeds growing on the check plots.

Conclusions

The survival of beets on plots treated with a surface application of ½ lb. Monuron and the complete kill of beets on plots when the ½ lb. of Monuron was placed below the germinating seedlings indicates that beets may owe part of their Monuron tolerance to their initial position in respect to the herbicide and second to a rapidly developing tap root system away from the zone of highest Monuron concentration.

The pigweeds that persist on the Simazin plots when the herbicide is placed at 4,8 and 12 inch depths presents another type of problem. Since surface applications of the herbicide is toxic to all species of plants considered in this test, it is evident that all are sensitive. However, depth of location effected the persisting pigweeds in four ways, 1) the time elapsed before toxic symptoms were expressed, 2) the length of time plant growth was inhibited, 3) ability to resume growth with time which was regulated by depth, and 4) the ultimate plant size. These four expressions of Simazin activity within the plant were entirely different responses than those on the surface applicant plots.

One possible explanation for these differences is that the seedlings which germinate in soils treated with surface applications have much of their root system initially in the active herbicide zone. The amount absorbed may be small but adequate to bring about complete kill of the aerial portion. Thus as the herbicide is placed deeper in the soil, the percentage of the entire root area in contact with the herbicide decreases because of lateral root extension. That which is absorbed may be adequate to cause inhibition of growth and chlorosis but below the lethal threshold. This does not explain the difference in the length of time of the inhibition of growth. This phenomena appears to be best correlated to the depth of placement of the herbicide. It may be that Simazin breakdown by soil microorganisms may be expediated by reducing the oxygen tension or, that increased depth of placement presents a larger total mass of herbicide free soil above the herbicide zone for laterial root development.

Summary

1. Monuron (CMU) at two rates (½ and 1 pound/a)and Simazin 2 lbs/a) were applied to an Ontario sanday loam soil at four depths (0" (surface application) 4, 8 and 12 inches).

1" rain moves some of herb down 1" 2" oxygen

2. Seeds of both crops and weeds were sown on the plots to check differences in plant response to the herbicides at various levels.

3. In the Monuron plots only the ½ lb. surface application allowed any of the seedlings to develop, these were, beets and a scattering of Chenopodium album. When these two species grew into a zone of ½ lb. Monuron, death quickly resulted regardless of the depth of placement. The tolerance exhibited by beets to a surface application of Monuron is partially acredited to the depth of planting and the rapidly developing tap root system away from the toxic zone above.

4. Simazin (2 lbs/acre) surface applications were effective in killing all seedlings. However, placement of the herbicide at 4, 8 and 12 inch depths favored only Amaranthus retroflenus growth. The growth of these plants before showing chlorosis and stunting was proportionate to depth and the inhibitory period of growth was inversely proportional to depth i.e., plants on 12" depth plots were the largest when chlorosis appeared and had the shortest inhibitory period.

5. Both of responses of plants on Monuron and Simazin plots are acredited in part to particular root systems.

(a) The beets surviving on ½ lb. Monuron surface applications were favored by a root system growing away from the active herbicidal zone above,

(b) Red-root pigweed survived on 4, 8 and 12 depth plots because of the percentage of roots at the herbically active zone did not translocate sufficient quantity to be lethal to the aerial portion.

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Neburon: Newest of the Substituted Urea Herbicides

by P. L. Poulos
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E. I. du Pont de Nemours & Company (Inc.)
Northeast Weed Conference
New York - January 8-10, 1958

Since the commercial introduction of monuron several years ago, the substituted urea herbicides have become recognized as an extremely versatile group of compounds. Du Pont has prepared and studied a great many herbicidal compounds in this family. Both monuron and the newer diuron are now familiar as commercial products. Neburon, which is the subject of this paper, was introduced commercially a month or two ago.

The introduction of monuron brought a new concept into both agricultural and industrial weed control. For agriculture, it was the first compound which could be applied to the soil at extremely low rates to give long-lasting residual control of weed seedlings. At application rates of one to four pounds per acre, properly timed, both monuron and diuron have proved to be useful as selective weed killers in many crops.

Difference in water solubility among the substituted ureas is one characteristic which gives this family of herbicides their versatility. Some of you in the Northeast have found that diuron is safer to use on certain crops than monuron. One of the reasons for this is that diuron is only about one-sixth as soluble as monuron. Diuron has a solubility of about 40 parts per million, while the solubility of monuron is 230 parts per million.

Neburon has an even lower water solubility -- five parts per million -- which may give it a place for chemical weed control in crops where other compounds have not been successful.

Neburon is the accepted generic name for the chemical compound, 1-n-butyl-3-(3,4-dichlorophenyl)-1-methylurea. It is a white crystalline compound with a melting point a little higher than the boiling point of water. The compound has an exceptionally low order of toxicity to warm-blooded animals, and presents no unusual hazard in handling, application, or in normal use of treated areas by people and animals. In addition to its low water solubility, it is only sparingly soluble in common hydrocarbon solvents.

Neburon is now registered for use, as "Karmex" N Neburon Herbicide, in commercial plantings of certain ornamental evergreens in the eastern states, for control of annual weeds and grasses. "Karmex" N is a wettable powder, containing 18.5 percent neburon. This formulation can be successfully applied in any sprayer with good agitation in the tank. With slotted screens, up to 35 pounds of the product (six pounds of active ingredient) can be mixed and applied in as little as 80 gallons of water.

In addition to the registered use, there is a good deal of promising experimental evidence to indicate that rates ranging from two to four pounds of active ingredient per treated acre can be used for selective weed control in other ornamental species and in certain horticultural and agricultural crops. These include about 20 ornamental species, tomatoes, strawberries, lima beans, pole beans, spinach, onions, carrots, peas, celery, soy beans, birdsfoot trefoil, dichondra seed fields, potatoes, lettuce, peppers, gladiolus, caneberries, and freshly seeded alfalfa.

Optimum use levels for neburon are in the range of from two to four pounds of active ingredient per treated acre. The two-pound rate has been found to be sufficient where the weed population consists largely of particularly susceptible species such as pigweed, mustard, water grass, and chickweed. Three pounds applied prior to weed emergence will control most annual broadleaf species but may permit some of the annual grass plants to survive. At four pounds per acre, neburon has provided excellent control of mixed annual weed population for six weeks or longer. By limiting treatment to a band over the row the chemical requirement per crop acre can be held to half or one quarter of this recommendation.

ORNAMENTALS - REGISTERED USE

Our first commercial recommendation for the use of neburon ("Karmex" N Neburon Herbicide) is for control of weeds in narrow-leaved evergreen ornamental plantings in commercial nurseries. The product has been evaluated for several years on established plantings in the field. On evergreens, applications may be made at any time; however, late fall or early spring is generally preferred as rainfall is more likely to be plentiful during these periods.

As a blanket application, neburon may be applied to clean cultivated areas with a fixed boom power sprayer at the rate of four pounds of active ingredient per acre in a minimum of 80 gallons of water per acre. Where a band application is preferred, neburon may be applied in any desired band width to clean cultivated soil, with the spray directed to the ground at the base of the plants. Again the recommendation is four pounds of active ingredient per acre of area treated in a minimum of 80 gallons of

Either rainfall or irrigation water following application is necessary for good results. The more promptly it is available, the better the results. Approximately 1.5 inches of water is needed on treated soil within two weeks after application.

ORNAMENTALS - EXPERIMENTAL WORK

Applications of neburon have given effective control of chickweed in established plantings of juniper, yew, and Chamaecyparis, and in lining-out beds in Pennsylvania and Delaware. Similar results were obtained in plantings of nearly 20 different ornamental species in a New Jersey nursery. The highest degree of weed control was achieved in rhododendron plantings with a fall and spring application on clean soil; that is, ground which was cultivated prior to the fall application.

On deciduous species, experimental data to date show that neburon performs best when applied in the late fall after the leaves have fallen or in the early spring before the plants break dormancy.

Tests have been conducted to determine the tolerance of recently transplanted ornamental plants to successive annual soil applications of neburon. In one test, 10 different species of common perennial ornamentals were set out in March and the ground around them was treated in early May with neburon at rates of 4, 6, 10 and 15 pounds of active ingredient per acre. The spray was directed so that the foliage of the ornamentals was not touched. Thirteen months later, the soil around the plants was cultivated for aeration and retreated with neburon at the same rates as had been used in the previous year. Weed control ranged from 65 to 98 percent on nine different species of broadleaved and grass weeds. There was no evidence of serious chemical injury. Another test under somewhat more severe conditions is now in its third year -- three applications of neburon at rates of four, eight and 16 pounds on ornamentals approximately a year apart. No adverse effect attributable to chemical residue in the soil has been noted three months after the third annual application but observations are continuing.

The safety of neburon to ornamentals has been confirmed in phytotoxicity studies at three locations along the east coast, in Delaware, North Carolina, and Florida. There has been no significant injury to 40 perennial ornamental species after two successive annual treatments each of 16 pounds of active ingredient per acre, which is four times the rate necessary for weed control. Also, no injury has been observed when these plots were cultivated and new plantings made as in commercial practice following the sale of the first crop.

Of the plants studied, azaleas were the only group that seemed susceptible to injury at proposed rates of application, although there was some injury to Ilex micro and Euonymous spp. at the six-pound rate. The list of species on which the use of neburon has been successfully demonstrated includes:

Roses	Forsythia	Euonymous	Lilac
Spirea	Privet	Firethorn	Crabapple
Viburnum	Maple	Honeysuckle	Gum
Hibiscus	Ash	Jasmine	Osmanthus
Oleander	Boxwood	Magnolia	Ligustrum
Croten	Bougainvillea	Rhododendron	Cedar
Spruce	Juniper	Hemlock	Yew

CROPS - EXPERIMENTAL WORK

Tomatoes

Neburon has been tested on tomatoes in New York, Indiana, Maryland, California and Virginia. Typical of these tests is a trial in a commercial field of transplanted Manaluci tomatoes on Long Island in 1957. The material was applied May 7 and the treated area was irrigated the next day. Major weed species were lambs-quarter, Galinsoga, and seedling crab grass. A rate of 3.7 pounds of neburon (active) per acre gave 95 percent weed control two weeks after application and 98 percent four weeks after application. Two months after application the tomato plants showed no injury. However, in the untreated area, plants were small and chlorotic, showing the effects of weed competition.

In our work with tomatoes, neburon has shown a degree of safety that has probably never been equalled in tomatoes with any other weed control chemical. At rates up to six pounds of active ingredient per acre, the only injury noted was a slight degree of early stunting which the plants outgrew.

Strawberries

Trials on strawberries were conducted in New York, Delaware, Quebec, California, Kansas, Kentucky, New Brunswick, and Canada. Trials were set up in 1957 in both new and established strawberry beds on Long Island. In one of the new beds, neburon at 2.13 pounds of active per acre showed 97.5 percent control of broad-leaved weeds five weeks after application but this dosage apparently was not high enough to give commercial control of grasses. The weed species in this bed were lambs-quarter, rag-weed, and smartweed. The bed was planted April 15 and treated April 16. There was no evidence of phytotoxicity at any of the rates used.

In another new strawberry bed, neburon at 3.4 pounds of active material per acre gave 94 percent control of broadleaved weeds and 100 percent control of crabgrass for three weeks after treatment. Commercial control of the broadleaved weeds continued for another three weeks. At 4-1/2 pounds active ingredient per acre, neburon gave 100 percent control of broadleaved weeds and crabgrass for about three weeks and commercial control of both classes of weeds continued for another three weeks. This bed was planted April 19 and sprayed May 1.

Neburon at rates ranging from 2.8 pounds of active per acre up to 6.1 pounds of active per acre was applied on May 1 in an established strawberry bed on Long Island. Excellent chickweed control was achieved at the three rates tried. Although chlorosis was evident at all rates three weeks after treatment, the strawberry plants in the plot receiving 2.8 pounds per acre completely outgrew this by early July. Since 100 percent control of chickweed has been achieved at this rate, the evidence of chlorosis which remained in the plots treated at higher rates is merely a gauge of the safety margin to established plants. Several species of weeds survived all treatments, indicating the need for further study of timing and irrigation to achieve best control of mixed weed infestations in established strawberry beds.

SUMMARY

In neburon we have a compound which has proved its effectiveness against many species of weeds with a wide margin of safety to high-value perennial plantings and to certain species of annuals which have hitherto been highly susceptible to herbicidal injury.

Applications both before and after crop emergence have been successful, depending upon the crop and the method of culture.

On many crops, including tomatoes, strawberries and most ornamentals, overall post-emergence sprays have been used without plant injury. However, where the plants to be treated are of sufficient size and of such a habit of growth as to permit the use of shielded or directed sprays, these methods would probably be most desirable.

Neburon is peculiarly adapted to the weed control requirements of the northeastern part of the United States because it needs a substantial amount of rainfall or irrigation water in order to be effective. As we learn more about adjusting its selectivity by timing and varying rates of application, and suiting the treatment to both the soil type and the crop species involved, we can expect to see the selective use of neburon extended to certain specialized situations where chemical weed control has previously been difficult or impossible.

CONTROL OF BINDWEED IN GRAPES

M. W. Meadows[1], H. A. Sweet[2], C. V. Flagg[2]

Problem:

Convolvulus arvensis L. and Convolvulus sepium, known synonymously as bindweed or wild morning glory are very difficult weeds to control in grape vineyards. Since both species were present where this work was accomplished, the term "Bindweed" will be used.

Because of their vining habits, these weeds present a serious problem during the harvest operation. The combination of competition during the growing season and shattering of the grape cluster during harvest undoubtedly result in yield reductions.

Experiment I - Materials and Methods

In 1956 the pure acids of the following benzoics were obtained:

- 2,3,6-trichlorobenzoic acid
- pentachlorobenzoic acid
- 2,3,4,5-tetrachlorobenzoic acid
- 2,3,5,6-tetrachlorobenzoic acid
- 2,5-dichlorobenzoic acid
- 2,3,5-trichlorobenzoic acid

The acid was reacted with sodium hydroxide to produce a water soluble salt. Each salt was applied as a directed spray beneath trellises of three mature grape plants August 31, 1956 at the rate of 1 lb. acid equivalent per acre.

Experiment I - Results

The sodium salt of 2,3,6-trichlorobenzoic acid was the only material that had any noticeable effect on bindweed. Bindweed plants treated with this material first showed typical 2,4-D-like hormone effects and were dead at the end of several weeks. No regrowth was noted the following year. No effects were noted on the grape plants in 1956 or 1957.

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Experiment II - Materials and Methods

Sodium salt solutions of the benzoic acids listed in Experiment I were applied to potted Concord grape plants in the greenhouse January 22, 1957 as follows:

1. Foliar Spray - Plants were sprayed with an atomizer to the point of run-off with a 2500 ppm solution of each benzoic. Two plants per treatment.

2. Soil Application - An application equivalent to 1 lb. per acre of the benzoic acids was applied to the soil and watered in. Two plants per treatment.

Experiment II - Results

The 2,3,6-trichlorobenzoic acid and pentachlorobenzoic acid, soil and foliar applications, gave pronounced hormone effects and plants were dead in approximately 2½ weeks. The other materials had no visible effects.

Experiment III - Materials and Methods

A commercial formulation of polychlorobenzoics, *Benzac 103A, was applied as a directional spray to mature plants in a commercial vineyard May 28, 1957. Plot size was 6 x 24 feet each plot containing three grape plants. Each treatment was replicated twice.

According to the manufacturer, the composition of Benzac is as follows:

2,3,5-trichlorobenzoic acid	16.3%
2,3,6-trichlorobenozic acid	7.8%
2,3,5,6-tetrachlorobenzoic acid	36.4%
Other isomers	39.5%

Rates of application were 1, 2, 4, and 8 lbs. acid equivalent per acre. Refractometer readings were taken September 25, 1957 and October 11, 1957. Grapes were harvested and yield records taken October 10, 1957.

Experiment III - Results

The 1 lb. application rate had no visible effects on the grape plants, giving little to no control of bindweed.

The 2 lb. rate resulted in commercial control of bindweed. Suppression of growth was sufficient to prevent the bindweed plants from invading the grape trellis. A majority of the bindweed plants were killed with no regrowth during the current season. Slight hormone effects were noted on grape leaves that

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*American Chemical Paint Company

formed after the application of Benzac.

At the 4 and 8 lb. rate of application all bindweed plants were killed with no regrowth occuring. Hormone effect on the grape plants was rated from moderate for the 4 lb. rate to severe for the 8 lb. rate.

Yield and Refractometer data are as follows:

Chemical Rate	Average Yield Per Vine in Lbs.	Refractometer Readings Sept. 25	Oct. 11
1	11.9	15.7	15.4
2	11.4	15.7	16.2
4	16.4	16.5	16.3
8	11.0	15.2	15.6
Check	12.2	16.5	16.4

There were no significant differences in yield or refractometer readings.

Conclusions:

1. The sodium salt of 2,3,6-trichlorobenzoic acid at the 1 lb. rate was the only benzoic that was effective against bindweed. At this rate complete kill was obtained.

2. The sodium salts of 2,3,6-trichlorobenzoic acid and pentachlorobenzoic acid applied to the soil at 1 lb. per acre and as a foliar spray at 2500 ppm killed young vigorously growing grape plants in the greenhouse.

3. Benzac 103A, a commercial product, containing a mixture of polychlorobenzoics gave commercial control of bindweed at 2 lbs. per acre with slight hormone effects on the grape plants. Four and eight lbs. per acre gave complete control of bindweed with hormone effects on the grape plants ranging from moderate to severe. The 1 lb. rate did not control bindweed or affect the grapes. No significant differences in yields or refractometer readings were noted.

4. The polychlorobenzoics show excellent promise as a control for bindweed in grape vineyards.

Additional work is necessary to determine the effect of wind drift, soil type, age and vigor of the plants, etc., in relation to hormone effects on the grape plants.

HERBICIDE EFFECTS ON STRAWBERRY YIELD

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A wide variety of weed spray practices are used in commercial strawberry plantings. Some are founded on a broad base of research data. Others are supported by data referring only to narrowly restricted conditions of season and variety, or by little more than observational results. Nearly all have some record of reducing crop yields, either in quantitative experiments or in grower reports that are numerous and similar enough to be indicative.

Considering the variability in evidence and the widely differing conditions of variety, season, and growth stage under which herbicides might be used, much more yield data is needed for guidance in their safe employment. The purpose of this report is to amplify the record on several herbicides with some yield data obtained in western New York.

1956 Yield Results with CIPC, 2,4-D, Sesone, and Sesin

Six varieties of strawberries, planted in May of 1955, were subjected to twelve differential spray treatments beginning in August. The treatments involved factorial combination of three treatments in August with four different subsequent treatments, as follows:

August 5, 1955

1. 2,4-D, 0.6 lb/A in amine salt; plus 3.3 lb. sesone (sodium 2,4-dichlorophenoxyethyl sulfate).

2. 2,4-D, 0.6 lb/A; plus 2.4 lb/A sesin (2,4-dichlorophenoxyethyl benzoate).

3. Check, hoed free of weeds August 27.

Subsequent treatments.

1. November 5; 2,4-D, 1.0 lb/A in amine salt.

2. " "; CIPC, 1.7 lb/A (isopropyl N-(3-chlorophenyl) carbamate).

3. May 4, 1956; CIPC, 1.5 lb/A.

4. Check, hand weeded.

All the above rates are expressed as pounds active ingredient applied per acre of treated ground surface. Treatments were applied in about 50 gal/A with a knapsack sprayer fitted with two "Teejet flat spray" nozzles positioned to treat a three-foot band centered on the row.

At the time of the August treatment about three runners were rooted from each mother plant and others were forming. Temperature was 90° F. at the time of spraying; mean maximum and minimum for the next week was 79° and 63° F. Rainfall amounted to 0.03" seven hours after spraying, 0.1" the next day, and 4.8" during the sixth to eighth day. The November date was cool (40° F.) followed by a week with mean maximum of 47° and a mean minimum of 32° F. and rainfall of 0.1". The planting was mulched with wheat straw December 20, and remained under continuous snow cover from soon after that date until early April. The May treatment was applied on a 40° day and followed by a week with 56° mean maximum and 39° mean minimum.

Yields. Table 1 summarizes the yield results. The one-pound application of 2,4-D in November resulted in a significant yield reduction of about 28%. There is a trend for yield reduction by the August sesin treatment, but it is not quite significant. No other effects can be seen from the several treatments or combinations; nor is there any indication that the damage from the November 2,4-D was aggravated by the previous 2,4-D application in August.

Table 1. Yield of strawberries following herbicide treatment. 1956 crop from plants set in May, 1955, Geneva, N. Y. Pounds berries per 18 linear feet of matted row; six plots in each of the combination treatments.

August, 1955 treatment	Subsequent treatments: Check, hand weed	2,4-D 1.0 lb. Nov.	CIPC 1.7 lb. Nov.	CIPC 1.5 lb. May	Average
Check, hoed	5.4	3.5	5.4	6.5	5.2
2,4-D, 0.6 lb; sesone, 3.3 lb.	4.9	4.4	5.5	5.2	5.0
2,4-D, 0.6 lb; sesin, 2.4 lb.	4.9	3.6	5.0	4.7	4.6
Average	5.1	3.8**	5.3	5.5	4.9

** Yield reduction significant at P=0.01. LSD (P=0.05) between August treatment averages, 0.7; between subsequent treatment averages 0.9; among the twelve combinations, 1.3.

The six varieties that provided the replicates differed markedly in their response to the November treatment with 2,4-D. As shown in Table 2, yields of Premier and Eden were not altered by the 2,4-D, while Robinson, Catskill, and Sparkle suffered serious reduction in yield. It is interesting that the yield of the "sensitive" varieties was not affected materially by the 0.6 pound 2,4-D application in August. The wide difference between variety yields may in part stem from frost injury in the spring of the crop year.

Table 2. Variety and season factors in the yield effects of 2,4-D. The original plot data of Table 1 rearranged to compare 2,4-D treatments with others in each of the six varieties.

Variety	Subsequent treatments: 2,4-D 1.0 lb. Nov. 3 plots	Subsequent treatments: Check or CIPC 9 plots	Difference 2,4-D-Check		Aug. treatments: 2,4-D; sesone 4 plots	Aug. treatments: Check 4 plots
Howard (Premier)	5.7	5.3	0.4	±1.4	5.7	5.9
Robinson	2.2	5.1	-2.9	±0.7**	5.3	4.7
Catskill	3.5	5.5	-2.0	±0.8*	4.8	5.8
Sparkle	4.0	7.6	-3.6	±1.5*	6.5	6.3
N.Y. "96"	2.7	3.5	-0.8	±0.7	3.5	3.5
Eden	4.5	4.7	-0.2	±0.7	4.1	5.0
Average	3.8	5.3	-1.5	±0.4**	5.0	5.2

* Difference significant at P-0.05; ** at P-0.01.

Yield reduction by the November 2,4-D treatment seemed associated with reduced plant vigor and stand the following spring. Ratings of plot vigor, as density of cover with strawberry foliage, were made in May. Correlation between these ratings and yield was a highly significant 0.48 over-all, and 0.66 in the treatment X replicate variance. Treatment effects became insignificant if yields were adjusted for plot vigor by covariance analysis.

Symptoms of 2,4-D following the August treatment showed in epinasty of runners which had not yet rooted. This was particularly pronounced on the Robinson variety, but did not result in any measurable reduction in yield. No crop symptoms were noted in the CIPC plots. Higher rates of 4 lbs/A or more used on incidental plots at the time of the May treatment did cause leaf injury. Both mature and expanding leaves showed brown areas with a water-soaked appearance at their margins and extending inward between the main veins.

Weed control. At the time of the August treatment the block carried a dense carpet of seedling weeds in the cotyledon or first leaf stage, predominantly purslane (Portulaca oleracea), redroot (Amaranthus retroflexus), and mallow (Malva neglecta). Three weeks later, when all plots were hoed, the 2,4-D plots were practically free of weeds. A few parallel plots that had been treated with 2,4-D alone seemed as clean as the experimental plots that had received sesone or sesin with the 2,4-D.

Practically no weeds were present at the time of the November treatments, or through harvest time the next June. However, after the mulch was pulled from the plants in April, a heavy crop of seedling wheat appeared in all plots except those that had received CIPC. The May application of CIPC was made when the wheat was about four inches high. Subsequently there was a gradual diminution in the wheat cover from this treatment, and a light infestation in the previously wheat-free plots. The status on June 2, when all plots were rated visually and counts made in some sample sections, is summarized in Table 3. All plots were then hand weeded to remove the wheat and rare other weeds.

Table 3. Population of seedling wheat, June 2, 1956, in strawberries mulched with wheat straw December, 1955. 18 plots averaged for each treatment.

Treatment	Wheat cover rating 0=none to 10=dense Mean	Median	Average number shoots per sq. ft.
None	6.6	8	30
2,4-D, 1.0 lb., Nov. 1955	6.6	8	30
CIPC, 1.7 lb., Nov. 1955	2.8	2	2.0
CIPC, 1.5 lb., May, 1955	2.3	2	1.5

1957 Yield Results with CIPC, DN, MH, Sesone or Sesin on Plants Grown in the Hill System.

Strawberries grown in the hill system as spaced single plants have often outyielded the conventional matted row. Weed sprays should therefore be tested under this method of culture. The hill system also provides a means of evaluating the direct effect of herbicides on productivity, without the complicating factors of too few or too many runner plants, or the date and stage when a particular set of runner plants might have been affected by the herbicide spray.

Catskill and Empire varieties were planted in April, 1956 on a sand-gravel textured soil at Fredonia, N. Y. The plants were set and managed in a two-row hill system with a spacing of 12 inches between plants in the row, 18 inches between rows with a 30 inch alley between each pair of rows. Runners were removed at two-week intervals. Weeds were removed from all treatments at two to four week intervals depending on conditions of growth. Few weeds attained a height greater than two inches and it is assumed that weeds did not compete with the strawberry plant for either water, nutrients or light.

The following treatments were used: (1) Sesone - three pounds per acre applied on June 4, July 15, Aug. 15, and Sept. 12, 1956; (2) Sesin - two pounds actual per acre applied on June 4, July 15, Aug. 15 and Sept. 12, 1956; (3) CIPC 2 pounds per acre applied on Nov. 19, 1956; (4) DN - one pound per acre as amine sale applied on Nov. 19, 1956; (5) Maleic hydrazide - 2,000 ppm in water used as a foliage spray to wet both sides of the leaves - applied Aug. 15 and Sept. 12, 1956; (6) Check - no weed herbicides or runner inhibitors applied. The herbicides were applied in a spray of approximately 50 gallons of water per acre. All treatments were replicated 4 times at random on each variety with individual plots 4 feet wide and 20 feet long.

The Catskill plants were grown in a Maryland nursery from virus free stock. The Empire plants were grown by a commercial grower near Geneva. Some of the Empire plants showed symptoms of winter injury previous to planting. This condition is considered the main factor in stand of plants shown in Table 4.

The fertilizer program consisted of 20 tons per acre of strawy manure plowed down before planting. Supplemental applications of ammonium nitrate were applied at the rate of 80 pounds per acre on May 7, June 4 and Aug. 28, 1956. The planting was irrigated once in 1956 and 5 times in 1957 either previous to or during harvest.

Table 4. The effect of five materials on the yield of two varieties of strawberries grown in the hill system, 1957.

	Pounds of fruit per plot	Pounds of fruit per plant	% Stand of plants	Number of berries per plant	Number of berries per pound
Catskill					
Sesone, 4 trts.	30.6	0.78	98	48.2	61.4
Sesin, 4 trts.	32.1	0.82	98	51.5	62.4
DN, Nov.	26.1	0.71	93	46.0	65.5
CIPC, Nov.	25.8	0.68	95	43.3	63.7
Check	32.3	0.83	97	51.1	61.7
MH, 2 trts.	32.2	0.87	93	49.9	57.1
L.S.D. at 5%	3.6	0.09			
Empire					
Sesone, 4 trts.	21.5	0.79	68	34.8	49.0
Sesin, 4 trts.	23.5	0.70	84	33.7	47.8
DN, Nov.	16.1	0.52	75	27.8	52.8
CIPC, Nov.	16.7	0.52	80	24.4	46.4
Check	22.5	0.66	85	29.7	44.9
MH, 2 trts.	22.4	0.67	79	31.7	47.1
L.S.D. at 5%	5.4	0.15			

Table 4 shows the effect of treatments on the yield of field capped fruit in pounds per plot. A yield of 30 pounds is equivalent to 20 quarts per plot or approximately 11,000 quarts per acre.

Table 4 indicates that CIPC and DN markedly reduced yields. This reduction in yield is approximately 20% and is statistically significant at the 5% level. However, from a practical viewpoint the reduction in yield by CIPC and DN are not too serious because either of these materials when correctly applied will control certain weeds which, if left uncontrolled, may cause up to 100% reduction in crop depending on stand of weeds.

Effect of Sesone on the Yield of Premier Variety in the Matted Row

The Premier (Howard 17) variety was planted in April of 1956 adjacent to the previous experiment. The planting was managed as a typical matted row. Plants were set two feet apart in the row with $4\frac{1}{2}$ feet between rows. All runners which developed and rooted in a band 18 inches wide were left undisturbed while those plants which extended outside of this band were removed by disks on the cultivator. The plants were from a very productive planting near Geneva. After the variety was planted a report from Beltsville indicated all plants contained a mild virus. The experiment consisted of 48 plots which were 20 feet long and $4\frac{1}{2}$ feet wide. Half of these plots received Sesone at 3 pounds per acre in 50 gallons of water on Aug. 1 with a second application on Sept. 15, 1956. The remaining 24 plots were used as checks - no weed sprays applied. Weeds in all plots were removed at intervals of two to four weeks and it is assumed that weeds did not seriously compete with the strawberry plant at any time.

The mean yield of fruit in pounds per plot in 1957 were as follows: Sesone treatment - 18.3 lbs, and check treatment 20.7 pounds. A difference of treatment means of 2.4 pounds was obtained which is not quite statistically significant at the 5% level. A yield of 20 pounds per plot is equivalent to approximately 6,300 quarts per acre.

Sesone did control many germinating weeds whereby labor for hand weeding was greatly reduced. Numerous workers have shown that Sesone may inhibit the development of roots on runner plants particularly if the weather turns dry. Perhaps the injurious effects of this material on the development of strawberry roots might be partially alleviated by supplemental irrigation during the period of runner formation. New York strawberry growers need a herbicide to control weeds in late summer and in early fall when the runners are developing roots and forming the matted row. Sesone should be further tested under a wide variety of conditions.

Summary

The following yield results were observed in comparison with controls that were maintained free of weeds.

(In a block of six varieties)

(1) 2,4-D at 1.0 lb/A in November reduced yield of Catskill, Robinson, and Sparkle by up to 50%; but had no effect on Premier and Eden. Yield results were related to plot vigor in the spring after treatment.

(2) 2,4-D at 0.6 lb/A in August, with Sesone at 3 lb/A, was not measurably detrimental to any of the varieties, nor did it aggravate damage by the subsequent November treatment.

(3) CIPC at 1.5 to 1.7 lb/A in November or May did not decrease yield. Either treatment controlled seedling wheat that started in the straw mulch.

(In a hill planting of Catskill and Empire)

(4) Four applications of Sesone or of Sesin repeated during the summer were not detrimental to yield.

(5) Two late summer applications of maleic hydrazide at 2000 ppm did not reduce yield.

(6) DN amine at one lb/A in November reduced yield by a significant 20%.

(7) CIPC at two lb/A in November reduced yield by a significant 20%.

(In a matted row block planting of Premier)

(8) Two late-summer applications of Sesone while runners were forming tended to reduce yield by about 10%, but the difference was not statistically significant.

These results, with those of other workers, suggest that the herbicides commonly used in strawberry beds have the potentiality of causing reduced yields as compared with thoroughly weeded controls. The occurance of damage, and its magnitude, is however dependent on variety and on the cultural and growth factors included in the generality "season".

In practice, a yield reduction of ten to twenty percent is rarely a loss as compared to the cost of removing weeds by other means, or as compared to the loss in actual or picked crop when weeds invade the fruiting bed. Even greater reduction in inherent productivity can be accepted in an effective herbicide when weeds would otherwise force abandonment of the planting.

3-AMINO 1,2,4-TRIAZOLE FOR CONTROL OF REDROOT (*LACHANTHES TINCTORIA*) IN CRANBERRIES

W. F. Meggitt[1] and R. J. Aldrich[2]

ABSTRACT[3]

Redroot (*Lachnanthes tinctoria*) is a particularly troublesome weed in many New Jersey cranberry bogs. It, as well as many other weeds in the bogs, interferes with harvesting especially since mechanical harvesters have been introduced.

Tests were begun in 1953 in New Jersey to find a herbicide that would satisfactorily control redroot. Of the herbicides investigated 3-amino-1,2,4-triazole (ATA) was the only one which showed promise of selectively removing redroot from the cranberries. Results in 1953 and 1954 suggested that 2 pounds per acre of ATA are about the maximum rate that cranberries will tolerate even though in some tests higher rates have been used without reduction in yield. These results also suggested that repeat applications were worthy of consideration.

In 1951, 1 and 2 pounds per acre of ATA were applied on June 6 to plots 5 by 10 feet. On September 1 additional treatments of similar rates were made to certain of these plots to provide a combination June and September treatment. Redroot was satisfactorily controlled with the combination June-September treatments at both rates whereas treatments made on June 6 only, did not provide adequate redroot control. Yields of cranberries from these plots in 1956 and 1957 were not reduced.

Additional plots were established in 1956 to evaluate further the combination spring and fall treatments and fall treatments alone, as well as the effect of timing of the spring application. In 1956 ATA was applied at 1 and 2 pounds per acre on May 29, June 5, and June 12; each plot receiving only 1 rate on 1 date. On September 13 one-half of each plot was treated with 1 pound of ATA per acre thereby giving a fall treatment in all combinations with the various spring treatments including the check.

The fall treatment alone or in combination with any of the spring treatments gave adequate control of redroot. There were no differences among dates of application in the spring with regard to redroot control. Spring application alone was not satisfactory. There was no reduction in yield of cranberries from any application of ATA made in 1956.

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Pre-emergent and Post-hilling Weed Control Tests with Potatoes[1]

R. S. Bell and Thomas F. Tisdell[2]

During 1956 Karmex W, Karmex DW, and Neburon, which are substituted ureas with low solubilities and persistent toxicity, were tested as pre-emergent herbicides. Neburon, which has shown some promise as a crabgrass inhibitor, was also used in split application with the other ureas in a post-hilling test. In 1957 some of the newer herbicides, such as EPTC, G-27901, and G-30028, were compared to DNBP and cultivation in pre-emergent tests, while 3Y9, Simazin, Amid, and Sesone were included in the post-hilling trials. The chemical names of the herbicides, the percent active toxicant, and source are shown in the appendix.

The soil in the test plots on the Agronomy Farm is Bridgehampton silt loam. Each plot contained five 40-foot rows of Katahdin potatoes which were planted in mid-April and fertilized with one ton per acre of 8-12-12-2 in bands. Four replicates of each treatment were randomly located in the experimental area. In addition to the chemical treatments, one set of replicates was hand-hoed occasionally and 4 other replicates were not cultivated until late June. These are called "delayed cultivation" checks. All potatoes were hilled during the first week of July.

The pre-emergent herbicides were applied May 15 each year and potato tops appeared about May 20. Post-hilling herbicides were applied immediately after hilling, about July 10. The amount of herbicide necessary for each plot was weighed out and sprayed individually onto the proper plot with a knapsack sprayer. The amount of water used for the slightly soluble materials was approximately 50 gallons per acre, while 30 gallons per acre sufficed for the readily soluble herbicides.

Results and Discussion - 1956

The bushels per acre of U. S. #1 potatoes, their specific gravities, and the percent weed cover on June 22 and September 14 are presented in Table 1.

Average yields from the delayed cultivation checks, hand-hoed plots, and pre-emergent applications of Karmex W, Karmex DW, and Neburon were 541, 564, 537, 558, and 570 bushels per acre, respectively, of U. S. #1 potatoes. The differences in yield were not significant for any of the treatments.

Very few annual grasses had appeared by June 27. The weeds were principally redrooted and mealy pigweed, spurry, and wild radish. All the substituted ureas reduced the stands of weeds considerably. No particular benefit was found from dividing the Neburon into pre-emergent and post-hilling applications as the percents of annual grasses were the same. There was considerably

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[2]Assistant Professor and Graduate Assistant, respectively.

Table 1. Average Yield of Katahdin Potatoes, Specific Gravities and Weed Ratings, 1956.

Treatment	Lbs/A*	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	Percent Weed Cover Dicots 6/27	Percent Weed Cover Annual Grasses 9/12
1. Hand-hoed Check		564	18	1.0738	30	40
2. Karmex W Premerge	1	537	19	1.0730	15	40
3. Karmex DW Premerge	2	558	15	1.0732	6	30
4. Neburon Premerge	20	570	12	1.0699	22	27
5. Neburon Premerge and Post	10 10	552	12	1.0762	32	37
6. Karmex W Premerge and Post	1 20	528	16	1.0692	22	25
7. Karmex DW Premerge & Neburon Post	2 20	556	12	1.0775	2	22
8. Karmex W Premerge & Neburon Premerge	1 20	534	14	1.0758	6	27
9. Karmex DW Premerge & Neburon Premerge	2 20	545	21	1.0743	6	20
10. Delayed Cultivation		541	15	1.0740	82	70
L.S.D. at 0.05		NS			10	20

* Commercial Grade: Karmex, 80% Active; Neburon, 18.5% Active.

more crabgrass on the plots on which cultivation was delayed compared to the previously hand-hoed plots. The reason for this is not clear. The plots that received Neburon either in pre- or post-hilling applications had somewhat less crabgrass although the differences were not statistically significant. The cover crop of winter rye showed no symptoms of residual toxicity from any of the chemical treatments.

Three cultivations were saved by the use of chemical treatment. One cultivation by the third week of June favors tuber production, probably due to improved soil tilth.

Pre-emergent Herbicide Tests - 1957

The amounts of herbicides, yields of potatoes, and weed cover for the pre-emergent test are shown in Table 2.

Table 2. Average Yields of Katahdin Potatoes, Specific Gravities and Weed Cover for Pre-emergent Weed Control Tests, 1957.

Treatment	Lbs./A	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	% Weed Cover Dicots	Annual Grasses
					June 17	
DNBP*	3	167	28	1.069	27	17
EPTC*	3	108	32	1.073	27	20
EPTC*	6	114	31	1.069	65	17
Hand-hoed Check		204	23	1.069	10	13
Karmex DW	2	160	35	1.070	15	8
Karmex W	1	172	30	1.065	5	10
Delayed Cult.		97	33	1.069	62	20
G-27901	2	175	34	1.072	8	20
G-27901	4	163	32	1.068	0	10
G-30028	4	147	31	1.071	27	20
Neburon	20	147	31	1.071	30	8
Regular Cult.		324	14	1.071	0	0
L.S.D. 0.05		45			29	NS

*Actual amounts of toxicant per acre for liquid formulation. Amounts of the other herbicides are in total pounds of dry formulation per acre. Multiply by percent active toxicant to get pounds per acre.

The rainfall was very deficient during the summer of 1957 and small yields of potatoes were obtained where chemicals were used or where cultivation was delayed. The soil apparently dried out more severely where it was not cultivated. Cultivation instead of chemicals was the outstanding treatment. By July 1, the regularly cultivated potatoes were about twice the size of the uncultivated plants. Yields of U.S. No. 1 potatoes for the delayed cultivation, hand-hoed, and regularly cultivated areas were 97, 204, and 324 bushels per acre respectively.

None of the chemically treated plots produced average yields as large as those with cultivation. The EPTC plots were heavily infested with spurry and yields were similar to the delayed cultivation check. The DNBP, Karmex W, Karmex DW, G-27901, G-30028, and Neburon produced yields significantly higher than those with delayed cultivation. Broad-leaved weed control was satisfactory except in the case of EPTC. The differences among the grass stands were not significant although there were slightly fewer annual grasses where Karmex W, Karmex DW, and G-27901 were used.

Post-hilling Weed Control - 1957

The herbicides used in the post-hilling tests are presented in Table 3, along with yields per acre, weed control ratings, and specific gravities. The yields per acre were not significantly different and ranged from 270 bushels per acre of U. S. #1 tubers where G-27901 was applied to 333 on the check and Simazin plots.

Table 3. Average Yields of Katahdin Potatoes. Specific Gravities and Weed Ratings for Post-hilling Weed Control Tests, 1957.

Treatment	Lbs./A	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	% Weed Cover Dicots	% Weed Cover Annual Grasses
					Sept. 4	
3Y9*	4	304	17	1.068	12	10
Simazin	4	333	16	1.076	23	33
G-27901	4	270	18	1.067	20	43
Emid	2	287	16	1.073	6	8
Sesone	3	338	20	1.071	13	13
Neburon	20	313	17	1.072	10	33
Check		333	14	1.070	70	80
L.S.D. 0.05		NS			14	22

*Actual amounts of toxicant per acre for liquid formulation. Amounts of the other herbicides are in total pounds of dry formulation per acre. Multipy by percent active toxicant to get pounds per acre

3Y9 at 4 pounds per acre, Emid at 2 pounds, and Sesone at 3 pounds seemed to give the best weed control; however, all herbicides reduced the weed stands significantly.

Summary and Conclusions

Regular cultivation during the very dry summer of 1957 was superior in weed control and potato production to chemical treatments. Hand-hoeing, (surface scraping) did not produce as large yields of potatoes as did standard mechanical cultivation. Regular cultivation in more normal seasons produced

In pre-emergent tests Karmex W, Karmex DW, Neburon, G-27901, G-30028, and DNBP reduced the stands of broad-leaved weeds considerably. The effect on annual grasses was not as pronounced. All materials used after hilling reduced the stands of broad-leaved weeds and grasses. Amid, Sesone, and 3Y9 were particularly effective in reducing the numbers of annual grass plants.

Appendix I. Chemical Constituents of Herbicides

1. DNBP. (Dow Premerge) Alkalamine salt dinitro-o-sec-butylphenol.
   (3 lbs./gal. active)
2. EPTC (Stauffer) Ethyl N, N-di-n-propylthiolcarbamate.
   (6 lbs./gal. active)
3. Karmex DW (Diuron) (DuPont) -3-(3,4-dichlorophenyl)-1, 1-dimethylurea.
   (80% active)
4. Karmex W. (Monuron) (CMU) (DuPont) 3-(p-chlorophenyl)-1, 1-dimethylurea.
   (80% active)
5. G-27901 (Geigy) 2-chloro-4-ethylamino-6-diethylamino-s-triazine.
   (50% active)
6. Neburon (DuPont) 1-n-butyl-3-(3,4-dichlorophenyl)-1-methylurea.
   (18.5% active)
7. 3Y9 (U. S. Rubber) Tris-(2,4-dichlorophenoxyethyl) phosphite.
   (2 lbs./gal. active)
8. Simazin (Geigy) 2-chloro-4, 6-bis(ethylamino)-S-triazine.
   (50% active)
9. Amid (Am. Chem. Paint) 2-4-dichlorophenoxyacetamide.
   (75% active)
10. Sesone (Crag 1) Na,2,4-dichlorophenoxyethyl sulfate.
    (90% active) (Union Carbide)
11. G-30028 (Geigy) 2-chloro-4,6-bis-(isopropylamino)-S-triazine.
    (50% active)

AN EVALUATION OF SPRAY AND GRANULAR APPLICATIONS OF HERBICIDES FOR WEED CONTROL IN POTATOES AFTER THE FINAL CULTIVATION

W. F. Meggitt,[1] R. J. Aldrich[2] and J. C. Campbell[3]

Annual weeds, particularly grasses, are a problem in potato production after the final cultivation. These late germinating weeds probably do not reduce potato yields to any great degree but are extremely troublesome at harvest time. There has been a continuing search for a chemical which would satisfactorily control weeds after it is no longer possible to do so by cultural methods. A chemical satisfactory for this purpose would have to provide weed control from late June until September or October when potatoes are harvested. Many of the chemicals evaluated in the past have either reduced potato yields or given unsatisfactory weed control.

The purpose of the present investigation was to evaluate both spray and granular applications of several herbicides for control of late season weeds in potatoes.

1956 EXPERIMENT

Materials and Methods

The following chemicals were applied to potatoes on July 2 immediately after the last cultivation: 1-n-butyl-3-(3,4-dichloro-phenyl-1-methyl urea (neburon), 3-(p-chlorophenyl)-1,1-dimethyl urea (monuron),4,6-dinitro-o-sec-butyl phenol (DNBP), 2-chloro-N,N-diallyl-acetamide (CDAA), 2-chloro-4,6-bis (diethyl-amino)-s-triazine (CDT)and a combination of DNBP and 2-chloro-allyl diethyl dithio-carbamate (CDEC). The rates and type of application of these materials are shown in Table 1. The sodium salt of 2,2-dichloropropionic acid (sodium dalapon) at 5 pounds per acre and a combination of 5 pounds per acre of sodium dalapon and 1/4 pound of 2,4-D were applied as directional sprays on July 20 after the weeds had emerged. All granular formulations were applied as a 2 percent concentration on attaclay, and the sprays were applied in water at a rate of 40 gallons per acre. Plots were 4 rows wide by 32 feet long, and the experiemental design was a randomized block with 3 replications. Potatoes were harvested on October 17 and graded in the field. The effectiveness of the treatments for wedd control was estimated by 3 persons immediately prior to harvesting.

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Results and Discussion

Potato yields and weed control are shown in table 1. The weed control percentage was determined independently by three evaluators immediately prior to harvesting. Since the weed population was almost completely annual grasses, a separate evaluation was not made for broadleaf and grass weeds. In this test monuron was not adequately effective in controlling weeds and yields were significantly reduced. Neburon provided the most effective control of weeds before they emerged, but 8 pounds significantly reduced potato yields. Yield reduction by 4 pounds of neburon approached significance. The foliage of potatoes in plots treated with monuron and neburon appeared to be burned and was generally lighter green than untreated foliage shortly after treatment. Six pounds of granular CDT gave relatively good weed control with no reduction in potato yields. A few days after treatment foliage of plants in these plots showed symptoms of damage manifested as chlorotic upper leaves; however this effect was soon outgrown. DNBP CDAA and the combination of DNBP and CDEC did not give satisfactory weed control and did not reduce potato yields.

Table 1. Effect of herbicide applications after the final cultivation on weed control and yield of potatoes. New Brunswick, New Jersey 1956.

Herbicide	Rate lbs./acre	Method of application	U.S. #1 Bu. per acre	Weed control percent 10/17/56
Sodium dalapon	5	Spray	354.7	71
Sodium dalapon + 2 4-D	5 + ¼	Spray	293.5	76
Neburon	4	Spray	360.3	70
	8		339.4	76
Monuron	3/4	Spray	347.1	49
DNBP	6	Granular	421.1	48
CDAA	4	Granular	435.4	36
CDT	6	Granular	415.4	62
DNBP + CDEC	3 + 3	Granular	412.6	38
Check			409.4	14
L.S.D. .05			52.2	13
.01			71.1	20

Lay-by treatments of sodium dalapon alone and in combination with 2,4-D caused significant yield reductions when applied after the weeds had emerged. The plants from these plots did not show visible damage even though yields were reduced.

1957 Experiment

Materials and Methods

Potatoes, variety Katahdin, were planted at New Brunswick, New Jersey on April 29, 1957, and were kept free of weeds by cultivation and handhoeing until chemical treatments were made on June 23.

Ethyl N,N-di-n-propylthiocarbamate (EPTC) was applied at the rate of 5 and 10 pounds active ingredient per acre as a spray and as a 5% granular formulation on attaclay. CDT was applied at 3 and 6 pounds per acre as a spray and a 4.6% granular formulation on attaclay. One and one-half and 3 pounds per acre of 2-chloro-4,6-bis-(ethylamino)-s-triazine (simazin) was applied as a spray and a 10% granular formulation on attaclay. All spray applications were made in water at 40 gallons of solution per acre.

The spray applications were made with a 110 degree nozzle so that approximately 3/4 of the potato plant was contacted by the herbicide. No special precautions were taken to keep the spray off the potato vines. All granular applications were made broadcast with no attempt to remove any herbicide which might have fallen on the vines.

The experimental design for this experiment was a randomized block with 4 replications. Plot size was 4 rows 34 inches apart, by 27 feet in length.

An evaluation of the weed control treatments was made on September 19, approximately 3 months after treatment, by three investigators who rated the percent control independently. Since the weed population was nearly 100% crabgrass (Digitaria sp.), barnyard grass (Echinochloa crusgalli), and foxtail (Seteria sp.) no effort was made to separate the control of broadleaved and grass weeds. The potatoes were harvested and graded on September 19.

Results and Discussion

The yield of U. S. No. 1 potatoes and the percent weed control for each herbicidal treatment are shown in table 2. EPTC at all rates was the only chemical which provided satisfactory weed control without reducing the yield of potatoes. The granular application of EPTC provided longer lasting weed control than did the spray application. Weed control from 6 pounds of CDT was only fair and from 3 pounds was poor. Weed control from 3 pounds of simazin was commercially acceptable.

The low percent weed control shown in table 2 for the handweeded check was caused by the presence of crabgrass which

Table 2. Effect of herbicide applications at early layby on weed control and yield of Katahdin potatoes. New Brunswick, New Jersey 1957.

Herbicide	Rate lbs/acre	Method of application	U. S. # 1 Bu. per acre	Percent weed control
EPTC	5	Spray	367.4	82
	10		339.9	86
	5	Granular	350.8	97
	10		346.7	99
CDT	3	Spray	331.6	44
	6		267.6	51
	3	Granular	328.5	39
	6		296.5	54
Simazin	1½	Spray	269.5	63
	3		149.8	89
	1½	Granular	298.0	47
	3		211.2	73
Handweeded Check			311.2	23
Check (nonweeded)			278.4	
L.S.D.	.05		37.4	
	.01		50.5	

in these plots was much younger than in other plots where poor weed control was obtained. A 2 to 3 week period had elapsed between the final handweeding and the weed control evaluation.

Yields of potatoes from plots treated with EPTC at all rates and methods of application were significantly higher than the untreated check in which weeds were allowed to grow after the last cultivation. While weeds coming in after the final cultivation have not usually provided sufficient competition to reduce yields, it is felt in this experiment that the potatoes were layed by approximately 2 to 3 weeks early thereby allowing weeds to come in sufficient time to provide competition and reduce potato yields over plots where weeds were sufficiently controlled. Yields from plots treated with 5 pounds per acre of EPTC were significantly higher than the handweeded check at the 5% level. Increased yields from plots treated with 10 pounds per acre of EPTC neared significance at this same level. This increase was probably due actually to a reduction in yield in the handweeded check because of some physical injuries caused by handweeding. With CDT at 3 pounds where some degree of weed control was obtained, potato yields for these plots were significantly higher than the weedy check. However, 6 pounds of CDT

Simazin at 3 pounds either as a spray or granular application significantly reduced yields indicating considerable injury to the potatoes. Simazin applied at 3 pounds as a spray application significantly reduced potato yields below that of 3 pounds used as a granular application indicating that the granular applications are somewhat safer. However, both methods of application at the 3 pound rate reduced yields, thereby making this material unsatisfactory for use in potatoes at the last cultivation. There was no apparent foliage damage or injury from any of the herbicide treatments.

Summary

1. In 1956, granular formulations of DNBP, CDAA, CDT and a combination of DNBP plus CDEC, and spray treatments of neburon and monuron were evaluated on potatoes after the final cultivation but before weeds emerged. Sodium dalapon and dalapon plus 2,4-D were applied to potatoes after the weeds had emerged following the final cultivation.

2. In 1957, EPTC, CDT and simazin were applied at 5 and 10 pounds, 3 and 6 pounds, $1\frac{1}{2}$ and 3 pounds, respectively, to potatoes at the last cultivation. These materials were applied as a spray and as granular formulations.

3. In 1956 only CDT provided satisfactory control of weeds with no reduction in potato yields. In 1957 only fair weed control was obtained from CDT and potato yields were reduced by the higher rate when applied as a spray.

4. EPTC at both rates and methods of application appeared very promising as a layby treatment in potatoes in that it provided satisfactory weed control through harvest without reducing potato yields.

5. Granular applications of EPTC appeared to give longer lasting weed control than spray applications and deserve further investigation.

6. Simazin at 3 pounds provided satisfactory weed control but reduced potato yields markedly.

7. In 1957 yield of potatoes was significantly increased where weeds were controlled after the last cultivation.

PROGRESS REPORT ON TOLERANCE OF POTATOES TO HERBICIDES APPLIED AT LAST CULTIVATION[1]

R. L. Sawyer, S. L. Dallyn and G. Collin[2]

Lay-by weed control with potatoes has been under investigation for several years on Long Island. The data included in this report is a continuation of the work already reported in previous proceedings.

Materials and Methods

Katahdin tubers were planted April 11 and given normal culture until lay-by sprays and granular materials were applied on June 25. A total of three weedings and three cultivations had been made at this date. Rainfall and irrigation water for the month after treatment were as follows: irrigation of 1.00 inch on July 6, July 20 and July 29; rainfall of .72 inches on July 13 and .58 inches on July 14.

Plots were three rows wide and 30 feet long with 4 replications of each chemical treatment in a randomized block design. There were check plots beside each chemical treatment so that adjustments could be made for uneven weed populations. Plots were harvested and specific gravity measurements made on September 20.

The storage results reported are for determinations made with samples from the 1956 growing season. Black spot index was obtained by bruising tubers and peeling after 48 hours. The black spot index runs from 0 to 90 taking into consideration both the severity of the black spot and the percent of tubers showing the blackening. The peeled darkening index was obtained by abrasively peeling tubers and determining the amount of discoloration that had taken place in 1 hour. 1 indicated no discoloration and 9 severe discoloration. The chipping index was obtained by frying cured samples and rating the color of the chips 1 through 9. 1 indicated very dark chips and 9 very light chips with 5 considered the darkest level for commercial acceptability.

Results and Discussion

The materials used, dosages, yield of tubers and specific gravities of tubers are given in Table No. 1.

[1] Paper No. 411, Department of Vegetable Crops, Cornell University, Ithaca, N.Y.

[2] Long Island Vegetable Research Farm, Cornell University, Riverhead, New York

Table 1. Tolerance of Katahdin Potatoes to Lay-by Herbicides

Material	Lbs/A	Bu/A #1	Bu/A size 2 - $3\frac{1}{2}$"	Specific Gravity
Alanap 2	4	735	443	1.069
Alanap 2	6	722	441	1.066
Alanap 3	4 Granular	726	464	1.064
Alanap 3	6 Granular	705	409	1.063
Natrin	4	728	484	1.066
Natrin	8	703	430	1.063
Diuron	½	752	441	1.064
Diuron	3/4	684	437	1.068
Diuron	½ Granular	726	481	1.063
Diuron	3/4 Granular	662	437	1.059
Diuron	1 Granular	722	471	1.063
3Y9	3	648	392	1.064
3Y9	6	662	415	1.069
Vegedex	6	701	417	1.067
Vegedex	9	688	430	1.063
EPTC	4	763	471	1.064
EPTC	8	633	403	1.070
Check		758	490	1.065
		ns	ns	ns

Such an uneven weed population was encountered in the check strips running beside the chemical treatments that no conclusion could be drawn from weed count data. The materials under consideration had already shown weed control ability and the primary consideration in this experiment was to determine if potato vines would tolerate the chemicals without detrimental effects on quality and yield. In a grower trial where there was even weed population, Alanap 2, Alanap 3, Diuron, Natrin and 3Y9 all demonstrated an ability to control grasses which are the most important lay-by problem. None of the materials significantly decreased yield or quality this past year. Diuron as an overall spray had given some injury in previous years.

Storage results for the 1956-57 season are given in Table 2. Black spot was not affected by the various sprays in the total analysis although two materials 3Y9 and Alanap 3 gave consistently low readings in all replications. No such indications have been obtained in previous work with these materials, however, black spot was much worse this year than in any of the previous years of testing.

Peeling discoloration, chipping color and storage specific gravity were not affected by the various chemical sprays. Shrinkage was greater in the Dalapon plots at both dosage levels and in diuron plots at the 3/4 lb. per acre level than checks. These three materials had caused considerable more vine damage in the field and delayed maturity which probably accounts for the greater shrinkage due to maturity effect on skin set.

Tubers from Natrin plots had about half as many sprouts as tubers from check plots. This is the third year that the effect of Natrin on sprout suppression has been observed. In years when there is little storage sprouting, this would not be of much value. In years of bad storage sprouting, it could be of con-

Table 2. Effect of Last Cultivation Sprays for Weed Control in Potatoes on Several Storage Determinations

Material	Dosage	Black Spot Index	Peeled Index	Chipping Index	% Shrink	Grams of Sprouts	Storage S.G.
Natrin	7.5	27.91	6.2	5.7	4.42	5.84	1.072
Natrin	4.0	28.44	8.5	5.5	3.74	6.17	1.078
Alanap 2	4.0	34.63	7.2	6.2	5.43	12.16	1.072
Alanap 2	6.0	27.47	6.2	5.0	4.85	12.38	1.076
3Y9	3.0	24.91	7.0	6.5	3.90	7.69	1.077
3Y9	6.0	12.52	8.0	5.5	5.19	12.46	1.078
CDEA	4.0	29.20	7.7	6.7	5.30	10.78	1.077
CDEA	8.0	22.83	6.2	7.0	5.80	12.01	1.075
CDEC	6.0	24.37	7.2	5.5	5.51	13.59	1.079
CDEC	9.0	24.59	5.5	6.2	4.88	13.82	1.078
Diuron	1/2	36.63	6.2	7.0	5.88	13.66	1.075
Diuron	3/4	36.85	7.0	5.2	8.85	15.32	1.072
Dalapon	2	23.54	6.2	5.7	9.10	11.46	1.074
Dalapon	4	29.18	6.0	5.2	8.77	11.12	1.073
Diuron	1/2 G	28.88	6.5	4.0	5.67	11.42	1.076
Diuron	3/4 G	26.65	6.5	7.0	5.31	11.04	1.072
Check		28.51	7.5	6.3	5.09	9.38	1.074
Check		27.68	6.7	7.0	4.78	10.47	1.077
Alanap 3	4 G	25.08	7.0	6.7	5.22	13.24	1.078
Alanap 3	6 G	12.17	6.2	6.2	4.78	12.35	1.078

Summary

All of the materials tested merit further consideration in lay-by weed control work with potatoes. Katahdin potatoes have demonstrated a good tolerance to Alanap 2, Natrin, 3Y9 and Vegedex as overall sprays, and Alanap 3 and Diuron as granular materials for a period of several years.

PROGRESS REPORT ON WEED CONTROL IN ONIONS, CORN, TOMATOES, AND SEED-BEDS[1]

S.L. Dallyn, R.C. Cetas, R.L. Sawyer, R.W. Robinson and H.H. Bryan[2]

ONIONS

Several years' results have indicated that the best herbicide for transplanted Sweet Spanish - type onions in this area is CIPC. The first application should be made between the time of setting and the appearance of the first weeds -- under our conditions normally two to four weeks. Subsequent applications can be made at three to four week intervals, depending on the weed problem involved. All treatments should be at the rate of three to four pounds per acre and preferably as band sprays directed towards the base of the plants. The primary purpose of this year's work was to compare several other herbicides with the standard CIPC treatment.

General Methods

The chemicals and treatments used are listed in Table 1. The two granular formulations of dinitro were obtained from Standard Agricultural Chemical and the first one, listed as #1, is a more stable form than the other; both were included in the test to determine whether any difference in persistence would be evident. The transplants were set in the field April 22 and the various treatments applied as listed. All plots were hand weeded prior to treatment. Weeds were not allowed to compete with the onions in any of the treatments - if the herbicide was not holding them down the weeds were counted and pulled by hand. All herbicide treatments were applied to moist soil - used primarily in conjunction with irrigation this season.

Results & Discussion

Data from the experiment are summarized in Table 1. CIPC gave satisfactory weed control with no crop injury. Control of broadleaves was essentially complete; some grass did come in from midseason on.

EPTC proved to be a relatively weak weed-killer, particularly in May; it appeared somewhat more active when used in June and July - perhaps a temperature relationship. It was ineffective against crab grass and barnyard grass.

Water soluble DN caused severe leaf burning but, surprisingly, had little effect on yield. A t-test comparison between the mean of the two checks and the 6 plus 12 week treatment showed a significant reduction in yield. The two granular forms of this chemical caused no crop injury and weed control was fully as good as with the spray. Late season grass came into all the DN plots rather badly.

Simazin used 6 weeks after transplanting caused some crop injury; its herbicidal activity was equal to CIPC and in this case also grasses were the only weeds in the plots. Neburon gave only moderate control at the rates used.

1. Paper No. 409, Department of Vegetable Crops, Cornell University

Our standard recommendation of CIPC was superior to any of the other materials used in this experiment. It would be desirable to have a material that could be used during the last half of the growing season to provide better grass control. Simazin was the only chemical that showed any promise at all in this regard.

Table 1. Performance of Several Herbicides in Transplanted Sweet Spanish Onions

Treatment		Yield Bu/Acre	Herbicidal Rating Activity[1]	Herbicidal Rating Persistence[2]	Visible[3] Crop Inj.
1. CIPC 4 lbs.	6, 12 weeks	524	4.0	3.5	1.0
2. CIPC	6,9,12 "	584	4.0	3.8	1.0
3. CIPC	3,6,9,12 "	545	4.0	4.0	1.0
4. EPTC 2.5 lbs.	3 weeks	559	2.0	2.0	1.0
5. " 5 lbs.	3 "	486	2.0	2.0	1.0
6. " 10 "	3 "	493	3.0	2.5	2.5
7. " 2.5 "	6 "	553	2.5	2.0	1.0
8. " 5 "	6 "	566	2.8	2.0	1.0
9. " 10 "	6 "	561	3.3	2.8	1.5
10. " 2.5 "	12 "	515	2.0	2.0	1.0
11. " 5 "	12 "	570	2.5	2.0	1.0
12. " 10 "	12 "	559	2.4	2.0	1.0
13. DN 3 lbs.	6 "	515	3.4	3.0	3.0
14.	12 "	543	3.4	3.0	2.5
15.	6,12 "	470	3.8	4.0	3.0
16. DN granular 3 lbs.	6 "	599	3.8	3.0	1.0
17. (form. #1)	12 "	618	3.4	3.0	1.0
18.	6,12 "	545	4.0	3.4	1.0
19. DN granular 3 lbs.	6 "	507	3.6	3.0	1.0
20. (form. #2)	12 "	551	3.6	3.0	1.0
21.	6,12 "	580	3.8	3.0	1.0
22. Simazin 1.5 lbs.	6 "	424	4.0	3.8	3.0
23.	12 "	549	4.0	3.8	1.0
24.	6,12 "	518	4.0	4.0	1.5
25. Neburon 2 lbs.	6,12 "	503	2.5	2.0	1.0
26. Neburon 4 lbs.	6,12 "	505	3.5	2.8	1.0
27. Check		547	---	---	1.0
28. Check		555	---	---	1.0

L.S.D. 5% n.s.

1 - 1 low, 5 very high
2 - 1 slight, 5 - complete weed control for minimum of 3 weeks
3 - 1 none, 5 severe

SWEET CORN

Water soluble dinitro is the only herbicide used to any extent on corn in this area. The primary objective of this year's test was to compare the new materials Simazin and EPTC with the standard. Two varieties, Carmelcross and Iochief, were used and the treatments applied are listed in Table 2. Seed was sown May 6, irrigated immediately and the pre-emergence sprays put on the next day. Carmelcross was harvested July 24, Iochief August 1. Experimental design was a randomized block with four replications.

Results and Discussion

The data are summarized in Table 2. None of the treatments had any effect on yield, maturity, or quality of the corn. EPTC treatments did not give satisfactory weed control. The dinitro performed well and simazin very well. The higher rates of simazin provided commercial control over the growing season.

There have been some reports that residual effects from simazin have prevented normal growth of the following cover crop. We have not noticed this effect under our conditions. In 1956 rates up to 1.5 pounds per acre were used on corn. Following harvest, the ground was disked and sown to winter rye - growth was normal over all plots. In 1957 an experiment with simazin was superimposed over this with rates up to 4 pounds per acre and applied as late as August 14. These plots were disked and sown to rye the last of August. Growth, this past fall at least, has been normal on all plots except those receiving 4 pounds at the late date. The latter had retarded growth and reduced tillering; color and other characteristics appeared normal.

Table 2. Results from Several Herbicides used in Sweet Corn

Treatment	Ears per Acre		Av. Ear Weight		Herbicidal Rating	
	Carmelcr.	Iochief	Carmelcr.	Iochief	Activity[1]	Persistence[2]
Simazin 1 lb/A pre	13,248	14,208	.65	.69	3.0	7
2 " "	11,328	15,552	.68	.69	4.3	10
4 " "	12,096	14,784	.67	.66	5.0	10 +
DN 3 " "	11,712	14,592	.67	.69	3.0	6
" 3 " emerg.	11,328	14,784	.67	.69	3.3	7
EPTC 2½ " pre.	11,520	13,632	.65	.73	2.0	2-3
" 5 " "	12,864	14,592	.67	.69	2.0	3
" 10 " "	12,096	13,824	.67	.72	2.5	3
Check	9,984	14,400	.65	.70	---	2
Check	11,328	14,400	.68	.71	---	2
L.S.D. 5%	n.s.	n.s.	n.s.	n.s.		

1 1-low, 5 - very high
2 figure given as weeks of commercial control

TOMATOES

The chemical Natrin, which has been used with some success in upstate New York, was compared with Neburon, Simazin, EPTC, and granular CIPC. The experiment was divided into two parts - one on the early variety Moreton Hybrid, and the other on the mainseason variety Queens. The plants were set in the field May 17 and the treatments applied 25 days later when the plants had fully recovered and were growing vigorously. Directed sprays were used with the exception of the granular CIPC which was applied with a small modified Gandy Spreader. Only a small amount of the spray materials hit the leaves and any adhering CIPC was brushed off by dragging a rope over the plants. Moreton Hybrid was treated only once; Queens both once and twice - the latter July 8. On this latter date the plants were large and beginning to sprawl, so that a considerable amount of the foliage was hit by the spray. Moreton Hybrid was harvested 18 times during the interval July 20 - August 28; Queens 20 times during the interval July 22 - September 6.

Results and Discussion:

The data are summarized in Tables 3 & 4. The early yields of Moreton Hybrid were reduced, statistically, by Natrin and the low rates of Neburon and EPTC. Whether these differences are meaningful is probably questionable in view of the results with the higher rates of the same materials. Considering both experiments - Natrin and EPTC did not give sufficient weed control; Neburon was fairly satisfactory, and both Simazin and CIPC looked very good. Simazin did not appear to cause any serious injury to tomatoes when used early; where it was used late, however, with considerable foliage contact the plants were badly damaged. Both materials look good and are worthy of further investigation. Neburon also should probably be tested further and at higher rates than used in the present case.

Table 3. Effects of Several Herbicides on Moreton Hybrid Tomatoes

Treatment	Weed Count[1] July 1	Rating[2] July 1	Rating Aug. 1	Crop[3] Injury	Yield - lbs./A Early #1[4]	Total #1	#2	Av. Wt. #1 Frt.
Natrin 2 lb/A	50	1.3	1.0	1.3	2590	42,000	14,190	.43
Neburon 1 "	13	4.0	2.0	1.0	2400	33,320	12,290	.43
Neburon 2 "	18	3.7	2.5	1.3	2870	37,190	11,340	.42
Simazin 1 "	7	4.0	2.5	1.7	3190	27,090	13,480	.41
Simazin 2 "	3	4.3	3.5	2.3	3120	35,810	12,480	.42
EPTC 2 "	13	3.0	1.5	1.3	2540	37,330	17,330	.42
EPTC 4 "	24	3.0	2.0	1.3	3550	36,650	15,520	.43
CIPC(gran)2 lb/A	8	4.7	3.5	1.3	2870	37,700	12,880	.47
Check	42	1.0	1.0	1.0	3570	32,870	14,460	.42
LSD 5%	16				840	n.s.		

1. Area 4' x 1'
2. 1 - poor weed control, 5 - excellent
3. 1 - slight, 5 - severe
4. 6 harvests - to August 2.

Table 4. Effects of Several Herbicides on Queens Tomatoes

Treatment	Weed Count[1] July 1	Rating[2] July 1	Rating Aug. 1	Crop[3] Injury	Total Yield-lbs/A #1	#2	Av. Weight #1 Fruit
Natrin 2 lb/A	43	1.7	1.0	1.3	30,980	16,480	.37
Neburon 1 "	25	3.3	2.3	1.0	33,820	10,340	.37
Neburon 2 "	14	3.7	2.7	1.3	38,510	9,680	.39
Simazin 1 "	5	3.7	2.3	1.7	39,920	12,050	.37
Simazin 2 "	3	4.7	3.7	2.0	29,700	9,360	.36
EPTC 2 "	32	2.0	1.0	1.0	28,270	12,704	.38
EPTC 4 "	48	2.3	1.3	1.0	29,630	14,736	.35
CIPC(gran)2 lb/A	12	4.0	2.0	1.0	38,720	10,336	.38
CIPC " 3 "	8	4.0	2.5	1.3	32,660	10,544	.37
Check	71	1.0	1.0	1.0	39,020	11,072	.36
Tr. #1 ey. & layby	--	---	2.0	1.3	31,840	9,728	.40
" #2 " " "	--	---	2.7	1.3	33,860	11,248	.37
" #3 " " "	--	---	3.0	1.3	32,740	11,616	.38
" #4 " " "	--	---	3.0	2.0	27,650	10,208	.36
" #5 " " "	--	---	4.3	2.7	14,080	9,008	.32
" #6 " " "	--	---	1.7	1.3	29,730	13,616	.36
" #7 " " "	--	---	1.7	1.3	34,590	12,320	.37
" #8 " " "	--	---	3.7	1.3	41,040	10,176	.39
" #9 " " "	--	---	4.0	1.7	41,540	11,744	.40
Check	--	---	1.0	1.0	41,800	13,920	.37
LSD 5%					8,100	n.s.	

1. Area 4' x 1'
2. 1 - poor, 5 - excellent
3. 1 - slight, 5 - severe

SEEDBEDS

Vapam, Mylone, and MC-2 were compared for effectiveness in controlling weeds in seedbeds. Counts on incidence of wirestem and clubroot were also made but all plots were essentially free of these diseases. Vapam was applied in solution - some plots were then watered in with one inch of irrigation, others were rototilled. Mylone was also applied in solution, plots were then either rototilled or raked. MC-2 was applied under polyethylene according to manufacturer's directions.

All treatments were applied to moderately dry soil on April 29 - the day was clear with air temperature above 70° F. Recordings of soil and air temperature were kept throughout the course of the experiment. Two test crops, cabbage seed and strawberry plants were planted in all plots at 5, 10, 15, and 20 days after treatment. On June 11 the first two seedings of cabbage were pulled, counted, weighed and examined for disease.

Results and Discussion

Treatment details together with a large share of the results are presented in Table 5. Vapam, watered in, gave excellent weed control and produced no detrimental effects on any of the cabbage seedings. The 5 and 10 day plantings of strawberries were injured; the 15 day one was not. Rototilling Vapam into the soil was not satisfactory - weed control was decreased, crop injury increased. One quart/100 square feet was as effective as higher rates in this test.

Mylone, in contrast to last year's work here, was not as effective as Vapam in controlling weeds. Unfortunately no comparison was made with Mylone watered in. All plantings of cabbage, except the first on the raked-plots, appeared free from any toxic effects of the chemical. The first two plantings of strawberries showed some signs of injury, the 15-day plants were free from it.

MC-2 at both rates produced excellent control of weeds. The 5-day setting of strawberries on the 3 lb/100 square feet treatment were slightly injured, all other MC-2 rates and time of planting combinations were satisfactory.

The loss from the soil of all the chemical residues was unusually rapid. This was probably due largely to this year's warm spring. Soil temperature at the 4" level varied from 48° to 66° during the first week (April 29 - May 6), 46°-70° during the second, 52° - 68° during the third, 46° - 70° during the fourth, 52° to 72° during the fifth, and averaged approximately 70° during the last 10 days of the test. The soil was a light silt loam with a pH of 6.0.

Table 5. Weed Control in Seedbeds with Three Materials

Treatment		5-Day Stand[1]	Seeding Weight	10-Day Stand	Seeding Weight	Weed Control[2] June 4	Weed Control[2] June 11
Vapam 1 qt/100 sq.ft.,	watered	94	462 gm	103	410 gm	5	5
Vapam " " " "	rototilled	76	374	77	407	3	3
Vapam 1.5 " " "	watered	71	517	69	358	5	5
Vapam " " " "	rototilled	60	180	86	345	5	4
Mylone 100 lb/A	"	83	649	51	366	3	2
Mylone 150 "	"	83	586	84	509	3	3
Mylone 200 "	"	68	438	71	402	3	3
Mylone 150 "	raked	56	452	89	440	3	2
MC-2 1 lb/100 sq.ft.		88	749	78	394	5	5
MC-2 3 " " "		70	613	72	321	5	5
Check		52	424	80	368	1	1
Check		70	594	70	258	1	1
LSD 5%		19	246	n.s.	n.s.		

1. 3' of row
2. 1 - poor, 5 excellent

SUMMARY

1. In a comparison of several new herbicides with CIPC on transplanted Sweet Spanish onions, the latter was found to be still the most satisfactory. Simazin is worth further study for use in lay-by applications to control grass.

2. In sweet corn best weed control was obtained with Simazin.

3. Simazin and granular CIPC produced the most promising results in tomatoes.

4. Vapam and MC-2 were very effective in seedbed weed control. Application of vapam is considered easier than that required by MC-2.

5. The new material EPTC was used on a variety of crops but did not produce satisfactory control of weeds under our conditions.

A Progress Report on Chemical Weeding of Onions, Beets, Spinach, Sweet Corn, Lima Beans, and Tomatoes.[1]

Charles J. Noll[2]

Six vegetable crops were chemically weeded with from 3 to 10 herbicides during the summer of 1957 at University Park, Pa. The early plantings had sufficient moisture for good germination and good early growth. Later plantings suffered from lack of soil moisture at time of germination and throughout the growing season. All experiments were on Hagerstown silt loam soil.

Most chemicals were applied with a small sprayer over the vegetable row for a width of 8 inches. On tomatoes the width of application was 6 feet. Where granular applications were made width of treatment was either 2 or 4 feet.

An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most desirable and 10 being least desirable.

ONION

Seeds of the onion variety Utah Valencia were planted April 17, 1957. Pre-emergence chemicals were applied 3 and 5 days after planting and post-emergence chemicals 13 days after planting. See table 1 for chemicals, rates of treatment and time of treatments. Individual plots were 24 feet long and 2 feet wide. Treatments were randomized in each of 10 blocks. The onions were hand weeded twice; records on the effectiveness of chemical weed control were taken prior to the first hand weeding.

The results are presented in table 1. In the pre-emergence treatments CIPC at 6 and 8 lbs. per acre, Neburon at 3 and 4 1/2 lbs. per acre and Chlorazine at the 6 lb. per acre rate resulted in a significant increase in weed control as compared to the untreated plot. Both Neburon and Chlorazine in the post-emergence treatment resulted in a significant increase in weed control as compared to the untreated check plot. Stand of plants was significantly reduced by Neburon in both pre-emergence and post-emergence treatments, by EPTC at the 6 lb. rate in a pre-emergence treatment, and chlorazine at the 4 lb. rate in a post-emergence treatment. No chemical treatment resulted in increased yield as compared to the check plot. Neburon at all rates in both pre- and post-emergence treatments significantly reduced the yield as did chlorazine at the 4 lb. per acre rate in a post-emergence treatment.

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[2] Assistant Professor of Olericulture, Department of Horticulture, College of Agriculture and Experiment Station, The Pennsylvania State University, University Park, Pennsylvania.

On the basis of weed control, stand and yield of onion plants, CIPC was the best of the chemicals included in this test. Chlorazine looks promising and should be further tested in both a pre- and post-emergence application for the weeding of this crop. If plots had not been hand weeded the yield of the check plot would have been much less due to weed competition.

Table 1. Weed control, stand and yield of onions under chemical herbicide treatments.

			Average per Plot		
Herbicides	Rate per acre lbs. Active	Herbicides applied days after planting	*Weed Control	Stand of Plants	Weight of untopped onions in lbs.
Nothing	-	-	6.5	56.0	19.7
CIPC	6	3	3.9	43.0	17.6
"	9	3	3.0	44.2	20.1
Neburon	3	3	3.7	18.0	8.0
"	4 1/2	3	3.0	14.5	7.2
Chlorazine	4	3	5.8	56.5	19.7
"	6	3	4.0	47.9	19.8
EPTC	4	3	6.3	54.9	18.4
"	6	3	5.5	40.2	15.9
KOCN	8 in 100 gal. H_2O	5	6.0	61.7	20.8
"	12 in 100 gal. H_2O	5	6.4	45.2	15.5
Neburon	3	13	3.3	13.9	5.7
"	4 1/2	13	2.6	6.0	2.0
Chlorazine	4	13	1.3	37.4	13.8
"	6	13	1.7	44.6	17.2
Least Significant Difference (P = .05)			1.6	13.8	5.0
" " " (P = .01)			2.1	18.4	6.7

*Weed Control 1-10   1 = Perfect weed control
10 = Full weed growth

BEETS

Seeds of the beet variety Seneca Detroit were planted April 22, 1957. Pre-emergence applications of herbicides were made the following day. Salt was applied 20 days after planting when the beets had 4-5 true leaves. See table 2 for chemicals and rates of treatment. Individual plots were 24 feet long and 2 feet wide. Treatments were randomized in each of 10 blocks. Cultivation controlled the weeds between the rows, no other weeding was done.

The results are presented in table 2. All chemicals except EPTC and CIPC resulted in highly significant increase in weed control as compared to the untreated check. No significant differences were found in stand of plants. Yield of topped beets in comparison with the check plot was significantly increased by the following treatments: Endothal TCA combination, Granular Endothal, Monuron at 3/5 lbs. per acre, Vegadex, Randox at both rates and CIPC at 3 lbs. per acre rate.

Taking weed control and yield into consideration the best treatments were Endothal and TCA, Granular Endothal, Monuron at the heavier rate, Vegadex, and Randox.

Table 2. Weed control, stand and yield of beets under chemical herbicide treatments.

Herbicide	Rate per Acre lbs. Active	When Applied	*Weed Control	Stand of Plants	Weight of topped beets in lbs.
Nothing	-	-	8.0	90.0	4.5
Endothal + TCA	6 + 10	Pre-emerg.	3.6	98.2	6.2
" "	9 + 10	"	3.9	100.0	7.8
°Endothal Granular	9	"	4.5	89.1	6.5
Monuron	2/5	"	5.9	96.1	5.1
"	3/5	"	4.8	112.9	6.4
Vegadex	4	"	4.4	81.5	6.3
"	6	"	4.1	76.7	6.9
Randox	6	"	4.3	89.1	6.8
"	9	"	2.7	71.5	7.2
EPTC	4	"	7.9	115.6	4.5
"	6	"	8.1	109.3	4.6
CIPC	2	"	6.5	92.7	4.9
"	3	"	6.3	99.5	6.1
FW 450	5	"	4.9	91.7	5.5
"	10	"	3.8	80.6	5.4
Salt	200 in 400 gal. H_2O	Post-emerg.	4.1	84.2	5.1
Least Significant Difference (P = .05)			1.6	NSD	1.4
" " " (P = .01)			2.1	NSD	1.8

*Weed Control 1-10 1 = Perfect weed control
10 = Full weed growth

°2% Granular Endothal applied in a 2 foot band at rate 450 lbs. per acre.

SPINACH

The spinach variety America was seeded April 22, 1957. Three chemical herbicides were applied, each at two rates the day of seeding. See table 3 for chemical and rates of treatment. Individual plots were 24 feet long and 2 feet wide. Treatments were randomized in each of 10 blocks. Cultivation controlled the weeds between the rows, no other weeding was done.

The results are presented in table 3. All chemicals at all rates increased weed control significantly when compared to the untreated check plot. No significant differences were found in stand of plants or weight of spinach at time of harvest.

Table 3. Weed control, stand and yield of spinach under chemical herbicide treatments.

