Granular Herbicides and New Developments in Application Equipment 1/

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(Abstract)

Research on granular herbicides has increased rapidly in very recent years. In 1958, seven papers on this subject appeared in the Proceedings of the Northeastern Weed Control Conference. There were 22 papers in 1959. This increase is clear evidence of the interest in granular herbicides among weed research scientists, agricultural chemical manufacturers, and growers.

Review of the research in this field indicates that a balance between basic and applied investigations is now being achieved, whereas early research was concerned primarily with the direct solution of practical problems.

The accumulated data from the applied studies indicate some of the practical advantages and disadvantages of granular herbicide formulations. Some of the advantages are (1) their physical selectivity, (2) their convenience in application, and (3) the broadening of herbicide usage. Some of the disadvantages are (1) their inability to control established weeds in growing crops, (2) some herbicides do not lend themselves to granular formulation, and (3) specialized equipment is required for commercial field application. Research has shown that granular and spray formulations of herbicides may be used interchangeably for certain weed control problems, but it is also clear that each formulation can be used to perform specific functions not achievable with the other.

The lack of suitable field-application equipment for granular herbicides has been a weak link between research and practical use. This problem is being solved at present by the development and sale of specialized commercial equipment by a number of companies.

The need for basic research on granular herbicides has been recognized and preliminary investigations on a number of the fundamental aspects of their herbicidal activity are in progress. These basic problems may be grouped in four general catagories as follows: (1) chemical, (2) physical, (3) biological, and (4) environmental. The chemical problems are concerned with the chemistry of the herbicides, their solvents, the required surfactants, and other adjuvants used in granular herbicide formulation. The physical problems are associated with granule density, size, structural permanence, adsorptive capacity, and color. Some of the more obvious basic biological problems in the use of granular herbicides are those associated with the anatomical and morphological characteristics of plants. These problems involve comparisons

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1/ An invitational paper to be presented at the Northeastern Weed Control Conference in New York, January 6, 1960.

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of herbicidal activity in relation to such factors as upright versus procumbent or rosette growth habits, terminal versus intercalary growth patterns, flowering or fruiting stages of development versus vegetative stages, hairy versus non-hairy leaves and stems, waxy versus non-waxy plant surfaces, and smooth versus wrinkled or savoyed leaves. The initial herbicidal activity and residual activity of granular herbicides are affected by environmental factors such as soil composition, type of irrigation, rainfall, humidity, wind velocity, temperature, sunlight, and interactions of these factors.

Initial contributions in these basic studies indicate their value and the need for intensifying such research as a means of implementing the continuous progress in the solution of applied problems.

PROMISING NEW CHEMICALS FOR WEED CONTROL

M. W. Meadows(1)

Today we find ourselves in a most dynamic period as it refers to a widespread interest in the control of undesirable plant growth. This interest undoubtedly stems from the fact that we have a large number of old and new herbicidal materials to work with. New uses for old materials and a promise that the next new compound will be the answer to some hard to handle weed problem.

In this vein of thought we have made considerable progress during the past year.

The following is an attempt to list progress in various categories with new and old chemicals. Due to limited time and space it would be impossible to cover the many chemicals that deserve mention here.

Expanded Use of Granular Materials.

Aquatics: Chemicals such as 2,4-D, silvex and Simazine are effective against many submerged rooted aquatics. A major problem has been to get the chemical down to the bottom of a body of water in sufficient concentration at a reasonable rate per acre to obtain control of the weeds.

Impregnation or absorption of the toxicant on a specially prepared granule that will sink to the bottom of a body of water before it disintegrates or releases the chemical has effectively answered this problem. In this manner a high concentration of the chemical can be placed near the root zone of a submerged plant without making the water useless for other purposes.

An interesting innovation of this method of controlling submerged weeds has arisen from the use of granular herbicides spread on ice during the winter months thereby simplifying the application procedure.

Nursery Crops: Granular herbicides such as CIPC, Simazine and Dinitro have proven to be very effective in controlling weeds in a wide variety of nursery stocks without injury to the nursery crop.

A major problem in this field is the perfection of equipment to properly apply the granular herbicide over a range of plants that vary so much in growth habit.

Air applications: The use of aircraft to apply dusts, fertilizers and sprays is an established practice. To date however not too much attention has been given to the application equipment

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necessary for applying granular herbicides.

There are many instances where this type application could be useful - weed control on waterways (even 2,4-D could be more widely used by this method); weed control on wet or rough fields that are not adapted to ground application equipment; brush control, etc.

<u>Mulch alone and in combination with chemicals:</u> Although mulch materials have been used for centuries, plastic materials have revived interest in this practice.

More recently machines have been perfected that can lay down mulch materials quickly and efficiently. Some attention has been given to machinery for planting or transplanting crops through the mulch material.

Some work has been done with paper mulchs that will break down during the course of a year. Plastic materials will not disintegrate so quickly and present a problem of soil tillage unless the plastic is removed before tillage in preparation to plant another crop.

A possible additional value of mulch materials is the increased effectiveness obtained with some soil fumigants that can be applied to the soil in conjunction with the mulch laying operation.

<u>Combination of herbicides:</u> In many instances the complex of weeds is such that no one material is available that will give adequate control.

<u>CIPC plus Randox</u> at 6 lbs. active of each material has proven to be effective on the muck soils of New York State. Control of annual grasses, purslane, rag weed, smart weed, lambsquarter, chickweed, etc. has been attained with sprays or granulars containing the two herbicides.

<u>Dalapon plus Dinitros</u> - annual grasses have become an increasingly greater problem where Dinitros have been used as a pre-emergence weed control material on potatoes. The addition of about 3 lbs. Dalapon to the Dinitro spray mixture has resulted in good annual weed and grass control.

<u>Amino Triazole plus Simazine</u> - For purposes of soil sterilization a 1 to 3 mixture of these two materials has given excellent long lasting control of a wide variety of weeds. The combination gives an excellent burn down of existing foliage. Rates of about 6 to 12 lbs. active per acre of the combined ingredients have given soil sterilization for 6 months to 2 years.

New Approach to Brush Control:
Pelleted or granular formulations of Fenuron and Urab offer a convenient method for controlling brush. The materials can be spread by hand or machine either broadcast or in a 3' x 3' grid system. This obviates the necessity for using a sprayer and hauling water.

New Chemicals:
Triazines:
Atrazine at rates of 1 to 2 lbs. active material per acre has given excellent control of annual weeds and annual grasses when applied pre or early post emergence to corn. Late post emergence applicatinns have been effective against many broadleaf weed species without any apparent effect upon the corn.

Rates of 4 to 5 lbs. active chemical per acre pre- or post emergence to the corn have given excellent seasonal control of nutgrass.

Amiben:
Has afforded good annual weed and annual grass control in such crops as soybeans, peanuts, and carrots. A liquid spray applied at planting time has been effective at rates of 3 - 4 lbs. active ingredient per acre. Granular formulations at rates of 3 - 6 lbs. active per acre have shown promise on such transplanted crops as tomatoes, crucifers and peppers. The material, to be effective, must be applied before weeds emerge.

Fenac:
Applied in the spring to quack grass 4" to 6" tall, plowed two weeks later and planted to corn has given good control of quack grass plus seasonal control of annual weeds and annual grass. Effective rates range from 2 to 4 lbs. active chemical per acre.

Silvex:
Silvex is not a new compound but new uses are constantly cropping up. More recently it has showed promise in controlling cinquefoil in Birdsfoot trefoil as a late fall application at ½ to 1 lb. active; spotted knapweed at about 1½ lbs. active; and about ½ lb. active per acre has controlled dog fennel in wheat as a late fall, winter or early spring application.

Karsil (Niagara 4562):
Used as a post emergence spray has shown promise on such crops as celery, carrots, parsley, parsnips, strawberries and sweet potatoes. Effective rates are around 4 lbs. active material per acre. A number of crops are tolerant of directional sprays of this compound.

Solan (Niagara 4512):
Used as a post emergence spray has been effective in controlling annual broadleaf weeds in tomatoes, carrots, celery and strawberries. Effective rates have been around 4 lbs. active chemical per acre.

Dacthol (DAC 893):
A number of crops have shown tolerance to the chemical. Pre-emergence applications to such crops as carrots, cole crops, tomatoes and beans at rates of 4 - 8 lbs. have been effective. Post emergence spray applications to tomatoes and cole crops have been effective. The material is effective against germinating weed seeds.

Of considerable interest is the effectiveness of this material in controlling crab grass in lawns, at the rate of 8 - 10 lbs. active chemical applied pre-emergence to the crab grass, as a spray, has given excellent results.

Zytron (Dow M-1329):
As a pre-emergence spray application this compound has shown promise in the control of weeds in carrots.

Excellent control of crab grass has been obtained in turf. Granular formulations applied pre-emergence have been more effective than sprays.

Effective rates have been around 10 - 15 lbs. per acre.

Eptam Analogs:
Eptam has shown some excellent uses particularly in the control of nut grass in such crops as beans and potatoes.

Several of the analogs have shown excellent activity against weeds with good crop tolerance.

Stauffer 2061 incorporated in the soil at rates of 3 - 4½ lbs. per acre active chemical shows promise on such crops as the crucifers, spinach, corn, tomatoes and beans. An interesting observation has been the difference on the waxy bloom of the crucifers - Eptam destroys the bloom, 2061 does not.

2,3,6 TBA:
An additional use for this material has been the effective control of Bindweed (Convolvulus sepium) in Concord grape vineyards. Used as a spray at rates of 0.8 to 1.0 lbs. active chemical per acre in late August has resulted in no damage to grape yield and quality.

A most interesting observation is the lack of damage to grape vines with a hormone material used at these rates.

A National Organization for Weed Control and Some Significant Results

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The major part of weed control research in Canada is conducted by personnel of the Research Branch, Canada Department of Agriculture. Most of the thirty-five Research Stations and Experimental Farms and two hundred and twenty-five illustration stations condutt some form of wedd research. These units are located throughout our agricultural areas. In addition, three of the ten Research Institutes have projects closely related to weeds or their control.

In general, the Research Stations and Experimental Farms concentrate on the more practical aspects such as crop rotations, tillage, seed cleaning and spraying equipment, evaluation of herbibides and the relative tolerance of crops to these herbicides.

The Entomology Research Institute for Biological Control at Belleville, Ontario, has released insects for the contrll of St. John's Wort (*Hypericum perforatum*) and Toadflax (*Linaria vulgaris*,) and is currently studying others for use on Ragwort (*Senecio jacobaea*). Insects which control local infestations of weeds such as wild buckwheat (*Polygonum convolvulus*), burdock (*Arctium* spp.) and sagebrush (*Artemesia* spp.) at irregular intervals, are being observed and encouraged.

At the Pesticides Research Institute at London, Ontario, bacteriologists, chemists, entomologists, plant pathologists and plant pathologists working individually and in cooperation with each other, study problems associated with the use and mode of action of pesticides.

Officers trained in these and similar diciplines located in the Plant Research Institute at Ottawa, study the ecology, cytology, taxonomy and incidence of weeds and the dormancy and germination, etc., of weed seeds. The control of weeds in cereals, turf and horticultural crops is also their responsibility.

By means of extra-mural research grants our department has assisted Provincial Departments of Agriculture and/or universities. Much of the data concerning the incidence of persistent perennial weeds was made possible by the Dominion Provincial Cooperative Weed Surveys started in 1949. Reference will be made to some of this data later. The current studies on some phase of the life history or control of the following weeds were made possible by these grants.

Russian knapweed (*Centaurea repens*) and Ragwort (*Senecio jacobaea*) at the University of British Columbia; Leafy spurge (*Euphorbia esula.*) Toadflax (*Linaria vulgaris.*) and Wild Oats (*Avena fatua*) at the University of

Let us now consider some of our important legislation -

Legislation

The Plant Products Division of the Production and Marketing Branch, Canada Department of Agriculture, administer several Acts which have a bearing on weed control. In addition, their laboratories analyze seed drill survey samples and conduct longevity and dormancy studies. All matters pertaining to the registration and sale of pesticides are handled under the Pest Control Products Act. It would be comparable to the Federal Insecticide, Fungicide and Rodenticide Act in this country. In Canada, however, no further provincial registration is necessary. Similarly, feeds and feeding stuffs are graded and licensed under the Feeding Stuffs Act. It limits the amounts of certain weed seeds in their preparation. The sale, importation, testing and inspection of seed for seeding purposes is regulated by the Seeds Act. Under it the total number of weed seeds is controlled, certain species are prohibited and the number of noxious weed seeds limited. It is governed on a grade basis.

The number of weed seeds in grades established for wheat, oats, barley, flax, rye and corn when sold for feed or for human consumption is governed by the Canada Grain Act. This Act is administered by the Board of Grain Commissioners.

We have no uniform overall weed control act. Each province is entitled to and most have their own provincial weed control acts.

I would now like to say a few words about the National Weed Committee -

The National Weed Committee

The National Weed Committee was set up in Canada to study the weed problems and make recommendations as to what can and should be done about them. It is composed of key representatives from research stations, universities, agricultural colleges and departments of agriculture who meet with technical representatives of the trade.

The National Weed Committee is divided at the Ontario-Manitoba border into an Eastern and Western Section, each of which hold regular meetings. I am the full time executive secretary and am located in Ottawa. Each section has two main committees. The Research Appraisal and Recommendations Committee reviews the current data and status of each project and issues weed control recommendations. Further research is planned and outlined by the Research Planning Committee. There are also several sub-committees for the major weeds, legislation and extension.

The Annual Research Report for each section contains up-to-date information on all major weeds, projects or investigations etc. It forms the basis for the weed control recommendations which are agreed upon at our annual meetings. These recommendations are in turn adopted or modified by the provincial Departments of Agriculture. Thus, the National Weed Committee has made it possible for weed workers from all these groups and interests to come together, exchange information, and reach agreement on

An effiient division of labour has been evolved and very good cooperation has existed and continues to exist between Dominion, Provincial, university and industrial workers. Our committee is an organized body to which all problems, criticisms, suggestions and inquiries from individuals or agencies, both domestic and foreign, can be referred. It is a repository and a clearing house for policy information on weeds.

It is believed that this organization set up under one department of agriculture, utilizing the facilities of all research institutions and uniting all weed workers, is both unique and remarkable. The balance of this paper will deal with some of the significant data produced by a few of our units.

Botanical Surveys

Botanical surveys have been conducted on most of our agricultural land and also on large areas of non-crop land, by members of the Canada Department of Agriculture, Provincial Departments of Agriculture and by University personnel. Collections and observations are available on 12,000 species. The incidence and distribution of each of them is available. Although we recognize more than 1000 weedy species only about 200 of these are considered to be of economic importance.

The most significant survey data (1) concerns the incidence of certain perennial weeds in Western Canada. (See Table 1.). Only small parts of each province have been surveyed.

TABLE 1

Acres infested with certain perennial weeds in Western Canada.

Weed	Manitoba	Saskat-chewan	Alberta	British Columbia	Totals
Russian Knapweed *Centaurea repens* L.		1,899	10,560	30	12,489
Hoary cresses *Cardaria* spp.	patches	1,356	128,000	600	129,956
Field bindweed *Convolvulus arvensis* L.	13,920	4,681	26,400	1,000	46,001
Leafy spurge *Euphorbia esula* L.	8,000	7,706	39,680	100	55,486
Toadflax *Linaria vulgaris* Hill	patches	134,602	319,000	475	454,077

Surveys such as these aid those responsible for the control campaigns. It has been shown, for example, that 57% of the acreage infested with leafy spurge is cropland, while 27% has been dropped from cultivation usually because of the weed. The other 16.7% occurs in land which has never been cultivated.

Toadflax, by comparison, was on cultivated land in 86% of the surveys.