Herbicides	Rate per Acre lbs. Active	When Applied	Average per Plot: *Weed Control	Stand of Plant	Weight of Spinach in lbs.
Nothing	-	-	7.4	38.9	9.3
CIPC	2	At seeding	3.1	68.5	9.3
"	3	" "	3.0	69.5	8.9
Vegadex	4	" "	4.0	70.0	8.6
"	6	" "	2.4	67.6	8.4
Monuron	2/5	" "	4.1	76.4	9.5
"	3/5	" "	2.1	71.8	8.6
Least Significant Difference (P = .05)			2.2	NSD	NSD
" " " (P - .01)			3.1	NSD	NSD

*Weed Control 1-10 1 = Perfect Weed Control

10 = Full Weed Growth

SWEET CORN

Sweet corn, variety Iochief, was seeded May 17, 1957. Pre-emergence chemicals were applied 4 days after seeding, emergence chemical 12 days after seeding when corn was in the spike stage and the post-emergence treatment 34 days after seeding at the time that the corn had 4 true leaves. See table 4 for chemicals, rates of treatment and time of treatments. Individual plots were 76 feet long by 3 feet wide. Treatments were randomized in each of 6 blocks. Weeds between the rows were controlled by cultivation.

The results are presented in table 4. All chemicals resulted in highly significant increase in weed control as compared to the untreated plot. Best weed control was with Simazin at 2 and 3 lbs. per acre applied in a pre-emergence application. Next best treatments for weed control were 2,4-D amine and Dinitro applied at time of corn emergence. The stand of corn plants was not changed significantly by any chemical treatment. Yield as measured by weight of unhusked ears was significantly increased by all chemical treatments except Monuron applied at 1 and 1 1/2 pounds per acre and 3Y9 applied at 3 lbs. per acre. Highly significant increases in yield as compared to the untreated plot were obtained in the pre-emergence application with Simazin at 2 and 3 lbs. per acre, Diuron at 1 1/2 lbs. per acre and Vegadex at 6 and 9 lbs. per acre. Both 2,4-D amine and Dinitro applied at emergence gave highly significant increases in yield at both rates of treatment. Diuron applied at the 4 leaf stage of corn growth significantly increased the yield as compared to the untreated checks. The average weight of unhusked ears was significantly increased over the untreated checks with a number of herbicidal treatments.

Taking weed control, weight of unhusked ears and average weight of ears into consideration best treatments were Simazin applied in a pre-emergence application at 2 lbs. per acre, 2,4-D amine applied at emergence at 3/4 lbs. per acre and Dinitro applied

Table 4. Weed control stand, yield and average ear weight of sweet corn under chemical herbicidal treatments.

Herbicides	Rates per Acre lbs. Active	Herbicides applied days after planting	*Weed Control	Stand of Plants	Weight unhusked ears in lbs.	Average weight of ears in lbs.
Nothing	-	-	9.5	34	16.5	.49
Simazin	2	4	2.5	47	27.0	.58
"	3	4	1.8	49	26.7	.54
Diuron	1	4	6.3	44	22.3	.51
"	1 1/2	4	5.0	40	23.9	.61
EMID	1	4	5.8	44	23.6	.53
"	1 1/2	4	5.2	45	24.3	.54
Benzac 103A	1	4	4.8	39	22.4	.57
"	1 1/2	4	4.5	42	24.3	.58
3Y9	3	4	6.3	40	20.1	.49
"	4 1/2	4	5.0	42	23.1	.56
Vegadex	6	4	6.1	46	26.6	.59
"	9	4	4.0	49	25.5	.53
Monuron	1	4	6.0	35	20.8	.56
"	1 1/2	4	4.5	37	20.9	.57
2,4-D Amine	1/2	12	4.8	43	26.3	.61
"	3/4	12	3.2	47	29.1	.62
Dinitro	2	12	4.3	44	26.4	.61
"	3	12	3.5	50	30.4	.62
Neburon	3	34	4.2	49	26.5	.54
Least Significant Difference (P = .05)			1.4	NSD	5.6	.08
" " " (P = .01)			1.9	NSD	7.4	.10

*Weed Control 1-10 1= Perfect Weed Control
10= Full Weed Growth

LIMA BEANS

Lima Beans, variety Fordhook 242, were seeded June 5, 1957. Pre-emergence chemicals were applied 4 days after planting. See table 5 for chemicals, and rates of treatment. Individual plots were 22 feet long and 3 feet wide. Treatments were randomized in each of 10 blocks. Cultivation controlled the weeds between the rows.

The results are presented in table 5. Good weed control together with corresponding good yield as compared to the untreated plot were obtained with G 27901 applied at the rates of 4 and 8 lbs. per acre and granular Dinitro applied at the rate of 13 lbs. actual Dinitro per acre.

Table 5. Weed control, stand and yield of lima beans under chemical herbicide treatments.

Herbicide	Rate per Acre lbs. Active	Average per Plot *Weed Control	Stand of Plants	Weight of Beans in Pods in lbs.
Nothing	-	8.2	24.6	2.3
Dinitro	4	5.0	25.9	3.4
"	6	5.5	24.8	3.4
CIPC	4	7.1	24.8	2.7
"	6	6.3	27.6	3.1
Granular Dinitro	6 1/2	4.6	25.9	3.6
" "	13	2.8	24.1	4.2
Chlorazin	4	5.4	26.9	3.3
"	6	4.4	25.5	4.4
Niagara 5521	1 1/2 gal.	6.7	24.0	2.9
"	2 1/4	7.1	21.0	2.8
ACP M118	3	4.4	21.5	3.7
"	4 1/2	3.2	18.7	3.6
ACP M119	2	4.0	24.1	4.0
"	3	3.9	23.7	4.1
Neburon	4	3.6	19.7	2.1
"	6	4.8	26.5	3.8
G 27901	4	1.9	28.4	4.6
"	8	1.7	25.4	4.8
Least Significant Difference (P = .05)		1.0	NSD	0.9
Least Significant Difference (P = .01)		1.3	NSD	1.1

*Weed Control 1-10 1 = Perfect Weed Control
10 = Full weed growth

TOMATOES

Rutgers tomatoes were transplanted to the field May 28, 1957. Randox was applied 10 days after transplanting without sign of injury to the tomatoes. At the time of last cultivation, July 19, all chemical herbicides were applied including another Randox application on plots already treated with Randox. Hot weather followed the lay-by application. See table 6 for chemicals and rates of treatment. Individual 5-plant plots were 15 feet long and 6 feet wide. Treatments were randomized in each of 8 blocks.

The results are presented in table 6. Weeds were not a problem with any treatment.

Results are measured in injury or lack of injury to the tomato as measured by yields of marketable fruits or weight of marketable fruit. Under the conditions of this experiment only Granular Dinitro at 5 3/4 and 11 1/2 lbs. per acre, Vegadex at 6 lbs. per acre and Neburon at 3 and 4 1/2 lbs. per acre did not significantly reduce the number of marketable tomato fruits.

Table 6. Number and weight of marketable fruit of tomato under chemical herbicide treatments.

Herbicides	Rate per Acre lbs. Active	When Applied	Number of Marketable Fruit	Weight of Marketable Fruit lbs.
Nothing	-	-	171.1	38.5
Simazin	2	Lay-by	138.3	30.6
"	3	"	132.0	30.5
Natrin	6	"	132.0	32.4
"	9	"	137.1	33.6
*Dinitro Granular	5 3/4	"	161.8	36.4
" "	11 1/2	"	174.1	39.5
Vegadex	6	"	152.9	36.3
"	9	"	120.8	33.4
Neburon	3	"	154.3	37.6
"	4 1/2	"	143.1	36.2
Randox	6	After planting and Lay-by	136.9	33.8
"	9	" " " "	126.5	33.7
Least Significant Difference (P = .05)			28.8	5.64
" " " (P = .01)			38.2	7.48

*6% Dinitro on attaclay

SUMMARY

Results of this year's weed control experiments were obtained under extremely dry growing conditions. Results were measured in terms of weed control, stand, and increase or suppression of yield of the treated crops. In general, chemicals found to be effective in previous years were among the best herbicides used this year.

For onions CIPC looked good with Chlorazine worthy of further investigation. For beets Endothal TCA combination looked good with Granular Endothal, Vegadex and Randox worthy of further research. Spinach was weeded equally well by CIPC, Vegadex and Monuron without affecting spinach stand or yield. The best three chemicals used in the experiment for weeding sweet corn were Simazin in a pre-emergence application, 2,4-D amine and Dinitro applied at time of corn emergence. Most herbicides gave only fair weed control in lima beans. The chemical G 27901 did a good weeding job as did Granular Dinitro at 13 lbs. actual Dinitro per acre. Weeds were not a problem in tomatoes. Only Granular Dinitro, Neburon and Vegadex at the 6 lbs. per acre rate did not, in comparison to the check plot, significantly reduce the number or weight of marketable fruits.

ABBREVIATIONS

ACP M118	Dimethylamine salt of 4-(2,4-dichlorophenoxy)-N-butyric acid
ACP M119	Dimethylamine salt of 4-(4-chloro-2-methylphenoxy)-N-butyric acid
BENZAC 103A	Mixture - 2,3,6 trichlorobenzoic acid 16.3%
	- 2,3,5 " " 7.8%
	- 2,3,5,6 tetrachlorobenzoic acid 36.4%
G27901	2-Chloro 4 ...

QUACK GRASS CONTROL WITH AMINO TRIAZOLE* AND ITS EFFECT UPON A SUCCEEDING CROP OF SWEET CORN.

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INTRODUCTION

Kommedahll (2) reported both reduced stand and reduced growth per plant when alfalfa, barley, flax, oats and wheat were grown in quack grass infested soil. He stated that research in Europe and The United States had indicated that quack grass may produce substances deleterious to the growth of other plants. Barrons (1) found fall application and spring application of Dowpon** effective in controlling quack grass.

The experiment reported here was conducted to observe the effectiveness of fall and spring application of Amino Triazole in combination with fall and spring plowing, in controlling quack grass (*Agropyron repens* (L.) Beauv.) and to measure its influence upon yield of a succeeding crop of sweet corn.

PROCEDURE

The plots were located in Litchfield, New Hampshire. The soil was a sandy loam. The study was initiated in October 1956 and terminated in November 1957. At the time of initiating the experiment the area had a nearly solid cover of quack grass.

Three rates of Amino Triazole (0, 4 and 8 pounds of 50% active ingredient in 50 gals. water per acre) were replicated three times in each of four blocks. Listed below are the time of chemical application and time of plowing for each block.

Block A. Chemical application in the fall (Oct. 10, 1956) followed by fall plowing (Oct. 30, 1956).

Block B. Chemical application in the spring (May 8, 1957) preceded by fall plowing (Oct. 30, 1956).

Block C. Chemical application in the spring (May 8, 1957) followed by spring plowing (May 24, 1957).

Block D. Chemical application in the fall (Oct. 10, 1956) followed by spring plowing (May 24, 1957).

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*American Cyanamid Co. Product containing 50% 3-amino-1,2,4-triazole. The Amino Triazole for this study was supplied by the Amer. Cyanamid Co.

**Dow Chemical Co. product containing 85% sodium salt of dalapon.

The entire area was harrowed prior to seeding F. M. Cross sweet corn on May 29, 1957. Each plot was 12. ft. wide and 50 ft. long. Sweet corn yield records were taken from the center 40 ft. of the 2 center rows of each of the 9 plots in each block. The experiment consisted of 36 plots and required approximately one-half acre.

The number and weight of marketable ears from each plot was recorded at harvest on August 22, 1957. The height of twenty stalks in each plot was recorded on August 22, 1957. Pictures showing the degree of quack grass control were taken prior to planting, in mid-July and in November 1957.

RESULTS AND DISCUSSION

Observations two weeks following the fall chemical application revealed that both the 4 and 8 lb. rates had resulted in considerable injury to the quack grass. Only slight differences were apparent between these two rates, with the 8 lb. rate showing slightly more injury. In May 1957 the plots which had been sprayed on Oct. 10, 1956 and plowed Oct. 30, 1956 could be identified as to rate of chemical application because quack grass regrowth was greatest in the check plots, intermediate in the 4 lb. rate plots and least in the 8 lb. rate plots. In May 1957 the plots sprayed on Oct. 10, 1956 and not yet plowed or harrowed indicated a nearly complete absence of live quack grass in the 8 lb. rate plots, and about an 80-90% control in the 4 lb. rate plots; the check plots had a very luxurious nearly solid cover of quack grass.

In mid-July 1957, at harvest time on Aug. 22, 1957, and as late as mid-November 1957 the plots which had been sprayed in the fall (Oct. 10, 1956) and not plowed or harrowed until the following spring (May 24, 1957) were practically free of quack grass. The differences between the 4 lb. and 8 lb. rate were very small, with perhaps less quack grass in the heavier application plots. In the other blocks quack grass control was not nearly as good as in the fall application followed by spring plow block. At mid-July the check plots could be identified from the sprayed plots in each block. The 4 lb. and the 8 lb. rate plots could not always be identified without a plot diagram.

In regards to quack grass control both of the fall chemical application treatments (blocks A and D) gave better quack grass control than either of the spring chemical application treatments. The fall chemical application with no soil tillage until spring (block D) gave the best quack grass control.

The growing season of 1957 was a very dry one in southern New Hampshire. At Windham, which is about 9 miles from the location of the plots (Litchfield), rainfall during June, July and August totaled approximately 4 to 5 inches, compared to a normal of about 10 to 11 inches. No irrigations were made to the plots. The competition of quack grass in an unusually dry season in which no irrigations were applied might influence sweet corn yields more than in a season of adequate rainfall or when irrigations had been made.

Listed in Table 1 are the average number and weight of marketable ears per plot together with the average height of stalks per plot for each rate of chemical application. These averages were obtained by combining the data from all four blocks. Analysis of the combined data (as for a randomized plot design) indicated that the differences in yield of sweet corn were significantly larger from the Amino Triazole plots than from the check plots.

Table 1. Yield and height of sweet corn following Amino Triazole application at various rates

Amino Triazole (50% active) (lbs. per acre)	Marketable ears per plot		Height of stalks (feet)
	Number	Pounds	
None	30.50	22.23	6.28
4	50.50**	36.29**	6.75
8	46.75**	34.08	6.68
L.S.D. 5%	11.92	9.15	N.S.D.
L.S.D. 1%	16.21	12.44	

*Significantly different from check at 5% level
**Significantly different from check at 1% level

Statistical analysis of the data for each block separately revealed that the only block which contained significant differences in yield or growth of the sweet corn was block D. The average yield and stalk height per plot for each rate of chemical application in each of the four blocks are given in Table 2. The differences in yield in Block D apparently were of sufficient magnitude, when combined with the smaller and not significant differences obtained in the other Blocks, to result in significant differences noted in Table 1. There were no significant differences in height of the sweet corn stalks in any Block except Block D. In no instance were there any significant differences in yield or height of stalks between the 4 lb. and 8 lb. rate of chemical application.

Table 2. Yield and height of sweet corn following Amino Triazole application at various rates (Listed by time of Chem. Appl. and soil tillage)

Amino Triazole (50% active) (lbs. per acre)	Marketable ears per plot		Height of stalks (feet)
	Number	Pounds	
Block A. Chemical applied Oct. 10, 1956, plowed Oct. 30, 1956			
None	45.67	34.03	7.14
4	56.00	42.00	7.13
8	44.00	33.53	6.75
		No significant differences	
Block B. Chemical applied May 8, 1956, plowed October 20, 1956			
None	39.67	30.43	6.30
4	44.33	32.03	6.59
8	44.67	31.87	6.44
		No significant differences	

Block C: Chemical applied May 8, 1957, plowed May 24, 1957.

None	20.67	13.57	5.85
4	44.00	30.10	6.40
8	40.33	27.30	6.41
		No significant differences.	

Block D. Chemical applied Oct. 10, 1956, plowed May 24, 1957.

None	16.00	10.90	5.84
4	57.67**	41.03**	6.88**
8	58.00**	43.63**	7.12**
L.S.D. 1%	35.23	26.15	0.805

** Significantly different from check at 1% level.

SUMMARY

Amino Triazole at the rates of o, 4 and 8 lbs. per acre were applied in the fall or in the spring in combination with fall and spring plowing. Fall chemical applications resulted in better quack grass control than spring applications. Best quack grass control was obtained in those plots which received the chemical in the fall and had no soil tillage until the following spring.

Sweet corn yields and stalk growth were significantly increased when the chemical was applied in the fall followed by no soil tillage until the following spring. Under this management system both the 4 and 8 lb. rates of chemical application resulted in significant differences from the checks. There were no significant differences betwean the 4 lb. and the 8 lb. rate of chemical application.

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PROGRESS REPORT ON HERBICIDES FOR WEED CONTROL IN TOMATOES

W. F. Meggitt[1]

Weeds in tomatoes present a problem after the final cultivation, not only from the standpoint of possibly reducing yields but also from the standpoint of convenience in harvesting. Many fruits are missed and many fields are abandoned before the entire crop has been harvested because of weeds. In others contract pickers simply refuse to pick because of weeds. The development of an herbicide which would control weeds after the final cultivation and not adversely affect the tomatoes would be highly desirable. With the advent of granular formulations of herbicides new possibilities are available for applying herbicides in tomatoes with minimum injury to the tomato plants. There is also continuing effort to develop or discover a new herbicide which may find a place for weed control in tomatoes.

The purpose of this field experiment was to compare the relative effectiveness of several chemicals in controlling weeds and to measure the response of the tomatoes when these chemicals were applied as sprays and as granular formulations.

Materials and Methods

Tomatoes, variety Rutgers, were transplanted on May 24, 1957 on a Sassafras sandy loam soil at New Brunswick, New Jersey. The plant spacing was 3½ feet x 6 feet, and plot size was 2 x 8 plants. The experimental design was a randomized block with 3 replications. Irrigation was provided throughout the growing season to eliminate any moisture stress. The plots were maintained weed-free by cultivation and handhoeing until the time of treatment.

The following herbicides were applied on July 3 1957: ethyl N N-di-n-propylthiocarbamate (EPTC), 2,4,5-trichlorophenoxyethyl sulfate (2,4,5-TES), 2-chloro-4,6-bis-(ethylamino)-s-triazine (simazin), 1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea (neburon), 2-chloroallyldiethyl dithiocarbamate (CDEC), isopropyl-N-(3-chlorophenyl) carbamate (CIPC), 2-chloro-N N-diallylacetamide (CDAA). The rates and methods of application of these chemicals appear in table 1. All spray applications were applied in water at the rate of 40 gallons of solution per acre with a spray boom using 110 degree nozzles which provided coverage over approximately 3/4 of the tomato plant. Attaclay at the percentages indicated in table 1 was used as the carrier for all granular formulations. The granular formulations were applied as a broadcast treatment with no effort being made to keep the herbicide off the tomato plants. The soil moisture at time of application of the herbicides was moderately dry. One and one-half inches of irrigation water were applied 8 days after treatment by the sprinkler method.

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[1]Research agronomist, Crops Research Division, ARS, U. S.

Table 1. The effect of herbicide applications made five weeks after transplanting on weed control and yield of tomatoes. New Brunswick, N. J. 1957.

Herbicide	Rate lbs./A	Method of application	Weeds/4 sq. ft. 8/6/57		Percent control 9/25/57		Tons per acre
			Broadleaf	Grass	Broadleaf	Grass	
2 4,5-TES	3	Spray	2.7	1.7	88	74	9.6
EPTC	5	Spray	1.0	0.3	90	78	9.6
	10		3.0	1.0	90	88	8.7
	5	Granular	3.0	0.0	89	83	3.7
	10	(5%)	2.7	0.0	97	98	9.8
Simazin	1½	Spray	3.0	1.0	88	63	8.7
	3		1.3	0.3	97	79	8.2
	1½	Granular	3.7	1.7	91	67	10.2
	3	(10%)	2.0	1.3	90	82	9.7
Neburon	2	Spray	1.7	1.0	89	49	10.4
	4		1.0	2.0	81	36	7.9
CIPC	4	Granular	3.7	0.0	79	63	11.7
	8	(5%)	4.3	0.3	72	61	8.1
CDEC	8	Spray	68.3	4.3	11	15	7.9
	4	Granular	35.7	6.7	43	19	8.3
	8	(10%)	17.0	5.7	63	47	8.7
CDAA	6	Spray	53.3	0.3	36	71	9.1
	6	Granular (10%)	30.3	1.3	43	72	10.3
Handweeded Check			81.0	15.7	81	68	10.3
Nonweeded Check			104.3	9.0	--	--	9.7
L.S.D. .05					24	22	NS
.01					32	29	

Results and Discussion

The effect of the herbicide applications on the control of weeds one month after application and at harvest time, which was approximately three months after application, are shown in table 1. The counts of broadleaf and grass weeds made one month after application showed very few weeds in any of the treated plots except those treated with CDEC and CDAA in which there were a considerable number of broadleaved weeds. The major weed species present in this experimental area were pigweed (Amaranthus retroflexus), lambsquarter (Chenopodium album), flower-of-the-hour (Hibiscus trionum), ...

foxtail (*Setaria sp.*), and barnyard grass (*Echinochloa crus-galli*). The evaluation of the percentage weed control made on September 25th, approximately 3 months after treatment, was made by three individuals independently, and the data presented as percent control in table 1 are the mean of these three individual evaluations.

EPTC, 2,4-5-TES, and simazin provided satisfactory control of broadleaf and grass weeds through the harvest period. Control of broadleaved weeds by neburon was satisfactory but grass control was not satisfactory. CIPC applied as a granular formulation gave fair control of broadleaved and grass weeds. CDAA gave satisfactory control of grass weeds but did not satisfactorily control the broadleaved weeds. CDEC did not provide satisfactory weed control. There was little or no difference between the spray or granular applications of these herbicides except that 8 pounds of CEDC granular formulation were more effective than 8 pounds as a spray.

CDAA, when applied as a spray, produced some initial contact burn of the tomato foliage which was apparent the day following treatment. This initial burning was outgrown later in the season. One week after treatment rather severe epinasty and effects indicating injury appeared on the plants which had been treated with 8 pounds of CEDC as a spray. Approximately 6 weeks after application, plants treated with 2,4,5-TES developed what appeared to be minor effects of injury but these were soon outgrown.

Harvests were begun on August 23 and continued until September 25 when terminated by a severe frost. The yield of tomatoes under the various herbicidal application is shown in Table 1. There was no significant difference between any of the yields in this experiment. It should be pointed out that while yields showed no significant differences there may be a depressing effect from several of the herbicides in that yields from the higher rates of treatment tended to be lower. Further yields from the plots receiving granular formulations were higher than from those receiving spray treatments with the exception of EPTC at 5 pounds per acre. This indicates that granular formulations may be somewhat safer than aqueous sprays. Visual observations were made as to the quality of fruit, and there were no apparent differences in shape, size, color, and degree of cracking among the various herbicidal treatments.

Summary

1. Lay-by applications of seven herbicides as aqueous sprays and as granular formulations were evaluated for weed control in tomatoes.

2. EPTC, 2,4,5-TES and simazin provided satisfactory weed control with no apparent reduction in yield of tomatoes.

3. Neburon gave satisfactory broadleaf control but did not control grass weeds satisfactorily. CIPC gave only fair control of weeds.

4. CDAA provided satisfactory grass control but unsatisfactory control of broadleaved weeds, and CDEC was not satisfactory in the control of broadleaved or grass weeds.

5. None of the herbicides evaluated in this investigation significantly reduced the yield of tomatoes.

6. Weeds which developed after the final cultivation, although they were a deterrent factor in harvesting, did not provide sufficient competition to reduce yields of tomatoes.

7. Granular formulations appeared to provide slightly better weed control in some situations which was manifested by a longer lasting control.

8. It appeared from yields although not significantly that granular formulations may be safer than aqueous sprays.

Effects of 2,4-D on Turnips[1]

by

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The widespread use of 2,4-D and 2,4,5-T to control roadside weeds and brush has resulted in considerable drift and vapour damage to sensitive plants. Many growers of table turnips in Southern Ontario have claimed damages from municipalities because at least some of their turnips had become mis-shapen and distorted. Since it was known that conditions other than 2,4-D could bring about distorted turnip roots there were sometimes uncertainties as to whether an individual claim was justified. The work reported here was begun in 1956 with the aim of studying the effects of known concentrations of 2,4-D on turnips in order to give more satisfactory answers to this problem.

Turnip seed (Laurentian Purple Top) was planted by means of a Planet Jr. hand seeder in 25 foot rows, June 25, 1956. In the first experiment, young turnip plants were sprayed on July 24, one week after thinning,with 2,4-D (low volatile ester) by means of a CO_2 pressurized sprayer at concentrations of 1, 5, 10, 25, 50, 100, 200, and 500 ppm. At this time 2,4,5-T was applied to other plants at concentrations of 5, 10, 25, 50, and 100 ppm. Each concentration was applied to three 25 foot rows.

One day after treatment all the leaves on the plants treated with 50 ppm or more 2,4-D or 2,4,5-T showed marked downward curvature. The petioles of the cotyledon leaves were curled by concentrations as low as 10 ppm of either chemical.

One week after treatment, epinastic bending was strong in all plants treated with 5 ppm or higher and a thickening or swelling was noted at the base of the petioles. Two weeks later most of the plants sprayed with 100 ppm or higher were dead or dying (100 ppm 2,4-D brought about greater injury than 100 ppm 2,4,5-T) while those treated with 50 or 25 ppm showed marked top and root injury. Although twisting or curving of the tops of these latter plants was no longer evident, the top size was reduced 40-60% in comparison with the checks. The roots were distorted and proliferated about the neck. An elongation of the upper part of the turnip giving an "hour-glass" effect was noted in turnips sprayed with concentrations of 5 ppm or higher.

[1] The financial assistance of the Dominion Rubber Co. is gratefully acknowledged.

Seven weeks after treatment, turnips sprayed with 5 or 10 ppm 2,4-D or 2,4,5-T were as big or bigger than the controls (Table 1) but those sprayed with 10 ppm exhibited marked splitting effects.

Table 1 - Effects of various concentrations of 2,4-D and 2,4,5-T on fresh weight and diameter of turnip roots.

	Treatment			
Concentration of	2,4-D		2,4,5-T	
Chemical Used (ppm)	Wt. (oz.)*	Diam. (in)*	Wt.(oz.)*	Diam.(in)*
0	26.6	4.1	26.6	4.1
5	27.6	4.1	29.4	4.3
10	29.8	4.0	24.3	4.0
25	16.1	3.3	21.9	3.8
50	12.7	2.9	17.9	3.4
100	----	---	5.8	2.4

*Average of 50 turnips.

Higher concentrations (25 and 50 ppm) of both chemicals led to badly elongated, distorted, proliferated roots. All of the plants treated with 100 ppm 2,4-D or higher were dead at this time but many of those treated with 100 ppm 2,4,5-T were still alive although very small and distorted. Apparently turnips are slightly more susceptible to 2,4-D than to 2,4,5-T.

In a second experiment, 2,4-D (low volatile ester) was applied August 17, 1956, at concentrations of 1, 5, 10, 25, 50, 100, 200, and 500 ppm, when the turnip roots were about 2 inches in diameter. One week later the petioles of all plants sprayed with 10 ppm or higher were extremely brittle and epinasty was shown by those sprayed with concentrations of 25 ppm or higher. At time of harvest, in early October, those plants sprayed with 100 ppm or more were almost all dead and many had rotted. Those sprayed with 25 or 50 ppm were badly proliferated and considerably smaller than the controls. Cutting these turnips revealed the presence of a bright orange pigment in a layer a few millimeters below the skin (in the region of the cambium). This pigment did not develop in any of the turnips sprayed when they were young (the first experiment).

The pigment mentioned above was extracted with acetone, chromatographed in petroleum ether and n-propanol (99:1), eluted into acetone and its absorption spectrum determined in a Beckman spectrophotometer. The curves for the pigment from the treated turnip approximated published curves for α and β carotene. It would seem that a mixture of carotenes is built up by the turnip in response to sub-lethal doses of 2,4-D. It is possible that such high pigment production is a response of all injured turnip tissue as similar pigmentation has been observed in the zone surrounding damaged areas on untreated turnips.

Turnips from both experiments were placed in storage for various lengths of time before reducing sugars and soluble and insoluble nitrogen were determined. Root tissue was extracted in boiling 80% alcohol for 2 hours (2) and reducing sugars were determined by the ceric sulphate method of Hassid (1). Nitrogen was determined colorimetrically by the use of Nessler's reagent (Ward & Johnston 3). The results of the first experiment are shown in Table 2.

Table 2 - Effects of 2,4-D on Turnips. Turnips sprayed July 24, 1956. Soluble and Insoluble N and Reducing Sugars Determined January and May, 1957.

Conc. of 2,4-D ppm.	Soluble N* % Dry Wt. Jan.	May	Insoluble N* % Dry Wt. Jan.	May	Reducing Sugars* % F.W. Jan.	May
0	5.6	4.8	1.9	1.9	3.3	5.6
5	4.2	3.9	2.1	2.9	3.9	5.6
10	5.6	3.5	1.9	1.7	3.1	5.7
25	5.7	2.8	2.3	1.8	4.3	6.5
50	3.1	4.5	2.1	2.2	4.1	5.4

*Average of 6 samples.

Low concentrations of 2,4-D had little effect on either nitrogen or reducing sugar content of stored turnips when the turnips were sprayed early in their development. However, later spraying with higher concentrations did affect both nitrogen and reducing sugar levels (Table 3).

Table 3 - Effect of 2,4-D on turnips. Turnips sprayed when 2 inches in diameter. Soluble and Insoluble N and Reducing Sugars Determined May, 1957.

Conc. of 2,4-D ppm.	Soluble N* % Dry Wt.	Insoluble N* % Dry Wt.	Reducing Sugars* % F.W.
0	2.6	0.8	5.2
50	5.1	1.2	1.3
100	5.6	1.6	1.1
500	4.8	1.5	0.7

*Average of 6 samples.

The marked differences in the soluble and insoluble nitrogen levels between the control turnips of the two experiments is probably due to differences in date of harvest. The turnips analysed in the second experiment (Table 3) were harvested three weeks later than the others (Table 2) and the controls were considerably larger. One would expect, therefore, that nitrogen levels on a dry weight basis would be reduced, although the amount of reduction is higher than was anticipated .

The high concentrations of 2,4-D used in the second experiment (Table 3) increased both soluble and insoluble nitrogen and decreased reducing sugar content. Since spray drift damage on turnips seldom occurs when they are as far advanced as they were at time of spraying in this experiment, the value of this information in terms of diagnosing 2,4-D injury is slight. From a physiological point of view, however, these effects of 2,4-D would seem to merit further work.

The 1956 experiments showed that the critical 2,4-D concentration for marked distortion of turnips was between 10 and 25 ppm. As well as verifying 2,4-D symptoms, experiments in 1957 were designed to fix this critical concentration more precisely. It was found that concentrations of 15 ppm or higher sprayed on plants having 4 - 5 true leaves brought about 50-75% reduction in size, proliferation, and marked distortion of the roots. In one such experiment, reducing sugars and alcohol soluble nitrogen were determined at 1, 2, 3, and 4 weeks after treatment in turnips sprayed with 5, 10, 15, 20 and 25 ppm of low volatile ester 2,4-D. There was more variation between the controls at different dates of analysis than between any of the treatments.

Summary

Morphological and chemical changes brought about in turnip roots by 2,4-D have been investigated with the aim of establishing positive identifying symptoms of damage by this herbicide. With the possible exception of using carotene build-up as a diagnostic tool, there appears to be no easy chemical way of identifying 2,4-D damage in young turnips. However, gross morphological changes are definite enough that by using one's knowledge of 2,4-D symptoms on turnips, in conjuction with other information about the area in question, one may usually give a definite answer to the question "Was this damage brought about by 2,4-D"?

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GRASS AND WEED CONTROL UNDER PEACH TREES

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Peach orchards of the northeast are usually cultivated thoroughly during the spring and early summer. If cultivation is done as close to the trunks as possible, so that an occasional tree suffers mechanical damage, the trees trunks are still circled by grass. Even if the island of grass did not offer appreciable direct competition to the trees, it provides a haven for rodents and shields the trunks from deposits of borer-control sprays.

This paper reports tree growth results under repeated use of some weed sprays that can serve to control the island of grass close to the tree trunks.

Materials and Methods

The herbicides employed, and the active ingredients referred to in expressing rates were:

Amino triazole; 3-amino-1,2,4-triazole, used as the product supplied courtesy of the American Cyanamid Company.

Dalapon; sodium 2,2-dichloropropionate, used as the product Dowpon supplied courtesy of the Dow Chemical Company.

Monuron; 3-(p-chlorophenyl)-1,1-dimethylurea, used as the product Karmex W.

Knapsack sprayers, equipped with Teejet flat spray nozzles were used to apply the sprays. The rectangular treated plot under a tree was covered by a spray swath on each of two opposite sides of the trunk. Trunks were wet freely except in the case of the oil used in Table 1. Herbicide rates are given in pounds active ingredient applied per acre of treated plot surface. These would amount to pounds per 100 gallons if the 100 gallons were applied to a 4x4 foot square under 2700 trees.

Most of the data concerns a young peach orchard growing on Yates gravelly loam soil near Geneva. The first treatment was applied three years after planting. Normal cultural practices of pest sprays, fertilization, and pruning were followed in the orchard. Cultivation by disking was usually started by mid May and repeated several times until mid June. The later cultivations worked the soil to within one to two feet of the trunks, and encroached on the treated zone of even the smallest treated plots.

The predominant cover was a strain of field brome (Bromus arvensis) in half of the orchard and perennial rye grass (Lolium perenne) in the other half, with quack grass (Agropyron repens) appearing occasionally throughout the orchard. The first two grasses typically died out in midsummer after developing seed; then a new crop, starting from seed in August or September, formed a dense over-wintering sod. A number of summer annuals, chiefly redroot (Amaranthus retroflexus) barnyard grass (Echinochloa Crusgalli) lamb's quarters (Chenopodium album) and old witchgrass (Panicum capillare) appeared each summer in areas free of established grass sod and monuron residues.

Results

An example of results with a combination of dalapon (7 lbs./A) and monuron (3 lbs./A) applied to a restricted plot around the tree trunk is given in Table 1. For comparison, the same area under matched trees was weeded with carefully directed spray of oil, or by hand hoeing. Rainfall following the dalapon-monuron application was light each year, being near 0.2" within 10 days, 2" during the first month, and 3" the next month.

Grass control by the dalapon-monuron mixture was excellent. Growth ceased at the 6" to 10" height attained before spraying in 1956, and the grass foliage died gradually during the next month. When the plots were treated again the following spring the weed cover was little more than the rare grass shoot shown in the August 1956 record of Table 1. The pattern in the hoed plots or the oiled plots was quite different, with no live cover immediately after treatment, a sparse cover later in the summer, and, increasing grass cover between late summer and the following spring. The contrast between low growth of recovered or seedling grass in all treated plots and the tall screening growth on check plots is not adequately portrayed in the data on percentage ground cover.

Tree growth differences associated with the treatments of Table 1 are of no statistical significance. Neither the treatments, nor the narrow border of grass around the trunks of check trees, have as yet affected tree growth.

Table 1. Results from weed control measures used on a 4x4 foot square under peach trees, 1956, 1957. 12 trees in each treatment.

Treatment, applied in late May each year	2-yr. gain in trunk girth, mm	Weed cover by trunks, %	
		Aug. 1956 (3)	Oct. 1957 (4)
7 lb./A Dalapon, 3 lb./A Monuron (1)	129	3	0.3
Fortified oil, avoiding trunks (2)	132	6	14
Hoed, May and June - - - - - - - - -	129	16	31
Check - - - - - - - - - - - - - - - -	128	76	68

(1) In 50 gal./A, or 54 trees per gallon.
(2) Kerosene with one quart Dow General per 100 gal. Sprayed at about 200 gal./A, or 14 trees per gallon.
(3) Survival or regrowth of perennial rye grass and quack grass, also summer annual grass and weeds.
(4) As (3), plus seedling perennial rye grass.

In a more extensive exploratory experiment in the same orchard, heavier doses of dalapon or monuron were repeated every year on the same trees for three years. The heavier per-tree doses involved either a high per-acre rate on a small 16 square foot plot under the trees, or a moderate rate on a 48 square foot plot. The larger plot extended beyond the spread of the tree branches until the 1957 season. Table 2 lists the treatments and the average results in tree growth. Rainfall that occurred within the first two months after each herbicide application is given in Table 3.

Tree growth records of Table 2 suggest that the amounts of dalapon and monuron sufficient to control grass in a 4x4 foot square around the trunk, as used in Table 1, are not likely to entail tree damage. The much larger per-tree doses involved in all treatments of Table 2 tend to reduce growth in only a few cases.

Two instances of significant but slight growth reduction appear in the data. The high 9 lb./A rate of monuron (Trt #4) reduced growth by 7% in 1956, though not in the other two years nor in the three-year total. The same rate applied to a larger area under the trees in Trt #8, resulting in a per-tree dose three times as large, also tended to decrease growth, but not drastically nor even significantly as measured on a smaller number of tree pairs. Most of the effect of this latter treatment also occured in the 1956 season.

Application of dalapon and monuron together under the full spread of the tree branches (Trt #5) has reduced the growth significantly, by about 9%, over the three years of repeated treatment. No completely satisfactory explanation of this response is offered. Neither ingredient alone shows appreciable effects on growth, even at higher rates. A pertinent factor may be the almost complete lack of grass cover on these plots when the 1956 and 1957 sprays were applied; spray interception by weeds over the entire treated area was estimated to be less than ten percent in both years. The fact that a comparable lack of cover prevailed on the monuron plots of Trt #3 suggests that the dalapon ingredient may have caused damage when deposited directly on the soil. However, the trees did not show leaf symptoms of dalapon injury; and the similar dalapon dose with monuron on the trees of Trt #6 has shown no tendancy to reduce growth.

Certain leaf symptoms have shown occasionally in the orchard. Their description below is based in part on observation in a population of younger and smaller trees, where the incidence of visible symptoms was greater under the same range of application rates.

A leaf symptom of excessive dalapon has been a narrow band of pale or chlorotic tissue, often with reddish coloration, around the margin of the leaves. A more severe symptom has been premature senescence and dropping of the older leaves, which results in a more open head of foliage in late summer and early

Table 2. Peach tree growth during three years of annual herbicide treatment. Herbicides applied in May of each year to the indicated plot area under the tree; each treated tree paired with a check. All cultivated to within 1 to 2 feet of the trunk before and/or after treatment. Planted in April, 1952; initial trunk girth in 1955 about 190 mm.

	Herbicide treatment	No. pairs Trt. vs Ch.		Growth in trunk girth, mm Trt.	Check	Diff; Trt-Ch	
	Dalapon						
#1	7 lbs/A on 48 sq ft	18	1955	44	46	-2	±3
			1956	54	57	-3	±2
			1957	60	63	-3	±2
			3-yr	158	165	-7	±6
#2	21 lbs/A on 16 sq ft	18	1955	45	46	-1	±3
			1956	58	57	1	±3
			1957	65	64	1	±3
			3-yr	168	167	1	±6
	Monuron						
#3	3 lbs/A on 48 sq ft	16	1955	51	49	2	±4
			1956	62	64	-2	±2
			1957	67	66	1	±2
			3-yr	180	179	1	±7
#4	9 lbs/A on 16 sq ft	16	1955	50	50	0	±3
			1956	57	61	-4	±2*
			1957	66	68	-2	±2
			3-yr	173	179	-6	±6
	Dalapon plus Monuron						
#5	7 lbs/A Dal) on 48 sq ft 3 lbs/A Mon)	18	1955	45	45	0	±2
			1956	52	59	-7	±2**
			1956	56	64	-8	±2**
			3-yr	153	168	-15	±3**
#6	13 lbs/A Dal) on 16 sq ft 3 lbs/A Mon)	16	1955	47	49	-2	±4
			1956	58	56	2	±2
			1957	63	64	-1	±3
			3-yr	168	169	-1	±7
	Miscellaneous, on 48 sq ft						
#7	21 lbs/A Dalapon	6	3-yr	153	145	8	±5
#8	9 lbs/A Monuron	6	3-yr	176	185	-9	±16
#9	5 lbs/A Amino triazole	7	3-yr	189	179	10	±7
#9a	6 lbs/A Amino triazole	12	1957	72	69	3	±2

The lightest symptom of monuron has also been a narrow band of chlorotic tissue at the leaf margin, particularly at the tip of the leaf. The zone of chlorotic tissue seemed more sharply defined than in the case of dalapon. More severe effects showed in a wider chlorotic area extending between the main veins, and as interveinal patches of chlorosis that imparted a mottled appearance. The symptoms tended to appear on individual branches or on sectors of a tree that was otherwise normally green. Affected branches were very conspicuous, because the chlorotic areas were almost devoid of chlorophyll.

Under the highest rates of monuron used in Table 2, slight symptoms have been visible each year. In the 1957 season symptoms were more prevalent than previously. Of the six trees receiving the heaviest monuron application (Trt #8) five showed light to severe chlorosis on one or more branches. A few extra trees, treated with this high rate for the first time in 1957, were affected in about the same severity. About half of the trees under Trt #4 had one or more branches with light to moderate chlorosis; and about one-quarter of the population under the three-pound application of Trt #3 and Trt #5 showed visible monuron symptoms. The symptoms appeared earlier, and were generally more frequent on the trees treated at the mid-May date in 1957.

Dalapon symptoms have been discerned less frequently. In 1957, for example, marginal leaf symptoms showed on only two of the six trees that received the heaviest application of Trt #7, and premature defoliation was not apparent on any of the trees under dalapon treatment.

Table 3. Inches rainfall following the herbicide applications considered in Tables 2 and 4.

		20 hours	10 days	1 month	2 months
Treated mid-May;	1955	0.31	0.8	1.4	2.5
	1956	0.03	0.2	1.4	3.8
	1957	0.04	2.5	3.6	7.0
Treated late-May;	1955	0.00	0.1	0.7	2.4
	1956	0.00	1.0	1.2	5.4
	1957	0.00	0.4	2.4	5.7

The first six treatments of Table 2 were distributed equally among the four different varieties listed in Table 4. Treatment was subdivided further on each variety to include two dates of application each year. Half of the population was treated in mid May; the other half was treated about two weeks later, after some rainfall had intervened. Thus a year's results would sample more conditions than those pertaining to one single day of application.

By combining the six treatments into three main classes of dalapon, monuron, and mixtures, analysis of variance could be made on a reasonable population in each class to determine if the effect of materials differed with variety or with date of application. This was done with the first two years of growth results. Whether calculated separately or as a two year total, only one indication of an interaction has appeared. The varieties have differed somewhat in their response to monuron. The main source of the apparent variety difference was in the contrast between Triogem and Sunhigh. This is illustrated in Table 4, where the two-year results are summarized by expressing growth of treated trees as percentage of the growth observed on check trees. Differences in date of treatment have not yet been an appreciable factor in the results. The slight and insignificant trends relating to date in Table 4 were similar in the two years.

Table 4. Growth of herbicide-treated peach trees in relation to variety and to date of treatment. 1955+1956 growth under the first six treatments of Table 2.

Factors compared	No. tree pairs each column	Growth as percent of checks		
		Dalapon #1, 2	Monuron #3, 4	Dal. plus Mon. #5, 6
Halehaven	8	95	96	98
Redhaven	8	91	103	94
Sunhigh	8	104	110	97
Triogem	8	102	87	95
			**	
Treated mid-May	16	97	96	93
Treated late-May	16	99	102	98
Average	32	98	99	96

** Varieties differ significantly (P= 0.01) in response to monuron.

Weed control data for the six main treatments is partially reported by the summary in Table 5. The weed control shown for dalapon treatments in the late-season dates of record is much less than was evident during the summer period of each year. Practical control of the grass cover has been obtained by the lowest application rates of dalapon or monuron. However, the pattern of control action has been dissimilar.

The most conspicious effect of monuron came late in the first season, when the normal seedling crops of perennial rye grass and field brome failed to appear. Subsequently all plots under monuron treatment have been nearly free of these grasses and of summer annuals as well. The area of control covered the entire area of treatment, even where disking disturbed the soil surface after treatment. The weed cover recorded for monuron treatments in Table 5 consists largely of quack grass, and even this weed has been greatly diminished by the repeated treatments.

Under the lightest dalapon treatment of 7 lbs./A all grass was severly stunted. Little or no further growth in height occurred after treatment, and foliage progressively died from base to tip of the culms. Quack grass has disappeared from the plots, but a crop of seedling rye grass and field brome has appeared in late summer or early fall each year. A sparse growth of summer annuals occurred each year.

Dalapon and monuron exhibited a marked synergistic action on field brome the first year, which was the only time the comparison could be made on a large number of plots. While monuron alone had no obvious effect on the growing sod, and the immediate effect of dalapon was only to stop further growth in height, combination of the lowest rates resulted in prompt kill of the grass.

Table 5. Weed cover under the trees receiving the herbicide treatments of Table 2 compared with adjacent check trees. Percent ground cover in the area near the trunks that was not disturbed by cultivation.

Herbicide treatment		Initial May 1955	Sep 1955 (1)	Aug 1956 (2)	Oct 1957 (3)
#1	7 lbs /A Dalapon	Trt 70	60	21	20
		Ch 63	81	78	84
#2	21 lbs/A Dalapon	Trt 68	32	8	15
		Ch 68	88	86	83
#3	3 lbs/A Monuron	Trt 56	16	11	3
		Ch 42	88	82	88
#4	9 lbs/A Monuron	Trt 54	6	3	0
		Ch 55	88	88	83
#5	7 lb Dal, 3 lb Mon/A	Trt 69	5	7	0
		Ch 67	82	84	82
#6	14 lb Dal, 3 lb Mon/A	Trt 72	4	3	0
		Ch 78	87	90	85

(1) (2) (3) Composition of weed cover at record dates was:

(1) Dalapon; seedling perennial rye grass and field brome; regrowth from rye grass; summer annual grass and broadleafs.
Monuron; quack grass.
Checks; all of above.

(2) Seedlings of perennial rye grass and field brome did not appear until after this record was taken.

(3) Similar to Sept 1955.

The amino triazole treatment, listed in Table 2 under miscellaneous treatments, has also provided a satisfactory degree of weed control under the treated trees, with no sign of damage to tree growth. It is not listed in Table 5 because the number and distribution of treated trees does not allow accurate comparison with the other treatments.

The degree and duration of weed control by amino triazole when used under the trees has seemed greater than when similar applications were used in more open situations. This is also true in reference to the generally successful weed control with dalapon alone. Perennial broad leaved weeds have not been a factor in the orchard weed population as yet.

Summary

A four-foot square around the trunk of peach trees has been freed of quack grass, some other grasses, and summer annual weeds by a spring application of a mixture of dalapon and monuron at respective rates of 7 lbs/A and 3 lbs /A on the treated area. Tree growth has not been impaired by annual application repeated for three years.

Extending this application to beyond the full spread of the branches has resulted in about 10% lesser tree growth during three years of continued treatment on the same trees. However, after the first year much of the spray was deposited superfluously on weed-free soil surface.

Much heavier applications of the separate ingredients have not caused severe damage in tree growth, but leaf symptoms have been seen occasionally.

Amino triazole at 5 lbs/A under the spread of the tree branches has been effective in suppressing weed growth without injury to the trees.

Granular Herbicides for Weeds in Ground Cover Plantings

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Plots 8 x 10 feet were used to compare the effectiveness of CIPC formulations with and without SES in controlling seedling groundsel, Senecio vulgaris, in freshly planted ground covers of myrtle, Japanese spurge, English ivy and Euonymus.

The soil was rototilled in May prior to planting. The planting was irrigated. Herbicides were applied after the foliage dried. A second irrigation was given in mid-June. Subsequent rainfall was scant. No further irrigation was given.

On August 1 weed control was rated good (less than 2 weeds per sq. ft.), fair and zero. On August 16-20 all plots were hand weeded by cutting Senecio vulgaris and other weeds. Chenopodium, Amaranthus and Portulaca were present in small numbers but were of large size. Fresh weight of tops was taken in ounces. Counts were made of ground cover plants surviving.

The data collected are given in Table 1 as the mean value of four plots except for SES spray when only two plots were used.

Table 1. Growth of weeds (fresh weight) and of ground covers survival following application of granular herbicides as final stage of planting operation.

	Wt. weeds oz. (mean)		Surviving plants of ground cover (mean) No. plants in 30 set out			
Treatment June 1957	Senecio vulgaris	Other weeds Chenopodium, etc.	Vinca minor	Pachysandra	Hedera helix	Euonymus fortunei
Untreated (check)	3.5	28.7	19.5	22.5	23.0	17.5
Misc.CIPC 8 lbs./A	2.4	11.1	17.5	18.0	22.5	9.5
Gr. CIPC 4 lbs./A	3.0	12.6	16.0	23.5	23.5	21.0
Gr. CIPC-SES 4 lbs./A	1.0	13.1	19.0	21.0	23.5	18.5
Gr. CIPC 12 lbs./A	2.2	15.8	9.5	20.0	21.5	12.5
Gr. CIPC-SES 12 lbs./A	1.6	2.7	17.5	15.5	20.5	16.5
SES spray 4 lbs./A	8.6	26.3	16.0	14.5	----	----

Groundsel was reduced by the addition of SES on granules carrying CIPC. Other weeds than groundsel were reduced by 50% or more where CIPC was used. SES spray was less effective than miscible or granular CIPC in present tests.

SES on the granules with CIPC appears to enhance the effectiveness. Those plots rated as good were 12 lbs. CIPC-SES, 8 lbs. CIPC miscible and 4 lbs. CIPC-SES. Results are in line with screening tests conducted in the greenhouse where controlled environment conditions prevail.

Two additional plantings of ground covers were made in late June. Applications of granular herbicides were made in one case after a heavy July rainfall; in the second case following last cultivation in October. Observations were made in November. The major weed present was annual bluegrass.

July treated plots showing annual bluegrass in November included:
Control - abundant stand,* 5 plots
Carbagran - 10 lbs./A to 30 lbs./A   Endothal - 2 lbs./A
Dinitro - 1 lb./acre   Amino triazole - 5 lbs./A
* abundant stand means over 10 plants per square foot

Plots clean of annual bluegrass in November, 4 months after treatment in July were: CIPC - 4 lbs./A, 12 lbs./A also at same rates; CIPC-SES (4 lbs./A, 12 lbs./A); CIPC-Simazin (4 lbs./A, 12 lbs./A); CIPC-Endothal (4 lbs./A, 12 lbs./A); CIPC-amino triazole (4 lbs./A, 12 lbs./A) and Simazin - 12 lbs./A

Plots clean in November after treatment in October with granular formulations included: CIPC - $\frac{1}{4}$ lb./A, 1 lb./A, 4 lbs./A; CIPC-SES ($\frac{1}{4}$ lb./A)* 1 lb./A, 4 lbs./A; amino triazole 5% - 1 lb./A, 2 lbs./A, 4 lbs./A, 8 lbs./A; Diuron 2% - $\frac{1}{4}$ lb./A; $\frac{1}{2}$ lbs., 1 lb./A, 2 lbs./A; Simazin 10% - 1 lb./A, 2 lbs./A, 4 lbs./A. * = scattered light stand of annual bluegrass.

Control plots show moderate to heavy infestation of annual bluegrass. Ground covers responded to amino triazole in varying degrees of discoloration.

Table 2. Effectiveness of granular formulations under intermittent mist spray. Under greenhouse conditions.

			Redtop counts Pounds per acre				Erodium sp. counts Pounds per acre			
Herbicide	Carrier	Load	16	4	1	$\frac{1}{4}$	16	4	1	$\frac{1}{4}$
CIPC	Attaclay	20	0	0	3	70	35	36	41	38
		10	0	2	0	41	30	36	42	22
		8	0	0	2	38	31	72	58	43
		5	0	0	2	54	22	53	54	51
	Vermiculite	5	0	0	0	92	62	34	63	52
	Attaclay	4	3	193	453	485	19	29	38	28
	Perlite	4	0	0	5	65	73	56	47	60
CIPC-SES	Attaclay	4	0	0	2	61	0	3	29	46
Simazin 10% 4 lbs. max.	Vermiculite		13	19	107	214	0	0	0	0
Diuron 2% 2 lbs. max.	Attaclay		16	93	193	300	0	0	0	10
Endothal 2% 16 lbs. max.	"		21	0	5	23	0	10	24	67
Control					4000					50

For a specified amount of active herbicide this can come from any load per particle from 4 to 20%. CIPC does not control *Erodium* sp. at rates used. Simazin, Diuron, and Endothal granulars do control *Erodium* sp. Simazin at $\frac{1}{4}$ to 16 lbs./acre controls *Erodium* sp. but not redtop. Simazin would appear a likely supplement for CIPC for a wider range of seedling weed control.

Summary. Under standardized conditions seedling weeds may be controlled effectively with as low as one pound of active ingredient per acre, provided a suitable load of herbicide is carried per granule. Also provided that a moist soil surface and maximum condition for germination are maintained. A wider spectrum of weeds can be controlled when two or more herbicides are combined, as per example CIPC-SES.

Low poundage of herbicide also increases the range of usefulness in horticultural plantings. Crop tolerance to granular versus liquid herbicide applications was reported last year as increasing the usefulness of herbicides in ornamental plantings.

References

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Granular Herbicides for Weed Control in Nursery Plantings

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Tolerance of *Rosa dilecta* var. Better Times to granular CIPC was reported at the 1957 conference. Additional granular formulations were used in 1957 on Fashion and on Better Times, planted June 20. Treatments were made July 29 following cultivation when young rose foliage was first present. September 9 weeds were mainly pussley. All weeds were cut and green weight of tops records in ounces, Table 1. No further weed control treatment was made. Final observations November 15 were based on the stand of annual bluegrass. Control was rated as excellent, good, fair or poor. The presence of quackgrass or other perennial weeds was also noted. Growth of roses was observed periodically and showed no obvious abnormalities as compared to untreated check plants.

The results indicate over 90% weed control with the following granular formulations: CIPC 4%, 12 lbs. of active ingredient/acre; Diuron 2%, 4 lbs. of active ingredient/acre; Simazin 10%, 12 lbs. active ingredient/acre.

Effective combinations at reduced poundage: CIPC 4 lbs. active with Diuron 1 lb. active/acre; CIPC 4 lbs. active with Simazin 4 lbs. active/acre.

Fall applications in evergreen plantings of lining out stock were treated October 20. Actively growing plants of groundsel, annual bluegrass, and annual chickweed were present. Results within 30 days showed the following granulars had killed the weeds: granular Simazin 10%, 4 lbs. active/acre; granular Diuron 2%, 2 lbs. and over/acre; granular amino triazole, 8 lbs. and over/acre; spray Simazin 2 lbs./acre, but injury to Iberis; spray Karmex DW,

Table 1. Effectiveness of granular herbicides on germinating weeds in newly planted roses.

Granular treatment	Rate act. ingr. per acre	Green wt. oz. 7/29-9/9 pusley	others	Rating* - November 15 Annual bluegrass	Others (rocket, groundsel, quack
Control	0	156	20	10+ per sq. ft. Heavy	
Amino triazole 5%	5	58	6	Poor	yes
Carbagran 10%	10-30	46	24	Poor	yes
CIPC 4%	4	10	3	Fair	few
	12	10	3	Excellent	few
D.N. 6%	2	60	30	Poor	yes
Diuron 2%	1	79	7	Good	few
	2	30	3	Excellent	no
	4	2-	2-	Excellent	no
Endothal 2%	4	145	19	Poor	yes
Simazin 10%	12	2-	2-	Excellent	no
Combinations with CIPC					
CIPC - A. T.	4 and 2½	35	21	Fair	yes
	12 and 5	2-	2-	Good	few
" - D.N.	4 and 1	20	14	Fair	yes
" - Diuron	4 and 1	2-	2-	Excellent	some
" - Endothal	4 and 4	17	11	Fair	yes
	12 and 4	12	4	Good	few
" - SES	4 and 4	16	4	Fair	yes
	12 and 4	2-	2-	Excellent	few
" - Simazin	4 and 4	2-	2-	Excellent	no
	12 and 12	2-	2-	Excellent	no

*Rating: excellent - up to average of 1 weed per sq. ft.; good - up to 1-2 weeds per sq. ft; fair - 3-5 weeds per sq. ft.; poor - 5-9 weeds.

Nursery stock included arborvitae, taxus, juniper, boxwood as well as privet and ground covers Iberis, Euonymus and Pachysandra. No injury was immediately noted where control was achieved.

In October granulars were used on a stand of groundsel first to third true leaf stage. These were in a planting of Taxus cuspidata. Senecio vulgaris was eliminated 90% or more with granular amino triazole 8 lbs., Diuron 2 and 4 lbs., Simazin 1, 2 and 4 lb. rates, Alanap 2 lbs., CIPC-SES at 1 and at 4 lb. rates. For nursery weed control granulars appear to have a place in weed control at the time of planting when rain or irrigation keeps soil moist for seed germination. Long residual herbicides are effective as granulars for several months as indicated by control of annual bluegrass from July herbicide applications. Residual granulars are effective in controlling established seedling autumn weeds in some crops and may be as effective as use of CIPC miscible has been over the past 10 years in control of

TOLERANCE OF TAXUS AND JUNIPERUS TO SELECTED HERBICIDES

R. L. Ticknor and P. F. Bobula*

Several herbicides were applied at higher than normal rates in order to determine the tolerance of Taxus media hicksi and T. baccata dovastoni as well as Juniperus chinensis pfitzeriana. The plants used in this experiment were three years old, having been in the field two years.

Chemicals and rates of application were as follows: CDAA - 40 lbs./A; CDEC - 40 lbs./A; EPTC - 5, 10, and 15 lbs./A; and Simazin - 4, 6, 8 and 10 lbs./A.

Chemicals were applied to weed-free duplicated plots 12' x 16' containing 45 plants on May 20, 1957. It was necessary to reapply the 5, 10, and one of the 15-pound per acre EPTC plots on June 27, 1957, since over 40 percent of the soil surface was covered with purslane. Final records for this application were taken on August 8, 1957, and are presented in Table I. The weed population was almost pure purslane in these plots.

All of the plots were made weed-free and the same chemicals were reapplied on September 10. Up to October 28, weed development has been confined to the check plot.

Discussion

No evidence of any injury caused by the chemicals was seen this season. These treatments will be continued another year to see if damage does occur. The 1957 growing season was the second year that plots treated with CDAA and CDEC had received these chemicals at a rate of 40 lbs./Acre.

Simazin at 6, 8, or 10 pounds per acre applied on May 20 held the plots relatively weed-free for a 12-week period. Differences between Reps. 1 and 2 were probably caused by the fact that Rep. 2 received some water when adjacent plots were irrigated. CDEC at 40 lbs./A was also quite satisfactory for long residual action. EPTC was not satisfactory when applied to dry soil followed by irrigation.

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TABLE I. Weed control ratings following application on May 20, 1957, of higher than normal rates of several herbicides around Juniperus and Taxus. Record taken August 8, 1957.

Chemical Rate/Acre		Rep. 1	Rep. 2
Check		5 *	4.5*
CDAA	40	4.5	4.5
CDEC	40	4	4
EPTC	5	5 *	3 *
EPTC	10	2.5*	3 *
EPTC	15	4	3.5*
Simazin	4	5	4
Simazin	6	2	2.5
Simazin	8	1	3.5
Simazin	10	1.5	3.5

* Chemicals reapplied on June 27 to weed-free plots.

The ratings are based on a scale of:

0 - less than 4 weeds per square foot
1 - 20 percent of the soil surface covered by weeds
2 - 40 " " " " " " " "
3 - 60 " " " " " " " "
4 - 80 " " " " " " " "
5 - 100 " " " " " " " "

PREPLANTING TREATMENTS FOR WEED CONTROL IN NURSERY AND HERBACEOUS ORNAMENTALS

Robert L. Ticknor and Eugene C. Gasiorkiewicz*

PART I

Interest in the use of temporary soil sterilants by nurserymen and estate, cemetery, and park gardeners has increased. Weed control efficiency and a determination of a safe date for planting following application of soil sterilants were the objectives of this study.

Materials and the rates of application on 100 square foot plots (5' x 20') were as follows: Allyl Alcohol (Bedrench) 653 c.c.; Chloropicrin 3 c.c. injections on 6" centers; Methyl Bromide 1 lb.; Mylone 3/4 lb.; Vapam 1 quart; 1.5 mil. Black Polyethylene; and untreated control. Allyl alcohol, Mylone, and Vapam diluted in 2 gallons of water were applied by means of a watering can followed by at least 15 gallons of water per bed. Mylone was not mixed with the soil following application. Forty-eight hours were allowed for methyl bromide to diffuse under the plastic covers. Black polyethylene strips, three feet wide, were lapped and the edges buried to make a bed five feet wide.

Each treatment was replicated three times except for Vapam for which four replications were used, one of which was applied by injection. There were two check plots. Walkways, three feet wide along the bed and two feet wide at the ends of the beds, were treated with DN or Diuron prior to mulching with one inch of cocoa shells. This treatment gave a neat appearance and pathways remained weed free.

Plant materials used in these trials were as follows:

Nursery Stock

Forsythia intermedia	-	Forsythia
Kalmia latifolia	-	Mountain Laurel
Pieris floribunda	-	Mountain Andromeda
Pinus Thunbergi	-	Japanese Black Pine
Taxus media Hicksi	-	Hicks Yew

Contribution No. 1137 of the University of Massachusetts College of Agriculture, Experiment Station, Amherst, Mass.

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Florist Crops

Ageratum houstonianum	-	Ageratum
Begonia semperflorens	-	Wax Begonia
Chrysanthemum morifolium var.		Bonnaffon Deluxe
Coleus blumei	-	Coleus
Hedera helix	-	English Ivy
Pelargonium hortorum	-	Geranium

Spacing between the plants was eight inches, and between the rows ten inches. Six plants of each type were set at each planting date; 7, 14, and 21 days after applying the soil treatments on May 8, 1957.

Soil temperature at the time of treatment on May 8 was 60° F. One week later at first planting date, the soil temperature was 69° F. On third planting date, May 22, the soil temperature was 60° F.

All plots requiring a water seal were surface irrigated on May 8. Following transplanting on May 15, all plots were watered. Weather predictions of a killing frost on May 16 necessitated the precaution of overhead irrigation of all test plots from 3 a.m. to 6 a.m. on May 17.

Observation records were taken periodically.

Results and Observations

Allyl Alcohol	No observable damage to crop plants; 30 percent weed control.
Chloropicrin	Woody nursery plants were injured by a browning of aerial parts followed by necrosis. Injury was observed only in the May 15th planting. The herbaceous bedding plants were not affected. Non-effective in weed control.
Methyl Bromide	Plant growth was good. The most effective material; over 95% weed control.
Mylone	No plant injury; plant growth good. Approximately 85 percent weed control.
Vapam	No plant injury; plant growth good. Approximately 85-90 percent weed control resulted when applied as a soil drench, but only 40 percent weed control when applied by injection.

Polyethylene, Black	Crop plant development was best in this treatment, probably because of the more even soil moisture supply. Weeds flourished in the planting holes but could be controlled manually.
Check	Plant growth good but in general shorter than treated plots. Weed population was predominantly purslane in early season, and lamb's quarters and henbit later in the season.

Weed control effectiveness was much more critical around the nursery stock than around the ornamental bedding plants. The slow growth of nursery stock produced little shading of weed seedlings. Bedding plants developed rapidly to cover the soil surfaces, crowding out many weed seedlings.

Conclusions

Methyl bromide was the most effective for weed control.

Mylone and Vapam were approximately equal in effectiveness in controlling 80-90% of the broadleaf weeds.

Chloropicrin was ineffective in controlling weeds.

Allyl Alcohol was not satisfactory for weed control, being less than 50% effective.

Black polyethylene controlled weeds in the areas covered by the film, but very lush weed growth developed in the openings where the nursery and herbaceous ornamentals were planted. Plant growth was best with this treatment, possibly because of the greater amount of soil moisture. We do not feel that this material is suitable for bedding plants and small nursery stock because of the excessive labor involved in planting through the plastic film.

None of the soil sterilants were phytotoxic to the herbaceous ornamentals planted one week after application when soil temperatures do not drop below 60° F.

Phytotoxic effects were observed only in the woody ornamentals planted a week following application of chloropicrin. Subsequent plantings were unaffected.

PART II

Since Vapam appeared to be safe to use around most herbaceous bedding plants, part of the All-America Annual Trial beds at the Waltham Field Station were treated on May 17, 1957. These beds are typical of most beds in home gardens or parks in that they are completely surrounded by turf composed of bent, creeping red fescue, and Kentucky blue grasses.

Four beds, which measured 5' x 40', were treated with Vapam and VPM at a rate of one quart per 100 square feet, and four beds at a rate of one and one-half quarts per 100 square feet. Vapam and VPM were applied in a watering can and were water sealed at the rate of 15 gallons per 100 square feet. No barriers were used to protect the grass from the liquid.

Planting in these beds was started on June 6, 1957. Two beds were devoted to an old fashioned garden and could be compared with mirror-image beds which were not treated. The other six beds were planted to petunias, sweet alyssum, and gomphrena. A list of the annuals planted in the old fashioned garden were as follows:

Ageratum	Larkspur
Annual Phlox	Marigold
Bells of Ireland	Nicotiana
Blue Salvia	Salpiglossis
Bush Morning Glory	Scobiusa
Calendula	Snapdragon
Celosia	Torenia
Centaurea	Verbena
Cleome	Vinca
Coleus	Violas
Dahlias Unwin's Hybrid	Zinnia
Dianthus	

Observations

The weed population was greatly reduced but not eliminated; approximately 90% weed control resulted from this treatment. No observable difference was noted between the two rates of Vapam and VPM.

No injury occurred among the annuals, and the early season growth appeared to be stimulated although measurements were not taken.

One of the most important findings in this study was that there was insufficient lateral movement of the chemical to cause injury to adjoining turf. Vapam or VPM apparently can be used on soil in borders without danger to surrounding turf. The grass was killed when the solution was applied directly to it.

Acknowledgments

The authors wish to thank the following companies for providing the materials used in these studies: Dow Chemical Company, Dupont Chemical Company, Eastern Chemical Company, Niagara Chemical Company, Stauffer Chemical Company, and Union Carbide and Carbon Corporation. Further thanks are due the Stauffer Chemical Company for a grant-in-aid used in these studies.

COMPARISON OF GRANULAR AND LIQUID APPLICATIONS OF HERBICIDES IN GLADIOLUS

E. C. Gasiorkiewicz*

The successful use of chemicals for the control of weeds in vegetable crops has created an interest in the use of herbicides for ornamentals. Granular herbicides have been reported by Danielson (3) as post-emergence treatments in vegetable crops. Limited use of granular herbicides in herbaceous ornamentals has been reported within the last two years. Pridham (4) compared granular and miscible CIPC in relation to crop and weed growth in Chrysanthemum morifolium. Butterfield and Gasiorkiewicz (2) compared 7 granular formulations with liquids in gladiolus trials. Bing (1) referred to use of granular CIPC, and Pridham (5) recommended this material for weed control in gladiolus. The present report includes performance tests of liquid and granular herbicides used in gladiolus.

Uniform plots, 10x10 feet with 2-foot buffers, planted with 4 rows of gladiolus each with 25 corms were treated 10 days after planting. The gladiolus had emerged about 3 to 4 inches at time of application. No precaution was taken with granular materials to avoid contact with plants. All plots were uniformly watered by an overhead skinner system for 30 minutes, 24 hours before and immediately after application of herbicides.

The test materials and dosages used are presented in Tables 1 and 2. All treatments were replicated 3 times.

Weed control ratings were based on the percent of treated area covered by weeds. Six rating classes were established as follows:

1 - 4 weeds or less per 100 square feet
2 - 20 percent of area in weeds
3 - 40 " " " " "
4 - 60 " " " " "
5 - 80 " " " " "
6 - 100 " " " " "

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The granular treatments were repeated on July 23, following weeding and rototilling. Liquid dinitro was applied to all plots indicated by ff. in Table 2.

Results

In the early summer applications, EPTC-liquid, EPTC-clay and vermiculite, and Sesone-vermiculite were completely ineffective. CDEC-vermiculite, CDEC-liquid, and Sesone-liquid plots were 80 percent or more weed infested. Dinitro-clay, CIPC-liquid, and CIPC-vermiculite were about 50 percent effective. CIPC-clay and Mylone-liquid gave about 70 to 80 percent control. Simazin-vermiculite, Diuron-vermiculite, Diuron-liquid, and Dinitro-liquid gave the most effective control with less than 4 weeds per test plot. Mylone-granular and Simazin-liquid treated plots had about 5 percent weeds.

Liquid treatments of Dinitro following initial treatments of EPTC, and Sesone, were not as uniform in performance as were the early summer applications listed in Table 1.

Simazin was the longest lasting herbicide, with the liquid and vermiculite material effective from June through October.

Diuron, liquid and granular, was outstanding for effectiveness of control. These plots could be described as weed-free.

None of the test materials caused any plant injury except liquid Mylone which caused a curling of the young leaves.

Granular herbicides were as effective as similar liquid preparations. Herbicides impregnated on vermiculite gave better control than materials on clay.

Granular herbicides appear to be safer than liquid when used for post-emergence treatments.

Diuron and Simazin liquid and granular were outstanding at 1½ and 2 pounds per acre, respectively.

The ease of application of granular herbicides should appeal to commercial and amateur gladiolus growers.

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TABLE 1. Comparison of granular and liquid applications of herbicides in gladiolus. Waltham, Massachusetts, 1957. Applications: June 13, 1957 - Final Reading: July 19, 1957.

HERBICIDE	CARRIER	RATE Lbs/Acre	WEED CONTROL[a]	DOMINANT WEEDS
Dinitro 10%	vermiculite	6	1.6	purslane pigweed
Dinitro 10%	clay	6	3.2	purslane quackgrass
Dinitro 6#/gal.	liquid	6	1.0	quackgrass
Chloro IPC 10%	vermiculite	6	3.3	grasses henbit
Chloro IPC 5%	clay	6	2.0	purslane
Chloro IPC 40%	liquid	6	3.3	lamb's quarters
Diuron 2%	vermiculite	1½	1.0	
Diuron 80%	liquid	1½	1.0	
Simazin 50 WP	liquid	2	1.3	
Simazin 10%	vermiculite	2	1.0	
EPTC 6#/gal.	liquid	10	6.0	purslane
EPTC 5%	clay	10	6.0	purslane pigweed
EPTC 10%	vermiculite	10	6.0	pigweed purslane
Sesone 90%	liquid	4	5.2	purslane
Sesone 10%	vermiculite	4	6.0	purslane
CDEC 10%	vermiculite	8	5.6	pigweed
CDEC 4#/gal.	liquid	8	5.3	pigweed purslane
Mylone 95%	active granular	200	1.3	
Mylone 85 WP	liquid	200	2.6	purslane
Check			6.0	purslane pigweed chickweed grasses

(a) Average of 3 replications. Rating Scale: 1 = no weeds; 2 = 20% of area in weeds; 3 = 40% of area in weeds; 4 = 60% of area in weeds; 5 = 80% of area in weeds; 6 = 100% of area in weeds.

TABLE 2. Comparison of granular and spray applications of herbicides in gladiolus. Waltham, Massachusetts, 1957. Applications July 25, 1957 - Readings October 7, 1957.

HERBICIDE	CARRIER	RATE Lbs/Acre	WEED CONTROL[c]	DOMINANT WEEDS
Dinitro 10%	vermiculite	6	2.0	purslane
Dinitro 10%	clay	6	2.8	purslane
Dinitro 6#/gal.	liquid	6	1.0	
" ff.[a] EPTC liquid	"	6	1.3	
" ff. EPTC clay	"	6	1.0	
" ff. EPTC verm.	"	6	2.0	
" ff. CDEC verm.	"	6	1.3	
" ff. CDEC clay	"	6	1.6	
" ff. CIPC liquid	"	6	2.0	chickweed
CIPC 10%	vermiculite	6	2.8	chickweed
CIPC 5%	clay	6	4.3	chickweed
Diuron 2%	vermiculite	1.5	1.1	grass
Diuron 80%	liquid	1.5	1.0	
Mylone 95%	granular	200	1.3	purslane
Mylone 85 w.p.	liquid	200	2.0	purslane
Simazin 50 w.p.[b]	liquid	2	1.3	
Simazin 10%[b]	vermiculite	2	1.0	
Sesone 90%	liquid	4	3.6	chickweed
Sesone 10%	vermiculite	4	5.0	chickweed
Check			6.0	chickweed purslane lamb's quarters

(a) ff. = following

(b) Fall readings are for single application made June 19,1957.

(c) Average of 3 replications. Rating Scale: 1 = no weeds; 2 = 20% of area in weeds; 3 = 40% of area in weeds; 4 = 60% of area in weeds; 5 = 80% of area in weeds; 6 = 100% of area in weeds.

TOLERANCE OF SOME PERENNIALS AND WOODY PLANTS TO SESONE (CRAG #1) AND CHLORO IPC

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Controlling weeds in perennials and nursery stock is costly in comparison to weed control in short season vegetable or field crops. The weeds include spring, summer and fall germinating annual weeds as well as many troublesome perennial weeds. In addition to controlling weeds throughout the entire year the crops often require several season's growth in one location before digging. The long time investment prior to sale, limits the selection of weed control procedures and herbicides to those which do not interfere with subsequent growth or quality of the nursery stock. The present report is a summation of recent studies of crop response based on both small plots and on demonstration field plots in nurseries on Long Island, New York.

Earlier studies by the author and others (1, 2, 3, 4, 5, 6) have shown Sesone (Crag 1) and Chloro IPC to be generally satisfactory for control of seedling weeds in the early stages of growth from juvenile seedling foliage to first true leaf stage. Condition of soil moisture and near optimum temperature for growth are also prerequisites for consistently satisfactory seedling weed control. Where these circumstances have been ignored and where other than recommended rates or uniformity of application has been followed, some unfavorable crop response has been noted.

The studies on which the present report is based were conducted at the Cornell Ornamentals Research Laboratory of the New York State College of Agriculture, at Farmingdale, and in the nursery plantings of the Agricultural and Technical Institute at Farmingdale.

Methods

A limited range of perennial and woody nursery crops were selected on the basis of grower interest in crop tolerance to Sesone and CIPC in both spray and granular formulations. Perennials were lined out in the spring and summer of 1955. Five to seven days after planting the herbicide was applied. Sesone was applied at 4 and 6 pounds per acre rates both directional and overhead. Chloro IPC was used at 4 and 8 pounds per acre rates in granular and emulsifiable forms. The emulsion was used both in directional and overhead applications. Repeat applications were made in the fall and a third series made the following spring. In October of the second fall (1956) all plants were rated for condition. Weed data was not taken because of sufficient data taken in earlier study (1, 2, 3, 5, 6, 7). In general Sesone at 6 pounds and CIPC at 8 pounds per acre gave fairly good weed control for about 1 month periods.

Results and Discussion

Table I shows the results of preliminary studies of Sesone and CIPC. There is no differentiation in the tables between results from directed or overall sprays of Sesone or between miscible and granular CIPC. With the plants used there were no great differences. Where differences occur, they are mentioned in the footnotes. Table I indicates that some crops such as Iberis, Lily of the Valley, and English Ivy are very tolerant to effective rates of Sesone and miscible and granular CIPC. Iberis was slightly stunted and Phlox paniculata and Arenaria were severely injured by CIPC at the 8 pound per acre rate with miscible or granular applications. The weed Galinsoga parviflora was not controlled by CIPC at the 8 pound rate but was controlled by Sesone at 6 pounds per acre.

The results of larger scale applications of CIPC at 4-8 pounds per acre by nurserymen on perennials is summarized in Table II. Most of the perennial data comes from the Martin Viette Nursery, Manetto Hill Road, Plainview, Hicksville, Long Island, N. Y. The applications at the Viette Nursery were on dormant stock in the spring at the rate of 5 quarts of miscible CIPC per 100 gallons of water per acre. The results of the large scale applications agree with results of the preliminary treatments. Most plants show a high degree of tolerance to miscible CIPC. However, Phlox paniculata is severely damaged and sprouting buds of Heuchera and Peony were injured by CIPC. CIPC stunted and reduced flowering of Iberis and also slightly stunted Delphinium and caused brittle leaves.

Both newly planted and established nursery stock at the Ornamentals Research Laboratory, the neighboring nursery of the Long Island Agricultural and Technical Institute and sections of several commercial nurseries were treated with Sesone or granular or miscible CIPC. The tolerance data is summarized in Table III. Practically all woody plants have shown very good tolerance to herbicidally effective applications of Sesone and CIPC. Starting buds on Viburnum carlesii and budded Pink Dogwood were injured by a directional application of CIPC. They were not directly exposed to the spray. One large block of yews were severely stunted by an early September treatment of 8 quarts of miscible CIPC per 100 gallons per acre.

Summary

Most plants tested were quite tolerant to recommended rates of Sesone spray and both granular and spray Chloro IPC. A few plants showed a lack of tolerance to spray and or granular application of Chloro IPC especially during bud break or sprouting. This data is partial information presented as a guide to further herbicidal studies on perennial and nursery plants.

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Table I

Tolerance of Perennials to Sesone and Chloro IPC

Botanical Name	Common Name	Sesone[(a)]	Chloro IPC[(b)]
Arenaria sp.	Sandwort	2(c)	2 at 1# 5 at 8#
Chrysanthemum morifolium	Garden Chrysanthemum	1	2
Convallaria majalis	Lily of the Valley	1	1
Dianthus sp.	Garden Pink	1	2
Dianthus barbatus	Sweet William	-(d)	1
Gaillardia aristata	Blanket Flower	-	1-2
Hedera helix	English Ivy	1	1-2
Heuchera sanguinea	Coral Bells	1-2	1-2
Iberis sempervirens	Candytuft	1	2
Iris germanica	German Iris	1	1
Leucothoe catesbaei	Drooping Leucothoe	1-2	-
Pachysandra terminalis	Japanese Spurge	1	1-2
Phlox paniculata	Summer Perennial Phlox	1	1-2 at 1# 5 at 8#
Rhododendron catawbiense	Rhododendron	1	1
Rhododendron Obtusum	Azalea	1-2	-
Vinca minor	Myrtle	2-3	1-2

(a) Directed and overall spray applications
(b) Directed and overall spray and granular applications
(c) Crop response at harvest

1. Equal or better than check
2. Slightly inferior to check
3. Definitely inferior to check
4. Very poor compared to check
5. Dead or missing

(d) Insufficient data

Table II

Tolerance of Perennials and Bulb Crops to Chloro IPC

Botanical Name	Common Name	Reaction to Chloro IPC
Aquilegia (hybrids)VLD(a)	Columbine	Tolerant
Astible sp. VLD	Spirea	Tolerant when dormant
Cimicifuga racemosa VLD	Black Snakeroot	Tolerant
Convallaria majalis VLD	Lily of the Valley	Tolerant
Delphinium cultorum VLD	Perennial Delphinium	Slight stunting, brittle leaves
Doronicum sp. VLD	Leopards-Bane	Tolerant
Epimedium sp. VLD	Bishops Hat	Kills young plants, stunts and stops flowering
Ferns (Various) VLD	Ferns (Several kinds)	Severe damage
Gladiolus sp.	Gladiolus	Tolerant
Hedera helix	English Ivy	Tolerant
Helenium autumnale VLD		Tolerant
Heleopsis scabra VLD		Tolerant
Hemerocallis sp. VLD	Day Lily	Slight damage
Heuchera sanguinea VLD	Coral Bells	Injured only when sprouting
Hosta sp. VLD	Funkia	Tolerant
Iberis sempervirens VLD	Candytuft	Reduced flowering slight stunting
Iris germanica VLD	German Iris	Tolerant
Iris kaempferi VLD		Tolerant
Iris pumila VLD		Tolerant
Leucojum aestivum VLD	Snowflake	Tolerant
Mertensia virginica VLD	Virginia Bluebells	Tolerant when dormant
Nepeta mussini VLD		Tolerant
Narcissus sp. VLD	Daffodil (Several var.)	Tolerant
Paeonia albiflora VLD	Peony	Tolerant when dormant, slight injury to sprouts
Paeonia suffruticosa VL	Tree Peony	Severe Damage
Papaver orientale VLD	Oriental poppy	Severe damage
Phlox paniculata VLD	Summer perennial phlox (several varieties)	Severe damage at over 4#
Phlox subulata	Moss Pink	Tolerant
Polygonatum multiflora	Major Solomon's Seal	Tolerant
Primula sp. VLD	Primrose	Stunting, damage
Sagina subulata VLD		Severe damage
Sidalcea VLD		Severe damage
Spirea filipendula VLD	Spirea	Severe damage
Trollius europeus VLD	Globe flower	Tolerant

(a) D Dormant G Granular L Miscible liquid application

Table III

Reaction of Some Nursery Plants To Sesone and Chloro IPC

Botanical Name	Common Name	Reaction to Herbicide Sesone	Chloro IPC
Cornus florida L[a]	Flowering Dogwood		Buds injured
Ilex crenata convexa LG	Boxleafed Holly		Tolerant (b)
Juniperus chinensis pfitzeriana G	Pfitzer's Juniper		Tolerant (b)
Leucothoe cataesbaei LG	Drooping Leucothoe	Tolerant	Tolerant (b)
Pieris floridunda G	Andromeda		Tolerant
Pieris Japonica LG	Andromeda		Tolerant (b)
Platanus acerifolia L	London Planetree		Tolerant
Prunus laurocerasus G	Cherry Laurel		Tolerant
Rhododendron			
carolinianum LG	Carolina R.	Tolerant	Tolerant
catawbiense LG	Mountain Rose Bay	Tolerant	Tolerant (b)
indicum alba G	Indica azalea		Tolerant
molle G	Mollis azalea		Tolerant
mucronulatum G			Tolerant
obtusum Var. amoenum LG	Kurume azalea	Questionable[c]	Tolerant
Taxus sp. LG	Yews (several var.)	Tolerant	Tolerant (d)
Thuja occidentalis globosa L	Globe Aborvitae		Tolerant
Viburnum carlesii L	Fragrant Viburnum		Buds injured

(a) L liquid G granular

(b) Very young plants mulched with sugar cane. Received considerable overdose of granular in a lath house.