Taxonomic Studies

Growing tests by the author revealed that Wild Carrot (Daucus carota), commonly believed to be a biennial or a short-lived perennial, also can germinate and flower in one year. This is believed to explain why some spray operations have been successful initially when the annuals would be removed, but later treatments have not been satisfactory. Yellow rocket (Barbarea vulgaris) has been found with roots showing eight annual rings thus indicating that it can be more than an annual or biennial. (2)

The fifteen areas where Cypress spurge (Euphorbia cyparissias) is causing control problems have been found to be the type which produces seeds. The other infestations are not spreading rapidly because no seed is produced.

We are constantly watching for new arrivals or for changes in the economic status of any weed. Star-flowered Solomon's seal (Smilacina stellata) (3) a native plant which has been behaving itself quite well until recently, has been found invading adjoining hay and range land in southern Alberta. Australian Field Pea (Swainsonia salsula) (4) which was declared noxious by the states of Colorado and Wyoming in 1954, was found in Saskatchewan (Canada) for the first time in 1958. These plants were "spotted" by officers from our research stations at Lethbridge, Alta., and at Swift Current, Sask., respectively.

A possible explanation for the persistence and spread of certain species has been the production of hybrids. These have been found in goatsbeard (Tragopogon pratensis X T. dubius), knapweeds (several Centaurea combinations) and in hawkweeds (Hieracium).

Recent anatomical studies (5) of the subterranean organs of leafy spurge (Euphorbia esula) at the University of Saskatchewan, have indicated rather strikingly why this weed is such a problem. Tissue differentiation in primordia of lateral organs developing on roots does not take place while the primordia are within the parent organ. In its earlier stages of development, therefore, a shoot primordium cannot be distinguished morphologically from a root primordium. This would suggest that the primordia, until their emergence from the mother root, are potentially capable of forming either a root or a stem.

Let us now turn to a consideration of some investigations on the penetration and persistence of herbicides in the soil.

The Penetration and Persistence of Herbicides in the Soil

The soil penetration and persistence of erbon at rates ranging from 20 to 160 lbs. per acre was studied (6) at the Ontario Agricultural College at Guelph, Ontario. As erbon is believed to be split into dalapon and 2,4,5-T type moieties under soil conditions, it was possible to determine by chemical analysis (Dow Chemical Company method) the concentrations remaining in the soil. During the first six weeks, penetration of dalapon was relatively slow, at 2 weeks 5.4 per cent and at 6 weeks 4.2 per cent was found in the 4-8 in. layer. Total rainfall during this period was 5.36 in.

A continual drop in the dalapon content was observed during the course of the season. This loss was most rapid during a period of heaviest rainfall and during the latter part of the season. At 10 weeks there was only 33.7 per cent as much dalapon present as at the end of 2 weeks, or a net loss, in the 8-week interval of 54.9 per cent. No dalapon was found at any of the sampling depths one year later. The total precipitation during the experimental period was 39.3 in. No damage was observed where oats were planted on all plots one year after treatment.

The penetration and persistence of monuron (7) at rates from 1.6 to 64 lb/A in the same types of soil was also studied.

On most of the plots over 90% remained in the 0-2 in. layer during the first year. By the following spring an average of over 44 per cent had penetrated below the 2 in. depth, and by the end of the first year approximately 90% had disappeared from all except the most heavily treated plots. Oats were planted as indicator crops. After three years the 16 lb. plot showed 70% survival of oats and only a few plants survived on the 32 lb. plot. These workers believed that photodecomposition was a factor during the first few weeks, but under field conditions the disappear of this chemical is due primarily to microbiological decomposition.

In tests at the University of British Columbia (8) Simazine at 20 lb/A was shown to leach down 4½ inches in clay loam and 5½ inches in sandy loam in a 3-month period.

Unfortunately time does not permit presentation of further examples of this nature. Let us now consider some results of physiological investigations.

Influence of Daylength on Species of Chenopodium (9)

Preliminary investigations with response to photoperiod as the sole variable factor, revealed three main groups.

(1) Annual species. No initial rosette stage develops and plants flowering most rapidly under short daylengths (SD) of 6 to 8 hours and least rapidly under continuous light.
(a) Under SD floral initiation can occur within 12 days from the time of visible germination with a minimum leaf number prior to flowering of between 2 and 5; perianth and male members may be absent. Example: C. glaucum L. var. glaucum Aellen.

(2) Annual species. Have an initial rosette stage and stem elongation is inititated just prior to flowering. Floral initiation is most rapid and minimum leaf number least under continuous light. Example: *C. capitatum* (L.) Aschers. As this species becomes more common northward, daylength may be a factor governing its distribution.

(3) Perennial species. Have no rosette stage and a rate of stem elongation less rapid than in (1). In addition, these species, such as *C. californicum* S. Wats, under optimum daylength conditions take longer to flower than do the species in (1) or (2).

Differential susceptibility of Wild Carrot (10)

Spray tests conducted at the Agricultural College, Guelph, Ontario revealed that some strains of wildcarrot, even though they showed initial injury symptoms, survived 2,4-D and also treatments with M C P B and 2,4-DB. The chemical 2,4-D caused no differences in the germination of seeds from suseeptible and resistant plants. Elongation of radicles in the presence of 2,4-D was also similar.

This difference in susceptibility appears to arise between the time the seed germinates and the cotyledons expand. Possible explanations are that rapid catabolism is carried out by the resistant plants or that these herbicides are absorbed in these plants on certain proteinaceous materials to a greater extent than in the susceptible strain.

Growth Suppression (11)

Distilled water extracts of ground leaf and stems of Russian Knapweed were found to inhibit the germination and radicle development of alfalfa, alsike clover and turnip seeds when these were moistened with the extracts. A 10% solution prevented any germination of turnip, reduced the alsike by 65% and the alfalfa by 34%. On the other hand, the same concentration had hardly any effect on the germination of barley and perennial rye grass. That Russian Knapweed does influence the development of nearby plants was indicated when tomato seedlings were transplanted into soils which had been growing this weed. Nine weeks later the average fresh weight was over 100 grams less than the check plants.

Influence of ATA on Photosynthesis and Respiration (12)

Potted greenhouse plants of bush beans at the first trifoliate leaf stage and wheat at the three leaf stage were sprayed with an aqueous solution of ATA at 4000 ppm. Distilled water was sprayed on the controls. Two, 5, 24, 48 and 96 hours later one - c m disks, cut from the bean leaves and one c m segments from the wheat leaves were taken. Warburg flasks, covered with aluminum foil were used to measure respiration and four containing an atmosphere of 1% CO_2 and illuminated by mazda light of 1200 foot candles, were used to measure apparent photosynthesis. The sum of oxygen consumed in the dark and evolved in the light was taken as indicative of true photosynthesis.

An immediate and continued increase in respiration occurred in the bean plants. This was 115% of that of control plants within 2 hours and rose to 232% by the 96th hour. The photosynethetic rate dropped to 75% of that of control plants within 2 hours and decreased steadily thereafter. A similar response was measured in wheat. Bleaching of primary and first trefoliate leaves was evident within 48 hours of treatment and was very pronounced after 72 hours. It is apparent that amitrol is absorbed very quickly by the leaves of both plants and immediately brings about an increase in rate of respiration and a decrease in rate of photosynthesis. This work was conducted at the University of British Columbia.

Wild oats, the number one weed of Western Canada, is a good example of how our national organization can focus attention on one problem and secure results.

<u>Wild Oats</u>

Surveys by workers from the Experimental Farm at Regina, Sask., and other groups in western Canada have revealed that wild oats infests some 85% (or 30 million acres) of crop land in the Prairie Provinces to some extent. 45% of which could be considered to be seriously infested. (13. The losses caused from this one weed are believed to exceed those caused by stem and leaf rust of wheat combined. It is understandable therefore, that a large percentage of our research and investigational effort has been with this weed. It has been established that there are four types or varieties, namely; vilis, glabrata, intermedia and pilosissima, and that these varieties are distributed in varying concentrations and mixtures. Although the variety glabrata was found in all three Prairie Provinces with the exception of the Peace River district of Alberta, the percentage of any one population was never higher than 7. The variety intermedia was found to comprise 86% of the wild oat population at Lacombe, Alta. and the variety pilosissima constituted the highest percentage at Indian Head, Sask.,

To further complicate the problem, it has been established at the Research Station, Lethbridge, Alta. that the seeds of these four types have different degrees of dormancy, the latest information indicates that the degree of dormancy is related to the color of the hull. The first two named, namely; vilis and glabrata with grey hulls showed a germination of 45 and 42% respectively, while the other two varitties were found to have brown hulls and germinations as low as 11% (14).

This relationship between color of hull and dormancy was confirmed by similar tests on seeds from nine locations and periodic tests throughout one year. When the dormant seeds were de-hulled and the seed coats pricked, all four varieties germinated 100%.

At present the most successful method of cultural control is to delay seeding until one or two crops of wild oats can be cultivated out and an early maturing variety, usually barley, is seeded at a rate slightly heavier than normal. The weather however, is unpredictable, and continued wet weather may result in a weedy crop or no crop at all. To offset the possibility of poor weather for cultivating in the spring, research at Regina and Indian Head has shown that fall tillage of stubble land is more effective in reducing wild oats in barley than spring tillage, thus providing one more opportunity for effective control.

The main reason why wild oats are a problem is their ability to shatter early and remain dormant in the soil. Where wheat has been grown continuously, as in areas where barley does not prosper, 6000 wild oat seeds have been found in the top inch of one square yard of soil. Several teams have been delving into this interesting phenomenon of dormancy. A few of their findings would be of interest here.

Seed at maturity with practically no dormancy become dormant after six days in a nitrogen atmosphere. (15) Dormancy can also be induced by soaking the seeds in air-free water under certain temperature and light conditions. (16) The dormancy induced by these methods was shown to be similar to natural dormancy in persistence during storage and could be readily reversed by the breakage of the seed coat. Investigations into the role of the hull in relation to dormancy have indicated that the hull contains a germination inhibitor. As this inhibitor extracted from the hull caused dormancy in dehulled seeds, the hull itself was exonerated. It is suggested that this inhibitor prevents the utilization of carbohydrate reserves in the endosperm. The carbohydrate reserves of the embryo are depleted by anaerobic respiration. The seed would therefore be unable to germinate due to the lack of available respiratory substrate.

A tremendous effort has been put forth in recent years to find a suitable chemical which will control this weed. Forty-two abstracts were reported in the 1959 Research Report for Western Canada representing work at nine research stations and three universities.

Of the 16 chemicals used as pre-planting treatments, C D A A and T C A were promising in sugar beets; simazine, atrazine and trietazine in corn; C I P C and eptam in flax and avadex in flax and barley. Carbyne, a new carbamate, for post-emergent treatments, has given promising results in wheat and barley.

Today, our teams of agronomists, cerealists, extension men, plant physiologists and plant ecologists are continuing their efforts to find a practical control for this problem.

In conclusion, may I again thank you for inviting me to your Conference, and giving me this opportunity to tell about our national organization for weed control and give some of our results.

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The Effect of Urea Herbicides on Photosynthesis

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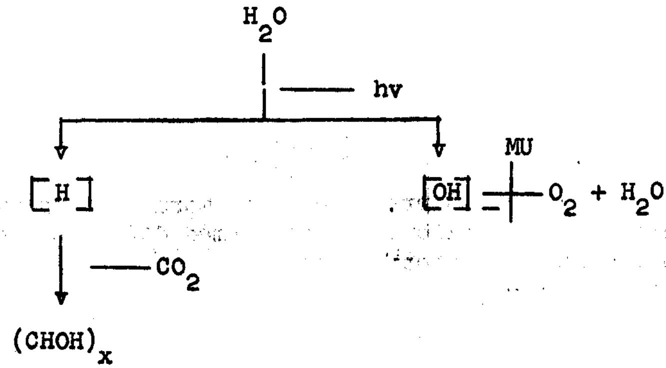
The specific effect of the urea herbicides on plants suggested that they may act through blockage of photosynthesis. In accord with this point of view, it has been found that less than 1 ppm of monuron abruptly halts oxygen evolution from Swiss chard chloroplasts. In studies with euglena it was found that oxygen evolution can be halted without affecting respiration and that removal of monuron by washing restores the ability of euglena to evolve oxygen. This finding indicates that primary action of the urea herbicides is to interfere with the operation of the photosynthetic apparatus without altering its structure (1).

Monuron impedes the growth of euglena in the light, but not in the dark, on an organic medium. This finding indicates that the effect of the urea herbicides is mediated through the generation of a phytotoxic material in the light, rather than through starvation resulting from the inaccessibility of photosynthate

Whereas 1 ppm of monuron markedly inhibits the growth of euglena in the light, over 50 ppm are required to inhibit the growth of a photosynthetic bacterium <u>Rhodospirillum</u> <u>rubrum</u>. Monuron at 1/4 ppm halts photosynthetic phosphorylation in Swiss chard chloroplasts, but photosynthetic phosphorylation in extracts of Rhodospirillum rubrum is much more resistant. These facts suggest that the site of action is on the oxygen-liberating pathway, which is present in algae but absent in the photosynthetic bacteria.



This viewpoint was confirmed through experiments with scenedesmus in which an alternative pathway for the removal of the [OH] fragment was provided by reduction with molecular hydrogen (2). Under these conditions carbon dioxide fixation was not affected by monuron. Similarly, the effect of monuron on the rate of growth of chlorella was found to be dependent on the presence of carbon dioxide. This is interpreted as indicating that photosynthesis must occur to permit the phytotoxic material on the oxygen-liberating pathway to accumulate.

From these experiments it seems likely that monuron acts very close to the early steps in which light is converted to excitation energy in the chlorophyll molecule and then to the chemical energy required for the photosynthetic process.

Experiments on the effect of monuron on light re-emission (3) indicate that the light energy absorbed by the chlorophyll resides briefly in chemical intermediates in the photosynthetic system before being re-emitted. An analysis of the kinetics of the decay curves of the re-emitted light as a function of temperature has provided evidence that the monuron block is less than 2.5 kilocalories removed from the singlet state of the excited chlorophyll molecule.

Flavin mononucleotide has been found capable of interacting with monuron in the presence of light containing energy in the blue region of the spectrum to form a reaction product no longer capable of inhibiting photosynthesis. In this way treatment of plants with flavin mononucleotide has enabled them to withstand an otherwise lethal treatment with monuron.

Summary

Evidence is presented that monuron acts by causing to accumulate a phytotoxic material formed during the process of oxygen evolution in photosynthesis.

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BACTERIAL DECOMPOSITION OF HERBICIDES

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The reciprocal relationships of various weed and brush control chemicals and soil microorganisms has been the subject of study in this laboratory for more than ten years. Chemical compounds employed have included representatives of the aryloxy, dinitro, substituted urea, chlorinated acid, triazine and triazole types of herbicides and many related compounds. The effect of the chemical compound on the biological activities in the soil has been investigated by the use of modified Lees-Quastel soil percolators employing changes in the nitrification rate as a measure of changes in the activity of the soil microflora. The effect of the soil microflora on the chemical compound has been studied by the use of percolators and by shake-flask enrichment and pure culture techniques. Central Pennsylvania soils have been employed and have included samples of high and low organic matter content.

Results obtained in the study of the effects of five compounds on soil nitrification are presented in Table 1. In a footnote to this table are listed compounds studied which were found to be similar in effect on nitrification to four of the five compounds for which tabular data are presented in the table. Attention is called to the rates of application of these compounds, ranging from a minimum application of 25 ppm to a maximum of 150 ppm. In many of the studies, rates of 500 and 1000 ppm have been used and in some instances rates have ranged upward to a maximum of 3500 ppm. The minimum rate, 25 ppm, is much greater than recommended field applications. These rates were employed for a number of reasons. In the first place, a significant amount of the compound is necessary in the analytical procedures employed. In addition, large amounts are necessary under those conditions in which the compound under investigation provides the sole energy source available to the heterotrophs of the soil. Finally, it should be noted that the attempt was made throughout the investigation to provide optimum conditions for the aerobic population of the soil. Temperature was maintained at 23-25 C and aeration provided at all times. Nitrification was brought to a maximum for the soil under study prior to the introduction of the organic compound. It is believed that results obtained under these conditions should be comparable to those obtained in field experiments in which much lower application rates are employed.

The data presented in Table 1 show that under the experimental conditions employed maximum nitrification is restored in periods ranging from 28 to 80 days with applications of 25 ppm. It should not be assumed

Table 1

Nitrification inhibition by soil treatments with herbicides and other toxic compounds. Soil not treated previously*

Nitrification as compared with control expressed in per cent (control taken as 100 per cent)**

Days	ppm	2,2-dichloropropionic acid Na salt	$K_3Fe(CN)_6$	2,4-dinitro-*o*-*sec*-butyl-phenol	2,4-dinitro-*o*-*sec*-butyl-phenol, triethanolamine	3-(*p*-chlorophenyl 1,1-dimethyl-urea
14	25	30.0	59.3	29.9	6.3	5.0
	50	22.5	58.3	3.6	4.2	2.8
	100	20.1	50.0	3.8	2.2	1.4
	150	1.5	3.6	2.3	2.2	1.4
28	25	95.0	61.4	26.2	34.7	44.0
	50	80.1	58.6	15.1	3.8	4.6
	100	76.6	53.2	6.1	3.4	3.6
	150	47.5	37.7	5.9	3.5	3.5
40	25			28.2	47.8	45.0
	50			15.6	7.9	5.0
	100			14.0	3.6	4.0
	150			14.1	3.4	1.5
60	25			100.0	80.9	57.1
	50			100.0	59.8	8.1
	100			100.0	4.9	4.1
	150			18.0	3.3	2.7
80	25					97.0
	50					23.6
	100					23.4
	150					2.0

Table 1 (Continued)

* Studies conducted in modified Lees-Quastel percolation units employing a field soil in which maximum nitrification had been established by percolation with N/30 ammonium sulfate solution for 35 days.

** 2,2-dichloropropionic acid, sodium salt. Results presented for this compound are similar to those obtained with the sodium salt of 2,4-dichlorophenoxyacetic acid. Esters and amine salts of the latter exhibit slightly greater inhibition.

$K_3Fe(CN)_6$. Results presented for this compound are similar to those obtained with $K_4Fe(CN)_6$, $Na_4Fe(CN)_6$ and KSCN. Cyanates and cyanides were found to exhibit somewhat greater inhibition.

2,4-dinitro-o-sec-butyl-phenol. Results similar to those obtained with this compound were obtained with 2,4-dinitroresorcinol, 2,4-dinitrotoluene and toluene-2,4-diamine.

2,4-dinitro-o-sec-butyl-phenol, triethanolamine. Similar results were obtained with the ammonium salt of this compound.

Comparable data are at present incomplete on the following compounds under study: 2,4,5-trichlorophenylacetic acid; 2,3,6-trichlorophenylacetic acid; 3-amino-2,5-dichlorobenzoic acid; 3-amino-1,2,4-triazole and 2-chloro-4,6-diethylamine-1,3,5-triazine.

that this restoration coincides with the disappearance of the compound from the soil. Our data indicate that maximum nitrification is restored in the presence of significant quantities of the compound. It would appear to be an adaptation of the nitrifying population to the environment.

The data presented in Table 2 tend to confirm this hypothesis of adaptation. These data show the effect of the second application made 120 days after the first. It will be noted that with an application rate of 25 ppm, maximum nitrification was restored in a period of less than three weeks in all cases. This is in contrast to the 80 days required for resumption of normal nitrification following the first application of 25 ppm 3-(p-chlorophenyl)-1,1-dimethylurea (Table 1). Analysis showed that although this compound was disappearing at a somewhat more rapid rate following the second application than had been true following the first application; nevertheless, most of the compound was present when the maximum rate of nitrification for the soil was resumed.

One may speculate as to what has taken place in the nitrifying population. Adaptive enzyme systems, selection, mutation are possible answers. We have no direct evidence that all important segments of the soil microflora are undergoing similar changes but it may be assumed that this is true. Present plans call for future investigation in this area.

The portion of this investigation which has dealt with the effects of organic herbicides and related compounds on the biological activities of the soil may be summarized briefly. Using nitrification as a measure of this effect, it may be concluded that applications of 25 ppm produce only temporary depression of activity and that this depression is less marked following a second application of the compound. The duration of the depressing effect varies with the compound but in general chlorinated compounds have been found to depress nitrification for a shorter period of time than compounds containing significant amounts of nitrogen. However acceptable nitrification may be as a measure of the effect of a compound on the biological activities of the soil, it is not useful in determining the persistence of an organic additive in the soil because of the pronounced tendency of the nitrifying population to adapt to the new environment.

With the knowledge that certain important biological activities in the soil are depressed only temporarily by applications or organic herbicides as large as 25 ppm and that these activities are resumed in the presence of significant concentrations of the compound, the more important questions from the standpoint of use of such compounds are these: How long do these compounds persist in soil? What agencies are responsible for their removal? Do toxic by-products of their decomposition remain? The major portion of the work on herbicides in this laboratory has been devoted to an attempt to answer these questions.

Table 2

Nitrification inhibition by soil treatments with herbicides and other toxic compounds. Soil received second treatment 120 days after first treatment*

Nitrification as compared with control expressed in per cent (control taken as 100 per cent)**

Days	ppm	2,2-dichloropropionic acid Na salt	$K_3Fe(CN)_6$	2,4-dinitro-o-sec-butyl-phenol	2,4-dinitro-o-sec-butyl-phenol, triethanolamine	3-(p-chlorophenyl) 1,1-dimethyl-urea
14	25	100.0	100.0	10.0	17.1	44.4
	50	100.0	100.0	5.7	7.3	11.1
	100	78.5	100.0	5.3	5.5	12.2
	150	53.4	60.0	5.6	6.1	11.1
20	25			100.0	100.0	100.0
	50			100.0	100.0	62.8
	100			100.0	76.2	54.2
	150			90.9	71.4	22.8

* Studies conducted in modified Lees-Quastel percolation units employing samples of field soil presented in Table 1.

** Compounds listed in footnotes to Table 1 as behaving in similar manner to those for which data are presented likewise were found comparable in nitrification studies following second application of the compound.

The microflora of the soil have been found in these investigations to be the most important agency responsible for the disappearance of any organic additive employed. Two important groups of soil bacteria, the soil diphtheroids (Corynebacteriaceae) and the soil pseudomonads (Pseudomonas species) have been found to share the major burden of removal of such compounds from soil. There is presented in Table 3 information concerning the types of organic compounds which members of these two groups may use as sole energy source. Whether more than one species of the soil diphtheroids is involved is still a question. If one is a "lumper", he may conclude that all of the chlorinated acids, triazoles, triazines and nicotine are primarily attacked in the soil by variants of a single species, a species known at one time as Bacterium globiforme, a common soil diphtheroid. On the other hand, the degree of adaptation to a compound is great and it is possible that several closely related species are involved. In the case of the pseudomonads it is obvious that a number of species of the genus Pseudomonas are active, each with its own preference as to the type of herbicide or related compound it will attack for energy.

Table 3

Type of organism found responsible for the microbial decomposition of certain herbicides and other toxic organic compounds

Organism	Compound
Corynebacteriaceae species (soil diphtheroids) at times associated with species of Streptomycetaceae	chlorinated phenoxyacetic acids chlorinated phenylacetic acids chlorinated phenols chlorinated benzoic acid chlorinated propionic acid triazoles triazines nicotine
Pseudomonadaceae species usually species of Pseudomonas	dinitrophenols dinitrocresols dinitroresorcinols dinitrotoluene chlorinated dinitrophenols substituted ureas thiourea guanidine semi-carbazide ferricyanides ferrocyanides thiocyanates

Although the Lees-Quastel type soil percolator proved advantageous in following the nitrification process in a soil sample, there are definite disadvantages to its use in attempting to follow the decomposition of small amounts of organic additives. Accordingly, other techniques were employed to supplement the information gained from the percolator studies. Chief among these techniques was pure culture study of soil isolates in shake-flasks. At times the shake-flask was employed in obtaining isolates by the enrichment technique. In a few cases results obtained by the use of percolators and shake-flasks were confirmed by the use of the Warburg apparatus.

Analytical procedures varied with the compound under study. The destruction of aryloxy type herbicides was followed by both ultra-violet absorption spectra and chloride-chlorine determinations. The former proved possible in percolation studies if the soil sample was low in organic matter and had been leached with ammonium sulfate solution prior to the introduction of the herbicide. Some of the other chlorinated compounds were followed by chloride-chlorine determinations. The use of the Beckman Model B proved satisfactory in following some of the dinitro type compounds in shake-flask culture. The type and quantity of nitrogen compounds present in the flask were used in following urea and certain substitution products of urea. Solubility was also made use of in the case of some of the substituted ureas. Oxygen uptake and carbon dioxide evolution were made use of in train type setups and in Warburg studies.

It may be stated without qualification that by the employment of these techniques it has been possible to demonstrate the use of every compound investigated by one or more soil isolates as an energy source. The extent of reproduction in the case of a few of the many compounds studied is shown in Table 4. It will be noted that the cell concentrations at the end of incubation ranged between 3×10^6 and 8×10^8. At the time many of these values were obtained, the extent of adaptation to a compound following the fifth serial transfer was not realized. As a result this table is incomplete without record of transfer used. This information is given in the right hand column. It should be noted that with organisms of this size growth is not macroscopically visible with values below 5×10^7. In many cases, therefore, the extent of growth was not apparent until plate counts had been made.

Of greater importance than cell yield is destruction of the compound. Results obtained with a few of these compounds are presented in Table 5. As in the case of reproduction the values are not in proper perspective in the absence of knowledge as to the serial transfer used. This information is given in the third column of the table. Incubation period is also of considerable importance. It will be noted that one rather difficult compound was incubated for a period of 35 days. An incubation period of 20 days showed a destruction of about 62 of the original 500 ppm, at 35 this value had increased to 98.

Table 4

Reproduction of soil isolates in mineral salts broth containing 500 ppm of herbicide or other toxic compound as sole energy source*

Compound	Concentration Cells Reached	Days' Incubation	Notes
2,4-dichlorophenoxy-acetic acid, Na salt	7×10^8	3	at 75th trf.
2,2-dichloropropionic acid, Na salt	4×10^6	3	at 7th trf.
3-amino-1,2,4-triazole	8×10^6	3	6×10^8 at 35 da incubation
2-chloro-4,6-diethylamine-1,3,5-triazine	5×10^6	4	at 8th trf.
1-methyl-2-(3 pyridyl) pyrrolidine	8×10^8	5	at 75th trf.
2,4-dinitro-<u>o</u>-<u>sec</u>-butyl-phenol	6×10^8	3	at 20th trf.
2,4-dinitro-<u>o</u>-cresol	1×10^7	3	at 7th trf.
2,4-dinitrophenol	3×10^8	3	at 7th trf.
1,1-dimethylurea	1×10^7	4	at 7th trf.
1,3-dimethylurea	2×10^6	4	at 7th trf.
3-(<u>p</u>-chlorophenyl) 1,1-dimethylurea	8×10^6	4	at 80th trf.
Urea	8×10^6	4	4×10^7 with atm O_2
$K_3Fe(CN)_6$	3×10^6	4	at 5th trf.
KSCN	3×10^6	4	at 5th trf.

* Concentration of inoculum ranged from 5×10^2 to 2×10^3. Shake-flask

Table 5

Destruction of herbicides and other toxic compounds by pure cultures of soil bacteria growing in mineral salts solutions containing the compound in question as the sole source of energy*

Compound	Organism	Transfer	Days Incubated	ppm Destroyed	Analytical Method
2,4-dichlorophenoxy-acetic acid, Na salt	Corynebacter-iaceae sp.	75th	4	340	UV absorption
2,2-dichloropropionic acid, Na salt	Corynebacter-iaceae sp.	8th	3	89	Cl dtmn
3-amino-1,2,4-triazole	Corynebacter-iaceae sp.	10th	35	98	AC Co method
1-methyl-2-(3-pyridyl) pyrrolidine	Corynebacter-iaceae sp.	80th	7	490	UV absorption
2,4-dinitro-*o*-*sec*-butyl-phenol	Pseudomonas putida	16th	20	482	Absorption spectra
2,4-dinitro-*o*-cresol	Pseudomonas cruciviae	12th	7	122	Absorption spectra
1,1-dimethylurea	Pseudomonas desmolyticum	80th	3	138	Nitrogen form
3-(*p*-chlorophenyl) 1,1-dimethylurea	Pseudomonas desmolyticum	80th	30	375	N form and solubility

* 500 ppm of compound in mineral salts broth; shake-flask incubation at 23 C.

Some knowledge of adaptation of an isolate to a herbicide may be gained by a glance at the data presented in Table 6. This isolate was obtained by the enrichment technique using an original inoculum of soil from the Jordan Fertility Plots. The isolation was made from the fifth serial transfer in the enrichment process and immediately tested for its ability to decompose the herbicide in a herbicide-mineral salts broth. An incubation period of 20 days resulted in the destruction of slightly more than fifty per cent of the 500 ppm present. The isolate was transferred serially through this medium and tests were made following the seventh, eighth, twelfth and sixteenth serial transfers. Adaptation proceeded, as may be seen by the data presented in Table 6, to the point at the sixteenth transfer where only 18 of the original 500 ppm of the herbicide remained. Similar experiences were not uncommon during the study of adaptation. Whether this may be accounted for by adaptive enzymes, selection or mutation is not known. The ability to attack the herbicide is readily lost if serial transfer is made in nutrient broth. Loss is not as rapid as a rule if the substrate is nutrient agar.

Table 6

Effect of serial transfer in herbicide-mineral salts broth on utilization of herbicide*

No. of transfers in medium	Concentration of herbicide in ppm				
	0 days	5 days	10 days	15 days	20 days
5	490	385	315	280	230
7	500	347	214	148	120
8	493	340	200	159	100
12	490	230	155	100	50
16	488	155	47	40	18
Uninoculated control	500	487	480	482	480

* Shake-flask incubation, 23 C., *Pseudomonas putida* in mineral salts broth containing 500 ppm 2,4-dinitro-*o*-*sec*-butyl-phenol. Organism was isolated by enrichment technique using broth of this composition.

This investigation has yielded some information on the decomposition products of certain of these compounds. By use of the Warburg apparatus, ultra-violet absorption spectra and a few other determinations data have been accumulated which indicate:

(1) The ring in the case of aryloxy compounds is subjected to early attack; carbon dioxide evolution does not exceed oxygen uptake until at least fifty per cent of the compound is destroyed and decarboxylation of the side chain begins at about this point; appearance of chloride-chlorine bears an inverse relation to ultra-violet absorption; end products are chloride-chlorine, carbon dioxide and water.

(2) In the case of nicotine, dehydrogenation takes place before either ring is broken and an intermediate with its own ultra-violet absorption spectrum accumulates; end products are ammonia, carbon dioxide and water.

(3) In the case of 2,4-dichlorophenol, the end products are chloride-chlorine, carbon dioxide and water.

(4) In the case of urea, the amount of nitrate-nitrogen found depends upon oxygen availability; if incubated in an atmosphere of oxygen the end products are nitrate-nitrogen and carbon dioxide; with less oxygen available a great deal of the nitrogen is in the form of ammonia and fewer cells are produced.

(5) In the case of 1,1-dimethylurea, less than thirty per cent of the nitrogen can be accounted for as nitrate in an atmosphere of oxygen; the remainder of the molecule can be accounted for as ammonia, carbon dioxide and water.

(6) In the case of 2,2-dichloropropionic acid, carbon dioxide evolved is roughly related to chloride-chlorine released.