(c) In one large scale test and some small scale tests had severe injury.

(d) One large block of Hicks yews stunted by a September spray.

Defoliants for Roses

A. M. S. Pridham, Cornell University, Ithaca, N. Y.

The present studies deal with the problem of increasing the effectiveness of defoliants at temperatures below 60°F. Earlier reports in this series indicate low activity of apple gas, endothal and other defoliants at temperatures below 70°F.

Laboratory tests have been standardized by using experimental samples of a single compound leaf of Rose Better Times in a pint milk bottle containing 10 cc. of water to maintain turgor and capped to prevent loss of the water. Experimental samples are run in quadruplicate. The leaves are sprayed from a plastic Windex sprayer till they are thoroughly wet with defoliant spray. The leaf or twig is then shaken free of excess moisture and placed in the bottle which is immediately capped and sealed with paraffin. Privet and other shrub samples are of twigs bearing 5 or 10 leaves of mature size but still the full green color of a functioning leaf.

Endothal (4629) was used as a major defoliant. Other chemicals showing defoliant properties were added to a formulation listed as A-6. The additional chemicals included chelated copper and zinc (Antara Chemicals of General Aniline and Film Corp.), the wetting agent Nonic 218 (Sharples) and a formulation 6249 (American Cyanamid Co.). The effectiveness of these chemicals as defoliants at 90°F and at 50°F is illustrated in Table 1. Twigs of privet (*Ligustrum ovalifolium*) were used.

Table 1. Defoliation related to the ingredients of A-6 and expressed as per cent of foliage dropping four days after treatment with 10 replicates of ten leaf twigs of privet (*Ligustrum ovalifolium*) for two temperatures.

Defoliant	50°F	90°F
None	0	0
Endothal 4069 2%	34	55
Chelated Copper 2½%	1	32
Chelated Zinc 2½%	0	8
Chelating Agent 2½%	0	0
Nonic 218 5%	0	20
6249 2%	0	23

The control and chelating agent were without effect on defoliation as measured in this test. Endothal and copper resulted in some defoliation at 50°F. The effectiveness of these defoliants and of the group collectively are shown in Table 2, Section A for privet and Section B for roses (var. Better Times).

Table 2. Defoliation related to two major ingredients of A-6 formulation and of the total formulation for two temperature levels 90°F and 50°F using 10 leaf twigs of Ligustrum ovalifolium in single containers, 4 replicates, Section A, and for leaflet defoliation from compound leaves (4) of Rose Better Times, Section B.

Defoliant	90°F Days 1	2	3	4	50°F Days 1	2	3	4
Section A. Privet								
4069 2%	45	80	80	85	--	--	33	40
" - NACU 2½%	70	80	100	100	--	45	70	93
A-6	25	50	60	90	33	80	90	100
Section B. Roses								
4069 2%	--	--	10	15	--	--	--	--
" - NACU 2½%	--	--	5	5	--	--	--	5
A-6	--	--	20	20	--	--	--	35

The tables indicate again that copper salts modify defoliation stimulating it in both privet and rose at the low temperatures of 50°F. Using all of the selected ingredients which individually influenced defoliation, the group have enhanced defoliation at 50°F.

Outdoor test on potted plants of Rose Better Times

Plants of Rose Better Times were grown in Mennes paper pots of approximately 1 gallon capacity. The plants were watered daily from 5-7 a.m. with florida nozzles operated through a solenoid valve and time clock. The foliage was dry during bright sunshiny weather. In July watering was cut out and the plants allowed to "harden off." Change in growth includes: (1) sparse flowering; (2) relatively thick stiff foliage with (3) little new shoot growth.

Defoliants applied included Endothal 4069 at the rate of 2 gallons of Endothal per 100 gallons of spray mix or 2% mix. Chelated copper 2½% by weight were added both singly to 4069 and as an A-6 group. Defoliation was improved when the A-6 group was used.

In September 10 varieties of roses were treated in normal non-hardened growth. Nonic was reduced from 3% to 1% and chelated zinc and chelated iron were added each 1% by weight. This expanded A-6 group gave prompt defoliation under 50°F-70°F days. The final formulation for field testing for rose defoliation in 1955 was:

Endothal 4069	2% by volume
American Cyanamid 6249	0.1% by weight
Chelated copper	1.0% "
" zinc	1.0% "
" iron	1.0% "
Sharples Nonic 218	3.0% by volume

A-6 formulations under field conditions

Applications were made at Tyler, Texas on November 10 with maximum temperatures in the 70s. Plots of Rose var. Red Radiance were 30 feet long and received 2 quarts of spray (100 gpa). Dr. Eldon Lyle estimated the defoliation 4 days after application to be 80% with the A-6 formulation and 5% with endothal 4069 2%. Where chelates in the formulation were reduced from 1% to 1/10% and Nonic from 3% to 1%, defoliation was correspondingly reduced from 80% to 30%. Final data taken 7 days after treatment indicated 95% and 60% defoliation for the formulations and 10% for Endothal 4069 2%.

The A-6 formulation on Rose Better Times in Arizona during November resulted in a reported 80% defoliation for the formulation vs. no defoliation for Endothal 4069 2%.

References

Pridham, A. M. S. and Robert Hsu. Screening tests of defoliants for nursery stock. Proc. 8th ann. meet. Northeastern Weed Control Conference, 1954.

________________________________. Defoliation of nursery stock with copper salts and endothal. Proc. 8th ann. meeting Northeastern Weed Control Conf. 1954.

Preliminary Tests with Three Additional Materials as Defoliants for Nursery Stock

A. M. S. Pridham, Cornell University, Ithaca, N. Y.

New formulations under number were screen tested in 1956 with poor results and again in 1957 with better results. Later the names Folex and DEF were assigned to these formulations; Folex by Virginia Chemical Company and DEF by Chemagro Company.

Initial comparisons of the defoliant activity of these formulations with Endothal were made using *Ligustrum ovalifolium* and *Rosa dilecta* var. Better Times both in the laboratory and outdoors.

Table 1. Preliminary (1957) evaluation of defoliant activity of DEF and Folex with *Ligustrum ovalifolium* and *Rosa dilecta* var. Better Times, defoliation expressed in per cent from leaf count.

Plant	Endothal 4%	Endothal 2%	Endothal 1%	DEF 4%	DEF .4%	DEF .1%	Folex 4%	Folex .4%	Folex .1%	Control
Laboratory Test										
Ligustrum ovalifolium 80°F	X*	X	100	X	X	0	X	30	10	0
Rose Better Times 80°F	X	X	80	X	90	90	X	70	40	0
Rose Better Times** 45°F	-	65	--	-	70	--	-	55	--	0
Rose Better Times** 53°F	-	75	--	-	75	--	-	90	--	0
Twig Treatment Outdoors										
Ligustrum	72	62	10	½	0	½	0	0	0	0
Rose Better Times	100	85	75	X	-	-	X	65	0	0

*X - tissue injured seriously. All treatments average of 4 replicates.
** - Figures are given for all concentrations tested; - indicates no test.

The 4 per cent composition of the defoliants resulted in injury. Lower concentrations indicate some practical value as defoliants for roses in comparison to Endothal. Little reaction was noted as a defoliant for Ligustrum ovalifolium.

The possibility of combining Folex or DEF with Endothal was studied. The results are shown in Table 2.

Table 2. Defoliation resulting from Endothal, Folex, or DEF independently and in combination with Endothal. All defoliants used at a range of concentrations. Defoliation stated as per cent and based on average count of four replicates.

		Folex			DEF		
Endothal	0	1/8%	1/4%	1/2%	1/8%	1/4%	1/2%
Rose Better Times							
0		80*	75	45	65*	100	95
1/8%	30*	40**	55	25	70***	70	70
1/4%	65	75	70	75	75	65	80
1/2%	55	90	85	70	60	70	75
1%	67	30	25	70	50	60	75
Ligustrum - 4 replicates, 6 leaf twigs, maximum 24"							
0	0	0*	0	0	0*	0	0
1/8%	12*	16**	16	32	0***	12	32
1/4%	44	76	76	72	32	28	0
1/2%	54	68	64	80	81	68	88
1%	90	60	80	64	100	100	100

* - Single component

** - Endothal and Folex

*** - Endothal and DEF

In the case of Rose Better Times, DEF and Folex are equally effective as Endothal for defoliation within the range of concentrations used. Combination of DEF or of Folex with Endothal does not seem to be advantageous except with defoliation of privet.

Table 3. Comparison of defoliants alone and in combination used on single rose plants of Better Times variety under field conditions. Defoliation recorded as per cent on estimate rather than leaf count.

	Folex				DEF		
Endothal	0	1/8%	1/4%	1/2%	1/8%	1/4%	1/2%
0	2	5*	5	10	3*	1	0
1/8%	10*	10**	4	10	5***	6	6
1/4%	20	4	10	5	6	5	20
1/2%	17	4	75	80	40	10	80
1%	5	15	10	94	85	15	10

* Single component

** Endothal and Folex

*** Endothal and DEF

Under field conditions Folex and DEF at low concentrations show additive effect with Endothal but only when the Endothal level approaches that used for defoliation purposes.

Field trials in nurseries were made in October and November. The following crops responded.

Hydrangea hortense	1-2% Folex or DEF. Regrowth normal.
Rose varieties (30)	2% Folex with or without copper added. Requires two weeks. Regrowth normal.
Forsythia	A-6 or Folex with copper. Requires 3 weeks.
Peach	Folex 1-2% - DEF 1-2%. Regrowth doubtful though no obvious injury.
Chinese chestnut (Castanea mollissima)	Folex 2%; DEF 2% defoliant

The following plants reacted satisfactorily for defoliant purposes during the fall of 1957:

Acer platanoides

Acer rubrum

Berberis thunbergii

Philadelphus hort.

Rosa rugosa

Syringa vulgaris var. hort.

Viburnum opulus

Viburnum tomentosum

Cornus florida

Lonicera japonica halliana

Lonicera fragrantissima

The prompt defoliation in Lonicera japonica halliana offers special interest.

Table 4. Defoliation resulting from the use of DEF or of Folex with A-6 mixes used on single plants of Rose var. Better Times under field conditions. Data taken on August 9.

Endothal 1%	60%
Folex 1%	50%
A-6	70% injury
A-6 + Folex 1%	75% "
*A-6 + Folex ½%	95%

* Mean value 3 replicates

The use of Folex or DEF with Endothal and copper, etc. of the A-6 mix is not detrimental when used under summer conditions.

The third defoliant tested was compound under number from Vero Beach Laboratories. This was tested only under greenhouse conditions with Better Times Roses. Defoliation was equivalent to 1% Endothal. Some indication of delayed budbreak and abnormal flowering has been noted. Its behavior is similar to 6249 of American Cyanamid but its value as an additive or defoliant per se is not established for nursery crops.

PRE-EMERGENCE CONTROL OF GOOSEGRASS IN TURF AREAS

J. R. Fulwider and R. E. Engel[1]

Goosegrass, Eluesine indica, is a widely distributed annual weed which increases readily in heavily used turf grass areas. Its presence on some areas such as golf greens virtually destroyed their play ability. Little is known about goosegrass except through experience, a few semi-technical articles and a preliminary report of pre-emergence control of goosegrass by Engel and Aldrich at the 1955 Northeastern Weed Control Conference.

Materials and Methods

Pre-emergence treatments were conducted on a turf area which contained a mixture of Kentucky bluegrass, colonial and creeping bentgrasses. These grasses had been maintained for the past few years at 3/4 inch cut. The experimental design was a randomized block with three replications. Each plot was three by five feet, with one foot border between plots. The test area was severely scarified with a Verticut machine, and seeded on June 5, 1957 to goosegrass. Eleven chemicals with different rates and combinations were applied to this area on June 8, 1957. All spray applications were made with 100 gallons of water per acre using a bicycle sprayer. The dry materials were spread by a lawn type fertilizer spreader.

Chemicals and rates of application applied are listed below:

Material	Abbreviation of chemical	Rates per acre*
Phenyl mercuric acetate	PMA	7
2,4-dichlorophenoxyacetic acid, alkanolamine salt	2,4-D	**
Arsenate of lead		653
Sodium 2,4-dichlorophenoxyethyl benzoate	Sesin	3
2-chloro-N,N-diallyacetamide	CDAA	3 & 6
Ethyl N,N-di-n-propylthiocarbamate	EPTC	1½, 3 & 6
2-chloro-4,6-bis (ethylamino)-s-triazine	Simazin	½ & 1
Chlorodane		60
1-n-butyl-3-(3,4-dichlorophenyl)-1-methylurea	Neburon	2 & 4
2,3,6-trichlorobenzoic acid	TBA	**
Sodium 2,3-dichloroisobutyrate	FW-450	5

*The PMA rate is given in pints of 10% active. All other materials are listed on a pounds per acre of active material basis.
**2,4-D was used only in conjunction with one of the PMA treatments at a rate of 1/2 lb./acre. TBA was used alone at 2 lbs./A

PMA with and without 2,4-D, neburon, sesin, TBA, and FW-450 were applied as a spray. Arsenate of lead, CDAA, EPTC and chlordane were applied with clay as a carrier. Simazin and the combination of CDAA and TBA were impregnated on vermiculite.

The PMA treatment and the PMA plus 2,4-D were repeated after a three week interval. The neburon treatment was repeated after six weeks. All other treatments received only the initial treatment.

Results and Discussion

The pre-emergence control of goosegrass obtained with dry applications of chlorodane in this experiment was consistently superior to that obtained with other chemicals. Also, the chlorodane plots were in the group which showed no turf grass injury.

The arsenate of lead, sesin, and neburon showed some pre-emergence control. The value of the latter treatment was reduced by turfgrass injury.

PMA, PMA plus 2,4-D, CDAA at both rates, CDAA and TBA combination, and FW-450 did not give any damaging effects on the turf, but they did not show good pre-emergence control.

A large number of goosegrass plants were found in the EPTC treatments at all rates, simazin at the 1/2 lb./acre rate, and neburon at the high rate, as compared with the check plots. It was believed that the injury to the turf was sufficient in these cases to encourage growth of the goosegrass.

The simazin treatment at the one pound per acre rate controlled goosegrass germination, but also killed practically all of the turf grass population. Also TBA severely injured the turf grasses.

Summary and Conclusions

1. Chlorodane gave highly satisfactory control of goosegrass when used as a pre-emergence treatment. Before a general recommendation can be made for chlorodane, more results on season and rate of application should be obtained.

2. All rates of EPTC, simazin, neburon at 4 pounds per acre, and TBA were too injurious to the turf grass to give satisfactory pre-emergence treatments.

3. Maintaining a good dense turf sod is very helpful in controlling germination and growth of goosegrass as was shown by comparision of treatments which did and did not produce severe turf grass injury.

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FOUR YEARS OF HERBICIDAL TREATMENT OF *POA ANNUA* IN BENTGRASS TURF

Ralph E. Engel[1]

Herbicidal control of *Poa annua* in bentgrass fairways was reported as promising in the 1955 Proceedings of the Northeastern Weed Control Conference. One series of the treatments was continued through 1957 and some of the results are given in this report.

Procedure

Treatments of maleic hydrazide (1 lb./acre), sodium arsenite (1 lb./acre) plus 2,4-D (1/4 lb./acre), and disodium-3,6-endoxohexahydrophthalic acid (endothal) (1/2 lb./acre) were made during the spring of 1954 on bentgrass fairway turf.[2] These were continued through the spring of 1957 with the exception of maleic hydrazide which was discontinued earlier because of turf damage and the associated clover invasion.

All chemicals were applied in 40 gallons of water per acre on plots 30 feet wide which extended across the width of the fairway. All treatments were applied three times per season in 1954 and 1955, and twice per season in 1956 and 1957. The treatment dates for the four seasons ranged from March 25 to May 19.

The effect of the treatments were determined by use of the point quadrat to measure plant composition of the turf cover in 1954 and 1957.

Results and Discussion

At the close of the first season, the endothal and sodium arsenite plus 2,4-D treatments showed 37 and 15 percent more bentgrass, respectively, than the check. Both treatments showed 37 and 33 percent less *Poa annua*, respectively, than the check. At the close of the 1957 season, the bentgrass content of the endothal and sodium arsenite plus 2,4-D plots had increased to 55 and 28 percent greater, respectively, than the check plots. Also, both treatments had produced a further decrease in the *Poa annua* content to 62 and 40 percent, respectively, as compared with the check. The early spring treatment with endothal produced moderate temporary discoloration while the sodium arsenite treatment produced only slight discoloration. The loss of color in the endothal plots was slight on bentgrass and more severe on *Poa annua*.

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[2]

The maleic hydrazide treatment continued to damage the turf seriously during the second and third years which made it necessary to discontinue the treatment. While this chemical had marked ability to stop flowering of Poa annua, it suppressed the bentgrass to the extent that clover made very heavy invasions.

Conclusions

Endothal as an early spring turfgrass treatment produced a marked decrease in Poa annua and a corresponding increase in bentgrass during the first season. The differences were even more marked at the end of four seasons of treatment. Also, the endothal treatment showed excellent clover control. It produced only moderate discoloration of the bentgrass but was more severe on Poa annua. The use of endothal should be confined to areas that have enough bentgrass to replace the Poa annua.

While sodium arsenite at a rate of one pound per acre plus 2,4-D was not as effective as the endothal treatment, measurable suppression of Poa annua and increases of bentgrass were obtained. Discoloration obtained with this early spring treatment was slight.

Experience obtained in this study showed the necessity for herbicide treatments that do not interfere seriously with the vigor of the desired grasses. Also, early spring proved to be a reliable and safe season for chemical treatment.

Selective Control of Veronica filiformis in Turf

Robert G. Mower and John F. Cornman*

Veronica filiformis, an escaped rock garden plant native to southern Europe, has become a serious lawn problem in many of the more populous counties of upstate New York. There are also unconfirmed reports of its presence as a lawn weed in eastern Pennsylvania and near Baltimore, Md.

Veronica filiformis spreads by small filamentous runners and is first noticed as small dense patches that rapidly enlarge, crowding out existing turf grasses, until an entire area may be solid veronica.

This paper reports the work of the past season on the control of this lawn weed. Reports by Jagschitz and Cornman (1) of work in 1954 indicated the promising aspects of endothal as a selective chemical for the control of *Veronica filiformis*. At that time none of the herbicides conveniently available to home owners for the selective control of broadleaved weeds were very effective against *Veronica filiformis*. Several new herbicides have appeared on the home market since then and any promising ones of these, along with endothal were considered worthy of further investigation to help solve this pressing practical problem.

Field screening tests of a number of chemicals for *Veronica filiformis* control began in May 1957 on a Kentucky bluegrass-red fescue-creeping bent lawn near Ithaca, N. Y. A nearly uniform stand of Veronica filiformis occupied 75-85% of the test area. The chemicals and formulations used were:

1. 2,4-D (Propylene glycol butyl ether esters 70.5%), ("Dow Esteron 10-10" 4# acid equivalent/gal., Dow Chemical Co., Midland Division, Midland, Mich.
2. 2,4-D (Alkanolamine salts of 2,4-D acid 23.8%) (Dow Home Use Weed Killer, 2,4-D, 14% acid equivalent).
3. 2,4,5-T (Propylene glycol butyl ether esters 65.3%) ("Dow Esteron 245", 4# acid equivalent/gal.)
4. 2,4,5-T (Butoxy ethanol ester 17.3%) ("Weedone Clover Killer", 1# acid equivalent/gal., American Chemical Paint Co., Ambler, Pa.
5. 2,4,5-T (Butoxy ethanol ester 10.8%, 2/3# acid equivalent/gal.) plus 2,4-D (Butoxy ethanol ester 22.6%, 1-1/3# acid equivalent/gal.) ("Weedone Brusher Killer 32")
6. Kuron 2(2,4,5-trichlorophenoxy) propionic acid (Propylene glycol butyl ether esters 64.5%) ("Dow Brush Killer", 4# acid equivalent/gal.)
7. Enthodal (Disodium 3,6-endoxohexahydrophthalic acid 19%) ("Endothal-Turf Herbicide",2# acid equivalent/gal. Pennsylvania Salt Manufacturing Co., Tacoma, Wash.
8. Neburon 1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl-urea 18.5% (DuPont Crabgrass and Chickweed Prevent, E. I. DuPont, DeNemours and Co., Grasselli Chemical Dept., Wilmington, Dela.

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9. Dalapon (2,2,dichloropropionic acid-sodium salt 85%) (Dow)

10. Sodium arsenite (Sodium arsenite 42.5%) (Arsenic trioxide 4# acid equivalent/gal., Acme Weed Killer, Acme Quality Paint Inc., Detroit, Mich.)

11. Disodium monomethyl arsonate 40% plus sodium 2,4-dichlorophenoxyacetate 16% (Artox Lawn Weed Killer, Nott Manufacturing Co., Mt. Vernon, N. Y.)

Twenty three treatments were made on May 4, 1957. The materials were applied as sprays to non-replicated plots, measuring 4 x 25 feet, using a small plot sprayer. Pressure was supplied by CO_2 at 30 psi to 4 fantype Tee Jet nozzles on a hand boom. Each chemical was applied in water at the rate of 100 gallons to the acre.

The temperature at time of treatment was in the middle 60's and the soil was moist. The veronica was in flower and growing vigorously. The area was cut with a rotary type mower with a mulcher attachment at the height of $1\frac{1}{2}$" one day prior to treatment and clippings were not removed.

The materials used, rates of application, and dates on which grass discoloration and veronica control estimates were made are shown in Table I.

An additional fifteen treatments were applied on June 8, 1957. The environmental conditions were essentially like those on May 4 except that the veronica plants were no longer in flower. The data concerning these trials are shown in Table II.

Results of Screening Tests

From the data in Tables I and II it is apparent that the 2,4-D and 2,4,5-T formulations used in these trials (treatments 1 through 5) had little or no effect on Veronica filiformis. Such minor control as did occur was only temporary. The disodium methyl arsonate plus 2,4-D combination (7) also was not effective. As might be expected, Dalapon (treatment 10) was very effective in destroying grass, but had no apparent effect on the veronica. Both Kuron and Neburon (treatments 6 and 12) have shown some promise for the control of chickweeds and similar weeds but in these trials neither showed enough promise for further consideration of veronica control. Only sodium arsenite and endothal gave any real and lasting measure of veronica control. Admittedly, the higher rates of sodium arsenite were beyond the range normally used for selective weed control but the lightest rate of 2 pounds to the acre (about 3/4 oz. to 1,000 square feet) damaged the turf severely even under the favorable climatic conditions prevailing during the experimental period. Lighter rates of sodium arsenite in repeated applications might have value in controlling veronica, as they are in experienced hands for controlling other broadleaved weeds, but the narrow safety margin and the toxicity of the materials rules sodium arsenite out when safer and more selective materials are at hand.

The endothal treatments (8 and 9) gave really selective control of veronica. With our favorable weather conditions for selective weed control, the endothal caused little or no damage to the grasses. For these particular plots a turf injury rating on our 0-4 scale was impossible because the grasses were so sparse and uniformly distributed. However, it was apparent that any turf injury was very minor for the plots appeared green from a distance as

Table I. Veronica filiformis control in lawn turf. Exploratory trials.

Sprayed May 4, 1957 at 100 gallons per acre rate
Plots 4 x 25 feet, unreplicated

Material	Rate in pounds of active ingredient per acre	Grass discoloration 5/11	5/30	8/30	% veronica control 5/11	5/30	8/30
1. 2,4,5-T	½	0	0	0	0	6.3	0
propylene glycol	1	0	0	0	0	6.3	0
butyl ether esters	2	0	0	0	6.3	12.5	0
	4	0	0	0	12.5	12.5	0
2. 2,4,5-T	½	0	0	0	0	0	0
butoxy ethanol	1	0	0	0	6.3	6.3	0
ester	2	0	0	0	6.3	6.3	0
3. 2,4-D	½	0	0	0	0	0	0
propylene glycol	1	0	0	0	0	0	0
butyl ether esters	2	0	0	0	0	0	0
4, 2,4-D	½	0	0	0	0	0	0
alkanolamine	1	0	0	0	0	0	0
salts	2	0	0	0	0	0	0
5. 2,4,5-T +	½	0	0	0	0	0	0
2,4-D butoxy	1	0	0	0	0	0	0
ethanol esters	2	0	0	0	6.3	12.5	0
6. Kuron	½	0	0	0	0	0	0
	1	0	0	0	0	0	0
	2	0	0	0	6.3	12.5	0
	3	0	0	0	6.3	12.5	0
	4	0	0	0	6.3	12.5	0
7. Disodium	8 DSMA	-	-	-	0	0	0
monomethyl arsonate	16 DSMA	-	-	-	0	0	0
(+ 2,4-D)							

Grass discoloration estimates: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete browning. The symbol - indicates little or no discoloration of grasses but impossible to estimate because of uniform, sparse stand.

% veronica control calculated on basis of average area covered by veronica foliage in adjacent untreated areas at the time of estimating.

Table II. Veronica filiformis control in lawn turf. Exploratory trials.

Sprayed June 8, 1957 at 100 gallons per acre rate
Plots 4 x 25 feet, unreplicated

Material	Rate in pounds of active ingredient per acre	Grass discoloration 6/15	Grass discoloration 7/10	Grass discoloration 9/11	% veronica control 6/15	% veronica control 7/10	% veronica control 9/11
8. Endothal	½	-	-	-	50.0	75.0	62.5
with	1	-	-	-	92.5	92.5	82.5
activator	2	-	-	-	92.5	92.5	87.5
9. Endothal	½	-	-	-	50.0	75.0	50.0
without	1	-	-	-	90.0	90.0	87.5
activator	2	-	-	-	90.0	87.5	87.5
10. Dalapon	1	Selectively removed			0	0	0
	2½	all turf grasses			0	0	0
	5	from area			0	0	0
11. Sodium	2	3.5	3.0	3.0	92.5	92.5	97.5
arsenite	4	4.0	4.0	4.0	100.0	100.0	100.0
	8	4.0	4.0	4.0	100.0	100.0	100.0
	16	4.0	4.0	4.0	100.0	100.0	100.0
12. Neburon	5	0	0	0	0	0	0
	10	0	0	0	0	0	0

Grass discoloration estimates: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete browning. The symbol - indicates little or no discoloration of grasses but impossible to estimate accurately because of uniform sparse stand.

% veronica control calculated on basis of average area covered by veronica foliage in adjacent untreated areas at the time of estimating.

Rates of Endothal and Volumes of Spray

To determine the rate of endothal and gallonage of water for the maximum control of veronica with the least turf discoloration, nine treatments were applied on July 10, 1957. Endothal at rates of ½, 1, and 2 pounds of active ingredient was applied in 25, 50, and 100 gallons of water to the acre. Plots were 4 x 15 feet, replicated three times in a complete randomized block design. Three plots served as controls.

Two days before treatment the area was cut with a rotary mower with mulching attachment at 1½" height of cut. The clippings were not removed.* Adequate rainfall for good turf growth continued during July. The materials were applied with a small plot sprayer. Pressure was supplied by CO_2 at 30 psi to 4 fantype Tee Jet nozzles on a hand boom. Nozzles were changed for different gallonages. Two passes were made over each plot for uniform coverage. This procedure was used in all subsequent experiments unless otherwise noted.

*At the time of treatment the temperature was in the high 60's and the soil was moist.

Turf discoloration and veronica estimates were made on July 15, 30, and September 23, 1957. These data appear in Table III. Veronica estimates were based on reduction in area covered by veronica leaves from the amount present prior to treatment in the individual plots. As noted in the tables, seasonal changes observed in the check plots were minor.

From the data in Table III it appears that 25 gallons of spray to the acre was inadequate to give coverage. The two higher gallonages produced better veronica control at each rate of endothal without any important increase in grass discoloration. The results from different rates of endothal at each gallonage indicate that the ½ pound rate gave considerably poorer veronica control than the others. The two higher rates gave similar degrees of control for each of the higher gallonages, but the 1 pound rate produced much less severe grass discoloration than the 2 pound rate. Thus of the various combinations, a rate of 1 pound endothal in 50 or 100 gallons of water to the acre produced the most desirable combination of veronica control and degree of grass discoloration.

Table III. Veronica *filiformis* control in lawn turf. Endothal rates vs. gallonage.
Sprayed July 10, 1957. Plots 4 x 15 feet; complete randomized block, in triplicate.

Rates of active ingredient #/A	Gallon-age/A	Average Grass discoloration			Average % veronica control		
		7/15	7/30	9/23	7/15	7/30	9/23
½	25	1.0	.25	0	30.0	25.0	42.5
	50	.8	.25	0	45.0	70.0	70.0
	100	1.3	.25	0	75.0	75.0	62.5
1	25	1.5	1.2	0	67.5	75.0	70.0
	50	1.2	.9	0	67.5	72.5	80.0
	100	1.5	.9	0	82.5	85.0	85.0
2	25	2.0	1.7	0	57.5	67.5	67.5
	50	2.3	1.8	0	80.0	87.5	77.5
	100	2.5	1.5	0	87.5	90.0	87.5
% veronica in check plots	7/10 - 70				75.0	73.0	70.0

Grass discoloration estimates: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete browning.

% veronica control calculated on the basis of average amounts present in each plot prior to treatment. Note negligible seasonal changes in check plots.

Repeated Endothal Sprays

It appeared that in the single application treatments the major problem was one of wetting all veronica plants with the spray, for such veronica as did survive appeared not as a uniformly distributed, thinner stand but as isolated spots and patches. Thus another trial was made to study the effectiveness of two and three successive applications of endothal.

Eight treatments in a randomized block design were applied on July 10, 1957. Endothal was used at rates of ½, 1, 1½, and 2 pounds in 50 and 100 gallons of water to the acre. Individual plots measured 4 x 45 feet. One plot served as a check.

Several days prior to each treatment the area was mowed at 1½". Clippings were not removed. At the time of the first treatment the temperature was in the middle 70's and the soil was moist. Showers occurred the following day and there was adequate moisture for good turf growth throughout July. Turf discoloration estimates and veronica control estimates were made on July 15, July 30, September 23, and November 18, 1957.

A second application was made to two-thirds of the plot area on July 31, 1957 using the same rates as those of the first treatments. At the time of this treatment the temperature was in the high 70's and the soil was moist. August was a relatively dry month and turf growth rather slow. Turf discoloration readings and veronica estimates were made on August 8, September 23, and November 18, 1957.

A planned third application was not made to any of the plots since excellent control was obtained with the first two treatments. The results of these tests are shown in Table IV.

The data in Table IV indicate that the ½ pound per acre rate of endothal was inadequate for veronica control even with two successive applications. Two applications at the three higher rates produced complete veronica control under our conditions without lasting turf grass discoloration. While the 1 pound rate of endothal produced somewhat less initial control than the two heavier rates, the control after the second application was as complete.

Combinations of Endothal and 2,4-D

Endothal was observed not to control other broadleaved weeds in the test area and often, although the veronica was selectively removed, other weeds became so prominent that poor looking turf still remained. To determine if endothal and 2,4-D together would act independently or whether the presence of one would increase or decrease the effect of the other on other broadleaved weeds and turf, a series of plots was sprayed on July 26, 1957. Nine treatments, replicated three times in a complete randomized block, included endothal at the rates of ½, 1, and 2 pounds to the acre and endothal at the ½, 1, and 2 pound rates plus 2,4-D (propylene glycol butyl ether esters) at the rate of ½ and 1 pound to the acre. All sprays were at the rate of 100 gallons to the acre. Individual plots measured 4 x 15 feet.

Table IV Veronica filiformis control with repeated endothal sprays.
Sprays applied July 10 and July 31, 1957
Plots 4 x 45 feet; randomized block design, unreplicated.

tes of tive in- edients #/A	Gallon- age of water/A	Average Grass discoloration							Average % veronica control						
		1 application				2 applications			1 application				2 applications		
		7/15	7/30	9/23	11/18	8/6	9/23	11/18	7/15	7/30	9/23	11/18	8/6	9/23	11/18
½	50	1.5	0.5	0	0	1.5	0	0	37.5	75.9	75.0	62.5	92.5	87.5	75.0
	100	1.0	0.25	0	0	1.5	0	0	37.5	75.0	75.0	57.5	100.0	92.5	92.5
1	50	1.5	1.0	0	0	2.0	0	0	62.5	87.5	62.5	57.5	100.0	100.0	100.0
	100	1.5	0.5	0	0	2.5	0	0	62.5	75.0	62.5	62.5	100.0	100.0	100.0
1½	50	2.0	1.5	0	0	2.0	0	0	75.0	75.0	62.5	62.5	100.0	100.0	100.0
	100	2.0	1.5	0	0	2.0	0	0	87.5	87.5	75.0	62.5	100.0	100.0	100.0
2	50	3.0	1.5	0	0	2.0	0	0	87.5	75.0	87.5	75.0	100.0	100.0	100.0
	100	2.5	2.0	0	0	2.0	0	0	87.5	92.5	75.0	75.0	100.0	100.0	100.0
veronica in check (75 at start)									70.0	75.0	80.0	70.0	75.0	80.0	75.0

ass discoloration estimates: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete browning.

veronica control calculated on the basis of average amounts present in each plot prior to treatment.
(Note negligible seasonal changes in check plots.)

At time of treatment the temperature was in the low 70's and the soil was moist. During August there was a period of low rainfall and turf growth was slow.

Turf discoloration estimates and estimates of veronica and broadleaf weed control were made on August 3, 19, and September 23, 1957.

Estimates of broadleaf weed control were based on the reduction of dandelions and the two plantains (narrow and broadleaved) present in plots prior to treatment.

Table V. *Veronica filiformis*, dandelion and plantain control with endothal-2,4-D combinations.
Sprayed July 26, 1957.
Plots 4 x 15 feet; complete randomized block, in triplicate

Pounds of active ingredient/A		Average Grass discoloration			Average % Dandelion and Plantain Control			Average % Veronica control		
Endothal	2,4-D	8/3	8/19	9/23	8/3	8/19	9/23	8/3	8/19	9/23
½	-	1.0	0.5	0	0	0	0	65	68	55
½	½	1.2	0.7	0	25	75	76*	68	65	43
½	1	1.0	0.5	0	57	96	100	80	83	63
1	-	1.3	1.0	0	0	0	0	90	90	83
1	½	1.3	0.8	0	34	82	87	88	93	78
1	1	1.5	0.5	0	40	86	93	85	80	75
2	-	2.0	1.2	0	0	0	0	90	98	83
2	½	2.0	1.1	0	43	82	90	90	93	83
2	1	1.7	1.6	0	60	78	100	90	95	90
% veronica in check plots at start - 75%								70	75	70

* New seedling dandelion and plantain not included.

Grass discoloration estimates: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete browning.

% veronica control calculated on the basis of average amounts present in each plot prior to treatment. (Note negligible seasonal changes in check plots.)

From the data in Table V it appears that with a given rate of endothal veronica control was nearly the same, whether or not 2,4-D had been included. Also, a given rate of 2,4-D was about as effective in controlling dandelions and plantain with or without the endothal included. Grass discoloration was about the same after any comparable applications.

Summary and Conclusions

From the data presented it appears that, of the materials tested, only endothal shows real promise for the selective control of Veronica filiformis in lawn turf. Single applications of endothal were inadequate but rates of 1 pound per acre and up in two successive applications did provide complete veronica control. The addition of 2,4-D to the endothal produced nearly complete control of dandelions and plantains without interfering with the degree of veronica control or affecting the degree of turf injury. Apparently two successive applications of endothal at the rate of 1 pound active ingredient in 50 to 100 gallons of water, with or without 2,4-D, will completely control Veronica filiformis with only slight to moderate grass discoloration.

Other work carried out this past season and not presented in this paper indicates that endothal may produce rather severe injury to bentgrass (Agrostis sp.) or Poa trivialis. These are commonly found associated with veronica in shaded moist situations. More trials will be carried out to observe effects on individual grass species. Work with other formulations of endothal, including a 2% granular material, also shows promise of giving excellent control with a minimum of turf injury.

Because of the complete inadequacy of materials now available to home owners for selective weed control, and in spite of lack of complete knowledge of some phases of the problem, it is expected that endothal will be recommended for the control of Veronica filiformis in New York lawns during the coming year. It is understood that formulations of endothal will soon be marketed for use by home owners.

Literature Cited

1. Jagschitz, J. A. and J. F. Cornman. Studies in the control of Veronica filiformis in turf using KOCN, endothal, 2,4-D and 2,4,5-T. Proc. Northeastern Weed Control Conf. 1955: pp 365-369.

CHICKWEED CONTROL TEST 1956-57

John E. Gallagher and Charles C. Jack

During the month of November and December of 1956 nineteen materials were applied to annual chickweed (Stellaria media) and to sixteen common turfgrasses. Based on these results, seven materials at two rates were applied to perennial (mouse ear) chickweed (Cerastium vulgatum) in the month of May, 1957. Control figures for annual chickweed were derived from the per cent plant cover before and after treatments, and on counts of perennial chickweed plants before and after treatment.

Materials and Rates:

The choice of materials and rates was influenced by the report of work done in Missouri by Hogard and Hemphill.[1] 2,4,5-TP was then reported as producing 100% control of annual chickweed at 1.5 lb/A. Materials and rates used for control of annual chickweed and applied to the turf grass species were: KOCN, KOCN + MCP and DMA at 8 lb/A; trichloro iso butyric acid, dichloro iso butyric acid and Simazin at 4 and 8 lb/A; 2,4,5-T, 2,4,5-TP, 2,4-DP, and MCPP at 1.5 lb/A; CIPC, DNBP and sodium arsenite at 1 lb/A; trichloro benzoic acid, and Neburon at 2 lb/A; monuron at ½ lb/A; Alanap 1F at 720 lb/A; ammonium sulfate at 1 lb/100 sq. ft.

These materials were used for the control of perennial chickweed: 2,4,5-TP, 2,4-DP and MCPP at 1 and 1.5 lb/A; Neburon at 1 and 2 lb/A; sodium arsenite at 1 lb/A; KOCN, and KOCN + MCP at 8 and 16 lb/A.

All materials except Alanap 1F were applied with 200 gallon of water per acre.

Plot Design:

The plot area for the annual chickweed series were set out in an abandoned corn field. Three reps were laid out in a randomized pattern to allow the first rep to receive a single application, the second rep to receive two treatments, and the third rep to receive three treatments. At the same time, single 18" bands were sprayed across 10' strips of the following turfgrasses: Chewings, Illahee, Kentucky 31 and Meadow fescue; Seaside, Astoria and Highland bentgrass; Kentucky, Merion, Roughstalk (Poa trivialis), and annual blue grass; Perennial ryegrass, Timothy, and dormant U-3 Bermuda grass and Meyer Zoysia grass. Two treatments were applied to the turfgrass species.

Treatment Dates:

Annual chickweed - 11/23, 12/6, 12/20/56
Turfgrass strips - 11/29, 12/27/56
Perennial chickweed - 5/11, 5/29/57

Observation Dates:

Annual chickweed and turfgrass - 4/22/57
Perennial chickweed - 8/1/57

Observations:

Annual Chickweed Control

Materials and rates that produced 100% control

1 Application	2 Applications	3 Applications
2,4,5-TP 1.5 lb/A	2,4,5-TP 1.5 lb/A	2,4,5-TP 1.5 lb/A
Neburon 2 lb/A	Neburon 2 lb/A	Neburon 2 lb/A
Simazin 4 & 8 lb/A	Simazin 4 & 8 lb/A	Simazin 4 & 8 lb/A
KOCN + MCP 8 lb/A	Emid 6 lb/A	Emid 6 lb/A
DMA 8 lb/A	TBA 2 lb/A	CIPC 1 lb/A
	CIPC 1 lb/A	DNBP 1 lb/A
	Sodium arsenite 1 lb/A	2,4-DP 1.5 lb/A
	2,4-DP 1.5 lb/A	MCPP 1.5 lb/A
	MCPP 1.5 lb/A	Alanap 1F 720 lb/A

Perennial Chickweed Control

Materials and rates that produced 100% control

1 Application	2 Applications
2,4,5-TP 1.5 lb/A	2,4,5-TP 1 & 1.5 lb/A
MCPP 1 & 2 lb/A	2,4-DP 1.5 lb/A
	MCPP 1.5 lb/A
	KOCN + MCP 16 lb/A

Turfgrass Control

All materials applied to turfgrasses during November and December produced no discoloration or injury except Simazin and CIPC. Simazin at both rates killed all cool-season turfgrasses. A July application of 2,4,5-TP at 1.5 lb/A in 15 gallons of water per acre produced only slight discoloration to bentgrass species. CIPC produced a general thinning of all cool-season turfgrasses.

In the annual chickweed test, all other materials except KOCN and iso butyric formulations produced control of 90% or better with three applications. In the perennial chickweed test, all other materials except KOCN at 8 lb/A and Neburon at 1 lb/A produced 90% control or better with two applications.

Summary:

Tests conducted during 1956-57 for the control of annual and perennial chickweed species compared nineteen different chemicals at one and/or two rates. Control was recorded either as reduction in total plot cover or plant survival based on plant counts. Turfgrass response was recorded for sixteen different species.

In the annual chickweed series 2,4,5-TP at 1.5 lb/A, Neburon at 2 lb/A and Simazin at 4 and 8 lb/A produced 100% control regardless of number of applications. In the perennial chickweed series 2,4,5-TP at 1.5 lb/A, and MCPP at 1.5 lb/A produced 100% control with one and two applications. Simazin at both rates 4 and 8 lb/A killed all cool-season turfgrasses and CIPC at 1 lb/A produced a general thinning of all cool-season grasses.

[1]Hogard, T. W. and Hemphill, D. D. - (1956) Spring Control of Chickweed in Lawns. Thirteenth Annual Meeting of the NCWW. P. 129.

Contribution: American Chemical Paint Company
Agricultural Research Department

CONTROLLING WILD TURNIP (BRASSICA RAPA) IN SEEDLING ALFALFA[1/]

By Paul W. Santelmann and John A. Meade[2/]

During the winter of 1956-57 wild turnip (Brassica rapa), a very close relative of field mustard (Brassica campestras), severely infested many seedling alfalfa fields in central and north central Maryland. The weed appeared in September and early October very soon after the alfalfa had been seeded in the late summer. The wild turnip proceeded to make a rapid growth and to develop large turnip-like roots. In many instances by November or December they had formed an almost complete mat of foliage over the field and the seedling alfalfa was not visible. In almost all instances the farmers when asked about the fields stated that they had never seen the weed in that field before. Apparently the seed had been in the soil for some period of time, and some combination of climatic conditions had caused it to germinate. However, the actual cause of the widespread infestation of this weed is not known. Many of the fields were seeded with certified alfalfa, and thus the wild turnip very likely could not have come in with the seed. This situation has also occurred during this present winter with many fields outside the area of original infestation having wild turnip this year. There have been no corresponding increases in infestation of field mustard or of yellow rocket (Barbarea vulgaris) at this same time.

PROCEDURE

During the winter of 1956-57 plots were established at two locations in central and north central Maryland in seedling alfalfa fields in an attempt to discover what chemicals could be used to control the wild turnip without injuring the alfalfa. In all instances 6 by 23 foot plots, replicated three times, were used. The alfalfa had been seeded in late August or early September and was in the seedling stage. At the time of treatment in the fall the wild turnip was 10 to 12 inches high with roots of 1/2 to 1 inch thick. The chemicals were applied in 30 gallons of water per acre with a bicycle type experimental plot sprayer.

The chemicals used were:

2,4-DB: 4-(2,4-dichlorophenoxy) butyric acid, dimethyl amine form.
MCPB: 4-(2 methyl-4 chlorophenoxy) butyric acid, dimethyl amine form.
2,4-D: 2,4-dichlorophenoxy acetic acid, alkanol amine form.
MCP; 2 methyl, 4 chlorophenoxy acetic acid, alkanol amine form.
DNBP; dinitro ortho secondary butyl phenol, alkanol amine form.

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The dates of treatment and the air temperature at the time of treatment were as follows:

Gaithersburg - early treatment - November 11, 1956 - 70° F.
Gaithersburg - late treatment - March 14, 1956 - 60° F.
Bel Air - November 7, 1957 - 65° F.

In all instances the soil moisture at the time of treatment was adequate.

Stand counts were made in early July of the summer following treatment (1957). Unfortunately, yields could not be taken.

RESULTS AND DISCUSSION

The results of these experiments are given in tables 1 and 2. In both instances where the early treatment was used (November), the phenoxy compounds had little effect for at least one month after treatment. However, by the time three months had passed, in most instances there was a very noticeable decrease in the stand of wild turnip. Dinitro caused an initial early killing of the leaves. However, within a few months new leaves had been produced at the crown of the turnip plants, and by the end of the season there appeared to be only slight control with dinitro.

With regard to the control of wild turnip as observed the following May, it appeared that both November treatments resulted in good control of turnip when the phenoxy type compounds were used. 2,4-D and MCP resulted in good control regardless of the rate of chemical used (1/4 and 1/2 pound per acre). The butyric compounds also controlled the turnip except for the one pound rate of 2,4-DB at one location. The March treatment at one location did not result in as satisfactory control of wild turnip as that of the November treatments. Here again the 2,4-D and MCP treatments resulted in good control, but the butyric compounds were not quite as satisfactory.

The various early treatments at Gaithersburg caused no significant differences in alfalfa stand. With regard to the late (March) treatment at Gaithersburg, both the 2,4-D and the MCP compounds caused a highly significant reduction in the alfalfa stand. The butyric compounds did not affect the alfalfa stand whatsoever. This statement was also true with the Bel Air treatment made in November, except that MCPB at 3 pounds per acre reduced the alfalfa stands significantly. In no instance did the 2,4-DB injure the alfalfa. Probably the most consistently satisfactory treatment for controlling the weed and not injuring the alfalfa was 2,4-DB at 2 pounds per acre. No treatment significantly increased the alfalfa stand over that of the check plot.

SUMMARY

Several chemicals were applied to fall seeded stands of alfalfa to study their effect on wild turnip (Brassica rapa) and on seedling alfalfa. Applications in November of 2,4-DB, MCPB, 2,4-D amine and MCP amine appeared to give very satisfactory control of the wild turnip at rates varying from 1 to 4 pounds per acre for the phenoxy butyric compounds and 1/4 and 1/2 pound per acre for the phenoxy acetic compounds. At one of two locations for the November treatment the phenoxy acetic compounds highly significantly reduced the alfalfa stand below that of the check. There also appeared to be stand reductions at the other location, but they were not statistically significant.

Treatment was made at one location in March of 1957. The same treatments were used. Control was not as satisfactory with the butyric compounds as the treatments that had been made the previous November. The phenoxy acetic compounds did cause a highly significant reduction of the alfalfa stand below that of the check plot.

DNBP at 2 pounds per acre did not materially reduce the stand of the wild turnip nor did it hurt the alfalfa stand at any date of treatment.

Appreciation is expressed to the Dow Chemical Company and the American Chemical Paint Company for supplying the chemicals that were used in these experiments.

Table 1. Percent control of wild turnip (Brassica rapa) in seedling alfalfa by various chemicals. Plots treated November 7, 1956.

Chemical	Rate	Date of Rating 11/16/56	3/22/57	5/3/57	Alfalfa Plants/sq.ft.
		%	%	%	No.
2,4-DB	1	3	30	0	10
2,4-DB	2	13	100	100	10
2,4-DB	3	13	90	98	9
MCPB	2	13	70	90	9
MCPB	3	13	70	95	8*
MCPB	4	23	80	95	12
2,4-D	1/4	10	100	100	5*
2,4-D	1/2	10	100	98	7*
MCP	1/4	13	70	93	8*
MCP	1/2	20	100	100	3*
DN	2	43	0	27	11
MCP+ DN	2+ 1/2	63	90	97	10
Check		0	0	0	12

*Stand significantly less than the check at the 1% level.

Table 2. Percent control of wild turnip by various chemicals applied to seedling alfalfa at Gaithersburg, Md. Treatment made 11/11/56 (early) and 3/14/57 (late).

Chemical	Rate	Date of Rating: Early Treatment Dec.'56	Early Treatment 3/14/57	Early Treatment 5/8/57	Late Treatment 5/8/57	Alfalfa Plants/sq.ft. Early	Alfalfa Plants/sq.ft. Late
						No.	No.
2,4-DB	1	10	93	95	62	11	11
2,4-DB	2	3	100	100	95	12	14
2,4-DB	3	13	97	97	95	11	14
MCPB	1	7	83	95	70	10	11
MCPB	2	17	90	95	67	10	10
MCPB	3	13	100	97	90	10	13
2,4-D amine	1/4	3	100	100	97	9	7*
2,4-D amine	1/2	13	100	98	100	7	6*
MCP amine	1/4	3	100	100	87	11	8*
MCP amine	1/2	17	100	100	95	10	5*
DNBP	2	60	20	10	30	12	11
DN + MCP	2 + 1/2	70	100	100	78	9	8*
Check		0	0	0	0	11	12

* Stand significantly less than the check at the 1% level.

EFFECT OF HERBICIDAL TREATMENT ON THE WINTER HEAVING OF LATE SUMMER SEEDED ALFALFA.

A. J. Kerkin and R. A. Peters*

Introduction

Competition from weeds has a definite detrimental effect on both the rate of establishment and the yields of forage legumes once established. Recent tests have shown that several new herbicides are effective in controlling weeds without causing injury to forage legumes (1,2,6,7). The authors, in a previous report, have shown the benefits of rapid, weed-free establishment of alfalfa and birdsfoot trefoil (4). Data given in this paper corroborate the previous findings both in weed control and establishment and yields of legumes. In addition, data were obtained which related establishment to winter heaving and yields of the following spring.

Materials and Methods

The late summer seeding was established on August 6, 1956. The design was a randomized block consisting of three replications. The individual plot size was 8 feet by 14 feet.

Vernal alfalfa and black mustard as a weed species were broadcast seeded with a grain drill and uniform stands were obtained. The stands of volunteer weeds (ragweed, lamb's quarter and grasses) were very irregular. A high uniform level of fertility was established.

The chemicals were applied on August 30 and 31, 1956. The plot sprayer used was modeled after that designed by Shaw (5). The alfalfa was in the 2nd true leaf stage. The mustard was 2 inches tall and budding. Lamb's quarter was 2 inches tall and ragweed was 1 inch tall. The grasses ranged from ½ inch to 8 inches with some germinating after spraying. There was no canopy effect. At the time of spraying it was mild (maximum of 70 and minimum of 58) but very humid and drizzly. The soil had been dry for two to three weeks before seeding but 0.91 inches of rain fell from August 11 to 13, 1956 so that good germination was obtained. The field used for this seeding is relatively low and wet and, therefore, offered possibilities for a winter heaving study.

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The chemicals and rates used were as follows:

1. 2,4-dichlorophenoxy acetic acid, alkanolamine form, (2,4-D) .2, .4 and .8 pounds acid equivalent per acre.

2. 2,4-dichlorophenoxy butyric acid, dimethylamine form, (2,4-DB) .75, 1.5 and 3 pounds acid equivalent per acre.

3. 2, methyl-4,chlorophenoxy butyric acid, dimethylamine form, (MCPB) .75, 1.5 and 3 pounds acid equivalent per acre.

4. 2-(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate, (erbon) .5, 1 and 2 pounds active ingredient per acre.

5. 2,2-dichloropropionic acid, sodium salt, (dalapon) 2 pounds acid equivalent per acre plus 2,4-DB amine .75, 1.5 and 3 pounds acid equivalent per acre.

6. 3-(3,4-dichlorophenyl)-1-methyl-1-n-butylurea (neburon) 1, 2 and 4 pounds active ingredient per acre.

7. 2-chloro-4,6-bis(ethylamino)-s-triazine, (simazin) 1, 2 and 4 pounds active ingredient per acre.

All materials were applied in 40 gallons of water per acre.

General observations and stand counts (made immediately before and one month after spraying) provided information regarding weed control and toxicity to the seeded legume from the various herbicides.

Data obtained in the spring of 1957 furnished information as to the over-wintering of alfalfa. Stand counts were made on alfalfa on April 16, 1957. The alfalfa plants were classified in one of the three following categories: normal, heaved and alive or heaved and dead. The degree of heaving ranged from one inch to complete upheaval. Also, yield data were obtained on June 13 and 14, 1957. Yields were based on a 39-inch swath mowed through the center of each plot. Sub-samples were taken from each plot and hand separations were made that consisted of alfalfa and all weeds combined.

Results and Discussion

General Observations

The general observations and counts made one month after spraying support the results obtained by the authors in a previous experiment (4). Neburon, 2,4-DB and dalapon plus 2,4-DB were the most effective of the herbicides used. Of the two additional chemicals included in the present test, erbon gave no response on any of the species present at the rates used while simazin was very active against all species present causing injury to the seedling alfalfa.

Overwintering of Alfalfa

Stand Data - A general analysis of variance on the three categories (normal alfalfa, heaved alive and heaved dead) showed high significance for treatments.

Table I contains fall counts (made September 27, 1956) which indicate the stands present before overwintering. Only the .2 and .4 lb. of 2,4-D and the 3 lb. rate of MCPB significantly reduced alfalfa stands as compared with the check. Neburon, 2,4-DB, simazin and hand-weeded plots showed significantly higher stands of alfalfa than the check. However, simazin injury did occur with the stands becoming thinned considerably. The erbon treatments which showed no effects had stands very similar to the check plots. In comparing the fall and spring counts (see Table I) it is evident that they were very similar in most cases with the big differences occurring between normal and heaved alive alfalfa plants after overwintering. Poor winter survival and lowered yields of alfalfa were the result of either initial injury (2,4-D, MCPB and Simazin) or poor establishment caused by lack of weed control (erbon).

A comparison of averages of stands after overwintering was only carried out on the normal alfalfa counts. Stands of normal alfalfa were significantly higher on all neburon plots, the weed free plot, and the three pound rate of 2,4-DB than on the check or mulched check. Either the neburon treatments or the weed free plots had significantly higher stands than all other treatments. Table I also shows that neburon and weed free plots contained few heaved dead plants. Previous tests have shown neburon to be effective against broadleafed and grassy weeds without injury to alfalfa which accounts for the good establishment and subsequent winter survival obtained.

Treatments with 2,4-DB, the combination of dalapon plus 2,4-DB, simazin, .2 pounds of 2,4-D or the mulched check contained a majority of plants in the heaved alive plus normal alfalfa categories. Treatments with .4 and 12 pounds of 2,4-D, MCPB, erbon or the non-weeded check definitely caused a shift to the heaved dead category as indicated by numbers of plants in that grouping. These results indicate the toxicity of 2,4-D or MCPB to alfalfa for as rates were increased the number of heaved alive and normal alfalfa plants decreased. All rates of erbon ranked as poorly as the high rates of 2,4-D or MCPB in normal alfalfa plants not because of direct injury to the alfalfa but because weed competition was not removed. These relationships are illustrated in Figure 1. The benefits of mulching are shown by the increased number of heaved alive plants on the mulched check as compared to the normal check. However, the mulching was not as effective as the neburon treatments.

Yield Data - The spring yields also indicated the degree of winter heaving of the alfalfa.

In the general analysis of variance, alfalfa yields showed high significance for treatments. There was no significant residual effect on the weed yields from any of these chemicals. However, the percent bare soil was much

TABLE I. Effects of Winter Heaving on Stands of Late Summer Seeded Alfalfa Treated With Herbicides.

Treatments (rates in lb. active ingredients per acre.)		Stand Counts Per 2 Sq. Ft. Quadrat			
		Fall Counts[1]	Normal Alfalfa[2]	Heaved Alive[2]	Heaved Dead[2]
2,4-D	.2	30.0	8.0	17.0	2.0
2,4-D	.4	23.0*	3.0	8.0	10.0
2,4-D	.8	16.0*	0.0	1.0	12.0
2,4-DB	.75	36.0*	5.0	22.0	6.0
2,4-DB	1.5	34.0	6.0	22.0	3.0
2,4-DB	3	37.0*	13.0*	18.0	3.0
MCPB	.75	33.0	4.0	14.0	12.0
MCPB	1.5	28.0	4.0	16.0	6.0
MCPB	3	22.0*	1.0	12.0	7.0
Dal. + 2,4-DB	2+.75	35.0	0.7	19.0	12.0
Dal. + 2,4-DB	2+1.5	37.0*	7.0	17.0	8.0
Dal. + 2,4-DB	2+3	34.0	5.0	19.0	6.0
Erbon	.5	29.0	0.0	12.0	14.0
Erbon	1	33.0	0.7	13.0	15.0
Erbon	2	31.0	0.7	8.0	19.0
Neburon	1	38.0*	25.0*	8.0	0.7
Neburon	2	42.0*	30.0*	6.0	0.0
Neburon	4	43.0*	27.0*	8.0	1.0
Simazin	1	39.0*	9.0	20.0	6.0
Simazin	2	37.0*	7.0	21.0	5.0
Simazin	4	35.0	4.0	12.0	13.0
Check - normal		30.0	0.3	11.0	16.0
weed-free		41.0*	23.0*	8.0	2.0
mulched		----	1.0	22.0	5.0
Average of all rates of each chemical					
2,4-D		23.0	4.0	9.0	8.0
2,4-DB		36.0	8.0	21.0	4.0
MCPB		28.0	3.0	14.0	8.0
Dal.+2,4-DB		35.0	4.0	18.0	9.0
Erbon		31.0	0.5	11.0	16.0
Neburon		41.0	27.0	7.0	0.7
Simazin		37.0	7.0	18.0	8.0

[1] Counts made September 27, 1956 before overwintering.

[2] Counts made April 16, 1957 after overwintering; an analysis was only done on the normal alfalfa.

* Denotes significance from check or mulched check at .05 level.

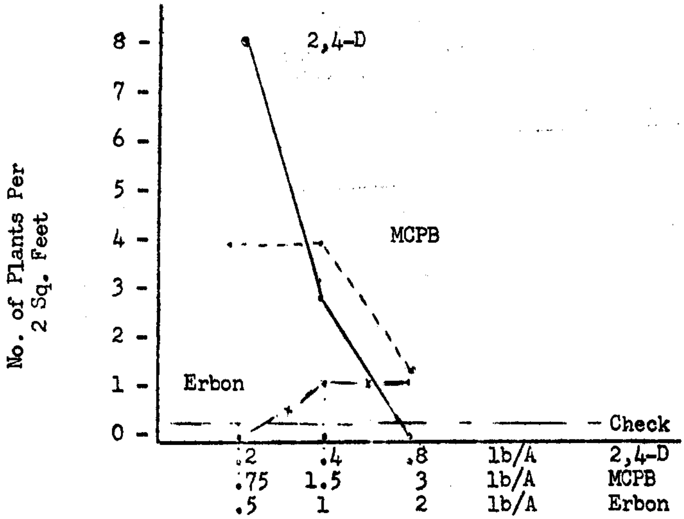

Figure 1. Reduction in Counts of Overwintered Normal Alfalfa Plants From Injurious Chemicals (2,4-D and MCPB) Compared With No Weed Control (Erbon and Check).

greater on simazin treated plots and it appeared that there were fewer weeds in these plots than in adjacent ones. The yield data are given in Table II.

The individual treatment comparisons showed that all neburon treatments, all 2,4-DB treatments, the .75 and 1.5 pound rates of MCPB, the .2 pound rate of 2,4-D and the hand weeded check had significantly higher yields than the check. The combination of dalapon plus 2,4-DB did not show significantly increased yields of alfalfa in this test. This was in direct contrast with the results of a previous spring test. Simazin and 2,4-D reduced yields of alfalfa but not significantly because the check itself yielded poorly due to competition. However, both caused highly significant linear decreases in yields of alfalfa as shown by Figure 2 which compares these responses with that of neburon.

As stated, yields of the summer seeding are directly correlated with the overwintering of the alfalfa which, in turn, is dependent upon the effect of the chemical treatments on early establishment. A positive correlation of .90 was found between the live plants and yields taken after winter heaving. This relationship is shown in Table III which compares the chemicals (average of all rates). The chemicals are arranged in order of increasing numbers of total live alfalfa plants.

TABLE II. Spring Yields of Late Summer Seeded Alfalfa and Weeds Following Early Post-Emergent Treatment With Herbicides.

Treatment (Rates in lb. active ingredients per acre)		Pounds Air Dry Per Acre: Alfalfa	Pounds Air Dry Per Acre: Combined Weeds
2,4-D	.2	2667.0*	867.0
2,4-D	.4	1667.0	767.0
2,4-D	.8	250.0	1117.0
2,4-DB	.75	3267.0*	317.0
2,4-DB	1.5	2733.0*	1367.0
2,4-DB	3	3300.0*	400.0
MCPB	.75	2833.0*	433.0
MCPB	1.5	2800.0*	633.0
MCPB	3	2100.0	833.0
Dal.+2,4-DB	2+.75	2183.0	283.0
Dal.+2,4-DB	2+1.5	2333.0	700.0
Dal.+2,4-DB	2+3	2400.0	433.0
Erbon	.5	1367.0	433.0
Erbon	1	1590.0	310.0
Erbon	2	1233.0	600.0
Neburon	1	3967.0*	567.0
Neburon	2	3833.0*	867.0
Neburon	4	3933.0*	433.0
Simazin	1	2433.0	533.0
Simazin	2	2000.0	240.0
Simazin	4	733.0	267.0
Check		1333.0	400.0
Weed Free Check		3533.0*	367.0
Mulched Check		2500.0	733.0
Average of all rates of each chemical			
2,4-D		1528.0	917.0
2,4-DB		3100.0	695.0
MCPB		2578.0	633.0
Dal.+2,4-DB		2306.0	472.0
Erbon		1397.0	448.0
Neburon		3911.0	622.0
Simazin		1722.0	347.0

* Denotes significance from check at .05 level.

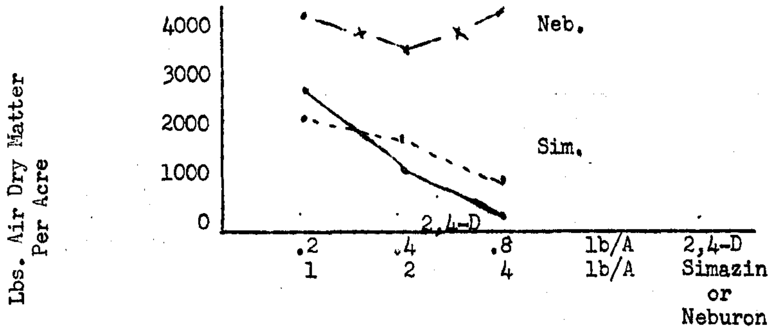

Figure 2. Effect of Rate of Chemical on Yields of Late Summer Seeded Alfalfa.

TABLE III. The Relationship Between Winter Heaving and Yields of Summer Seeded Alfalfa as Affected by Herbicides.

Treatments (average of all rates of each chemical.)	Plants Per 2 Sq. Ft. Quadrat: Normal Alfalfa	Heaved Alive	Total Alive	Lbs. Per Acre Air Dry Yields
Check	0.3	11.0	11.3	1333.0
Erbon	0.5	10.8	11.3	1397.0
2,4-D	3.6	8.9	12.5	1528.0
MCPB	3.1	14.1	17.2	2578.0
Dal.+2,4-DB	4.2	18.2	22.4	2306.0
Mulched Check	1.0	22.3	23.3	2500.0
Simazin	6.7	17.9	24.6	1722.0
2,4-DB	8.3	20.8	29.1	3100.0
Weed Free Check	23.3	8.0	31.3	3533.0
Neburon	27.2	7.4	34.6	3911.0

A correlation coefficient of .90 was obtained between live plants and yields of alfalfa.

Neburon, which enabled essentially competition-free establishment of alfalfa without any injury, had the highest number of live plants and gave the highest yields. If neburon proves to be selective for brome as well as alfalfa, as indicated by Friesen and Walker (3), more work should be done with this chemical. As noted, yields of alfalfa were not significantly increased by the combination of dalapon plus 2,4-DB whereas they were by 2,4-DB alone. It seems that dalapon caused a temporary setback to alfalfa and that the summer seeding didn't permit enough time for good establishment to occur. Although 2,4-DB ranked close to the hand weeded check and neburon treatments in total live plants and yields, it was decidedly lower in normal alfalfa plants. Perhaps this indicates a slight depressive effect on alfalfa from 2,4-DB with no effect from neburon.

Simazin ranks high in number of live alfalfa plants but among the lowest in yield. Simazin either "killed" the alfalfa or did no damage and these remaining plants became well established. The overall stand was thinned due to this direct injury which accounts for the low yields. It is interesting to note that the 2,4-D treatment which caused direct injury to alfalfa, but nevertheless gave broadleaf weed control, gave slightly higher yields of alfalfa than erbon treatments. Erbon didn't injure alfalfa but the weed competition was more injurious than the direct injury of 2,4-D.

Summary

Neburon treated plots provided the most rapid early establishment, showed the least winter heaving, and gave the highest spring yields of alfalfa in the late summer seeding. The hand-weeded check and 2,4-DB treated plots ranked second and third, respectively.

Those herbicides showing direct toxicity to alfalfa (2,4-D, MCPB and Simazin) or providing no weed control (erbon or check) gave the poorest overwintering and the lowest yields. The mulched check indicated that mulching helped to reduce winter heaving, but neburon was decidedly superior.

The results indicate the influence of weed free conditions during establishment on the overwintering of alfalfa.

Acknowledgement is made to the Dow Chemical Company for supplying Dalapon and Erbon, to DuPont de Nemours and Company for supplying Neburon, to the Geigy Chemical Corporation for supplying Simazin, and to the American Chemical Paint Company for supplying the other chemicals used.

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The Effect of Selected Herbicides - Alone and in Combination - on the Establishment of Legume Seedings[1]

R. J. Hull and A. C. Wakefield[2]

Introduction

Weeds compete with legume seedings for light, moisture and plant nutrients. Selective chemicals recently developed offer promise of controlling broadleaf and grass weeds (1, 2, 4, 5).

Use of herbicides for this purpose should help toward more successful establishment of legume seedings both in terms of plants per unit area and size and vigor of plants. In addition, substantial harvest of weed-free forage may be made during the season of establishment.

Procedure

An experiment was established May 3, 1957, on the University dairy farm to determine the effectiveness of several herbicides on the establishment of legume seedings. The field used had been seeded to alfalfa the previous year, and the planting failed as a result of serious weed competition.

A split plot design was used with alfalfa (Narragansett - 15 lbs./A), birdsfoot trefoil (Viking 15 lbs./A), and ladino clover (Certified - 2 lbs./A) as main plots. Post-emergent herbicide treatments were randomized within each main plot. Pre-emergent treatments were included as a supplement to this test as space permitted. Three replications were used. A non-replicated red clover series (Pennscott 8 lbs./A) was included for observational purposes. Individual plot size was 6 x 20 feet.

Weed populations were extremely heavy and consisted of lambsquarters (Chenopodium sp.), pigweed (Amaranthus sp.), smartweed (Polygonium sp.), quackgrass (Agropyren sp.), barnyard grass (Echinochloa sp.), and yellow foxtail (Setaria sp.). Lambsquarters and quackgrass generally predominated in the test area during the spring and early summer while yellow foxtail became important during the summer months.

Chemicals were applied in 30 gallons of water per acre with a sprayer similar to that designed by Shaw (3). Chemical treatments were as follows:

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Pre-emergent

1. Ethyl N,N-di-n-propylthiolthiolcarbamate (EPTC) 6 lbs. A.E./gal.; 4 and 8 lbs. acid equivalent per acre.
2. 3-(3,4 dichlorophenyl-1-methyl-1-N-butylurea), (Neburon), 18.5% active; 2 and 4 lbs. active material per acre.

Post-emergent

3. 2,2-dichloropropionic acid, sodium salt 74% A.E. (Dalapon); 2 and 4 lbs. acid equivalent per acre.
4. 4 (2,4-dichlorophenoxy) butyric acid, dimethylamine salt, 2 lbs. A.E./gal. (4 (2,4-DB)); $1\frac{1}{2}$ and 3 lbs. acid equivalent per acre.
5. Dinitro-o-sec-Butyl-phenal, alkanalamine salt, 3 lbs. A.E./gal. (D.N.); $\frac{3}{4}$ and $1\frac{1}{2}$ lbs. acid equivalent per acre.
6. 2,2-dichloropropionic acid, (Dalapon) 2 lbs. acid equivalent per acre plus 4 (2,4-dichlorophenoxy) butyric acid (4 (2,4-DB)) $1\frac{1}{2}$ and 3 lbs. acid equivalent per acre.
7. 2,2-dichloropropionic acid (Dalapon) 4 lbs. acid equivalent per acre plus 4 (2,4-dichlorophenoxy) butyric acid (4 (2,4-DB)) $1\frac{1}{2}$ and 3 lbs. acid equivalent per acre.
8. 2,3-dichloropropionic acid (Dalapon) 2 lbs. acid equivalent per acre plus Dinitro-o-sec-Butyl-phenol (D.N.) $\frac{3}{4}$ and $1\frac{1}{2}$ lbs. acidequivalent per acre.
9. 2,2-dichloropropionic acid (Dalapon) 4 lbs. acid quivalent per acre plus Dinitro-o-sec-Butyl-phenol (D.N.) $\frac{3}{4}$ and $1\frac{1}{2}$ lbs. acid equivalent per acre.

The times of application of herbicides and stages of plant development were as follows:

a. Pre-emergent - May 10
   Legume species - none appearing
   Broadleaf weeds - germinating
   Quackgrass - shoots emerged 1-2 inches

b. Post-emergent - June 13 and 14
   Alfalfa - 2-4 leaf stage (4-5 inches)
   B.F. trefoil - 2-3 leaf stage (1-2 inches)
   Ladino clover - 1-2 leaf stage ($\frac{1}{2}$-1 inch)
   Broadleaf weeds - 5-7 inches
   Quackgrass - 4-5 inches

Rainfall following pre-emergence treatments exceeded 1.5 inches within 7 days and germination of all seeded species was excellent.

Temperatures at the time of post-emergence treatments ranged between 75 and 80° F. Precipitation following treatments was negligible for nearly one month. The season was extremely dry. Rainfall for June was 0.12 inches and July only 1.06 inches.

Three handweeded check plots were maintained in addition to an unweeded check. Broadlef weeds, grass weeds, and all weeds were handweeded in order to evaluate the effect of these populations on legume establishment. Handweeding was started at the time of post-emergent spray applications and once thereafter.

All plots were rated for herbicidal effectiveness, injury to legumes and vigor of legumes at two dates following spraying - July 2 and August 1. Pre-emergent treatments were rated also on May 15. Plant counts were made using two 2-square foot quadrats at 2 locations in each plot on 2 dates - July 2 and August 22.

Plots were harvested for yields on August 5. In addition, alfalfa plots were harvested on October 9. A 38-inch strip (the width of the mower) was removed from each plot and green weights determined. Dry matter samples were taken from each plot. Botanical composition was estimated and then checked by occasional hand separations.

Plant samples for crown and root observations were dug from 1-square foot areas in each plot on October 11. The number of tillers per plant were counted and the average dry weight per root (clipped to six inches) and total root weight per square foot was determined.

Results and Discussion

General Observations

Pre-emergent

Initial observations indicated that EPTC and Neburon effectively controlled all broadleaf weeds except pigweed, which was suppressed only at the highest rates. Good annual grass control was noted for both chemicals, particularly at the high application.

EPTC showed no indications of damaging alfalfa, birdsfoot trefoil or red clover at either the 4- or 8-lb. rates; however, ladino clover showed distortion and was seriously retarded, especially at the high rate. Neburon showed no injury to birdsfoot trefoil and very little to alfalfa at both rates used. Both ladino clover and red clover were seriously injured by this chemical.

By July 1, no indications of injury were noticeable on any species tested with the exception of ladino clover which continued to be suppressed by the 4-lb. rate of Neburon. The weeds which had at first been suppressed eventually became established and constituted a serious weed problem. No control of annual grass was noticeable at this time and quackgrass became established in many plots of both treatments.

Post-emergent

One hour after spraying, wilting of lambsquarters was noted on all 2,4-DB plots. In 13 days some injury was noted on all legumes treated with D.N., particularly when combined with Dalapon. Slight damage to alfalfa and ladino clover was caused by 2,4-DB; however, birdsfoot trefoil and red clover appeared unaffected.

The characteristic epinastic reaction of 2,4-DB was noted on lambsquarters, pigweed, and smartweed with mustard and ragweed showing some resistance. D.N. "burned" most of the broadleaf weeds at the $1\frac{1}{2}$-lb. rate but failed to effect permanent injury to any but lambsquarters at the $\frac{3}{4}$-lb. rate. Dalapon showed con-

Table 1. Stands Alfalfa and Birdsfoot Trefoil Following Herbicide Treatments.

Treatment		Stand Counts - July 3 Plants per Square Foot			Stand Counts - October 11 Plants per Square Foot		
		Alfalfa	B.F. Trefoil	Treat. Avg.	Alfalfa	Trefoil	Treat. Avg.
Post Emergent							
Dalapon	2	19.7	24.0	21.8	24.0	24.3	24.0
Dalapon	4	15.0	24.3	19.7	18.0	27.3	22.7
2,4-DB	1½	24.0	24.3	22.5	27.7	18.3	23.0
2,4-DB	3	18.0	18.0	18.0	23.0	29.0	26.0
DN	¾	20.0	23.0	21.5	25.6	31.0	28.5
DN	1½	24.3	18.3	21.3	19.0	26.0	22.0
DAL + 2,4-DB	2+1½	21.0	18.3	19.7	30.0	19.0	24.5
DAL + 2,4-DB	2+3	21.0	16.3	18.7	24.7	19.0	21.8
DAL + 2,4-DB	4+1½	15.0	17.3	16.2	26.7	26.3	26.5
DAL + 2,4-DB	4+3	20.7	17.7	19.2	25.0	29.7	27.3
DAL + DN	2+¾	24.7	18.7	21.7	18.0	23.7	20.8
DAL + DN	2+1½	17.3	11.3	14.3	18.0	14.3	16.2
DAL + DN	4+¾	13.3	18.0	19.2	13.0	29.7	21.3
DAL + DN	4+1½	16.7	13.3	15.7	19.3	9.6	14.5
Check-Unweeded		23.7	22.7	23.2	2.50	31.0	28.0
Check-Grasses Handweeded		21.3	20.7	21.0	19.3	35.3	27.3
Check-Broadleaf Weeds Handweeded		20.3	16.7	18.5	17.3	23.0	20.2
Check-All Weeds Handweeded		22.7	18.3	20.5	32.3	27.0	29.7
LSD (P=.05)		6.7	N.S.	5.4	10.4	8.2	8.2
Pre-Emergent							
EPTC	4	23.3	25.0	24.2	18.7	23.0	20.8
EPTC	8	25.3	29.7	27.5	19.7	22.3	21.0
Neburon	2	25.0	22.7	23.8	17.3	29.7	23.5
Neburon	4	23.0	19.0	21.0	19.7	18.0	18.8

Vigor ratings made 47 days after spraying showed that much of the legume injury previously noted had disappeared. This was especially true of the Dalapon plus 2,4-DB treatments. Dalapon proved quite detrimental to red clover, completely eliminating it from those plots receiving the 4-lb. application. Unfortunately, due to dry weather, ladino clover stands failed and no reliable data could be obtained from these plots.

Stand Counts

Plant counts made 19 days after treatment (Table 1) showed that stands of alfalfa were significantly reduced below the unweeded check by the high rate of Dalapon. This was particularly true when Dalapon was used in combination with D.N.

Birdsfoot trefoil showed less injury due to the chemicals and no significant differences in stand were recorded. This may be in part the result of the almost complete canopy of broadleaf weeds which tended to protect the smaller trefoil plants. The data show some reduction in stand from the combination of Dalapon with $1\frac{1}{2}$ lbs. of D.N.

Counts made October 11 showed a general increase in stand for both alfalfa and birdsfoot trefoil. This was undoubtedly due to the germination of hard seed during the intervening period. Despite this general increase in stand, Dalapon plus D.N. resulted in stands significantly below those of the unweeded check for both alfalfa and birdsfoot trefoil.

Evidence from the variously handweeded check plots indicated that grasses were much more competitive than broadleaf weeds to trefoil. Significantly lower stand counts were recorded when broadleaf weeds were handweeded. The same trend was noted in alfalfa plots although differences were not statistically significant.

The pre-emergent treatments showed a generally higher stand count in July for both alfalfa and birdsfoot trefoil due to the early reduction in weed competition. These treatments, however, did not show the stand increase in October that was characteristic of the post-emergent test. Extensive grass and broadleaf weed competition was present in these plots during July and August.

Effect on Yield

Yields of alfalfa and birdsfoot trefoil are presented in Table 2. As will be noted, treatment differences were not significant for either legume species. This may have been partially due to the lack of moisture which lowered the expected response to the reduced weed competition and also to the variability in weed population over the test area.

The botanical composition of harvested material varied widely and is summarized in Table 2 as average legume, broadleaf weed, and grass yields for each treatment.

Table 2. Yields of Alfalfa, Birdsfoot Trefoil and Weeds Following Herbicide Treatments.

Treatment		Yields–Tons Dry Matter/Acre–Aug. 5 Alfalfa	Trefoil	Average Legume	Average B.L. Weeds	Average Grass	Percent Quackgrass Oct. 9
Post Emergent							
Dalapon	2	0.54	0.03	0.28	0.98	0.35	13.3
Dalapon	4	0.49	0.04	0.26	0.79	0.18	3.3
2,4-DB	$1\frac{1}{2}$	0.54	0.02	0.28	0.04	0.89	55.0
2,4-DB	3	0.62	0.03	0.33	0.06	1.10	45.0
DN	$\frac{3}{4}$	0.40	0.06	0.23	0.49	1.49	41.7
DN	$1\frac{1}{2}$	0.45	0.04	0.24	0.31	1.19	36.7
DAL + 2,4-DB	$2+1\frac{1}{2}$	0.71	0.02	0.36	0.02	0.52	23.3
DAL + 2,4-DB	2+3	0.47	0.04	0.25	0.04	0.62	38.3
DAL + 2,4-DB	$4+1\frac{1}{2}$	0.75	0.03	0.39	0.08	0.13	3.3
DAL + 2,4-DB	4+3	0.90	0.04	0.47	0.02	0.16	3.3
DAL + DN	$2+\frac{3}{4}$	0.63	0.04	0.34	0.30	0.75	38.3
DAL + DN	$2+1\frac{1}{2}$	0.49	0.02	0.26	0.16	0.75	30.0
DAL + DN	$4+\frac{3}{4}$	0.74	0.06	0.40	0.47	0.31	3.3
DAL + DN	$4+1\frac{1}{2}$	0.68	0.02	0.35	0.32	0.39	6.7
Check–Unweeded		0.64	0.06	0.35	0.80	1.23	11.7
Check–Grasses Handweeded		0.59	0.03	0.31	1.22	0.23	8.3
Check–Broadleaf Weeds Handweeded		0.37	0.02	0.19	0.10	0.86	61.7
Check–All Weeds Handweeded		0.74	0.05	0.40	0.01	0.08	8.3
LSD (P=.05)		N.S.	N.S.	N.S.	0.26	0.21	
Pre-Emergent							
EPTC	4	0.90	0.04	0.47	0.89	1.16	46.7
EPTC	8	0.61	0.04	0.32	0.40	1.41	73.3
Neburon	2	0.83	0.12	0.48	0.61	1.74	50.0
Neburon	4	0.69	0.15	0.42	0.37	1.39	53.3

The broadleaf weed yield was significantly lower than the unweeded check in the case of D.N. and 2,4-DB. The results with 2,4-DB reveal almost perfect control of broadleaf species in this experiment.