(7) In the case of the dinitro compounds, it has not been possible to account for all the nitrogen following shake-flask incubation, a situation that holds for urea and the substituted ureas in shake-flask culture. It is believed that some is lost as N_2 or N_2O. There is reason to believe that certain intermediates may persist for some time.

(8) In the case of triazoles and triazines, it has been impossible to date to arrive at good nitrogen balances. The same is true of carbon although less accuracy is expected in this case.

In summary it can be stated that all compounds employed have been found useful by some soil bacteria as energy sources. Some are decomposed much more rapidly than others, but in most cases it is easily possible to demonstrate progressive adaptation to the compound. With proper temperature, moisture, and aeration, none can persist over long periods of time. Intermediates may be of more significance in the case of some of the nitrogen compounds than in the chlorinated acids of various types. Whatever these intermediates may be and however great their concentration following applications of 25 ppm, their presence does not long interfere with a typical soil process such as nitrification.

THE RESPONSE OF SOYBEANS TO SEVERAL SUBSTITUTED BENZOIC ACIDS

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The biological activity of some chlorobenzoic acids was reported as early as 1942 by Zimmerman and Hitchcock[1]. Since that time a considerable amount of greenhouse and field testing of the various chlorobenzoic acids has been done. In general, the 2,3,6-trichlorobenzoic acid (2,3,6-TBA) is considered to have the highest herbicidal activity, while 2,3,5,6-tetrachloro and 2,3,5-trichlorobenzoic acid (2,3,5-TBA) follow closely behind. Of the dichlorobenzoic acids, the 2,5-dichlorobenzoic acid (2,5-DBA) is quite active.

The crop selectivity pattern of the chlorobenzoics has been examined closely by a number of investigators[2]. Corn appears to be the only crop exhibiting reasonable tolerance of them. Even in the case of corn, the margin of safety for satisfactory weed control is rather narrow; when rates are used that will give dependable weed control, crop injury often occurs.

In 1956 primary screening was testing several different nitrated chlorobenzoic acids. It had been noted earlier that certain crops, such as soybeans and squash were slightly tolerant of 2,5-DBA. By nitrating 2,5-DBA, a compound was formed with a definite degree of crop selectivity. This compound, 3-nitro-2,5-dichlorobenzoic acid ($3NO_2$-2,5-DBA), is being called "Dinoben". Important crops which have exhibited tolerance are soybeans, squash, carrots, peas and members of the Cruciferae. Another significant difference in activity was the weed response. The 2,5-DBA does a fairly good job of controlling germinating broadleaves but is quite poor in controlling grasses. On the other hand, the preemergence weed control spectrum of 3-NO_2-2,5-DBA included a wide variety of both broadleaved and grassy weeds.

The first sample of 3-NO_2-2,5-DBA submitted for testing had been recrystallized several times. Subsequent tests with a less pure sample did not display the same degree of crop selectivity. Soybeans, in particular, were sensitive to the impure nitration product, as strong formative effects developed in both the primary and trifoliate leaves. Since the amount of impurity was judged to be less than 5% the severe degree of leaf malformation could hardly be explained on the basis of unnitrated 2,5-DBA.

The chemists in the laboratory were able to isolate and identify the "bad actor" in the impure product as 6-nitro-2,5-dichlorobenzoic acid (6-NO_2-2,5-DBA). In the nitration of 2,5-DBA to form the desired 3-nitro product, some 6-nitro substitution also occured. In spite of the strong formative effects produced by 6-NO_2-2,5-DBA, its herbicidal activity was far below that of 3-NO_2-2,5-DBA.

In 1958 another interesting compound was prepared by reducing the nitro group in Dinoben to form the corresponding 3-amino-2,5-dichlorobenzoic acid (3-NH_2-2,5-DBA). This compound is being called Amiben. In general, its selectivity was found to be very similar to that of Dinoben, although even greater soybean tolerance was observed with Amiben.

Since the conversion of 3-NO_2-2,5-DBA to the corresponding 3-$NH_2$2,5-DBA increased soybean tolerance, it seemed advisable to study the reduced form of the "bad actor", 6-NO_2-2,5-DBA. On testing the 6-amino-2,5-dichlorobenzoic acid (6-NH_2-2,5-DBA) on soybeans, it was noted that formative effects were still present but were not as severe as with the 6-nitro isomer.

The above sequence of events have been presented as they occurred in the discovery and development of Dinoben and Amiben over the last three years. Only recently have sufficient quantities of the 6-nitro and 6-amino 2,5-dichlorobenzoic acids been available to make direct comparisons with the 3-nitro and 3-amino 2,5-dichlorobenzoic acids.

In order to examine the response of soybeans to the substituted benzoic acids mentioned above, an experiment was conducted where soybeans were grown in nutrient solutions containing various benzoic acids. The technique generally used for this type of comparison is to germinate the test species in an inert medium and transfer the seedling to the Hoagland's solution containing the test chemical[3]. This approach was modified to allow the germinating seed to be exposed to the herbicide as well. Four Harosoy boybean seeds were planted in 2½" square plastic pots containing vermiculite. Each container was then immersed in 800 cc. of Hoagland's solution in a waxed milk carton. After the vermiculite was saturated, the plastic container was raised and supported above the solution; thereby allowing excess solution to drain back into the milk carton. The plastic container was re-immersed in the Hoagland's solution periodically to keep the vermiculite moist. As soon as the soybeans developed beyond the crook stage, the plants were thinned to two plants per pot. Thereafter, the plastic containers were lowered and remained in contact with the solution. Constant volume of the Hoagland's solution was maintained by adding distilled water periodically. In twenty days from the time of planting the average height of untreated soybean plants was 19 cm. and weighed 4.3 grams.

The response of the soybeans to the different benzoic acids was measured by the amount of formative effects, the height and weight of soybean tops, and rootgrowth. In Table 1 the relative

T A B L E 1

Relative Formative Effect on Soybean Leaves

(Formative Effect: Narrow leaves generally thickened with pronounced veination, typical 2,4-D damage.)

Rating Scale:
- 0: No formative effect
- +: slight formative effect
- ++: moderate formative effect
- +++: severe formative effect
- ++++: only a rudimentary leaf structure development

Substituted Benzoic Acids	Rate (ppm)	Primary	First Trifoliate
3-nitro-2,5-dichlorobenzoic	1	0	0
	5	0	0
	10	0	+
	15	0	++
	20	0	+++
3-amino-2,5-dichlorobenzoic	1	0	0
	5	0	0*
	10	0	0*
	15	0	0*
	20	0	0*
2,5-dichlorobenzoic	0.5	0	0
	1	0	0
	5	0	0*
2,3,5-trichlorobenzoic	0.5	0	0
	1	++	0
	5	+++	0
6-nitro-2,5-dichlorobenzoic	0.25	++	+++
	0.5	+++	++++
	1	+++	++++
6-amino-2,5-dichlorobenzoic	0.5	++	++
	1	+++	+++
2,3,6-trichlorobenzoic	0.25	++++	++++
	0.5	++++	++++
	1	++++	++++

* Leaves appear normal but not fully expanded

effects on soybean leaves, resulting from the various substituted benzoic acid treatments is recorded. 3-NO_2-2,5-DBA caused injury at 10 ppm and above, while no leaf malformation was present at any concentration of the 3-NH_2-2,5-DBA or 2,5-DBA. It should be noted, however, that in the case of 3-NH_2-2,5-DBA full leaf expansion did not occur in treatments of 5 ppm and above. 2,3,5-TBA behaved peruliarly in this test in that formative effects developed in the primary leaves, but not in any of the trifoliate leaves. Soil applications of 2,3,5-TBA have produced formative effects in soybean trifoliates. Soybeans showed extreme sensitivity to 2,3,6-TBA. Even at concentrations of 0.25 ppm the primary leaves were grossly malformed and unable to produce any measureable growth. Buds were initiated in the axils of the cotyledonary leaves at concentrations of 0.25 and 0.5 ppm, but this growth was also stunted and malformed. The degree of leaf malformation produced by 6-NO_2-2,5-DBA began to approach that of 2,3,6-TBA. 6-NH_2-2,5-DBA produced notably less formative effects than did 6-NO_2-2,5-DBA.

The various substituted benzoic acids produced large differences in soybean height. In figure 1 the logarithm of the concentration of the different benzoic acids is plotted against the height of soybeans when expressed as percent of control. In the ranges of 1 ppm to 15 ppm of 3-NO_2-2,5-DBA, the height of soybeans was greater than control plants. The highest stimulation in height was obtained from 1 ppm of 3-NH_2-2,5-DBA, where the height was 42% above the controls. Below 1 ppm the relationship between height and concentration decreases almost linerally. In contrast to height stimulation is the marked stunting caused by 2,3,6-TBA and 6-NO_2-2,5-DBA at concentrations as low as 0.25 ppm. The relative order of the above benzoic acids as to their increasing ability to suppress the height of soybeans is as follows:

$$\text{3-NO}_2\text{-2,5-DBA} < \text{3-NH}_2\text{-2,5-DBA} < \text{2,5-DBA} < \text{2,3,5-TBA}$$
$$< \text{6-NH}_2\text{-2,5-DBA} < \text{6-NO}_2\text{-2,5-DBA} < \text{2,3,6-TBA}$$

In figure 2 the logarithm of the concentration of the different benzoic acids is plotted against the weight of soybeans expressed as percent of control. The least amount of weight reduction was given by 3-NO_2-2,5-DBA. The greatest weight reduction was caused by 2,3,6-TBA with 6-NO_2-2,5-DBA close behind. The relative order of the above benzoic acids as to their increasing ability to suppress soybean weight is as follows:

$$\text{3-NO}_2\text{-2,5-DBA} < \text{2,3,5-TBA} < \text{2,5-DBA}$$
$$< \text{3-NH}_2\text{-2,5-DBA} < \text{6-NO}_2\text{-2,5-DBA} < \text{2,3,6-TBA}$$

It is difficult to determine the relative degree of weight suppression by 6-NH_2-2,5-DBA because the two low concentrations used did not establish any trend.

Figure 1: The effect of various concentrations of benzoic acids on the height of soybeans grown in Hoagland's solution.

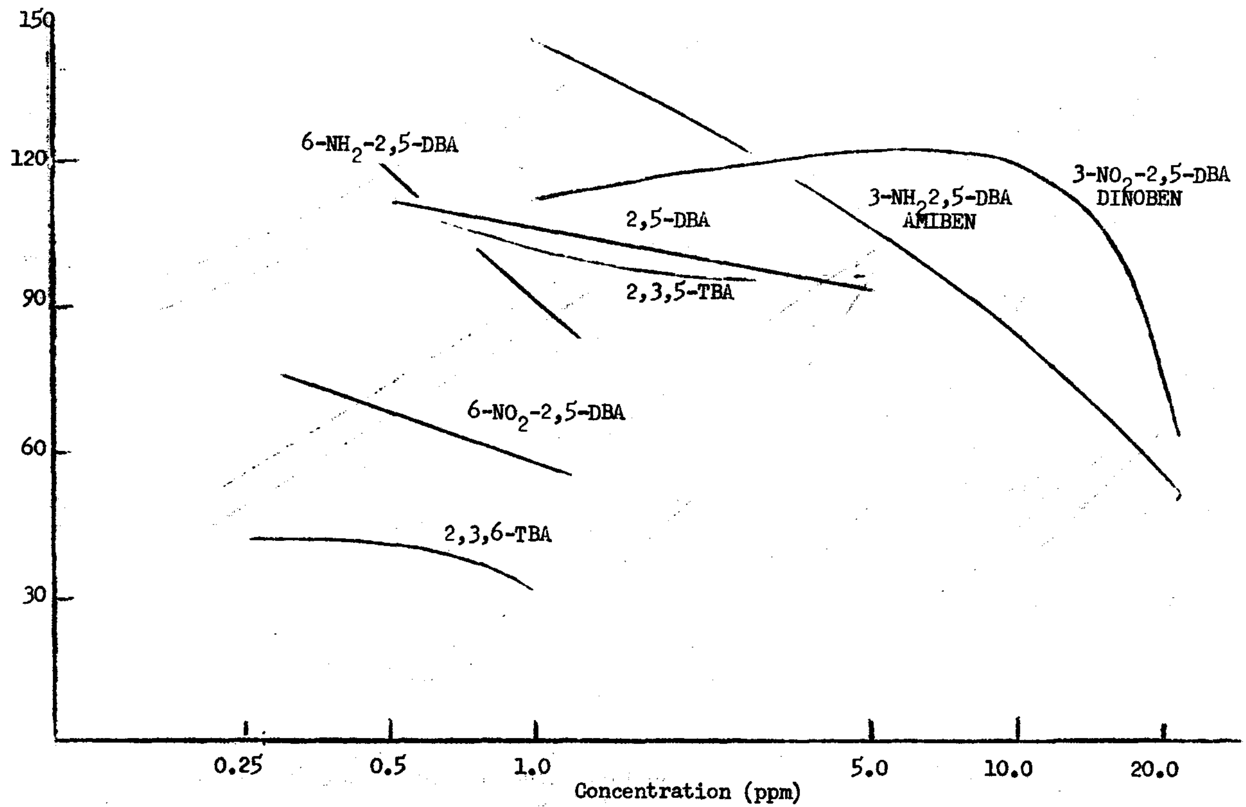
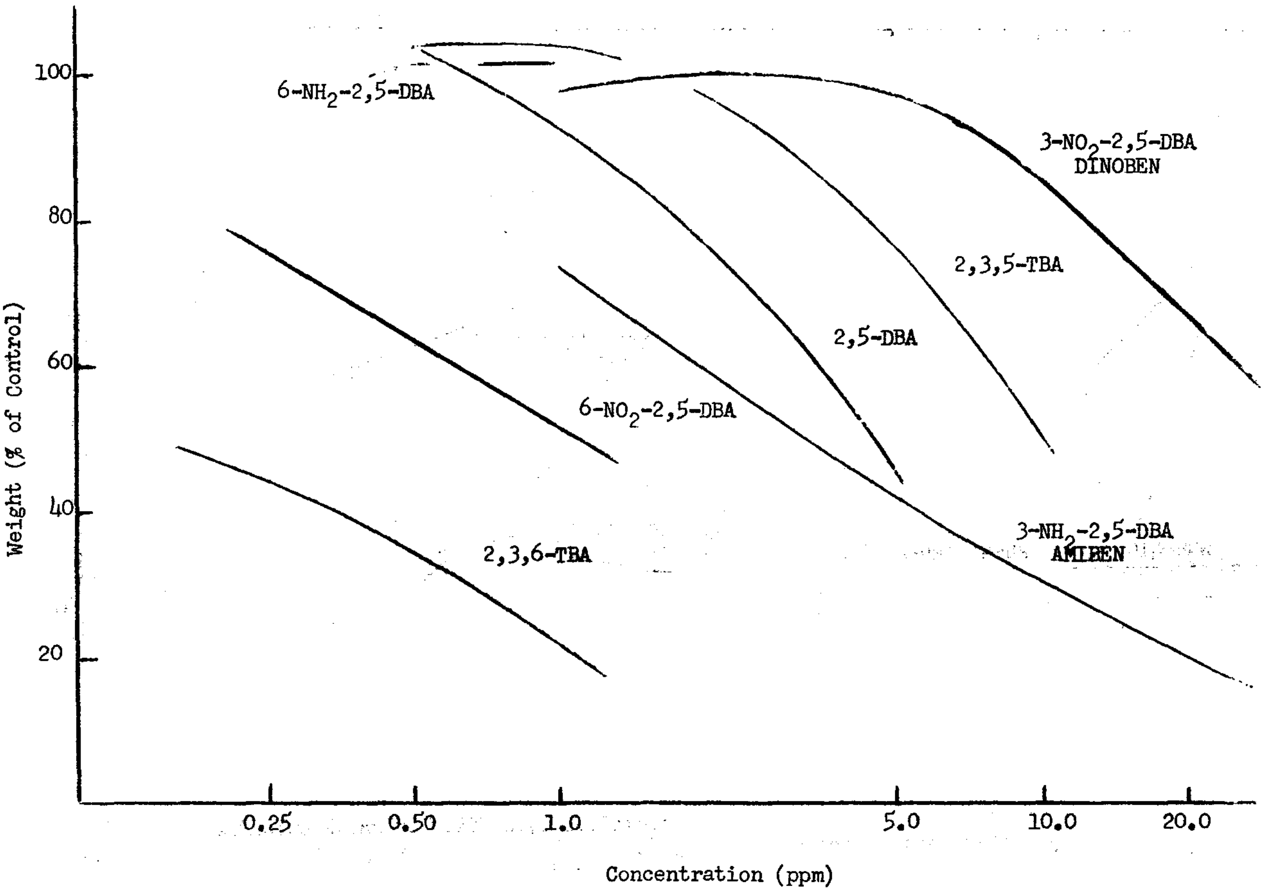


Figure 2: The effect of various concentrations of benzoic acids on the fresh weight of soybean tops grown in Hoaglund's solution.