Grass yields were significantly reduced by Dalapon both alone and mixed with other materials. The 4-lb. rate of Dalapon was superior to 2 lbs. Since yields of grass are confounded somewhat by dead grass in the yield determinations as well as the presence of both annual and perennial species, estimates of quackgrass control on October 9 are presented. The completeness of quackgrass control by Dalapon, particularly at the 4-lb. rate, is clearly evident.

The overall control of weeds was accomplished by the mixture of Dalapon at 4 lbs. per acre plus 2,4-DB at $1\frac{1}{2}$ or 3 lbs. per acre. The lower rate of 2,4-DB was entirely satisfactory.

Tiller and Root Measurements

Data on the number of tillers and root weights of alfalfa and birdsfoot trefoil are summarized in Table 3.

The number of alfalfa tillers did not change significantly regardless of chemical treatments or hand removal of weeds as in the check plots. However, tillers on birdsfoot trefoil increased significantly as weeds were controlled either by handweeding or with a combination of 4 lbs. of Dalapon plus 2,4-DB at $1\frac{1}{2}$ or 3 lbs./A.

The average root weights of plants dug from 1-square foot areas of each plot did not change significantly for either alfalfa or birdsfoot trefoil. An analysis of the overall treatment effect on both legumes showed significantly greater average root weights from either handweeding or a combination of 4 lbs. of Dalapon plus 2,4-DB at the $1\frac{1}{2}$-lb. or 3-lb. rate. The total weight of roots per square foot (to a depth of 6 inches) followed a similar pattern of significance.

The full significance of treatments resulting in greater tillering and larger root weights of individual plants as well as changes in numbers of legume plants per unit of area can not be fully evaluated during the season of establishment. Yield data and other observations on this experiment will be continued.

Summary

Post-emergent applications of several herbicides applied alone and in combination were evaluated on several legume species during the 1957 season.

Excellent control of annual broadleaf and grass weeds was obtained with a combination of Dalapon at 4 pounds per acre and 2,4-DB at $1\frac{1}{2}$ or 3 pounds per acre with little or no injury to alfalfa or birdsfoot trefoil. Yields of legumes were virtually weed-free. Root and tiller development was superior and compared favorably with handweeded check plots.

Neither Dalapon nor 2,4-DB was satisfactory when applied alone.

Table 3. Root Weights and Tiller Counts of Alfalfa and Birdsfoot Trefoil Following Herbicide Treatments.

Treatment		Tillers/Plant Alfalfa	Tillers/Plant Trefoil	Tillers/Plant Treat. Avg.	Root Weight/Plant (Grams Dry) Alfalfa	Root Weight/Plant (Grams Dry) Trefoil	Root Weight/Plant (Grams Dry) Treat. Avg.	Total Root Wt./Sq.Ft. Treatment Average
Post-Emergent								
Dalapon	2	5.04	4.89	4.96	0.59	0.11	0.35	8.2
Dalapon	4	5.58	6.27	5.93	0.54	0.17	0.36	7.2
2,4-DB	1½	4.41	3.79	4.10	0.49	0.09	0.29	7.5
2,4-DB	3	5.07	5.09	5.08	0.73	0.13	0.43	10.4
DN	¾	5.05	5.83	5.44	0.57	0.13	0.35	8.2
DN	1½	5.68	4.62	5.32	0.65	0.31	0.48	8.5
DAL + 2,4-DB	2+1½	4.59	6.31	5.45	0.53	0.15	0.34	9.9
DAL + 2,4-DB	2+3	5.22	5.28	5.25	0.51	0.19	0.35	8.2
DAL + 2,4-DB	4+1½	5.63	9.22	7.42	0.72	0.34	0.53	5.9
DAL + 2,4-DB	4+3	5.95	7.94	7.42	0.72	0.34	0.53	5.9
DAL + DN	2+¾	4.94	5.32	5.13	0.48	0.12	0.30	14.0
DAL + DN	2+1½	5.38	5.80	5.59	0.50	0.13	0.32	14.7
DAL + DN	4+¾	6.31	7.55	6.93	0.76	0.22	0.49	8.5
DAL + DN	4+1½	6.06	4.30	5.18	0.78	0.07	0.42	7.7
Check-Unweeded		5.69	4.84	5.26	0.67	0.08	0.37	8.7
Check-Grasses Handweeded		5.64	4.52	5.08	0.61	0.09	0.35	6.9
Check-Broadleaf Weeds Handweeded		5.07	5.09	5.08	0.55	0.12	0.33	6.5
Check-All Weeds Handweeded		5.56	8.54	7.05	0.78	0.39	0.58	18.3
LSD (P=.05)		N.S.	2.95	1.53	N.S.	N.S.	0.20	5.5
Pre-Emergent								
EPTC	4	5.39	5.44	5.42	0.63	0.13	0.38	7.6
EPTC	8	6.15	4.34	5.24	0.87	0.07	0.47	9.3
Neburon	2	5.94	6.15	6.04	0.79	0.21	0.50	9.6
Neburon	4	5.40	7.45	6.42	0.82	0.38	0.60	11.8

D.N. did not give effective broadleaf weed control and in combination with Dalapon resulted in injury to legumes.

Pre-emergent applications of EPTC and Neburon initially controlled most broadleaf weeds and annual grasses with no injury to alfalfa and birdsfoot trefoil. However, the period of residual activity of both materials was too short for fully effective weed control.

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PRE-EMERGENCE WEED CONTROL IN CORN*

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The corn planted on the area used in this experiment was planted with a four row planter. The center two rows were sprayed with a six foot hand boom seven days after planting. The two outer rows were used as check plots.

The spring was rather dry and the soil was lumpy. Germination of the corn and weed seed was retarded so that the control of weeds with the lower rates of chemicals was poorer than generally expected. The higher rates of most chemicals were generally satisfactory.

When one considers cost and the results, the 2,4-D compounds were still the most satisfactory. The other outstanding chemicals were Simazin, Geiggy 444E, EPTC, ACPM354 and ACP360.

There was no apparent injury from any treatment, but it must be remembered the season was much dryer than normal.

Table 1. Percent Control of Weeds With Pre-emergence Chemicals applied 7 Days after Planting.

Material	Rate in pounds per acre	Monocots	Dicots
2,4-D amine	1	78	93
	2	78	86
	3	95	94
2,4-D ester	1	68	92
	2	73	94
	3	95	95
2,4-D LVE	1	88	95
	2	82	97
	3	94	94
Emid	1	85	90
	2	67	83
	3	90	92
Kuron	1	48	62
	2	57	67
	3	67	75
DiNitro	3	60	70
	6	83	78
	9	96	93

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*Authorized for publication on November 22, 1957, for publication as paper No. 2215 in the journal series of the Pennsylvania Agricultural Experiment Station.

Table 1. (Continued)

Material	Rate in pounds per acre	Monocots	Dicots
Simazin	1	78	83
	2	87	83
	3	97	96
Geiggy	4	82	82
	8	95	94
	12	96	99
ACP 118	1	20	30
	2	63	65
	3	82	80
ACP 360	1	87	85
	2	72	93
	3	92	94
ACPM354	1	85	95
	2	80	97
	3	94	97
Amino triazole	2	12	12
	4	23	15
	8	30	30
CDEC	1	48	28
	2	70	52
	3	91	63
EPTC	2	88	90
	4	83	81
	8	99	97
Monuron	5	37	27
	1	68	73
	2	97	90
Diuron	5	53	50
	1	73	78
	2	73	80

Pre-emergence and Emergence Weed Control in Corn[1]

Collins Veatch[2]

Many of the chemicals that have been tested by pre-emergence or emergence applications on corn have delayed weed growth so that subsequent cultivation or post-emergence spraying has been effective in controlling the weeds. It is recognized that rainfall and the presence of weed seeds in the soil influences the effectiveness and persistence of weed control chemicals. However the search continues for a chemical that will give full season weed control.

The trials here reported were designed to test some of the recently developed chemicals, as well as chemicals that have been under test for some time, when applied as pre-emergence or emergence sprays on corn plots.

Material and Methods

The plot areas were prepared and fertilized as uniformly as possible. The corn was check planted. Individual plots were two rows wide by ten hills long. The chemicals were applied with a special plot sprayer calibrated to apply the desired amount of weed control chemical in 41 gallons of water per acre under a pressure of 20 p.s.i. (pounds per square inch).

The chemicals used for pre-emergence or emergence spray and the rates of application in pounds per acre of active ingredient are listed in the accompanying Table. The chemicals were applied as pre-emergence sprays at Point Pleasant and as emergence sprays at Reedsville and Wardensville.

Two complete trials with four replications each were carried on at all three locations. At Point Pleasant and Wardensville the weedy plots in one trial were given a post-emergence or lay-by spray with 2,4-D while in the other trial the weedy plots were sprayed with DNBP. At Reedsville no post-emergence spray was necessary to control the weeds. The number of plots requiring a post-emergence spray of either 2,4-D or DNBP at Point Pleasant and Wardensville are indicated in the Table. In this Table the results of the two trials were averaged so that each yield and each weed index is an average of eight plots.

The soils on all three of the plot locations were sandy loams; Point Pleasant, Wheeling sandy loam; Reedsville, Pope sandy loam; Wardensville, Monongahela sandy loam. The Reedsville plot area was comparatively free of weeds and was higher in organic content than the soils at the other locations.

Discussion of Results

The accompanying Table gives the yields in bushels per acre, the weed index at harvest at three locations and the number of plots receiving a post-emergence spray under each treatment at Point Pleasant and Wardensville.

[1] Technical Paper No.568 West Virginia Agricultural Experiment Station.
[2] Associate Agronomist, West Virginia Agricultural Experiment Station.

The weed index is an estimate of the comparative weed population at the time of harvest, zero indicating few if any weeds and nine complete coverage of the plot area with weeds. An index of two or less indicates good weed control.

The results at Point Pleasant indicate that satisfactory weed control was secured with nearly all of the chemicals tested in combination with a post-emergence spray. The checks were low in yield due to a high population of weeds as indicated by the weed indexes of over six. The checks were given only one late cultivation, which was not effective in controlling the weeds because of a rain shortly after cultivation. These checks should really be considered as having no effective weed control. At this location Simazin, G-27901 and Diuron gave excellent weed control with comparatively high yields of corn. In the case of the G-27901 only two of eight plots needed a post-emergence spray, with Simazin and Diuron three of the eight plots needed a post-emergence spray. Monuron and Emid sprays gave good weed control but lower yields than the Simazin, G-27901 or Diuron. When the plots treated with Simazin, G-27901, Monuron or Diuron required a post-emergence spray, nut grass or other perennial weeds were usually present. The corn yields were low here this year due to dry weather.

At Reedsville the sprays were applied at emergence. The area was comparatively free of weeds and good yields were secured from all of the plots irrespective of treatment. No post-emergence treatment was needed to control the weeds. Simazin, G-27901, Dimmon, Monuron and DNBP gave better weed control than the other treatments. At this location rye grass was seeded in the corn at lay-by for a cover crop. At harvest time it was noted that the stand of rye grass was comparatively poor or even absent on the plots sprayed with Simazin, G-27901, Monuron or Diuron.

The results at Wardensville were quite similiar to those at Point Pleasant in that the yields were low due to dry weather and that the checks were given only one cultivation at a time when it was not effective in controlling the weeds. The weedy plots were given a post-emergence spray with 2,4-D or DNBP. The same chemicals were outstanding in controlling the weeds here as at Point Pleasant, namely Simazin, G-27901, and Diuron. The weed control was excellent on the Monuron treated plots but the stand of corn was seriously reduced. Previous work has indicated that pre-emergence applications of Monuron at a rate of 1.5 pounds per acre on sandy soil will give good weed control with little reduction in the stand of corn.

Summary

The trials here reported indicate that full season weed control can be secured in corn under West Virginia conditions with pre-emergence or emergence sprays with Simazin, G-27901, Monuron or Diuron in the absence of perennial weeds.

The two pound rate per acre was satisfactory with Simazin, G-27901 and Diuron, but with Monuron a lower rate than two pounds per acre should be used on sandy soils low in organic matter.

Summary of 1957 Weed Control in Corn Plots

	Rate Per A. lbs.	Point Pleasant Bu. Per A.	Point Pleasant Weed Index 0-9	Point Pleasant Weedy Plots Given Post-emergence Spray	Reedsville Bu. Per A.	Reedsville Weed Index 0-9	Wardensville Bu. Per A.	Wardensville Weed Index 0-9	Wardensville Weedy Plots Given Post-Emergence Spray
Check	---	14.5	8.25	0	155.5	.75	20.5	5.13	0
2,4-D	1	56.5	1.25	7	131.5	1.50	32.5	4.50	7
DNBP	4	52.5	1.88	8	135.5	.50	42.5	4.50	7
EPTC	5	50.5	1.50	8	131.5	2.13	39.5	4.00	4
Vovon	1	56.5	2.88	8	131.5	1.75	23.0	5.00	8
Vovon	2	51.5	1.38	8	130.5	2.00	26.0	4.25	7
Randox	4	57.5	2.00	8	136.5	1.50	28.5	4.63	6
2,4-DB	1	56.5	1.75	7	134.5	1.50	28.5	4.63	7
Check	---	35.0	6.13	0	135.5	1.25	37.0	4.75	0
Simazin	2	57.5	.50	5	137.0	.63	58.0	.63	1
Simazin	4	67.0	.25	3	127.0	.13	63.0	1.63	2
-27901	4	69.0	.25	2	133.0	.38	60.0	1.25	3
Monuron	2	53.0	.25	5	122.5	1.00	37.5	1.25	1
Diuron	2	60.5	.25	3	132.5	.63	52.0	1.63	6
Amid	2	53.5	.75	3	132.5	1.25	42.0	3.75	6
Amizol	2	48.5	2.25	7	133.5	1.38	27.0	4.88	6
Check	---	12.0	6.88	0	139.5	1.63	33.5	5.25	0
L.S.D. .05		16.3			9.7		14.9		
Average Yield of Treated Plots		56.6			132.1		40.0		

Acknowledgement

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Pre-emergent Weed Control Tests with Silage Corn[1]

I. S. Bell and Thomas F. Tisdell[2]

Weed control studies in silage corn were continued in 1956 and 1957. The 1956 tests were confined to comparing the abilities of Karmex W, Karmex DW, and Neburon alone and in various combinations to inhibit weed growth. These materials, known as substituted ureas, are only slightly soluble and therefore their toxicity persists in the surface soil. During 1957 some of the promising new herbicides, such as EPTC, Simazin, and Emid, were compared with the standard DNPB herbicide and hand-hoeing. The source of the herbicides, their chemical names, and percent active toxicant are listed in the appendix.

Penn. 602A hybrid corn was planted on the Agronomy Farm during the third week of May. The soil is a Bridgehampton silt loam. The fertilizer used consisted of 1000 pounds per acre of 8-12-12-2, one-half plowed down and one-half in bands at planting time. There were 4 replicates of each treatment. The herbicides were applied with knapsack sprayers using amounts of water equivalent to 30 gallons per acre for readily soluble materials and up to 50 gallons per acre for those more difficult to keep in suspension. The kinds and amounts of herbicides used are shown in Table 1.

One set of untreated plots was hand-hoed as needed. On another set cultivation was delayed until July 1 as it was on the chemically treated plots, so that the percent weed cover could be compared.

Results and Discussion - 1956

Table 1 shows that the average yields of green silage corn for the standard applications of Karmex W, Karmex DW, Neburon, delayed cultivation, and hand-hoed check were 21.7, 20.7, 20.9, 21.2, and 22.5 tons per acre, respectively. When Neburon was applied at the rate of 20 pounds per acre, or smaller amounts were combined with Karmex DW, the yields were reduced so that they were significantly lower than those of the hand-hoed check.

All the substituted ureas markedly reduced the stands of broad-leaved weeds but there were no significant differences among any of the plots in the final estimate of annual grasses on September 14. The broad-leaved weeds were principally wild radish, meally pigweed, spurry and redrooted pigweed. The principal annual grass was hairy crabgrass. No broad-leaved weeds were recorded for the area receiving Neburon at 20 pounds per acre or Neburon at 15 pounds combined with one-fourth pound of Karmex W and 1 pound of Karmex DW. The combinations reduced the yields of corn slightly. Karmex DW at 1 pound per acre was more effective than Karmex W at one-half pound. All 3 substituted ureas at the rates used reduced the broad-leaved weeds effectively. Since none of them alone or in combination suppressed the final stands of crabgrass, there does not seem to be any special advantage in mixing them.

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[1]Contribution No. 933 R. I. Agricultural Experiment Station

Table 1. Average Yields of Silage Corn and Percent Weed Cover, Pre-emergent Weed Control Tests, 1956.

Treatment	Herbicides	Lbs./A.*	Tons/A. Green	Tons/A. Dry	Percent Weed Cover: Dicots 7/1	Percent Weed Cover: Annual Grasses 9/14
1.	Karmex W	½	21.7	4.68	11	37
2.	Karmex DW	1	20.7	4.46	5	30
3.	Neburon	10	20.9	4.51	5	35
4.	Neburon	15	20.8	4.49	5	30
5.	Neburon	20	19.4	4.22	0	23
6.	Hand-hoed Check		22.5	4.86	12	15
7.	Karmex W	¼				
	Karmex DW	1	21.4	4.62	5	30
8.	Karmex W	¼				
	Neburon	10	21.4	4.61	5	30
9.	Karmex DW	½				
	Neburon	10	19.6	4.22	5	25
10.	Karmex W	¼				
	Karmex DW	½				
	Neburon	10	19.9	4.28	5	47
11.	Karmex W	¼				
	Karmex DW	1				
	Neburon	15	19.4	4.18	0	37
12.	Delayed Cultivation		21.2	4.58	42	32
	L.S.D. 0.05		2.5		5	NS

*Commercial Grade. Karmex - 80% Active; Neburon -- 18.5% Active.

Results and Discussion - 1957

The 1957 season was exceedingly dry but the Bridgehampton soil has an excellent moisture supplying capacity so the average green weights of silage corn were comparable to those of 1956. The dry weights averaged higher than in 1956. While the soil was adequately moist at the time of herbicide application, the surface soon became very dry because of deficient rain and weed seeds did not germinate. On June 10, three-fourths of an inch of water was applied by rotating sprinklers. This stimulated the growth of weeds. The weed species, as usual, were not evenly distributed over the area, and consisted of wild radish, meally and redrooted pigweed, and spurry, with a mixture of foxtail, barnyard grass, and crabgrass. Although the grass cover was quite heavy in late June, annual grasses did not become re-established after the thorough cultivation July 1, probably due to the dry surface soil in July.

The average yields of silage corn and the percent weed cover are shown in Table 2. The hand-hoed check yielded 21.7 tons per acre while the plots on which cultivation was delayed averaged only 15.7 tons. All herbicides except Karmex DW at 1 pound per acre and EPTC at 3 pounds per acre allowed

Summary and Conclusions

The substituted ureas--Karmex W, one-half pound per acre; Karmex DW at 1 pound; and Neburon at 15 pounds--reduced the numbers of broad-leaved weeds in corn without lowering the yield. Twenty pounds of Neburon or lesser amounts combined with Karmex DW reduced the yields of corn. In 1957 Karmex DW at 1 pound per acre reduced the silage corn yields. This may be related to the low rainfall this past season. No reduction in annual grasses was noted at the end of the season from the residual effects of the substituted ureas.

In 1957 DNBP, Simazin, G-30028, EPTC, and Emid reduced the stands of broad-leaved weeds, but Emid alone showed a significant reduction in the percent of annual grasses. The use of suitable herbicides can eliminate 3 cultivations where grasses are not a problem. Cultivation is still a satisfactory way of controlling weeds in corn and at least one cultivation by late June favors maximum yields. A combination of inexpensive, safe, effective herbicides with a late cultivation would seem to be a sensible weed control program for Rhode Island.

Appendix I. Chemical Constituents of Herbicides 1957.

1. DNBP. (Dow Premerge) Alkalamine salt dinitro-o-sec-butylphenol (3 lbs./gal. active)
2. EPTC. (Stauffer) Ethyl N, N-di-n-propylthiolcarbamate (6 lbs./gal. active)
3. Karmex DW. (Diuron) (DuPont) -3-(3,4-dichlorophenyl)-1,1-dimethylurea. (80% active)
4. Neburon. (DuPont) 1-n-butyl-3-(3,4-dichlorophenyl)-1-methylurea. (18.5% active)
5. Simazin. (Geigy) 2-chloro-4, 6-bis (ethylamino-S- triazine. (50% active)
6. Emid. (Amer. Chem. Paint) 2-4-dichlorophenoxyacetamide. (75% active)
7. G-30028. (Geigy) 2-chloro-4,6-bis-(isopropylamino)-2-triazine. (50% active)
8. Karmex W. (Monuron) (CMU) (DuPont) 3-(p-chlorophenyl)-1,1-dimethylurea (80% active)

AN EVALUATION OF THE EFFECT OF CARRIERS AND METHOD OF APPLICATION ON THE EFFICIENCY OF HERBICIDES APPLIED PRE-EMERGENCE

D. T. Lillie[1], R. J. Aldrich[2], and W. F. Meggitt[3]

ABSTRACT[4]

Herbicides applied as pre-emergence treatments have not given generally satisfactory weed control under conditions where no rainfall occurs within a reasonable period following treatment.

Modification of formulation techniques and application methods offer a possible means of increasing the efficiency and reliability of pre-emergence treatments under dry soil conditions. Studies were initiated to evaluate the comparative effectiveness of pre-emergence applications of herbicides formulated with such carriers as vermiculite, fuller's earth (attaclay), organic matter, and as aqueous sprays. All applications were compared when applied to the surface of the soil, and when incorporated with the surface layer of soil.

Herbicides applied as soil incorporated pre-emergence treatments in greenhouse and laboratory experiments under controlled conditions gave significantly better weed control than surface applied pre-emergence treatments. The results of laboratory studies also showed that the soil incorporated pre-emergence herbicides in this study were more readily leached to greater soil depths than the same herbicides applied as pre-emergence treatments to the soil surface. The slightly greater leachability of soil incorporated pre-emergence herbicides indicates that soil incorporated pre-emergence treatments might give increased crop injury under conditions of high rainfall following treatment.

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In field studies conducted in 1956 and 1957, several herbicides formulated with carriers such as water, fuller's earth, vermiculite, and organic matter were compared as pre-emergence soil surface and soil incorporated treatments for weed control in corn. In both years, the pre-emergence soil surface treatments were more effective in controlling weeds than the pre-emergence soil incorporated treatments. However, there were significant differences due to the various carriers. In 1956, 2-chloroallyl diethyldithiocarbamate (CDEC) was more effective when applied as an aqueous spray than when formulated with other carriers, while 2,3,6-trichlorobenzoic acid (2,3,6-TBA) was most effective when formulated and applied with vermiculite. There were no significant differences in crop injury between surface and soil incorporated pre-emergence treatments in either year.

PRE- AND POST-EMERGENCE WEED CONTROL IN SOYBEANS[1/]

By J. A. Meade and Paul W. Santelmann[2/]

In recent years most farmers in Maryland have converted from broadcast seeding of soybeans to row seeding. This has been in part the result of an effort to decrease by cultivation the incidence of the many weeds that are found in soybeans in this State. Soybeans are undoubtedly one of the weediest crops grown in Maryland. Weeds not only reduce yields of soybeans through the severe competition which they offer to the beans, but also they cause quite a problem at harvest time. At present Maryland is recommending the use of two chemicals to control weeds in soybeans. These are DNBP (dinitro ortho secondary butyl phenol) and CIPC (isopropyl-n-(3-chlorophenyl) carbamate). In some years these chemicals will do very satisfactory jobs in controlling weeds that are found in soybeans in Maryland. However, too frequently years occur in which the chemicals do not give very satisfactory weed control. There are an increasing number of experimental chemicals for trial in soybeans. The experiments described in this report were carried on to see how some of these experimental chemicals compare with the two recommended chemicals for controlling weeds in soybeans.

PROCEDURE

Plots were established at three locations in Maryland to test the various chemicals under different environmental conditions. In all instances three replications were used and the plots were either 10 or 13 feet wide by 20 feet long. At all locations the air temperature was about 85° at the time of treatment with the exception of the treatments made at Trappe. Here air temperature was 75° at time of treatment. Plots at Fairland (Central Maryland) received no cultivation, except for the cultivated check plot, which received two. The plots at Upper Marlboro (Southern Maryland) and Trappe (Eastern Shore) were cultivated once after the bean plants were well developed.

Applications were made with a modified bicycle type experimental plot sprayer. In all instances treatments were made in thirty gallons of water per acre. The yields for the plots (both pre- and post-emergence) at Fairland are reported herein. The yields for the plots at Upper Marlboro will be given at the meeting of the Northeastern Weed Conference in 1958. Yields were not available for the plots at Trappe. Stand counts were made at Fairland and Upper Marlboro.

1/Miscellaneous Publication No. 307. Contribution No. 2865 of the Maryland Agricultural Experiment Station, Department of Agronomy.

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The treatments used were:

Alanap-3: N-1-naphthyl phthalamic acid, sodium salt.
CDAA: A-chloro-N-N-diallyl acetamide.
CDEC: 2-chloroallyl diethyl dithio carbamate.
DNBP: dinitro ortho secondary butyl phenol.
Neburon: 1-n-butyl-3-(3,4-dichlorophenyl) 1-methyl urea.
CIPC: isopropyl-n-(3-chlorophenyl) carbamate.
Emid: 2,4-D acetamide.
EPTC: ethyl N,N-di-n-propylthiolcarbamate.
Simazin: 2-chloro-4-6-bis (ethyl amino) s-triazine.
2,4-D: 2,4-dichlorophenoxy acetic acid, low volatile ester.
2,4-DB: 4-(2,4-dichlorophenoxy) butyric acid, dimethyl amine salt.
PCP: penta chloro phenol, sodium salt.

Not all treatments were used at all locations. In the treatments at Fairland, German millet was overseeded to serve as a grass weed.

The providing of chemicals and assistance by The Dow Chemical Company, the Naugatuck Chemical Company, the Monsanto Chemical Company, the E.I. du Pont de Nemours and Company, the American Chemical Paint Company, the Stauffer Chemical Company, and the Geigy Agricultural Chemicals is gratefully acknowledged.

RESULTS

Tables 1 and 2 give the results of the pre-emergence experiments. Alanap-3 controlled the weeds satisfactorily on the somewhat light soils of Southern Maryland (Upper Marlboro) and the Eastern Shore (Trappe), but was not as satisfactory in Central Maryland (Fairland). CDAA, CDEC and CIPC were similar in that their use generally resulted in good grass control, but the broadleaved weed control varied according to location. CDAA was generally not as satisfactory as the other two.

The three substituted phenoxy compounds used (Emid; 2,4-D; and 2,4-DB) resulted in good control of grasses with apparently no lasting soybean injury. At Fairland, where yields were obtained, these compounds did not significantly reduce yields or stands of soybeans. At Upper Marlboro Emid appeared to injure the plants early in the season, but the injured appearance disappeared as the season progressed. Soybean stands were not affected. Broadleaved weed control with these compounds varied according to location.

The use of Simazin resulted in good weed control, but also caused considerable soybean injury, particularly at the 3-pound rate. EPTC appeared to be promising, particularly for control of grass type weeds. PCP and DNBP also resulted in good weed control.

DNBP was also used at several stages post-emergence at Fairland, and the results are given in table 3. Although 4 to 6 pounds per acre of DNBP applied pre-emergence were required for satisfactory weed control, only 1½ pounds per acre were needed when used at the correct post-emergence stage. The use of 1½ and 3 pounds at the emergence stage and 1½ pounds at the single leaf stage did not significantly reduce the soybean yield below that of the cultivated check plots at the 1 percent level of significance. Weed control was considered good with these treatments.

SUMMARY

Alanap-3, CDAA, CDEC, DNBP, Neburon, CIPC, Emid, EPTC, Simazin, 2,4-D, 2,4-DB and PCP were applied pre-emergence for weed control in soybeans at three locations. The carbamates resulted in good grass control with varying degrees of success in control of broadleaved weeds. CDEC was least satisfactory. The phenoxy compounds also resulted in good weed control, and did not reduce soybean yields at the one location reported. PCP and DNBP gave good results in general, although this varied somewhat according to location. Simazin gave good weed control, but caused some injury to soybeans.

DNBP used post-emergence at the emergence and the single leaf (low rate only) stages did not reduce the soybean yield and gave good weed control. When used at the cotyledon, first trifoliate and second trifoliate leaf stages, soybean yields were reduced below that of the cultivated check treatment.

Table 1. Effectiveness of various chemicals when used pre-emergence for controlling annual grass and broadleaved weeds in soybeans at two locations. Control given as ratings at various numbers of days after treatment, made on the basis of 0 = no injury or control, 10 = complete kill. Stand count at Upper Marlboro is soybeans per 20' of row.

		Upper Marlboro							Trappe					
		25 days			40 days				19 days			50 days		
Chemical	Rate	Soy-beans	Brlv. Weeds	Grass Weeds	Soy-beans	Brlv. Weeds	Grass Weeds	Stand Count	Soy-beans	Brlv. Weeds	Grass Weeds	Soy-beans	Brlv. Weeds	Grass Weeds
	lb/A													
Alanap-3	2	0	4	5	0	3	5	113	0	7	10	0	4	4
Alanap-3	4	0	7	8	0	4	7	112	0	8	10	0	3	5
CDAA	3	0	6	7	0	1	6	113	1	4	10	0	2	2
CDAA	5	0	3	8	0	0	5	100	0	8	9	0	2	4
DNBP	4	0	9	6	1	7	6	100	0	9	10	0	4	5
DNBP	6	0	9	7	0	5	3	85*	0	9	10	0	5	5
CDEA	3	0	2	0	1	2	1	98	3	7	10	3	5	5
CDEA	5	0	1	1	0	0	3	116	0	7	10	0	1	3
Neburon	2	0	3	3	0	0	2	106						
Neburon	4	0	1	0	0	2	3	99						
CIPC	6	0	8	7	0	7	7	107						
CIPC	8	0	9	8	0	6	8	106						
Emid	3/4	3	9	8	1	8	7	104						
Emid	1½	4	9	9	2	7	9	107						
EPTC	2	0	6	4	0	1	5	101	0	4	6	0	2	4
EPTC	4	0	5	9	0	2	9	117	0	8	10	0	2	3
EPTC	8	1	8	9	0	5	9	112						
Simazin	1½	0	10	7	1	8	6	97	4	6	10	8	8	7
Simazin	3	9	9	8	3	6	8	77*	8	8	10	5	5	5
2,4-D	3/4								0	9	10	0	7	8
2,4-D	1½								1	10	10	0	7	8
2,4-DB(A)	1½								0	8	10	0	7	8
2,4-DB(A)	3								0	8	10	0	7	8
PCP	20	0	8	7	0	5	6	90						
Check		0	0	0	0	0	0	114	0	0	0	0	0	0

*Stand significantly less than check at the 5% level.

Table 2. Effectiveness of various chemicals when used pre-emergence on soybeans, in controlling annual weeds. Control given as injury ratings on the basis of 0 = no injury, 10 = complete kill. Stand count is plants per 10' of row, yield in bushels per acre. Fairland, Md.

Chemical	Rate	July 19			July 31			Sept. 24	Stand count	Yield
		Soy-beans	Brlv. Weeds	Grass Weeds	Soy-beans	Brlv. Weeds	Grass Weeds	Grass Weeds	July 5	
	lb/A									bu/A
Alanap-3	2	0	0	1	0	1	2	1	44	13.3
Alanap-3	4	0	0	3	0	0	4	3	53	15.4
CDAA	3	0	0	9	0	0	8	7	43	15.6
CDAA	5	0	0	9	0	0	9	8	33	18.5
2,4-D (LVE)	3/4	0	0	6	0	0	5	4	46	14.4
2,4-D (LVE)	1 1/2	2	5	7	0	3	6	4	41	12.2
2,4-DB	1 1/2	1	1	5	0	0	5	5	39	16.3
2,4-DB	3	4	4	7	1	3	6	6	39	17.4
DNBP	4	0	8	5	0	9	3	1	38	16.3
DNBP	6	0	9	7	1	9	7	7	39	12.3
CDEA	3	0	0	4	0	0	3	2	31	15.5
CDEA	5	0	0	5	0	0	4	3	33	14.9
CIPC	6	0	0	6	0	2	4	4	43	20.0
CIPC	8	0	5	7	0	3	7	8	43	16.4
Emid	3/4	2	0	6	0	0	5	3	38	18.7
Emid	1 1/3	0		5	0	1	2	2	37	12.3
EPTC	2	0	2	8	0	1	7	6	47	14.5
EPTC	4	0	0	8	0	1	7	5	42	15.1
EPTC	8	0	3	9	0	2	9	8	40	16.8
Check-uncultivated		0	0	1	0	0	0		42	12.1
Check scraped		0	10	10	0	10	10	10	47	21.5
Check handweeded		1	10	10	0	10	10		45	17.1
Check cultivated		-	-	-	-	-	-		35	17.1
									$LSD_{.01}$ = 7.6	NSD

Table 3. Effectiveness of DNBP, when used post-emergence on soybeans at various stages, in controlling annual weeds. Control given as injury ratings on the basis of 0 = no injury, 10 = complete kill. Stand count is plants per 10' of row, yield in bushels per acre. Fairland, Md.

					Ratings									
					July 19			July 31			Sept. 24			
Soybean Stage	Plant Height	Treatment	Rate of D.N.	Air Temp.	Soybeans	Brlv. Weeds	Grass Weeds	Soybeans	Brlv. Weeds	Grass Weeds	Soybeans	Grass Weeds	Stand Count	Yield
Emergence	½"	6/16	1½	85°	0	6	5	0	6	6	0	2	46	18.7
	½	6/16	3	85°	0	10	8	0	3	8	0	3	41	17.0
Cotyledon open	1	6/18	1½	82°	6	10	9	5	10	8	0	4	21	10.9
	1"	6/18	3	82°	3	9	7	1	8	7	0	4	38	13.5
Single leaf	1½"	6/21	1½	75°	3	9	6	3	5	5	0	2	32	16.9
"	1½	6/21	3	75°	8	10	3	5	9	8	4	4	22	9.6
1st trifoliate	2½"	6/25	1½	80°	8	9	7	7	8	8	2	1	15	10.5
	2½"	6/25	3	80°	10	10	9	10	9	9	[illegible]	4	0	0
2nd trifoliate	5"	7/3	1½	85°	0	6	1	0	8	1	0	1	40	12.2
	5"	7/3	3	85°	1	9	1	0	6	2	0	0	42	11.3
Check - uncultivated					0	0	0	0	0	0	[illegible]	0	42	13.0
Check - cultivated													45	18.0
												$LSD_{.01}$	10.6	3.8
												$LSD_{.05}$	12.8	4.6

QUACKGRASS CONTROL IN PENNSYLVANIA*

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Chemical control of quackgrass at medium and high treatment rates was satisfactory, but the lower treatment rate gave poorer control than in 1954 or 1955.

A thick stand of quackgrass was treated with the chemicals listed in table 1 when the plants were 4-6 inches tall. The quackgrass was allowed to grow 2 weeks after treatment, then the land was plowed, disked and the area planted to corn the same day. The higher rates of dalapon and FW 450 were replanted to corn four weeks after plowing.

There was some injury to the replanted corn on the 10, 20, and 40 pounds of dalapon, and on the 40 pounds of FW 450.

This means, though dalapon is effective in controlling quackgrass, it is not very practical to try to grow corn after spring treatment with dalapon on quackgrass in Pennsylvania for it is necessary to let the quackgrass grow until it is 4-6 inches tall, treat, allow to stand one week before plowing and 4 weeks or more after plowing before planting corn. Under some conditions dalapon persists in the soil for a much shorter period than 4 weeks.

The leaves of the corn grown on the 2,3,6 trichloro-benzoic acid plots were somewhat more turgid and upright than normal corn leaves. There was no apparent injury from any amino triazole treatment.

There are many factors which influence the effectiveness of amino triazole on quackgrass. It is hard to kill quackgrass when it is growing slowly due to lack of nutrients, heavy soils, or wet conditions. Heavy aftermath, manure or corn cobs may delay the early emergence of quackgrass and often give spotty control because not all the quackgrass is up when the amino triazole is applied. A good job of plowing and seed bed preparation is essential for good control. It is desirable to plant the corn the same day the sod is plowed so that the quackgrass does not get a head start on the corn. Amino triazole makes the quackgrass "sick and slow growing." Cultivation of the corn kills the weakened quackgrass plants. Do not use 2,4-D pre-emergence on corn which is planted on soil which is treated with amino triazole.

The 2,3,6 trichloro-benzoic acid look promising for the control of quackgrass but there may be several hazzards with this treatment.

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Table 1. Percent Quackgrass Control Estimated November 21, 1957. Average of 4 Replications.

Material and rate per acre in pounds		Percent Control
Amino triazole	1	50
" "	2	53
" "	4	87
" "	8	96
" "	4 ≠ 50 lbs. Nitrogen in early spring	91
Dalapon	2	35
"	4	42
"	6	55
"	10	83
"	20	92
"	40	98
FW 450	10	63
"	20	70
"	40	94
Amino triazole 1 Dalapon	2	57
" 1 "	4	50
" 1 "	6	60
" 2 "	2	56
" 2 "	4	65
" 2 "	6	66
" 1 2,3,6 trichloro-benzoic acid	1	52
" 2 " "	2	57

Studies with EPTC for Nutgrass Control

by

Walter J. Saidak

Nutgrass (Cyperus esculentus L.) is one of the most serious perennial weeds in New York State. It is an exceedingly strong competitor with crop plants especially row crops such as corn, beans, and potatoes. Recently, there has been a trend to increasing occurrences of entire field infestation, as well as the standard spot infestations. The nutgrass control program at Cornell has had two main objectives. One has been the search for some treatment which will result in complete eradication. The other objective has been to obtain some treatment which would enable a row crop to compete more favorably with the pest.

Low rates of EPTC were found by Probandt (3) to have marked inhibiting effects on nutgrass. His finding coupled with the wide range of crops tolerant to this chemical as reported by Antognini et al (1), drew attention to the possibility that this chemical might answer the control program objective of maintaining row crops, as well as controlling nutgrass. Thus, a preliminary greenhouse study was initiated in March 1957 to determine the effect of rates of 1 to 20 pounds of EPTC on various stages of nutgrass growth. It was found that equal control was obtained with applications varying from the pre-emergence stage to plants which were two inches high. A ten pound per acre rate was found to give 100% control for a period of one month following treatment. In all cases, however, regrowth with new tuber formation occurred.

Subsequently, a series of field experiments were conducted to evaluate the effectiveness of nutgrass suppression by EPTC, in various row crops which were tolerant to the chemical. A total of seven locations were used. Three of these locations were in Western New York and four locations were in Central New York. The Central New York crops included two locations with field corn, and one each of potatoes and red kidney beans. Potatoes, field corn and red kidney beans were the crops at the Western New York locations. The area of the field selected was based on previous years observations of heavy uniform natural infestations. The treatments were applied to the crop which the grower had in the selected field. At all locations a randomized complete block with four replications was used. Plot size was three feet by thirty feet with the crop row being used to center the plot. All treatments were applied using a small plot sprayer.

Generally a period of one week separated the various spray dates. The regrowth applications for treatments 7 and 8 were made at a much earlier date than expected due to a lack of any indication of chemical activity. The treatment list which was identical for all locations is as follows:

Paper number 417. Vegetable Crops Department
Cornell University, Ithaca, N.Y.

Treatment Number	Treatments (All in Pounds active EPTC per Acre)
1.	5 at or soon after planting
2.	10 at or soon after planting
3.	5 at or soon after emergence
4.	10 at or soon after emergence
5.	2-1/2 at or soon after planting + 2-1/2 lbs at or soon after emergence
6.	5 at or soon after planting + 5 lbs. at or soon after emergence
7.	2-1/2 at or soon after planting + 2-1/2 lbs. at or soon after emergence + 2-1/2 on regrowth.
8.	5 at or soon after planting + 5 lbs. at or soon after emergence +5 on regrowth.
9.	Check.

A single location in Central New York was used to evaluate the effectiveness of pre-planting soil incorporation of EPTC. A randomized block design with four replicates was the experimental design. Plot size was three feet by thirty feet. On June 18th the entire area had a uniform nutgrass stand about two inches high. The plots receiving the pre-planting treatment were treated on this date, using a small plot sprayer. The area was then thoroughly harrowed with a spring tooth. A single row of snap beans was then planted in the center of the plots in two replicates. The other two replicates were planted to sweet corn. The second set of treatments were applied on July 3rd. This was followed by the first and only cultivating the plots received, was on July 3rd. Nutgrass height on this date averaged two inches. The following treatments were used for this study.

Treatment Number	Treatment (All in pounds active EPTC per acre)	
1.	2-1/2	pre-planting
2.	5	pre-planting
3.	10	pre-planting
4.	20	pre-planting
5	2-1/2	pre-planting + 2-1/2 prior to cultivation
6.	5	pre-planting + 5 prior to cultivation
7	10	pre-planting + 10 prior to cultivation
8.	Check.	

All field plots were rated in late August for the degree of nutgrass control using a visual rating scale. Ratings varied from one through nine with a one rating representing no control and a nine rating representing 100% control. Records were taken on any evidence of EPTC crop damage.

Results:

Ratings were not made at the locations where potatoes were used as no nutgrass control due to chemical treatment was observed. There were no evidences of any crop damage due to EPTC at either location.

In July, a period of control was noted at both the Western New York locations, with the single ten pound treatment being outstanding. Both locations had no EPTC damage to the bean and corn test crops. In August, however, no consistent plot differences were apparent.

The Central New York bean and corn locations were rated on August 20th. The ratings were statistically analyzed using Duncan's multiple range test (2). For each location the error mean square had twenty-four degrees of freedom. The error mean square values at the various locations were: Usher farm .41, Currie farm .30, and Wilson farm .54. The treatment mean values are presented in Tables 1,2, and 3. Means which are underlined are not significantly different at the five per cent level. Numerals I, II and III represent treatment applications applied pre-emergence, at emergence and on regrowth respectively.

Table 1. Usher Farm - Field Corn.

5 lbs.	10 lbs.	5 lbs.	2-1/2 lbs.	10 lbs.	5 lbs.	5 lbs.	2-1/2lbs.	Ck.
I		I	I			I	I	
II	II	II	II	II	II			
III			III					
7.5	5.5	5.3	5.0	4.8	4.0	3.5	3.3	2.0

Table 2. Currie Farm - Red Kidney Beans.

5 lbs.	2-1/2 lbs.	10 lbs.	10 lbs.	5 lbs.	5 lbs.	2-1/2lbs.	5 lbs.	Check
I	I			I	I	I	I	
II	II	II	II	II		II		
III	III							
9.0	6.8	6.0	5.8	5.8	4.0	3.8	3.5	2.0

Table 3. Wilson Farm - Field Corn

5 lbs.	10 lbs.	5 lbs.	10 lbs.	10 lbs.	2-1/2 lbs.	2-1.2 lbs.	5 lbs.	Check
I		I	I	I	I	I	I	
II	II	II			II	II		
III					III			
8.3	7.0	6.5	6.0	5.0	5.0	4.8	4.5	2.0

The red kidney beans showed no indications of any EPTC injury from any treatment. Yields taken on the check and the fifteen pound total EPTC treatment revealed a twenty-eight per increase in the dry weight of beans from chemical treatment. Field corn was severely damaged by the fifteen pound total treatment and some damage was noticed at the ten pound rate.

The treatment mean rating values for the soil incorporation experiment are given in Table 4. Treatments applied pre-planting are represented by a I, and the pre-cultivation treatments are represented by a II. Duncan's multiple range test (2) was used for statiscal analysis employing an error mean square of a .71 with twenty-one degrees of freedom for the

Table 4. Soil Incorporation Experiment.

10 lbs. I and 10 lbs. II	5 lbs. I and 5 lbs. II	20 lbs. I	2-1/2 lbs. I and 2-1/2 lbs. II	10 lbs. I	5 lbs. I	Check and 2-1/2 lbs I
8.5	7.0	5.5	4.8	4.3	2.8	2.0

None of the treatments used in this experiment produced any EPTC damage on the snap beans or sweet corn.

Discussion:

The results indicate that nutgrass control with EPTC was much more successful in the Central New York locations than in the Western locations. A possible explanation of these results might be the fact that Western New York experienced a much drier growing season in comparison to the Central portion of the State. Another possibility might be that more thorough cultural practices were used in Central New York. A critical study of the influence of climatic conditions and cultural practices on EPTC activity, would be valuable in future studies.

Tables 1,2 and 3 illustrate that the total rate of EPTC applied was more important than the timing. The fifteen pound total rate gave significantly better control than any other treatment. At one location 100 per cent control at harvest from this treatment was observed. Apparently, beans were not damaged at any rate used in this experiment. Field corn was sensitive to rates in excess of ten pounds.

The lack of any nutgrass control in potatoes is possibly explained by soil dilution of the chemical due to the cultural practices employed with this crop. The above argument becomes more valid when we consider the soil incorporation experiment results where a considerable loss of activity was noted due to soil incorporation.

Conclusions:

EPTC seems to have a marked suppressing effect on nutgrass if applied pre-emergence or shortly after emergence. Beans and potatoes appeared tolerant to rates of the chemical which gave nutgrass control. Therefore, the possibility of using EPTC in conjunction with a nutgrass control program in beans appears quite promising, as a control practice.

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Control of Nut Grass (Cyperus esculentus) in Corn with DNBP

Collins Veatch [1]

Nut grass Cyperus esculentus is a serious weed in some sandy soils in West Virginia. This is especially true during wet seasons in cultivated fields. Under normal or dry seasons it can be controlled by cultivation. DNBP has given good control of nut grass in experimental plot work and field trials in West Virginia during the past four growing seasons when applied as a post-emergence spray.

During the 1954 season corn plots at Point Pleasant were given a post-emergence spray of DNBP, using drop pipes, when corn was about 24 inches in height. This spray gave good control of all weeds including the nut grass. Similiar observations in 1955 confirmed the possibilities of controlling nut grass in corn by the use of directed post-emergence sprays of DNBP.

In 1956 a corn field on the Reymann Memorial Farms at Wardensville, West Virginia, which was badly infested with nut grass was sprayed with DNBP. Drop pipes were used to give a directed spray. The DNBP was applied at the rate of three pounds per acre in 28 gallons of water at a pressure of 80 p.s.i. This field spray gave better nut grass control then the four pound application with a plot sprayer when using a pressure of 20 p.s.i. The increased effectiveness was apparently due to more effecient wetting or more thorough coverage at the higher pressure.

In 1957 a post-emergence application of four pounds of DNBP gave good control of nut grass in corn in plot experiments at Point Pleasant and Wardensville. A field test was made at Wardensville by applying three pounds of DNBP per acre when the corn was six to eight inches high and the nut grass only a little shorter. The corn leaves were damaged by the spray but soon recovered. The nut grass was almost completely killed or controlled.

Summary

Nut grass in corn has been successfully controlled by post-emergence spraying with DNBP at rates of three to four pounds of active material per acre.

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COMPARISONS OF COMMERCIAL HERBICIDES FOR BRUSH CONTROL ON POWER LINE RIGHTS-OF-WAY

by

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and W. R. Rossman*

INTRODUCTION

Chemical brush control has been proven economically successful by utility companies and commercial applicators during the past ten years. (1) More recently, the main concern has been what chemical treatments are most efficient to use over a period of several years. With many new products available for brush control and several methods of application being advocated, an experiment was arranged to compare various treatments under commercial conditions.

MATERIALS AND METHODS

Treatments were applied to a section of one of Potomac Edison Company's 132 KV transmission lines in Frederick County, Maryland. The first replication was applied on a northern exposed slope and the second replication was on the southern exposed slope. The mixed brush was typical of this Appalachian mountain area and consisted primarily of the following species:

Oak:	
White Oak	_Quercus alba_ L.
Red Oak	_Quercus rubra_ L. (predominant)
Chestnut Oak	_Quercus montana_ (l. Willd)
Maple, Red	_Acer rubrum_ L.
Locust, Black	_Robinia Pseudo-Acacia_ L.
Sassafras	_Sassafras albidum_ (Nutt.) Nees
Birch, Yellow	_Betula lutea_ Michx.
Cherry, Wild Black	_Prunus serotina_ Ehrh.
Cherry, Choke	_Prunus virginiana_ L.
Dogwood	_Cornus florida_ L.
Chestnut	_Castanea dentata_ (Marsh) Borkh.
Hickory	_Carya_ spp.
Witch-hazel	_Hamamelis virginiana_ L.

* Plant Physiologist, The Dow Chemical Company; Forester, Potomac Edison Company; Forester, Penn Line Service, Inc.; Forester, Pennsylvania Electric Company; respectively.

Elm:

American Elm	*Ulmus americana* L.
Slippery Elm	*Ulmus rubra* Muhl.
Ailanthus	*Ailanthus altissima* (Mill) Swingh.
Ash:	
White Ash	*Fraxinus americana* L.
Red Ash	*Fraxinus pennsylvanica* Marsh.
Black Ash	*Fraxinus nigra* Marsh.
Tulip Poplar	*Liriodendron tulipifera* L.
Black Gum	*Nyssa sylvatica* Marsh.

The line had been capital cleared in 1954 and most species had growth 6 to 8 feet high. No chemical treatment was applied to this area prior to these treatments. Some black locust and tulip poplar were 15 to 20 feet high.

Applications were made on June 27, 28, 29 and July 2, 1956, with a John Bean sprayer mounted on a power wagon. A commercial spray crew of four men and a foreman working with two hose lines and adjustable spray guns fitted with No. 7 discs made all applications. A spraying pressure of 175 to 200 pounds per square inch was used for all leaf-stem applications. The spray was applied as a conventional leaf-stem application by directing the spray at the base of the stems and following up the stems to thoroughly wet all sides of the stems and leaves. Average volume per acre was 276 gallons. Basal applications were applied with a commercial basal spray gun with 50 to 75 pounds per square inch pressure. Ninety-two gallons of spray were used per acre.

The water and oil-water emulsions were applied as leaf-stem sprays in 100 gallon plots and the basal applications were applied in No. 2 fuel oil in 30 gallon plots.

The following treatments were applied in randomized duplicate plots:

Common Name **	Lbs./Ahg.	Carrier	Formulation Used
2,4,5-T ester	4	Water	Esteron 245 O.S.*
2,4,5-T and 2,4-D ester	2 2	Water	Esteron Brush Killer O.S.*
Silvex ester	4	Water	Kuron*
2,4,5-T ester	2	Water + 10% No. 2 fuel oil	Esteron 245 O.S.*
2,4,5-T and 2,4-D ester	2 2	Water + 10% No. 2 fuel oil	Esteron Brush Killer O.S.*
2,4,5-T amine salt	4	Water	Veon 100*
2,4,5-T amine salt	16	Water	Veon 100*
2,4,5-T ester	16 (basal)	Oil (basal)	Esteron 245 O.S.*

*Trademark of The Dow Chemical Company
**All esters applied were the propylene glycol butyl ether esters.

At the time the applications were made the species present in each plot was recorded. The temperatures at the time of application and two months following were normal for the area. The precipitation for the month of June was .75 inches below normal, for July, 1.82 inches above normal, and for August, 2.81 inches below normal. The plants were making normal growth at the time of treatment and this growth continued on the untreated areas throughout the summer.

Observations were made during the applications and at intervals throughout that growing season. A control rating of the treatments was made on September 12, 1956. In the spring and summer of 1957, additional observations were recorded and on September 17, 1957, the treatments were rated as to control of each individual species or clump by rating two separate quarter sections of both replications.

RESULTS AND DISCUSSION

All formulations applied in water and oil-water emulsions formed satisfactory mixtures with no apparent separation of the various components in the sprayer mixing tank. There was no noticeable sediment formed when the 2,4,5-T ester was used in oil as a basal application. The spray men had difficulty in applying the basal treatments because of the herbaceous growth and dense brush covering many of stems to be treated. All mixtures appeared to give satisfactory wetting of the leaves and stems when they were applied.

Three days after the applications were made with the oil-water emulsions, extreme browning of the leaves of all species was evident. The rate of browning of the leaves from the other treatments were as follows in descending order: 2,4,5-T plus 2,4-D ester in water, 2,4,5-T ester in water, 2,4,5-T amine salt - 16 lbs./ahg. in water, 2,4,5-T amine salt - 4 lbs./ahg. in water, silvex ester in water, and 2,4,5-T ester in oil as a basal spray.

1956 Observations

Control ratings, made on September 2, 1956, are given in Table I.

Table I.

Treatment	Lb./Ahg.	Type of Application	Carrier	Control Rating*
2,4,5-T ester	4	Leaf-stem	Water	70
2,4,5-T plus 2,4-D ester	4	Leaf-stem	Water	65
Silvex ester	4	Leaf-stem	Water	70
2,4,5-T ester	4	Leaf-stem	Oil-water	65
2,4,5-T plus 2,4-D ester	4	Leaf-stem	Oil-water	65
2,4,5-T amine salt	4	Leaf-stem	Water	80
2,4,5-T amine salt	16	Leaf-stem	Water	90
2,4,5-T ester	16	Basal	Oil	90

* 0 = No control; 100 = Complete top-kill.

Leaf-stem applications of 2,4,5-T ester in water gave a slightly higher rating than did similar applications of the same chemical in an oil-water emulsion. In the plots treated with the oil-water emulsions, some maple and black locust were resprouting while the water applications resulted in excellent top kill of maple with no sprouting from the root collar. Treatments with 2,4,5-T plus 2,4-D ester in water exhibited some root sprouting of black locust, and most of the yellow birch had green stems which resulted in the lower rating as compared with the 2,4,5-T ester in water. The 2,4,5-T plus 2,4-D ester, applied as an oil-water emulsion, showed no resprouting of black locust, but sassafras was root sprouting. This was responsible for the lower rating. The silvex ester treatment showed poor top kill of ash and green stems were found on yellow birch, black locust and hickory but little resprouting was observed. Plots treated with 2,4,5-T amine salt at 4 lbs./ahg. of water received a rating of 80 since good top kill of all species, was evident, except ash, with no resprouting. The 2,4,5-T amine salt at 16 ahg. of water gave excellent top kill and was the best leaf-stem treatment. However, some of the ash still had green stems.

Basal application of 2,4,5-T ester gave good top kill with no resprouting, but some stems were surviving, probably because they were missed during application due to herbaceous growth and dense brush.

1957 Observations and Ratings

Spring Observations - Observations made on May 7, 1957 indicated only a slight difference in species response from the earlier observations. The oil-water treatments exhibited excellent top kill of most species and had fewer green stems on oaks than the water treatments. Red maple was sprouting profusely from root collars where the oil-water treatments had been applied. The plots treated with 2,4,5-T plus 2,4-D ester formulation in water showed more sprouting of red maple from the root collar than did the plots treated with 2,4,5-T alone. Silvex gave excellent top kill of cherry, yellow birch, dogwood, black locust, hickory, and red maple. However, a few red maples were sprouting from the root collar and some of the oaks had green stems and were stem sprouting half way up. 2,4,5-T amine salt gave excellent top kill of all species, including ash, at both concentrations but some oak stems were still green. Red maple showed slight resprouting from the root collar where 2,4,5-T amine salt was applied at 4 lbs./ahg. The lack of vegetation around the base of the clumps sprayed with 2,4,5-T amine salt was particularly noticeable at this time especially where 16 lbs./ahg. water were applied. The basal applications were showing an excellent top kill on all species except for some small seedlings which probably were missed.

Grasses and herbaceous plants were rapidly invading all of the sprayed areas regardless of the treatment. May apple (*Podophyllum peltatum* L.) and poke weed (*Phytolacca americana* L.) were the most abundant species invading the plots.

Fall Observations - Although the treatments were studied and rated on July 30, 1957, final ratings were made on September 17, 1957. These were arrived at by evaluating each species or clump in separate quarter sections of both replicates of each treatment. Results are shown in Table II. A response rating was given for a species only if at least five or more clumps or individual plants of that species were present in areas evaluated.

Table II. The Percent of Plants Falling Within Each Response Rating* Following the Application of Herbicides** to Several Species.

Species	Response Rating*	2,4,5-T Water	2,4,5-T + 2,4-D Water	Silvex Ester Water	2,4,5-T Oil-Water	2,4,5-T + 2,4-D Oil-Water	2,4,5-T Amine Salt 4 lbs. Ahg. Water	2,4,5-T Amine Salt 16 lbs. Ahg. Water	2,4,5-T Oil Basal
		%	%	%	%	%	%	%	%
Oak	1						4		4
	2								
	3	12	10	6	8		10		
	4	21	16	18	24	24	19	11	4
	5	67	74	76	68	76	67	89	92
Maple	1								6
	2								
	3		7		4				
	4	12	26	25	41	50	11		12
	5	78	67	75	55	50	89	100	82
Black Locust	1						5		
	2								
	3								
	4	36	33	21	39	38	7		3
	5	64	67	79	61	62	88		97
Ash	1		20			9			49
	2			15	20	9			17
	3		40	31		18	36		
	4		20	54	60	64	14	17	17
	5		20		20		50	83	17
Hick-ory	1								
	2			20			10		11
	3			20					11
	4	25	40	20	60	17	60		33
	5	75	60	40	40	83	30		45
Cherry	1								20
	2	4							20
	3			10	6	14	14		
	4	4		50	23	29			40
	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]

Species	Response Rating*	2,4,5-T Water	2,4,5-T + 2,4-D Water	Silvex Ester Water	2,4,5-T Oil-Water	2,4,5-T + 2,4-D Oil-Water	2,4,5-T Amine Salt 4 lbs. Ahg. Water	2,4,5-T Amine Salt 16 lbs. Ahg. Water	2,4,5-T Oil Basal
		%	%	%	%	%	%	%	%
Elm	1								3
	2								29
	3						15		21
	4						62	7	
	5						23	93	47
Black Gum	1								
	2								
	3								
	4				93	43	20	20	50
	5		100		7	57	80	80	50
All Species Total	1		1			1	2		5
	2	1		1	1	1	1		7
	3	2	4	4	3	3	9		3
	4	21	21	23	32	38	21	10	12
	5	76	74	72	64	57	67	90	73

*Response ratings:
1. Little or no effect.
2. Incomplete top kill with sprouting from both old stems and roots or root collar.
3. Incomplete top kill -- no resprouting from root collar or roots.
4. Complete top kill -- with regrowth from the roots or root collar.
5. Complete top kill -- no regrowth.

**All treatments employed propylene glycol butyl ether ester formulations except where otherwise indicated.

The total ratings for all species includes all woody species except sassafras and yellow birch. Sassafras was top killed by all treatments but some root sprouting occurred. The plots with southern exposure were invaded by numerous sassafras seedlings 1 year after treatment and it was difficult to differentiate between them and root sprouts. Excellent control of yellow birch was obtained with all treatments. However, the density of this species varied among plots, and consequently, obscured the responses on the other species when all species were totaled.

Oak Response

The basal applications of 2,4,5-T ester and the leaf-stem treatment of 2,4,5-T amine salt at 16 lbs./ahg. gave the highest percent kill, representing 92 and 89 percent, respectively. These treatments also gave the least root collar sprouting of any of the treatments. The oil-water treatments with 2,4,5-T ester gave more root collar sprouting of oak than the water-borne sprays of the same chemical. There was very little difference in kill between water or oil-water treatments when comparing 2,4,5-T ester alone or in combination with 2,4-D ester.

Silvex at 4 lbs./ahg. and 2,4,5-T plus 2,4-D in oil-water both gave 76 percent kill. However, silvex gave less root collar and stem sprouting. Since silvex reacts slowly, next year's observation may indicate a greater difference between these treatments. (2)

Maple Response

2,4,5-T amine salt at 4 and 16 lbs./ahg. gave 89 and 100% kill, respectively. These 2,4,5-T amine treatments were the outstanding treatments on maple. 2,4,5-T and silvex esters at 4lb. per ahg. of water gave a considerably higher percent kill than either 2,4,5-T plus 2,4-D ester in water or in oil-water. 2,4,5-T ester alone and in combination with 2,4-D ester as oil-water treatments gave 41 to 50% root collar sprouting, respectively. It is interesting to note that the percent root collar sprouting correlates with the rate of brown-out resulting from these treatments. Perhaps, with this species, at least, the increase in contact leaf burn obtained after application reduces translocation of the herbicide in the woody plants as pointed out by Leonard. (3)

Black Locust Response

2,4,5-T ester as a basal application gave 97% kill and was the best treatment. 2,4,5-T amine salt at 4 lbs./ahg. gave 88% kill, which was a slightly higher percent than the silvex treatments and considerably higher than the other water or oil-water treatments. There was an insufficient number of black locust present to evaluate the 2,4,5-T amine at 16 lbs./ahg. treatments.

Root sprouting was more prevalent in the oil-water treatments than where water applications were made. Where 2,4,5-T ester was applied in an oil-water emulsion, 38 percent of the black locust was root sprouting, and 2,4,5-T ester in combination with 2,4-D ester resulted in 39% root sprouting, with black locust, silvex and 2,4,5-T amine which gave the slower leaf burn, also gave the least resprouting.

Ash Response

The ash species were not present in sufficient numbers to evaluate in all treatments, however, 2,4,5-T amine salt at 16 lbs./ahg. gave 83% kill. This was the best treatment evaluated. 2,4,5-T amine salt at 4 lbs./ahg. gave 50% kill with 14% showing root collar sprouting and 36% exhibiting regrowth from the stems. 2,4,5-T ester alone and in combination with 2,4-D applied as an oil-water emulsion and silvex treatments gave between 54 and 64% root collar sprouting.

Cherry Response

Wild black cherry and choke cherry was present in sufficient numbers to be evaluated in four treatments. 2,4,5-T ester plus 2,4-D ester as oil-water emulsions gave 71% kill with 6% showing stem sprouting and 23% showing root collar sprouting, In the silvex treatments, only 10 individuals were rated, with 50 percent of them showing kill and 40 percent showing root sprouting.

Yellow Birch Response

Yellow birch was controlled by all treatments with the least effective treatment giving 94 percent kill. A comparison of the various treatments was impractical.

Elm Response

The slippery elm and American elm showed 93 percent kill with 2,4,5-T amine at 16 lbs. ahg. 2,4,5-T amine at 4 lbs. ahg. gave only 23 percent kill with 62 percent showing resprouting from the root collar. 2,4,5-T ester as a basal application gave only 47 percent kill.

Black Gum Response

2,4,5-T amine at both 4 and 16 lbs. ahg. gave 80 percent kill of black gum and 20% showed regrowth from the root collar. 2,4,5-T ester alone and in combination with 2,4-D ester as an oil-water emulsion gave 93 percent and 43 percent regrowth respectively from the root collar.

Hickory Response

Hickory species were not present in sufficient numbers to properly evaluate their reaction to the various treatments.

All Species Total Response

In averaging the response of all species 2,4,5-T amine at 16 lbs. ahg. gave 90 percent kill with only 10 percent showing regrowth at the root collar or roots. 2,4,5-T ester alone and in combination with 2,4-D ester in water gave 76 and 74 percent kill respectively. Silvex and the 2,4,5-T ester applied as basal applications gave 72 and 73 percent kill respectively. The oil-water emulsion treatments gave the lowest percent kill and highest percent regrowth from the root collar or roots, of any of the treatments. Basal treatments gave the highest percent of individuals showing little or no effect, and with incomplete top kill and with regrowth occurring from both the stem and root areas. 2,4,5-T amine at 4 lbs. ahg. gave the highest percentage incomplete top kill with regrowth from the stems.

Additional evaluation of these treatments will be made in 1958 and 1959.

SUMMARY

Several brush control treatments were evaluated under commercial conditions. Observations during the 16 months following application indicated the following results:

1. 2,4,5-T amine at 16 lbs. ahg. of water gave excellent control of all species.
2. 2,4,5-T amine was more effective on red maple and black locust than any other herbicide or formulation.
3. Oil-water emulsion sprays gave good top kill of some species but root or root collar sprouting was greater than resulted from water borne sprays.
4. Treatments causing rapid contact injury or burn to leaves resprouted vigorously, thus indicating lessened herbicidal effectiveness possibly due to a reduction in translocation.
5. 2,4,5-T ester gave a higher percent kill of most species than did combinations of 2,4,5-T ester plus 2,4-D ester.
6. Silvex gave a higher percent kill of oak and black locust -- than did the 2,4,5-T ester or combinations of 2,4,5-T plus 2,4-D esters.

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RIGHT-OF-WAY BRUSH CONTROL RESEARCH AND ITS RAMIFICATIONS

by
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Right-of-way brush control research, like the weather is something that we all discuss but none of us have been able to do much about. In fact, most of us haven't really known what we are trying to accomplish. This paper is a brief outline of some of the problems involved in right-of-way research, some experiences the writer has had and some suggestions for improvement of a situation which unlike the weather can be changed.

Right-of-way brush control with herbicides was virtually a new concept in 1945, and as a new concept, very little prior art in research methods had been established. The situation as far as agronomic weed control was, of course, similar, but the greater effort which was put forth by research agencies in this field and well established techniques for evaluating crop response permitted more rapid progress. In contrast, woody plant research as an art is relatively immature. An "Atmosphere of Mystery" still prevails in this field, and such a climate has often been exploited improperly. It is, therefore, important to the contractor, user and to the chemical company to give greater consideration to the basic technical aspects of right-of-way brush control, particularly to the research devoted to solve specific problems, to the research behind the products being marketed, and to the evaluation of commercial programs.

SOURCE OF CHEMICALS

In most instances, new chemicals and new formulations (which, incidentally, exceed the number of new chemicals) are provided to public agencies and industrial research personnel by the chemical industry. Most companies have facilities to give them at least a cursory evaluation before they are forwarded to other groups. This should, of course, be done conscientiously. It is inconsiderate and unfruitful to sample formulations and chemicals indiscriminately to experiment stations or other research agencies on the basis of hunches, theories or "just try it out". The shelves of most industrial organizations are lined with poor hunches and this is part of the price of industrial research. The shelves of public agencies, in contrast should contain potentially successful herbicide candidates.

[1] The Dow Chemical Company, Midland, Michigan

TESTING TECHNIQUES

Laboratory:

All new herbicide compounds must be subjected to basic laboratory tests before becoming candidates for right-of-way brush control. Field research dollars cannot justifiably be expended on compounds which have not shown real phytotoxic merit; are too hazardous to use; are uneconomical to produce; or are to difficult to formulate. Laboratory evaluation can be divided into several classes of investigation.

1. Phytotoxicity: Screening tests, using chemicals of unknown phytotoxicity, are ordinarily made on seedling annual crops to determine if the compound is basically herbicidal. Those showing adequate activity are tested further to determine the use spectrum and mode of activity. Laboratory plants and techniques are useful in the evaluation of these points. They also permit accumulation of considerable information regarding the compound, using micro quantities of compounds which are not readily available.

2. Human Toxicity: A low hazard to the user is an important qualification. We have long since evolved from the era when man fought nature with anything at hand and sometimes succumbed himself in the process. The spray crews and the public must be protected.

3. Production: Field research programs built on compounds which cannot be put into the consumer's hands on an economic basis have a shaky foundation and can't hope to be successful. Commercial products must be profitable to both the user and to the manufacturer.

4. Formulation: Tests to determine the most feasible formulation from economy, handling, performance and packaging standpoints are an important part of product evaluation. Inverton*- a new invert emulsion formulation, is an example of the importance of formulation research. The concept of an invert emulsion was well known; however, an adaptation of this principle to herbicides required some extensive laboratory research. Formulating a material to form an invert emulsion was not difficult, but producing an economical formulation suitable for potential field use and satisfactory from the standpoint of packaging, storage retention, etc. required considerable laboratory investigation.

* Trademark of the Dow Chemical Company.

Nursery:

The use of a nursery planting of woody plants is helpful for "range finding" work in establishing information on the spectrum of activity, dosages required, techniques of application, timing, and other essential factors for promising herbicides. The nursery permits the testing of a number of species with a very small amount of experimental herbicide. One of the first axioms of the medical profession is "know the disease, then seek the cure". In woody plant research a similar axiom is true in that it is essential to know the species to be controlled and how it responds to specific compounds. In the nursery it is possible to isolate a given species and establish its response to a certain herbicide. This has been an important contribution of many public research agencies.

The nursery permits selection for uniformity, thus eliminating one of the variables which confront the research man studying woody plant control in nature. We have found that, even though we are able to select plants with similar morphology and exact cultural history, a minimum of 10 plants is required for reproducable results. This being true in the nursery, it is easy to visualize the futility of working with small numbers of plants on the right-of-way where natural variables are extremely significant and numerous. Several years ago, the writer established a latin square, with six replicates one-hundreth acre in size, on a right-of-way uniformly populated with oak. In spite of all precautions, the variation in control within treatments varied as much as 45%.

In general, the critical dosages are somewhat lower on two and three year old nursery seedlings than on stump sprouts on the right-of-way. For example, the use of 12 to 16 pounds acid equivalent of 2,4,5-T, 2,4-D or silvex per 100 gallons required for satisfactory control with basal treatment of some right-of-way species might be reduced 50% on nursery trees. A further advantage of the nursery is the relative freedom from hazards, such as fire, insects, bulldozers, blasting, erosion and cutting. The nursery permits the treating of vegetation close to headquarters, thus reducing travel time, and by its convenience encourages a more diligent effort in follow-up observations.

A recent experiment to explore the importance of leaves in herbicidal action is an example of the type of use for which a nursery is ideally suited. The experiment was conducted on white ash (Fraxinus americana) and red osier dogwood (Cornus stolonifera) using 10 uniform plants per treatment. Esteron 245 O.S. was applied with a knapsack sprayer at a concentration of 4 lb. agh. in several ways as outlined in Table I. The principal introduced variable was stripping leaves from some plants prior to spraying while others were left intact. The results (shown in Figure 1) demonstrate the importance of testing more than one species. Ash failed to respond when no leaves were present while dogwood responded very well. It further points out that the type of application is important as a variable since all dogwood plants were killed when the entire plant was sprayed, while most of them sprouted from the root collar when only the tops were sprayed.

Table 1

RESPONSE OF ASH AND DOGWOOD NURSERY STOCK TO SEVERAL HERBICIDAL TREATMENTS

	Carrier*	Leaves	Application	Response Index***	
				Dogwood	Ash
1.	Water + oil	Clipped**	Top only	4.0	1.0
2.	Water + oil	Not clipped	"	4.5	4.8
3.	Water	Clipped	"	4.2	1.3
4.	Water	Not clipped	"	4.9	5.0
5.	Water + oil	Clipped	Entire plant	5.0	1.4
6.	Water + oil	Not clipped	"	5.0	5.0
7.	Water	Clipped	"	5.0	1.0
8.	Water	Not clipped	"	5.0	5.0

Rating system: 1.0 = No effect.
(see p. 6) 2.0 = Partial top-kill
3.0 = More than 50% of top-kill.
4.0 = Top-kill with root collar sprouting.
5.0 = Dead

*All sprays contained 4 lb. ahg., 2,4,5-T as Esteron 245 O.S.
**Entire leaf including petiole clipped off immediately before spraying.
***Readings taken 12 months after treatment.

There are, of course, some problems associated with the development and use of a woody plant nursery. The primary one is that of maintenance, since weed control, ironically enough, is a real problem. This can be overcome through the use of methyl bromide for fumigation of weeds and weed seeds prior to establishment. The timing of planting is very critical and if delayed a high mortality may result.

Testing On The Right-Of-Way Is Essential For Final Proof Of Performance

The sites should be chosen carefully, using as extensive an area as the supply of chemical and application facilities permit. Application should be made uniformly and in a similar manner to that which will ultimately be recommended for the product. Research workers are on occasion critized for making applications superior to those commonly made commercially. However, it is impossible to evaluate research work which has not been applied properly. Right-of-way evaluation is, of course, a further responsibility of the chemical company which must be assumed prior to putting a new product on the market. The minimum size for a right-of-way test plot has not been well established. In most instances, it should involve at least 100 gallons of spray mixture. It is possibly even more essential to have plots located in as many areas as possible to get an adequate evaluation.

It is seldom practical to evaluate combinations of herbicides in this type of a treatment before the specific value of the individual compounds have been established. As far as research is concerned, the "brush killer or mixture" philosophy has done much to retard the progress of good research since it has diverted effort away from the primary target of establishing response of species to individual compounds and has attracted research time and effort to the evaluation of mixtures whose individual component activity is not known.

EVALUATION OF RESULTS

This is an item of major importance to the user and to the scientist. Ordinarily, a primary point to note is the nature of action of the herbicide, including speed and type of activity. In many instances, tests should be established in such a way that evaluations can be made for a period of two to three years to observe amount and type of regrowth. The researcher must restrain himself and avoid enthusiasm for the quick burning or early "cosmetic effect" which may be misleading. Patience is the keynote of woody plant research and products which often look best a short time after application may ultimately be the least effective. The researcher should evaluate not only the kill but the entire plant response. In our own work, we have devised a method which we term the plant response profile.

The plant response profile is developed by evaluating a large number of individual clumps of a given species in such a way that a response rating is given to each clump. When these response ratings are converted to a percentage which can be plotted on a graph, the profile of the herbicidal activity on the species is illustrated. For this purpose, an arbitrary numerical designation is given to a particular type of response, i.e., (1) little or no response, (2) partial top kill ordinarily restricted to the new terminals but never exceeding more than 50% of the top growth, (3) more than 50% top kill with regrowth from the remaining live stems, (4) complete kill to the ground line with new sprouts developing from the root collar or the lateral roots, (5) complete kill with no resprouting. This evaluation can be used any time after application, but it is most useful during the next growing season following application.

Beyond the evaluation of an individual experiment which is in itself important, is the art of "cumulative evaluation". This concept accepts the premise that woody plant responses are such that one properly or improperly conceived experiment merely contributes to the art itself. It does not in itself solve a particular problem or provide the basis for large scale recommendations. Valid impressions, truths and sound recommendations are developed as a result of continuing evaluation of woody plant control work whereever it may be. Individual applications, situations, responses and results must be catalogued mentally for future reference in field observations.

BASIC RESEARCH

Basic research in control of woody plants is very important and excellent contributions have been made by such workers as Crafts, Thimann, Bonner, Mitchell, etc. It is, in this area of research that Public agencies with their excellent facilities and trained specialists, can make vital contributions. The literature may be permeated by the results of empirical field work which contributes moderately to the art of woody plant control, but the stars that shine out in this literature are the discoveries on methods of translocation, specificities of compounds, modes of action, techniqques of application, etc. The worker in the field should attempt to relate these basic findings to his field observations and to use these findings in a positive way to improve his results.

RAMIFICATIONS OF BRUSH CONTROL RESEARCH

Right-of-way brush control research like any other research undertaking involves responsibilities with regard to the handling of the findings of that research. It is probably an understatement to say that there has been more confusion in the field of right-of-way brush control than the complexity of the problem can justify. Much of this has been perpetuated by fragmentary and/or misleading statements. Such statements, oral or written, have created many misconceptions. The researcher must realize that actually very little right-of-way brush control research work is being done, and the users in particular are hungry for "new" information. Conclusions properly described as tentative, however conscientious, often are not tentative to the user. They may be expanded out of proportion by the "grapevine" or may be regarded as established fact by the user.

In conjunction with the publication or publicity on special concoctions, it should be emphasized that "concoctions can confound confusion". For the most part, research with special concoctions, however well conceived, do not ordinarily result in research which is definitive and which has real value. It frequently creates an interest in materials which not only are unavailable but which may have toxicological and storage properties which make them unsatisfactory for Public use.

Conclusion:

There are obviously many things yet to learn, but chemical brush control has proved to be an eminently feasible, practical and economical practice. In spite of many smoke clouds, actually little change has been made from basic programs developed several years ago predicated on low volatile esters of 2,4-D and 2,4,5-T. There is abundant opportunity for sound fact finding research in this new field.

PROGRESS REPORT ON DORMANT APPLICATIONS OF BRUSH KILLERS ON POWER LINE RIGHTS OF WAY[1]

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In an effort to extend the period over which brush growing in rights-of-way can be sprayed effectively three exploratory tests were conducted in 1956. One of these was a regular basal treatment in which sprays were applied in January. Another was a broadcast stem spray in March with the chemicals being applied to the lower one third of the plants. The third test was a fall blanket or cane broadcast spray in which the chemicals were applied over the entire plant. Preliminary data on regrowth in these tests are reported herein.

Standard Basal Treatments

Ten treatments were applied in number 2 fuel oil to brush averaging four feet in height on a right-of-way near Blacksburg, Virginia on January 27, 1956. The predominant species present were red oak, chestnut oak, aspen, black locust, and sassafras. Application was made with a Jeep mounted gear pump equipped with by-pass agitation, and was operated at a pressure 80 pounds p.s.i. The nozzle used for application was a ¼" Spraying Systems adjustable Conejet.

The right-of-way was divided into plots 50 x 50 feet or approximately one twentieth acre. The lower 18 inches of each stem was sprayed with enough solution to insure wetting of the crown. Each of the following treatments were applied at the rate of 100-150 gallons of oil per acre depending upon the number of stems present.

1. ACP Industrial Brush Killer (butoxyethanol esters of 24D-245T) 12#AHG
2. " " " " " " " " " 16#AHG
3. 2(245TP) " " " " " " " " " 12#AHG
4. " " " " " " " " " " 16#AHG
5. American Chemical Paint 533 (24D-245T esters) 12#AHG
6. " " " " " " " 16#AHG
7. Isooctyl ester of 2,4,5T (Technical) 12#AHG
8. " " " " " 16#AHG
9. " " " " and 24D (Technical) 12#AHG
10. " " " " " " " 16#AHG

In October, 1957 counts were made and the following information recorded: Number of stems per acre, number and percentage of stems dead to the ground, number and percentage of stems resurging and the degree of sprouting from the ground. These data are presented in Table 1.

1/ These studies were supported by research grants from the Appalachian Electric Power Company, the Bartlett Research Laboratories and the American Chemical Paint Company.

2/ On Educational Lease from the F. A. Bartlett Tree Expert Company.

Table 1
Standard Basal Treatments
Sprayed January 27, 1957

Treatments	No. Stems Per Acre	Stems Dead to Ground No.	o/o	Stems Resurging No.	o/o	Degree of Sprouting from Ground 1/
ACP IBK 12# AHG	4,234	3,531	83.4	703	16.6	High
ACP IBK 16# AHG	5,848	3,984	68.1	1,864	31.9	High
2(245TP) 12# AHG	5,227	3,723	71.2	1,504	28.8	Low
2(245TP) 16# AHG	4,542	2,753	60.6	1,789	39.4	Medium
ACP 533 12# AHG	4,757	3,398	71.4	1,359	28.6	Low
ACP 533 16# AHG	5,469	3,955	72.4	1,504	27.6	Low
Tech. T 12# AHG	4,322	3,282	75.9	1,040	24.1	Medium
Tech. T 16# AHG	3,897	3,043	78.1	854	21.9	Medium
Tech. D & T 12# AHG	3,868	3,119	80.6	749	19.4	Low
Tech. D & T 16# AHG	4,995	3,955	79.2	1,040	20.8	Low

BROADCAST BASAL TREATMENTS

The treatments in this test were applied in March, 1956 with the same equipment as used in the standard basal test except that a Beam adjustable nozzle was employed. Application was made broadcast covering the lower one-third of brush averaging 8 feet in height. Number 2 fuel oil was again used as a carrier and the following chemicals were applied in an average volume of 200 gallons per acre.

1. American Chemical Paint #329 (24D-245T esters) 20# AHG
2. Aminotriazole (liquid) (ATA) 10# AHG
3. ACP Industrial Brush Killer (24D-245T esters) 20# AHG
4. 236TBA Isooctyl esters of 24D-245T 20# AHG
5. Isooctyl esters of 2,4,5-T (Technical) 20# AHG
6. Esteron D45T (245T ester) 20# AHG

1/ Low - - 200 - 700 Sprouts Per Acre
Medium - 700 - 1,200 " " "
High -1,200 - 1,700 " " "

7. (2,4,5-TP 20# AHG

Counts were taken in October, 1957 and the data presented in Table 2.