From figures 1 and 2 it was possible to obtain the ED_{50} (Estimated Dosage required to reduce the growth of soybeans 50%) for the various substituted benzoic acids. The ED_{50}, as measured by height and by weight, is given in Table 2. This means of expressing the tolerance of soybeans to the different substituted benzoic acids further emphasizes the wide differences that are present. Under the conditions of this particular test, soybeans were at least 133 times more tolerant of 3-NO_2-2,5-DBA than of 2,3,6-TBA when weight was used as the basis of comparison.

TABLE 2

ED_{50}: Estimated Dosage Required to Reduce Soybean Growth 50%

Substituted Benzoic Acids	ED_{50} on basis of height	ED_{50} on basis of weight
3-nitro-2,5-dichlorobenzoic	>20 ppm	>20 ppm
3-amino-2,5-dichlorobenzoic	>20 ppm	3.3 ppm
2,5-dichlorobenzoic	*	4.3 ppm
2,3,5-trichlorobenzoic	*	10 ppm
6-nitro-2,5-dichlorobenzoic	1.7 ppm	1.1 ppm
6-amino-2,5-dichlorobenzoic	3.1 ppm	*
2,3,6-trichlorobenzoic	<0.25 ppm	0.15 ppm

*Curve not well enough defined to be able to obtain value

At the conclusion of the experiment the soybean roots were examined. Table 3 lists the relative injury produced by the different benzoic acids. The chemicals listed in order of increasing ability to cause root injury are as follows:

$$3\text{-}NO_2\text{-}2,5\text{-DBA} < 3\text{-}NH_2\text{-}2,5\text{-DBA} < 6\text{-}NH_2\text{-}2,5\text{-DBA} < 2,5\text{-DBA} < 2,3,5\text{-TBA} < 6\text{-}NO_2\text{-}2,5\text{-DBA} < 2,3,6\text{-TBA}$$

TABLE 3

Relative Suppression of Soybean Roots Grown in Hoagland's Solution Containing Benzoic Acids

Rating Scale:
0: normal roots
+; slight stunting
++: moderate stunting
+++: severe stunting
++++: only a rudimentary root development

Chemical	Concentration (ppm)						
	0.25	0.5	1	5	10	15	20
3-nitro-2,5-dichlorobenzoic			0	0	+	+	+
3-amino-2,5-dichlorobenzoic			0	++	+++	++++	++++
2,5-dichlorobenzoic		+	+	++			
2,3,5-trichlorobenzoic		+	+	++			
6-nitro-2,5-dichlorobenzoic	0	+	+				
6-amino-2,5-dichlorobenzoic		0	+				
2,3,6-trichlorobenzoic	++	+++	++++				

SUMMARY

It has been found that 3-nitro-2,5-dichlorobenzoic acid (Dinoben) can be used for selective weed control in soybeans. In its preparation from 2,5-dichlorobenzoic another isomer, 6-nitro-2,5-dichlorobenzoic acid, is also produced that caused strong formative effects in soybeans. The reduction of Dinoben to 3-amino-2,5-dichlorobenzoic acid (Amiben) produces an even more desirable herbicide for weed control in soybeans. If the "bad actor", 6-nitro-2,5-dichlorobenzoic acid, is present during the synthesis of Amiben the corresponding 6-amino-2,5-dichlorobenzoic acid is formed. This compound also causes formative effects in soybean leaves but not to the same extent as the 6-nitro isomer.

An experiment was conducted to compare the response of soybeans grown in Hoagland's solution to the different substituted benzoic acids. Under conditions of this test soybeans showed the greatest tolerance to 3-nitro-2,5-dichlorobenzoic acid when height, weight, and root response were considered. However, strong formative effects appeared at concentrations of 10 ppm and above.

No formative effects were produced by even 20 ppm of 3-amino-2,5-dichlorobenzoic acid, but marked suppression of soybean tops and roots were produced at concentrations of 5 ppm and above.

The response of soybeans to 6-nitro-2,5-dichlorobenzoic acid compares closely to the activity of 2,3,6-trichlorobenzoic acid. The suppression of height and weight by 6-amino-2,5-dichlorobenzoic acid was much less than that of the 6-nitro isomer, but formative effects were still produced.

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PROGRAM FOR DETERMINING LOSSES DUE TO WEEDS

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A Conference on Agricultural Pests was called on November 4 and 5, 1959 by the National Research Council at Washington, D. C. The writer was asked to represent the Northeastern Weed Control Conference at a meeting of the subcommittee on weeds at this conference. The purpose of this conference was to stimulate studies and publication of reliable data on losses caused by weeds, insects, plant diseases, nematodes and vertebrate pests in the United States.

The National Research Council is a part of the National Academy of Sciences, which is a non-governmental organization of over 550 distinguished scientists, dedicated to the furtherance of science. The National Research Council does not finance or conduct research, but tries to stimulate and coordinate research programs. The National Academy of Sciences is financed by both public and private contributions.

It is generally felt that losses in agriculture published in the past are chiefly estimates and are not reliable. Therefore, there is a need for reliable data on losses as they occur in local areas in a given year. Representatives from each of the four regional weed conferences and the Weed Society of America were asked to attend the meeting of the subcommittee on weeds. This committee would like the regional weed conferences and the Weed Society of America to promote studies and publication of factual data on actual losses, both agricultural and non-agricultural, caused by weeds in local areas.

Among the reasons for obtaining loss data are the following:

1. To justify expanded research in weed control.
2. To provide bases for determining desirable lines of research for both public and industrial organizations.
3. To use in educational programs in the introduction of new practices.
4. To aid in the development of practices to reach maximum efficiency.
5. To provide bases for justification and direction of regulatory programs.
6. To assess benefits occurring from group activity in weed control, such as work done by regulatory groups.
7. To determine the place of weeds in maximum agricultural production.
8. To expose the direct and indirect costs of weeds in agricultural and non-agricultural situations to the public.

What should weed loss data consist of? For agricultural crops, the committee felt that losses should consist of the sum of two factors: the cost of conventional control methods plus the loss in potential yield and quality. For non-agricultural situations losses should consist of the sum of the cost of conventional control methods plus losses in such things as human efficiency, public health, recreation, etc. Examples of non-agricultural areas would be: industrial, urban, aquatic, highways, and recreational.

The committee has prepared weed loss data guides for a number of situations. Two are presented here:

Weed Loss Data Guide for Crops:

Crop - Identify
Location - County and State
Soil - Description
Weed species - Stand, intensity, and time of growth.
Yield related to control practices:
- Weed free
- Conventional control
- Improved practices

Control practice costs:
- Hand labor (hours)
- Machinery (hours)
- Herbicides (per acre costs)

Harvesting costs - (weeds vs. clean fields).
Effect of weeds on grade, and on average market value of crop (dollars per bushel, etc.).

Weed Loss Data Guide in Regard to Public Health:

Extent of allergic conditions and poisoning caused by weeds:

- Identity of diseases.
- Number of persons affected.
- State
- County
- Municipality

Cost per case of allergy or poisoning if weeds are not controlled:

- Doctor bills
- Medicines
- Loss of wages or vacation or sick leave.
- Travel and expenses to leave infested area and live during season away from infested area.
- Loss of efficiencies affecting production.

Control practice costs for each weed (ragweed, poison ivy, etc.):
- Herbicide (per acre cost)
- Labor: for spraying (hours)
- Machine spraying (hours)
- Locating and estimating extent of areas for spraying (hours).

Areas requiring control measures:
- Municipal streets, alleys, vacant properties, drainage areas, etc.
- State, county and township road rights-of way.
- Public utility and railroad rights-of-way and properties.
- Abandoned farm-land, and subdivided lands being developed or awaiting development.
- River and stream banks and adjacent lands subject to flooding and wash.

CROP TOLERANCE AND WEED SUSCEPTIBILITY TO DAC-893, A NEW PRE-EMERGENCE HERBICIDE

Paul H. Schuldt, L. E. Limpel, and David Lamont

Abstract 1/

Greenhouse studies and small plot field trials during two years have clearly demonstrated that DAC-893 (dimethyl 2,3,5,6-tetrachloroterephthalate) possesses pre-emergence weed control properties which merit extensive field evaluation. This chemical provided one of the best compromises between crop tolerance and control of weeds by virtue of its activity against many annual weeds without injury to numerous horticultural and agronomic crops. DAC-893 is relatively inert when applied to foliage making it useful not only for pre-emergence treatment but also for lay-by application. These properties combined with long residual action and safeness in handling make this chemical particularly attractive for many potential uses.

In greenhouse pre-emergence spectrum studies, 20 weed species were grouped into three categories: susceptible -- at least 50 per cent control at one pound of DAC-893 per acre; intermediate -- at least 50 per cent control at rates of one to four pounds per acre; and resistant -- greater than four pounds necessary to produce greater than 50 per cent control.

The susceptible species were purslane (*Portulaca oleracea*), common chickweed (*Stellaria media*), curley dock (*Rumex crispus*), narrow leaf plantain (*Plantago lanceolata*), green foxtail (*Setaria viridis*), yellow foxtail (*S. lutescens*), crabgrass (*Digitaria sanguinalis* and *D. ischaemum*), and spreading witchgrass (*Panicum dichotomiflorum*). The intermediate species were pigweed (*Amaranthus retroflexus*), lambsquarter (*Chenopodium album*), barnyard grass (*Echinochloa crusgalli*), annual bluegrass (*Poa annua*), and Johnson grass (*Sorghum halapense*). The resistant weeds were ragweed (*Ambrosia artemisiifolia*), Jimson weed (*Datura stramonium*), burdock (*Arctium minus*), frenchweed (*Thlaspi arvense*), quack grass (*Agropyron repens*), and wild oats (*Avena fatua*).

Excellent correlation was obtained between susceptibility in the greenhouse and in field tests. It was necessary, however, to increase the field rate of application to 4 lb./acre to obtain good long-range control of many of the susceptible weeds. Weeds classed as intermediate in the greenhouse required up to 8 lb./acre for control in field trials. Additional weeds encountered in the field which were not examined in the greenhouse included one susceptible species, carpetweed (*Mollugo verticillata*), and three resistant species: wild mustard (*Brassica* sp.), horse-weed (*Erigeron canadensis*), and two species of smartweed (*Polygonum persicaria* and *P. Pennsylvanicum*).

In a replicated test with normal greenhouse surface watering DAC-893 gave uniform control of yellow foxtail when seeds were planted at 1/4, 1/2, 1, and 2

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1/ Paper to be submitted for publication in CONTRIBUTIONS FROM BOYCE THOMPSON INSTITUTE.

inches below the soil surface. The weed control obtained, at 1 lb. per acre, based on weight of corresponding checks, was 95, 87, 78, and 91 per cent, respectively. In a test where DAC-893 was applied at 3, 10, 14, and 18 days after planting, sensitive weeds (curley dock, purslane, chickweed, yellow foxtail, and crabgrass) were controlled successfully before and immediately after emergence, i.e. when plants were in either the cotyledonary or the one-leaf stage. However, as growth proceeded before application, the effectiveness of DAC-893 decreased sharply in a sigmoid curve indicating this chemical has very limited post-emergence activity. Similar results with weeds and susceptible crops were obtained in field trials. Tests with different soil types showed that higher rates of application will be required in muck soil than in various lighter soils.

Results from small plot tolerance tests during the last two years indicate that the following crops are apparently resistant to DAC-893 at 8 lb. active per acre: alfalfa, cabbage (seeded and transplants), corn, cotton, gladiolus, lima beans, oats, onions, peas, potatoes, red clover, sorghum, soybeans, turnips, tomato transplants, and wheat. Crops which have shown a variable response and tend to be inhibited between 4 and 8 lb. per acre include: birdsfoot trefoil, flax, snapbeans, squash, cucumber, pumpkin, spinach, and leaf lettuce. Of the crops tested those which are susceptible to less than 4 lb. of DAC-893 per acre are millet, beets, and seeded tomatoes. These crop tolerance tests are preliminary and more extensive testing will be required in different soil types and and under a variety of climatological conditions.

Growth and Development of Northern Nutgrass As Affected by Certain Environmental Conditions

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Delaware Agricultural Experiment Station

ABSTRACT 1/

In general, over-all plant growth and development of vegetative shoots of northern nutgrass (Cyperus esculentus L.) was promoted by increasing the following: photoperiod, light intensity, soil temperature, and soil moisture. Development of tubers, on the other hand, was promoted by decreasing photoperiod. This effect of photoperiod on tuber development was more pronounced under reduced light intensity.

Germination was greatly affected by depth of planting in the soil, by soil compaction, and by dormancy. Tubers germinated readily at 3 - 6 inch depths in the soil. Below 6 inches germination was very low. Germination was very low in highly compacted soils. Newly formed tubers germinated as low as 4 per cent. Whereas when similar tubers were stored at 48°F. for 30 days they germinated 95 per cent. This shows the necessity of a rest period. This rest period was partially broken by dipping tubers momentarily in solutions containing thiourea (5%) or ethylene chlorohydrin (1%).

Eptam (ethyl-N, di-n-propylthiolcarbamate) prevented germination of tubers without killing them. Atrazine (2-chloro, 4-ethylamino, 6-isopropylamino-s-triazine) applications did not prevent germination but eventually killed the young plants.

Tubers buried in the soil for 12 months at varying depths failed to germinate. Tubers placed on top of the soil in the field in October for 5 months germinated 12 per cent in April, even though the temperatures dropped as low as 3°F. Tubers placed at constant temperatures of 0°F., 5°F., and 20°F., remained viable for 3 days or less.

1/ Abstract of a manuscript to be submitted to WEEDS.

Experiments with the Germination of Northern Nutgrass Seed[1]

R. S. Bell and Erling Larssen[2]

Northern nutgrass (Cyperus esculentus L.) flourishing in fertile cropland produces an abundance of seed. The question of how viable the seed is and what factors influence its germination is being studied at the Rhode Island Agricultural Experiment Station as part of the Northeastern Regional Project concerning the life history of this weed.

Justice and Whitehead (1) reported in 1946 that preliminary tests indicated that it might reproduce freely from seed. Orsenigo and Smith (2) decided that seed seemed to be a minor source of infestation in New York State.

The purpose of this paper is to present briefly the results of some of the preliminary tests made during the first year of the regional project.

Procedures

The germinators were the standard table models with thermostatic control of electrical heating units. Diffused light enters through a glass panel in the door. Most of the tests were made by placing the seeds on moistened filter paper in standard size petri dishes. In some tests, however, a thin layer of potting soil was used instead of the paper. In other tests the seeds were planted out of doors either in pots of soil or directly in the ground.

The following solutions were compared; tap water and 0.1 and 0.2 per cent KNO_3 made with tap water. In the petri dish tests 5 ml. of solution was used to moisten the seeds. Subsequently tap water was added as needed to keep the germinating medium moist.

Inflorescences containing seeds were obtained from New York (Cornell U.), Delaware, Maine and Rhode Island. Massachusetts supplied threshed seeds. The inflorescences were examined and were all judged to be Cyperus esculentus L.

In the laboratory tests, 400 seeds, divided into lots of 100 seeds each, were used as replicates for each variable studied. The germination percentages were usually checked at the end of each 7-day period. Most tests were carried 3 weeks, but some were held as long as 5 weeks.

In the statistical analysis of the data the percentage germination was transposed to arc-sine values for a normal curve.

Results

The following average percent germinations of the regional strains of nutgrass were obtained from seeds germinated on a thin layer of soil in petri dishes at 85°F. day temperature: Mass. 89%, N. Y. (Parkes Farm) 84%, N. Y. (Tabilby Farm) 76%, R. I. (Agron. Farm, 1957) 61%, R. I. (Agron. Farm, 1958) 58%, Delaware 55% and Maine 28%.

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[1]Contribution No. 989. Rhode Island Agricultural Experiment Station.

These data indicate that all the strains tested have considerable potential for reproduction by seeds. The lower germination of Maine seed might possibly be due to immaturity of the inflorescence due to a shorter growing season in that state. About 33 percent of the seedlings from Delaware and Maine seed were devoid of chlorophyll.

Since a considerable amount of the New York (Parkes Farm) seed was available this was used in a combined test of the effects of 75°F., 85°F., and 95°F. daytime temperature with 70°F. night temperature; continuous darkness vs. normal light conditions in the germinator; and tap water compared to 0.1% and 0.2% KNO_3 solutions. Aluminum weighing cans with filter paper in the bottom were used to provide continuous darkness in the same germinators as those containing the glass petri dishes. The test was started December 16th and the germination count was made January 2nd, a period of 17 days.

The average percent of germination for each combination of treatments is shown in Table 1. The germination was poor at 75°F. and the figures were not included in the statistical analysis. The 95°F. temperature was significantly better than 85°F. at the 5% level. Germination was also better in the glass petri dishes than in the aluminum cans. But, even in the cans the percent of germination ranged from 65 to 85 percent. This indicated that continuous darkness *per se*, was not a particularly depressive factor, but that the environment in the darkened cans was not as favorable as in petri dishes. Potassium nitrate solutions were no more favorable than tap water in this test. The experiment described above was repeated in April 1959 with similar results.

Table 1. Effect of Light, Temperature and KNO_3 Solutions on the Average Percent Germination of Northern Nutgrass Seed from N. Y. (Parkes Farm).*

	75°F.**	85°F.		95°F.		Av. Both Temp.	
Solution	%	%	Arc-sine	%	Arc-sine	%	Arc-sine
			Alternate Light				
Tap water	0	73	58.6	96	78.1	84	68.4
0.1% KNO_3	1	76	60.7	93	74.3	84	67.5
0.2% KNO_3	2	69	56.4	85	60.0	77	58.2
Av.		73	58.6	91	70.8	82	64.7
			Continuous Darkness				
Tap water	1	68	55.6	82	65.8	75	60.7
0.1% KNO_3	7	65	54.1	80	63.6	72	58.9
0.2% KNO_3	13	66	54.5	85	67.9	75	61.2
Av.		66	54.7	82	65.8	74	60.3

*Significance for temperature at 1% level = 7.6 arc-sine value
Significance for light-darkness x solution at 5% level = 5.8 arc-sine value.
**Not used in statistical analysis.

An experiment with seeds from Rhode Island (Agron. farm, 1957) and New York (Parkes) was made to compare filter paper vs. potting soil as a germination media. The germinations were conducted in diffused light in a greenhouse with 85° daytime temperatures. The night temperatures ranged from 60-70°F.

In the test, water and 0.1 and 0.2 percent KNO_3 solutions were compared. The average percent germinations are shown in Table 2. Statistical interpretations of the arc-sine values shows that the Rhode Island strain germinated significantly better on soil than on filter paper, the average for soil being 84 percent compared to 69 for paper. Comparing paper to soil, with Parkes Farm seed, the average percent germinations was 79 and 87%, respectively. In this particular test, germination was statistically superior where the KNO_3 solutions were used. With average germinations as high as 85 percent for tap water, these differences are probably not of practical significance.

Table 2. Effect of Media and Solutions on Germinating of 2 Nutgrass Strains at 90°F. Day Temperature.*

Solution	Potting soil %	Potting soil Arc-sine	Filter paper %	Filter paper Arc-sine	Av. sol. & Media %	Av. sol. & Media Arc-sine
			R. I. '57			
Tap water	78	62.5	68	55.4	73	59
0.1% KNO_3	86	68.1	75	61.0	80	64.6
0.2% KNO_3	88	69.9	65	54.0	76	62.0
Av.	84	66.8	69	56.8	76	61.9
			N. Y. (Parkes Farm) '58			
Tap Water	74	59.4	85	68.0	79	65.7
0.1% KNO_3	86	68.3	91	72.7	88	70.5
0.2% KNO_3	78	62.3	84	67.0	81	64.7
Av.	79	63.3	87	69.2	83	66.3

*Significance for solutions LSD at 5% level = 8.4 arc-sine value.
Significance for variety x media LSD at 1% level = 11.1 arc-sine value.
Others NS

Storage Temperatures

Some Rhode Island and New York (Parkes Farm) seed was placed in a 36°F. refrigerator for a comparison of room storage (70°-90°F.) to cold storage. At the end of three months germination was considerably better for seed stored at room temperature. At the end of 8 months the room storage still favored the Rhode Island seed which produced 81 and 54 percent germination, respectively, for warm vs. cold storage. The results with Parkes Farm seed was 92 and 85 percent, respectively, for the same conditions. The New York (Parkes Farm) seed seems less sensitive to cold than does the Rhode Island strain.

Effect of Sodium Arsenite Vine-Killer

Seed was obtained in late September 1958 from nutgrass sprayed 10 days previously with vine-killer. Unsprayed seed heads were collected for a comparison. Germination tests in January 1959 showed no significant difference in the percent of germination. It does not seem likely that vine-killer reduces the viability of mature nutgrass seed.

Depth of Seeding

A depth of seeding test was conducted in the field in pots of soil sunk into the ground. One hundred seeds of the Parkes Farm strain of nutgrass were used per pot with 4 replicates at each of the following depths; $\frac{1}{4}$, $\frac{1}{2}$, 1 and $1\frac{1}{2}$ inches. The average percent germination for these depths was 31, 20, 5, and 0, respectively.

Field Plantings

Two plantings of nutgrass seed were made at the Peckham farm, one on May 26, 1959 and the other July 6. Nutgrass seed from New York (Parkes Farm), Rhode Island and Massachusetts were used. Three hundred seeds were planted per row and there were 4 replicates. A few seedlings from the May 26 planting were up by June 10. The total germination from 1200 seeds in the first test was 391, 176 and 10 for the New York, Massachusetts and Rhode Island strains, respectively.

Flower heads were found on the seedlings as early as August 26. At the time of killing frost 31, 9, and 3 seed heads, were present, respectively, for the New York, Massachusetts and Rhode Island strains.

Counts of nutlet production were not made on this stand because it is being saved for future seed production. In a greenhouse test yields of nuts from individual seedlings ranged from 124 to 179.

Summary

Seeds of Northern Nutgrass (*Cyperus esculentus* L.) from Delaware, Maine, Massachusetts, New York and Rhode Island were subjected to various germination tests in the laboratory, greenhouse and field. Seeds from all states had a potential germination. Temperatures ranging from 85°F. to 95°F. were more favorable than lower temperatures in promoting maximum seed germination. Seed germinated nearly as well in continuous darkness as in alternating light and dark. Storage in a warm room for a period of 8 months was somewhat more favorable than refrigeration for germination of the Rhode Island strain of nutgrass.

Under field conditions, seeds of the New York (Parkes Farm) strain germinated and grew vigorously. The Massachusetts nutgrass was intermediate while the Rhode Island strain germinated poorly.

Seed is a potential source of infestation and should not be ignored in considering nutgrass control.

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WEED CONTROL IN CULTIVATED BLUEBERRIES WITH DIURON[1]

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As long as labor was cheap and growers could afford to cultivate and hoe their fields, weed control in cultivated blueberries was not a serious problem. As labor costs rose, less and less hoeing and cultivation was done. In some fields where the rows were planted too close it became very difficult, if not impossible, to use machinery. Consequently, grass and other weeds gradually took over. Where this process has been allowed to go on for several years, large, very troublesome weeds have come in. Even where weeds are not excessively large, it is desirable to have them suppressed during the picking season. Also, it is probable that weeds compete with the blueberries for nutrients, particularly early in the season during the period of rapid growth and fruiting.

A considerable number of types and kinds of herbicides were tried. Among these diuron appeared to be the most promising. The first applications of diuron were made in the spring of 1956 in a grower's field. It was applied around Rubel and Atlantic bushes at the rate of 1, 2, and 3 pounds per acre with 2 replicates. The weeds were mostly grasses, Poa annua, and quack grass, with a few rushes and broadleaf weeds. The control of grasses and broadleaf weeds varied from 85-100 per cent. Rush control was almost as good, 80-90 per cent. The blueberry bushes were not injured. Plots in two Rubel rows in one of our Experiment Station fields were treated at 1, 2, 4, and 8 pounds of diuron per acre with 2 replicates. One replicate had a ground cover of almost solid quack grass, the other had mostly annual and bunch grasses. Weed control was estimated at 80-100 per cent. There was no injury to the blueberry bushes.

In the spring of 1958 two more series of plots in two growers' fields were treated at 1, 2, and 3 pounds per acre with 2 replicates in each field. When the plots in grower A's field were treated, it was observed that, although some weeds had grown, the outline of the plots treated in 1956 could still be made out. Since the previous diuron applications had not injured the blueberry bushes, on June 25, 1958, two plots in grower B's field were treated with 4 pounds per acre. The midsummer weed control was good on plots treated at 1 and 2 pounds per acre, very good at 3 pounds, and excellent at 4 pounds. By early fall weeds had started to come back in the 1 and 2 pound plots but weed control at 3 and 4 pounds was good to excellent.

In the fall of 1958 diuron was applied in three Rubel blueberry fields to see how effective for weed control fall applications would be and to learn if any injury to the bushes would result. Applications were made at 2, 3, 4, and 8 pounds per acre. These fields had been in sod for a number of years. Two of them had a wide variety of weeds: grasses, broadleaf and perennials including such woody perennials as Smilax sp. and a trailing Rubus. The third field was almost solid quack grass. On June 1, 1959, 90 per cent of the plot area of this last field was free of quack grass. By fall this had been reduced to 60 per cent. Control in the other two fields is shown in Table 1.

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[1]Misc. Contribution No. 1011, Massachusetts Agr. Exp. Sta., Amherst, Mass.

Table 1.--Percentage weed control following one fall application of diuron to cultivated blueberries in 1958.

Date of observation	2		3		4		6		8	
	Pounds of diuron per acre									
	6-1	7-10	6-1	7-10	6-1	7-10	6-1	7-10	6-1	7-10
% Control	65	--	65	--	78	45	85	70	90	90

Better control would have been obtained in these fields had not so many of the weeds been deep-rooted perennials which are very resistant to diuron. As the susceptible weeds died, the resistant ones spread. Under these conditions 6 to 8 pounds of diuron per acre did an outstanding job of weed control.

The results of the 1956 and 1958 tests were so encouraging that the work was expanded in 1959. To learn the effects of repeat applications, the plots treated in 1958 were retreated at the same rates in 1959. In addition, plots were laid out in a number of varieties to determine if there might be varietal differences in susceptibility to diuron injury if any should occur. Plots in each variety were treated at 4, 6, 8, and 10 pounds of diuron per acre. Estimates of weed control were made June 1 and July 10. Control is expressed as per cent of weeds eliminated compared with an untreated control. The amount of weed control is given in Tables 2 and 3.

Table 2.--Percentage weed control following two annual spring applications of diuron to cultivated blueberries in 1958 and 1959.

Cultural treatment	Number of replicates	Pounds of diuron per acre 1	2	3	4
Mulch	2	65	87	90	99
Sod	2	50	83	73	--

By the fall of 1958 and increasingly in 1959 it was evident that one pound per acre is insufficient to give satisfactory weed control. Two pounds would do a fairly satisfactory job providing certain resistant annuals or deep-rooted perennials were not present. In the sod plots of Table 2, there were a considerable number of rushes. These are more resistant to diuron but fortunately are not common in blueberry fields.

Weed control resulting from diuron applications made in the spring of 1959 only is given in Table 3.

Cultivation preceding diuron applications gave excellent weed control. When diuron was applied to a weed-free soil in spring, the area remained practically weed free the entire summer. Control was generally good where sawdust, shavings or wood chips were used as mulch. There was considerable Equisetum in some of the mulch plots. This may or may not be controlled depending on whether the root system is deep or shallow. Also, late in the season smartweed appeared

Table 3.--Percentage weed control following one spring application of diuron to cultivated blueberries in 1959.

Cultural treatment	Number of replicates	Pounds of diuron per acre							
		4		6		8		10	
		6-1	7-10	6-1	7-10	6-1	7-10	6-1	7-10
Sod*	3	69	46	93	88	94	92	94	93
Cultivated#	7	100	99	100	97	100	99	100	99
Mulch	7-9	88	86	95	96	97	95	96	98

* Plantain in one series of plots was not controlled.
# Before diuron application.

in a few of the mulch plots. The poorer control in the sod plots was caused by the presence of broad- and narrow-leaf plantain in two series of plots. Diuron does not control plantain.

During late spring and early summer such good weed control with no plant injury looked very promising. By late July or early August some of the leaves on bushes in the heavier rate plots began to show dead areas along the margins or between the veins. By mid-August plants on a number of plots showed signs of injury, some at application rates as low as 4 pounds per acre. On September 21 all plots were gone over and an estimate made of the amount of injury. On a scale of 0-3, 0 equals no injury; 1, slight injury, a few leaves on one or more bushes showing dead areas; 2, moderate injury, 25-50 per cent of the leaves on one or more bushes showing dead areas; 3, severe injury, all bushes showing 50 per cent or more injured leaves, in the worst cases many leaves shed. The average amount of injury by varieties is given in Table 4.

Table 4.--Estimate of injury to cultivated blueberries following one spring application of diuron in 1959. Scale 0-3.

Variety	No. of reps.	Lb. of diuron/a. 4	6	8	10	Variety	No. of reps.	Lb. of diuron/a. 4	6	8	10
Atlantic	1	3	3	3	3	Earliblue	1	0	0	0	3
Berkeley	3	0	0	0	0.3	Herbert	2	0	0	0	1
Bluecrop	2	0	0	0	0	Ivanhoe	1	0	2	2	3
Blueray	1-2	0	0	0	1	Jersey	1	0	0	0	2
Burlington	1	0	0	0	1	Rancocas	1	0	2	3	3
Concord	1	3	3	3	3	Stanley	1	0	0	0	0
Coville	2	0	0.5	1.5	1.5						

These results indicate that the varieties Atlantic, Concord, Ivanhoe, and Rancocas are more susceptible to diuron injury than other varieties. Coville may belong in this group for it was injured at 6 pounds per acre and severely injured at 8 and 10 pounds in one series of plots but uninjured at all rates in another.

Injury resulting from two annual spring applications at lighter rates is given in Table 5.

Table 5.--Estimate of injury to cultivated blueberries following two spring applications of diuron in 1958 and 1959. Scale 0-3.

Variety	Pounds of diuron per acre			
	1	2	3	4
Bluecrop	0	0	0	-
Coville	0	0	0	2
Jersey	0	0	2	-
# 73	0	0	0	-

Since no injury appeared at 1-4 pounds per acre in 1958 but some injury did appear at 3 and 4 pounds per acre in 1959, a cumulative effect of the diuron is suggested.