Table 2
Broadcast Basal Treatments
Sprayed March, 1956

Treatments	No. Stems Per Acre	Stems Dead to Ground No.	o/o	Stems Resurging No.	o/o	Degree of Sprouting from Ground 1/
Tech. T 12#-100	16,515	12,882	77	3,854	23.0	Low
2(245TP) 12#-100	17,001	15,890	93.5	1,111	6.5	Low
ACP 329 20# AHG	8,553	7,534	88.1	1,019	11.9	High
ATA 10# AHG	10,006	4,709	47.1	5,297	52.9	Low
ACP IBK 20# AHG	7,835	7,434	94.9	401	5.1	Medium
236TBA 10# AHG	7,832	3,325	42.5	4,570	57.5	Low
Tech. D & T 20# AHG	9,488	9,022	95.1	466	4.9	Medium
Tech. T 20# AHG	12,332	12,127	98.3	205	1.7	Medium
Esteron T 20# AHG	18,831	17,843	94.8	988	5.2	High
245TP 20# AHG	14,801	14,219	96.1	582	3.9	High
ACP 889 12# AHG	14,310	7,834	54.8	6,476	45.2	Low
Tech.D & T 12#-100	15,750	13,199	83.8	2,552	16.2	Low
Tech.D 12#-100	14,461	12,061	83.4	2,401	16.6	Medium

1/ Low - 2,000 - 4,000 Sprouts Per Acre
Medium - 4,000 - 8,000 " " "

CANE BROADCAST TREATMENTS

The same equipment employed in the broadcast basal test was used in this test. The entire stem was treated so that both sizes were wet but no attempt was made to soak the crowns. An average of 150 gallons of oil per acre was used. The following chemicals were applied in October, 1957.

1.	Isooctyl esters of 24D-245T (Technical)	8# AHG
2.	" " " " " "	4# AHG
3.	" " " 245T (Technical	8# AHG
4.	" " " " "	4# AHG
5.	" " " " "	2# AHG
6.	ACP Industrial Brush Killer (24D-245T esters)	8# AHG
7.	" " " " " " "	4# AHG
8.	236 TBA	9# AHG

Counts were made in October, 1957 and the data recorded in Table 3.

Table 3
Cane Brodcast Treatments
Sprayed October, 1956

Treatments	No. Stems Per Acre	Stems Dead to Ground No.	Stems Dead to Ground o/o	Stems Resurging No.	Stems Resurging o/o	Degree of Sprouting from Ground
Tech. D & T 8# AHG	12,787	12,452	97.4	335	2.6	High
Tech. D & T 4# AHG	14,467	13,712	94.8	754	5.2	Medium
Tech. T 8# AHG	8,328	7,695	92.3	632	8.5	Low
Tech. T 4# AHG	10,939	10,709	97.9	230	2.1	High
Tech. T 2# AHG	13,578	10,627	78.2	2,961	21.8	High
IBK 8# AHG	10,076	10,011	93.9	65	6.1	Medium
IBK 4# AHG	7,517	5,207	69.3	2,310	30.7	High
236TBA [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(Table 3 Cont.)

Treatments	No. Stems Per Acre	Stems Dead to Ground No.	Stems Dead to Ground o/o	Stems Resurging No.	Stems Resurging o/o	Degree of Sprouting from Ground 1/
Tech. D & T 4# AHG	14,467	13,712	94.8	754	5.2	Medium
Tech. T 4#-100	10,939	10,709	97.9	230	2.1	High
IBK 4#-100	7,517	5,207	69.3	2,310	30.7	High

DISCUSSION

The standard basal and broadcast basal tests applied early in 1956 had two growing seasons and cannot be directly compared to the October Cane broadcast test which had only one growing season when the data were taken. Also different methods of application were employed with each test and direct comparisons cannot be made. There are, however, certain inferences that can be made at this time.

1. There was a higher percentage of stem sprouting in the standard basal than in the other two tests.
2. There was less sprouting from the ground in the standard basal than with the other two tests.
3. There appears to be less sprouting from the ground in the October Cane broadcast treatments as compared to the March broadcast basal treatments.

1/ Low - 500 - 1,000 Sprouts Per Acre
Medium - 1,000 - 2,000 " " "
High - 2,000 - 3,000 " " "

Geigy Agricultur l Chemicals
Division of Geigy Chemical Corporation

SIMAZIN AS AN INDUSTRIAL HERBICIDE

E. O. Schneider

The control of weeds and grasses around industrial sites relieves the danger of costly fires, reduces maintenance by minimizing hand labor and adds to the attractiveness of the site. Beside these factors, weeds cause health hazard and are a general nuisance. In this paper the experimental testing of Simazin to control weeds around industrial sites, roads, electric substations, oil and gas installations, etc., will be discussed.

CHEMICAL PROPERTIES

Simazin (2-chloro-4,6-bis-ethylamino-s-triazine) was synthesized in the Geigy Research Laboratory in Basel, Switzerland. Technical Simazin is a white, crystalline substance which is practically insoluble in water and only slightly soluble in organic solvents. The solubility in water is approximately 3.5 ppm, in methyl alcohol 400, in petroleum ether 2, and in chloroform 900. The pure chemical melts at 225° C. The acute LD_{50} of Simazin to rats and mice was found to be in excess of 5 gm/kg. No irritation to skin, eyes or mucous membranes have been reported in over two years of field and laboratory testing. In addition to these features, the chemical is non-inflammable and non-corrosive, it has low electrical conductivity and does not contaminate equipment used in application.

THE MODE OF ACTION

Simazin acts through the root systems and does not kill foliage on contact. At Purdue, Simazin applied at the rate of 1/2 lbs. per acre in greenhouse soil was lethal to tomato plants 3 inches tall, whereas these tomatoes were unaffected with a foliage spray applied at the rate of 4 lbs. per acre. A few deep-rooted perennials such as Canada thistle have been noted to be unaffected by pre-emergence applications while early post-emergence applications have given control. No explanation is available for this post-emergence action.

It is suggested that pre-emergence treatments to industrial sites be made because germinating weeds are more susceptible, applications are generally more simple at this time, and the fire hazard from killed vegetation is eliminated.

Post-emergence applications require sufficient water to wash the chemical from the foliage and into the root systems in order to be effective. The height and density of the foliage will determine the gallonage necessary for root zone penetration. Usually 200 to 500 gallons of water have been found sufficient for foliage ranging from 4 inches to 2 feet. Cutting and removal of the foliage if practical will permit root zone penetration with fewer gallons of water.

The action of Simazin on growing plants is very slow. From four to six weeks are required for killing established weeds. The first symptoms exhibited by treated plants is usually a yellowing of the margins of the leaves. Gradually the whole plant becomes chlorotic and dies. Shallow rooted annual plants usually are affected more quickly than are deeper rooted annuals and perennials. Plants respond to Simazin faster during periods of excessive rainfall, as the water carries the herbicide to the root zone where it exerts its toxic action.

Following pre-emergence applications, the time required to kill germinating weeds is from 4 to 7 days. Seedling weeds usually germinate and emerge before the Simazin uptake is sufficient to cause death. Kill of successive germinating weeds have been observed for periods over six weeks.

Application of Simazin to dry soil at the rate of 2 lbs. of the active chemical has killed weeds and grasses that emerged from below the treated zone when treatment and first rain were separated by 12 days. The soil was a silty loam with 4% to 6% organic content. In another instance the 2 lb. rate failed to give good control when the first rain was delayed for 15 days. The clay loam soil had an organic matter content of 8% or higher and had a very high weed population.

EXPERIMENTAL FIELD TRIALS

Simazin was tested as a corn herbicide in the United States in 1956. In the fall of that year tests were started to determine the effectiveness of this chemical as an industrial herbicide. The formulation used in all of the tests reported herein was Geigy Simazin 50W (a wettable powder containing 50% of the active ingredient). Early fall work in Texas utilizing 20, 40 and 80 lbs. per acre of Geigy Simazin 50W and work in California at the same time using up to 40 lbs. per acre are giving complete control the second year.

Many experimental test areas were established in the spring and summer of 1957 throughout the United States. Those to be reported in this paper will cover the mid-west and sections of the east and south.

On March 5 an area at the stock yards in St. Joseph, Missouri was treated with 20 lbs. per acre of Geigy Simazin 50W in 50 gallons of water with a 50 gallon Hardy sprayer. The area treated included a section of a spur railroad track and an area adjoining the stock pens. The clay loam was high in organic matter, well fertilized, and capable of carrying a heavy plant growth. The weed species consisted of the annual grasses and broadleaf grasses plus some perennials. Weed control was outstanding with 98% control. Damage to the sterile layer of treated soil by traffic and equipment storage on the area accounted for some of the weed growth.

In June an area in an electric substation in the Chicago area was treated with Geigy Simazin 50W at 20 lbs. per acre in comparison with monuron at 32 lbs. (actual). Kill was slower with the Simazin, however it appeared to be more complete. Additional data will be taken on residue next year.

In May an area around several propane tanks and an area at a gas terminal in Springfield, Illinois were treated with 10 lbs. of Geigy Simazin 50W per acre in 300 gallons of water. The heavy clay loam soil was covered with a deep ballast. Weed growth in these areas has been very profuse in the past years. Observation in October revealed 96% weed control with only an occasional chlorotic morning glory vine or a horse nettle still surviving.

In the Chicago area applications at 20 lbs. of Geigy Simazin 50W per acre in 200 gallons of water in May were made around sewage settling basins and filter units. These areas have a cinder fill varying in depth from 6 inches to 5 feet. Sewage particles have filtered into the interspaces for years making the area capable of sustaining plant growth. Control was judged to be 95% in the treated area. 32 lbs. of monuron (actual) used on the adjoining area gave similar control. Weeds escaping in both treated areas were crabgrass and a few prostrate spurge plants.

An application of 10, 20 and 30 lbs. of Geigy Simazin 50W was made on a rock covered propane storage area in Louisville, Kentucky in comparison with monuron at 24 lbs. (actual) per acre. Application was made in June when the weeds were about 6 to 10 inches tall. Again the kill required 4 weeks. On October 24 the weed control at the 10, 20 and 30 lb. rates were judged to be 80%, 80% and 95% control respectively in comparison to 75% with the monuron. Weeds escaping the treatment were patches of green foxtail and crabgrass.

On June 5 Geigy Simazin 50W at 10, 20 and 30 lbs. in 232 gallons of water was applied on the Seaboard Airline Railroad between Jacksonville, Florida and Savannah, Georgia. The 10 and 20 lb. rates were applied with and without 2,4-D at 8 lbs. per acre. Tests were 1/4 to 2 miles in length. The standard treatment for the railroad was 40 lbs. of Dalapon plus 8 lbs. of 2,4-D per acre. Other experimental compounds under code numbers were applied in the tests.

Weed control was rated unsatisfactory about 2 months after application. Inspection of the area in September and again in November revealed a consistent improvement in weed control. All other areas were resprayed in early fall because of regrowth brought about by the unusually large amount of rain this summer. Weed control in November was rated as 55% for the 10 and 20 lb. rates and 65% to 75% for the 30 lb. rate when compared to the untreated area. Woody species in the treated area were not controlled. Florida purslane, crabgrass and a sprinkling of the spurge still remained. The lower rates did not control Bermuda grass.

On July 12 Simazin at the rates given in the Jacksonville experiment were applied on the Norfolk and Western Railroad between Lynchburg and Roanoke, Virginia. The basic treatment was 58 lbs. Dalapon plus 8 lbs. 2,4-D per acre. This rail line has an extreme amount of fine coal or carbon particles sifted into the ballast. On September 24 observations of the 10 and 20 lb. rates showed the chemical had stunted the Bouncing Betty quite severely and extreme amounts of chlorosis still remained. Some stunting of Bermuda grass was evident. The annual weeds and grasses were killed with the exception of the spurges. An area of Johnson grass was 90% to 95% killed when sprayed with 20 and 30 lbs. of Simazin. The Johnson grass when sprayed was starting to develop plumes. At the higher rates Bermuda grass was severely stunted. Observations in the spring are needed to determine the length of residue. The addition of 2,4-D to the Simazin had little or no affect on the total kill.

RESULTS AND DISCUSSION

No difficulties were experienced in making applications with a pressure sprayer, sprinkling can, knapsack or other types of sprayers.

All of the applications of Simazin described above were made pre-emergence to the weeds except one. Despite the time of application the results were remarkably uniform. Twenty pounds of Geigy Simazin 50W has given from 90% to 99% weed control in most mineral soil types medium in organic matter. Lower rates have appeared promising for weed control where only easy to kill annual weeds and grasses were present, with no complication from ballast or cinders. In areas having a moderate rock or cinder fill, 20 lbs. of the formulation has been very successful, however, the rate appears on the light side for railroad right-of-way control. This is undoubtedly true because of the ballast and because of the persistent perennial plants found. It appears that carbon (from coal) has little or no affect on the action of Simazin.

In areas of almost pure sand with little or no organic matter, a rate at 30 lbs. per acre was required for control when applications were made in mid-summer.

In areas of high organic matter where the soils are of peat or muck derivation, the rate required for control will be higher than for mineral soils.

Simazin will not control wood species at the low rates that will give control of most annuals and perennial weeds.

FURTHER WORK

Further work is needed on the following problems:

1. Evaluation on individual species of weeds.
2. Length of residual activity from various rates of application on the major soil types.
3. Rate of accumulation of Simazin in soil from repeated applications.
4. The effect of the organic content of soils on Simazin.

CONCLUSION

Simazin was tested as an herbicide on such industrial sites as electric substations, railroads, and oil and gas installations in various areas of the United States in 1957. Rates from 10 to 80 lbs. of the active chemical were utilized. No major complications in spraying resulted from applications made by a sprinkling can, knapsack sprayer, and different types of pressure sprayers.

Twenty pounds of Simazin per acre gave from 90% to 99% control of all annual broadleaf weeds and grasses and most perennials on industrial sites where the soil was not complicated with excess ballast or sand with little or no organic matter. Higher rates gave control of most ballast complications and resistant perennial species.

Slides will be shown.

Effect of Volume of Spray Upon Top Kill and Resurge of Oak-Maple Brush

W. R. Byrnes, W. C. Bramble, and R. J. Hutnik[1]

During June of 1956, a study was initiated to determine the effects of various volume applications of chemical sprays on the top kill and resurge of oak-maple brush existing on a transmission right-of-way in Central Pennsylvania. Specifically, this paper presents a comparison two growing seasons after treatment of the effects of stem-foliage sprays when applied at rates of 100, 200, 300 and 400 gallons per acre. The test area is located on a section of the Penelec right-of-way on the south slope of Tussey Mountain in Huntingdon County, Pennsylvania.

This study is an outgrowth of previous research on the same right-of-way in Centre County. This previous research indicated that an excellent top kill of 94 percent can be obtained with stem-foliage applications when high volumes of spray averaging 460 gallons per acre are applied (1), (2), (3), (4). Commercial sprays of this nature in the past have seldom exceeded a volume of 100 to 200 gallons per acre with varying degrees of control resulting. The question arose, "Are these extremely high volumes needed to obtain such results on oak-maple brush?" Or, to put it on a dollar-and-cents basis, "What is the smallest volume of spray that will give the desired control of brush?" This study is designed to answer these questions for one of the techniques and one of the chemicals used in the previous study.

PROCEDURE

The forest composition in this area is commonly referred to as mixed oak-maple which is typical of the ridge and valley section of the oak-chestnut forest. The dominant species present is chestnut oak in association principally with red oak, black oak, and red maple and to a lesser extent with scarlet oak, white oak, sassafras, and black gum. The ground layer, composed of woody shrubs and herbaceous plants, is relatively sparse with blueberries, huckleberries and mountain laurel as the major constituents.

The forest cover on this experimental area had been removed by cutting during the winter of 1951-1952 to form a cleared right-of-way 180 feet wide. Following cutting the stumps sprouted prolifically. By June of 1956 this regrowth, consisting primarily of compact well-distributed sprout clumps of tree and shrub species, had attained an average height of 8 feet and covered 43 per cent of the ground area.

Species composition was relatively uniform over the entire study area and brush density ranged from 25 to 65 percent. The variations due primarily to topographic position and terrain were segregated by establishing four blocks or replications. Each block was then divided into five plots of one-half acre each.

[1]Members of the staff of the School of Forestry, The Pennsylvania State University, University Park, Pennsylvania.

The test design consisted of five treatments which were randomly assigned to the five, one-half acre plots within each of the four blocks previously established. The treatments applied were:

Treatment	Approximate Volume of Application
A	Unsprayed
B	100 gallons per acre
C	200 gallons per acre
D	300 gallons per acre
E	400 gallons per acre

A 100 percent tally was made of the number of plants comprising the woody brush present on each treatment area. The species composition and relative abundance by treatments is given in Table 1. To evaluate the effect of these sprays on the ground cover an estimate was made before spraying by the system of Braun-Blanquet (5) of the abundance and grouping of species comprising this vegetation along with an estimate of their combined cover values.

Table 1. Composition of Woody Brush by Treatments Based on Plants of Stump Origin Before Spraying.

Species	Treatment				
	A	B	C	D	E
	%	%	%	%	%
Oaks					
Chestnut oak	65.3	72.3	77.8	74.7	73.4
Red oak	5.9	8.2	10.0	8.0	8.5
Scarlet oak	0.7	0.2	0.6	0.0	0.0
Black oak	7.9	3.7	2.6	0.3	4.0
White oak	0.6	0.4	0.5	0.0	0.4
Total all oaks	80.4	84.8	91.5	83.0	86.3
Maple					
Red Maple	14.5	11.2	7.2	14.0	12.8
Other Hardwoods					
Sassafras	1.3	1.1	0.3	1.3	0.2
Black gum	2.2	1.3	0.6	0.0	0.4
Flowering dogwood	0.7	0.5	0.0	0.6	0.0
Hickory	0.1	0.0	0.2	0.0	0.0
Juneberry	0.1	0.3	0.0	0.0	0.0
Black birch	0.0	0.2	0.0	0.0	0.0
Tulip poplar	0.1	0.2	0.0	0.0	0.0
Black walnut	0.0	0.0	0.0	0.5	0.0
Witch-hazel	0.6	0.4	0.2	0.6	0.3
Total Other Hardwoods	5.1	4.0	1.3	3.0	0.9
	100.0	100.0	100.0	100.0	100.0

In order to be consistent with the broadcast foliage treatment conducted in 1953, the same chemical, concentration and carrier was used. In addition, the actual applications were made with similar power spray equipment and local labor supervised by the same experienced foreman who directed the earlier tests. The chemical consisted of a one to one mixture of butoxy-ethanol esters of 2,4-dichlorophenoxy acetic acid and 2,4,5-trichlorophenoxy acetic acid, hereafter referred to as 2,4-D + 2,4,5-T. One gallon of this brush killer, containing four pounds acid equivalent, was added to 99 gallons of water to make 100 gallons of spray material.

The technique of application may be termed a selective, stem-foliage spray in which the spray solution was applied directly to the scattered sprout clumps. Depending upon the volume applied, the procedure was to thoroughly wet the outer foliage, the inner foliage and the stems. Treatment B (100 gallons per acre) provided very little coverage of inner foliage and stems of dense clumps with almost no drip observed from the leaves. Treatment C (200 gallons per acre) provided coverage of all foliage, fair coverage of stems, and a moderate drip from the leaves. Treatment D (300 gallons per acre) provided good coverage of all foliage and good stem wetting with moderate to heavy drip from the leaves. Treatment E (400 gallons per acre) provided thorough wetting of all foliage and stems with abundant run-down on the stems. This heavy application also resulted in excessive drip from the leaves.

The sprays were applied using a Bean Royal 20 pump capable of delivering 20 gallons per minute at variable pressures up to 700 pounds. The spraying was done with Bean Spray Master guns which permit variable application from a solid stream to a full cone with instant trigger shut off. In order to vary the application to meet the required volumes, nozzle tips on the Bean gun were varied from No. 5 to No. 8 and pressure was increased from 300 to 400 pounds.

Actual volume of spray material applied, which varied somewhat from theoretical volumes, were measured and recorded after each plot was sprayed. The average volume of spray material applied per acre and per plant by treatments is given in Table 2.

Table 2. Volume of Spray Solution Applied.

Treatment	Av. No. Plants[1] per Acre	Av. Vol. Spray Applied per Acre		Actual Vol. Spray Applied per Plant	
		Theoretical	Actual		
		(gal.)	(gal.)	(gal.)	(oz.)
A	659	--	--	--	--
B	421	100	85	.20	25.8
C	434	200	190	.44	56.3
D	492	300	280	.57	72.8
E	530	400	385	.73	93.0

[1]Includes plants of stump origin and plants of clump origin.

RESULTS

Effect of Sprays on Woody Brush.

In October 1957, two growing seasons after treatment, an evaluation of the effectiveness of the sprays was made. An earlier evaluation would have been unreliable, since top kill and sprouting is generally progressive for a period of more than one year and many of the resprouts die during this period.

Comparative effects of the 4 volumes of application on top kill of woody brush are given in Table 3. Top kill in this case refers to the complete killing of all parts of the plants above the ground line. This includes stems as well as foliage. All of the chemical treatments top killed at least 60 percent of the clumps of stump origin. The percent top kill increased with increasing volume up to the 300 gallons per acre application. There was little difference in the percent of top kill for the 2 highest volume applications.

Table 3. Top Kill of Original Plants Two Growing Seasons After Treatment. (Basis: plants of stump origin.)

Species	Treatment			
	B	C	D	E
	%	%	%	%
Oak	65	74	85	83
Maple	45	74	89	87
Other Hardwoods	50	100	100	100
All Species	61	74	86	84

Differences in top kill between red maple and the oaks were apparent only in the lightest application. In this treatment, red maple and the "other hardwoods" group were more resistant than the oaks. In the other treatments, maple and oak reacted similarly while all of the "other hardwoods" were completely top killed.

However, top kill is not the whole story. It is also important to know what happens to the plants that have been completely top killed. In other words, what percentage resprout, and how is this resprouting capacity affected by the volume of spray applied? This information is presented in Table 4.

Table 4. Regrowth of Sprouts From Those Original Plants With Complete Top Kill (all species). (Basis: plants of stump origin.)

Sprouting Characteristic	Treatment			
	B	C	D	E
	%	%	%	%
Top Kill Not Resprouting	79	85	88	91
Top Kill Resprouting:				
Dead Sprouts Only	13	11	8	6
Living Sprouts	8	4	4	3

The proportion of plants in the category "Top Kill not Resprouting" shows a definite progression from 79 percent for the lightest application to 91 percent for the heaviest. This indicates that the higher volumes with surplus run-down of spray on the stems results in more permanent control.

It is of further interest to note that by the end of the second growing season after spraying only about 1/3 of those plants that had resprouted still retained living sprouts. New sprouts on the rest of the plants had died, due perhaps to residual action of the chemical or inherent weakness of the sprouts. In summary then, of the original plants completely top killed, 8 percent retained life through root-collar sprouts under treatment B, as compared to 4 percent for treatments C and D, and only 3 percent for treatment E.

The treatments can also be evaluated by comparing the living woody brush that remained on each of the plots 2 growing seasons following treatment. This information is presented in Table 5. In the 2 heaviest applications, less than 20 percent of the plants of stump origin were still alive. In comparison plots receiving 190 gallons per acre had 29 percent still alive, and the plots receiving 85 gallons per acre, 44 percent. However, it must be remembered that all of these living plants were damaged by the spray - some almost completely killed. This is quite a contrast to the clumps in the controls which have become larger and more vigorous during the past 2 growing seasons.

Except for the heaviest application, the treatments have resulted in an increased proportion of red maple in the surviving plants because of its greater resistance to 2,4-D + 2,4,5-T. In treatment E, the maple and oak reacted similarly.

Table 5. Living Plants Remaining Two Seasons After Treatment as a Percent of Plants Present Before Treatment. (Basis: plants of stump origin.)

Species	Treatment			
	B	C	D	E
	%	%	%	%
Oak	41	28	17	19
Maple	58	36	22	19
Other Hardwoods	50	0	0	8
All Species	44	29	18	19

Effect of Sprays on Plants of the Ground Layer.

To determine changes brought about by spraying, the abundance and grouping of species comprising the ground layer were estimated by the system of Braun-Blanquet (5). This evaluation is important from the standpoint of wildlife food and cover and also for aesthetic reasons. Observations before spraying indicate that a uniform ground cover existed throughout the study area. This layer consisted primarily of the woody shrubs, blueberry, huckleberry and sweet-fern in association with vernal sedge, panic grass and mixed herbs.

Damage to the ground cover plants first became evident within a few weeks after spraying. The extent of damage was related to the volume of spray applied, with the least damage occurring with light applications. This damage was due principally to drip from the foliage. As volume of spray was increased, with a corresponding increase in pump pressure and nozzle size, kill of ground cover also increased. This may have been a direct result of more thorough coverage leading to surplus drip and rundown, penetration through the clumps, and spray drift. Estimated ground cover kill 8 weeks after spraying is listed below.

Treatment	Ground Cover Killed (%)
B	20
C	38
D	65
E	70

Dominant species of the ground layer most severely damaged by all spray treatments were blueberry, huckleberry, sweetfern and the herb loosestrife. The sedges and grasses suffered very little damage and appear to be relatively resistant to the 2,4-D + 2,4,5-T sprays. Voids created by extensive kill on the plots receiving high volumes were partially filled by spreading of sedges and grasses and by invasion of fireweed and other herbaceous plants.

Combined estimates of the total ground cover before treatment and one year after treatment are presented in Table 6. For the control plots (treatment A), the average ground cover value increased 17 percent over the preceding year. As no spray was applied on these plots the plants already present were able to increase in both number and distribution. Areas receiving the lighter volumes of spray (treatments B and C), even though expressing a moderate kill of 20 to 38 percent within the first 8 weeks, had an overall increase in ground cover one year after spraying. The heavier applications (treatments D and E) resulted in excessive kill of ground cover within the first 8 weeks. This kill was still reflected by the marked decrease in total ground cover after one year.

Table 6. Estimate of Total Ground Cover Before Treatment and One Year After Treatment.

Treatment	Ground Cover	
	Before Spraying 1956	One Year After Spraying 1957
	%	%
A (control)	68	85
B (100 gal./acre)	71	78
C (200 gal./acre)	64	70
D (300 gal./acre)	61	38
E (400 gal./acre)	61	35

Discussion and Conclusions

This study has shown the effect of different volumes of spray for the control of woody brush on utility-line right-of-ways. However, only limited conclusions can be drawn. Only one chemical, one technique, one crew, one area, one forest type, one density of brush, and one season were used in this study. Changes in any of these factors will of course affect the results. In most cases, the magnitude of these effects will have to be determined from other experiments.

However, allowances can be made for other densities of brush. The density on the study area ranged from 25 to 65 percent and averaged 44 percent. Its average height -- approximately 8 feet -- was somewhat greater than that encountered in the usual commercial operations. For these reasons, dense brush would require about twice as much spray material for a control equivalent to that obtained in this study.

A question that often arises in brush control work is, "Can we predict the control we will get from a specific application, and if so, how accurate will that prediction be?" As a result of a regression analysis of the data, such a prediction can be made, but only for conditions similar to those used in this study. The results of this analysis are summarized in Table 7.

Table 7. Regression analysis summary. Predictions and confidence limits for the percentage of plants that will be completely topkilled within 2 growing seasons after application of various volumes of spray. Oak-red maple brush averaging 323 stump clumps per acre.

Volume of Spray	Predicted Topkill	Confidence Limits[1]			
		For a single application		Within which the true mean lies	
gal./acre	percent	percent		percent	
100	60	35	82	50	70
200	77	53	92	72	82
300	85	61	96	79	90
400	89	66	98	82	94
500	92	68	99	84	96

[1]At the 95 percent confidence level

Two important points are immediately apparent. First, the rate of top kill does not keep pace with volume applied. For example, increasing the volume from 100 to 200 gallons per acre resulted in an additional top kill of 17 percent; increasing it from 300 to 400 resulted in an additional top kill of only 4 percent. Therefore, the volume applied in commercial practice will have to be a compromise between the desired percent kill and the cost of the additional volume of spray. Obviously, a company will have to set its sights lower than a 100 percent or even a 95 percent kill of brush of this type within 2 years after spraying.

The other important point is that the actual top kill following a single application of a specific volume can vary within rather wide limits. For example, although 77 percent is our best estimate of the proportion of plants that will be top killed 2 years following an application of 200 gallons per acre, we are confident only that the actual kill will probably lie between 53 and 92 percent. The average top kill of a number of applications may also vary considerably. For the 200 gallons per acre application, we can be confident only that the true average probably lies between 72 and 82 percent.

In summary, this study has shown that volume applications between 200 and 300 gallons per acre should give satisfactory control of woody brush without excessive damage to the ground vegetation. This figure can vary depending upon the kill desired, the acceptable risk of getting a poor kill, and the money available. This recommendation is also subject to revision as the results of additional research become available and future observations are made on the study area.

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VEGETATIONAL SURVIVAL ON SOME PUBLIC UTILITY LINES IN NEW HAMPSHIRE FOLLOWING FOLIAGE SPRAYING WITH 2,4-D AND 2,4,5-T ESTERS

A. R. Hodgdon[1]

Introduction and review of literature

Until recently there has been little exact information about the effects on vegetation of herbicide treatments. There is considerable known about the effects of herbicides on tree-species, somewhat less on shrubs and much ignorance about herbaceous species. In Pennsylvania, Bramble and Byrnes (1) have taken into account all important species whether trees, shrubs or herbs. Their research along a power line right-of-way involves the relative effects of different types of herbicide application. Vegetational studies were carried on both before and after the herbicide treatments. One of the ways of application of herbicide was foliage spraying, in early summer, using half and half mixtures of compounds containing 2,4-D and 2,4,5-T at a concentration of 4 lbs. combined acid equivalent per 100 gallons of water. They noted the following results of this application - a 90-100 per cent kill of Bracken and an 80-90 per cent kill of Sedge, while a nearly complete top-kill resulted with blueberries, witch-hazel and teaberry. After two years low shrubs such as blueberries had nearly disappeared while Bracken was of minor importance. The cover had become essentially a Sedge-Grass-herb plant cover.

In our experimentation it was decided to concentrate on areas which could be studied both before and after spraying. Suitable situations were found along a power line right-of-way of the Public Service Company of New Hampshire* near Durham. The ingredients used were 2,4-D and 2,4,5-T in half and half mixture at the rate of 4 lbs. acid equivalent per 100 gallons of water. The mid-summer application for New Hampshire is in contrast to the early summer Pennsylvania treatments.

In those parts of the right-of-way that were sampled, seedlings, sprout growth and young trees were so generally distributed that the foliage application of spray was very complete.

Description of areas studied

Area A in Madbury, was cleared by cutting in 1953. Here had been a mixed forest stand about 40-50 years of age with a dominance of White Pine, Red Maple, Red, White and Black Oaks, Hop-Hornbean, and Black Cherry, and with a considerable

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admixture of more transitory species such as Gray Birch and Quaking Aspen. Much of the area sampled was low and swampy and suitable for occasionaly Black Gum (Nyssa sylvatica) trees and frequent plants of Highbush Blueberry, Viburnum cassinoides and Black Alder. Drier places supported a few Pitch Pines. Hemlocks were very few, Low Sweet Blueberry, Vaccinium angustifolium occurred abundantly in a suppressed condition beneath the forest cover, soon becoming vigorous and spreading rapidly following the cutting of trees and clearing of the line.

The area was sampled in 1954 and treated with herbicide in 1956 following which it was again sampled in 1957.

Area B in Durham, about 2 miles west of A was cleared in 1949. This area was a middle-age forest stand of White Pines and mixed hardwoods of several species, including, Shagbark Hickory, Black Birch, Red Maple, Red, Black and to a lesser extent White Oaks and Black Cherry with Hop-Hornbean and American Hornbean,(Carpinus caroliniana)abundant in the understory. Beaked Hazelnut, Witch-hazel and Maple-leafed Viburnum were the most common shrubs. In contrast to Areas A and C (next to be described) this section of the right-of-way was in a reasonably good condition of forest soil fertility as would appear to be indicated by the near absence of ericaceous species such as Blueberry, the occasional occurrence of such tree species as Basswood, Sugar Maple and Ash and the presence of a somewhat diversified vernal herbaceous flora.

This area was treated with herbicide in 1952. In July 1955 part of it was sampled and the remainder done in early June 1956. In midsummer of 1956 a foliage treatment of herbicide was applied after which in June 1957 the area was again sampled.

Area C in Lee, some 2 miles west of B was cleared in the early months of 1954. Before cutting, this was a forest dominated by young to middle growth White Pine with a considerable admixture of Gray Birch, Aspen, Pitch Pine, Red, Black and White Oaks and Red Maples. The following shrubs were common Sweet-fern, Meadowsweet, Low Sweet Blueberry and Juniper. This part of the right-of-way was dry with a light sandy soil.

Vegetational sampling was done in late July 1956, after which the foliage spray was applied. In mid-June 1957, it was again sampled.

Methods of sampling

Each of the 3 areas selected for study covered 1000 feet of right-of-way. One tenth of the total area was arbitrarilly selected for sampling. After delimiting an initial rectangular plot with its long axis extending across the full width of the line and the short axis extending 10 feet along the line, the next plot was laid out beginning 90 feet along the line from the first plot. Thus, for every 100 feet along the right-of-way 10 feet were sampled. Ten of such samples were considered to provide an adequate diversity of local habitats and minor vegetational varients. The vegetation was divided for purposes of sampling into 3 groups, trees, shrubs and herbs. The species, irrespective of height or dominance at the time of sampling, were classed as to their potential develeopment in one of these 3 classes. The numbers of individuals and the heights were given of the tree species. For shrubs and herbs a scale of 1 to 5 of abundance was followed; 5. indicating general coverage; 4. more than half of area covered;

3, less than half, but abundant; 2, found in more than 2 places in the plot, but not abundant; 1, one or two occurrences only.

The areas selected for study represented as uniform forest types as could easily be found and at the same time provide us with before and after effects of foliage spray.

Some attempt was made to use the same plots for sampling after spraying as before. The spraying operations in general however, were so disruptive as to obliterate markers and stakes. The numerous and relatively large sample plots selected are likely to provide reliable data on most species even when the areas do not coincide. It was possible to identify all important species of vascular plants. The only other plants recorded were mosses of which the genera Polytrichum and Sphagnum were often abundant. No attempt was made to identify them more precisely than to genus.

Results and discussion

Table 1 Effects of foliage spraying on tree-species

	Area A				Area B				Area C			
	Before herbicide		After herbicide		Before herbicide		After herbicide		Before herbicide		After herbicide	
Name of species	F*	A*	F	A	F	A	F	A	F	A	F	A
Pinus Strobus	7	29	1	1	10	45	10	69	4	6	7	25
P. rigida	2	2							4	6	1	2
Tsuga canadensis	1	1			1	1	2	2				
Populus tremuloides	2	5	1	8	9	59	8	39	4	63	2	75
P. grandidentata					1	1			1	4		
Ostrya virginiana	1	1			4	18	7	28				
Carpinus Caroliniana					8	46	8	52				
Betula populifolia	9	70	9	43	3	6	1		10	79	8	36
B. papyrifera	2	3			2	2						
Carya ovata	2	3			9	46	8	27				
Fagus grandifolia	3	7										
Quercus alba	7	12			3	5			8	20	1	2
Q. rubra	10	48			7	12			7	15	1	1
Q. velutina	5	29	2	4	5	19			9	26		
Crataegus sp.	2	2	1	1	3	4	6	9				
Prunus serotina	7	22	9	16	7	24	2	2	9	44	6	13
P. pensylvanica	3	7	4	7	4	4	1	1	8	106	5	35
Amelanchier laevis					2	2	1	1				
Acer rubrum	8	81	10	35	9	44	9	37	8	31	5	9
A. saccharum					1	1	1	1				
Tilia americana					1	1	1	1				
Nyssa sylvatica	3	4										
Fraxinus americana					3	7	3	5				

*F = Frequency or number of plots in which species is found.

Table 2 General effects of foliage spray on tree-species

Areas	Before treatment No. species	Before treatment No. individual plants	After treatment No. species	After treatment No. individual plants
A	17	326	8	115
B	20	347	12	274
C	11	400	9	200

The effects of foliage spraying of 2,4-D and 2,4,5-T on tree-species in New Hampshire are: (1) to eliminate a considerable number of kinds that are present on the lines, (2) to reduce the total number of plants of most of the species that are not totally killed and (3) to retard the growth rate of most species. Reduction of kinds of species and numbers of individuals are expressed in Table 2, but the pronounced suppression of growth and killing back of such common trees as Red Maple is not shown. Also a considerable percentage of individuals of some species appearing after treatment perhaps consists of new seedlings. This is particularly true of White Pines in Area C and of Gray Birch and Pin Cherry in Area A. It is not possible to tell whether these young plants started to grow in all cases after the foliage spryaing. However, some must have because they are so much more numerous in the new samples than in the old.

Effects of foliage spraying on shrubs.

Several shrubs were totally killed by the treatment. The Speckled Alder is very susceptible, willows seems to be nearly or quite destroyed while both Staghorn and Smooth Sumach were mostly killed. But most other shrubs showed varying degrees of resistance. Sweet-fern, Comptonia peregrina is of much interest. Initially it appears to be killed totally, yet after a period of time new shoots appear - often at some distance from the top-killed shoots. Some parts of a colony of Sweet-fern plant ordinarilly survive and after a year or two regain the areas they previously occupied before spraying.

There is some evidence also that one result is to promote a certain amount of expansion of the colonies through the results of new shoots appearing at considerable distances from the parent stems. Areas of Sweet-fern, appear barren for sometime following spraying. Yet they seem to survive even two foliage applications as in Area B. Another very desirable low shrub is Low Sweet Blueberry, Vaccinium angustifolium. Under New Hampshire conditions there is nearly always some survival, but recovery is slow requiring two or three years to regain vigor after treatment. One other low shrub which is resistant to the spray is Meadowsweet, Spiraea latifolia. Partial stem killing took place, but sometimes the plants appeared to be uninjured. The following species also are resistant to a considerable degree, Maple-leaf Viburnum, Bush Honeysuckle, Sheep Laurel and Huckleberry. Black Alder and Highbush Blueberry (Vaccinium corymbosum) sugfer considerable stem killing and often are killed outright.

Table 3 Effect of foliage spraying on shrub-species

	Area A				Area B				Area C			
	Before herbicide		After herbicide		Before herbicide		After herbicide		Before herbicide		After herbicide	
Name of species	F	A	F	A	F	A	F	A	F	A	F	A
Juniperus communis	2	2	2	3	3	4	2	2	7	14	7	13
Salix discolor									4	4	1	1
S. humilis					1	2			1	1		
Comptonia peregrina	3	5	1	2	5	9	4	8	10	22	8	19
Corylus americana									6	10	1	2
C. cornuta					7	14	7	13			1	2
Alnus rugosa	2	2										
Clematis virginana									2	2		
Hamamelis virginiana	1	1			5	9	5	10				
Spiraea latifolia	1	1	4	7	2	4	3	6	8	17	8	15
S. tomentosa									2	3	1	1
Pyrus melanocarpa	1	1	1	2							1	1
P. floribunda	2	4	2	4								
Amelanchier arborea	3	6	3	3	1	1	1	2				
Rubus alleghaniensis	3	4			7	12	7	11	7	15	5	9
Rosa virginiana			1	1	1	2						
Prunus virginiana	1	2			3	7	2	2	5	10	5	10
Rhus glabra					2	3	1	1	1	2		
R. typhina					1	1						
R. radicans					1	2						
Ilex verticillata	4	9	5	9	1	2	2	3	1	1		
Nemopanthus mucronata	2	3	1	3					1	1	1	1
Cornus racemosa					3	9	1	2				
C. alternifolia					2	2	2	2	1	1		
Kalmia angustifolia	4	7	5	8							1	2
Lyonia ligustrina	1	2	3	5								
Gaylussacia baccata	5	11	4	8								
Vaccinium angustifolium	10	29	9	20	2	5	2	3	7	14	4	8
V. corymbosum	5	8	7	17					1	2		
V. myrtilloides	1	2										
Lonicera canadensis					1	1	3	3				
Sambucus pubens					1	1						
Diervilla Lonicera					4	6	3	5				
Viburnum acerifolium					6	13	7	14				
V. recognitum					3	4	1	1				
V. cassinoides	5	10	5	8					1	1	1	1
V. Lentago									1	2		

Table 4 General effects of foliage application on shrub-species

Area	Before Spraying No. of species	Before Spraying Abundance of species	After Spraying No. of species	After Spraying Abundance of species
A	19	169	15	100
B	22	113	17	88
C	18	122	14	85

On the whole, shrubs, particularly the lower and more spreading types are remarkably persistent under our conditions following herbicide applications though some kinds may seem at first to be completely killed.

Table 5 Effect of foliage spraying on important herbaceous groups

	Area A				Area B				Area C			
	Before spraying		After spraying		Before spraying		After spraying		Before spraying		After spraying	
Name of group	F	A	F	A	F	A	F	A	F	A	F	A
Mosses	8	19	7	15	4	9	5	11	5	8	9	19
Bracken (Pteridium)	4	11	3	8	10	33	10	33				
Other ferns	5	37	7	44	4	11	4	15			2	2
Lycopodiums	9	36	8	25	3	6	9	25	2	2	5	12
Danthonia spicata	4	8	4	10	8	23	7	14	10	22	10	21
Panicum spp.	5	9	4	8	5	15	9	22	10	33	8	25
Other grasses	3	4	5	17	9	52	9	49	8	22	8	3
Carex pensylvanica	8	17	9	22	6	17	9	22	8	19	6	17
C. umbellata	5	6	6	13	2	4	2	4	5	8	10	27
Carex spp.	4	13	9	55	6	25	9	30	9	33	9	24
Juncus spp.	1	1			1	1			6	10	5	9
Maianthemum	9	21	10	21	4	8	10	20	2	3	9	18
Potentilla simplex	1	1	4	7	7	13	8	15	8	16	5	8
Fragaria virginiana					9	16	8	15	2	3		
Rubus spp. (exculsive of R. allegheniensis	9	22	9	20	4	6	3	5	9	27	10	21
Hypericum perforatum					4	8	3	6	7	12	4	7
Gaultheria procumbens	6	13	3	6	7	17	9	20				
Lysimachia quadrifolia			7	13	4	10	4	9	8	16	9	20
Trientalis	7	19	10	17	1	1	4	6	1	1		
Apocynum androsaemifolium	1	2			3	8	4	8				
Solidago spp.	1	1	4	11	10	55	10	54	10	35	7	28
Aster spp.	3	5	4	9	7	22	8	21			2	2
Achillaa millefolium			1	2	2	2	3	4	3	4	3	5

Table 6. General effects of foliage spraying on herbaceous vegetation

Area	Before treatment No. of Species	Before treatment Abundance of Species	After treatment No. of Species	After treatment Abundance of Species
A	47	288	74	429
B	75	415	78	469
C	56	335	49	346

From Tables 5 and 6 it can be seen that there has been no large and lasting damage done to any abundant single species or groups of related species. In contrast to the situation in Pennsylvania, Bracken, with us, quickly recovered from any injury that it had sustained. The Hay-scented Fern and other upland species of ferns reacted similarly, but considerable killing of Cinnamon Fern was noted in some plots. Upland mosses such as Polytrichum commune, that often provide effective seed beds for some species of trees, also survived the treatment. The behavior of grasses is apparently about the same as in Pennsylvania; Panicums, Danthonia spp. Andropogon scoparius and Poa compressa at least held their own and often increased in some plots. The reaction of sedges of the genus Carex to the spraying in New Hampshire is very different from the Pennsylvania response. Three species are particularly common in well drained sites, C. pennsylvanica, C. umbellata and C. debilis var. rudgei, while several others are present in moist areas. The first two tend to become more abundant one or two years after herbicide application than before. This tends to be true not only for the three areas involved in this study, but for numerous other rights-of-way in New Hampshire that have been sampled.

Two species that are often classed as shrubs, Gaultheria procumbens and Mitchella repens, both showed some resistance to the herbicide while the same is true of the trailing species of Rubus. Little if any sustained damage seemed to have been done to the several common species of Goldenrod and Aster.

Of some conservation interest is the effect of the foliage spraying on several species that come under the general classification of "Wild Flowers". The following list includes species that held their own or that were seen after treatment, but not before. Uvularia sessilifolia, Maianthemum canadense, Smilacina racemosa, Lilium philadelphicum, Cypripedium acaule, Spiranthes, sp. Hepatica amercana, Aquilegia canadensis, Coptis groenlandica, Viola spp., Cornus canadensis and Houstonia caerulea. The greatest concentration of these occurred in Area B which had received two foliage sprayings, one several years earlier and the other the year before sampling.

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volume to insure satisfactory control. A high volume-low concentration basal application of 2,4,5-T ester to white oak was found to be considerably superior to a low volume-high concentration application of the same chemical even though three times as much chemical per tree was applied using the low volume-high concentration treatment. The most practical concentration of chemical recommended by Coulter (5) for brush control was 16 lbs. ahg[1/] of oil when the 2,4,5-T ester is used alone and 24-32 lbs. ahg of oil when a mixture of 2,4,5-T and 2,4-D is used.

Dormant basal trunk applications require a petroleum oil as the carrier but highly toxic oils should be avoided since they may hinder rather than enhance the translocation of the herbicide. Ahlgren, et al (1) stated that high grade diesel oil and kerosene are particularly effective with the 2,4-D and 2,4,5-T formulations. In comparing oil and water as a carrier Peevy (10) found the oil to be considerably more effective than water when 2,4,5-T ester was applied at 16 lbs. ahg of carrier but at 8 lbs. ahg the results were equally unsatisfactory with either the oil or water. The ineffectiveness of water as a carrier, even when high concentrations of chemical are used, has been confirmed by a number of investigators. Water-oil emulsion carriers, although proven to be superior to water as a carrier, do not seem to be as effective as oil.

Procedure

Experiment I -- Activity and Time of Application of Chemicals

This study was initiated in 1954 along a drainage ditch located near Georgetown, Delaware. The chemical treatments indicated in Table 1 were evaluated for the control of both coniferous and deciduous brush growth. Two series of plots, one of which represented coniferous growth (predominantly loblolly pine) and the other represented deciduous growth (predominantly red maple, white oak, with a scattering of sweet gum) were required. Brush growth on these plots was predominantly 1/2 to 2 inches diameter breast height. Individual plots were 15 feet x 30 feet.

1/ ahg - acid equivalent per hundred gallons

Table 1. Chemical treatments which were evaluated for the control of coniferous and deciduous brush.

Designation	Chemical Name	Rate of Application[a]
	Basal spray - Oil carrier	
Esteron Brush Killer	propylene glycol butyl ether ester of 2,4,5-T and 2,4-D	24 lbs. ahg
Weedone Brush Killer	butoxy ethanol ester of 2,4,5-T and 2,4-D	24 lbs. ahg
Esteron 245	propylene glycol butyl ether ester of 2,4,5-T	16 lbs. ahg
Esteron Ten-Ten	propylene glycol butyl ether ester of 2,4-D	16 lbs. ahg
Weedone 2,4,5-T	butoxy ethanol ester of 2,4,5-T	16 lbs. ahg
Weedone LV-4	butoxy ethanol ester of 2,4-D	16 lbs. ahg
MCP	2-methyl-4-chlorophenoxy-acetic acid	16 lbs. ahg
	Basal spray - Water carrier	
Karmex W	3-(p-chlorophenyl)-1, 1-dimethylurea	1 lb./gal.
NaTCA	Sodium trichloro-acetic acid	1 lb./gal.
Ammate	Ammonium sulfamate	4 lbs./gal.
	Soil application - Dry form	
Karmex W		50 lbs./A
NaTCA		50 lbs./A
Ammate		500 lbs./A
Polyborchlorate	Borate complex	2000 lbs./A
Borascu	Sodium borate	2000 lbs./A

a/ ahg - acid equivalent per 100 gallons

Basal spray treatments were applied at two different dates to provide a comparison of treatments at different stages of dormancy. The first date of application was on February 14 when growth was completely dormant. The second date of application was April 15 which approximated the breaking of the dormancy period. The base of all woody growth from the soil surface to a height of 12-15 inches was sprayed to the point of runoff using a 3 gallon knapsack sprayer (diaphragm type). All liquid formulations were applied with #2 diesel oil as the carrier. The dry formulations were applied with water as the carrier.

Soil treatments were broadcast by hand on the soil surface. Before application each chemical was mixed with five pounds of dry sand in order to facilitate an even distribution over the plot.

The activity of each chemical was evaluated on September 1, 1955. Visual estimates of the degree of brush control were made and accordingly were rated on a basis of 0 to 10; 0 = no control and 10 = complete kill without any resprouting.

Experiment II -- Concentration of Chemical

In 1955 a study was initiated in the vicinity of Georgetown, Delaware, to determine the most effective concentration of the chemical which in preliminary observations appeared to show most promise in the 1954 screening test.

Esteron Brush Killer was applied on March 8 as a basal spray treatment at the rates of 8, 12, 16, and 20 lbs. ahg of #2 diesel oil. Similar to the 1954 study two series of plots were included, one of which represented pine and the other deciduous growth. Individual plots were 15 feet x 30 feet. All treatments were replicated in triplicate in a randomized block design.

The treatments were evaluated on September 15, 1956, in accordance with the procedure used in the 1954 study.

Experiment III -- Oil-Water Carriers

In 1956 a study was conducted to evaluate combinations of oil and water as carriers.

Esteron Brush Killer at 20 lbs. ahg of carrier was applied on March 5 as a basal spray to separate plots of coniferous and deciduous brush using the following oil-water combinations: 25% oil - 75% water, 50% oil - 50% water, 75% oil- 25% water, and 100% oil. Triton X-100 was used as an emulsifying agent. Plot size, experimental design, and evaluation of control were the same as that outlined in the 1955 study.

Results and Discussion

Experiment I -- Activity and Time of Application of Chemicals

The results of the basal spray treatments for the two dates of application are summarized in Table 2. A comparison of the dates of application indicates that more effective control of pine was obtained from the April application date except with the Esteron Brush Killer and Karmex W, in which case the results were identical. It was interesting to observe after the application of the chemicals at each date, the difference in time before any herbicidal effect was visible on the pine. Within a week after the April application epinastic effects on the terminal growth became evident. Approximately 6 weeks had elapsed after the February application before any such effects were noted.

Table 2. The effect of chemicals applied as a basal spray and time of application on the control of coniferous and deciduous brush.

Chemical	Rate	Control Rating[a/] 2/15/54 application Coniferous[b/]	Control Rating[a/] 2/15/54 application Deciduous[b/]	Control Rating[a/] 4/15/54 application Coniferous[b/]	Control Rating[a/] 4/15/54 application Deciduous[b/]
Oil Carrier					
Esteron Brush Killer	24 lbs. ahg	9	8	9	5
Weedone Brush Killer	24 lbs. ahg	4	6	9	4
Esteron 245	16 lbs. ahg	5	7	9	7
Esteron Ten-Ten	16 lbs. ahg	8	4	-	-
Weedone 2,4,5-T	16 lbs. ahg	3	8	9	6
Weedone LV-4	16 lbs. ahg	4	5	-	-
MCP	16 lbs. ahg	4	3	-	-
Diesel Oil, #2		0	0	0	0

Table 2. (Continued)

Chemical	Rate	Control Rating[a/] 2/15/54 application Conifer-ous[b/]	Decidu-ous[b/]	4/15/54 application Conifer-ous[b/]	Decidu-ous[b/]
		Water Carrier			
Karmex W	1 lb./gal	10	10	10	10
NaTCA	1 lb./gal	1	4	-	-
Ammate	4 lbs./gal	8	0	-	-
Polyborchlo-rate	2 lbs./gal	3	0	-	-

a/ Control rated on basis of 0-10: 0 = no control, 10 = complete kill. (rating taken 9/1/55)

b/ Coniferous predominantly loblolly pine; deciduous predominantly red maple and white oak.

In contrast to effect of time of application on the pine, very little difference between the February and April application in the control of red maple and white oak was obtained. In general, the April application was slightly less effective than the February treatment.

Complete kill of all vegetation, woody as well as herbaceous, was obtained from Karmex W at 1 lb./gal of water. These plots at present (approximately four years after treatment) are devoid of vegetation. Although this has been the most effective treatment, it is not the most satisfactory for the solution to the problem. The persistent sterilizing effect of the soil is undesirable from the standpoint of exposing the ditch banks and the slopes in particular to erosion. Very satisfactory control of both coniferous and deciduous brush growth without any serious effect on the herbaceous cover was obtained from Esteron Brush Killer at 24 lbs. ahg.

In comparing the activity of the esters of 2,4-D with 2,4,5-T in Table 2 (2/15 application) it appears that the esters of 2,4-D are more effective in the control of pine than 2,4,5-T. In contrast, the esters of 2,4,5-T appear to be more effective than 2,4-D in controlling the deciduous growth.

Ammate at 4 lbs./gal gave good control of pine but no control of red maple and white oak.

Karmex W applied to the soil at the rate of 50 lbs./A was equally as effective as the basal spray treatment in the control of all woody growth, Table 3. The soil sterilization effect of this treatment still persists at present similarly to the basal treatment with this chemical. Borascu, also as a soil treatment, at the rate of 1 ton/acre gave good control of all brush. However, the objection to both of these materials as previously mentioned for Karmex W, is the control of the herbaceous growth.

Table 3. The effect of chemicals applied as soil treatments on the control of coniferous and deciduous brush (applied 2/15/54)

Chemical	Rate lbs./A	Control rating[a/] Coniferous[b/]	Control rating[a/] Deciduous[b/]
Karmex W	50	10	10
NaTCA	50	4	0
Ammate	500	5	0
Polyborchlorate	2000	7	5
Borascu	2000	10	7

a/ Control rated on basis of 0-10: 0 = no control, 10 = complete kill. (rating taken 9/1/55)

b/ Coniferous predominantly loblolly pine, deciduous predominantly red maple and white oak.

Experiment II -- Concentration of Chemical

A summary of the results is presented in Table 4. Unsatisfactory control of either coniferous or deciduous growth was obtained from concentrations of 8, 12, or 16 lbs. ahg of oil. At 20 lbs. ahg satisfactory control was obtained. However, the results indicate that a concentration higher than 20 lbs. ahg may be necessary to achieve better control of brush.

Table 4. The control of coniferous and deciduous brush growth with different concentrations of Esteron Brush Killer (applied 3/8/55)

Esteron Brush Killer (lbs. ahg oil)	Control rating[a/] Coniferous[b/]	Control rating[a/] Deciduous[b/]
8	2.0	2.7
12	3.0	3.3
16	5.0	4.7
20	8.0	8.0

a/ Control rated on basis of 0-10: 0 = no control; 10 = complete kill. (rating taken 9/15/56)

Experiment III -- Oil-Water Carrier

A summary of the results is presented in Table 5. The 100% oil carrier was superior to all oil-water combinations in the control of both coniferous and deciduous growth. The 75% oil - 25% water carrier gave good control of coniferous brush and fair control of the deciduous growth. In comparing the effectiveness of the various carriers in controlling coniferous and deciduous growth, it appears that slightly better control of the coniferous brush is obtained in each combination of carrier.

Table 5. The control of coniferous and deciduous brush growth with 20 lbs./ ahg of Esteron Brush Killer in oil-water carriers of different composition (applied 3/5/56)

Composition of Carrier (% by volume)	Control rating[a/]	
	Coniferous[b/]	Deciduous[b/]
25 oil - 75 water	4.0	3.3
50 oil - 50 water	7.0	5.7
75 oil - 25 water	8.3	7.0
100 oil - 0 water	9.0	8.7

a/ Control rated on basis of 0-10: 0 = no control; 10 = complete kill. (rating taken 9/10/57)
b/ Coniferous - loblolly pine; deciduous - predominantly red maple and white oak.

Summary and Conclusions

Growth of coniferous and deciduous brush along drainage ditches seriously interferes with the mechanical maintenance operations of these artificial waterways if control is neglected for a period of five years or more. Most troublesome species include loblolly pine, red maple, white oak, and sweet gum. The use of chemicals was investigated in the present studies as a possible solution to the problem. These studies were designed to determine: (1) a chemical treatment for satisfactory control of coniferous and deciduous brush, (2) minimum concentration of chemical for effective brush control, and (3) effectiveness of oil-water combinations as suitable carriers. The results of these studies indicate the following:

(1) Complete control of all vegetation, herbaceous as well as woody was obtained from Karmex W at a concentration of 1 lb./ gal of water applied as a basal spray or 50 lbs./A as a direct

application to the soil. This treatment was unsatisfactory from the standpoint of the persistent sterilization effect of the soil. Consequently, the bank slopes became more susceptible to erosion.

(2) Most satisfactory control of loblolly pine, red maple, and white oak was obtained from Esteron Brush Killer at 24 lbs. ahg of diesel oil.

(3) Minimum concentration of Esteron Brush Killer for effective results was 20 lbs. ahg of oil. Concentrations of 8, 12, and 16 lbs. ahg were unsatisfactory.

(4) 2,4-D ester was more effective than the 2,4,5-T ester in the control of pine whereas in the control of deciduous growth the 2,4,5-T ester was more effective.

(5) April basal spray was superior to the February application for the control of pine whereas in the control of deciduous growth the February application was superior to the April treatment.

(6) A 100% oil carrier was necessary for satisfactory control of both pine and deciduous brush. A 75% oil - 25% water carrier was satisfactory for the control of pine. In general, oil-water carriers resulted in more effective control of pine brush than of deciduous brush.

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HERBICIDE WORK BY THE OHIO DEPARTMENT OF HIGHWAYS

By

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Today we have an expansion in highway use of a magnitude generally unappreciated except by those who live with it and struggle to solve it. With this expansion there has been an unpublicized but never the less hard and difficult struggle to keep our roadsides well maintained.

At the present time we have approximately 48 million passenger cars, ten million trucks and a quarter of a million buses operating on our 3,348,000 miles of highway in the country.

What does this mean for Ohio and how does it directly effect the Ohio Highway Department? It means that Ohio is having its share of increased traffic and in order to handle this efficiently and safely, wider roads and many divided lane highways have been constructed to handle the 11,095,631,537 annual vehicle miles for 1956. This means also that more right of way had to be acquired and consequently maintained.

A new type of acreage is becoming manifest in our economy, narrow strips seem to be inevitable. What does all of this amount to acreage wise? The State of Ohio has approximately 16,000 miles of rural state highways, or a conservative figure of 55,000 roadside acres. This long acreage is a challenge for new techniques. Still, whatever methods we employ must satisfy the basic needs of the Highway Department.

These needs involve the elements of erosion control and traffic safety. The best control for erosion is the establishment of turf, which we are obligated to keep free of weeds. We have this obligation because of Ohio's weed law which requires the cutting of noxious weeds and because of the pride we have in the appearance of our roadsides and the urgency for good public relations. Closely related to this problem of erosion is traffic safety demanding control of woody growth within the right of way particularly at intersections and inside of curves.

Weed and brush, out of control are ever present problems on our roadside acreage. We have found that a program of herbicide spraying is the most effective method of dealing with it. With the release of herbicides for several usages a new front line was established in this endless war. We were ushered suddenly into an age of chemical control with new dust and liquid killers being compounded for nearly every damaging and discomforting weed pest of mankind and his crops. Keeping close pace were developments in the equipment used to apply it.

The first chemicals were the type that killed everything. Then came selective herbicides such as 2,4-D. This herbicide is effective in small doses on many plants. It is selective, non-toxic to man or livestock, non-corrosive to equipment, and easy to apply. It has no unfavorable effect on soil bacteria or other micro-organisms. In our

Now, 2,4,5-T has been added as a chemical to control undesirable brush having pernicious characteristics. Chemically, it differs from 2,4-D only in having three chlorine atoms in its molecule instead of two.

Dr. C. J. Willard, Professor of Agronomy at Ohio State University states in his bulletin on Chemical Control of Woody plants, that plants react with widely varying effects when sprayed. He continues by saying "With sufficient doses, some plants are killed almost at once after application. In other plants and other dosages they stimulate any tissue that is growing at the time to abnormal growth. Essentially they disorganize the biochemical process within the cells of the plants so that they do not proceed, or proceed abnormally, but each kind of cell in each plant responds in its own unique way.

These herbicides themselves are organic acids which are not soluble in water or oil and so cannot be used generally for weed killing in their uncombined form. They must be compounded for use.

These compounds and their formulations will, in turn, contain different proportions of 2,4-D or 2,4,5-T acid. Since the acids are the part of the compounds which kill, all rates of application should be stated in terms of the amount of 2,4-D or 2,4,5-T acid present, that is, as the acid equivalent. There are two general forms of 2,4-D on the market: (1) Liquids that mix with water in any proportion, making clear solutions. These are water solutions of certain organic salts of 2,4-D commonly referred to as amine salts or amine forms of 2,4-D. (2) Liquid that makes milky mixtures with water. These contain esters of 2,4-D dissolved in miscible oils. Because they are in oil solutions, which wet the plant and permit the 2,4-D to penetrate, the ester forms are more effective on hard-to-kill plants, under dry conditions and under unfavorable conditions generally.

The esters first used were the alkyl esters (methyl, ethyl, butyl, isopropyl and amyl.) Recently much more complex long chain esters have been introduced as "low-volatile" esters. These actually are much less volatile than the other esters, but another important reason for using the low volatile esters is their herbicidal activity. They are the most active compounds of 2,4-D and 2,4,5-T so far produced, and are particularly valuable against woody plants.

One must never forget, when using 2,4-D and 2,4,5-T, that he is using extremely potent materials. Use no more than necessary, and use every precaution to prevent drift and misapplication.

Drift and volatility are frequently confused. They are somewhat similar in result but completely distinct in origin. Drift refers to the down-wind drifting of droplets of spray at the time of application. If applied as a fog such droplets can easily drift a half mile or even several miles. Volatility refers to the evaporation of the herbicides after application, and moving with the wind in vapor form. Use low pressures and nozzles producing as large droplets as are feasible.

Obviously, the danger from volatility at any location will increase in proportion to the amount of material applied at the location. This means that applications, which are usually made on long, narrow strips of land, are less likely to cause injury from volatility than field applications of the same materials."

We have in the hormone herbicide a tremendously effective and useful tool but we must use it carefully with regards to the rights and even the prejudices of others, or we are going to have the tool taken away from us.

Our best success to control erosion is by the use of grass. Erosion control makes the highway safer and better looking but of greater importance is the fact that it lowers maintenance costs by helping to prevent the deposition of eroded earth in highway ditches, stops gullying, permits the stabilization of shoulder soils, and prevents the blocking or undermining of culverts. It is a boon to the maintenance engineer, but also an obligation, for vegetative erosion control is not a magic cure all to be installed and forgotten. Herbaceous and woody plants need fertilizer and other forms of maintenance. It is important, too, to inspect them regularly to detect weak spots and repair them, before they develop into major and costly repairs.

Ground cover consisting of shrubs and vines has provided good erosion control. In some instances trees have been used. All have a place in roadside management and should be considered as such. It has sometimes seemed inconsistent to find miles of this type of vegetation destroyed.

We have probably all seen the results of improper treatments along our highways. This is quite unnecessary. We have the proper materials and the proper methods, if you will but follow our prescribed policy, which may be effectively used without damage to adjacent vegetation.

Three of the most important factors in preventing this damage, and in assuring effective control, are first, adequate planning, second adequate supervision by informed and alert personnel; and third, to have the men who are actually doing the spraying be well informed as to the material and the spraying operation. This cannot be emphasized too strongly as the success of the operation depends greatly upon these factors.

Our chemical weed control program was started in 1945 when we began experiments in using herbicides to eradicate poison ivy. The following year we included areas that could not be mowed with power equipment. In 1951 we decided to spray all the roadsides in an entire county. Our program continued to expand because of the good results obtained.

In 1956, approximately 75% of the roadsides on the "rural mileage" in the state highway system were sprayed. This included spraying roadsides in varying amounts in 77 of Ohio's 88 counties for a total of 12,190.95 miles at a cost of $222,647.89. This is the largest weed

The average cost per mile for spraying in 1956, is lower than in each of the two preceding years, and compares as follows:

1953	$16.39
1954	19.41
1955	20.58
1956	18.26

We anticipate this cost to be further reduced in the future as the roadsides are rid of the major quantities of weeds through intensive spraying and the areas then maintained by a reduced spray program.

The cost per mile of mowing sprayed roadsides (both sides included) has continued to decrease.

1953	$91.78
1954	82.61
1955	69.33
1956	53.32

The combined costs of spraying and mowing were:

1953	$108.17
1954	102.02
1955	89.91
1956	70.03

The costs per mile of mowing roadsides (both sides) not sprayed were:

1953	$92.75	
1954	117.89	
1955	120.00	(Estimated)
1956	69.46	

Thus there is a huge drop in the cost figures for mowing untreated roadsides during the 1956 season. There are two reasons why this change may have occurred. First, there may be some relaxing in the intensity of the mowing program over that of former years. Second, most of the difficult areas to mow, those inaccessible to power mowers, are now being sprayed and only those easily maintained with a tractor-mower remain untreated.

Briefly, the object of the herbicide weed control program is:

To eliminate the several varieties of weeds.
To reduce the need of hand mowing.
To eliminate poison ivy.
To clear and maintain ditches and drainage structures.
To open and maintain adequate sight distance.
To inform the general public so that the program will be accepted by them.
To provide a grass border that is restful to the motorist and helps to eliminate driver fatigue.

When a spray program is adopted consideration will have to be done with highway personnel the department has closer control. It can supervise applications to all needed parts of the right of way and see to it that there are heavier applications where needed. By the same token, the department will then be responsible for criticism and complaints from organizations and individuals and will have to meet claims for damages.

Based on the success of herbicide control on Ohio's roadsides I can make the following recommendations to you:

1. That a three year program of three sprays per season be used.
2. That the first spray be applied early in the season and the mixture contain a minimum of three pounds acid equivalent of a polypropylene glycol butyl ethar ester or a butoxyethanol ester of 2,4-D, per 100 gallons of water at a minimum rate of 100 gallon per mile ($2\frac{1}{2}$ to 3 A.).
3. That the second application be performed by July first and contain two pounds of 2,4-D, and one pound of 2,4,5-T.
4. That the third spray be applied before September first and contain three pounds of 2,4-D.
5. That the equipment be prequalified 1,000 gallon sprayers.
6. That after a three year period only one application per year be made.
7. That trained crews and accurate amounts of material be used and that wind, atmospheric conditions and susceptible vegetation be considered.
8. That prior to spraying the areas should be investigated and that slopes subject to erosion should not be sprayed. Likewise, desirable vegetation should be designated not to be sprayed.
9. That spraying and mowing operations be coordinated and a fertilizing program be included.
10. That when cattle claims arise, you work very closely with your University and with the Department of Agriculture, especially the Veterinary Division.
11. That all damage claims should be investigated.
12. That no opportunity be overlooked to promote good public relations. Publicity should stress safety, economy and efficiency.

Mowing and applying herbicides, if properly carried out, not only means lower cost maintenance, but results in a more pleasing environment to the motorist, and serves as good public relations between the highway department and the general public.

THE HERBICIDE PROGRAM FOR NEW YORK STATE HIGHWAYS

NELSON M. WELLS
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NEW YORK STATE DEPARTMENT OF PUBLIC WORKS

New York State initiated its first state wide program of applying herbicides to the State highway roadsides in 1957. Experimental work and study began in 1947 and has continued. Several districts have accomplished economical results and proven the value of the work since that time. Close association with interested research agencies, utility companies and other public agencies with comparable problems has been maintained.

The principal objective in using herbicides as a maintenance tool is to enable the present standards of roadside maintenance to be continued at a reduced cost with improved safety and appearance.

The economical control of vegetation on the state highway rights-of-way presents problems which are, in many cases, unique in the field of herbicidal control of vegetation. The right-of-way varies greatly in width requiring a very flexible type of application. The right-of-way is spotted with utility poles, signs and trees. Herbicides for weed control or in chemical mowing of guide rails must be applied at relatively high speeds. Susceptible crops border a considerable mileage of the state highway system. Appearance on these generally heavily travelled routes is of the utmost importance.

The magnitude of problems facing New York State can be shown by the following figures: It is estimated that the 13,000 miles of existing state highways have approximately 70,000 acres of roadsides. The acreage in roadsides will continue to increase as present standards of design require a much greater area of roadsides than those built in the past. The state maintains several thousand miles of guide rail which requires costly mowing. Fence line brush and tree growth is found along the entire state highway system. It is estimated that approximately 7,000 miles of state highway right-of-way is bounded by brush or woodlands continually crowding in on the highway.

An analysis of our special requirements was made and it was decided as a start to purchase ten 600 gallon, 35 gallon per minute sprayers, and ten 100 gallon, 7 gallon per minute sprayers, one of each assigned to each of the ten engineering districts. A special training course was organized to familiarize operating personnel with the chemicals, equipment and policy. Emphasis was placed on precautions to avoid damage claims and the departmental policy of no foliage spraying except under special conditions.

The 1957 program did not get underway until mid-summer due to unforseen delays in purchasing the equipment but enough work was accomplished with both the new and makeshift equipment to begin to form a picture of the costs, results, operating procedures and necessary equipment modifications.

Broadleaf Weed Control

The primary objective of this treatment was to eliminate at least one mowing by reducing the weed population on the right-of-way.

Approximately 2700 acres were covered with one treatment.

The recommended treatment was ½ gallon of 2, 4-D low volatile ester in a minimum of 50 gallons of water per acre applied at any time throughout the growing season.

Good results were obtained with the mid-summer treatment. The results obtained by late summer and early fall treatments will have to be evaluated in the summer of 1958. It appears reasonable from limited observations that at least one mowing can be eliminated by removing weed growth from the right-of-way. Further work is needed in developing the equipment to permit safer and more economical coverage of the varying widths of our rights-of-way.

Chemical Mowing

The primary objective of this treatment was to control all vegetation adjacent to structures such as guide rails, signs, fences, etc. to eliminate the costly mowing.

Approximately 1000 miles of guide rail were treated.

The recommended treatment was ½ gallon of 2, 4-D low volatile ester and 30 pounds of radapon in 30 gallons of water per acre applied before growth reaches 9" in height.

The results were generally satisfactory. Timing of the application appears to be of utmost importance. Treatments made in early spring gave excellent initial results insofar as eliminating all vegetation. In some instances, however, orchard grass and quackgrass sent up strong new growth from the roots and annual weeds and grasses such as foxtail infested the treated area. A second treatment designed to control the developing vegetation is indicated. Treatment in July after an initial mowing achieved satisfactory control. There was very little regrowth of permanent grasses and practically no weeds or annual grasses had appeared in the treated area by early September.

Brush Control

Brush is constantly crowding onto the highway impairing sight distance and causing snow drifting. In the past it has been removed by costly hand cutting or grubbing every few years. It was felt that herbicides properly used could control this brush growth, eliminating the hand cutting and replacing the brush with easily maintained grass. The four methods used for controlling brush are as follows:

Foliage Treatment

Approximately 175 acres were treated.

The recommended treatment was ½ gallon of 2, 4-D* and ½ gallon of 2, 4, 5-T* or 2 to 12 pounds of amino triazole in 100 gallons of water applied at 100 gallons to 200 gallons per acre, depending on the kinds of plants to be treated, throughout the growing season.

No acreage figures are available of the treatment of poison ivy infested areas spotted over much of the state highway system. The recommended treatment was 2 pounds of amino triazole in 100 gallons of water applied to wet all foliage throughout the growing season.

The initial results show excellent kill.

Semi-Basal Treatment

Approximately 55 acres treated.

The recommended rate was 3/4 gallon of 2, 4-D*, 3/4 gallon of 2, 4, 5-T* and 10 to 20 gallons of oil in 80 to 90 gallons of water applied at 100 to 200 gallons per acre throughout the growing season.

Basal Treatment

Approximately 3 acres treated.

The recommended rate was 2 gallons of 2, 4-D* and 2 gallons of 2, 4-5-T* or 4 gallons of 2, 4, 5-T* in 100 gallons of oil applied to runoff from base up to 12" on all stems at any season.

Stump Treatment

Approximately 1 acre treated previous to October 1, 1957.

It is expected that more acreage will be treated as fall and winter brush cutting operations get underway. The recommended rate was 2 gallons of 2, 4-D* and 2 gallons 2, 4, 5-T* in 100 gallons of oil applied overall to runoff at any season.

Initial results appear excellent for all treatments but insufficient time has elapsed to fully evaluate the effectiveness.

The cost of the various herbicide treatments varies considerably between the various districts and appears to be directly influenced by the efficiency

* Low volatile esters of 2, 4-D and 2, 4, 5-T are used in all brush control.

of the application. It must be remembered that the crews were working with unfamiliar equipment and in most aases without previous experience. It is anticipated that costs will drop considerably in future years' operations.

The approximate average costs for work accomplished in 1957 and including labor, materials and equipment are as follows:

Broadleaf Weed Control	$ 3.00 per acre			
Chemical Mowing Guide Rail	$ 16.50 per mile			
Brush Control				
Foliage	$ 17.	to	$25.	per acre
Semi-Basal	$ 20.	to	$30.	" "
Basal	$175.	to	$265.	" "
Stump	$180.			" "
Poison Ivy	No figures available			

It is anticipated that a considerably greater volume of work will be accomplished in all phases of herbicide application in 1958. Approximately 7000 acres will be treated for broadleaf weed control and about 1000 acres for brush control. About 3000 miles of guide rail will be treated to eliminate hand mowing and the program to eradicate poison ivy from the roadsides will continue.

Our comparatively limited experience of roadside herbicide control on a state wide basis has indicated some general considerations which might be of value to others.

While the materials and methods presently available are remarkably effective when properly applied there should be an informed appreciation of their capabilities by those responsible for their use. We should not expect miracles just because the present chemicals achieve good results. Research indicates that more effective materials will become available in the future and it is in our best interest to remain informed of developments as they occur.

Better equipment is much to be desired. Speed of operation is essential not only for economy but for safety in operation on the highway.

Exchange of information will help all of us to advance our programs wisely and the Northeast Weed Control Conference is to be commended for being the first to provide such a program devoted to highways.

IMPORTANT PROGRESS IN THE USE OF HERBICIDES ALONG CONNECTICUT HIGHWAYS

By

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Tremendous advances are now being made throughout the nation in the development of a highway transportation system to meet the demands of the greatly increased high-speed traffic. This system means that everyone connected with the various segments of the department—planning, design, construction, and maintenance--must accomplish his responsibilities with improved efficiency, more economy, and higher standards of performance.

As with other states involved in this program, Connecticut is hard at work in an attempt to meet this great challenge of highway advancement. For a number of years we have been conducting research projects that would develop techniques and methods to improve the quality and efficiency of our productive operations.

We all know that the roadway and roadside, with all the necessary appurtenances, must be moulded together to give us the "complete highway"— the road that we can travel safely, efficiently, comfortably through healthful, beautiful countrysides. Also, we are familiar with the fact that, in the roadside areas, those acres under vegetation are becoming increasingly more important in the functional aspects of highway transportation. In the highways constructed in the past, at least an equal amount of acreage has been required in vegetation as in the travel area. In the highways of the future, we foresee that the roadside areas will be almost three-fold that required for the travelway.

It is in these vast areas of vegetation that the valuable chemical tools, known as herbicides, are becoming increasingly important, not only to perform the operations more economically and efficiently with less manpower, but to accomplish the required maintenance work so that the standards of health, beauty, and safety are at a much higher level.

The work that has evolved from our research in the field of herbicides, under the guidance and helpful assistance of the scientists and representatives of the manufacturing industries, has now been developed into a constructive program along Connecticut's highways. Thus, I say, we have made <u>important progress</u> in our extended use of these materials.

We hope to improve our programs of the future. As newer materials and application techniques are developed, we intend to evaluate them as to effectiveness, ease of application, economy, and reduction in use hazard.

(The following is a brief summary for the record. Detailed information at the meeting is to be presented orally and is to be illustrated with accompanying slides.)

Briefly, our program as now developed is as follows:

1. Early application of 2,4-D on roadsides and areas under vegetation to eliminate broadleaf weeds in turf areas.

2. Eradication of grass and weed growth under guide rails, around signs, delineators, etc., where the soil has not been sterilized and the cross-section causing a drainage impediment needs revamping. This is accomplished by the application of a systemic grass killer and 2,4-D.

3. A continuing program during the foliar season (June to September) for the eradication of poison ivy and toxic woody growth by the application of selective auxins.

4. The elimination of ragweed and other annual weeds when the plants are small and less resistant to herbicides.

5. A late summer (August 15th to September 15th) foliar application on woody brush using 2,4-D plus 2,4,5-T. This spray is timed so that the unsightly brown-out blends in with Nature and eliminates a great deal of criticism, yet it is effective.

6. The application of soil sterilants under guide rails and similar locations is a continuing program. As all new construction is completed and the build-up on our older roads is eliminated, the material is applied. It is covered almost immediately with bitumen to retain its effectiveness in the soil, prevent erosion, and improve the appearance.

7. The basal spraying of stubble (cut brush) with 2,4,5-T in oil may be done at any time of the year, but our work is generally performed during the dormant season.

The application equipment we use is very simple but adaptable and effective. The supply tanks are salvage steel drums, easily available and quickly mounted on most any truck.

The pumping units are small portable piston-type pumps that provide hydraulic agitation through a by-pass valve. With these units we are able to apply efficiently low-pressure, low-volume coverage.

Trucks are equipped with a front-end frame, easily assembled from a few pieces of steel, bolts and a spring. This is mountable on either side of the truck and is controlled by the operator from the cab by means of an hydraulic lift.

The nozzles are off-set boom jet, equipped with two tips that may be easily adjusted to produce the desired spray pattern. Also, there are attached to each rig one or more hand booms with T-jet nozzles for selective spraying and spot coverage.

Training the drivers and operators of this equipment is most essential. It is a fairly simple operation but it requires skill and ability. The men on these rigs can either make or break a program. Sound judgment must be exercised even though the men have the knowledge and background of what to use, and when and where to use it.

. . . .

A sound conservative program with the use of herbicides along the Connecticut highways has resulted in decided benefits to our department. Not only have the areas under vegetation been maintained at reduced costs and with far less manpower, but we have made decided improvements resulting in safer, cleaner, healthier, and more beautiful roadside areas. Important progress has been made with the use of herbicides and it is anticipated in the years to come even more benefits will be derived.

HIGHWAY DESIGN AND THE USE OF HERBICIDES FOR BETTER MAINTENANCE

By Robert T. Walker, Landscape Architect
Bureau of Public Roads, Washington, D. C.

INTRODUCTION

The present expansion of highway construction programs, including the planned completion of the entire Interstate system, will require the full capabilities of the Federal and State highway organizations. The State or local highway administrator is required to produce more plans for new traffic facilities, designed to higher standards. He must also consider the never-ending maintenance burden to be carried by his organization, after these highways are completed and opened to traffic. Some idea of the size of this problem may be gained from the fact that the Interstate system consists of 41,000 miles of highway. The roadside area of this system alone will comprise approximately one million acres or more. Anything that will help reduce the maintenance problems on roadside areas of this size certainly should be explored to the fullest extent.

Papers presented before the Highway Research Board in recent years have suggested the exchange of information between the Weed Control Conferences and various highway authorities, to produce more effective work and greater efficiency in the control of undesirable growth along our highways.

It is the purpose of this paper to discuss certain elements of highway design and their possible relationship to the part that herbicides can play in highway maintenance.

ELEMENTS OF HIGHWAY DESIGN

In this discussion we are concerned with the design and maintenance of roadside areas within the right-of-way on which turf or other vegetation is growing or will be established.

The modern controlled-access divided highway includes a number of separate cross section elements; pavments, preferably at different levels to take advantage of terrain and other features; shoulders, turfed or surfaced; drainageways; slopes in cut and fill sections; medians both of fixed and variable width; border areas undisturbed by construction; and special areas such as interchanges and safety rest areas.

Adjacent to the highway right-of-way, private or public lands exert some influence on the cross section design, and definitely affect the methods or types of maintenance operations performed within the highway limits.

Two outstanding examples of modern highway facilities with which I presume you are familiar, are the New York Thruway and the Garden State Parkway in New Jersey. They exemplify many of the latest trends in improved design for controlled-access highways.

Shoulders

direction, and amount of cross pitch or slope, composition, need for curbs or inlets, rounding of outer edge, and adjacent slopes.