Although the Rubel variety had previously shown no signs of injury even at 8 pounds per acre, one bush on one of the three plots treated in the fall at 8 pounds did show slight injury. The injury from fall treatments is given in Table 6.

Table 6.--Estimate of injury to cultivated blueberries following one fall application of diuron in 1958. Scale 0-3.

Variety	Pounds of diuron per acre		
	4	6	8
Rubel	-	-	0
"	0	0	0
"	0	0	1

A considerable number of varieties were included in the 1959 treatments because previous work had suggested that there might be varietal differences in resistance or susceptibility to diuron injury. In order to include as many varieties as possible, bushes had to be included which were under different types of soil management and of different ages. Did age of bush or type of soil management influence the amount of diuron injury? The data is limited because no variety was grown under all three types of culture and only one comparison between sod and cultivation is available. Table 7 gives these comparisons.

Table 7.--Estimate of injury to cultivated blueberries following one spring application of diuron in 1959. Comparison of mulch vs. cultivation and sod vs. cultivation. Scale 0-3.

	Pounds of diuron per acre							
	4		6		8		10	
Variety	Mulch	Cult.	Mulch	Cult.	Mulch	Cult.	Mulch	Cult.
Berkeley	0	0	0	0	0	1	0	1
Bluecrop	0	0	0	0	0	0	0	0
Coville	0	0	1	0	3	0	3	0
	Sod	Cult.	Sod	Cult.	Sod	Cult.	Sod	Cult.
Blueray	0	0	0	0	-	0	-	1

Type of culture probably had nothing to do with amount of injury. Since Coville is the only variety that even suggests an influence and this variety appears to be quite sensitive to diuron, it would be premature to assume an effect of culture.

A comparison between young and old bushes is given in Table 8.

Table 8.--Estimate of injury to cultivated blueberries following one spring application of diuron in 1959. Comparison of young vs. old bushes. Scale 0-3.

	Pounds of diuron per acre							
	4		6		8		10	
Variety	Young	Old	Young	Old	Young	Old	Young	Old
Berkeley	0	0	0	0	0.5	0	0.5	0
Bluecrop	0	0	0	0	0	0	0	0
Blueray	0	0	0	0	0	-	1	-
Coville	0	0	0	1	0	3	0	3
Herbert	0	0	0	0	0	0	0	2

Except in the case of the sensitive Coville, no difference in injury resulting from difference in age is suggested. This was surprising since the young bushes had been in the field only one year and were set in a very light, sandy soil.

In conclusion it can be stated that:

1. Diuron is most effective when applied to a weed-free soil.
2. Varieties of blueberries vary in their tolerance to diuron.
3. The use of diuron for weed control in cultivated blueberries at rates in excess of two pounds active per acre may result in injury to some varieties.
4. The repeated use of diuron at 3 pounds or more per acre may result in cumulative toxicity.

The diuron used in these experiments was supplied by E. I. Du Pont De Nemours & Company, Inc. of Wilmington, Delaware.

EVALUATION OF SEVERAL HERBICIDES FOR STRAWBERRIES.

By

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Sesone (sodium 2,4-dichlorophenoxyethyl sulfate) has been reported during the past several years as an outstanding herbicide for control of summer annual weeds in strawberries (1, 3, 5, 6, 7). Sesone has one shortcoming despite its extensive use by Delaware growers to reduce hand weeding; it provides weed control for too short a period, approximately one month. This has been the case experimentally, (2, 4, 7). Three or four applications a year are needed, preceded each time by cultivation and hoeing. In recent years, new herbicides have been introduced that may provide weed control over a longer period. Among these are Neburon (3-(3,4-dichlorophenyl) 1-methyl-1-n-butylurea), Simazine, (2-chloro-4, 6-bis(ethyl-amino)-s triazine), and Eptam (ethyl N, N-di-n-propylthiocarbamate). The purpose of this investigation was to evaluate these newer herbicides particularly with regard to duration of weed control.

Neburon granular, 6 lb/A active, has been reported to be effective on strawberries, whereas Neburon spray at the same rate reduced plant vigor (4). Simazine spray, 1½ lb/A active, has been effective for a very long period, but did cause some stunting which was not significant (4).

Procedure

Experiment A. - Plants of the Pocahontas variety were set into the field on March 16, 1957. The soil was Norfolk loamy sand located at the Georgetown Substation. Plots consisted of single rows 20 feet long and 4 feet apart. Plants were set 2 feet apart in the row. Treatments were replicated 12 times in a randomized block arrangement. All herbicides were applied to the surface of freshly cultivated soil. Plots receiving herbicides were hoed and cultivated just prior to herbicide application only. The check plots were hoed at the same time - four times in all. Thus the check plots were treated essentially equivalent to grower practice when herbicides are not applied. Sesone was applied as an over-all spray at 50 gal/A. Neburon and Simazine were applied similarly in the first application on April 21, only. When it appeared that Neburon and Simazine sprays caused some contact injury, these herbicides in subsequent applications were applied to their respective plots in the granulated form, the rate of active ingredient applied per acre remaining the same.

Weed counts and weights weights were taken on a 1 by 3 foot area over the row and 6 feet from the edge of the plot. Only the tops of weeds were weighed.

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Experiment B. - This experiment was conducted the same as Experiment A with a few exceptions. The planting date was March 17, 1958. A split-plot arrangement was used to test three levels of irrigation. The main treatments were irrigation levels replicated 5 times, and the sub-treatments were herbicides which were replicated 15 times. However, since rainfall during the 1958 season was abundant and well-distributed, irrigation was not used. The spring of 1959 was very dry and consequently three irrigation levels were maintained through the harvest season in 1959. They were: irrigation whenever available soil moisture dropped to 50%; irrigation whenever the wilting point was approached; and no irrigation. Available soil moisture was measured by a Bouyoucos moisture meter attached to gypsum blocks placed in the root zone. To maintain the soil at the 50% level of available soil moisture, it was necessary to apply 4 inches of water in four irrigations. To maintain the soil at the medium level of available soil moisture, it was necessary to apply 1½ inches of water in one irrigation.

Results and Discussion

Table 1. Weed counts, rooted plants, marketable yield, and number of fruit per quart for Experiment A, conducted at Georgetown, Delaware, during 1957 and harvested in 1958.

Herbicide	Rate, lb/A, active	Application dates	Weeds/3 sq. ft. on 7/8 b/			Rooted plants per 3' of row, 12/1/57	Market yield, qts./A.	Ave. no. of fruit per quart
			Ann. grasses, No.	Ann. broadleafs, No.	Total wt., (gms.)			
Sesone	2	4/12, 6/4, 7/15, 8/26	17.0	4.7	154	62	10,845	59
Neburon	4	4/12, 6/4, 8/26 a/	1.3	.5	22	58	10,300	63
Neburon	8	" " "	.6	0	3	50	8,621	60
Simazine	1½	" " "	.2	.1	1	44	6,852	61
Simazine	3	" " "	.2	0	1	14	2,133	69
Check, hoed	--	--------	13.2	4.0	215	67	11,026	57
L.S.D. 5%	--	--------	8.8	1.4	20	10	1,316	7

a/ On 4/12, over-all sprays were used. On 6/4 and 8/26, granulars were used on the same plots.

b/ This date was 5 weeks following the application of herbicides on June 4.

Experiment A. - Considering both yield and weed control, Neburon at 4 lb/A was the best herbicide treatment (Table 1). Three applications of Neburon were made during the season. Two applications would probably have been sufficient for full season weed control, for on June 4, when the Neburon and Simazine plots were relatively clean, all plots regardless of weed growth were clean cultivated because the Sesone and check plots were very weedy. As explained above, the first application of Neburon was an over-all spray which caused some contact injury. Granular Neburon, therefore, was used for the last two applications which caused no crop injury. This agrees with the findings of Chappell and Bower (4). Weights of weed per 3 square feet on July 8, which was 5 weeks after herbicides were applied, were 22, 154, and 215 grams for Neburon at 4 lb/A, Sesone at 2 lb/A, and check, respectively. The Neburon plots had to be hoed 12 weeks after this application, whereas the Sesone plots had to be hoed 6 weeks after application. Rooted runner plants, yields, and berry size for hoed check plots and those receiving Neburon at 4 lb/A and Sesone at 2 lb/A were not significantly different.

Neburon at 8 lb/A and Simazine at 1½ and 3 lb/A gave excellent weed control but reduced plant stand and yield.

Several herbicides were screened on the border rows. Of these, Eptam spray at 5 and 10 lb/A was outstanding for control of both annual weeds and northern nutgrass (Cyperus esculentus) with no apparent crop injury. The following treatments were inferior either due to poor weed control or crop injury: Vegadex spray and granular at 6 lb/A; Randox granular at 6 lb/A; and Trietazine spray at 1, 2, and 4 lb/A.

Experiment B. - Both Neburon granular at 4 lb/A active and Eptam granular at 5 lb/A active provided satisfactory control of annual weeds over a relatively long period (Table 2). Neburon was slightly superior to Eptam for control of

Table 2. Weed counts for Experiment B, conducted at Georgetown, Delaware, during 1958 and harvested in 1959.

Herbicide	Rate, lb/A, active	Application dates	Weeds/3 sq. ft. on 6/12[b], gms. Annuals	Weeds/3 sq. ft. on 6/12[b], gms. Nutgrass	Weeds/3 sq. ft. on 9/2[c], gms. Annuals	Weeds/3 sq. ft. on 9/2[c], gms. Nutgrass
Neburon[a]	4	4/23, 5/21, 7/2	0	11	18	60
Eptam [a]	5	" , " , "	8	2	25	1
Check, hoed	-	-- -- --	22	9	372	71
L.S.D. 5%	-	-- -- --	3	6	64	26

a/ Granular formulations were used.
b/ This was 3 weeks following the application of herbicides on May 21. The first rainfall after May 21 was 0.95 inches on May 26.
c/ This was nearly 9 weeks following the application of herbicides on July 2. The first rainfall after July 2 was 0.53 inches on July 7.

control of nutgrass. Although the check plots were hoed four times during the season, weed competition and crop injury from hoeing apparently were the causes for significantly less rooted runner plants on these plots. This is reflected in lower yields as compared with the herbicide treated plots where the high level of irrigation was used (Table 3). The Eptam plots in turn out-yielded

Table 3. Rooted plants and marketable yield at three levels of irrigation during harvest season for Experiment B, conducted at Georgetown, Delaware, during 1958 and harvested in 1959.

Herbicide	Rate, lbs/A, active	Rooted plants per 3 ft. of row, 10/15/58	Mkt. yield, qts./A at 3 levels of irrigation during harvest season		
			Irr. at 50% A.S.M.[a]	Irr. near wilting point	No irr.
Neburon	4	59	9,030	6,256	6,098
Eptam	5	56	10,173	6,256	5,549
Check, hoed	-	40	7,942	6,310	6,419
L.S.D. 5%	-	12	1,045	1,045	1,045

a/ A.S.M. = available soil moisture as measured with a Bouyoucos moisture meter.

the Neburon plots under high irrigation, presumably because Eptam controlled nutgrass, whereas Neburon did not. Berry size was not affected by herbicide treatments. Berry size was affected by irrigation, however, the largest berries being on plots receiving the most irrigation.

Several herbicides were screened on the border rows, but were inferior either due to poor weed control or crop injury. They were: DNBP granular at 9 lb/A active; Falone granular at 4 lb/A active; and Dinoben spray at 1, 2, and 4 lb/A active.

Summary

Of a number of herbicides tested on strawberries during 1957 and 1958, Neburon granular at 4 lb/A active and Eptam granular at 5 lb/A active were outstanding with regard to degree and duration of weed control and lack of crop injury. These chemicals were applied to the surface of freshly cultivated soil.

A much higher plant population resulted from the above treatments in 1959 due to lack of weed competition. This resulted in greatly increased yields where a high level of irrigation was provided during the dry harvest season of 1959.

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CONTROL OF THE COMMON BRAKE, TERIDIUM AQUILINUM L., IN LOWBUSH BLUEBERRIES WITH POLYBORCHLORATE[1]

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One of the chief concerns of the managers of lowbush blueberry areas is the control of weed species. When such species infest a blueberry field, they crowd out the blueberries and seriously interfere with harvesting. In 1948 a weed survey was made in the lowbush blueberry fields in the Granville-Blanford area of Massachusetts. Thirty-five weeds were listed as more or less general pests. Eight of these were considered serious: bayberry, Myrica carolinensis Mill., sweet fern, Myrica asplenifolia L., American aspen, Populus tremuloides Michx., meadow sweet, Spirea latifolia Borhk., common brake, Teridium aquilinum L., chokeberry, Aronia melanocarpa (Michx.) Britton, sheep laurel, Kalmia angustifolia L. and trailing dewberry, Rubus hispidus L. Controls for bayberry, sweet fern, and sheep laurel are available.

The common brake is an extremely serious weed in many places and is very difficult to control. The above-ground portions are very easily killed but the below-ground rhizome and root system is very difficult to kill. Braid (1) reported that in Scotland it took six years to eliminate brakes when they were cut twice a year, first in early June and again six weeks later. Conway and Forrest (2) reported that none of the following compounds killed the rhizomes: amino triazole, ammonium sulfamate, MCPA, 2,4-D, 2,4,5-T, 4-CPA, MCPB, 2,4-DB, 2,4,5-TB, 4CPB, TCA, monuron and MH.

Because of the poor results following the use of chemical or mechanical means which kill the tops, it was decided to try only those chemicals which would penetrate the soil and, it was hoped, be absorbed by the brake roots and kill the rhizomes. Several chemicals were tried but only polyborchlorate killed the brakes. The polyborchlorate had the following analysis: Disodium octaborate tetrahydrate, 73%; Sodium chlorate, 25%; (Boron trioxide equiv., 49%; Boron-B, 18%); Inert, 2%.

The first applications were made in June, 1951, at 800, 1200, and 1600 pounds per acre. A month later all vegetation on all plots appeared dead except a few oaks. In August, 1952, there were still no brakes nor blueberry plants on the plots. Polyborchlorate would kill brakes but at these rates it also killed the blueberries.

In July, 1952, another series of plots in another location were treated at 600, 800, and 1000 pounds per acre. A month later all brakes appeared dead but the blueberries were badly injured at all rates. By mid-August, 1953, the blueberries had almost completely recovered on all plots. There were only a few brakes in the 600 and 800 pound plots and none in the 1000 pound plot. With this encouragement the work was expanded in 1953.

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On Nov. 10, 1953, plots in six fields were treated at 400, 600, 800, and 1000 pounds per acre. Three of the fields had been burned in the spring of 1953 and, therefore, treatments were applied just prior to the bearing year. The other three fields were burned in the spring of 1954 and, therefore, were treated just before burn.

On June 11, and on Aug. 25, 1954, estimates were made of the percentage reduction of blueberry plant stands and the percentage reduction in brake populations as compared with adjacent untreated areas. The results are given in Tables 1 and 2.

Table 1.--Estimated per cent reduction in blueberry plant stand of plots treated with polyborchlorate 11-10-53 before the year of burn or before the cropping year.

	Application preceding burn								Application preceding crop							
	Est. 6-11-54				Est. 8-23-54				Est. 6-11-54				Est. 8-23-54			
Location	A	B	C	Ave.	A	B	C	Ave.	D	E	F	Ave.	D	E	F	Ave.
Lbs/acre																
400	25	50	--	38	10	10	50	23	40	95	25	53	10	--	10	10
600	75	40	--	58	25	5	75	35	20	98	25	48	15	25	10	17
800	80	60	--	70	50	35	85	57	15	85	85	62	20	50	50	40
1000	80	60	75	72	50	25	90	55	10	85	95	63	20	25	75	40
Average				58				43				59				27

Table 1 shows that the injury to the blueberry plants was quite variable according to location, but that the plants had started to recover as the season progressed. The injury increased as the rate increased and rates in excess of 600 pounds per acre were undoubtedly too heavy. There was little difference in initial injury whether the polyborchlorate was applied just before burn or just before cropping. In this experiment plant recovery seemed to be best when application preceded cropping. However, application at this time ruined the crop.