The design standards for the Interstate system provide for shoulders usable by all classes of vehicles in all weather, on the right of traffic. The usable width of shoulder is to be not less than 10 feet. In mountainous terrain involving high cost for additional width, the usable width of shoulder may be less but at least six feet. Usable width of shoulder is measured from edge of through-traffic lane to intersection of shoulder and fill or ditch slope, except where such slope may be steeper than four to one, where it is measured to beginning of rounding. Shoulder design standards for primary and secondary highways also have been clearly defined.

Design criteria and accepted values practiced by the States for cross slope of shoulders, range from 1/4 inch to 1 inch pitch per foot for surface water runoff. Where guardrail, guard and guideposts are to be used, as on fill areas, the normal width of shoulder is usually increased about two to three feet.

Drainageways

The next cross section elements to be considered are drainageways. Earth drainageways or ditches, usually grassed, are the predominant type used along most highways. Paved drainageways are normally installed where grass fails to provide the desired erosion control. The depth and width of ditch are normally shown on the typical cross section sheet of project plans. On major highways where topography permits, roadside ditches built in earth should have side slopes not steeper than four to one (horizontal to vertical), and a rounded bottom at least four feet wide. Minimum depth should vary from about one foot in regions of low rainfall, to about three feet in regions of heavy rainfall. Ditches should be designed to prevent infiltration of water to shoulders and pavement subgrades.

Intercepting ditches are often necessary at the tops of both heavy cuts and heavy fills in order to protect slopes. Depth and width of these ditches varies according to rate of rainfall, area drained, soil conditions, vegetation and similar controlling factors. In areas where turf can be easily maintained, sod channels usually prove economical, and improve the appearance of the highway.

Slopes in Cut and Fill Sections

Other important elements of the cross section are the slopes in cut and fill areas.

Soil types, terrain and height of cut or fill usually determine the slope ratio to be used. In rugged topography slopes two to one or steeper may be required. Where terrain and economic conditions warrant, flatter slopes are normally provided.

The design standards for the Interstate system require side slopes to be four to one or flatter where feasible, and not steeper than two to one except in rock excavation or where other special conditions demand. Most project plans provide for rounding at top of cut slopes. Dimensions for rounding vary, ranging from two to five feet or more in front of, and in back of, the slope stake. Frequently State design

Transitioning or warped grading at the ends of cut and fill slopes, is effective in improving the appearance of the highway, reducing erosion, and permits easier operation of maintenance equipment.

Medians (earth)

A median is provided primarily to separate opposing traffic lanes. It should be highly visible both day and night, and as wide as feasible but of a dimension that is in balance with other parts of the highway cross section. Interstate standards require that medians, in rural areas where topography is flat and rolling, are to be at least 36 feet wide. Narrower medians may be constructed in urban areas where right-of-way costs are high, on long and costly bridges, and in rough mountainous terrain, but no median shall be less than four feet wide. Curbs or other devices may be used where needed to prevent traffic crossing the median strip.

In humid regions, turf or ground cover planting is generally used as a low-cost surfacing on medians six feet or more in width. Medians are often planted with selected types of vegetative material suitable for the control of headlight glare.

Quite often they are graded to drain surface water runoff to the center, to be picked up by drainage structures, or they may be crowned to direct the surface water to curbs and gutters or other structures. A median 60 feet or more in width will reduce the need for screen planting to control headlight glare. Completely separated roadways at different levels are most desirable, with undisturbed areas retained, particularly where existing woodland or other plant growth can be saved to reduce construction and maintenance costs.

Areas Within the Right-of-Way Undisturbed by Construction

Areas or physical features within the right-of-way undisturbed by construction may consist of turfed or wooded sections to be saved, streams, lakes, swamps, and cliffs. Scenic or historical sites may also be included.

The project plans normally indicate the existing features to be saved. The specifications state the methods of protection, and the engineer in charge is responsible to make sure that such protection is provided.

This may include the protection of existing vegetation from the stockpiling of salvaged soil, stone, or other materials, or the servicing or parking of construction equipment. Future development of such areas to serve as scenic overlooks or location of historical markers, or for other reasons, either on the Interstate or primary system will require consideration in the initial design stage.

Special Roadside Areas

Interchanges and safety rest areas are traffic facilities which require special design as influenced by topography or site location, volume of traffic, available right-of-way, and costs.

Grading design for an interchange is determined chiefly by the a contour grading plan of the whole area, showing all design features. Roadside improvements may be shown on the construction plans, or they may be indicated on a separate landscape development plan. Erosion control measures and planting should be considered in the initial design. Planting arrangement will usually be designed to guide traffic, frame structures, control erosion, screen out undesirable views, and for many other reasons.

Safety rest areas are off-roadway spaces, generally within the right-of-way, with prevision for emergency stopping and resting by motorists for short periods. Design standards include adequate exit and entrance connections, and appropriate size and arrangement of parking areas. Many such areas will include tables and benches, and may have toilets and water supply where proper maintenance and supervision are assured. Rest areas will normally occupy about three to five acres or more, and preferably should have turf and shade trees within the area. Where trees or shrubs are comparatively sparse, additional material may be planted to provide shade, to screen out unsightly views, and to reduce objectionable noise. A Policy for Safety Rest Areas on the Interstate system is under preparation by the American Association of State Highway Officials and should be available next year.

Adjacent Public and Private Lands

Public and private lands adjacent to the right-of-way include all kinds of land use, topography, soils, and vegetation which influence the design and maintenance of the roadside or border areas. Public lands such as State Parks or forests where conservation measures are controlling factors, in contrast with privately owned land being developed for residential or industrial use, would present entirely different problems in design and maintenance of the right-of-way area.

All of the above parts of the highway, from the median to the lands bordering the highway, but outside of right-of-way, tend to be occupied by varying types of vegetaion ranging from sod to brush, trees, and other forest growth. Each part of the highway thus presents a special problem of mowing, weed and brush control, and other maintenance problems.

MAINTENANCE OF THE HIGHWAY

Federal-aid highways are constructed to State design standards patterned on national guides adopted by the American Association of State Highway Officials and approved by the Bureau of Public Roads, but it is the responsibility of the State to satisfactorily maintain the highways built with Federal-aid funds. Furthermore the State must supply all funds for maintenance. Federal-aid regulations permit the State highway departments acting under the laws of the State to provide for maintenance of Federal-aid projects by agreement with municipal or other local authorities. The requirements are clearly stated in section 14 of the Federal Highway Act as amended by section 6 of the Federal-Aid Highway Act of 1950.

The particular maintenance problem with which we are concerned here is that of controlling certain types of vegetation within the right-of-way especially on highways in humid climates. This control of vegetation may be brought about by the use of chemicals.

On shoulders where turf has been or is to be provided, the control of weeds is important. Chemicals have also been used to inhibit the growth of grass in order to reduce mowing operations. In drainageways the problem may be controlling plant growth that interferes with surface-water runoff.

On cut and fill areas and in medians where steep slopes often occur, adequate vision clearance may require selective removal of weeds, brush, or tree growth. Periodic seasonal spraying often is the simple and logical means to provide the proper clearance.

In areas undisturbed by construction the control of shrub and tree-growth which causes snow drifting, or other conditions hazardous to safe driving, may be accomplished by a planned spray program.

Interchanges and safety rest areas generally will require control of weeds on grassed areas, elimination of noxious plants, proper vision clearance on ramps and speed-change lanes, and other maintenance operations that may be accompanied by proper use of herbicides.

CLASSIFICATION OF VEGETATION WITHIN ROADSIDE AREAS

The two general classifications of vegetation found within the right-of-way or roadside area are usually referred to as "desirable" and "undesirable".

In so classifying plant growth, a thorough analysis of a plant and the advantages or disadvantages of its existence within the right-of-way or border area should first be made. It can then be determined why, where, and when spraying with herbicides should be performed. In some cases other methods of control may be necessary. Only qualified personnel, directed by the proper State agency or local authority, should determine what growth is desirable or undesirable. Close consultation between the Maintenance Engineer, the Roadside or Landscape Architect, adjoining property owners, State Agronomist, and other personnel charged with conservation measures, may be useful.

HERBICIDES AS A MAINTENANCE TOOL

A review of available information in recent Roadside Development Reports published by the Highway Research Board shows that herbicides have been used to control the growth of undesirable plants in roadside areas principally to reduce mowing and clearing costs, to protect safety features in particular areas, and to improve the appearance of the highway.

The majority of States reporting on this subject indicate that it is economically sound and feasible to use herbicides to perform maintenance, either on a contract basis or by the use of State forces. More recent data on costs will be presented by other members of this conference and need not be covered here.

Most States have legislation requiring the control of noxious weeds on highway areas as well as other lands, and generally provide for appropriations under certain limitations to do the job.

In some cases it may be necessary to remove noxious or undesirable maintenance costs on highway areas, but the benefits to be derived may be justified.

ITEMS OF CAUTION

The following points brought out by past experience of some of the States should be kept in mind by those using chemicals to control plant growth:

1. Chemical spray materials have been used to advantage on public highways to control annual and broad-leaved weeds, thereby improving growth of turf. On shoulders, traffic islands, medians, and other areas where mowing can be done with power equipment, selective weedkillers have proved their value.

Extreme care, however, should be taken to make certain that selected weedkillers used on these areas do not come in contact with desirable plant growth on slopes below or adjacent to sprayed areas.

2. Chemical sprays have been used advantageously to kill undesirable woody plants on cut and fill sections and other areas, by the use of basal sprays or spot spraying. Spraying of this type may be used to encourage the development of desirable shrubs, trees, and other growth.

Here again extreme care should be taken not to injure or kill useful native or planted material. The use of high-power spray equipment for broadcast spraying on highway borders is questionable, especially where such operations may result in killing desirable trees and shrubs within the right-of-way, or in damage to orchards and planted areas on adjacent lands.

3. Chemical sprays have been used to reduce hand mowing by sterilizing soils around guardrail, guard posts, signs and markers, and other selected areas. They should be used with extreme caution, particularly where they may be washed or carried to adjacent lands by surface-water runoff.

4. Safe and effective use of chemical spray materials depends primarily upon doing the job with trained personnel, proper equipment, and following a well-conceived program.

5. Finally, may we suggest that the research coordinating committees of the four weed control conferences, in preparing a policy on various phases of highway herbicidal control, coordinate their activities with the AASHO Committee on Maintenance and Equipment. Through collaboration of these committees, a more effective policy on the use of herbicides for highway maintenance should be made available.

APPENDIX

List of References

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THE VALUE OF HERBICIDES IN HIGHWAY MAINTENANCE

H. Hagemeister[1]

Introduction:-

The problem of controlling and containing unwanted vegetation on and alongside our nations highways poses problems of some magnitude. It has been generally accepted that chemical weed control is a useful and economical tool for this purpose and has a definite and useful place in our highway maintenance program.

. Benefits of Highway Weed Control As Distinct From Brush Control:

1. Avoid unsightly appearance.
   a. Public relations value
2. Aid to maximum drainage of roadway and shoulder.
3. Prolongation of shoulder pavement life.
4. Reduction of mechanical maintenance costs.
   a. Scraping of shoulders
   b. Cleaning and retarring of joints
   c. Reduction in equipment purchase and repairs
   d. Reduction in labor requirements
5. Removal of fire danger.
6. Facilitation of litter (trash) removal.
7. Aid in establishment of desirable turf areas.
8. Prevention of sign guardrail and delineator posts obstruction.

Do we avail ourselves of all the different herbicides that chemists have developed or do we depend on a high pressure salesman to sell us his particular product?

Your fist mental reaction I am sure is somewhat like this. The fewer different products used the less complication in instructing the men as to the proper way of using said material. I wholeheartedly agree with that philosophy and I say fortunate is the Highway Department which can solve all its problems with one herbicide product. And fortunate we would all be if some manufacturer came up with a product that would solve all problems where herbicides are needed.

1/Chief Horticulturist, New Jersey Turnpike Authority, New Brunswick, New Jersey.

But as of today, I do not believe that such a product is available, but we do have enough different products available to cover nearly all phases of work where a herbicide can be of tremendous value in cutting down the cost of maintenance, as well as, doing a better job both from the point of appearance, as well as, cutting down the cost of maintenance labor. The important thing to consider is how extensively to use herbicides and where the cost of herbicide application can definitely cut the cost of maintenance. I believe we have not made full use of all the possibilities where herbicides can be used to advantage. On the Turnpike we have an interesting variety of conditions that call for different types of treatment. The use of 2-4-D has been deferred in most areas on the right-of-way until this time. The reason for this has been that in the areas of new slope fills, made during the widening of the Turnpike in 1954 and 1955, any kind or type of vegetation was desirable to prevent erosion. But we have now arrived at the point where the slopes have been sufficiently stabilized and enough desirable grasses established to make it practical to apply 2-4-D to eliminate the undesirable weeds, which in turn should improve the turf. There can be no question that the growth of weeds, especially along and behind guardrails, increase the number of mowings required to make a presentable appearance. Considerable 2-4-D was applied during 1957, but applications were mainly at Service Areas to eliminate dandelions and other undesirable weeds in lawns.

During the 1958 season it is planned to apply 2-4-D on the greater part of the Turnpike right-of-way, and all estimates point to the fact that such applications can be made to pay for themselves by eliminating at least two mowing operations during late summer when desirable grasses make slow growth, but the tall growing weeds quickly become unsightly and require constant mowing. Our records show that each mowing of the Turnpike right-of-way costs in the neighborhood of $15,000. If two mowings can be eliminated, or $30,000 saved in the cost of mowing, that will, according to pay estimates, pay for two applications of 2-4-D, leaving the cost of maintenance status quo, improving the general appearance of the turf and certainly eliminating to a great extent the undesirable weeds.

Types of Treatment:

Pre-surface treatment in my estimation has such tremendous value, but it is most difficult to sell because it precludes the problem,even so it is felt.

This is an important phase of new highway construction or highway pavement and shoulder area repair. In the preparation of the flexible base of the shoulder areas weed seeds and fragments cannot help but to be present. Application of a soil sterilant at this stage of construction will kill these weeds and what seedlings germinate at a later time. To be effective the sterilant should be well watered in so that the subsequent addition of the prime and finish coats will not render it ineffective. The effective life of such treatment may not be for more than four to five years. However, it is considered to be of value for even these few years of pavement and shoulder maintenance and should result in a longer pavement life with reduced overall maintenance costs.

Care should be taken to apply the sterilant only where needed and to water it in only to the point of saturation of the sub-base. Too much water will cause lateral movement and subsequent damage to adjacent turf areas.

In the matter of such non-selective herbicides, it has been found that different types are required. In certain areas where it is possible to make complete sterilization especially during new construction our choice is Telvar DW. I am referring to areas in the median where we have excavated to a depth of 3" between guardrails, applied Telvar DW, and then filled the excavation with crushed stone. This method has proved successful, but is is planned in future operations of this kind to increase the amount of Telvar, then give the area a light coating of road oil immediately after the application of Telvar. This will keep the Telvar in place and eliminate the danger of Telvar leeching out to areas where it could do considerable damage. By this method it is anticipated that such areas should stay free of weeds for a period of years. In other areas where crushed stone has been used from the curbing to about 2 feet beyond the guardrail, several types of herbicides have been tried. All did a good job of controlling the weeds, but some types discolored the granite and cement curbing considerably. Such discoloration disappeared after several rainstorms and a considerable lapse of time, but it was thought advisable to use a material that did not create this problem. Liquid Sodium Arsenite was used with excellent results. Although sodium arsenite has a very limited sterilization value we find that it has merits where it is not practical or economically advisable to try to make complete sterilization. I am referring to areas where dirt and dust accumulate enough to start some growth of weeds, such as bridge approaches, drain inlets, etc., where complete sterilization is not practical or possible. In those areas sodium arsenite does a good job. We apply it from a 500 gallon tank using gravity flow through a hose and a piece of pipe with a 5" sprinkler rose. The advantage of sodium arsenite is that it can be applied to areas where weeds appear in late season as a spot treatment.

During the summer of 1957 some rather interesting experiments were made with Chipmans Pelletized weed killer. The experiment was carried out in an area where only one side of a wide ditch was accessible. The application of the pelletized weed killer was made with our compressed air gun, ordinarily used for applying pelleted fertilizer. The operation was most successful; it was possible to distribute the material a distance of 50 to 60 feet with perfect control as to the amount of material desired to make an effective application.

This application if made in early spring when sufficient moisture is present, seems to us to have tremendous possibilities for a quick and easy way to apply weed killer in hard-to-get-at places. Chipman pelletized weed killer (Chlorea) is a formulation of sodium chlorate, sodium metaborate and Telvar and was brought into being as a non-selective weed killer in a dry pelletized form to do away with the necessity of hauling large quantities of water. Obviously the expense of water here, there and yonder is considerable and along with this the human element of error is eliminated from the standpoint of mixing, etc.

Ease of application of pelletized chlorea was demonstrated on the New Jersey Turnpike in 1957 and although it can be applied with all sorts of mechanical spreaders, i.e., salt spreaders, fertilizer spreaders, seeders, etc., just to name a few, we of the Turnpike prefer our method of blowing this pelletized material onto the area to be treated with a special hand gun and compressed air. However, other areas where general broadcasting as above cannot be utilized, such as areas around guardrails, delineators, etc. application techniques are only limited to the imagination.

New Jersey Turnpike tests in 1957 with this material in drainage ditches and around delineators have shown that the time of the year application is made soil conditions are important both from the standpoint of full effectiveness and absorbtion of the material into the soil itself.

In 1957 these limited trials showed that while good weed control was obtained, we feel the need of additional studies to determine the best timing and proper rates of application. We know,for example, that pelletized chlorea works best in early spring when weed and other vegetation are just breaking through the ground and also when soil moisture is high. We feel also that in early spring when soil moisture is high, Chlorea will be absorbed into the soil and root zone of vegetation and will be more likely to stay put since obviously we cannot have any run off onto desirable grasses which are utilized to prevent erosion.

The use of a pelletized weed killer such as this intrigues us for they are compatible with our other dry method applications and we plan extensive testing of Chlorea pellets in 1958.

One of our particular problems is the control of vegetation around the base of each of our delineator markers which represent approximately 10,000 in number, not to mention sign post bases, guardrails, etc. Since the bases of these delineators, posts, etc. are surrounded by desirable turf, you can see that our trimming and mowing operations are indeed a maintenance problem. Thus, we look upon pelletized Chlorea, when used at the proper time of the year and at the proper rate and control to stay where put as a hopeful solution to one of our big maintenance problems.

Our initial tests resulted in some lateral movement and subsequent injury to sod areas, but we feel that this was because the material was applied during the drought season and there was not enough soil absorbtion to hold the material where we wanted it and subsequent flash floods washed the pellets away instead of into the soil.

Because of the ease and safety in handling this nontoxic pelletized material, extensive trials will be made during spring of 1958 and if those trails come up to our expectations, it is hoped that we can equip our mowing machine operators with supplies of these pellets and a simple metering device so that they can then treat the base of each delineator or post at the time of first mowing.

WORK AND PLANS
of
Subcommittee on Chemicals
of
American Road Builders' Association

C. O. Eddy, Chairman *

In 1954, when it became evident that huge new funds would become available for road building, the American Road Builders' Association formed a new committee on Roadside Construction and Maintenance. The objectives of this committee was to secure a safer, beautiful and healthful highway area while reducing maintenance cost. Mr. H. J. Neale, Landscape Architect of the Virginia Department of Highways, is chairman of the Committee. This Committee is divided into five subcommittees. It is the Subcommittee on Chemicals that I shall discuss briefly for you in order that we may have your assistance and influence as well as that of your organization as such.

This Subcommittee is made up of people from the American Road Builders' Association and from the National Agricultural Chemicals Association, as well as people from any other groups that became interested in assisting in establishing the above objectives more thoroughly; but, in January, 1955 in New Orleans it was chiefly members of these two groups, the ARBA and the NACA, that started this committee studying and promoting better practices of roadside management through the use of pesticides developed in agriculture. Since that time the group has grown by additional members from colleges, universities, experiment stations, the United States Department of Agriculture, research and sales people with industry, garden clubs and from many other walks of life. In fact, any one interested is welcome to participate and assist.

The Subcommittee accumulates information, furnishes a platform and meeting place to discuss problems, and stimulates educational, advisory, and guidance programs. It is the purpose of the committee also to cooperate with garden clubs, park services, spray companies and other agencies, that are searching also for a way to improve roadsides.

* Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, New York

It is apparent that our organization is basing its activities, advice, for the most part, on information derived from agriculture. It is for this reason that we have called on technical people experienced in that area to assist in guiding us in our activities and in supplying technical information. Of course, our objective will eventually be to have information available directly from research and development work planned and performed under the supervision of programs having to do directly with rights-of-way along highways.

An important piece of work during the last year was a survey of pesticides used along state and federal highways. The resulting figures appear in the July 1957 issue of Agricultural Chemicals. Other papers mentioning or using some portion of this work are Farm Chemicals, June, 1957; Bulletin of the Entomological Society of America, Weeds and others.

In a survey recently made by this committee, it has been clearly shown that only a small beginning has been made in the use of chemicals in this field of effort. Of the chemicals used, of course, herbicides are by far the most important; 2,4-D and 2,4,5-T being the major materials used. In the survey of 43 states, it was reported that 7.3 percent of the mileage was treated with herbicides at a chemical cost of $628,320.00 in 1956. The cost of insecticides for 2% of this road mileage was reported to be $68,848. Of course, none of these costs includes application or any other handling costs. The report showed no use of fungicides except minor applications in two or three states.

Some people who have expressed opinions about the future of chemical application in this area believe that approximately one-third of the highway systems will use some method of chemical control within the next five years.

Mr. William C. Greene, Landscape Engineer for the State of Connecticut, estimates that in a program where they spent $40,000 on fungicides and insecticides, they reaped a benefit of $1,500,000 a year; and in spending $50,000 a year on herbicides, they accumulated a saving of $500,000 a year.

Mr. Wilbur Garmhausen, Chief Landscape Architect of the Department of Highways in Ohio, has said that the state in 1956 sprayed approximately 75% of the 16,000 miles of rural state highways, about half of it by contract and half by state spray equipment, at a cost of about $222,647.00.

In the study in Ohio concerning mowing and the use of herbicides or a combination of them, Mr. Garmhausen finds that costs are gradually decreasing as more spray materials are used.

In many areas a spring, a summer and a fall application of herbicides are required to get effective control of weeds at the start of the program, usually supplemented with one mowing at the end of the seeding season of the desirable grasses. Generally speaking, in the Northeast it seems that spraying will eliminate one or two or possibly three mowings, leaving only one mowing necessary. In some cases it has also been found that after a period of two years, applications can be reduced to two.

In many states we find that there are programs underway such as that in Virginia. Kentucky is starting a program of controlling weeds with chemicals. North Carolina is just getting underway, and according to our survey many other states are getting interested in it. In fact, 32 of the 42 states surveyed have shown some use of chemicals.

The Subcommittee on Chemicals of the American Road Builders' Associations' Committee on Roadside Construction and Maintenance will continue to function as its participating members, contributors, and guests offer their suggestions, guidance and help. The committee meets three times a year, the first meeting being in late January at the annual meeting of the ARBA. At the meetings in Washington, D. C., the Subcommittee brings together, for study, discussion and action, the more technical aspects of the problems associated with the use of chemicals along highways. At the fall meetings scheduled in the vicinity of New York, emphasis is placed on the manufacturing and industrial interests.

The American Road Builders' Association maintains an office at Washington 6, D. C. in the World Center Building at 918 - 16th Street.

The secretary of this Subcommittee is Dr. J. W. Zukel, Naugatuck Chemical, Bethany 15, Connecticut.

TRIALS OF SEVERAL HERBICIDES AND METHODS FOR HIGHWAY USE

EDWARD W. MULLER
LANDSCAPE ARCHITECT
NEW YORK STATE DEPARTMENT OF PUBLIC WORKS

Pre-Emergence Herbicides

The New York State Department of Public Works recommends a spray of 30 pounds of Radapon and two pounds of 2, 4-D per acre applied about May 1 as standard practice for the control of vegetation along structures such as guide rails. Summer weeds developing in these areas can become a problem, particularly when there is no broad leaf weed control program correlated with the above treatment. Trials of Experimental Herbicide, 3Y9, EPTC, Alanap and Baron incorporated with the Radapon $+$ 2, 4-D treatments to control late weeds were made in the Hornell District in the spring of 1957. These herbicides were also applied to areas that had recently been scraped clean of turf. It had been observed that weeds flourished on such areas until grass again became established on them two or three years later.

3Y9 was applied on May 14. No difference between 3Y9 treated and control areas was observed subsequently.

EPTC was applied on May 9. On May 13, dandelion and equisetum and seedlings of ragweed, bindweed and unidentified weeds were beginning to wilt and curl in the scraped areas.

On June 6 dandelion, burdock, sweet clover, equisetum and wild portulaca seemed to be dead or dying except that many equisetum plants were sending up new green shoots on the scraped areas. New ragweed seedlings were appearing. On this date in the sprayed turf areas ragweed and other unidentified weeds were germinating. Since ragweed seedlings were appearing about a month after spraying the treatment was considered ineffective for our purposes.

Alanap #3 was applied on May 3. On June 28 it was observed that equisetum and other weeds had been killed but others were appearing. On September 13 results were judged unsatisfactory.

Baron was applied on June 11 to turf areas at the manufacturer's recommended rate and at $\frac{1}{2}$ and $\frac{1}{4}$ this rate. Precipitation following treatment was unusually heavy. On July 12 all grasses seemed dead while weeds, including yarrow, canada thistle, devils paint brush, equisetum, milkweed and wild carrot were injured but not killed in the area treated at the recommended rate. Control at the other rates was proportional to the rates used.

By late August most of the weeds had been killed by the recommended rate and further browning of the grasses and most of the weeds by the reduced rates were observed.

By October the more vigorous grasses such as orchard grass had recovered from the reduced rates but not from the recommended rate, which gave satisfactory control.

Brush Control

Trials of several materials and methods for brush control were made in 1957 on islands in the Chemung River, where control of vegetation is desirable for flood control purposes.

Telvar DW with sand in the proportion of 1 to 20 was applied on May 10, 1957 at the base of sprouting stumps cut in 1956. Sprouts were three to four feet high. Species were mostly ash with some willow, elm and bamboo.

On June 3 the willow and bamboo were beginning to turn brown and the ash appeared to be unaffected, as it was on late inspection during the summer.

Telvar DW with sand in the proportion of 3 to 20 was applied on June 4 at the base of sprouting stumps (3' to 5') of mixed species.

Most species were browning three weeks later but ash did not seem to be affected. The area was bulldozed before later observations could be made.

Telvar DW as a concentrated solution in water was applied on May 15 to elm, willow, ash and bush honeysuckle. All plants were apparently killed.

D & T in May the following plants were treated as noted:

Plant	Size	Material	Treatment
Poplars	10" cal.	2.5 gallon D 2.5 " T 50 " Fuel Oil	Basal
Poplars Willows	10" cal.	2.5 gallon D 50 " Fuel Oil	Basal
Willows Poplars Maples	Sprouting Stumps 8" - 18" dia.	1.25 gallon D 1.25 gallon T 50 " water	Foliage
Maples Poplars Willows	8" - 18" dia.	2.5 gallon T 50 gallon water	Foliage

There was no apparent difference in control due to the treatment used. In late summer all plants treated appeared to have been killed.

WEED CONTROL FOR MUNICIPALITIES

WHAT A CITIZENS' ORGANIZATION IS DOING TO REDUCE POLLEN POLLUTION

By Charles N. Howison, Executive Secretary of the Air Pollution Control League of Greater Cincinnati

It is a privilege to be asked to address you today and to tell you about the progress being made to reduce pollen pollution of the air in Cincinnati, Ohio. But first, let me tell you something about our organization.

The Air Pollution Control League of Greater Cincinnati is a 52 year old organization which works continuously to advance the knowledge and practice of air pollution control throughout the metropolitan area. The League is one of the original charter agencies of the Community Chest, from which it receives its financial support. It is a non-political, non-profit corporation dedicated to the prevention of air pollution of all kinds.

The League carries on an intensive, continuous public educational program for air sanitation. It does this work with the help of all media of public information. The League also conducts many programs through its speakers bureau, and with the help of its many members. All groups (religious, school, fraternal or civic) are eligible to receive these services.

Public education, teamwork and cooperation with municipal, county and Federal officials and industry management are the League's chief tools for its community-wide program for cleaner air.

In April 1955, another citizens organization - The Hay Fever and Weed Control Committee of Cincinnati united with the Air Pollution Control League, thus presenting a united citizens organization working for cleaner air through the control and prevention of all forms of air pollution. The Hay Fever and Weed Control Committee was founded in 1941 and for many years was headed by Mrs. J. J. Bowman as chairman. She still heads that committee, while serving as a vice-president of the Air Pollution Control League.

For several years before the uniting of these two organizations, they worked together in a community-wide educational program for the reduction of pollen pollution through the destruction of weeds during the spring and summer months. In September, 1953, these efforts culminated in the adoption of a new Weed Control Ordinance in Cincinnati, incorporating the State law provision under which the city may destroy noxious weeds growing on private property and add the cost of this work to the weed violator's tax bill. Among other cities in Ohio using this feature of the State law are - Alliance, Cleveland, Cuyahoga Falls, Elyria, Euclid, Hamilton, Lakewood, Lorain, Mansfield, Marion, Toledo and Van Wert.

ORDINANCE ENFORCEMENT

The Cincinnati Weed Control Ordinance provides for notice or warning to be sent property owners where weeds are growing. This first step is taken by the Police Department. If the property owner cannot be located, or weeds are not destroyed, the Police Department provides information on the location of weed-grown lots on a Form #318 which is sent to the Department of Public Works. The next step calls for the destruction of weeds by the Public Works Department, with the property owner being charged for this service and billed directly. In event of failure to pay, the cost becomes a lien on the land, and is placed on the tax duplicate.

The splendid cooperation of the Police Department in notifying owners of private property where weeds are growing in violation of the ordinance, has been most helpful in obtaining citizen cooperation. We found, however, that the city itself owns or controls the largest acreage of weed growing real estate. It is vitally important that the city set a good example to the public by destroying weeds growing along streets and highways, and on property taken over for urban renewal purposes.

During the year 1957 the Cincinnati Police Department supervised 2,108 locations where weeds were growing in violation of City Ordinance #376-1953. Card notices were mailed to 1,583 property owners. No citations were made. In 1956 the owners of 2,256 properties were orally notified that weeds were growing in violation of the ordinance, and 1,497 written notices were mailed to property owners. Citations were issued to 16 property owners in 1956.

During the year 1957, the Police Department reported on Form #318 to the Department of Public Works that weeds were growing on 132 city owned locations and 21 privately owned locations. This compares with 150 city owned locations and 60 on privately owned property during 1956.

We soon found that the adoption of a stronger ordinance alone was not enough. We had to go to the City Council Finance Committee for funds to purchase equipment, tools, chemical spray, and provide for additional manpower, so that the Public Works Department could do their part of the job. In 1954 this appropriation was $5,000. In 1955 it was $30,000. In 1956 - $32,067. In 1957 it was $33,500. In addition to the funds expended by the Public Highways Division of the Department of Public Works Department, the Property Maintenance Division also expended $2,114.55 in 1957 for weed control purposes.

Here is what was accomplished by the city. The Public Highways Division used 54,000 gallons of diluted chemical spray. This was a 30 to 1 mixture containing 1775 gallons of 3 lb., acid equivalent (dry concentrate). This was used to spray weeds along both sides of approximately 60 miles of streets and highways.

The Public Highways Division cut weeds three times during the growing season along both sides of 140 miles of streets and highways. This Division also sprayed or cut weeds growing on some urban renewal property.

While 21 parcels of private property were reported to Public Works by the Police for serving in 1957, it was necessary for the Department to process only six parcels, the other 15 having made private arrangements for cutting or spraying weeds. During 1956 Public Works cut or sprayed weeds on 30 of the 60 privately owned properties reported to them by the Police Department on

Form #318. Of the 21 reported in 1957, none were duplications of those reported in 1956. This is further evidence of the effectiveness of the procedure, whereby the property owner is first notified.

In addition to the above accomplishments, the Property Maintenance Division of the Department of Public Works, used 750 gallons of diluted chemical spray. They sprayed five miles along both sides of streets. Personnel cut approximately 100 acres of weeds three different times. During the summer months the Workhouse prisoners cut weeds growing along 44 miles of streets and highways.

The splendid example set by the city itself has been an important factor in obtaining citizen cooperation. While the destruction of all weeds growing in Cincinnati will greatly reduce the suffering of persons allergic to weed pollens, it is also desirable for all surrounding communities to cooperate in a united program for the destruction of weeds during the spring and summer months.

I believe you are aware of the fact that Cincinnati and the Ohio River Valley area is known as the 'ragweed belt of the nation'. About 50,000 Cincinnatians are afflicted by the ragweed pollen menace. It is a menace to their health, their comfort and their pocketbooks. This health hazard, which is more than a nuisance, also affects the lives of thousands of other persons within the victim's families. Hay fever and asthma caused by ragweed pollen is also a costly burden to industry. Actually many millions of work days are lost by incapacitated hay fever sufferers.

COMMUNITY COOPERATION NEEDED - EDUCATION STRESSED

Our efforts to control and abate this health menace received a hearty welcome from the thousands of hay fever victims in Cincinnati and surrounding communities. The degree of public support which our program received has been both encouraging and fruitful. It was not too difficult to persuade at least the great majority of our citizens that weed control is desirable, possible and economically practical.

Our main objective is to motivate people to take action that will achieve weed control. A continuing educational program to "Get Ragweed Before It Gets You", starting in April and continuing until frost, about October 1, enlists the aid of the public in this annual battle of "Operation Ragweed".

This educational program has received splendid support from the daily and community newspapers and on radio and television. Editorials, feature stories, cartoons, news fillers and spot announcements, help to keep the subject constantly before the public. Our local papers contributed 578 column inches of space to the subject during the year 1957. This is equivalent to more than three pages of news space.

During the month of June in 1956 and again in 1957 the League provided 100,000 illustrated pamphlets showing how to recognize ragweed, telling how to destroy it, and why it should be destroyed. About 40,000 of these illustrated pamphlets were distributed by teachers in the public and parochial schools -

children taking them home to their parents. Another 40,000 were distributed directly to the homes of Cincinnatians by the Cincinnati Fire Department during the course of inspections for fire hazards in dwellings, which takes place each June. The balance being distributed by a number of organizations, including the Boy Scouts, Camp Fire Girls, garden clubs, Federated Civic Clubs, public libraries and the police department. In the latter instance they served as an educational aid to the police when notifying property owners that weeds were growing in violation of the city ordinance. Distribution was also made by the Fire Departments in several adjacent communities.

The illustrated pamphlet mentioned above is entitled "This Is Ragweed". Followed by the lead "Its Pollen Causes Hay Fever and Asthma". The pamphlet, printed in green on white background, shows both the Giant Ragweed and Common Ragweed as young plants and as full grown plants, for identification purposes. A brief description of each type plant is given. Following the illustrations are three sections which read as follows:

Section 1. 'GET' RAGWEED before it 'gets' YOU ... by:

1. Spraying ragweed with any spray containing 2,4-D weed killer,
   or
2. Cutting ragweed in June and July and again in August if there is still some growing,
   or
3. Pulling ragweed out by the roots during June and July.

Section 2. HERE'S WHY

By preventing pollen pollution of the air, we help -
To prevent sickness.
To reduce absenteeism caused by hay fever.
To prevent loss of life and damage to property caused by weed fires.
To get rid of places that harbor rats and insects.
To beautify the community.
To obey our weed laws.

Section 3. IF YOU SUFFER from HAY FEVER OR ASTHMA
(and 50,000 Greater Cincinnatians do)

You can help NOW by . . .

1. Destroying ragweed on your property and adjoining vacant property.
2. Report addresses of ragweed locations to your district police station and if the weeds are not destroyed within a reasonable time report this to the office of the Air Pollution Control League, 2901 Union Central Building, Cincinnati 2, Ohio. Phone MA 1-2539.
3. Ask your neighbors and friends to cooperate.

I would like to direct your attention to the fact that June is National Ragweed Control Month. This project originated in Cincinnati with the Air Pollution Control League and the Hay Fever and Weed Control Committee. It was placed in the national Calendar of Events by the United States Department of

Commerce in 1952. Each year the Governors of 21 or more States have been issuing Proclamations in support of Ragweed Control Month and urging all people and public spirited organizations to support this program, both by direct action and by acquainting others with the benefits of weed control. We received Proclamations from the Governors of the following States in 1957: Alabama, Arkansas, Colorado, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, Ohio, Oklahoma, Pennsylvania, Tennessee, West Virginia, and Wisconsin. The Mayors of many cities also proclaimed June as National Ragweed Control Month in their respective cities.

Many organizations and individuals cooperate in making National Ragweed Control Month in June an outstanding success and the beginning of a continuing weed control program throughout the balance of the growing season. The Boy Scouts came up with a new idea which we like very much. It is called "Today Good Deeds - Tomorrow No Weeds".

Last spring the annual war on ragweed opened with a Public Health Meeting sponsored by the Air Pollution Control League and the Academy of Medicine of Cincinnati on May 15. This was in the form of a panel discussion by three noted local allergists, speaking on "You And Your Allergies". A full house audience of 140 persons attended this health meeting at the downtown Public Library. This was the beginning of our community-wide program on "Operation Ragweed".

Another project which received splendid support was an essay contest which we sponsored in cooperation with the Camp Fire Girls of Cincinnati. A number of excellent essays were submitted by 7th and 8th grade girls on the subject "An Effective Weed Control Program Means Better Community Health". Winners of the 10 best essays received prizes in the form of a very attractive portfolio of birds and blossom prints provided by Mrs. J. J. Bowman, Chairman of our Hay Fever and Weed Control Committee.

Posters and potted plants of ragweed were also provided for display purposes in store windows. The downtown public library maintained a health alcove during the months of June and July, displaying ragweed plants - also illustrated literature, which we provided for the public.

In the schools, teachers of classes in health and community problems used our materials for class discussion and arranged for walks in the neighborhood to search for ragweed plants growing on curblines and empty lots. Pupils were encouraged to bring pressed specimens to class for examination. It was suggested that as an actual scientific experiment, the class could spray potted ragweed with 2,4-D weed spray and observe the results during the following week or ten days. Teachers also arranged for speakers on ragweed control for their classes.

Meetings were held with representatives of local industries and the railroads. The chemical spraying of weeds by the railroads was much more effective in 1957 than in previous years.

CONCLUSION

One of the most important factors in our municipal weed control program has been the teamwork and cooperation of the several city departments, which include the Police, the Fire and the Public Works Departments, on both the enforcement program and in support of our educational campaign to destroy ragweed. This united program to reduce pollen pollution of the air has benefited all who breathe the common atmosphere.

The benefits have been encouraging. As the result of our efforts, we have a more beautiful city. This is a welcome by-produce of our efforts to bring relief to our 50,000 hay fever-asthma victims. The allergist tells us that "Hay Fever due to ragweed pollen is the number one acute disease in the United States, and bronchial asthma is the third most common chronic disease. These diseases are a direct result of polluting obnoxious substances". Our aim is to abate the causes, and the most important way to reach this goal is by eliminating or lessening the quantity of ragweed pollen in the air.

At the close of the ragweed pollen season on October 1, we were happy to note that the official pollen count taken by the Cincinnati Department of Health, for the summer and fall of 1957 in Cincinnati was one-third lower than it was for the year 1956. This covers the period August 22 through September 30. The 1957 ragweed pollen count was 2,314 compared to 3,471 for the same period 1956.

Dr. Louis Kreindler, a Cincinnati allergist, who teaches allergy and physical diagnosis at the University of Cincinnati, College of Medicine says,

"I find that chronic cases of seasonal hay fever in Cincinnati, appears to be less severe this year (1957) than in previous years. There seems to be a direct correlation between the lower pollen count this year and the measure of relief which the sufferers of hay fever-asthma have received.

"In order to effectively treat any disease it is essential to find the cause and eradicate it. In ragweed-hay fever, we know the cause and yet the number of sufferers is increasing annually.

"An educational program to the public, and enforcement of weed eradication ordinances must be accomplished if the problem is to be completely solved."

Dr. Victor W. Fischbach, Senior Partner in the Murphy Memorial Clinic, and an Associate Professor of Otolaryngology at the University of Cincinnati Medical College, stated in November, 1957:

"In my clinical practice this Fall, particularly during Hay Fever Season, we have observed that treatments and care of our Ragweed pollen cases were much easier to handle, both as to controlling symptoms and those where complete relief by treatment was obtained, was much more evidenced in those patients living in communities where ragweed control was strictly executed.

"Many of my patients from the outlying districts, where weed control is lacking showed increased symptomology, which was more difficult to relieve by treatment.

"I am sure further study and observation of this fact will prove the efficacy of ragweed control and elimination".

Incidentally, Dr. Fischbach is the president of our Air Pollution Control League, and Dr. Kreindler is a member of our Board of Trustees.

With the recent advances in medicine such as antibiotics, chemotherapy, and various vaccines, the life span of our population is increasing. Since people are living longer, allergic diseases are on the increase. It is important to allow these people to live more completely and healthfully in cleaner air and hence enjoy their years of longevity.

A human being can go without food for perhaps 40 to 50 days and without water for four or five. But he cannot live more than three or four minutes without air. It is our most precious commodity. The program of the Air Pollution Control League of Greater Cincinnati is designed to remind us of that fact and lead us to study ways of working together throughout the year to avoid polluting the air.

Paper presented at the Northeastern Weed Control Conference -
Public Health Section, New York City, January 9, 1958

Also at The Weed Society of America -
Public Health Section, Memphis, Tenn. January 14, 1958

RAGWEED FREE AREAS IN QUEBEC AND THE MARITIMES

Elzéar Campagna (*)

This paper is a résumé of a survey on ragweed in 5 provinces of Eastern Canada from 1930 to 1957. It comprizes 3 parts. In the first part the physiographical and climatic conditions, the repartition of lands and population are exposed. In the second part, report is given of the botanical surveys to discover ragweed and the means to eradicate it. In the last part are the reports of ragweed air-pollen survey in the different provinces: Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick and Québec. (Fig. 1)

ENVIRONMENTAL FACTORS

Physical Geography - The surveyed territory includes three physiographical regions: the Canadian Shield, the St. Lawrence Lowlands and the Canadian Appalachians.

The Canadian Shield on the north, covers a large portion of Quebec Province and Labrador. "The whole makes up a knubbly, rocky plateau with old worn-down mountains above and enclosed plains beneath its general surface" **

The St. Lawrence Lowlands form a triangle, the apex of which would be in Quebec City and the basis drawing a line from the Ontario border along New York State. At the height of Montreal the width would measure about 60 miles. On the north it is bordered by the Laurentian Plateau and on the south by the Appalachian Region. More than one third of the population of Quebec and the Maritimes live in the St. Lawrence Lowlands.

The Canadian Appalachians are running from Lake Champlain to Quebec City, thence down the St. Lawrence Valley to the Gulf across the Gaspé Peninsula and Northwest Newfoundland. The hills and heights of Central and South Newfoundland, Nova Scotia and New Brunswick are also parts of the Appalachian system.

Climate - The western portion of Quebec and Northwestern New Brunswick are characterized by the extreme cold and heat of continental regions. The remaining territory has a milder climate due to the influence of the Atlantic Ocean.

The mean July temperature vary from 60° to 65° F. in the major part of the coastal areas of the settled parts of Eastern Canada and from 65° to 70°F. in the eastern and western parts of the populated interior of Quebec (14).

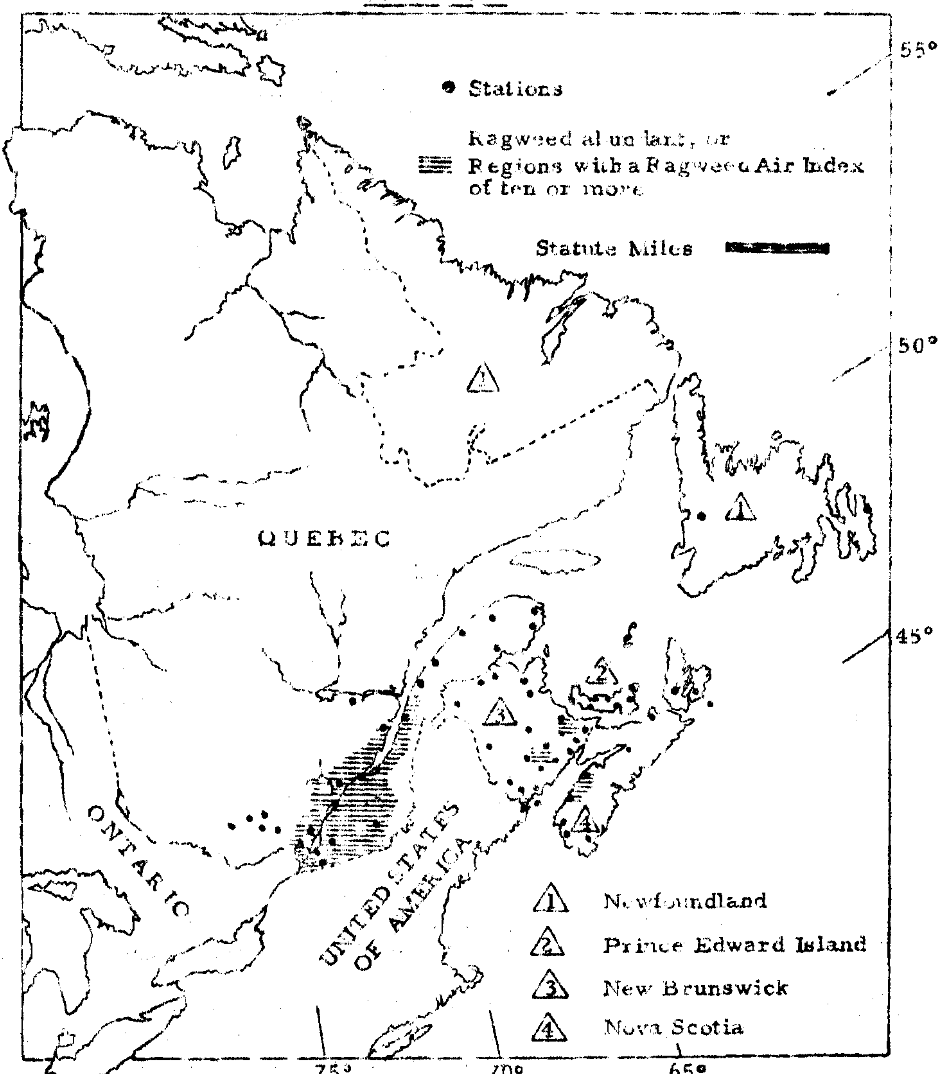
Wind - The surveyed region is rather still during the summer, and the mean summer wind speed rates 10 m. p. h. The prevailing winds are usually southwesterly in the Southern St. Lawrence and Maritimes with occasionnally

(*) Professor of Botany, Faculté d'Agriculture de l'Université Laval at Ste-Anne-de-la-Pocatière, Québec, Canada.

Fig. I

RAGWEED POLLEN STATIONS IN EASTERN CANADA

1950 - 1956



south and west winds. On the North Shore of the St. Lawrence, northwesterly winds prevail (14). Except for the Montreal Region the whole surveyed territory seems to be protected from wind carried ragweed pollen.

Rain - The mean summer precipitation for June, July and August, in the Gulf Zone is 7.5 inches and 10 inches for the western zone (14).

Hours of Bright Sunshine - In August the hours of sunshine vary from 200 to 225 hours and from 125 to 175 hours in September; the major part of the territory getting the mean 150 hours of sunshine in September (14).

Land utilisation and Farming Population - Of the 722,254 sq. mi. of supervized territory, only a portion of 17,456 sq. mi. consists of cleared land (1951 Census). The rest is covered with forest, inland water expanse or barren land. Considering the proportion of cleared land in each province, Prince Edward Island has the greatest portion of tilled land in its territory, while Newfoundland has the least (Table I). There are approximately 1,087,000 people living on farms in the five provinces.

The largest stretches of cultivated land are those bordering the St. Lawrence River in Quebec, the St. John Valley and Southern New Brunswick, Northern continental Nova Scotia and Annapolis Valley. In such regions ragweed is apt to flourish.

DISTRIBUTION AND ERADICATION OF RAGWEED

At least three species of ragweed have been observed in Quebec, the most common being short ragweed, (Ambrosia artemisiifolia L. var. elatior (L.) Descourtils). It was mentionned for the first time in Quebec by Abbé Provencher in 1862 in Flore Canadienne (10). Since then it has been observed in all of the five provinces of Eastern Canada.

Great ragweed (Ambrosia trifida L.) although not so widespread is also found in Prince Edward Island, Nova Scotia, New Brunswick and Quebec.

Perennial ragweed (Ambrosia psilostachya D.C. var. coronopifolia (T+G) Farw.) was found in about 15 localities of Quebec Province, covering about 25 acres of land. It has also been mentioned in Nova Scotia by Dr. A.E. Roland (11) and in Prince Edward Island by John Bassett (2).

Newfoundland - Ragweed (A. artemisiifolia) is practically non existant in Newfoundland. As far as I know a few plants only have been found. Dr. E. Rouleau (12) mentionned it in 1949, Mr. John Bassett (6) who investigated the weed flora in 1949 has not found any. I, myself have surveyed the region around St. John's and the Avalon Peninsula in 1950 and 1951 and I could not find any either.

Prince Edward Island - The first person to mention common ragweed in Prince Edward Island was John MacSwain (9) in 1907. Great ragweed was mentionned for the first time in 1927 by Herbert Groh (7) in his report of

Table 1 LAND UTILISATION AND FARMING POPULATION IN FIVE PROVINCES OF EASTERN CANADA (1951) **

Province	Land*	Fresh Water*	Total*	Agricultural Land*	Forested Land*	Population living on Farms (1951 Census)
Newfoundland	147,994	7,370	155,364	46	83,772	15,456
Prince Edward Island	2,184	-----	2,184	1,009	627	46,757
Nova Scotia	20,743	325	21,068	1,034	11,555	112,135
New Brunswick	27,473	512	27,985	1,572	23,128	145,771
Quebec	523,860	71,000	594,860	13,795	350,836	766,910
TOTAL	722,254	79,207	801,461	17,456	469,918	1,087,029

* In square miles

** Annuaire du Canada, :2, 23 et 156. Ottawa. 1956.

inquests on the distribution of weeds in Canada. John Bassett (1) who has made an 8 day survey in 1950 found 35 colonies of common and great ragweed. The inquest was resumed in 1952 and 1953 by the Travel Bureau which led to the discovery of 309 new colonies. In 1956 and 1957 the Provincial Department of Agriculture continued the survey when 625 ragweed colonies were sprayed with 2,4-D. Since 1950 about 650 colonies of Ambrosia have been discovered in Prince Edward Island.

Nova Scotia - Since 1950 the Nova Scotia Department of Agriculture entrusted the survey of ragweed to Professor A.E. Roland of Nova Scotia Agricultural College. Except for the Annapolis Valley where several colonies were found, ragweed is rather scarce. Actually the inquest and eradication work is carried on specially in Cape Breton Island and in the Yarmouth region where the local Tourist Bureau cooperates and a special care is taken to prevent the introduction of ragweed seed in feed grains or poultry feed.

New Brunswick - "The study of the distribution of ragweed began in 1940 and this inquiry has been continued every year with the exception of one year" (12). Professor C.W. Argue of the University of New Brunswick was in charge of the survey and eradication campaign. The work was planned in cooperation with the Provincial Travel Bureau and the Department of Public Works. The eradicators were granted a power sprayer, several hand sprayers and other necessary equipment. Twenty-four indexing stations were established and the cooperation of the people was sollicited to help and eradicate ragweed along the highways and in areas where high concentration occurred. A special mention should be made of the good work accomplished by Mssrs. E.M. Taylor and H.F. Stairs of the Department of Agriculture.

Quebec - Much could be said about the personalities as well as of the circumstances which induced the Quebec Provincial Government to undertake a survey to eradicate ragweed. Let us mention Professor K.M. Wiegand of Cornell University, Professor M.L. Fernald of Harvard University (1923), Thomas A. Edison (1930), Prof. Ernest H. Wilson "Chinese Wilson" keeper of the Arnold Herboratum of Harvard University (1930), Mr. W. Ormiston Roy of Montreal (1930), Hon. J.H. Kelly, Member of the Legislative Council (1931), Dr. Georges Maheux, Head of the Plant Protection Department, Quebec (1934), Dr. Ernest Choquette, M.D. (1931), Dr. E. Campagna, Professor of Botany of the Faculté d'Agriculture de l'Université Laval (1929).

In 1927, when I was a post graduate student at Cornell University, my professor of Botany Dr. K.M. Wiegand, who is himself a ragweed hay fever patient, told me that having been collecting endemic plants in the Gaspé Peninsula, he never suffered from hay fever while there. Besides he had observed but few ragweed plants in Gaspé and he seemed quite sure that it would be an easy matter to keep this territory free from ragweed. My distinguished professor then suggested to me that I undertake to keep the Gaspé Peninsula free from ragweed. Back home, I made investigations in Gaspé during the summers of 1929 and 1934. After finding a few colonies of ragweed, I made a report to Dr. Georges Maheux of the Quebec Department of Agriculture and submitted a plan to eradicate the colonies of ragweed and to try and keep this region free from that noxious plant.

The project duly approved in 1936, I started to investigate in Bonaventure County and later on Gaspé and Lower St. Lawrence during nine consecutive years. At first I had but one assistant. Then the situation growing rather exacting our staff was increased to fifteen. While some of the investigators were seeking new colonies, the others would proceed to eradicate the colonies already discovered. The results of the investigation and eradication campaigns in Gaspé have been published in "Le problème de l'herbe à poux en Gaspésie". (3)

A territory of about 700,000 acres of cleared land have been thus investigated along six counties. While pursuing this discovery and eradication program we also had a plan to educate the people by posting ragweed herbarium specimens in more than 300 rural schools and colleges. We also put up discovery contests among the school children who were thus entitled to prizes amounting in all to $300.00, for the discovery of new colonies of the hay fever plant.

The ragweed discovery contests have given very interesting results because they led us to remote colonies we might have missed otherwise. Another advantage of these contests was that through the school children we also caught the attention of the grown ups.

Since 1935, 703 colonies of ragweed have been discovered in this territory. In 1957, there still remained 78 colonies. On 46 of these we could count from 1 to 10,000 ragweed plants, the whole amounting to 19,477 plants. The remaining 32 colonies were real large ones which covered an area of 215 acres. Summing up, 88.9% of the discovered ragweed have been eradicated which I believe to be a real success. As each colony is surveyed and sprayed with 2,4-D every year, no doubt that sooner or later ragweed will have been wiped out of the Gaspé Peninsula.

City of Montreal - After Gaspé, the city of Montreal has launched in 1946 a ragweed eradication campaign through the "Jeunes Naturalistes" clubs in cooperation with the Montreal Botanical Garden. Later on this organization was put up on such a solid basis that it still is going on; the work being done by the City of Montreal. As Mr. R. Mondello, on a previous occasion (1954) told before this Section what was done in Montreal it is not necessary for me to repeat what has been said already.

Charlevoix County - In 1951 the Quebec Department of Agriculture entrusted Dr. G. Gauthier and Mr. R. Barabé with a ragweed campaign in Charlevoix County.

The inquest covered a territory of 58,000 acres, that is 65%. Out of the 428 colonies discovered covering an area of 260 acres, 319 consisted of common ragweed and 109 of great ragweed. All these colonies are sprayed with 2,4-D every summer.

Laurentide district - The inquest on ragweed in this region which includes Terrebonne, Labelle and Argenteuil counties was carried on from 1954 to 1957 by Mr. A. Dion and his assistants of the Provincial Department of Agriculture. They have already discovered 600 colonies of ragweed. 40 large ones covering an area of about 90 acres. Ragweed eradication is part of their routine program.

Discussions on the botanical surveys - Summing up, it may be said that field botanical surveys to discover ragweed are most important. However in order to obtain information as to the distribution and abundance of ragweed, it is advisable to proceed with the survey of the air-borne pollen so as to have an idea on the degree of infestation.

In the cities and villages, discovering ragweed is an easy job, but it is not so in the country. A common saying is that when ragweed is not prevalent around the farm buildings it ought not to be found in the fields. Nevertheless ragweed is often growing in fields remote from the buildings where none had been observed. The surroundings of poultry houses ought also to be well inspected because they are favorite habitats.

The habitat of the 617 colonies of ragweed discovered in the Gaspé Peninsula and Lower St. Lawrence have been noted carefully and rate as follows:

1)	Around houses, in gardens or garden plots	235 colonies	or	38.1%
2)	Around farm buildings	115 "	"	18.5%
3)	Around poultry-houses	144 "	"	23.3%
4)	In cultivated fields	72 "	"	11.7%
5)	On Roadsides	17 "	"	2.8%
6)	On waste-land	34 "	"	5.5%
		617 colonies	or	99.9%

RAGWEED AIR-BORNE POLLEN

Since 1930, air-borne ragweed pollen has been studied in at least hundred different places of the five Eastern Provinces and this has led to a good knowledge of the distribution of ragweed.

Dr. O.C. Durham (5) established the first pollen station in Montreal in 1930 and repeated the survey until 1933. Since then, as far as I know, research work has been carried on by Dr. H.C. Macdermot and Dr. C.R. Howell about 1935; the Health Service of the city of Montreal from 1947 to 1957; Mr. S. Baril in 1944; Dr. H.S. Mitchell in 1948-1949; Elzéar Campagna from 1938 to 1941 and afterwards from 1949 to 1955; Dr. Bram Rose et al. from 1949 to 1957; and Dr. H.S. Mitchell from 1948 to 1952. Outside of Montreal, let us mention Professor C.W. Argue of New Brunswick University who worked in his province from 1952 to 1957 and E. Campagna who surveyed pollen stations from 1939 to 1942 and from 1949 to 1957 in 68 different localities of Québec and the Maritime Provinces. From 1938 to 1942 Campagna's survey was carried on in cooperation with the Plant Protection Service of the pay the expenses and from 1949 to 1957 in cooperation with the Botany Division of the Science Service, Canada Department of Agriculture on the same basis.

The methods of proceedings have been described in former publications. (4) However I insist on the fact that from 1939 to 1943 the "Thomen air-sampling devices" were used and from 1949 to 1956 the "Durham air-sampling apparatus" were adapted. We always endeavoured to follow the recommendations of the Committee on National Pollen Survey of the American Academy of Allergy. (6)

In ordre to be sure that the slides were not contaminated during their preparation, five test slides were exposed at different places in the laboratory.

Newfoundland - Our air-sampling devices were stationed respectively at St. John's and Corner Brook, the two largest cities of Newfoundland.

In St. John's pollen slides were exposed during August and September from 1950 to 1956. A total of 37 pollen grains were captured, that is an average of 6 per season. In Corner Brook slides were exposed in 1951 and 1955. The total pollen grains captured per sq. cm. during the 2 years were 12 or an average of 6. The above data shows that Newfoundland is practically free from ragweed pollen.

Prince Edward Island - We had 8 stations in this province of 2,184 sq. mi. They were scattered so that they covered the whole territory, that is, one station for every 196 square miles of cultivated land.

Table II shows that the years 1953 and 1955 were 3 to 4 times more favorable for the pollination of ragweed than those of 1952, 1954 and 1956. The number of pollen grains captured is about the same at every station but Dalvay House station is the one where the highest score was counted in 5 years.

The number of hay fever days averages 0.63 for 5 years (Table II) and the ragweed air-index is 1.45 which is very good for a whole province.

Ragweed is occasional in Prince Edward Island and a systematic eradication campaign would not be onerous. The authorities in Charlottetown wondered if the Ragweed pollen captured on our slides were not wind-blown from afar. After a thorough examination of the daily reports of each station for 5 years, the answer is negative. If the pollen came from outside it would be scattered evenly over each station; this occured only once on August 30, 1953. This pollution from outside could possibly occur, but accidentally.

Nova Scotia - Nova Scotia is also a low pollen counting province. With Dr. A.E. Roland of Truro, we established 10 pollen stations during 5 years, one station per 103 sq. miles of cultivated land.

Table II shows that pollen is more abundant at Kentville, Yarmouth, Digby and Meteghan. Those stations are on the border of Fundy Bay where a certain ragweed infestation exists. But little pollen was captured at the other stations.

Table II

RAGWEED AIR-INDEX IN EASTERN CANADA 1951-1956

DISTRIBUTION of Sampling Stations	Pollen Grains per cu. yd. of Air (1): Annual Totals August and September						Pollen Grains per cu. yd. of Air (1): All-Time Maximum (Daily)	Hay Fever Days (app.) Average(3)	Ragweed Air-Index (2)						
	1951	1952	1953	1954	1955	1956			1951	1952	1953	1954	1955	1956	Average
PRINCE EDWARD ISLAND															
1. P.E.I. Nat'l Park (Dalvay House)	50	43	346	187	205	14	202	1.3	0.4	0.3	5.7	3.3	5.5	0.1	3.0
2. Charlottetown	--	104	83	90	83	32	83	0.6	---	2.4	2.0	0.6	1.7	0.2	1.4
3. Summerside	--	61	97	43	126	50	58	0.4	---	0.4	2.1	0.3	2.0	0.4	1.0
4. O'Leary	--	36	86	14	169	36	65	0.8	---	0.2	1.7	0.1	4.5	0.3	1.4
5. Tignish	--	68	140	86	94	50	83	0.4	---	0.5	2.5	0.6	1.9	0.4	1.2
6. Cavendish	--	76	184	32	---	---	68	1.0	---	0.5	4.6	0.3	---	---	1.8
7. Souris	--	43	101	11	162	29	90	0.4	---	0.4	1.8	0.1	2.7	0.3	1.1
8. Montague	--	32	130	47	72	18	29	0.2	---	0.2	0.9	0.3	1.6	0.2	0.6
AVERAGE	50	57.9	146	63.7	130	32.7	84.7	0.6	0.4	0.6	2.7	0.7	2.8	0.3	1.4
NOVA SCOTIA															
1. Truro	14	14	---	32	---	---	11	0.0	0.1	0.1	---	0.3	---	---	0.2
2. Kentville	--	---	252	407	284	---	155	2.3	---	---	4.8	5.6	3.7	---	4.7
3. Yarmouth	--	169	248	259	259	---	104	3.0	---	4.2	5.1	5.3	4.8	---	4.8
4. Chester	11	40	40	25	72	---	22	0.0	0.1	0.3	0.3	0.2	0.6	---	0.3
5. Digby	50	169	144	191	342	---	97	1.8	0.4	2.6	2.1	5.4	5.7	---	3.2
6. Antigonish	61	---	54	36	50	---	18	0.0	0.5	---	0.5	0.3	0.4	---	0.4
7. Baddeck	22	47	58	50	---	---	22	0.0	0.2	0.4	0.5	0.4	---	---	0.4
8. Ingonish Beach	50	25	158	79	68	---	50	0.4	0.4	0.3	3.3	0.5	0.5	---	1.0
9. Ingonish Island	40	68	126	68	122	---	54	0.8	0.3	1.6	2.0	1.8	2.2	---	1.6
10. Meteghan	162	270	---	---	---	---	58	3.0	3.4	5.7	---	---	---	---	4.5
AVERAGE	51.2	100	135	127	171	---	59.1	1.1	0.7	2.0	2.3	2.2	2.5	---	2.1

(1) To obtain the number of pollen grains by sq. cm., divide by the factor 3.6

(2) Common Ragweed (*Ambrosia artemisiifolia* L., var. *elatior* (L.), and Great Ragweed (*Ambrosia trifida* L.)

(3) Number of days with 25 grains or more per cu. yd. of air.

The average ragweed pollen air-index for 5 years varies from 0.2 to 4.9 for the various stations of Nova Scotia, being 2.1 for the whole of them which is a very good mark. Here also, wind air-borne pollen must be accidental if we consider the results of Kentville and Chester.

New Brunswick - Ragweed air pollen has been surveyed thoroughly in New Brunswick, due to the excellent work of the Dr. C.W. Argue of Fredericton. In "Statistical Report of the Pollen and Mold Committee of the American Academy of Allergy from 1956" as prepared by Dr. O.C. Durham, in section B of page 5, are the results of 28 pollen stations for a period of 6 years. A pollen station is up for 56 sq. mi. of cultivated land which totals 1572 sq. mi. Of the 28 stations, five have a mean ragweed air-index of 5 or more and 2 stations with an air-index of 10 and 11, at Gagetown and Pointe-du-Chêne. Except those two stations covering rather limited territory we can be quite sure that New Brunswick is almost free from ragweed. The extensive survey of air-borne pollen done in Maine by Dr. Hyland and his associates in 1952-1953 (8) has also demonstrated that this province will not receive an appreciable number of pollen from the state of Maine.

Quebec - Quebec having a considerably larger territory than the other Eastern provinces, it was necessary to subdivide the regions which have natural boundaries such as mountains or large tracks of lakes, rivers or forest.

Montreal Area - The Montreal Area includes the whole Island and the immediate adjoining territory. Table II shows that ragweed pollen is abundant. For a period of 5 years, 5 pollen stations yielded in August and September from 1865 to 4496 pollen grains per cu. yd. of air. The hay fever days amounted to 26.3, the air-index being 45.3. These figures would run even higher if the City of Montreal did not carry on an intensive ragweed eradication policy.

Central Quebec - Central Quebec include the St. Lawrence Lowlands, the Appalachian and the Laurentide regions.

The ragweed infestation is quite variable. The western stations have a high air-index 16.4 to 43.4. Moving eastwards the air-index decreases gradually, being 10.6 in Quebec City and 9.4 in Ste-Anne-de-la-Pocatière. Two of the stations on the North Shore of the St. Lawrence, Baie-St-Paul where the Department of Agriculture carries an eradication campaign and Jonquière in the Saguenay region where ragweed is scarce, have a respective index of 3.3 and 3.0.

The Laurentide District - The Laurentide District covers an area of about 6000 sq. mi. in the north of Montreal and is a famous summer and winter resort.

The ragweed infestation is still quite restrained but could become a menace if nothing was done to check it.

Table III

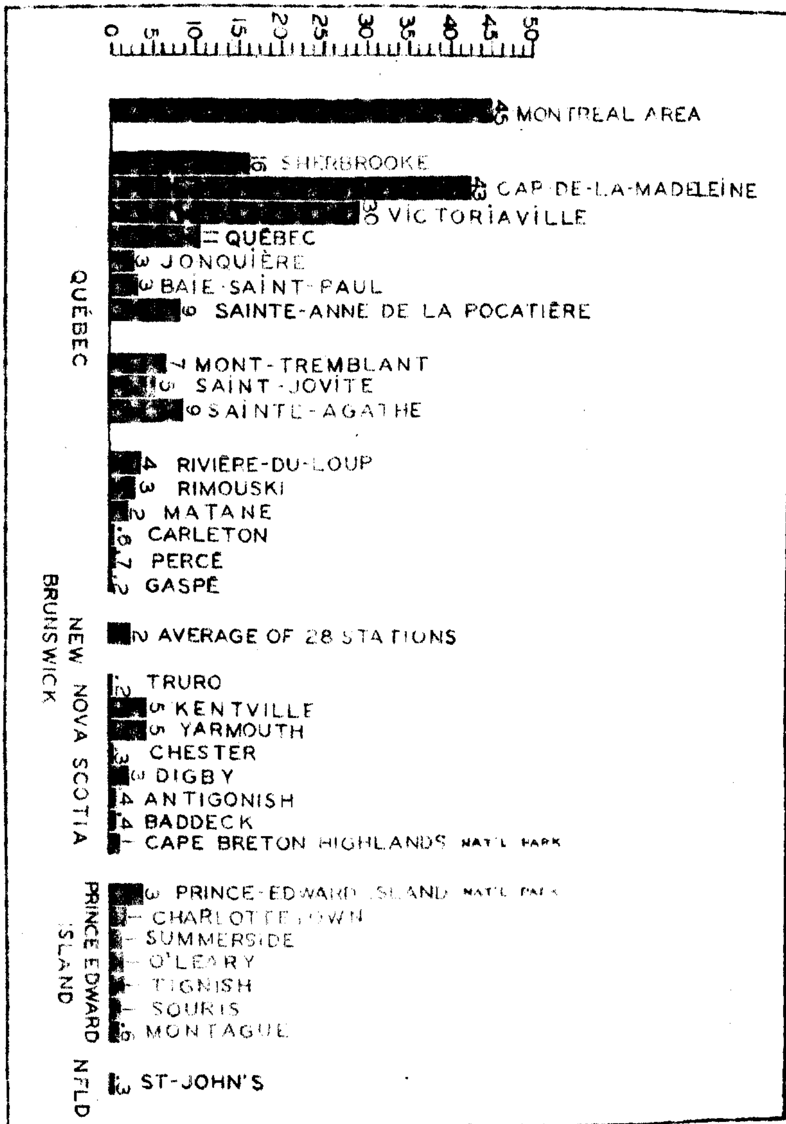
RAGWEED AIR-INDEX IN EASTERN CANADA 1951-1956

DISTRIBUTION of Sampling Stations in Quebec	Pollen Grains per cu. yd. of Air (1)							Hay Fever Days (app.)	Ragweed Air-Index (2)						
	Annual Totals August and September						All-Time Maximum (Daily)	Average							
	1951	1952	1953	1954	1955	1956			1951	1952	1953	1954	1955	1956	Average
MONTREAL AREA															
Average of 5 stations	2522	3394	4496	1929	3908	1866	652.4	26.3	40.6	49.9	54.3	36.9	53.9	35.6	45.3
LAURENTIDE DISTRICT (North of Montreal)															
1. Nominingue	---	194	328	140	500	252	76	4.6	----	4.3	8.4	3.1	11.2	5.7	6.5
2. Mont-Tremblant	---	292	313	281	680	234	137	4.2	----	5.2	6.1	5.8	12.8	3.6	6.7
3. Saint-Jovite	---	317	252	137	371	187	61	3.6	----	5.1	5.7	3.0	9.5	3.3	5.3
4. Sainte-Agathe	---	371	508	209	731	234	184	5.4	----	9.4	10.4	3.8	13.5	5.8	8.6
AVERAGE	---	293	350	192	570	227	114.5	4.4	----	6.0	7.6	3.9	11.7	4.6	6.8
CENTRAL QUEBEC															
1. Cap-de-la-Madeleine	---	---	3344	1753	3751	---	598	23.9	----	---	45.2	29.2	55.8	---	43.4
2. Sherbrooke	418	508	1123	745	1505	---	288	10.6	8.5	9.5	19.5	15.8	28.9	---	16.4
3. Victoriaville	738	2246	2196	1472	2239	---	605	17.8	16.5	33.8	36.0	29.8	31.9	---	29.6
4. Québec	313	493	443	292	1426	---	220	6.8	5.9	11.1	5.9	7.0	23.3	---	10.6
5. Jonquière	---	---	94	68	302	---	115	1.7	----	----	1.7	0.6	6.7	---	3.0
6. Baie-St-Paul	---	---	---	68	356	97	83	2.0	----	----	----	1.6	6.6	1.7	3.3
7. La Pocatière	223	540	608	205	1022	320	180	6.2	3.6	13.2	11.1	2.3	20.9	5.0	9.3
AVERAGE	423	947	1301	657	1514	208	298.4	9.8	8.6	16.9	19.9	12.3	24.9	3.3	16.5
GASPESIE AND LOWER ST. LAWRENCE															
1. Matane	---	---	---	11	310	18	83	1.3	----	----	----	0.1	6.4	0.2	2.2
2. Carleton	40	36	83	25	108	36	29	0.2	0.3	0.3	0.6	0.2	1.8	0.3	0.6
3. Percé	29	32	14	36	108	18	32	0.3	0.3	0.3	0.2	1.4	1.9	0.1	0.7
4. Rivière-du-Loup	212	184	241	94	677	68	155	2.3	3.0	3.3	6.0	1.8	10.9	0.5	4.2
5. Gaspé	25	47	11	4	7	18	18	0.0	0.2	0.4	0.1	0.1	0.1	0.2	0.2
6. Rimouski	151	126	270	54	439	47	151	1.3	2.0	2.2	4.5	0.5	7.7	0.4	2.9
AVERAGE	91	85	124	37	275	34	78	0.9	1.2	1.3	2.3	0.7	4.8	0.3	1.8

(1) To obtain the number of pollen grains by sq. cm., divide by the factor 3.6
(2) Common Ragweed (Ambrosia artemisiifolia L. var. elatior(L.) and Great Ragweed (Ambrosia trifida L.)

FIG. 2

RAGWEED AIR-INDEX IN EASTERN CANADA 1950 – 1956



The air-index is considered as "fairly good" by the Durham standard, as the air-index for 4 stations in 5 years was 6.8 and the hay fever days only 4.5. If the present eradication campaign is maintained the index is apt to decrease gradually.

Gaspé Peninsula and the Lower St. Lawrence - The Gaspé and Lower St. Lawrence district runs from Rivière-du-Loup to the town of Gaspé at the end of the Peninsula. The ragweed air pollen survey was started in 1938, but the figures for the 5 last years only are given in order to compare with the other regions of Eastern Canada.

The pollen crop is rather slight, the lowest years being 1956 and 1957, the highest 1955 and 1953. The average pollen yield per $cm.^2$ for 5 years was 21.7 per station. Hay fever days vary from 0 for Gaspé to 2.3 for Rivière-du-Loup which means an average of 0.9 for 6 stations. The air-index is 0.2 in Gaspé and 4.3 in Rivière-du-Loup, which means an average of 1.8 per station. (Table III)

SUMMARY

1. This paper is a résumé of the work done since 1927 to study the distribution of ragweed in Quebec and the Maritimes and exposes the means of eradication.

2. Only 2.4% of the surveyed territory consists of cleared land and offers a proper habitat for ragweed, the greater portion being covered with forests, inland water and waste land.

3. The settled territory extending only to the 50° of north latitude offers a favorable habitat for ragweed.

4. It is hoped that modern specialized agriculture and chemical weed control will become an important factor to prevent the dissemination of ragweed.

5. Our botanical surveys and the study of ragweed air-borne pollen allow us to presume that in the St. Lawrence Lowlands and the Montreal regions from 50 to 100% of the farms are infested with ragweed.

Apart from a few limited tracks of land in Eastern Quebec, New Brunswick, Nova Scotia and Prince Edward Island, our estimation is that out of every 2000 to 3000 acres of farm land, one acre is infested by ragweed.

6. The extensive inland waters and coastline of these territories have a great influence on pollen incidence.

7. Air sampling devices stationed as far as 25 miles in forest regions (Mont Albert, Gaspé) or located in spots clear of ragweed: St. John's (Nfld), Baddeck (N.S.), Campbelton (N.B.), and Gaspé (Québec), enable us to ascertain that the regions bordering the Gulf of St. Lawrence and

8. Since 1930 about 100 ragweed air pollen collecting stations have been established in the 5 Eastern Provinces. The air-index varied from 0.1 to

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CONTROL OF RAGWEEDS

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The ragweeds are by far the most important causes of hayfever in the United States. For that reason alone it is essential that they be brought under some sort of control. There is an old saying that to destroy your enemy you must understand him. So, today, I am going to point out the facts which are known about the ragweeds which may help us to better understand them.

It may come as a surprise to some to learn that the ragweeds, unlike most weeds, are native American plants. The whole group, of which there are 21 species, all potential hayfever plants, originated in the Americas, and in precolumbian times were unknown to Europeans. Yet the Indians had no hayfever.

Ragweeds are among the most successful plants in the world. They are not the "Lilies of the field" for their life's mission is to toil incessantly saving and repairing the soil against accidental damage. It is only incidental, though most unfortunate, that they cause hayfever.

They belong to the great composite family which stands at the summit of the evolutionary development of the flowering plants. They and their near relatives, the marsh elders, cocklebums and false ragweeds make up a compact little group of plants of the utmost importance to students of hayfever because they cause the greater part of all the hayfever throughout North America. Of these the only ones with which we are concerned in the eastern states are the short and tall ragweeds. Botanically they are very similar and closely related, so much so that their pollens cross react almost interchangeably. But by their superficial characters they are easily told apart. The short ragweed has divided fern-like leaves and is usually not more than four or five feet high, while the tall ragweed has a less divided leaf, usually 3 or 4 parted or even undivided, and may be 10 or 15 feet tall, sometimes more.

Their seeds are characteristic and easily recognized. They should be looked out for in seed grains. Each is enveloped in a fibrous coat which is the remains of the involucre which surrounds the flower heads of all Compositae, for the female ragweed flower is morphologically a one-flowered flower-head. The seed coat of the short ragweed is fragile and easily cast off. In looking for the seeds in grains you may find them both with and without their outer coats. Not so, the giant ragweed. Its seed is aquatic, designed to float on the surface of streams and ponds. It is enclosed in a tough corky envelope which is difficult to remove. So much so that the seedling is provided with a special device for removing it, reminiscent of the caruncle on the beaks of some embryo birds which they use to break out of their shells. When the seedling emerges from the ground the two cotyledons are generally still enclosed in the seed coat, which is likely to strangle the young plant. But it gets it off by wrapping itself around its own stem which is provided with a ridge into which the flaring tip of the seed coat is hooked and pulled off, leaving the seedling free to expand its cotyledons to the sunshine.

Ragweed is generally described as an 'unsightly weed'. This is purely subjective, an emotional response due to causes other than its appearance. It has grace and a certain elegance that other plants do not. It is wind pollinated so does not have attractive flowers, and, as is usual with such flowers, has the sexes separated. The staminate or pollen bearing flowers are born in little heads on terminal spikes. They are very numerous and each head contains 15 to 20 little flowers. Though these flowers are entirely male and produce no seeds, the pistil is retained for its secondary function of forcing the pollen out, characteristic of the flowers of all the Composite family, even those with fertile pistils.

What has been said of the short ragweed applies almost equally to the tall. In fact the two can generally be found competing with each other for waste places. It also has grace and beauty that characterize people, animals and things that are successes doing their job well and easily.

The flowering spikes of tall ragweed are larger and produce more pollen than those of the short. I once estimated that a spike like this would produce 6×10^6 pollen grains. And they say it only takes 25 grains per cubic yard of air to cause a sensitive person to sneeze. Tall ragweed pollen grains are about the same as those of the short but a little smaller.

Short ragweed has a surprisingly wide range. It extends from Nova Scotia southward to Key West in Florida and even to the islands of the Caribbean sea, and from the Atlantic coast westward to the foothills of the Rocky Mountains and even beyond, but not in effective quantity, its place there being taken by the perennial or western ragweed, which is very much the same, except that it is perennial. Short ragweed grows in all types of soil that can support vegetation and even some that otherwise can't.

Tall ragweed has a more restricted distribution. It is scarcely found north of the Canadian border nor south of Georgia and is not found much east of the Connecticut River Valley. It is less hardy, less versatile than the short ragweed and more partial to moist places.

The ragweeds are notable for flowering always at the same time in the same place, regardless of weather or other influences. In the New York area the time is about the 20th of August. At least that is when they reach a stage of flowering profuse enough to start the hayfever. Farther north they start earlier, about 1st of August in Nova Scotia. But farther south they flower later, and the farther south you go, within certain limits, the later they flower. Along the Gulf coast it is well into September before they reach the hayfever-producing stage.

This precision of flowering with only latitudinal variation is not unique. Asters, marigolds, chrysanthemums and other late-summer plants do it too. In fact the whole group are known as short-day plants, because it is the shortening of the day-light hours in the late summer which stimulate them to stop growing and begin to flower, like a warning of approaching frost. This can easily be demonstrated by giving the plants a few extra hours of artificial light as the natural daylight begins to shorten. An ordinary electric lamp is quite bright enough, turned on for a few hours each evening just as it begins to get dark. But it is not necessary to take this trouble because the experiment is being done for us under the street lamps in mostly any town. I once watched from day to day a clump of tall ragweed and another of short ragweed growing under street lamps in New York City. All those beyond the influence of the light, about 18 feet, flowered at the appointed time, and by the end of September had ripened their seeds and the plants were dead and dried up. Not so those under the street-lamps. All through October they continued to grow, becoming much taller than those beyond the range of the lights, but they did not flower. When the first killing frost struck them on the 11th of November they were still green. The frost cut them down in a stage of development that might be considered early adolescence. So we see that it is not the frost, as generally supposed, which terminated the ragweed season. It is the frost warning of the shortening days which does it some weeks before a killing frost.

Artificial shortening of the days has the opposite effect. Early one spring, about the middle of May, I selected a dozen seedlings of short ragweed, as nearly the same as possible. These were potted. Six were moved into a dark room every evening at five o'clock and out again at 9 in the morning. The other six were allowed to enjoy normal daylight. The short ragweed plants which were treated to artificially shortened days stopped growing immediately, developing flower buds instead, and by the end of June were in full bloom shedding quite normal pollen. The control plants had grown several feet in the meantime, but showed no signs of flowering. The same experiment was tried with tall ragweed, with essentially the same results, except that the plants did not cease growing in height. They grew tall and spindly without branching, and came into flower at the same time as the short ragweeds.

Because the ragweeds accept the shortening days as the frost warning, and are unable to flower until it is received, they are restricted in their northward range and in their elevation. The season starts too late and ends too early.

In Nova Scotia the ragweeds never grow tall. They get a late start because spring comes late there and they flower early because the short days come early, so they have only time to grow about knee-high. In the South the ragweeds grow tall because they start early and have a long season before they get signal to flower, which in the South comes late.

This is the way the ragweeds behave throughout the region of winter frosts. Since the shortening of the days is closely linked to the coming of frosts this reaction to daylength enables the plants to take advantage of the full growing season, whether it be long or short, without risking being nipped by the frost before they have matured their seeds. Ordinarily ragweeds are not killed by frost. When it comes it finds them with their house in order, and serves only to put the final touches on the ripening of their seeds.

But this is not the whole story. The ragweeds which grow far south, beyond the range of killing frost, flower almost the year round. In Miami, Coral Gables and Key West, for example, short ragweed may be found in all stages of development in March and April. Young seedlings may be seen growing beside mature plants ripening their seeds. The same is true in Cuba. Quite obviously south of the frost line the ragweeds behave like most other plants in tropical regions, in total disregard of the lengthening or shortening of the days. Why not? Why heed the frost warning where frost never comes?

One marvels that so humble a plant as the short ragweed can so perfectly adapt itself to climates ranging from the cold of Nova Scotia to the heat of Cuba, and how it can be so extraordinarily sensitive to shortening days throughout the northern part of its range and abruptly cease to respond to it when it finds itself south of winter frosts, recognizing the frost warning as only a false rumor.

The explanation of this curious phenomenon is that short ragweed, as generally understood, is a complex and variable species consisting of a number of genotypes which under natural conditions have a tendency to segregate out. Some of these have come to the attention of taxonomists and been given specific names despite the fact that they may be recognized among the progeny of a single plant. One of these is the southern strain or segregate which ignores the frost warning. Whenever it makes its appearances in the North it finds itself at great disadvantage and quickly succumbs to the competition of those with better regulated economy. But when this form makes its appearance in the South it finds itself better adapted than its competitors and soon gains the ascendency. The fact that short ragweed consists of many races which are readily sorted out to suit any clime or situation explains its enormous geographic range and adaptability. Just as we can breed a dog for any purpose we choose nature can breed a ragweed to suit any soil or climate.

People are always inclined to blame the ragweed for their hayfever, whereas we are the real cause of hayfever. The ragweed is only the unconscious instrument. To blame the ragweed is about as sensible as blaming the gun when somebody gets shot. The main cause of hayfever is soil abuse. Land which is stripped of its natural vegetation either becomes badly eroded; or covered with weeds. We should be thankful for the weeds. When land on too steep a slope is planted with an annual crop like corn it does not hold the soil. It is gradually eroded and abandoned to weeds.

It is the custom in some cases to cut the small grains like wheat early in the summer then abandon the fields to ragweeds as we see in many farms not far from here.

But there is no need for this. If the corn is grown only on more or less level land, in proper rotation and is followed by another crop, there is no ragweed. This is the way it is done on the Amish farms. With these people farming is both a science and religion. Weeds are allowed to play no part in it, so it will pay us to study their methods.

They plant wheat in succession. It is usually followed by a legume crop, then oats, then corn. Thus corn, the chief money crop, but also the one that may lead to soil destruction and weeds, comes in the field only once every third or 5th year.

Handled in this way the crops are practically free from weeds, no sprays, no cutting nor pulling by the roots and burning. And in the meantime the soil keeps improving. The wheat is sown in the fall. It makes a partial cover which helps to prevent erosion during the winter. In spring before the wheat starts to grow again it is planted with a legume such as alfalfa. When the wheat is harvested early in July the ground is already carpeted with alfalfa and protected against invasion by ragweed and other weeds. Later in the summer this field yields a crop of alfalfa. So each acre does the work of two and at the same time gains in fertility and there is no room for weeds.

Wheat may be followed by a number of other crops but generally a legume is chosen to restore the nitrogen that was taken out by the wheat. Clover is sometimes used and allowed to remain for several years to store up enough nitrogen for corn.

This seems like a lot of trouble to go to just to keep out the weeds, but the fact remains that the Amish are among the wealthiest farmers in the state. They are noted for always paying cash on delivery. They refuse to accept government aid and scorn crop subsidy. They keep the weeds completely under control at no expense, even making a profit doing it. I wish I could add that they also have no hayfever. Unfortunately they do. I asked an allergist in Lancaster. He says that the reason is that their farms do not cover a large enough area and are surrounded by and interspersed with other farms who do it the convential way.

The conventional way is to let the ragweed take over after a corn or wheat crop is taken off. It acts as a cover crop and is ploughed under in the spring. Of course, the seeds remain alive and the ragweed comes back again each year. The use of ragweed as a cover crop should be discouraged.

Ragweed is not an aggressive invader. Compared with other weeds farmers scarcely consider it a weed at all. Lazy farmers even welcome it as a volunteer ground cover, even though it returns next to nothing to the soil, because it is easy to control.

The citrus growers plant lespedeza or Mexican clover between the rows of trees as a ground cover. It easily controls ragweed. Besides this it escapes from the groves and occupies the roadsides keeping the ragweed to a minimum, at the same time supplying nitrogen to the soil.

What one should plant depends upon the soil and climate, but there are always plenty of things to plant that can easily outgrow ragweed so long as the soil has not become too depleted to support them. This is when ragweed gets the advantage. It can grow in soils too poor for most other plants.

It has been said that only two types of landscape are tolerable, that left to itself and that brought completely under control. These are all we need for human happiness. The correction of uneconomical misuses of the soil is strictly in accordance with the principles of land conservation and with the highest development of civilization. The best prevention of hay fever is to leave the land unmolested or to cultivate it properly and make it pay dividends. Anything in between means weeds, waste and hayfever.

Eleven Years of a Systematic Ragweed Control Program

by

Maurice S. Bowen, Shade Tree Superintendent, Teaneck, N.J.

The Township of Teaneck, Bergen County, New Jersey, population 39,000, on the first of September, 1957 completed the eleventh year of a systematic ragweed control program. A report concerning details and results of this program should be of interest, and perhaps encouragement, to those attending the Public Health Section of the Northeastern Weed Control Conference.

In the early spring of 1947 the New York City Health Department sent out to various communities in metropolitan New Jersey literature describing its own activities in attempting to control ragweed by spraying with a comparatively new chemical known as 2, 4-D. This chemical had been used with unusual success by the United States Army in destroying undesirable vegetation around camps in tropical areas. In addition to the information given to the New Jersey communities, the New York Health Department invited the voluntary cooperation of these towns and cities in a similar ragweed control program. This was done because of proven facts that much of the hay fever causing pollen in the air over Manhattan came from New Jersey on prevailing winds. As a result of this invitation and with a desire to do all that was possible to give relief from hay fever to its own citizens Teaneck, with the sanction of the Council and Township Manager, became one of the first communities in the State to inaugurate a program for the control of ragweed.

Immediate work began on the project in June, 1947 when a program was developed to acquaint the public with what was to be done. To aid in identification dried and pressed specimens of both giant and common ragweed plants were mounted on posters giving printed information about details of the eradication program and asking the public's cooperation in reporting locations of ragweed growth. These posters were placed in local store windows, banks, public buildings, and post offices. Such publicity was continued through the spring of 1948. From that time, except for occasional brief newspaper articles, no publicity has been attempted. The program has become an annual routine service given to Teaneck's taxpayers.

Because it had hydraulic spraying equipment and men who were familiar with its operation, Teaneck's Shade Tree Department was given the job of spraying ragweed and has continued with the project during the entire eleven year period. Two men are detailed from the Department each season to give their full time to the spraying program from about June 15th to September 10th. They operate a 100 gallon hydraulic spray tank, pulled by a small tractor, with 150 feet of hose which enables them to reach the farthest end of most vacant lots while the tank and tractor remain on the street.

This particular spray tank is never used for any type of spraying which requires the use of any chemical except 2, 4-D sodium salts or its derivatives. During the first year a straight 2, 4-D sodium salt was used which gave 100% kill on both giant and common ragweed. Since this was true it was decided in 1948 to attempt the eradication of poison ivy in the annual program but experience proved that 2, 4-D sodium salt was not too effective in killing this tough plant. The leaves died but the following spring much of the plant recovered and continued its growth. It took three successive years of thorough spraying to completely kill heavily infested areas of poison ivy. Beginning in 1951 all ivy was sprayed separately from ragweed with 2, 4-D amine salts. This gave a larger percentage of kill than the sodium salts but still was not 100% effective. In 1955 the newly developed combination of 2, 4-D and 2,4, 5-T in low volatile ester form was first used. As a single spray for both ivy and ragweed it has been proved most satisfactory in killing both plants when used at the rate of one quart to 100 gallons of water.

Teaneck has an area of slightly over 6 square miles and is entirely a residential community. In 1947 there were many empty lots and much vacant acreage throughout the Township including areas of marshland on both the eastern and western boundaries. Ragweed grew profusely on many of these vacant and wild areas and it could truthfully have been said that it made up a large percentage of the wild plant growth on such unused and waste land at the start of the spraying program in June. Spraying that first year was directed against the large areas of ragweed and time did not permit coverage of too many empty lots in residential sections. Spraying stopped sometime between August 20th and September 10th when ragweed was in full bloom. This schedule has prevailed during the entire eleven year period.

As the 1948 spraying progressed it was very evident that the 1947 program had been successful. Much less ragweed showed up where spraying was done in the previous year. In 1948 it was possible to cover practically all of the vacant areas throughout the town. By June of 1949 the home building boom was in full swing which greatly cut down the number of empty lots where spraying would have been necessary. Credit should be given where it is due and there is no doubt but that home building activity in Teaneck has played a major part in controlling ragweed and poison ivy by improving vacant properties to the point where these plants can no longer grow. The widespread disturbance of soil taking place when new homes are built temporarily stimulates ragweed growth but this is easily destroyed by one year's spraying. With the completion of the new homes ragweed ceases to be a problem.

From 1950 through 1957 it was possible to completely cover the entire Township during the approximate ten weeks of spraying. All publicly and many privately owned lots were sprayed and many areas in the rear of private homes were sprayed at the special request of the owners. A question sometimes asked is "By what authority do you enter upon private property to spray ragweed and poison ivy"?. In the first two years of the program the only privately owned properties sprayed were those where the owners requested such service. The owner was contacted and told that the work would be done only if he was willing to free the Township from any responsibility for damage done to valuable plant life or to the property itself. Assurance was given by the agent carrying Township liability insurance that any damage done by the Township employees or equipment on private property was covered as long as the work was being performed under orders of the proper Township officials. In April 1949 Teaneck Township Council passed an ordinance making it mandatory for property owners "to remove brush, weeds, dead and dying trees, stumps, roots, obnoxious growths, filth, garbage, trash and debris, for the preservation of the public health, safety, general welfare, or to eliminate a fire hazard within ten days after notice so to do has been given . . . . "

As stated earlier in this paper the ragweed and ivy spraying program was included, after the first two years, among the routine services given to Teaneck citizens. Beyond that time no notice was given to private owners that ragweed or ivy would be sprayed. Benefits derived from such service were so obvious that many people requested it voluntarily. During the eleven years the project has been in operation not more than a dozen complaints have reached the office. None of these were of too serious a nature. Lack of complaints may be attributed largely to carefulness and responsibility on the part of Township employees.

Another question frequently asked is "What is the annual approximate cost of the ragweed control program?" Exclusive of depreciation of equipment there are three major items constituting the cost - gas and oil for sprayer and tractor operation $275.00, cost of spray material $300.00, and ten week's wages for two men $1700.00. This is a total of $2,275.00.

A third question that should be asked is: "Do results of the ragweed control program justify its continuation?" It is freely admitted that a large amount of ragweed was growing in Teaneck in the summer of 1957. But to one who was familiar with the situation in 1947, '48, and '49 it is definitely encouraging to see how much less there is now than there was in those days. No longer can one find hundreds of square feet of solid ragweed plants or heavily infested areas of poison ivy. Where ragweed or ivy or both could have been found in every vacant lot in town there are now lots where none is growing. To be sure, there are many acres less of vacant land in town in 1957 than was the case in 1947 but whether the reason is due to new home construction or spraying the result is the same - definitely less ragweed and poison ivy. The decreased amount of giant ragweed is much more noticeable than that of common ragweed. This is because the giant variety for the most part has only one germinating period in the spring. When an area is once sprayed that is the end. On the other hand, common ragweed germinates continuously throughout the summer. All plants sprayed in a given area in July or even August will be killed but by the middle of September the same area will again be covered with healthy plants which have germinated since the original spraying was done. This indicates that the ragweed program might profitably be carried through September.

Teaneck is pleased with the results of its attempt to control two of Nature's most harmful weeds from the viewpoint of public health. Many residents have indicated that they have suffered less from hay fever since the spraying program began than they did previously. It is regrettable that communities adjoining Teaneck have not seen fit to conduct a program of like nature. The pollen count in the air over Teaneck would be very much lower if it were done. It cannot be said that the time will ever come when both plants will be extinct within the Township boundaries. It does, however, seem certain that they will become an ever decreasing menace to the health and physical comfort of Teaneck's citizens with each succeeding year of a spraying program.

THE CUSTOM APPLICATOR IN THE FIELD OF INDUSTRIAL WEED CONTROL

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Industry must control weeds, because vegetation can, in time, destroy anything that man has ever made. Weeds create fire hazards when they grow next to petroleum storage tanks, lumber piles, sheds, and buildings. They entrap moisture, which fosters the corrosion of metal and the rotting and warping of wood when they over-run fences, pipe-lines, rail sidings, utility poles, and platforms. They create safety hazards by concealing warning signs, fire hydrants, and security fences. Noxious weeds, such as poison ivy, and rag weed, are responsible for time-lost accidents, and impair the efficiency of personnel. Thus industry cannot ignore weeds, or do without some form of weed control.

In most instances, chemical weed control offers the only practical solution to industry's problem with vegetation. Chemical control is incomparably cheaper than paving,and the results are incomparably superior to cutting. In times of rising costs, chemical weed control provides the means of improving standards, and at the same time, reducing plant maintenance budgets.

While it is true that new herbicides constantly appear, man has known of chemical weed control ever since the Romans salted Carthaginian fields. Therefore, one might assume that American Industry, which makes enormous investments in labor-saving devices, would accept chemical weed control as standard practice. And yet, for the most part, this is not the case. In fact, one major oil company maintained a herd of weed-eating sheep in this area as late as ten years ago. Another industrial concern, having thirty-eight miles of railroad track, still employs men to pull weeds out of the road-bed by hand.

I should like to point out some of the reasons why Industry continues to cut, pull, and graze, and why the custom applicator is in the best position to handle weed problems for Industry.

Those companies which do not take advantage of custom weed control specialists usually assign chemical control to the plant engineer, who has no reason to know one weed from another. Furthermore, unless the problem is so vast as to occupy his full attention, he is not likely to come in contact with experiment stations, weed conferences, and other impartial sources of information. Since there is no single herbicide which does all jobs in all seasons, the plant engineer's chances of selecting the most efficient product is remote.

In the second place, it is most difficult for the average yard foreman to train spray-crews and to keep them together year after year. This is perhaps the most serious problem. Furthermore, harried yard foremen report that their spray-crews are shanghaied so often for construction or other maintenance work that herbicides sometimes never leave the warehouse.

Now there have been many instances where Industry has persevered and overcome these difficulties with good weed control. On the other hand there have been far more cases when companies have experienced poor control as the cumulative effect of these adverse factors and consequently, a sizeable segment of Industry feels herbicides to be unreliable.

Now a properly organized industrial weed control service company is in an ideal position to solve all of these problems. However, this service organization must have extensive specialized knowledge, trained men, and equipment specifically designed for its purpose.

Technical knowledge is essential. The organization must not only be familiar with the experimental work of others, it must also conduct its own investigations in order to meet problems unique to the field of industrial weed control. The more one knows about the fundamental relationship between weeds, soils, climate, and herbicides, the better he can serve. Stated even more positively, unless one is willing to acquire this basic information he has no place in this field.

There is no substitute for trained men in this work. Foremen must be capable of making important decisions on their own, because conditions may be vastly different in June, when the work is done, than they were in October, when the original survey was made. They must be capable of accurate, thorough applications under the most difficult circumstances, because there is little margin for error, and all mistakes are costly.

A proficient industrial weed control specialist must be prepared to assume responsibility for all phases of his work. This means that he must understand his client's needs, measure the area to be treated, determine which herbicide should be used, establish dosage rates, and make the application for charges agreed upon in advance. There is one final consideration -- in our opinion, he must guarantee the results to the client's satisfaction.

We are confident that industrial weed control has its place in our future economy, but at the present time there is a great deal of missionary work yet to be done. Industry does not generally appreciate the cost of permitting weeds to grow, or the value of chemical weed control. This is not the case with two of our clients in the Philadelphia area, who have had the foresight and good judgment to take full advantage of chemical weed control. One is the Union Tank Car Company, which manufactures and repairs railroad tank cars. The other is the Atlantic Refining Company.

The property lines of these two companies are separated by a railroad yard which is not the responsibility of either. This yard, which is seven or eight tracks wide, normally holds scores of box cars, some empty, some loaded. It was heavily weed-infested in 1957. This past November a weed fire started in this same storage yard according to the Fire Marshall, and rapidly spread to the box cars. In a short time, the fire gained such intensity that sparks were thrown hundreds of feet, and firemen were unable to protect either the refinery, or the Union Tank Car property which contained many cars filled with liquid butane gas. Before the fire was controlled, it had run some 4,000 feet between the two properties; it set railroad ties on fire, and burned utility poles; it ran up to the treated areas and stopped. Chemical weed control was the only thing which prevented disaster.

In all probability, the dollars saved in this one incident could buy chemical weed control for all refining properties in the Western Hemisphere. Yes, we are sure that there are some who agree that chemical weed control pays dividends!

This dramatic fire certainly demonstrates the value of chemical weed control, but the real savings accrue from the unspectacular day-to-day benefits which weed control affords -- the fence line which serves its full life unaffected by weeds -- the drainage ditch which does its job because it is not weed choked -- the oil tank farm which does not require cutting and which does not sap man-power from yard crews. When industry appreciates the full net value of such advantages as these, then chemical weed control for industry will come into its own.

HERBICIDES AND LEGISLATION

Thomas J. McMAHON

There has been, and there is being considered, legislation governing the use of herbicides. The concept of this legislation varies from state to state as the basis for the adoption of this legislation changes.

Mr. Torbert Slack, Roadside Development Engineer, Louisiana Department of Highways, reported on the laws in the various states at the National Highway Research Board Meeting in 1956. Most of these laws were passed because of bad application by inexperienced or improperly indoctrinated personnel. At that meeting, Mr. Slack suggested the need for some control because of the mutilation of the countryside which was of some concern. Mr. Slack's report may be found in the 1956 Report on Roadside Development, publication 419, National Academy of Sciences- National Research Council.

From Mr. Slack's Report, it may be seen that only seven states of the 36 reporting had no state legislation governing the use of herbicides. A review of this report will show that factors considered in arriving at final legal requirements are:

1- Experience of the Applicator

2- Suitability of Equipment Used

3- Insurance

4- Financial Responsibility of Applicator

5- Classification of Herbicides

6- Height of Spray and general requirements for subsequent handling of area sprayed

7- Miscellaneous.

Oregon requires that Custom-Applicators be licensed. Written examinations are required as to the characteristics of herbicides and the effect of their application to particular crops; the practices of application; etc.

Oregon also requires registration of herbicide equipment. In Louisiana, equipment requirements are related to maximum pressure to be used. California seeks control of equipment by specifying the size of the oriface, "not less than 0.059 inch in diameter nor at a pressure greater than 30 psi. nor at a rate less than 25 gal. of mixed material per acre."

Other similar efforts have been made to specify safe equipment. It should be noted here that there are three aspects to safety in equipment. They are:

1- Protection of desirable vegetation by a controlled spray;

2- Protection of pedestrians and property from vehicular damage while applying; and

3- Protection of personnel engaged in the work of application.

There is a deficiency in legislation, to date, in covering these three points so essential to safety, though among the various states laws to date, the intent is clear. Designers of roadside spray equipment have observed the need for these considerations.

The insurance requirements vary. Practically, insurance requirements depend on the applicator's experience and equipment. With both experience and equipment proved, a maximum of $25,000 should be adequate. Without these qualifications, all insurance available is needed.

The financial responsibility of the applicator is important. It is possible to get insurance with a $1000 deductible. Normally, this deductible clause is overlooked. It is not always stated in the Certificate of Insurance. It may be required that the Certificate state the deductible amount. The best one can get has a fifty dollar deductible.

Suppose a man has a series of damage claims, which is the most probable case, all of which are under his deductible amount,- what then? And if this deductible is $1000, how much are the people protected?

These questions of experience, equipment, insurance, and financial responsibility are inter-related. There is enough experience to determine this relationship.

In the classification of herbicides, most states referred to 2,4D; 2,4,5-T; and MCP. These laws, it should be noted, were passed between 1950 and 1956. There is reference to them as "injurious herbicides."

This is a misnomer. One might also pass a law against an injurious gun. It is the user who receives the permit for a gun. It is also the user who should be considered in any legislation affecting use of herbicides.

Perhaps a better way to put it is: What the gun is to the marksman, the equipment is to the sprayer; and what the bullet is to the gun, the herbicide is to the equipment. And what the hunter is with his gun and his ammunition, so the applicator is with his equipment and his herbicide.

One does not hunt deer with a pistol, nor tigers with a .22. Equipment considerations should proceed along the same reasonable lines.

Thus, any approach to classification of chemicals as injurious should be double checked with proper authority. As things stand in some quarters now, the gun and the bullet have been put in jail while the man who fired them has gone unnoticed.

The need for classification of chemicals as this classification is required for application in non-crop areas should be determined by a joint committee representing the Agricultural Chemical Society and the Association of Highway Officials, perhaps best coordianted by the National Research Council under Wilbur Simonson and the American Road Builders Association Roadside Development Committee under Harold Neale. Mr. Torbert Slack, Mr. Harry Iurka, Mr. Nelson Wells, Mr. Edwin Jones, Mr. John Wright, Mr. John McManmon, and others would make excellent members of this group whose experience and knowledge combined with the Ag. Chem. Society under Jack Dreesen would produce authoritative background for any legislative enactments. Frank Brant and Oliver Deakin should also be included. There are many others who would, with them, make outstanding contributions to such legislation.

The need for men with knowledge and experience in matters of this nature is well known to us. In the case of Sullivan County's Weed Control Program of 1954, findings of this Conference were used to support adoption of the program. A parcel of kittens in Grandma's knitting bag could never have caused a tangle such as the misinformed did to that program. It would take a special program to detail the events which followed over the next two years which finally reached a conclusion when Governor Harriman signed permissive legislation affecting Boards of Supervisors.

been referred for r[illegible]

Height of spray, [illegible]ements for cutting and removing after spraying and other miscellaneous details are contained in [illegible] legislation, but these, for the most par[illegible] local considerations which contemplate the [illegible] objectives of safety and beauty. They shou[illegible]treated on a local basis under the jurisd[illegible]n of the engineer of design or the superintendent or supervisor of roads. They call for a judgment decision.

Self rule is the best rule, and, if it were possible, any legislation would best be avoided. There is a danger that legislative will unduly restrict and hamper, rather than aid, progress in the public interest. Legislation is needed when men by their actions create conditions adverse to public interest and opinion. If applicators and manufacturers would adopt and follow ehtical practices which would avoid that bad work which antagonizes the public, then there would be no need for law.

With the absence of specific law, there would be fuller opportunity for all and with judicious application and selection of chemicals, progress would be unimpeded.

As a case in point, we have the experience of Sussex County, New Jersey. There three years of a planned program reached a climax this year. A study was made and a report issued. Among other things, the County saved $50 per mile. Roadsides were more beautiful, were safer, and were free of ragweed and poison ivy. 1080 man hours per year were saved from ivy poisoning alone.

Now the County has adopted other chemical controls and will lead in some tests this year.

An unexpected thing happened in the course of the political campaign. The weed and brush control program became an issue when one side said the incumbents had made no highway improvements. In reply, the incumbents brought forth the weed and brush control facts. And, in addition, there were the roadsides for people to look at.

Everyone has heard how the public is opposed to spraying. Based on what many people have said, these men who adopted the program should have been defeated. They were not. They won against the State trend. And what is very important,- they led all other candidates. These men were Lester Price and Senator George Harper.

Here was and here is conclusive proof that the considered actions of responsible men is the best law there is. Self rule is the best rule. There is no need for regulation in Sussex County, for the public has spoken more firmly than had been contemplated. When the public interest is best served, there is no need to be concerned about public opinion.

Great progress is possible there now, for public confidence has been established. It can only be lost by a deviation from the sound policies followed over the past three years.

One might like to consider that these things are outside the pale of politics, but they are not, nor should they be. Politics is the science of government and here in an election we have the measure of public opinion, consistent with that science.

Legislation might do well to consider that Sussex County vote, for all here know, without a vote, that what was done was worth the doing well; and those of you who have seen the results know that the work was done well; and that the public has by its vote in an election approved this program should be welcome news to you who have been told, what you did not believe but could not prove, that public opinion was against this work.

Let legislative recommendations include the successful scientific political policies of Sussex County and there can be no stopping the full benefits of this new field of bio-chemistry for the public good. And control of ragweed and poison ivy will be a by-product for public health; for in factually reporting it must be stated Sussex County adopted this program solely for reasons of economy and beauty. The health benefits came to them as a surprise.

And to those of you who are running for office, look into the story of Sussex County. Here is a tested successful political program. It was not meant to be; it just happened that way.

It might seem inconsistent to introduce the factor of public reaction to a discussion of legislative consideration; but such reaction is a prime consideration in legislation. Legislators are elected and it is important to them that public understanding and approval will follow legislative action. It is important, therefore, to point out to elected officials the voter support which is a matter of record.

Whether used as a guide for legislation or for the adoption of a program where legislation is not a factor, the elements which produced results and won overwhelming public support in Sussex County are worthy of study. They are:

1- Experience and record of applicator;
2- Safety of Equipment;
3- Safety of Material;
4- Results Guaranteed;
5- Public Relations;
6- Insurance; and
7- Economic factors.

No move was made which was not announced to the public. As a result, there was considerable discussion. Members of garden clubs and conservationists expressed their thoughts on the matter. There was in some quarters strong opposition. The merits of each argument were weighed by the Board.

Some elected officials avoid controversy. To some officials, quiet is preferred to progress. To these men in Sussex, whether there was quiet or controversy was beside the point. The question was what to do in the best interests of the County. But it must be noted here that there is an advantage to controversy; it secures public attention,- it gets the voter interested in what is going on. To deny progress in order to avoid controversy is to shirk duty and to seek political oblivion. Or to permit the loudest voice to take precedence over the best reasoning is equally to invite disaster. Government by the noisy is not always good.

Whether it is the adoption of a program or legislation, open discussion is healthy; and where informed right reason prevails, there is no doubt of the outcome. Sussex County proves that clearly.

It must be observed that too many times the reason advanced for not adopting the program is an imagined public opposition. Sussex County in its public relations left nothing to the imagination. The public was informed and right reason was followed. The outcome, after three years, proves the soundness of this procedure, both from the standpoint of the results achieved and the public endorsement realized. This was an endorsement of good government.

Consideration of all these elements belongs in a discussion of legislation, for it is not merely by enactment laws are made; the effect of law is created by practice in the absence of enactment. It is perhaps more important to consider the effect of this sound procedure than to think merely in terms of law, for if there is sound procedure there will be no need for special legislation. Self-control is

A PROGRAM TO ERADICATE RAGWEED

By Louis V. Fucci,
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INTRODUCTION

The Hay Fever Prevention Society was incorporated in New York State and chartered by the University of the State of New York on January 12, 1948 for the following purposes:

"To disseminate information for the relief of hay fever sufferers; to further by publication and teaching the knowledge of the cause and treatment of Hay Fever; to encourage research work toward finding a cure for hay fever; to co-operate with Federal, State and Municipal authorities in removing and eradicating ragweed and similar weeds; to solicit funds tobe used for the aforesaid purposes".

Since authority claims ragweed airborne noxious pollen is the chief cause of so-called hay fever (a misnomer since there is no thermometer fever or hay involved) which should be called ragweed pollen allergy, and since the cause is known, the society feels advisedly that it can be prevented and controlled by removing the cause, ragweed. Therefore, the society further feels since this pollen disease, chronic in nature, and of which about 30% become asthmatic, a fatal respiratory ailment, can be controlled, there is no economic justification for its existence. Ragweed eradication and control in the prevention of hay fever today is considered a definite and essential public health service, and if not checked soon may become a national health menace.

Only a short time ago the control of malaria was considered an impossible task. But today, control of swamps has reduced malaria from an epidemic menace to a rare malady. The malaria program was adopted on the premise that if the CAUSE is known, it can be controlled and so become ineffective.

As an authority has so clearly stated: "Control of Ragweed by a weed spraying operation is the only feasible and practical method we have at the present time to alleviate the suffering of the hayfever and asthma victims".

The eradication of the two most noxious species of ragweed, commonly known as the Giant (Ambrosia Trifida) and it, but would preserve the economic usefulness of the individual and also check agricultural and farm produce loss.

Since hay fever is not decreasing to any appreciable extent because of a lagging and lacking in the public health education in the cause and prevention of this disease, and inertia on the part of authority to unite their public health services nationally to encourage the organization of ragweed eradication and control programs, hay fever is just given a token thought, whereas it is a serious health problem and not a joke.

WHEN IS RAGWEED NOXIOUS?

Ragweed noxious pollen breeds disease only when its terminal spikes are allowed to ripen and give-off its pollen. However, if it eradicated prior to the time that pollen is allowed to ripen much suffering will be avoided. Moreover, the eradication of unripened ragweed decreases with the amount removed and in proportion thereto which proves the Law of Physics favors the benefits derived from activating ragweed eradication programs in general and nationally. Also the eradication of ragweed by the wonder 2,4-D chemical spray decreases the possibility of pollen spread for succeeding years, thus causing an aggregate decrease of the weed. It is said that about sixty days is taken for ragweed to ripen, so that between the time the weed first appears until the time it ripens much valuable time is available for eradication work.

Ragweed Must Be Identifiable.

The persons to do the actual work of eradicationg unripened ragweed must familiarize themselves with the two varieties of Giant and Common Ragweed, otherwise othern than ragweeds may be pulled up and much unncessary work done.

To guarantee the proper identification of ragweeds not only for workers in the field but to the public, posters, pamphlets, garden club bulletins, newspapers and magazines should have properly labeled pictures of ragweeds. Continuous publication of these pictures during the ragweed season will be beneficial to the eradicating crusade and so provide alleviation during the hay fever season.

WHAT MUST BE DONE TO ERADICATE RAGWEED?

Unfortunately, people and many in public health service and education are apathetic and indifferent to ragweed, it seems. Tnthusiasm for eradication must be aroused and the community's energy and interest must be marshalled. For, unless a concerted co-ordinated effort is made, isolated, spasmodic and invidual work by a single person or civic group will be of no use or avail to obtain the maximum overall benefit. The combined efforts directed by capable leaders only can produce lasting and telling effects.

RAGWEED ERADICATORS MUST BE ORGANIZED

Local service and civic organizations and chambers and boards of commerce and trades, garden clubs, etc. offer the most advantageous starting point because such groups are constantly working for the public health and welfare. The work done by such organizations if organized will result in definite accomplishment and success. A Ragweed Program Committee can be made to fit in easily either as a part of any organization or as a Committee set up to handle the eradication work solely. In this work, don't forget the girl and boy scout and like organizations can fit in nicely to co-operate with the said committee.

COMMITTEE CHAIRMAN GUIDES RAGWEED PROGRAM

Regardless of how the committee is designated by an organization the following is a plan for organizing. A Ragweed Program Committee is established which supervises, controls and co-ordinates the work of each of the major committees. These committees are namely: Education, Inspection, Eradication, Publicity, Fund Raising, and Legislation. On fund raising, write to the society for further information.

FUNCTION OF EACH OF THE COMMITTEES

The Chairman of the Ragweed Education is responsible for training inspectors, eradication supervisors, preparation and scheduling lectures, and the distribution of ragweed eradication and control literature.

Inspectors are necessary for bounding territory which they will survey and chart record and about which they can give a comprehensive accounting of sparse and densely ragweed infested areas, wooded sections, vacant lots and gardens, etc. highways, etc. This delimitation of territory will prevent work from being done haphazardly or being overlapped.

Training inspectors should include the positive identification of ragweed. Means of ascertaining ragweeds in out-of-the-way and hard to get to or at places. Inspectors wherever possible should try to enlist the co-operation of the landowner to eradicate ragweed before the month of August. To this end, Inspectors should visit landowners, advise them of the health and sanitary law regarding ragweed growth on their property being a violation, subject to a fine or jail, as the case may be, answer questions, advise him how and when to eradicate, distribute literature pertinent thereto. Eradication supervisors should be trained to quickly and effectively lead their groups in eradication work without damaging private property, creating a public nuisance or in any other way trespassing, unless given permission by the owner or by due process of law.

Lectures on ragweeds and hay fever prevention can be given at schools, garden clubs, 4 H Clubs, Civic, social ...

given with or without slides and in its place, posters, etc. used. The points to be emphasized should be the propér identification of ragweeds and their early eradication, that is, before August, before the weed is fully matured or before it pollinates. Talks should bring out what other other seeds can be sown in order to hold the ground against further ragweed infestation. Close rotation of crops prevents ragweeds from creeping in. If this is not possible, then grasses should be planted such as, creeping honeysuckles, legumes, kudzu vine, white clover or any other plant which will hold the soil against weeds.

Only by continuous flow of literature in the form of posters, pamphlets, bulletins, news-letters and so forth can the significance of the use of slogans such as "Ragweed Eradication and Control Means Hay Fever Prevention" and Give a Weed an Inch and It Will Take a Yard" and "Get Rid of Ragweed Before It Will Get You" will the idea of ragweed eradication permeate the consciousness of the general public. The education of the public in general is essential in order to earn its goodwill and to influence proper legislation to solve the hay fever problem

THE FUNCTION OF THE RAGWEED INSPECTION COMMITTEE

Whatever eradication work is to be done by the public, various groups and organizations, must be mapped out so that a definite goal is set. The area to be covered should not be too large. In this way intensive eradication is assured and each successive season could be used to expand the work until complete eradication is effected. Territory so mapped out and bounded can be controlled effectively and responsibility definitely delegated. The Chairman of the Ragweed Inspection shall be responsible for the accomplishment of ragweed eradication in this mapped area.

Inspectors should make the rounds of their assigned areas and report to the Eradication Committee all those sections with ragweeds. Inspectors should enlist the aid of landowners to weed their own land or have it done otherwise, and where not feasible, the Inspector should delegate its own group of workers to do the job with the co-operation and permission of the landowner.

FUNCTION OF THE ERADICATION WORK COMMITTEE

This committee should enlist work groups, and to supervise the work to be done, and compensating the workers for their time.

Enlisting work groups should be a simple task because public-spirited groups exist which are prone to become part of any worthwhile campaign. Young people are comparatively easy to control and enter into this work with enthusiasm and willingness.

It is necessary to enlist the aid with the sanction and co-operation of all group leaders. For instance, if a group of boy scouts volunteer for a Saturday afternoon, arrangements should be made well in advance with the Scout Leader in order to give him a chance to discuss the work whereby a maximum of efficiency may be expected from their efforts.

Each area for eradication which is allocated to an organization group should be supervised by a member of the Ragweed Eradication Committee. This supervisory work is vital because young poeple may wander from their objective or may become restive, or work inefficiently, or may fall short of the mark set for them, or extend beyond the borders mapped out for them to do their job.

For the eradication work done by an group something in the way of compensation must be made to it. It doesn't necessarily be financial, it can be compensated in the form of prizes, trophies, parties, contests and so on with good results, and the kind of reward should be left to the group or person doing the work, to vote on collectively, or chose individually, as the case may be. The workers MUST be left with the feeling that a fine time was had by all. In other words, the group or person must feel they were amply paid for their work. They must be made to go away with that feeling because those youngsters may be required to do more work the next week, month or year. Only by leaving them in a pleasant frame of mind will they be able to be enlisted again.

FUNCTION OF RAGWEED PUBLICITY.

Publicity in the newspapers, magazines, over TV and Radio will help tremendously in marshalling public opinion against the public health nuisance of noxious ragweed, the chief cause of chronic hay fever. Therefore, if photographs of ragweed infested areas and the work of ragweed eradication are taken or for that matter any other phase of the Ragweed Eradication and Control Program and released to the press, and other media, it will be of unquestionable benefit to the cause. Remember, photographs tell a convincing story which thousands of words and lines will not.

Press releases are essential to newspapers, etc., to civic organizations, etc. with uninterrupted regularity. Stories of activities, on how the public can help, articles on early identification of ragweed and when to eradicate it, pictures of ragweeds, how groups can be organized and where and when they should apply fore eradication work. All this and more must be done to impress the public public health nuisance of ragweeds.

Stories should be fed to all media. To get the best results from the radio, tie the story up with a human interest point-of-view. Tell stories about people in relation to ragweed and hay fever. Such stories are impressive and more action can be expected from the public in addition to appealing to their humanitarian side for sympathy.

CAUTION: Do not send insignificant or unimportant news items to the press or Tv or Radio. Send only broad news factors that takes in and affects a sizeable portion of the inhabitants of a locality. If editors or directors do not publish or broadcast your story releases - never question their judgment, leastwise argue with them. Rather win them with material thay are anxious about.

FUNCTION OF RAGWEED LEGISLATION.

Legislation is one of the most important adjuncts to the work of ragweed eradication. The job of getting legislation affecting the clearance and eradication of ragweeds on the statute books is slow and painstaking. However, once constructive legislation is on the books it becomes routine for the Ragweed Program Committee to see that such laws are enforced and obeyed by those it concerns.

The Chairman of Ragweed Legislation should have a simple bill to offer any legislator so that it can be presented to the legislative body for adoption.

The gist of the bill should be that landowners should be responsible for the eradication of ragweeds before pollination, in fact, not to cause it to grow on their property.

Laws with "teeth" in them combined with the effort of all who are engaged in ragweed eradication work is bound to be resultful and effective for the good of the community's health.

A National Program for the Eradication of Ragweed incorporating the work of hundreds of thousands of people may seem to be an elaborate task and impossible, also useless and too expensive. Q.E.D. All that is required is people with authority and the public backed up with the cry from more than 8,000,000 hay fever sufferers, plus faith and guts to get down to the business of helping to accomplish this task of ragweed eradication and control and wipe out Hay Fever in the United States of America.

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PRELIMINARY STUDIES USING KURON AS AN AQUATIC HERBICIDE 1/

by
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In the summer of 1956 the New Jersey Division of Fish and Game, under Dingell-Johnson Project No. F-1-R, Aquatic Weed Control, experimented with Kuron on one-acre plots in two northern New Jersey lakes. The chemical called Kuron - 2(2,4,5-Trichlorophenoxy Propionic Acid - is a hormone-type growth regulating compound which is absorbed by the leaf and translocated to other parts of the plant. The above mentioned plots were heavily infested with water milfoil, Myriophyllum heterophyllum; fanwort, Cabomba caroliniana, and white water lily, Nymphaea odorata. One week after application good control of the submerged species was evident; the emergents were not materially affected. (Huckins, 1956, ms.) It was felt that no further treatment was necessary after examination of the plots in the spring of 1957.

The results did seem to indicate that further evaluation was desirable and a testing program was initiated in the summer of 1957 2/.

Methods and procedures

Lakes and ponds, in order to be included as part of this testing program, had to meet certain requirements:

1. As a group they had to represent a cross-section of existing lakes and ponds throughout the state with regard to weed species, both emergent and submerged, alkalinity and hydrogen-ion concentration.

2. They had to have a woody shoreline so that the effect of Kuron on woody plants could be evaluated.

In treating a pond the procedure was to calculate the active ingredient in Kuron required to produce the predetermined concentration in parts per million.

To determine the effectiveness of Kuron at various concentrations the herbicide was tested at 0.5 p.p.m., 1.0 p.p.m., 2.0 p.p.m., and 2.5 p.p.m. One reclaimed lake in southern New Jersey was treated at 3.5 p.p.m.

The herbicide was applied by a Bean Estate Sprayer, skid mounted, with split intake lines and the by-pass was used for circulation and agitation. A spray boom was devised and a thirty-gallon drum served as a spray tank. The entire rig was mounted on a 11.5 foot aluminum boat and was operated by two men. The herbicide was applied in rows with a slight overlap between them.

1/ Misc. Report #21, New Jersey Fisheries Laboratory, Division of Fish and Game, Milltown, New Jersey.

2/ This program would not have been possible without the assistance of Dr. E. Evaul and Neal Munch of the Soil Conservation Service who obtained ponds for testing; Dr. Mark Wiltse of the Dow Chemical Company supplied the Kuron.

After the ponds had been treated water samples were taken and forwarded to the Dow Chemical Company for Kuron analyses. The water samples were taken from two to twenty-four days after application. (Table I)

Ponds were checked at seven day intervals for the first month with monthly checks thereafter.

Findings

During the course of the summer eight lakes received total applications and five lakes received plot treatments of a half-acre in area. A summary of these applications is presented in Table II.

The concentration of 0.5 p.p.m. was effective on white water lily, *Nymphaea.* The submerged species were only slightly affected. At 1 p.p.m. good control of water weed, *Anacharis* sp., yellow water lily, *Nuphar*, and mud plaintain, *Heteranthea* sp., was obtained. Complete control of water milfoil, *Myriophyllum*, and bladderwort, *Utricularia*, was achieved with concentrations of 2.0 p.p.m. and 2.5 p.p.m. From these data there is every indication that adequate control of most species can be obtained at 2 p.p.m. however, further testing of the effects of Kuron on pondweed, *Potamogeton*, is necessary since none of the concentrations employed controlled this species. Duckweed, *Lemna minor*, turned brown forty-eight hours after application of Kuron and then recovered fully.

As to the effects of Kuron on trees, either in the water or surrounding the lake, no damage was evident on such species as silver maple, black gum, pitch pine, willow and white cedar.

Since this herbicide contains phenol the possibility of its tainting fish flesh was considered. Fish were collected from a treated area and taste tests revealed that Kuron did not taint in any manner.

As mentioned earlier, measurements of pH, alkalinity and temperature were recorded. None of these water characteristics appeared to affect the herbicidal effects of Kuron.

Observations suggest that Kuron is slow to act. Seven days after treatment submerged plants appeared wilted and emergents were curled. Fourteen days after treatment open areas were visible; submerged vegetation had started to rot, while the emergents continued to curl. It was not until twenty-one days after treatment that the submergent weeds were completely disintegrated and leaf and stem systems of the emergent vegetation had broken free from the roots. One month after application root systems of both types of weeds were observed in windrows along the shore.

Since the affected plants did seem to break down quite slowly, there was some suggestion that no serious oxygen lag occurred. However, this cannot be substantiated since an insufficient number of D. O. determinations was taken. Observations also suggested the absence of algae blooms, sometimes characteristic of certain herbicidal applications, caused by the release of essential nutrients from the rapid breakdown of plant tissues. However, this lack of algae blooms could also indicate possible algacidal effects of Kuron.

Further evidence of the slow breakdown of Kuron was indicated by the water samples which were forwarded to the Dow Chemical Company for Kuron analyses. In the total applications the concentration of Kuron remained fairly constant while in plot applications the concentrations were affected by dilution, or a build-up in stream application. Residual effects cannot be determined until next spring when the viable seeds, if any, will germinate.

Plot applications were not as effective as total applications since reinfestation was possible when shoots and seeds from untreated areas floated into treated areas. The possibility also exists that once the vegetation has been destroyed other aquatic species, either desirable or undesirable, may over-run the treated area. Total applications were most effective since reinfestation was less likely to occur.

Summary and conclusions

The experiments conducted to date have more or less been designed to determine the herbicidal effects of Kuron on aquatic vegetation. Success has been obtained on the most predominant weed species in the thirteen lakes and ponds so treated, using a concentration of 2.0 p.p.m. The period necessary for total plant destruction is normally twenty-one days. The usual algal blooms were not observed following treatment with Kuron; preliminary data suggest no serious oxygen lag. This could be attributed to the slow breakdown of the plant tissues but the apparent scarcity of phytoplankton also suggests the possibility of algacidal properties.

None of the concentrations employed have affected the trees either in the water or along the shoreline. Neither pondweed, *Potamogeton*, nor duckweed, *Lemna minor*, has been effectively controlled by any concentrations of Kuron.

There are many important questions still to be answered regarding the possible use of Kuron as an aquatic herbicide. These questions include: At what time of year will application achieve the most effective control of weeds? Does this herbicide have any undesirable side effects on certain micro fauna and flora important to game and pan fish species? Will it control filamentous algae? Does it have a residual effect? Will its coat affect its use?

The results to date have been promising and the proposed questions are in the process of being investigated. In the meantime Kuron can be considered as one of the most important aquatic herbicides on the market since the development of sodium arsenite.

Table I. AMOUNT OF KURON DETECTED FROM FIVE TREATED PONDS 2 TO 24 DAYS AFTER APPLICATION
(Analyses conducted by Dow Chemical Company)

Name of Pond	Kuron applied p.p.m.	No. days sample taken after application	[illegible] detected p.p.m.
Rte. No. 1	2.0	2 days	2.0
Colomb's Pond	2.5	24 days	1.5
Keswick Pond	2.0	14 days	1.8
New Waywayanda	2.0	3 days	2.1
Panther Pond	2.0	8 days	Less than 0.5

Table II SUMMARY OF KURON APPLICATIONS - 1957

Name of lake or pond	Kuron applied p.p.m.	pH	Tot.alk. p.p.m.	Temp.	Dominant weed species	Degree of Control
Taylor Pond	1.0	7.2	13.0	86°	Heteranthera dubia	Complete
Mohawk Lake	1.0	8.4	82.0	78°	Anacharis canadensis Potamogeton crispus Typha latifolia Scirpus americanus Sparganium sp. Lemna minor Nuphar variegatum	Excellent control of s mergents, no control o emergents except those individual plants whic came in contact with s
Bell Lake	3.5	8.3	105.0	68°	Anacharis canadensis Nuphar variegatum	Excellent control of b species
Ludlum Lake	2.5 (plot)	6.4	14.0	81°	Eriocaulon septangulare Myriophyllum heterophyllum Vallisneria americana	Excellent control Reinfestation
Cape May Park Pond	3.0	6.[illegible]	12.0	79°	Nymphaea odorata Potamogeton sp. Anacharis canadensis Utricularia purpurea	Excellent control
Barker Pond	0.5	7.3	6.0	78°	Myriophyllum heterophyllum	In doubt. Pond was pre ly treated with sodium arsenite
Applegate Pond	0.5	7.0	27.0	80°	Nymphaea odorata Potamogeton sp. Vallisneria americana Cabomba caroliniana Myriophyllum heterophyllum	Only species affected water lily

Table II Cont.

omb Pond	2.C	6.7	12.0	81°	Myriophyllum heter›phyllum Nuphar variegatum Scirpus sp.	Excellent control
Lake	0.5-plot #1 0.1-plot #2 2.0-plot #3	5.4	53.0	80°	Nuphar variegatum Cabomba caroliniana Myriophyllum Lemna minor Anacharis canadensis	Plot #1 only Nuphar. Plot „2 and Plot #3 good control. No control of Lemna
wick Col- y Lake	2.5	5.6	2.0	78°	Utricularia purpurea Nymphaea odorata Potamogeton sp.	Excellent control except for Potamogeton
ther Lake	2.5	8.8	103.0	74°	Myriophyllum heterophyllum	Excellent control
Wayway- da Lake	2.0	8.8	107.0	76°	Nymphaea odorata Myriophyllum heteroɔnyllum	Excellent control
Dowell ond	2.C	6.8	76.0	80°	Scirpus americanus Potamogeton sp.	Only Scirpus was controlled

The Effect of the Weedicide Kuron upon the Flora and Fauna of Two Experimental Areas of Long Pond, Dutchess County, N.Y.

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The purpose of this paper was to attempt to discover what happens to the plankton and benthic organisms, as well as to the weeds, when a modern weedicide such as Kuron is sprayed over a limited area of a pond. This study was confined to two small experimental plots and one control plot on the shore of Long Pond, which is located in Schultzville, Dutchess County, N. Y. The conditions studied were temperature, pH, dissolved O_2 in ppm, plankton and benthic organisms, and aquatic weeds. The dates during which the studies were made were May 9 - October 1, 1957.

I wish to thank Mr. F. J. Carberry of Poughkeepsie, on whose land the work was done, for his interest and co-operation. Mr. John Gould of the New York State Department of Conservation also deserves thanks, not only for supplying the Kuron (given by the Dow Chemical Co.) and the pump used in spraying, but also for his continued encouragement and suggestions. Dr. Robert McIntosh of the Plant Science Department of Vassar College very willingly identified the aquatic weeds. To the many students and friends who gave of their time in the humble roles of oarsmen, sorters, and recorders, I certainly extend my most grateful appreciation.

Long Pond, about a mile long and in the shape of a pair of spectacles, is a very shallow pond. With the exception of one depression, the depth of water is not more than 10-12 feet, and for the most part is only 5-6 feet. The outstanding characteristic of the pond is a broad border of aquatic weeds which literally chokes the area from the margin of the pond 150 feet toward the center. These weeds are of the submerged, floating, and emergent types, and are very abundant. The substrate of the pond is very soft mud of at least 8-10 feet depth, mixed with partly decaying vegetation. Many fishermen rowing by in the narrow passages still open for navigation, rightly indicate that Long Pond is considered a "good fishing" pond.

No precise quantitative study of chemical or biological factors was even attempted in this experiment. Furthermore, since time has not yet permitted a careful analysis of data, this short paper is considered to be more of a progress report than one of final interpretations and conclusions. A more detailed and extensive paper, describing more of the interesting ecological data will appear later.

Two experimental plots were staked out in early May. Each one ran 50 feet along the shore and 100 feet out into the pond. The control plot, 100 x 100 feet, was located between these experimental plots which were then designated as North and South. The depth of water in these areas did not exceed 6 feet. In the

North plot some clearing of aquatic weeds had been carried out previously, but in the South and Control plots no clearing had ever been attempted.

Since these experiments had to be carried out by one person, they were set up very simply with the idea that it was better to try to do a little, and to do it consistently and well, than to attempt the impossible and have to retreat.

The first sampling was done May 9-15. This set the pattern for the following ones which were carried out June 9, immediately after the first spraying, June 30, immediately after the second spraying, July 17, and October 1. The routine was simple. In each quadrant of the North and South plots temperature was recorded with a maximum-minimum thermometer; a water sample was taken with a Kemmerer Bottle, and two dredges were made with an Eckman dredge for the benthic forms. Plankton samples were standardized as much as possible by hauling the standard net for three lengths of each plot. The control plot was sampled as near the center line as possible, in two areas. One sample was taken nearer the shore within the 1-50 foot band, the other nearer the center of the pond within the 50-100 foot band. The dredges were carefully sieved through ordinary window screening and the animals identified, counted, and recorded in the field. Immediately upon returning to the laboratory the plankton was studied and the determinations of pH and O_2 in ppm were made by use of the Hellige Testing Apparatus.

The experimental plots were sprayed twice, the first time on June 8, the second on June 29. The weedicide used was Kuron, a herbaceous weed killer with the formula, 2-(2,4,5, trichlorophenoxy) propionic acid, manufactured by the Dow Chemical Co. It was applied from the boat with an ordinary hand-pump. Since the concentrations used in the first spraying, 8 oz/ North plot and 16 oz/ South plot, proved too dilute, the concentration for the second spraying was increased to 24 oz./ 3 gallons of water/ per plot. Expressed in other words this concentration becomes roughly one and one-half gallons of Kuron per acre of surface. After each spraying copious notes were made for several consecutive days and many kodachromes taken to record the visible changes occurring on the surface of the water.

Before any spraying was done, a careful map of the pondweeds, submerged, floating, and emergent was made. This revealed that the commonest submerged plants were *Utricularia purpurea* and several species of *Potamogeton*. The most abundant floating plant was *Nymphaea odorata*, the white water lily. Of the emergent group, *Pontederia cordata* was the only common representative. Close to the margin of the shore, especially in the early summer, was a tangled mass of filamentous algae, *Ceratophyllum demersum*, and *Chara fragilis*.

Since the South plot proved the better experimental area, Results were similar in both North and South, but the more obvious and more intense reactions were better seen in the South plot where no clearing had ever before been attempted.

The most striking result of the application of Kuron to the pond was the rapid acceleration of the growth of the stems of the white pond lily. Within three days the stems elongated so that they arched several inches above the surface, the leaves were overturned, and the exposed stems and under side of the leaves gave a general rosy hue to the entire plot. It appeared as if the level of the lake had suddenly fallen by several inches. The elongated petioles became weak, usually near the rizomes, soon broke off from these underground structures, and within a week active decomposition of both leaves and petioles had set in. Since the first spraying did not clear the lily pads as completely as desired, a second spraying was tried after three weeks. This second attack, following closely upon the first, proved very effective. Six weeks later, the surface was relatively clear of lily pads, and by nine weeks almost completely so.

From the practical point of view, raking or mechanical removal of some sort about ten days to two weeks after spraying would hasten the clearing of the area, and make it more attractive to the summer resident.

Whether this clearance of the lily pads is more than of seasonal duration, it is impossible to say. Although the surface was almost completely clear, new red leaves could be seen shooting up from the rhizomes after six weeks. After nine weeks, however, only a few of these shoots had reached the surface, but since at this time the growing season was slowing down naturally it is difficult to make predictions.

The spraying apparently had no effect upon the submerged pond weeds which flourished continuously. However, the spray did kill very quickly and effectively the emergent pickerel weed.

The summer of 1957 was an exceedingly hot dry period, during which the bottom temperatures of the pond rose from the early reading in May of 68°F, through the high 70's and even to 80°F during the mid-summer weeks, dropping off to 60°F by October 1. The pH remained remarkably constant varying only from 7.3-7.5 for the entire period in all three plots. The dissolved oxygen content varied as expected with the season. In May there were 7.5-8.5 ppm decreasing in June and July to 5.5 ppm, and rising again to 7.5 ppm by October 1. Only once, immediately after the first spraying did the content drop in some quadrants to a disturbing level, 3.5-5.0 ppm, and this occurred also in the control plot.

It was found convenient to arrange the benthic organisms in the following groups: Annelida, mostly leeches; Mollusca, including 7 species of Gastropoda and 1 species of Pelecypoda

(Sphaerium); Amphipoda; Insecta, larvae of mayflies, damselflies, dragonflies, midges, and beetles. Members of these groups were found constantly throughout the entire period of study in both experimental and control plots. The groups showing the most frequent occurrence, that is in number of samples taken, were, Amphipoda, Gastropoda, Pelecypoda, and mayfly larvae. The same groups also showed the largest number of individuals, but in the order Gastropoda, Pelecypoda, Amphipoda, mayfly larvae. The Amphipoda maintained the most constant number of individuals per sample. As might be expected, the insect larvae showed an increase in the weeks of July over the counts of May and June. The seven species of snails also showed larger counts in July than in the preceding months. However, in summarizing it can be said that at no time did any one group drop out or any species show a marked decrease in numbers of individuals.

Exact counts upon the large aquatic vertebrates were not taken, but observations were made and recorded at the time that other work was being conducted. Sunfish and pickerel were always present. Green frogs and [illegible] frogs were sitting on the lily pads, while turtles sunned [illegible]lves in shallow areas. Many small fish (1-1 1/2 inches) [illegible]hools of 15 - 30 were regularly seen swimming in the experimenta[illegible] a[illegible]oughout the summer.

It was found convenient to ar[illegible]ankton according to the following large groups; M[illegible]phy[illegible], Chlorophyceae, Desmidaceae, Diatomaceae, Flage[illegible] other Protozoa, Nematoda, Rotifera, Annelida, Crustacea. [illegible] groups represent fifty easily identified and commonly [illegible]ng species as well as many minute forms which were not ide[illegible]d. The occurrence of these ten major groups was very const[illegible] all three plots but individual species within a group m[illegible] disappear and reappear. On the other hand, certain plankte[illegible] notable Ceratium and Dinobryon occurred in every sample. The [illegible]e most frequently taken plankters were Ceratium, Spirogyra, V[illegible]lvox, Daphnia, Tabellaria, Bosmina, Micrasterias, Fragilaria, and Synura. Of these, Ceratium, Dinobryon, Synura, and Bosmina were often present in numbers far exceeding other forms. The remarkable constancy of occurrence of the large groups was most impressive. No quantitative collecting or counting with Sedgewick-Rafter Cells was attempted, and it can b[illegible]ly that the plankton seemed to be continuously abund[illegible]

No precise quant[illegible]ta was recorded for either the benthic or plankton org[illegible]s, nor has detailed analysis been made of the qualitative data. However, it appears that both of these groups maintained their numbers of individuals and variety of species in a pattern paralleling that of the control area. The presence of Kuron appeared to have no ill effects upon these populations.

Summary

The species Nymphaea odorata was of special concern in these experiments.

2. Two experimental plots (50 x 100 feet) and one control (100 x 100 feet) were selected along the shore. The control was located between the experimental plots.

3. Preliminary study of the following conditions in these three plots was made in early May 1957; temperature, pH, O_2 in ppm, plankton, benthic organisms, large aquatic vertebrates, and aquatic plants. This routine was repeated at intervals namely, June 9, June 30, July 17, October 1, 1957.

4. The experimental plots were twice sprayed with Kuron, an herbaceous weed killer. The dates of the spraying were June 8 and June 29. The effective concentration proved to be roughly 1 1/2 gallons per acre.

5. The effect of the Kuron was to accelerate the growth of the stems of Nymphaea within a few days, after which they became weakened, broke off, and both stems and leaves died. After 4 weeks the surface of the water was fairly well cleared of lily pads; after 6 weeks better cleared, and after 9 weeks almost completely cleared.

6. After 6 weeks, new shoots began to appear from the rhizomes, but these were not as numerous as the original leaves. After 9 weeks some of these reached the surface.

7. The Kuron did not appear to weaken or kill any of the submerged weeds.

8. The temperature of the bottom water of the pond varied from 68°F in May to 78°F during July and returned to 60°F in October.

9. The pH was very constant, varying only from 7.3 - 7.5.

10. The dissolved oxygen content varied from 8 ppm in May to 5.5 ppm in June and July, returning to 7.5 ppm in October.

11. Plankton was constantly represented by the following groups: Myxophyceae, Chlorophyceae, Flagellata, Rotifera, Annelida, Crustacea. Usually several species were present within each group, but not necessarily the same species at all times.

12. Benthic forms were represented constantly and by greater numbers of individuals in the following groups; Gastropoda, Pelecypoda, Amphipoda, and Mayflies. They were represented irregularly and in smaller numbers of individuals by Annelida, Odonata, and Diptera.

13. Although precise quantitative studies were not carried out, it appears that both plankton and benthic organisms maintained

their number of individuals and variety of species in a normal pattern for the pond.

14. The large aquatic vertebrates, fish, frogs, and turtles, were constantly present. Many small schools of small (probably young) fish were regularly seen swimming in the experimental plots.

15. At present, on the basis of data obtained and studied, the only change resulting from the application of Kuron was the destruction of the water lily.

A New Mechanical Technique for Controlling Aquatic Vegetation

By William M. Darden and David R. Talbott

Until now all mechanical means of destroying aquatic vegetation, drag chains, sickle bars, wire dragged between two boats, agitation by boat propellers, hand scythe, etc., have been quite unsatisfactory. It appears that the old hand method, pulling each plant up one by one, has had the best results; but, obviously this method too, is unsatisfactory where any quantity of vegetation grows.

In recent years the chemical method, use of herbicides, of destroying aquatic vegetation has been relegated to the front row. Various types of vegetation call for various types of herbicides but this method too, has been found wanting, and not only from the expense side of the operation. In most instances where chemicals are used conditions have to be perfect before any sort of results can be expected. The weeds have to be the correct size and age, wind has to be non-existent, there can be no percipitation of aqueous vapors, there can be no sea running, and usually the poison has to be in solution. In many instances an oil solution would be the best but for obvious reasons cannot be used. However, the use of herbicides has met with some success but more success is necessary unless we want to wave good-bye to many useful and pleasurable waterways.

Most of the aquatic plants we have observed in the Chesapeake Bay area consist mainly of a stem with an extensive branch system. The part of the vegetation which holds the stem and branch in one place, the root system, is a rather superficial anchor for such a large body. Our new mechanical technique essentially fights this rather slight root system. Nevertheless, our machine is able to sink a pile to any desired depth or it is also able to cause merely the shifting of the silt or sand in as slight an agitation as desired.

It consists of a motor driven water pump which is connected to a manifold and which in turn is connected to batteries, or banks, of jets. This apparatus may be mounted on any platform that the operator is able to get to the vegetation. For instance, for use in a small pond a rowboat may be used; for use in a large body of water a pontoon barge may be used. For use in small restricted waterways such as canals it may be rigged on a dolly which is attached to the body of a truck.

There is no limit to the depth of water in which our machine is able to operate. Not only are we able to vary the pressure of the water coming from the jets but we can also raise and lower the jets any desired distance. If the jets become entangled with the vegetation we have a mechanical means of clearing them. The jets are able to be rotated around a 360 degree axis which insures an operation of the widest scope. The jets are also the motive power of the barge; with four batteries of jets we are able to move the barge forward, backward, sideways, in a circle, or have it remain stationary. Once the jets free the root systems of the plants from the bottom of the waterway we have an attachment which will catch the free-floating plants and rake them to the barge, allowing the operator to dispense with the plants as he sees fit.

We do in no way guarantee to be able to rid any waterway of aquatic vegetation forever. We have found that a good many pest aquatic plants are annuals. Therefore we feel the best time to attack these plants is when the plant has just begun to send its shoots forth from the root system, say the last of May or the first of June. If the vegetation is well treated at that time possibly no more attacks on it will be necessary, but as you well know it would be difficult to rid an area of vegetation with one application. Another treatment on the bottom might well come four weeks after the first to insure a fairly well cleaned area. But if more than one treatment were necessary, neither the cost nor the weather conditions would be a deterrent. Our machine may be efficiently operated in all kinds of weather, 12 months of the year. All it needs is an operator.

As we have explained, this machine is to be used as a preventative to the growth of aquatic vegetation rather than a harvester of the vegetation. We feel our machine is able to rid the headwaters of rivers, ponds, and open waterways of any excess vegetation which it is desirable to remove. Upon the advice of our patent attorney we have incorporated many features which we feel make our machine one of the most versatile implements in the aquatic field.

Panel talk given at Aquatics Section,
Northeastern Weed Control Conference,
New York City, January 9, 1958,
By R. H. Stroud, Executive Vice President,
Sport Fishing Institute, Washington, D. C.

THE IMPACT OF WEED CONTROL ON ANGLING

The U. S. is undergoing a gradual warming of its climate over the years. For example, southern marine animals are extending their ranges northward. * In inland waters this is evidenced by a shrinking of cold-water fish habitat, which is correlated with an increase in warm-water fish habitat.

An associated phenomenon is an apparent increase in the quantity of water weeds present in inland recreational waters. More and more attention is being focused on the problem, as the presence of this gathering attests.

To combat it very few funds are being spent on research. Yet a great many dollars, relatively, are being spent on chemicals to control these weeds to "improve" sport fishing!

The foregoing brief summary serves to sketch the aquatic weed picture in relation to sport fishing. It may be an oversimplification. But it is with reference to this outline, and within its implied limitations, that I wish to frame my remarks.

Specifically, then, I shall confine my comment to inland warm-water situations. I wish to note, however, that many of the generalities apply equally to cold-water habitats.

How much fishing water?

Various estimates have been made of the total area of inland fishing waters available to U. S. anglers. Based on rudimentary data of the U. S. Bureau of the Census officials of the U. S. Fish and Wildlife Service have suggested that the total may be somewhere near 35,000,000 acres. Direct consultation with some Bureau officials, however, leads to the conclusion that little reliance may be placed on the estimate. Another approach, perhaps equally tenuous, may be made.

The National Survey of Fishing and Hunting, conducted in 1956 by Crossley, S-D Surveys, Inc. (New York), revealed that 21,000,000 people spent about 400,000,000 days "out fishing" in 1955. Of these, some 339,000,000 days were devoted to recreational fishing on inland

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* Taylor, C. C., H. B. Bigelow and H. W. Graham. 1957. Climatic trends and the distribution of marine animals in New England. Fishery Bulletin 115, U. S. Fish and Wildlife Service, Washington, D. C.

waters.

If there were an average of 5 fishing trips per acre of water the country over, it would seem to follow that we are blessed with about 67,000,000 acres of water. If the average fishing pressure was 7 trips per acre, the figure is 48,000,000, etc.

Only a few data on water area are documented. For example, some 13 million acres of water are included in large and small artificial impoundments. Another 1¼ million acres represent farm fish ponds. Nationally, that's about as detailed as we can get.

Comparatively few states have sound appraisals of available surface water within their boundaries. It is encouraging, however, to find that most states are now bending to the task of securing such data.

For the Bureau of Census' estimate to be at all close, fishing pressure would necessarily have averaged about 10 trips per acre -- assuming that the Crossley Survey findings are valid. Most fishery biologists believe that 10 trips per acre is too high for the U. S. as a whole.

It may be several years until we have a firm inventory of our surface water resources. Nevertheless, it is obvious that proper management of the nation's fishing waters presents its inherent problems on a formidable scale.

<u>Importance of sport fishing</u>

Why is this important? Because it will provide an inventory of the basic resource needed to sustain America's most popular means of outdoor recreation -- either as individuals or in family groups -- that of sport fishing. Including children of all ages, about 25 million U. S. citizens depend upon angling for their relaxation. About three-fourths of the total depend upon inland waters.

Nationally, too, sport fishing provides a $2 billions annual shot-in-the-arm to the national economy. Again, inland fishing contributes about three-fourths to the total.

Obviously, excess aquatic weeds that interfere with recreational fishing have an important social and economic impact. In this discussion, however, we must confine ourselves solely to economic aspects. These, of course, derive from the social impact.

<u>Nature of weed problem</u>

I have not even a crude idea as to the number of acres of water adversely affected by excess weeds. I do <u>not</u> know how much water is effectively removed from use by anglers due to overwhelming mechanical interference by weed growths with fishing activities (including boat handling).

This is one extreme that must be considered and where we can all agree that a weed problem exists. Obviously, if a body of water is so choked with weeds that hooks and lines are perpetually tangled in aquatic growths, or boats cannot be properly propelled owing to physical resistance and weed entanglement, fishing is hardly possible.

A 1945 fishery survey of 74-acre Sandy Pond in Ayer, Massachusetts, found that aquatic vegetation was too dense to allow satisfactory fishing. Weed control was recommended at the time. The recommendation was carried out commencing in 1950, by means of a three-year fertilization program. As a result of the fertilization treatment, submerged aquatics (principally <u>Myriophyllum</u>) were effectively reduced, thereby converting Sandy Pond to an important multiple-use recreational lake. *

<u>$40 per acre too costly</u>

Costs of treatment including labor averaged a little under $40 per acre per year. This proved too costly to be financed indefinitely by the state fishery agency. However, local interests realized enough recreational benefit to continue the treatment at local expense after withdrawal of the state.

At the time, for Massachusetts, a rough estimate of the cost of treating and maintaining some 25,000 acres (for weed control through fertilization), thought to have sufficiently troublesome weed problems to warrant attention, came to one million dollars! This amount about equalled the state's entire annual fish and game budget for all activities at the time!

Such costs are too high for weed control to be undertaken out of fish and game budgets alone regardless of the benefits. With fertilization, however, there are often substantial added benefits for warm-water fishing. This is especially true in artificial impoundments in water-scarce regions of low fertility.

Added benefits are realized from increased fish production --double or even greater in many instances. So, costs assignable to weed control itself may be reduced to some $10 to $20 per acre per year.

But, this is still too high for any statewide program if it must be financed from conventional sources of revenue.

<u>Costs become feasible with intensive use</u>

Experience in Alabama state-owned public fishing lakes has demonstrated that such costs are feasible only if fishing is good -- and

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* Stroud, R. H. 1955. Fisheries report for some central, eastern, and western Massachusetts lakes, ponds, and reservoirs, 1951-1952. Mass. Div. of Fish & Game, Boston.

relatively scarce in relation to demand. In that state 17 such lakes comprising over 2,100 acres have been constructed and are currently under intensive management. The largest lake is 1,000 acres.

Management includes fertilization (for fish production and general weed control), additional specific weed control, fish population manipulation, occasional renovation, and restocking, and maintenance, a caretaker at each lake.

In the 1955-56 fiscal year, 15 of the lakes provided an average of 121 fishing trips (angler-days) per acre, and a harvest per acre of 472 fish weighing 143.4 pounds. That's 4 fish weighing 1-1/5 pounds per angler per trip (about 1 fish per hour).

This is satisfactory fishing judging by its continuing popularity over several years. Anglers pay daily fees of 50 cents each in addition to the regular state or county fishing license in order to participate. The daily fees are the source of the funds for all maintenance activities, as described above.

<u>An upper limit of potential</u>

The National Survey of Fishing and Hunting showed that anglers spend about $5 daily on the average to go fishing. Alabama has shown that intensively-managed waters have a potential to support at least 100 fishing trips (angler-days) per acre annually.

Using these figures, it would appear that each acre of well-managed fishing water has a potential to generate $500 in business activity each year. Assuming a 4 per cent interest rate, the capital value of such waters may be calculated to be $12,500.

A 100-acre lake can generate $50,000 in annual business. On this basis it has a capital value of $1¼ millions! It is apparent from an economic point of view that considerable annual investment would be justified to bring this about.

Excess aquatic weed growths are one among several factors that could destroy or limit this potential.

<u>The current picture</u>

In actual fact, it seems unlikely that much over one-twentieth of this potential annual revenue is being realized nationally per acre of fishing water. At our current guess of 5 fishing trips only about $25 of business activity is being generated by angling per acre of water.

As a guess it is my current opinion that weed control costs will be excessive if they exceed about $2.50 per surface acre for widespread application in fish management. (I make an important exception to this generalization where suitable daily fees for fishing apply to the waters in question to produce substantial revenues needed for intensive management.) It may be worthwhile developing this line of thought a bit.

No doubt most waters could support 10 to 25 angler-days of fishing per acre with one-shot, intermittent, or no management as is most generally practiced today. The species involved would serve to influence the sustainable level of fishing, of course, as would watershed fertility and a number of other variables.

Nevertheless, this gives us a crude measure of values under these conditions. Within today's limited management capabilities, fishing on many waters can be expected to generate \$50 to \$125 of business values per acre. These are the expenditures that we might reasonably expect anglers to make for necessary goods and services in our lifetimes at least.

As we have outlined, ultimate potential, with improved management on an intensive scale, could easily serve to quadruple this potential on any water. Though far in the future, at least \$500 of business activity seems realizable from each acre of fishing water with full use.

Whether under present conditions or in the much crowded future, here is a means of suggesting practical limitations to management expenditures. All costs of management, including administration and research, should be within the calculable values of business activity generated by use of the water in question.

There are at least 10 major activities that may be active in fishery programs at any one time (administration, research, raising fertility, weed control, fish population manipulation, renovation, stocking and restocking, physical maintenance of structures and grounds, creel census, enforcement, etc.). If 10 per cent of the total costs of individual project operations are charged arbitrarily to each, in a sense we have developed a rough "rule of thumb."

On this basis, for a fishery having an annual value of \$25 per acre, we may be justified in spending up to \$2.50 per acre for weed control where excess weeds are a problem. On a volume basis, in lakes averaging 5 feet deep, this works out to 50 cents per acre-foot of water. If 10 feet is the average depth, the price tag is 25 cents per acre-foot.

These costs may be compared to approximately \$1.50 per acre-foot for chemical renovation of fish populations. At this rate pond reclamation has proved entirely feasible for widespread incorporation into fishery programs. By the end of 1957, for example, nearly 200,000 acres of water had been so renovated in 47 states, Alaska, and two

Canadian provinces. * Moreover, experience shows that renovation costs may be pro-rated over a useful base of at least five year's duration.

Thus, average annual costs are 30 cents or less per acre-foot of water treated. Chemical control of aquatic weeds on the other hand requires annual expenditures for maintenance. Therefore, 30 cents may be compared to our guess of 25 to 50 cents for weed control. Such costs are economically feasible in relation to current fishery revenues and budgets. Greater costs may not be.

Fishing jeopardized by poisons

At the same time, the method of weed control employed must not be such as to materially damage fish production. To do otherwise is to kill the goose that lays the golden eggs.

For example, sodium arsenite is possibly the most popular chemical being employed for control of submerged aquatics. It is reasonably cheap, reasonably effective, and readily applied. Yet, recent work has indicated that use of this chemical in experimental ponds reduced production of certain sport fishes 17 to 65 per cent! **

These findings indicate need for much caution in employing this chemical even in moderately low concentrations. It may be argued that it is better to use it and realize recreational gains despite harm to fish populations that are otherwise unavailable. Perhaps there is merit in this view in some extreme circumstances.

The problem generally, however, is to meet increasing fishing pressures. This cannot be done satisfactorily on a large scale by reducing fish production! Because of this, coupled with failure by industry to make substantial funds available for needed research, an entirely new approach to weed control may have become necessary.

This is to investigate the virtually unexplored subject of possible biological controls. The Sport Fishing Institute, for example, is cooperating with the Farm Ponds Laboratory at Alabama Polytechnic Institute, at Auburn, to finance research along these lines. Preliminary findings suggest that this may prove to be a fruitful line of attack. Already, for example, printed observations suggest that Tilapia may be of some use in warm climates in controlling at least one troublesome alga that has defied chemical control -- and with added benefits to fishing as well. The research has only just begun and is continuing.

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* Stroud, R. H. and E. A. Seaman. 1957. Fish Conservation Highlights of 1956; and Stroud, R. H. 1957. BULLETIN, Sport Fishing Institute, Washington, D. C.

** Lawrence, J. M. 1957. Recent investigations on the use of sodium arsenite as an algacide and its effects on fish production in ponds. Alabama Polytechnic Institute, Auburn. Mimeo.

Financing needed research

Further research may turn up means of offsetting the harmful effects observed from some chemicals. Or it may be possible to discover better means of weed control.

What is needed is greatly increased research effort. It would appear logical for the chemical companies in the business of selling weed killers to make substantial investments in research in aquatic plant ecology.

They should also finance a search for organic compounds to replace poisonous inorganic compounds. Such research should be regarded as part of the necessary costs of doing business.

A possible alternative to voluntary action in this field suggests itself, modelled after the D-J program. A substantial manufacturers excise tax on the "weed-killers" -- with proceeds earmarked for research -- would be one possible means of raising the needed revenues.

THE SIGNIFICANCE OF WEED CONTROL TO A PRACTICAL STATE FISHERIES POLICY

Jay Harmic, Delaware Board of Game and Fish Commissioners, Dover.

Aquatic weed control is an essential fisheries management practice in any progressive state fish and game program today. Its economical and recreational implications have already been demonstrated in many of our northeastern states and in other sections of our country as well. In this paper stress will be placed on the importance of the role of such a program by the state agency rather than the detailed and specific materials, methods or applications. The latter can much better be worked out in the field.

One idea we can certainly all agree on from the start is that at the present time our weed control, effectively carried out, is expensive and is not, by any stretch of the imagination, permanent. The policy of state fisheries departments is necessarily restricted by the two primary factors - time and money - and they often must limit their research and development, at least to the realm of problems concerning the sportsmen, who are actually paying the bill by taxes and license fees. If this group doesn't stand to benefit then the program should be carried out by some other agency or fisheries agencies should be provided with general funds for the work.

Fifteen years ago the aquatic weed problems were apparently not considered serious. Careful searching through previous annual reports of expenditures of various game and fish commissions fails to show where any time, effort, or monies were allocated for this type of work. We can easily pick out a few good reasons why this was the case. Recreationwise, the relatively fewer number of sportsmen 15 or 20 years ago had more choice in picking the location for their particular interests. The post-war years brought about a considerable increase in the numbers of fishermen and furnished an impetus to the development of possible weed control chemicals. Hence, the general prosperity of the era necessitated a renewal of policy to supply better fishing to more people in the ever diminishing waters. Federal Aid to state fisheries programs, Dingell-Johnson funds, provided additional revenue which made possible the hiring of additional technical personnel qualified to cope with the problem. This has helped open the door to a new fisheries management technique - a phase of habitat improvement.

Day by day there are additional demands being placed on our valuable surface waters supplies. Sporting interests at national, state and local levels realize they must have a voice in water legislation and allocations. They are insisting, and rightly so, that recreation be given a high priority in the planned use of waters, especially where the primary interests in those waters have been recreational. However, in order to obtain and keep such priorities it must be shown that these waters are being managed in the best public interests. Weed choked, silty lakes are therefore in danger of being lost to other interests if the most effective steps are not taken to improve them and to maintain optimum fishing conditions. Successful weed control strengthens the case for the proponents of recreational use of water.

It is clearly indicated from meetings such as this that the problem is presently receiving considerable emphasis. Extensive weed control work, both successful and unsuccessful, has been done throughout the country. Various methods and products have been tested, and there has been an almost universal agreement indicating a greater success and a lower cost by the chemical method of eradication. We can attribute a considerable portion of the success, that we have had up to now, to close cooperation between the personnel of the chemical companies and the research and development men of the public agencies. This joint effort is essential. Fisheries people cannot expect chemical companies to do the actual field testing. The chemist has the ability to formulate products, and he knows their chemical limitations. The fisheries man understands the biology and the degree of control necessary for an effective solution to his particular fisheries problem. To reiterate, laboratory and field work must be a united effort.

We are continually hoping that improved weed control chemicals will be developed that are safe, inexpensive and more lasting in their effects. Fisheries field men are constantly looking for better methods and more adequate tools for application. Special aquatic consultants are advising and assisting private fishing clubs on aquatic weed control. Others, especially the small farm pond owners, are seeking technical assistance from the State Game and Fish Commissions and from the Soil Conservation Service. With all this interest and activity there is bound to be improvement.

State fisheries divisions should no longer need to defend relatively large initial outlays of funds if fishing is to be improved. There is a continual increasing demand by more and more fishermen for suitable fishing areas, and it is our business to take full advantage of the available potential. It has been difficult to measure the comparable productivity of weedy and clear ponds, but generally, according to creel census, more and bigger fish are caught more frequently in ponds free of algae and rooted vegetation. This is convincing proof of the detriment of aquatic weeds. Weed filled lakes are wasted waters from the standpoint of the fisherman. This is indeed an important economic aspect of a fish and game policy.

We know that excessive weed growth and continued build-up of the bottom detritus which is complimented by the increased deposition of silt was a deciding factor in washing out many pond sites. For example, it is now currently costing Delaware more than $2,000 an acre to impound this water again.

Of course clean ponds have considerable value to other recreational interests. Boating, swimming and varied water sports are dependent upon water without weeds. The demand for these types of recreation has also been increasing at tremendous rates and we expect it will continue to do so. It is understood that fishing and other water sports are closely related, and management practices to improve the waters for fishing frequently have far reaching effects on many other recreational uses.

The value of shoreline property on lakes which are free from weedy vegetation is considerably higher than those lands surrounding unimproved waters. This economic improvement has far reaching benefits and should be given definite consideration. These improved areas have been known to trigger an organized community recreational program.

Progressive fish and game commissions should recognize the value of participation in weed control not only in fisheries but in game management as well. Although there is considerable promise of improving wildlife habitat by simple chemical openings in dense stands of weeds, the most promising is in the field of marsh aquatics. Here undesirable vegetation is eliminated and replaced by open water or desirable food plants for waterfowl and fur-bearers. A tremendous amount of good work has already been done in this field, spearheaded by U. S. Fish and Wildlife Service in cooperation with chemical companies and several state conservation agencies.

The outlook for the future is certainly bright. I believe that we can look forward to continual investigative activity in the attempt to obtain better chemicals and better application methods. It is very probable that more agencies will recognize the desirability of increasing their appropriations for weed control. It is probable that there will be a search for better mechanical methods of weed elimination. Dredging is one possibility which will bear some investigation. Portable-type dredges could serve a dual purpose especially in the shallow silted coastal plain ponds where increased depth could be obtained and the weeds eliminated at the same time. Costs of this are probably still out of reach, but as the actual dollar value of fishing and recreation continues to grow it may soon be economically possible.

So it becomes more apparent that fish and game department policy should include provisions for weed control. Several states have recently indicated that their most serious fisheries problem is concerned with aquatic weeds; these will continue to grow and spread until something is done about them. We need to get on the offensive now in order to improve and to preserve fresh water recreational values threatened by excessive weed growth.

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Jay L. Harmic
December - 1957

PROFIT AND LOSS WITH AQUATIC WEEDS

Mark G. Wiltse
The Dow Chemical Company

Nature abhors a vacuum on land or in water. Where it is possible for plant life to grow, plants will rapidly invade. In water covered areas, nature sets about to change to dry land conditions by a succession of bacteria, algae, submerged plants, emergent plants and low land trees. Man requires bodies of water or water conducting canals or ditches to maintain his way of life. To maintain these water systems, it is often necessary to stabilize the aquatic vegetative growth or set back this plant succession.

The problem of aquatic vegetation control is of concern to many facets of our economy. Irrigation and drainage areas encompass large sections of our country. There are some 15,000,000 acres of land in this country that are dependent upon irrigation. Canals and ditches for irrigation total some 140,000 miles. Farm ponds number in the millions with many being built each year. Permanent bodies of water, such as lakes, reservoirs and ponds, that are more than 40 acres in size cover approximately 50,000 square miles in the continental United States without considering the Great Lakes, Gulf of Mexico or Long Island Sound. Wildlife marshes and small lakes and ponds are numerous throughout the country and are adversely affected by aquatic vegetation.

Aquatic plants may be objectionable in these areas by interfering with their use for recreational purposes such as hunting, fishing, boating, water skiing and swimming. Weeds may also impede the flow of water in ditches, canals, etc., and cause silting and wasteful water loss. The water hyacinth impedes water flow by as much as 50 percent in some southern states. There are many other ways in which aquatic plants may become a nuisance which will not be elaborated on here.

Some workers have attampted to divide the aquatic weeds into groups for easier discussion.

1. Emergent weeds are bottom rooted and their leaves extend above the surface of the water.

2. Floating weeds are free floating and are not bottom rooted.

3. Submersed weeds are bottom rooted but do not normally project above the surface of the water.

4. "Scums" consist of algae growth.

Mechanical control of aquatic weeds is practical in many instances; however, it is generally quite expensive and has a high labor requirement except under special conditions. In recent years, chemical control has shown the most promise for the economical control of many aquatic weeds. Many of the emergent weeds can now be controlled with known herbicides, such as 2,4-D, dalapon and aromatic oils. 2,4-D is also effective on some of the floating weeds. Copper sulphate has been used as an algaecide for many years in certain situations. In the past, the submersed aquatic weeds have generally been controlled with sodium arsenite and the chlorinated benzenes. There are certain limitations to the use of these chemicals for the control of algae and submerged weeds which instigated a search for new products.

In the search for new algaecides and herbicides to control submersed aquatic weeds, we have several factors to consider which complicates the problem. We would like to obtain a chemical that is easy to use and is relatively non-toxic to fish or mammals. It should have a broad spectrum of activity on aquatic weeds and be economical to use. These new products should not impart an off flavor in fish or affect water quality. In addition, the herbicidal activity should not be influenced by varying salt content, acidity, water temperatures, depths or organic matter content. These standards make the discovery of new products a laborious and costly project.

Terrestrial herbicides have been tested for the control of aquatic weeds in the past. Some workers have been critical of this procedure; however, recently some success has been obtained as Kuron*, containing the chemical known as silvex, has shown promise for the control of some submersed weeds. In reality, if some of these terrestrial herbicides now available could be used they would probably be more economical to use. The cost of a new product will have to include some or all of the expenses of discovering and developing a new herbicide similar to those outlined below:

Item	Thousands of Dollars
Synthesizing and Screening	70
Patent Costs	8
Field Testing	475
Pilot Plant	50
Analytical Methods	130
Residue and Flavor Studies	335
Toxicology Studies	75
Formulation, Corrosion and Packaging Studies	125
Registration, Legal, Misc.	100
TOTAL	1,368

* Trademark of The Dow Chemical Company

These figures represent the expense in discovering and developing an average new product and perhaps an aquatic herbicide would be even more expensive.

To protect the public from contamination of their water supplies, some states have regulations against the use of any chemical in water that has not been approved by their state agency. To sell a new aquatic herbicide in some of these states would require additional efforts to obtain approval for its use.

To justify the expenditure of this money, industry must have a product that is useful in a market with sufficient volume to return the stockholders a fair return on their investment. Patent coverage on the product is important in realizing such a return.

In some sections of the aquatic weed control market, the cost per acre foot is of little concern but in other sections, it is the controlling factor. A new product will have to be competitive on the cost per acre basis with the method now used or offer advantages which would offset the price differential to be acceptable.

The problems involved in developing a new aquatic herbicide are numerous but very challenging. The chemical industry accepts the challenge, and, with the cooperation of the public agencies, looks forward to success in helping to improve our water and wildlife resources which are becoming increasingly important in our American economy.

Aspects of Commercial Application of Aquatic Weedecides

by
John S. Grim
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A person professionally engaged in the application of aquatic weedecides must be primarily concerned with the cost of his operation. Like other businesses, these costs may be broken down into various subdivisions such as application costs, cost of materials, labor, overhead items, etc.

Rather than go into all the costs characteristic of a spray business (that would be similar to the costs of any other business) it would seem more appropriate to consider only items peculiar to an aquatic spray business. And since an aquatic weedecide is at least one item to which this conference is dedicated, it will serve as a limiting topic for this discussion.

Aquatic weedecides can be classified into two main categories: those that are toxic to people and animals as well as to plants and those that are non-toxic. Purely on a basis of their inherent dangers, of course, the non-toxic materials would be preferable. However, there are other factors to consider when choosing an aquatic weedecide. The efficiency of the weedecide, how specific it is in its action, and how its use affects the cost of application are important points to measure.

Application costs for highly toxic materials (toxic to animals) are higher than they are for many non-toxic materials. There are two main reasons for this:

1. It is more costly to handle toxic materials. The expense is incurred because more time is spent on tne job. Greater care must be taken when spraying, and all equipment must be thoroughly cleaned after each job. When I clean up after a job where sodium arsenite has been used, it means scrubbing and spraying the boat with clear water before taking it off the la ke. All pumps and machinery are given the same treatment as are the small tools. The danger of poisoning exists to a greater degree off the job tha n it does on the job. This is true because one is not alert to t he prescence of a toxic substance when he is not engaged in the process of applying it. It is for this reason that such care is taken to clean the equipment. Cleaning is an added labor item and increases costs.

The process of obtaining exact knowledge of the bottom contour of a pond, as well as of the surface area, and estimating the job cost, means obtaining additional information oneself. It entails making a special trip to the pondsite to map and sound the lake. This is a high, unproductive labor item. On an estimate I just recently made for a job scheduled next year, one and one-half man-days were spent sounding and calculating the volume of the lake. This cost will have to be covered in the cost of the job. A simple estimate of the surface acreage could have been done in a third of the time.

Time spent in estimating jobs up for bid must be prorated to all other jobs if the bid is not accepted. Therefore, it can be seen that the less time there is spent in estimating, the greater will be ones profit.

It is also an advantage when talking to a prospective client to be able to visually estimate the area involved in a weed job, and give him an on the spot estimate or a calculated estimate soon after seeing the pond. The time factor envolved in making quick estimates also enables one to cover more territory in a given time. This too means money in the pocket of the contractor.

It can be seen from the foregoing discussion, that the perfect toxicant for the person involved in eradicating aquatic weeds is a material which can be applied on an acreage basis to kill both submerged and emergent weeds simultaneously. This, of course, means changes from the present methods of formulating aquatic weedecides. If the producers of aquatic weedecides are doing any research, it is hoped that these items will be considered as they seek to improve the performance of old materials and develope new ones.

2. Liability insurance is an item which increases tremendously with the use of a toxic material.

If the cost of a non-toxic weedecide, however, is considerably higher in price than a toxic material, one must compare its value in rela tion to the applied cost of the toxic substitute. If one is in business, he may be forced to use a poisonous weedecide because the non-poisonous material is much to high in price.

Another item of economic significance is the amount of selectivity shown by a weedecide, regardless of its toxicity to animal life. Where water weeds are present to the extent of b eing obnoxious, there is quite often more than one species and type of weed involved. The job of choosing a suitable weedecide is relatively simple if the weeds all belong to one species or habitat group. If two types are present, such as submerged and emergent weeds, one material may not be used as effectively on both as on either single type. In that case two differe nt toxicants would be needed. Let me give you an example:

On one job done this past season, a charge of $500.00 was made. Emergent and submerged weeds were growing in profusion. The following species were included: bladderwort (Utricularia); broa-leaved pond weed (Potamogeton amplifolius); Potamogeton robinsii; coontail (Ceratophyllum sp.); water buttercup (Ranunculus sp.); water sheild (Brasenia); white water lily (Nymphaea); yellow cow lily (Nupha r); and pickerel weed (Pontederia).

An application of sodium arsenite was made and followed in one week by a treatment with the combination 2,4-D and 2,4,5-T. All the submerged weeds were killed by the sodium arsenite and many of the yellow cow lilies were also killed. It was necessa ry to use the 2,4-D and 2,4,5-T to eliminate the remainder of the emergent weeds. If the job could have been done with a single spray, the charges would not have been over $350.00 at the most.

Such situations are not too difficult to handle when the jobs are close to the home base. However, it is exceptionally expensive to make applica tions for the eradication of two types of weed growths when jobs are far away, because of the travel time and time consumed in setting up the equipment at each visit.

Another item indirectly affecting the cost of a job is estima ting dosages. It would be very desirable if dosages of all aquatic weed control materials could be made on an area basis instead of a volume basis. Calculating dosages and amounts of ma terial to be used can present a problem to the contractor, when that dosage is dependent upon the volume of water.

THE VALUE OF A WEED CONTROL PROGRAM TO A LAKESIDE COMMUNITY

Samuel Metzgar, Jr.

Deal Lake, located in Monmouth County, New Jersey, comprises an area of 158 acres. The maximum depth of the Lake is approximately 10', the mean depth approximately 5', and the elevation 8', and there is approximately 40,000,000 cubic feet of water.

The Lake is surrounded by five Municipalities, Asbury Park, Allenhurst, Interlaken, Township of Ocean and Deal.

For many years the Lake was entirely weed free and the recreational facilities were exceptionally high due to the heavy use of the Lake for boating, fishing and water sports. There were five boat houses situated on the Lake, all of which were very prosperous and canoeing Saturday nights was one of the most popular means of transportation to a famous restaurant known through the State as "Ross Fenton Farms". One could paddle up to the "Ross Fenton Farms" dock any evening and see from twenty to fifty canoes drifting in the water listening to the music of world famous orchestras playing nightly.

In those days the real estate development was just beginning and the value of property was pyramiding due to the fact that the most desirable homes were being built on the water front, not only for permanent all year living but for summer rentals also.

Some years ago, Deal Lake slowly began filling in and the shallow water and weed beds became more and more extensive. Real estate values began to stand still in those areas where the water was shallow and weeds had taken over. Recreational use became more limited and as the weed beds extended, the recreational use finally was restricted to only the deep portion of the Lake.

The five boat houses, two of which had large restaurants, finally closed the restaurants, and they themselves eventually went bankrupt with the exception of one whose business was so restricted that he was attempting to find another business in another County.

Complaints were received by the various Municipalities, not only of the loss of business and recreations, but because of the odor arising from the weeds.

The Municipalities were finally prevailed upon to effect some sort of cure and they arranged with a dredging company to dredge the Lake, which took many months, at a cost of approximately $200,000.

Within two to three years, it was noted that the dredging had done no good as regards the weeds which sprang up, not only in the fingers of the Lake where it was shallow, but also in the deepened part of the Lake.

Complaints were received from various individuals living around the Lake and from others whose recreation was impaired due to the fact that the weeds became so thick, that even the oars on a rowboat would be immersed in weeds so that with each stroke of the oar, progress was impeded. Fishing came to a standstill and public action demanded that something be done immediately.

The Mayors of the five Municipalities met and decided to form a committee on which there would be a representative of each Municipality and a Chairman.

The Chairman for the Control of Deal Lake, as he was known, called a meeting of the committee and for many months gathered information, not only from the United States Department of Agriculture, but from Rutgers University and the New Jersey State Bureau of Navigation and the New Jersey Fish and Game Commission. In addition, the committee also contacted various chemical companies and obtained information which they had gathered, not only in the State of New Jersey, but throughout the United States.

A plan of action was formulated and the committee presented this to the five Municipalities at which time the legal aspects of the plan were considered. Also presented was the pro-rated cost to each Municipality depending upon the amount of frontage each Municipality had on the Lake.

With local newspapers backing up our project and educating the public, we then proceeded to obtain a chemical to be sprayed on the weeds with the assistance of the New Jersey Bureau of Navigation, the New Jersey Fish and Game Commission and the New Jersey Health Department. The chemical used was "ATLAS A" which is a 40% liquid sodium arsenite, containing 4 lbs. of arsenic trioxide per gallon. For the 40,000,000 cubic feet of water, we used 5035 gallons of "ATLAS A" the first year at a cost of $3,724.50; 5170 gallons the second year at a cost of $3,522.30; and 4970 gallons the third year at a cost of $3,368.55.

Our results were phenominal as 70% of the weeds had been controlled within ninety days after the spraying took place in the Spring.

Boats and canoes began to reappear and the local real estate values seemed to be increasing in leaps and bounds, especially summer rentals.

By the end of the second year's spraying, the weeds were 90% under control, public opinion and praise was high for the committee and editorials began to appear in the local papers praising the committee for the action they had taken.

We have now completed the third year of our program of spraying. Boat houses have again appeared and by actual count, there are over two hundred outboard motor boats plying the waters of the lake, fishing, water skiing and pleasure riding.

Other Municipalities near our project have called constantly to congratulate us and ask if we would give them a copy of our program and the work done.

We realize of course, that there will probably be the need for continued treatment of the Lake on a reduced or staggered basis and certain "hot spots" or "build-up areas" will have to be watched continually, so that never again will the weed problem get ahead of us to the extent it did before. Our future program will depend on the results which we will observe in the coming season.

In summary, the committee feels that the small cost, amounting to less than $4,000. a year, has not only been offset by the increased values of real estate but by the increased recreational values gained by hundreds due to this program.

A REPORT ON MYLONE USED AS A SEED BED TREATMENT ON MUCK SOIL

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An experiment involving the use of Mylone (3,5-dimethyltetrahydro - 1,3-5,2 H thiadiazine-2-thione) on muck soils was conducted at the Ontario Agricultural College Research Station, Bradford, Ontario as a co-operative project by the Department of Botany and Department of Horticulture, O. A. C. The experiment was designed primarily to determine the rate required for weed control and the time interval necessary between treatment and seeding. A secondary consideration was the effect of the treatment on onion smut.

On the 10th of June, 1957 an area was prepared for seeding and marked out in three replicates each containing four 10 x 20 foot plots. Mylone was mixed in water and applied with a watering can to the soil surface at rates of 100, 200, and 300 pounds of product per acre. Each plot, including the check, was cultivated to a depth of 4 to 5 inches using a Rotospader. The surface was raked and the entire area watered by sprinkler irrigation for ten hours. Single rows of onions, cabbage, tomatoes, and celery were seeded across all plots on the 19th, 24th, and 27th of June (9, 14, and 17 days after treatment). The weather conditions for the week after treatment are recorded in Table I.

Table I. Weather conditions for week following treatment, Bradford, Ontario.

		Range	Average
Air temperature	Max.	72.5° to 86°F.	79.2°F.
	Min.	42.5° to 55°F.	50.8°F.
Soil temperature	Surface Max.	86 - 112°F.	101°F.
	Min.	42 - 62°F.	53.6°F.
	2" depth Max.	67 - 78°F.	73°F.
	Min.	51 - 62°F.	56°F.
Moisture	.36" of rain on June 13.		

The effect of the treatments on weed population is shown in Table II.

Table II. % ground cover weeds. July 24, 1957.

Treatment	% ground cover			Average
Check	100	100	100	100
100 lb/A	5	2	5	4
200 lb/A	2	2	1	2
300 lb/A	2	2	1	2

Readings taken on July 24th, 45 days after treatment, proved that even the lowest rate was practical as all plots had less than five percent ground cover weeds in comparison with the check. The higher rates had from a trace to two percent on the same basis. The weeds present in the area were purslane (Portulaca oleracea), oak-leaved goosefoot (Chenopodium glaucum), lamb's quarters (Chenopodium album), groundsel (Senecio vulgaris) and red root pigweed (Amaranthus retroflexus). All species were equally susceptible to the treatment.

Onions

Emergence of onion seedlings (var. Autumn Spice) was not affected by the treatment on any of the dates of sowing. The plants on the treated plots were similar to those on the checks for the first part of the growing period but later were slightly taller and growth was better. On the 8th of August counts were made by two independent observers (1) of the incidence of smut on all plots. A sample consisting of all plants on three feet of row was taken from each plot on September 12th. The weight and average height was recorded for each sample. These data are given in Table III.

Table III. Effect of Mylone on Onions* - Bradford, 1957.

Treatment	Weight (oz.) /3 ft. of row	Height (inches)	Smut %/100 plants
Check	17.0	22.5	26.9
100 lb/A	26.3	24.0	10.6
200 lb/A	60.3	24.7	4.7
300 lb/A	63.3	25.5	2.7

*Average of three plots

(1) Professors C. B. Kelly and S. G. Fushtey, Plant Pathologists, Department of Botany, Ontario Agricultural College.

Competition with weeds during the early stages of growth reduced the yield on the check plots. A definite increase in weight was associated with the 200 and 300 pound per acre rates. There was also a slight increase in average height. All rates reduced the incidence of smut.

Cabbage

The cabbage seedlings on the 300 pound per acre plots on the first date of sowing were yellowish green in colour for several days after emergence. Recovery was rapid and the plants appeared normal for the remainder of the season. The second and third sowings were normal. There was no significant difference in stand. On the 26th of August all plots were harvested and weights obtained of all ~~the above~~ ground portion of the plants. There was no significant difference in weight. All plots were free of disease.

Tomatoes

Tomato plants were normal at all stages of growth. Plants were cut at ground level and weighed on the 26th of August. There was no significant difference in weight for the third date of seeding. An increase in weight was associated with the higher rates of application as the average for all plots was:- Check - 68.8 lbs., 100 lb/A -83.8 lbs., 200 lb/A -114.8 lbs., and 300 lb/A -108.5. All plots were free of disease.

Celery

There were no differences in stand or yield of celery within the test area.

Summary

1. Under the conditions of the experiment weed control was excellent at 100, 200, and 300 pounds (product) of Mylone per acre.

2. There was an increase in weight of onions and tomatoes with the 200 and 300 pound per acre rate of chemical, but no increase in weight of cabbage or celery.

3. There was no reduction in stand of onions, tomatoes, cabbage, or celery when sown nine days after treatment at rates up to 300 pounds per acre of Mylone.

4. Mylone was effective in the control of onion smut.

WEED CONTROL IN SWEET CORN WITH SIMAZIN, PROPAZIN, EPTC, DIURON, CDAA, CDEC, AND DNBP.

M.F. Trevett and Ronald Burnham 1/

This paper is a report of 1957 tests of herbicides applied either at planting or at emergence of sweet corn. These tests were designed to compare percent annual grass control obtained with amine salt of dinitro ortho secondary butylphenol DNBP with percent control obtained with several new herbicides used alone or in combination with DNBP. The herbicides compared and the combinations tested are listed in Table 3.

PROCEDURE AND MATERIALS

Variety Carmelcross 30.13 sweet corn was planted 11 June 1957, approximately one inch deep in a sandy loam soil containing 4 percent organic matter. "Planting" treatments were applied June 12, "Emergence" treatments were applied June 17. On June 17 five percent of the corn had emerged. Herbicides were applied with one pass of a small plot sprayer, at 40 pounds pressure, and 50 gallons per acre volume. Treatments were replicated five times in paired, single-row plots. All plots were cultivated throughout the season, but during cultivation the soil was not disturbed six inches on either side of the crop row. Corn was harvested at the soft dough stage of maturity.

The principal broadleaf weeds were: Black Mustard (*Brassica nigra* Koch.), Wild mustard (*Brassica arvensis* Ktze.), Lambs-quarters (*Chenopodium album* L.), and Red-root pigweed (*Amaranthus retroflexus* L.). The annual grasses present were: Barnyard grass (*Echinochloa Crusgalli* Beauv.), and Foxtail (*Setaria viridis* (L.) Beauv.). Weed counts were made during the fifth week following treatment.

Table 1 contains rainfall data for the 1957 season. Sources of herbicides are listed in Table 2. Table 3 contains rates and combinations of herbicides applied, yield data, and percent broadleaf weed and annual grass control.

EXPERIMENTAL RESULTS

While exceptions may be noted, in this test the magnitude of yield in the array listed in Table 3 (column 3) appears to be associated more with percent broadleaf weed control (column 4) than with percent annual grass control (column 6). This situation maybe a consequence of the difference in potential competition of broad-leaf weeds compared to annual grasses. Thus the fact that in check

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1/ Associate Agronomist and Research Assistant respectively, Department of Agronomy, University of Maine, Orono, Maine.

plots broadleaf weeds averaged 47.5 per square foot compared to 6.7 annual grasses per square foot (Table 3) leads to the assumption that because of their greater potential number per square foot, broadleaf weeds if left uncontrolled, or if poorly controlled, would reduce yields to a greater degree than uncontrolled or poorly controlled annual grasses. The possibility also exists that, at the rather low level of density of stand of grasses in this test, even a low order of control might be sufficient to insure a season long comeptitive advantage to the corn. In any case it appears in the present instance that acre yields more accurately reflect percent broadleaf weed control than percent annual grass control. Thus the effectiveness of the various herbicides and combinations on broadleaf weed control can be evaluated by both yield and percent reduction in stand of weeds in treated compared to untreated plots. Annual grass control, on the other hand, can be evaluated reliably only on the basis of percent reduction in stand of grass in treated compared to untreated plots.

In the following table treatments are grouped on the basis of significant difference (5 percent level) from the standard of 4.5 pounds DNBP, with respect to effect on yield of sweet corn, percent broadleaf weed control and percent annual grass control:

TREATMENTS RESULTING IN:		
Higher yields than 4.5# DNBP	Higher percent broadleaf weed control than 4.5# DNBP	Higher percent annual grass control than 4.5# DNBP
None	None	4# Propazin, Pl.[1] 2# Simazin, EM. 4# Simazin, Pl. 3# DNBP plus 1# or 2# Simazin, EM. 4.5# DNBP plus 6# CDEC, Pl. 4.5# DNBP plus 1# or 2# Simazin, or 0.8# diuron, or 6# CDEC, EM. 10# EPTC, Pl. 6# CDEC, Pl. 9# CDAA, Pl. 0.8# Diuron, Pl.

TREATMENTS RESULTING IN:		
Lower Yields than 4.5# DNBP	Lower percent broadleaf weed control than 4.5# DNBP	Lower percent annual grass control than 4.5# DNBP
0.8# Diuron, Pl.		
6# or 9# CDEC, Pl.	6# or 9# CDAA, Pl.	2# propazin Pl.
5# EPTC, Pl.	6# or 9# CDEC, Pl.	
	0.4# or 0.8# Diuron, Pl.	
	5# or 10# EPTC, Pl.	

1/ "EM" indicates treatment was applied at crop emergence.
"Pl" indicates treatment was applied at planting.

SUMMARY AND CONCLUSIONS

Annual grass control in sweet corn can be increased beyond that obtained with 4.5 pounds per acre of DNBP by: 2 and 4 pounds per acre of Simazin, 4 pounds Propazin, 10 pounds EPTC, 6 or 9 pounds CDEC, 9 pounds CDAA, and by combinations of DNBP with lower rates of certain of the latter herbicides.

Combination treatments of DNBP with other herbicides may be warranted for several reasons. Combinations for example, may make possible a reduction in rates per acre of the individual herbicides without reduction in weed control. An example of this possibility is the approximately equivalent grass control obtained with either three pounds DNBP plus 1 pound Simazin or with 2 pounds Simazin alone. Such substitutions can be of economic consequence.

Combinations of DNBP with graminicides, such as CDEC or CDAA, or with a material such as EPTC that is less effective on broadleaf weeds than on annual grasses, are essential to insure adequate control of broadleaf weeds.

Table 1. Rainfall, Highmoor Farm, Monmouth Maine for June and July 1957.

Date 1/	Inches of rain	Date	Inches of rain
June 2	.33	July 1	.04
7	.36	4	.20
13	.06	5	.23
15	.15	6	.22
19	.13	8	.11
20	.20	10	.47
26	.60	22	.40
27	.94	23	1.25
28	.44	25	.65
30	.17	27	.05
		30	.51

1/ The precipitation indicated is for each 24 hour period beginning 7.30 A.M. of the date given to 7.30 A.M. the following day.

Table 2. Herbicides Used in Sweet Corn in 1957.

Abbreviation	Active Ingredient	Manufacturer
EPTC	Ethyl N,N-di-n-propylthiolcarbamate	Stauffer
DNBP	4,6 Dinitro-o-sec-butylphenol (Formulated as the amine salt-"Premerge")	Dow
* Simazin	2-chloro-4,6-bis-(ethylamino)-s-triazine	Geigy
CDEC	2-chloroallyl diethyldithiocarbamate	Monsanto
CDAA	2 chloro-N,N-diallylacetamide	Monsanto
Diuron	3(3,4-dichlorophenyl)-1,1-dimethylurea	Du Pont
Propazin	2-chloro-4,6-bis-(diethylamino)-s triazine	Geigy

Table 3. Yield of Sweet Corn and Control of Broadleaf Weeds and Annual Grasses.

Herbicide[1] and acre/rate	Yield[3] tons per acre	Weed Control[4] Broadleaf % control	Broadleaf % angles[5]	Annual grass % control	Annual grass % angles[5]
4# Propazin Pl[2]	6.7	99.8	87.70	86.9	68.76
2# Simazin EM	6.7	99.8	87.75	97.7	81.19
3# DNBP + 2# Simazin EM	6.6	100.0	90.00	99.7	87.29
2# Propazin Pl	6.5	99.3	85.41	4.3	11.94
4# Simazin Pl	6.5	100.0	90.00	100.0	90.00
4.5# DNBP + 2# Simazin EM	6.3	100.0	90.00	99.9	88.74
4.5# DNBP + 6# CDEC Pl	6.1	97.7	81.74	89.9	71.46
4.5# DNBP + 1# Simazin EM	6.0	100.0	90.00	92.8	74.47
4.5# DNBP + 0.4# Diuron EM	6.0	99.9	88.29	64.7	53.54
3# DNBP + 1# Simazin EM	6.0	100.0	90.00	96.3	78.83
4.5# DNBP EM	5.7	98.5	83.01	42.0	40.39
2# Simazin Pl	5.6	99.5	86.19	77.4	61.60
4.5# DNBP + 0.8# Diuron EM	5.3	100.0	90.00	99.5	86.16
4.5# DNBP + 6# CDEC EM	5.2	90.6	72.13	80.5	63.76
6# CDAA Pl	5.1	23.8	29.21	66.6	54.68
1# Simazin Pl	4.7	92.7	74.35	42.0	40.43
10# EPTC Pl	4.7	74.9	59.90	95.1	77.23
9# CDAA Pl	4.7	42.7	40.82	87.7	69.51
0.4# Diuron Pl	4.4	79.4	63.00	36.0	36.85
0.8# Diuron Pl	4.3	74.9	59.90	94.1	75.93
9# CDEC Pl	4.3	51.5	45.88	99.0	84.19
6# CDEC Pl	4.2	64.6	53.49	98.6	83.24
5# EPTC Pl	2.6	55.6	48.21	50.9	45.49
L.S.D. 5% level	1.36		14.46		21.21

1/ Rates given as pounds of active ingredient

2/ Pl = at planting
EM = at emergence

3/ Yields (for tons of snapped ears) were adjusted for stand of plants.

4/ Given as percent of untreated plots. Weed counts were made during the 5th week after treatments were applied.
Average number of weeds per square foot in untreated plots were:

Broadleaf	Annual grass
47.5	6.7

5/ Percent control was converted to angles for statistical analysis.

GRASS CONTROL IN LOWBUSH BLUEBERRY FIELDS WITH DALAPON

M. F. Trevett[1]

An effective perennial grass control program is a prerequisite to widespread use of commercial fertilizers in lowbush blueberry fields[2]. A grass control program is a necessity because grasses respond more vigorously to fertilizers than do lowbush blueberries, increasing both competition for nutrients and water, and the difficulty of obtaining high quality harvested fruit. In unfertilized fields the usual amount and height of grass plants present does not seriously interfere with obtaining a harvested product of high quality. In fertilized fields, however, the stouter, taller grass culms increase the percent of berries sliced, cut, or mashed during picking with the conventional blueberry rake. The minimum goal, therefore of a grass control program should be to contain the amount and height of grass in fertilized fields at levels similar to those found in unfertilized fields.

The results of several tests in which dalapon (2,2-dichloropropionic acid) was used to control perennial grasses in lowbush blueberry fields are reported in this paper.

EXPERIMENTAL PROCEDURE

Preemergence applications were made exclusively in the tests herein reported because exploratory post emergence trials indicated a low tolerance of lowbush blueberries to dalapon. Preemergence treatments were applied following burning the spring of the burn year[3] when new shoots of grass were from one to five inches tall, but before blueberry stems had emerged from rhizomes.

1/ Associate Agronomist, Maine Agricultural Experiment Station, University of Maine, Orono, Maine.

2/ *Vaccinium angustifolium* Ait., and related species and hybrids.

3/ Lowbush blueberry plants are pruned every two or three years by burning over fields in early spring before resumption of growth. The yield cycle for a three year burn follows the generalized pattern: 1957 - burn (fruit buds formed), 1958 first crop year, 1959 - second crop year, 1960 - burn.....

Aqueous solutions of the sodium salt of dalapon were applied with one pass of a small-plot sprayer.

Plot size varied with the type of comparison studied. Plots used solely for estimates of grass control were two feet wide and twenty-five feet long. Plots from which yields were obtained were five feet wide and one hundred feet long.

Injury ratings were made in late summer of the year of treatment. Ratings were based on the frequency of occurrence of "formative" effects. Formative effects included: stem curvature, crinkling and savoying of leaves, and coalescence of adjacent leaves.

Perennial grasses present included: Timothy (*Phleum Pratense* L.); Red top (*Agrostis alba* L.); Mountain rice (*Oryzopsis asperfolia* Michx.); Feather grass (*Stipa canadensis* Poir); Kentucky bluegrass (*Poa Pratensis* L.); Sheep's fescue (*Festuca ovina* L.); Danthonia (*Danthonia spicata* (L.) Beauv.)

EXPERIMENTAL RESULTS

A. Effect of Additives and Spray Volume on Grass Control

A one percent concentration of a wetting agent (Triton B 1956) did not increase grass control obtained with 1.6 and 3.2 pound acre rates of dalapon over that obtained with equal rates of dalapon alone.

Factorial combinations of two and four pounds acre rates of amino triazole with 0.8 and 1.6 pounds of dalapon did not increase grass control over that obtained with dalapon alone.

Varying spray volume with rate of dalapon constant, from 20 to 50 gallons per acre did not significantly affect grass control.

B. Effect of Rate of Application and Time of Application on Grass Control

The degree of grass control obtained increased with both increasing rate of dalapon applied and with increasing lateness of application, Table 1. Early applications, made when the grasses were less than two inches tall (two weeks after burning) were ineffective compared to the late application presumably because at the late date there was sufficient leaf surface to insure retention of a lethal amount of toxicant.

On the basis of the rates tested at least 3 pounds per acre of dalapon are required to give acceptable control.

C. Effect of Rate of Application and Time of Application on the Frequency of Occurrence of Formative Injury to Lowbush Blueberries

The effect of rate and time of application on the frequency of formative injury to blueberry plants is comparable to the relation between rate and time of application on grass control. In general, the percentage of blueberry stems showing injury increased with increasing rate of herbicide and with increasing lateness of application, Table 2.

The increased percentage of stems injured at the late treatment date (four weeks after burning, Table 2) is a consequence of the progress of development of new shoots from adventitious buds on rhizomes. The progress of shoot development was as follows: two weeks after burning, adventitious buds had barely begun to swell; 3 weeks after burning buds had begun to elongate and were about one eighth inch long, but had not emerged; four weeks after burning, buds from rhizomes shallowly covered with soil were barely protruding through the soil. Apparently the application of dalapon at the time new blueberry shoots are emerging will result in a high rate of injury compared to the amount of injury occurring from earlier dates of application.

D. Effect of Dalapon on the Average Number of Fruit Cluster Buds per Blueberry Stem

The magnitude of area yield in first crop fields is, among other factors, a function of the average number of fruit cluster buds per stem. The greater the number of fruit buds per stem the higher will the area yield. The stem average is in turn determined, in part, by the obvious relationship to the average of the percentage of stems in an area that have developed fruit buds, and by the proportion of stems that have developed laterals (side branches) the year of burn. In general stems with several laterals will have more fruit buds than unbranched stems. Any treatment that affects either the ability of stems to form fruit buds, or stimulates lateral production will have a pronounced effect on yield.

Data for a 3.4 pounds per acre rate of dalapon applied three weeks after burning, Table 3, indicate that treatment resulted in a significant increase in both number of stems without fruit buds and number of laterals per stem. The average number of fruit buds per stem for all stems in treated areas, on the other hand, was not significantly affected. The non-significant effect of dalapon, in this instance, on average fruit buds per stem is a consequence of the increased number of laterals per stem compensating for a reduction in the number of stems that failed to form fruit buds. However, it should be noted that increased numbers of laterals per stem do not invariably result in a greater number of fruit buds per stem compared to nonlateraled stems. If lateral development is stimulated in late season, fruit bud initiation will not occur, or at least, fruit buds will fail to mature. Hence, the assumption that any treatment stimulating development of laterals will result in an increased number of fruit buds per stem is subject to limitation by the proviso that such stimulation must occur sufficiently early in the growing season to insure an ample period of time for the usual sequence in bud initiation and development to occur.

E. Effect of Dalapon on Yields of Lowbush Blueberries

Although the average number of fruit buds per stem may not always differ significantly between treated and untreated plots, first crop yields from plots treated with either 3.4 or 6.2 pounds of dalapon per acre have been lower than yields of untreated plots, Table 4.

It has been assumed, without benefit of pertinent experimental data, that at certain levels of dalapon absorbed by blueberry plants, morphological or physiological changes occur that prevent either fruit set or fruit development. In any case, fruit buds in treated plots, macroscopically at least, develop normally and blossom at the same time as those in untreated plots. However, soon after full bloom the inflorescences begin to die. In extreme cases the entire terminal end of the stem, which includes all of the fruiting area in unbranched one year old stems, dies. Stems so affected become dark brown or tan in color, acquiring the overall appearance of stems that have been killed either by twig and blossom blight, or by winter injury. In less extreme instances only a part of the terminal portion of the stem may die, with some fruit maturing on the bottom half or less of the fruiting area of the stem.

Data in Table 4, for fields "5" and "6" indicate that dalapon applied the year of burn does not have a significant effect on total yields for first and second crops combined. This situation obtains because the second crop in treated plots is sufficiently larger than second crop yields in untreated plots to compensate for reduction in first crop yields due to treatment. The larger second crop in dalapon treated plots is presumably not a result of a stimulation of fruit bud initiation or of fruit development due to remnants of dalapon persisting in the plant, since the identical effect on second crop yields occurs whenever first crop yields are curtailed by unfavorable pollinating conditions, or by late spring frosts.

CONCLUSION

The use of dalapon at rates required for the control of perennial grasses in lowbush blueberry fields is uneconomical because of resulting reductions in first crop yields.

Table 1. Effect of Rate of Dalapon and Time of Application on Grass Control.

Acre Rate (acid equivalent)	Date applied - weeks after burning[1] 2	3	4	Average
	Grass control rating[2]			
1.6	1.0	1.0	2.5	1.5
3.2	3.0	1.0	5.0	3.0
6.4	3.0	4.0	4.2	3.7
Average	2.3	2.0	3.9	

1/ Burned May 2 '56

2/ 1 = very low control

5 = very high control

Ratings made August 1956

Table 2. Effect of Rate of Dalapon and Time of Application on Frequency of Occurrence of Formative Injury to Lowbush Blueberries.

Acre Rate (acid equivalent)	Date applied - weeks after burning 1/			Average
	2	3	4 2/	
	Percent of stems showing Dalapon "injury" 3/			
1.6	0.7	0.4	0.3	0.5
3.2	3.5	1.2	5.4	3.4
6.4	6.3	3.7	18.1	9.4
Average	3.5	1.8	7.9	

1/ Burned May 2, 1956

2/ Progress of shoot development following burning:
2 weeks after-shoot buds on rhizome had barely begun to swell
3 weeks after-buds on rhizomes had begun to elongate and were about 1/8" long
4 weeks after buds barely emerged from rhizomes with shallow soil cover

3/ "Injury" = stem curvature, and leaf deformity. "Injury" determined in August, 1956.

Table 3. Effect of Dalapon on Number of Fruit Cluster Buds per Stem the Year of Burn.

Treatment year of burn (acre rates)	Percent stems without fruit buds	Percent stems with lateral branches	Average number fruit buds per stem
Check	2.4	2.6	2.6
3.4# Dalapon	8.3	7.2	2.7
Significance at 5% level:	Significant	Significant	Not Significant

Table 4. Effect of Dalapon on Yield of Lowbush Blueberries

Field	Treatment acre rate acid equivalent applied 3 weeks after burning	Yield-bushels per acre 1st crop	2nd crop	Total
	No treatment	28.9		28.9
1	3.4# Dalapon	16.2 Sign.1/		16.2
	No treatment	55.8		55.8
2	3.4# Dalapon	31.6 Sign.		31.6
	No treatment	42.0		42.0
3	3.4# Dalapon	37.9 Sign.		37.9
	No treatment	23.3		23.3
4	3.4# Dalapon	21.6 N.S.2/		21.6
	No treatment	24.6	10.1 Sign.	34.7
5	6.2# Dalapon	13.8 Sign.	15.3	29.1 N S
	No treatment	37.2	22.9 Sign.	60.1
6	0.2# Dalapon	28.5 Sign.	33.1	61.6 N S

1/ Yields differ significantly at 5% level

2/ Yields do not differ significantly

WEED CONTROL IN SWEET CORN - 1957

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The testing of promising weed killers in plots of sweet corn has been carried on at this station for many years. This paper presents the results of testing some of the newer chemicals at Amherst, Massachusetts during 1957.

Materials and Methods

Thirty-three treatments involving sixteen chemicals were applied to plots of North Star sweet corn; these treatments were replicated four times. Each plot consisted of three 18-foot rows. The seed was planted by hand, with the rows spaced 3 feet apart and the hills 3 feet apart in the row. The soil, a Scarborough very fine, sandy loam was prepared in the usual manner, and a 8-16-16 fertilizer was broadcast at the rate of one ton per acre. The corn was planted on June 13, 1957 in rather dry soil. The soil remained dry until June 19 when there was .62 inch of precipitation and again on June 26 when 2.74 inches fell.

The chemicals were applied pre-emergence on June 13, the day of planting. The various chemicals with their respective per-acre rates of application are listed in columns 2 and 3 of Table 1. The weed killers were diluted with water and applied at the rate of 50 gallons per acre. The sprays were applied with a Brown Open-Hed No. 4 hand-pressure sprayer fitted with a No. 8004 Spraying Systems Tee Jet, fan type nozzle.

The weed population consisted of purslane, smartweed, lamb's quarters, galinsoga, pigweed and crabgrass. The readings on weed count, weed height, and crop height were made on July 17, and then the plots were all cultivated once prior to lay-by. Only 2.61 inches of rain fell during July and August when 8.18 inches are expected normally. Growth of the corn, however, was surprisingly good.

Results

The results of the tests are presented in Table 1. Highly significant differences are displayed among the treatments for weed population, weed height, and crop height, while differences were significant at the 5% level only for ear count and marketable yield.

*Thanks are due to the American Chemical Paint Co., Dow Chemical Co., Du Pont Co., Heyden Chemical Co., Geigy Chemical Corp., Monsanto Chemical Co., and Stauffer Chemical Co., who supplied the various weed killers.

Contribution No. 1133 of the University of Massachusetts, College of Agriculture Experiment Station, Amherst, Massachusetts

Table 1. Effect of Chemicals on Weed Control, Growth and Yield of North Star Sweet Corn
Planted and Sprayed June 13, 1957 - Recorded July 17, 1957 - Harvested August 22, 1957

Plot	Treatment	Lbs. Active	Weeds per 4 sq. ft.	Weed Height Inches	Crop Height Inches	Ear Count per Plot	Yield Marketable Ears Lbs.
1	Simazin	1.00	14.8	5.9	24.5	32.3	24.4
2	Simazin	2.00	1.0	1.1	23.5	36.8	27.6
3	Simazin	4.00	0.0	0.0	25.8	37.8	29.7
4	Simazin	6.00	0.0	0.0	23.8	32.8	23.6
5	Simazin	8.00	0.0	0.0	22.3	32.5	24.6
6	Chlorazin	4.00	19.3	5.4	25.8	35.3	24.3
7	Chlorazin	6.00	17.5	4.8	26.0	34.3	26.6
8	Chlorazin	8.00	10.8	3.8	26.0	39.0	28.4
9	Vegadex	6.00	14.0	4.1	23.0	33.8	23.4
10	Vegadex	9.00	12.5	4.1	23.3	28.3	20.7
11	Randox	6.00	32.3	8.0	25.8	35.0	26.7
12	Randox	9.00	27.5	6.4	24.5	33.0	23.8
13	G-27901	1.00	32.5	11.9	24.8	37.0	28.2
14	G-27901	2.00	10.0	5.3	24.0	33.5	25.2
15	G-27901	4.00	1.8	1.4	23.8	39.0	27.4
16	G-30031	1.00	23.3	8.5	24.8	36.8	29.0
17	G-30031	2.00	18.8	3.8	23.8	39.3	28.7
18	G-30031	4.00	1.5	1.6	25.0	30.0	24.0
19	G-30028	1.00	14.8	7.5	26.8	39.5	28.3
20	G-30028	2.00	11.3	4.0	25.5	38.3	26.8
21	G-30028	4.00	.8	1.0	23.8	35.5	26.3
22	EPTC	5.00	23.5	10.6	27.8	37.8	29.4
23	EPTC	10.00	17.3	8.8	23.0	31.3	23.5
24	DN (Premerge)	6.00	14.0	6.0	24.5	33.5	25.5
25	PCB (ACP 103-A)	1.50	11.8	5.8	23.8	29.5	23.0
26	Emid	3.00	22.0	3.9	22.5	29.8	21.6
27	TCB (H.C.1281-AD)	1.50	1.5	3.5	25.8	34.5	24.5
28	2,4-D Amine	1.50	11.8	6.0	23.3	34.3	25.3
29	PCB (ACP M-354)	1.50	20.3	7.5	23.0	29.5	21.2
30	CMU	0.80	9.5	10.3	23.3	28.3	20.8
31	CMU ⨍ 2,4-D Amine	0.80 ⨍ 1.50	7.8	6.0	22.0	28.8	22.1
32	Randox/DN(Premerge)	4.00 ⨍ 3.00	25.0	6.0	25.0	37.5	27.4
33	Check	---	44.0	19.0	25.8	34.0	24.6
L.S.D. @ .05			13.4	3.4	1.9	7.5	5.24
L.S.D. @ .01			17.7	4.6	2.6	N.S.	N.S.

The effects of the newer complex triazone compounds, Simazin, G27901, G30031 and G30028 are particularly noteworthy. Of these materials Simazin is apparently the best for use in corn culture, where two pounds of the chemical (active) gave excellent commercial control of weeds without affecting the yield. Four pounds of Simazin prevented weed growth entirely. Six and eight pounds of Simazin reduced the plant height but had little or no effect on yield.

As in previous years we have generally had better weed control with Vegadex than with Randox but the nine pound treatment of Vegadex resulted in the lowest yielding treatment in the test. EPTC, a new material, did not look very promising at the rates used in this test. It did not appear that the CMU, DN, 2,4-D and TCB materials performed as well as in previous years and this was attributed to the dry weather. If this is the answer then we would have to conclude that soil moisture is not so critical for good weed control when using Simazin.

Summary

Of the sixteen chemicals used in these tests Simazin proved to be the most effective in controlling annual weeds in plots of North Star sweet corn. Sweet corn displayed a wide tolerance to Simazin, for yields were not reduced even from an eight pound application. The effectiveness of Simazin appears not to be affected much from dry weather as compared to other treatments considered as standards.

WEED CONTROL IN ONIONS - 1957*

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The need for a safe and effective weed killer for onions is widely recognized. Given certain conditions, a few chemicals presently available do a creditable job of killing weeds in onion fields. Under other not easily identified conditions, however, the same chemicals prove not to be dependable and either fail to control weeds or else the crop is damaged to some extent. This paper presents the results of testing some promising weed killers in "set" and "direct seeded" onions during 1957. Field tests were carried out at Amherst on a Scarborough very fine sandy loam and in Hatfield on a Hadley very fine sandy loam. Soil preparation and fertilization were completed in the conventional manner.

The various chemicals with their respective per-acre rates of application are listed in columns 2 and 3 of Tables I, II, and IV. Treatments were replicated four times in Amherst and three times in Hatfield. The weed killers were diluted with water and applied at the rate of 50 gallons per acre. The sprays were applied with a Brown Open-Hed No. 4 hand pressure sprayer fitted with a No. 8004 Spraying Systems Tee Jet, fan type nozzle. The weed population consisted of redroot pigweed, lamb's quarters, galinsoga, smartweed, purslane and fox tail. Although the weather during May and June was about normal, it was exceptionally dry during April and July. Despite the dry weather, growth was about normal and a good crop of onions was harvested.

It is seen in Table I that the weed killers exerted a significant effect in controlling weeds. Randox was most effective of the treatments except on plots where extremely large amounts of Chloro IPC were used and these cases will be considered later. As has been reported previously, Randox is more effective than Vegadex in dry weather. Chlorazin and EPTC did not control weeds very well and the ten pound treatment of EPTC resulted in the poorest yield in the test.

The extra heavy applications of Chloro IPC were made to study their effects on weeds as well as the onion plants. We have used this chemical at rates ranging from two to sixty-four pounds per acre as a pre-emergence weed control agent for set onions since 1952. (1)

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**Thanks are due to the American Chemical Paint Co., Geigy Chemical Dorp., Monsanto Chemical Co., and Stauffer Chemical Co., who supplied the various weed killers.

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No visual damage to the crop or yield reduction resulted when these treatments were applied on the Scarborough very fine sandy loam plots of the experiment station farm. Sometimes weeds haven't been controlled at rates less than sixteen pounds per acre while at other times good weed control has been obtained from four to six pounds of the chemical. Using the same material at four to six pounds per acre, onion growers experience has varied from complete lack of weed control to excellent control. In some instances, on the Hadley soils, six pounds of Chloro IPC caused very severe yellowing and dwarfing of onions together with seriously reduced yields.

The results of some tests on a Hadley very fine sandy loam soil are presented in Table II. Significant yield reduction is apparent from some Chloro IPC treatments. The tops of the onion plants were dwarfed and, also, severely yellowed at rates of eight to sixteen pounds per acre and above.

Table I Effect of Chemicals on Weed Control and Yield of Golden Globe Set Onions (Amherst)
Planted April 22, 1957 - Sprayed April 23, 1957
Recorded May 31, 1957 - Harvested July 25, 1957

Plot	Treatment	Rate per Acre Lb. Active	Weeds per 4 sq. ft.	Height Tallest Weeds Inches	Yield Marketable Lbs.
1	CIPC	4.0	14.0	5.0	52.9
2	CIPC	6.0	10.0	3.3	55.7
3	CIPC	8.0	13.0	3.8	55.6
4	CIPC	12.0	5.3	2.4	55.0
5	CIPC	16.0	6.3	1.5	53.2
6	CIPC	24.0	4.0	1.2	55.5
7	CIPC	32.0	3.0	1.1	53.3
8	CIPC	64.0	1.8	0.4	56.8
9	Chlorazin	4.0	10.0	2.8	54.3
10	Chlorazin	6.0	9.3	2.7	58.0
11	Chlorazin	8.0	6.0	2.6	51.1
12	EPTC	5.0	13.0	3.9	53.4
13	EPTC	7.5	12.5	3.0	51.2
14	EPTC	10.0	5.3	2.7	46.7
15	Randox	6.0	3.5	2.3	55.9
16	Randox	9.0	1.0	1.1	55.1
17	Vegadex	4.0	7.5	3.1	51.4
18	Vegadex	6.0	5.8	3.6	55.1
19	Vegadex	9.0	4.3	3.4	52.1
Check			21.5	7.4	49.7
L.S.D. @ .05			5.8	3.5	5.0
L.S.D. @ .01			7.8	4.6	N.S.

Table II Effect of Chloro IPC on Marketable Yield of Ebenezer Set Onions (Hatfield)

Sprayed April 4, 1957

Plot	Treatment	Rate per acre Lbs. Active	Weeds for Sq. ft.	Yield Marketable Lbs.
1	CIPC	4.0	12.0	14.3
2	CIPC	8.0	6.7	13.6
3	CIPC	16.0	4.7	11.6
4	CIPC	32.0	4.3	10.7
5	CIPC	64.0	1.7	6.2
6	Check		16.3	15.1
L.S.D. @ .05			9.6	5.6
L.S.D. @ .01			11.9	8.0

An analysis of the soils involved in the tests reported from Table I and Table II are shown in Table III.

Table III Analysis of Soil From Onion Plots - 1957

	pH	Ca	K	P	Mg	NO_3	NH_4	Limestone Lbs. per A.	Sol. Salts	Organic Matter %
Hadley	5.1	L	MH	H	M	M	MH	7,000	22	1.7
Scarborough	5.9	H	H	H	M	H	H	6,000	35	5.1

Important differences between these two soils are readily apparent. The Hadley soil is low in calcium and a pH of 5.1 does not usually provide the best conditions for onion growth. The most outstanding difference between the two soils, however, is that the Hadley soil has only one-third as much organic matter as the Scarborough. This difference in organic matter may be one of the main factors responsible for injury from Chloro IPC on Hadley plots and no injury on the Scarborough plots. Working with seeded onions on muck soils Warren (2) reported that "onions showed no injury from pre-emergence treatments at rates up to 12 pounds of CIPC per acre under a wide variety of weather conditions."

Some pre-emergence treatments were also made on plots of direct seeded onions using soil of the Scarborough series. The treatments, their rates of application and the results are presented in Table IV. Here again Randox gave the best weed control among the treatments. Vegadex controlled weeds about as well but yields were affected adversely. Chloro IPC was not very effective in weed control while Chlorazin and EPTC caused significant reductions in yield.

Table IV Effect of Chemicals on Weed Control and Yield of Early Yellow Globe Seeded Onions
Planted April 18, 1957 - Sprayed April 18, 1957
Recorded May 22, 1957 - Harvested August 8, 1957

Plot	Treatment	Rate per A. Lb. Active	Weeds per 4 sq. ft.	Tallest Height Weeds Inches	Onion Plants per ft.	Onion Plant Height Inches	Yield Marketable Lbs.
1	CIPC	2.0	18.3	2.4	10.8	4.3	60.7
2	CIPC	4.0	13.0	2.0	11.0	4.6	68.5
3	CIPC	6.0	17.0	1.6	11.0	4.4	69.6
4	CIPC	8.0	10.8	1.8	10.3	4.3	65.1
5	Chlorazin	4.0	13.5	1.1	10.3	4.1	56.7
6	Chlorazin	6.0	6.5	0.7	9.0	3.9	46.6
7	Chlorazin	8.0	6.8	0.5	11.5	3.5	40.6
8	EPTC	5.0	11.3	1.3	8.3	3.6	37.7
9	EPTC	7.5	6.0	1.3	7.0	2.2	26.3
10	EPTC	10.0	5.3	1.3	5.8	1.8	15.0
11	Randox	2.0	7.0	1.2	9.8	4.5	66.9
12	Randox	3.0	9.8	1.4	10.0	4.2	54.7
13	Randox	4.0	3.8	1.0	10.3	4.0	58.5
14	Randox	6.0	3.8	0.9	8.5	4.0	56.2
15	Vegadex	2.0	19.3	2.2	9.0	4.2	58.8
16	Vegadex	3.0	7.8	1.7	8.0	3.7	48.3
17	Vegadex	4.0	11.3	1.7	8.5	3.8	52.7
18	Vegadex	6.0	8.5	1.6	9.0	3.7	49.0
19	Check	-	28.8	3.3	13.3	5.1	72.7
L.S.D. @ .05			6.5	1.0	2.3	1.5	10.8
L.S.D. @ .01			8.6	1.3	3.1	2.0	14.3

Summary

Randox provided the best weed control with least damage to seed and set onions in the relatively dry year of 1957. Injury to onions from pre-emergence applications of Chloro IPC may be due to low organic matter content of the soil.

Literature Cited

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THE EFFECT OF SEVERAL HERBICIDES ON POTATO YIELDS, 1954-1957

M.F. Trevett, C.E. Cunningham, and H.J. Murphy1/

The tests reported in this paper were designed to evaluate several herbicides for effect on both potato yields and control of broadleaf weeds and annual grasses. The acre rates of herbicides used were those that have been found effective, within selective limits, in other crops. However, because of low density of stand of both broadleaf weeds and annual grasses in the experimental areas the data obtained can be used only to evaluate the tolerance of potatoes to the various herbicides.

Experimental Procedure and Materials

Herbicides were applied with small plot sprayers. Treatments were replicated five times. Soil texture in the experimental areas was sandy loam or loam, depending upon location. Standard cultural practices were followed except for herbicidal treatment.

Table one contains the abbreviations of the active ingredients in the herbicides used, and sources of the herbicides.

Experimental Results and Discussion

Two and four pounds of Simazin per acre applied at planting were the only treatments resulting in yields significantly lower than check (untreated) plot yields in 1957 tests, Table 2. Treatments that produced yields not significantly different from check were: emergence applications of 4.5 pounds of DNBP; 2.6 or 5.2 pounds of dalapon; and 4.5 pounds of DNBP plus 2.6 pounds of dalapon. Planting treatments with yields not significantly different from check were: 2,4, or 8 pounds of EPTC; 5 or 10 pounds of FW-450 (see Table 1); 0.6 or 1.2 pounds of diuron; and 1 pound of Simazin. Specific gravity of tubers was not affected significantly by any treatment. In other tests made during the period 1954 to 1957 the following herbicides applied at emergence, at the rates indicated, did not significantly affect yields: 3 or 6 pounds of DNBP; 0.5, 1.0, or 1.5 pounds of neburon; and 4 or 6 pounds of NPA. One and one-half pounds of 2,3,6-TBA, however, significantly reduced yields compared to all other treatments.

Spring preplowing applications of either dalapon or ATA, made 7 days before planting did not significantly affect yields, Table 3.

1/ Respectively: Associate Agronomist, Maine Agricultural Experiment Station; formerly Assistant Agronomist, Maine Agricultural Experiment Station, at present Assistant Geneticist, Red Dot Foods, Inc., Madison, Wisconsin; Associate Agronomist, Maine Agricultural Experiment Station.

Similarly, fall preplowing applications of relatively high rates of dalapon did not significantly affect either yield or specific gravity of potatoes grown in the treated areas the following season, Table 4.

Combinations, or mixtures, of various herbicides have been applied in attempts to obtain increased control of both broadleaf weeds and annual grasses over the amount ordinarily obtained with the individual herbicides used alone. Tests, therefore, have been made of combinations of herbicides that are extremely effective on broadleaf weeds, but only moderately effective on grasses, (at the rates usually recommended), with graminicides that are relatively weak on broadleaf weeds but extremely effective on annual grasses. Examples of such combinations are, DNBP and either dalapon or ATA. Other combinations, as for example, those involving DNBP and monuron, have been made to determine whether or not the weed control potentials of the individual herbicides are additive. Data from a 1957 test on sweet corn 1/ indicated that either annual grass control or broadleaf weed control, or both, depending upon the herbicides involved, can be increased by combination treatments. For example, compared to 4.5 pounds of DNBP applied alone, a significantly higher percent control of annual grasses was obtained when 4.5 pounds of DNBP was combined with 1 or 2 pounds of Simazin, or 6 pounds of CDEC, or 0.8 pounds of diuron. On the other hand, a significantly higher percent broadleaf control was obtained when 6 or 9 pounds of CDEC or 0.4 or 0.8 pounds of diuron were combined with 4.5 pounds of DNBP than when the former herbicides were not applied with DNBP.

Tests of combination treatments in potatoes have been made either at emergence or preemergence but not post emergence, since it has been demonstrated under Maine conditions that if early infestations of annual grasses are controlled the late season annual grass problem will largely be eliminated. Post emergence applications, however, have been made of certain herbicides to detect the nature and potential extent of injury if, by chance in commercial practice, potatoes were treated when fully emerged.

Table 6 contains yield data and stands of annual grass that are representative of several tests in which combinations of DNBP and dalapon applied at emergence were compared with emergence applications of DNBP, and with both emergence and post emergence applications of dalapon. None of the treatments reported in Table 6 resulted in yields significantly lower than check plots. Treatments with yields significantly higher than check were: emergence applications of 6.0 pounds of DNBP, 4 pounds of dalapon, 3 pounds of DNBP plus 4 pounds of dalapon; and split applications of 3

1/ "Weed Control In Sweet Corn With Simazin, Propazin, EPTC, Diuron, CDAA, CDEC, and DNBP." M.P. Trevett and Ronald Burnham. 1958 Proceedings of the Northeast Weed Control Conference.

pounds of DNBP applied at emergence and either 2 or 4 pounds of dalapon applied 5 days before emergence. Treatments that did not differ significantly in yield from check were: emergence applications of 3 pounds of DNBP, 2 or 6 pounds of dalapon, 3 pounds of DNBP plus 2 pounds of dalapon; and post emergence applications of 2 or 4 pounds of dalapon. Apart from the effect of treatment on yield high rates of dalapon applied post emergence have occasionally affected the surface appearance of tubers.

In order to determine the effect of treatment on "seed" performance, tubers from the 2,4, and 6 pound rates of dalapon applied either at emergence or preemergence in 1954, Table 6, were saved for seed and planted in 1955. Seed tubers were planted both whole and cut (seed tubers halved or quartered, depending upon tuber size). Cut seed from plots treated post emergence in 1954 with either two or four pounds of dalapon gave significantly lower yields than seed grown in plots treated with 2 pounds of dalapon at emergence in 1954. Further, cut seed from plots that received 6 pounds of dalapon at emergence in 1954, produced significantly lower yields in 1955 than cut seed from plots receiving 2 pounds dalapon at emergence. The effect of time and rate of application of dalapon the yield potential of whole seed taken from the 1954 plots was not as marked as for cut seed. A significant reduction in yield for whole seed occurred at only the 4 pound post emergence rate of dalapon compared to the 2 pound emergence application. This reduction in yield is in part, at least a consequence of inhibition of sprouting following translocation of dalapon to developing tubers. The frequency with which sprouting is inhibited is apparently a function of the rate of dalapon applied. For example, potato plants sprayed in 1954 with 1, 2, 3, 4, 5, or 6 pounds acre rates of dalapon produced tubers with the following percentage of sprout inhibition (after four months storage at an optimum temperature for sprouting of 50° F):

Pounds dalapon applied per acre in 1954 to "mother" plants	Percent of tubers from treated plants showing varying degrees of inhibition of sprouting
1 or 2	0.0
3	20.0
4	45.0
5	75.0
6	80.0

Only plots that had received 3 or more pounds of dalapon per acre post emergence showed reductions in apical sprouting.

In other tests emergence applications of dalapon did not effect sprouting behavior in storage of tubers taken from non-irrigated and irrigated plots with an 8-inch differential in water supply. However, even though inhibition of sprouting may not occur in storage tests, the yield potential of the tubers nevertheless may have been reduced. Thus, as heretofore noted, data in Table 6 show that high rates (6 pounds per acre) of dalapon applied at emergence resulted in yield reductions when tubers from treated plants were cut for seed.

Summary and Conclusions

To adequately evaluate an herbicide for use in seed potato fields, yield tests of tubers grown in treated areas must be included in the research program. Estimates of sprout inhibition made prior to planting will not suffice, since it has been shown that tubers with an inferior yield potential may sprout normally in storage.

Emergence applications of mixtures of DNBP with dalapon, ATA, or monuron, in relatively weed free areas, have not significantly affected (5% level of significance) the yields of treated plants.

Herbicides that have not reduced yields of treated plants (5% level of significance) when applied to potatoes at emergence or pre-emergence are: 2, 4, or 8 pounds per acre of EPTC; 0.75, 3.0, 4.5, or 6.0 pounds of DNBP; 1 pound of Simazin; 4 or 8 pounds of CDEC; 4 or 8 pounds of CDAA; 0.6 or 1.2 pounds of diuron, 1 to 6 pounds of dalapon; 5 or 10 pounds of sodium, 2,3-dichloroisobutrate (FW-450); 0.5 or 1.0 pounds of monuron; 0.5 or 1.5 pounds of neburon; 4 or 6 pounds of NPA.

Herbicides that have reduced yields of treated plants (5% level) when applied at emergence are: 2 or 4 pounds of Simazin; 1.5 pounds of 2,3,6-TBA.

Emergence application of 6 pounds of dalapon has been shown to reduce the yield potential of tubers produced on treated plants if the tubers are cut for seed.

Post emergence application of 3 or more pounds of dalapon per acre has been shown to induce inhibition of apical sprouting of tubers produced on treated plants.

Fall preplowing applications of from 5 to 20 pounds of dalapon per acre have not significantly affected the yield of potatoes grown in treated fields the following season. Spring preplowing applications of 5 pounds of ATA per acre, and from 4.3 to 12.8 pounds of dalapon applied seven days before planting and plowed down three days before planting, did not significantly affect yields.

Table 1. Herbicides Used in Potatoes

Abbreviation	Active Ingredient	Manufacturer
EPTC	Ethyl N,N-di-n-propylthiolcarbamate	Stauffer
DNBP	4,6 Dinitro-o-sec-butylphenol	Dow
	(Formulated as the amine salt = "Premerge")	
Simazin	2-chloro-4,6-bis-(ethylamino)-s-triazine	Geigy
CDEC	2-chloroallyl diethldithio-carbamate	Monsanto
CDAA	2 chloro-N,N-diallylacetamide	Monsanto
Diuron	3(3,4-dichlorophenyl)-1,1-dimethylurea	Du Pont
Dalapon	2,2-dichloropropionic acid	Dow
ATA	3-Amino-1,2,4-triazole	Cyanamid
FW-450	Na 2,3-dichloroiso butrate	Rohm & Haas
Monuron	3-(p-chlorophenyl)-1-dimethylurea	Du Pont
Neburon	3-(3,4-dichlorophenyl)-1-methyl 1-n-butylurea	Du Pont
2,3,6-TBA	2,3,6-trichlorobenzoic acid	Du Pont
NPA	N-1-naphthyl phthalamic acid	U.S. Rubber

Table 2. Effect of Herbicides Applied at Planting or at Emergence on Yields and Specific Gravity of Green Mountain Potatoes. 1957

Herbicide, acre rate of active ingredient and time of application	Yield Bushels per acre	Specific Gravity of tubers
4# CDEC EM1/	476	1.075
2# EPTC Pl	452	1.079
Untreated (check)	442	1.078
4.5# DNBP EM	437	1.076
1.2# Diuron Pl	434	1.076
8# CDEC EM	434	1.075
4# EPTC Pl	407	1.079
10# FW-450 Pl	407	1.078
5# FW-450 Pl	401	1.078
5.1# Dalapon EM	397	1.078
0.6# Diuron Pl	396	1.075
4.5# DNBP + 2.6# Dalapon EM	389	1.076
2.6# Dalapon EM	379	1.077
8# EPTC Pl	376	1.077
1# Simazin Pl	372	1.075
2# Simazin Pl	345	1.074
4# Simazin Pl	168	1.073
L.S.D. 5% level	85.0	N.S.

1/ EM = Herbicides applied at emergence of potatoes.
Pl = Herbicides applied day after planting.
Potatoes planted 10 May and emerged 26 May.

Table 3. Effect of Spring Preplowing Applications of Dalapon and Amino Triazole on Yield and Specific Gravity of (Katahdins) Potatoes, 1957.

Acre rate of1/ active ingredient	Yields bushels per acre
Not treated	416
4.3# Dalapon	429
8.5# Dalapon	404
12.8# Dalapon	456
5.0# ATA	371
Significance at 5% level	N.S.

1/ Herbicides were applied 20 May '57
Plots were plowed 24 May '57
Potatoes were planted 27 May '57

Table 4. Effect of Fall Application of Dalapon on Yields and Specific Gravity of Potatoes1/

Acre rate of Dalapon (active ingredient)	Date of application	Yield 1956 Bu. per acre	Specific gravity of tubers 1956
NONE		430	1.075
5#	Oct. 21 '55	439	1.076
10#	" " "	422	1.076
15#	" " "	463	1.074
20#	" " "	449	1.074
5#	Oct. 28 '55	455	1.074
10#	" " "	435	1.074
15#	" " "	459	1.074
20#	" " "	430	1.074
5#	Nov. 4 '55	421	1.075
10#	" " "	409	1.075
15#	" " "	454	1.073
20#	" " "	442	1.075
Significance at 5% level		N.S.	N.S.

1/ Treatments were applied fall of 1955 at Presque Isle, Maine. Potatoes were planted May 1956. Plots were plowed the spring of 1956.

Table 5. Effect of Combinations of Herbicides Applied at 5 to 10% Emergence on Potato Yields. 1955

Herbicides and acre rates of active ingredients	Yield Bushels per acre
0.75# DNBP	569
3.0# DNBP	534
0.75# DNBP + 3.0# Dalapon	510
0.75# DNBP + 0.5# Monuron	507
0.75# DNBP + 1.0# ATA	506
Check (untreated	505
2.0# ATA	500
0.75# DNBP + 2.0# ATA	492
1.0# ATA	490
0.75# DNBP + 1.0# Monuron	484
2.0# Dalapon	480
3.0# Dalapon	480
0.5# Monuron	478
0.75# DNBP + 4.0# ATA	476
0.75# DNBP + 2.0# Dalapon	469
4.0# ATA	463
1.0# Monuron	455
L.S.D. 5% level	62

Table 6. Yield and Specific Gravity of Kathadin Potatoes and Number of Headed Grass Plants as Affected by Application of Dalapon and DNBP. 1954

Acre rate of active ingredient	Time of application[1]	Yield[2] Bu/acre	Headed grass[3] per sq. ft.
6.0# DNBP	Emergence	434	1.5
3.0# DNBP + 4# Dalapon 5 days prior to Emergence	Emergence	421	0.4
3.0# DNBP + 2# Dalapon 5 days prior to Emergence	Emergence	415	1.9
3.0# DNBP + 4# Dalapon	Emergence	406	0.1
4.0# Dalapon	Emergence	405	0.2
2.0# Dalapon	Post Emergence	370	0.1
3.0# DNBP	Emergence	366	1.6
2.0# Dalapon	Emergence	357	0.9
6.0# Dalapon	Emergence	356	0.1
3.0# DNBP + 2# Dalapon	Emergence	357	0.8
4.0# Dalapon	Post Emergence	350	0.0
Check (untreated)		341	6.3
L.S.D. 5% level		56	

1/ Post emergence treatments were applied when potatoes were 5 to 8 inches tall.
2/ Treatments did not significantly affect specific gravity of tubers.
3/ Echinochloa Crusgalli (L.) Beauv.

Table 7. Effect of Emergence and Post Emergence Treatments of Dalapon Upon the Value of Potato Tubers for Seed Purposes. 1955.

Rate of dalapon application 1954, and time of application	Yield in bu. per acre in 1955 of tubers taken from 1954 plots and used for seed in 1955. Tuber planted whole[1]	Tubers cut[1]
2 pounds, Emergence	486	399
4 pounds, Emergence	487	378
6 pounds, Emergence	479	323
2 pounds, Post emergence	461	338
4 pounds, Post emergence	408	316
L. S. D. 5% level	48	48
1% level	64	64

1/ whole = seed tubers planted whole
cut = seed tubers cut and planted

ACTIVITY OF EPTC AS EFFECTED BY SOIL MOISTURE AT TIME OF APPLICATION

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Data from co-operators strongly indicated that soil moisture at time of application of EPTC may be a factor which would cause variability of field results. As a result two green house experiments and one field experiment were conducted to determine the real importance of this factor.

It should be mentioned that prior to undertaking the study on the effect of soil moisture at the time of application a number of other factors had been studied. These included the effect of salt content of the spray water, irrigation at various intervals after application, soil types and soil pH, soil physical condition at time of application, soil temperature, and volume of spray solution. All of these factors within normal ranges, were found to exert little or no influence on the activity of EPTC.

In the greenhouse tests flats of soil infested with cultivated oat seeds were treated with EPTC at 2 1/2 lbs./acre. Soil moistures at time of application ranged from 1.4% to 32%. Field capacity of the soil was 15% and saturation 32%. By careful sampling of soil at different levels 24 hours after treatment it was shown that high soil moisture limited the penetration of EPTC vapors. In addition, the results indicated that the soil moisture dividing line between satisfactory and unsatisfactory control was approximately midway between field capacity and saturation.

The field test was conducted on Sorrento loam soil (F.C. = 17%) with EPTC applied at 4 lbs./acre to dry soil (5% moisture) and wet soil (near saturation). The test area was sprinkler irrigated 7 days after application. Excellent weed control was obtained where application was made on dry soil and very poor control was obtained on wet soil.

After obtaining the above data on compilation of data received from throughout the country was made to determine the correlation between soil moisture at time of application and weed control. The compilation clearly showed that poor weed control was associated with wet soil at time of application. Undoubtedly, on occasion, poor weed control will be obtained when the soil moisture is ideal at time of application. Since it is known that other factors have a small effect on EPTC activity it is possible that under certain conditions an accumulation of these factors will lead to poor control.

WEED CONTROL IN SPINACH, LETTUCE AND CARROTS - 1957

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This paper reports the results of a continuing search for satisfactory pre-emergence or selective weed killers for some of the small-seeded crops.

Spinach

Plots were well prepared and seeded to America spinach on April 16, 1957. The soil, a Scarborough very fine sandy loam, was relatively dry at the time of planting; a drought from April 9 until May 10 was interrupted by only .09 inch of rain which fell on April 25. The temperature was slightly above normal during this period. Germination of the crop and especially weeds was slower than usual. The weed killers with their rates of application are listed in Table I. The treatments were replicated four times. The chemicals were diluted with water and applied at the rate of 50 gallons per acre. The weed population consisted mainly of lamb's quarters and pigweed.

It was readily evident that Vegadex provided best weed control with least damage to the crop. Previous experience with Vegadex, however, indicated that it may cause damage to spinach on the sandier types of soils.

Chloro IPC was not at all effective while EPTC and Chlorazin reduced yields seriously.

Lettuce

Essentially the same conditions prevailed for the lettuce experiment as outlined above for spinach. The two crops were adjacent to one another and were planted and treated on the same day. Treatments are listed in Table II.

The Chloro IPC and CMU treatments were rather ineffective as compared to Vegadex which proved to be the most promising material in the test. Vegadex has also been promising on lettuce in previous tests. Both Randox and EPTC affected lettuce yields adversely.

Carrots

Some exploratory tests with carrots were carried out and these are presented in Table III. The three rates of EPTC were applied two days after planting the crop. All the other materials were applied post

*Thanks are due to the American Chemical Paint Co., Geigy Chemical Corp., Monsanto Chemical Co., and Stauffer Chemical Co. who supplied the various weed killers.

Table I. Effect of Chemicals on Weed Control, Growth and Yield of Spinach

Planted April 16, 1957 - Sprayed April 17, 1957
Recorded May 17, 1957 - Harvested June 10, 1957

Plot	Treatment	Rate per A. Lbs. Active	Weeds per Sq. ft.	Weed Height Inches	Spinach stand plants per yard	Plant Diameter Inches	Yield Lbs.
1	CIPC	1.0	18.0	1.7	8.8	5.1	22.2
2	CIPC	2.0	15.8	2.1	12.0	4.9	23.0
3	CIPC	3.0	21.5	1.9	12.3	4.5	22.9
4	CIPC	4.0	14.0	1.6	12.0	4.8	25.1
5	Vegadex	2.0	10.0	1.2	12.8	4.8	24.2
6	Vegadex	3.0	12.5	1.7	10.5	4.4	24.5
7	Vegadex	4.0	6.5	0.9	7.5	4.4	22.2
8	Vegadex	6.0	5.0	1.0	8.0	4.1	19.0
9	EPTC	4.0	12.0	1.3	8.0	4.1	17.5
10	EPTC	6.0	9.8	1.0	6.3	3.6	11.7
11	EPTC	8.0	7.3	1.0	7.3	3.1	13.2
12	Chlorazin	4.0	7.3	0.7	9.0	4.2	19.2
13	Chlorazin	6.0	5.8	0.6	9.0	4.0	16.4
14	Chlorazin	8.0	3.3	0.4	7.0	3.4	11.4
15	Check	-	19.0	2.1	10.5	5.1	18.1
L.S.D. @ .05			6.1	0.4	3.8	0.5	7.2
L.S.D. @ .01			8.1	0.5	5.1	0.7	9.8

Table II Effect of Chemicals on Weed Control, Growth and Yield of Lettuce

Seeded April 16, 1957 - Sprayed April 17, 1957
Recorded May 16, 1957 - Harvested June 27, 1957

Plot	Treatment	Rate per A. Lbs. Active	Weeds per Sq. ft.	Weed Height Inches	Lettuce Plant Height Inches	Yield Lbs.
1	CMU	0.25	17.3	1.6	2.4	62.7
2	CMU	0.33	16.3	1.5	2.4	58.7
3	CIPC	1.0	12.8	1.6	2.4	60.8
4	CIPC	2.0	18.5	1.6	2.4	68.7
5	CIPC	3.0	16.0	1.6	2.4	65.4
6	CIPC	4.0	14.3	1.6	2.5	60.9
7	Randox	2.0	5.8	1.1	1.8	54.1
8	Randox	4.0	4.0	0.7	1.3	46.4
9	Randox	6.0	3.0	0.5	1.1	32.8
10	Vegadex	2.0	8.3	1.5	2.3	62.8
11	Vegadex	4.0	12.8	1.0	2.3	60.6
12	Vegadex	6.0	8.0	1.0	2.4	63.1
13	EPTC	4.0	7.3	1.0	2.1	56.3
14	EPTC	6.0	8.3	0.8	1.9	44.7
15	EPTC	8.0	5.3	0.6	1.7	44.9
16	Check	---	22.3	1.8	2.5	55.4

Table III Effect of Chemicals on Weed Control and Growth of Carrots

Planted July 1, 1957 - Sprayed July 23, 1957
Recorded August 3, 1957

Plot	Treatment	Weed Control 1 Poor to 9 Excellent	Carrot Top Growth 1 Poor to 9 Excellent
1	1.0 lb. CIPC ≠ 75 gal. Stoddard Solvent	4.5	8.0
2	2.0 lb. CIPC ≠ 75 gal. Stoddard Solvent	6.0	6.8
3	4.0 lb. CIPC ≠ 75 gal. Stoddard Solvent	6.3	6.0
4	4.0 lb. Chlorazin	3.8	5.3
5	6.0 lb. Chlorazin	4.0	5.3
6	8.0 lb. Chlorazin	5.3	4.5
7	4.0 lb. Chlorazin ≠ 75 gal. Stoddard Solvent	7.3	7.0
8	6.0 lb. Chlorazin ≠ 75 gal. Stoddard Solvent	7.0	7.0
9	1.0 lb. G-30021	6.3	6.3
10	2.0 lb. G-30031	8.3	3.0
11	4.0 lb. G-30031	9.0	2.5
12	1.0 lb. G-30031 ≠ 75 gals. Stoddard Solvent	7.5	5.3
13	2.0 lb. G-30031 ≠ 75 gals. Stoddard Solvent	8.5	4.8
14	3.4 lb. EPTC	1.3	9.0
15	5.0 lb. EPTC	2.3	9.0
16	6.7 lb. EPTC	3.3	8.0
17	75 gals. Stoddard Solvent	3.3	8.3
18	100 gals. Stoddard Solvent	5.0	6.8
19	1.0 lb. G-30028	1.8	7.5
20	2.0 lb. G-30028	3.0	6.8
21	4.0 lb. G-30028	3.8	5.3
22	Check	1.5	9.0
L.S.D. @ .05		1.6	2.4
L.S.D. @ .01		2.1	3.1

emergence, about three weeks after the crop was planted. The carrot plants and weeds were about three inches tall at this time.

Most promising of these treatments were mixtures of Chlorazin and Stoddard Solvent. Geigy 30031 in water solutions were very effective in killing weeds but apparently the two and four pound treatment hurt the carrots. Further work with G-30031 at lower concentrations is certainly justified.

Summary

Vegadex provided good pre-emergence weed control in lettuce and spinach. Mixtures of Stoddard Solvent and Chlorazin provided excellent post emergence weed control in carrots. Tests with G-30031 at rather low concentrations seem to be justified.

Potato Vine Killing[1]

R. L. Sawyer, S. L. Dallyn, C. Collin[2]

Potato vine killing with sodium arsenite and mechanical beaters is a common thing in much of the potato acreage of the country. The methods now in use are quick killers and often impair the quality of tubers when compared to potatoes that mature normally. The work covered in this paper is aimed at finding a material which will simulate normal potato maturity in a seven to fourteen day period from time of application.

Materials and Methods

The materials listed in Table 1 were applied to Katahdin tubers on August 7 when the vines were still green but approaching the early stages of maturity. The effectiveness of kill of both stems and leaves was rated two, five and ten days after application. Tubers were dug on August 20, 3 days after the final kill rating to determine skin set and specific gravity.

Plots were single rows 30 feet long with 4 replications. Materials were applied with a hand sprayer at the rate of 100 gallons of water per acre.

Results and Discussion

The results from the various determinations made are given in Table 1. None of the materials significantly affected yield. If the check plots had been allowed to go to full maturity, there would have been a higher percentage of oversize in these plots than in chemically treated plots. This is frequently the reason for early killing.

In general the completeness and quickness of kill was closely associated with amount of skinning and feathering. The tubers with the best skin set came from plots with the quickest kill.

Those materials with the quickest kill tended to have the lowest specific gravities except in the case of Shed-A-Leaf. Shed-A-Leaf at the highest dosage, however, had only caused 50% kill of foliage ten days after application. Both liquid cyanamid and Niagrathal appear promising because of the slow stem kill. This type of kill should allow for some translocation of material to the tubers during the maturation process.

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Table 1. Performance of Several Vine Killers on Katahdin Potatoes

Material	Dosage	% Kill after 10 days Leaf	Stem	Yield	Skin Set	Specific Gravity
NA Arsenite	2	Medium	Slight	509	6.2	1.068
NA Arsenite	4	Complete	Heavy	467	6.5	1.069
NA Arsenite	6	Complete	Complete	531	7.2	1.067
Niagrathal	1/4	Medium	Medium	454	5.0	1.068
Niagrathal	1/2	Heavy	Medium	461	6.2	1.066
Shed-A-Leaf	2	Slight	None	522	5.0	1.066
Shed-A-Leaf	4	Slight	Very Slight	530	3.7	1.068
Shed-A-Leaf	6	Medium	Slight	458	6.2	1.070
Liquid Cyanamid	6	Heavy	Slight	504	5.7	1.069
Liquid Cyanamid	9	Heavy	Medium	492	5.2	1.068
Liquid Cyanamid	12	Complete	Medium	504	6.2	1.065
Check		None	None	524	4.0	1.070

Summary

Liquid Cyanamid and Niagrathal merit further investigation. The results indicate a possibility that materials may be found which will somewhat simulate normal maturity without the detrimental aspects associated with the quick kill followed closely by harvest.