Control of brakes was extremely variable, from practically none in one location to almost 100 per cent in others (Table 2). Although control appeared to increase with increasing rates of application, the increase obtained at rates above 600 pounds per acre did not justify the use of the extra material. The difference between preburn and precrop applications was small and of no practical value since precrop treatments destroyed the crop.

Table 2.--Estimated per cent of brake control on 6-11-54 in plots treated with polyborchlorate 11-10-53 before the year of burn or before the cropping year.

	Application time							
	before burn				before crop			
Location	A	B	C	Ave.	D	E	F	Ave.
Lbs/acre								
400	50	80	75	68	75	0	90	55
600	50	90	90	77	95	0	95	63
800	60	95	90	82	95	0	90	68
1000	60	95	95	83	98	20	98	72
Average				78				65

On May 25, 1955, plots at four locations were treated at rates of 400 and 600 pounds per acre. In mid-November it was observed that the blueberries were very severely injured at both rates at one location but much less at the other three. Brake control was estimated to be 75 to 85 per cent at 400 pounds per acre and 85 to 95 per cent at 600 pounds per acre. On July 20, 1956, the blueberries appeared to be recovering and brake control was still good.

In the fall of 1957 plots were laid out at four locations. Polyborchlorate was applied at 400, 500, and 600 pounds per acre. Half the plots at all four locations were treated on Nov. 13, 1957. The other half of the plots at three locations were treated April 25, 1958. Brake and blueberry plant population counts were made before treatment. A square-yard section at each corner of each plot was measured and the brakes in each of these squares counted. Blueberry plant counts were made by counting the number of blueberry plants on four one-foot square sections chosen at random on each plot. After-treatment counts of brakes were made on August 7, 1958, and on July 14, 1959, and those of blueberry plants on July 14, 1959. No counts of blueberry plants could be made in 1958. All plots were supposed to have been burned. Most were well burned, some were poorly burned, and a few were not burned. Where plots were not burned, the polyborchlorate either killed or severely injured the tops of the blueberry plants so that early in the season they appeared to have been burned. This damage was temporary and the plants made a good recovery.

Since the population of both brakes and blueberry plants was extremely variable, the use of an unwieldy number of untreated checks was avoided by making counts before and after treatment and calculating the percentage kill of brakes and the percentage recovery of blueberry plants. The number of brakes and the percentages killed after fall and spring treatments are given in Table 3.

Table 3.--Total number of brakes counted on 4 square-yard sections of 4 plots treated with polyborchlorate 11-13-57 and 3 plots treated 4-25-58.

	Fall application					Spring application				
	No. of brakes					No. of brakes				
	before treat.	after treatment		% Kill		before treat.	after treatment		% Kill	
Dates	1957	1958	1959	1958	1959	1957	1958	1959	1958	1959
Lbs/acre										
400	305	136	83	65	73	333	88	56	74	84
500	320	209	107	35	67	325	77	40	76	88
600	336	185	97	45	61	312	53	33	83	89

The data in this table was subjected to analysis of variance. The only statistically significant differences were between the 1958 and 1959 percentages of brake kill following fall applications and between locations following spring applications.

Since polyborchlorate appears to be such a good killer of brakes but does injure the blueberries, it is important to know how badly the blueberries are injured and how rapidly they will recover. Table 4 shows the percentage recovery following both fall and spring applications of polyborchlorate.

Table 4.--Per cent recovery of blueberries following fall and spring applications of polyborchlorate.

	Per cent recovery of blueberries							
	Fall application				Spring application			
Lbs/acre	400	500	600	Ave.	400	500	600	Ave.
Location								
1	160	87	80	109	80	86	70	75
2	134	122	174	143	--	--	--	--
3	88	128	133	116	73	86	155	105
4	128	119	96	114	60	58	65	61

The recovery following fall application was significantly better than that following spring applications. Differences between locations or rates were not significant.

Discussion and Conclusions

It is obvious from the data presented that polyborchlorate will kill both

Early in these experiments it was learned that very high rates of polyborchlorate were too injurious to the blueberries and that applications preceding the crop year ruined the crop. Further work was aimed at determining the lowest rate of polyborchlorate which would give a good kill of brakes with a minimum of injury to the blueberry plants and whether or not the blueberries would recover and how fast.

Both the amount of brake kill and blueberry injury were variable. This was probably caused by differences in rainfall, in soil type, or in soil moisture at different locations. Since wild blueberry plants grow from seed, the clones are sometimes quite dissimilar and may vary in their susceptibility or resistance to polyborchlorate injury.

The experiments started in 1957 were designed to find out, among other things, whether an application in fall or spring, just before burn, would give the better results. The data in Table 5 show that recovery following fall application was much better.

Table 5.--Total number of blueberry plants before and after fall or spring polyborchlorate applications and percentage recovery.

	Fall			Spring		
	No. plants			No. plants		
Date	before	after	% recov.	before	after	% recov.
Rate lbs/a						
400	341	413	121	288	204	71
500	361	410	114	257	194	75
600	239	273	114	319	202	63

There was no difference in recovery due to rate of application following either fall or spring applications. Under favorable conditions the blueberries survived following applications of as much as 600 pounds of polyborchlorate per acre and made a satisfactory recovery. In fact, after fall applications, there was an increase in blueberry plant population.

Generally, the brake kill was good. When both applications of polyborchlorate were made before burn, kill was better following spring application than following fall application, but this difference was not statistically significant. After both fall (1957) and spring (1958) applications, the kill in 1959 was greater than that in 1958 indicating a delayed action or carry-over value of the chemical (Table 3). This difference following fall application was great enough to have statistical significance.

Since the differences in kill between rates were not significant, 400 pounds of polyborchlorate may be more than is needed for adequate brake control.

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The polyborchlorate used in these experiments was supplied by the Pacific Coast Borax Company.

NEW YORK TRIALS IN WEED CONTROL OVER THE WHOLE VINEYARD FLOOR

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Current means of vineyard weed control beneath the trellis are: (a) tillage by grape hoeing and hand hoeing, or (b) a spray of diuron or of oil and dinitro (2) (3). Between the rows, weeds are controlled by three to seven cultivations in the period May to August.

A problem with between-row weed control by tillage is root pruning by deep tillage. This is governed by the depth of the tilled soil which ranges from two to six inches. Another problem is incorporation by tillage of the residues such as cover crop, chopped prunings, grape leaves, manure, grape pomace or waste hay often present on the vineyard soil.

The Experiment for Between-Row Weed Control

In the spring of 1956, a ten-year old Concord vineyard at the Vineyard Laboratory, Fredonia, N. Y. was divided into three blocks, each with four, one-sixth acre plots. The treatments are described in Table 1.

Table 1. The treatments of the between-row weed control experiment. Fredonia 1956-1959.

Year	Disking	Monuron	Monuron + Mulch	Rotobeater
1947-1955	All plots received 4 to 6 diskings per year.			
1956	6[1] (5/7-8/3)[2]	1(5/2)	May	5(5/15-8/3)
1957	4 (6/5-8/9)	1(4/12)	1 4/12	5(6/5-9/5)
1958	5 (5/21-8/4)	1(4/11)	1 4/11	5(5/13-9/28)
1959	5 (5/12-8/11)	1(4/14)	1 4/14	5(5/12-8/7)
Notes:	Maximum disk penetration was 2" due to depth control pans.	4 lbs./Acre of monuron in 1956, 1957,1958. 4 lbs.diuron in 1959.	20 tons of wood chips per acre in 1956. In 1957-1959, treatment was same as for monuron trt.	height of weeds before each treatment was 6" to 12"; it was ½" to 2" after treatment.

1 = frequency of treatment.
2 = time of treatment.

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Vine Responses

Table 2 presents the mean yield per vine for all pruning severities. Each weed control plot had equal numbers of vines pruned to 10+10, 20+10, 30+10 and 40+10(1). There was no relation between pruning severity and response to between-row weed control.

Table 2. The mean pounds of fruit per vine (from all pruning treatments) in weed control trials. 1955-1959. Treatments in 1956-1959.

	Disking	Monuron	Mulch	Rotobeater
1955	11.9	13.6	13.1	13.3
1956	11.7	10.4	11.6	13.4
1957	9.9	9.3	9.5	9.5
1958	12.5	11.5	11.5	10.1
1959	14.6	14.6	14.3	11.4
Mean for 1957-59	12.3	11.8	11.8	10.3

Serving as base data are those for 1955 and also for 1956 because the cluster number was not affected by 1956 treatment. These indicate equal production in all plots in 1955 and 1956.

These data show that, with respect to grape yield, one application of monuron was equal to five diskings. When only the vines pruned at 30+10 and 40+10 are considered the average annual yield for 1957, 1958, 1959 was 5.5 tons per acre for the disking treatment and the monuron treatment. The yield reduction in the Rotobeater plots was due to a reduced cluster number, which was basically due to a 30% reduction in vine growth in 1957 and 1958; this resulted in less buds retained, less shoots developed. Even in the drought year 1959, cluster size and berry size were similar under all treatments; the weed control effect was on vine vigor and hence on cluster number. The average 1957 and 1958 vine size for the treatments of disking, monuron, and mulch was 2.2 pounds of cane prunings.

Treatment Effect on Weed Control

Throughout the four years, weeds were well-controlled in the disked plots and the monuron plots. The 1956-applied mulch did not suppress weed growth sufficiently and herbicides were added after 1956. In the Rotobeater plots, there was a year-round green cover even though less than two inches high after each "mowing". The 1958 and 1959 estimates of ground cover are presented in Table 3.

Table 3. Ground Cover Estimates on Two Dates in Vineyard Weed Control Trials. Data are Means of Nine Estimates per Treatment.

Treatment	Oct. 16, 1958 Percent of soil surface covered by		Nov. 2, 1959 Percent of soil surface covered by:		
	green weeds	frost-killed weeds	green weeds	frost-killed weeds	plant residues
Disking	95	5	65	9	4
Monuron	4	23	7	4	37
Mulch	1	38	4	12	69
Rotobeater	87	12	78	9	5

These data show that the April application of monuron (diuron in 1959) reduced weed growth to 27 per cent of the soil surface in 1958 and to 11 per cent in 1959. This is nearly weed elimination; the rate could likely be halved to two pounds per acre in 1960. The plant residues accumulated under the monuron treatment and the mulch retained from the 1956 application aid in soil and water retention.

Chlorosis of ten per cent of the leaf area of several vines in one of the three replicates of the monuron treatment was the only symptom of excess herbicide in 1958. In 1959, there was no chlorosis due to diuron. This tolerance is even more surprising when it is considered that some grape roots in both the monuron and in the mulch plots were in the surface half-inch of soil. Mature grape vines usually root to a depth of five or six feet in this Howard gravelly loam which is more than ten feet deep.

Observations in the Duncan Vineyard

A three year trial of monuron and diuron as April-applied herbicides beneath the trellis and between the rows was started in 1957. The Concord vines had been growing in Canadea silt loam for more than fifty years.

Here, one goal was to observe the tolerance of the vines to these herbicide treatments. The criterion was the severity of the characteristic chlorosis which has been found to be closely associated with both the concentration of these herbicides in foliage and fruit as well as with reduction in vine vigor. The second goal was to record the extent of weed control. Table 4 records some of these data as first-year responses.

Table 4. The weed control between rows and vine tolerance to herbicides in the Duncan vineyard. Oct. 9, 1957.

In-row		Between-row		No. of	Percent	Percent of
Lbs./acre	Herb.	Lbs./acre	Herb.	replicates	soil cover by green weeds	Concord leaf area chlorosed
0	--	0	--	13	100	0
8	monuron	0	--	7	100	4
"	"	2	monuron	4	18	2
"	"	4	"	4	3	1
8	diuron	0	--	7	100	0
"	"	4	diuron	4	2	0

These data show that between-row applications of monuron did affect a commercial weed control without increasing the severity of herbicide chlorosis.

From a scoring on Nov. 3, 1959 all the herbicide treated plots had a trace or less of green cover or of frost-killed cover; the prunings and weed residues covered about 25 per cent of the soil surface. The control plots had 90 per cent green cover of ryegrass and orchard grass. The vines showed no herbicide chlorosis in 1959 and were higher in vigor than the vines which received only mowing between the rows.

Observations at the Rynalski Site

In a four-year-old Concord vineyard two acres were sprayed on a maintenance basis with diuron at the rate of four pounds per acre beneath the trellis and three pounds per acre between the rows. This April 1959 application controlled or eliminated the annual weeds and grasses. No tillage was necessary except in a portion of the vineyard in which there was annual bindweed, Convolvulus arvensis. There was no chlorosis due to herbicide use, while vine vigor and production were equal to that obtained by between-row tillage.

Summary

A report is made on a four-year experiment, a three-year trial, and a first year use of monuron or diuron as alternates to the use of tillage for between-row weed control in Concord vineyards.

These results suggest that an April application of either of these materials can be an acceptable substitute for between row tillage for the entire growing season. This is due to adequate weed control, vine tolerance as shown by maintenance of growth and yield, as well as by little or no diuron chlorosis.

The problem of bare soil can be met by the use of less diuron than necessary for weed elimination, or by the addition of organic materials as in the mulch plots.

The between-row application can be made at the same time as the recommended application of diuron for weed control beneath the trellis.

Rates of application suggested by these trials are two to three pounds of diuron per acre.

Acknowledgements

We are grateful for the cooperation of Mr. Harold Duncan in affording a portion of vineyard; and to the E. I. du Pont de Nemours Company for affording the materials for these experiments.

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BINDWEED CONTROL IN CONCORD GRAPES
1957-59

M. W. Meadows [(1)], Nelson Shaulis [(2)], and C. V. Flagg[(3)]

Chemical weed control has become an established practice in many of the Concord grape vineyards of western New York. This is particularly true since the application of Diuron has been worked out by Nelson Shaulis.

PROBLEM

Diuron has given excellent seasonal control of many annual and perennial weed species prevalent in grape vineyards. Notable exceptions of species that have not been controlled are species of bindweed, Hedge Bindweed (Convolvulus sepium) and Wild Morning Glory (Convolvulus arvensis). Of these two species Hedge Bindweed is the more troublesome due to the rapid rate at which the bindweed vines invade the grape trellis.

This intertwining mass of bindweed competes with the grape plant for light, fertilizers and water -- probably decreasing grape yields. Equally as important is the difficulty experienced in harvesting grapes from bindweed infested trellises plus the increased shattering of clusters during the harvest operation.

REVIEW OF LITERATURE

Meadows et al. (1958) reported preliminary results whereby the polychlorobenzoics and 2,3,6 trichlorobenzoic acid showed promise as a control for bindweed in grape vineyards. The 2,3,6 trichlorobenzoic acid was the more effective.

Bryant and Rasmussen (1951) report on the control of Convolvulus arvensis in apple orchards with 2,4-D. Late summer and early fall applications of 2,4-D were more effective in controlling bindweed. In addition, trees were not affected by the late season application of 2,4-D.

PROCEDURE

During the period 1953-59 a number of compounds was screened in vineyards containing bindweed. Such chemicals as Simazine, Mylone, substituted ureas, Amino triazole, Dalapon, CIPC, Atrazine, and Dinitro plus oil were used at varying rates with no appreciable control of Convolvulus sepium.

Chemicals such as 2,4-D, Diax, MCP and 2,3,6-TBA appeared to be effective. Considering these materials, excepting MCP, the following studies were set up.

(1) Herbicide Specialist, G.L.F., Ithaca, N.Y.
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2,4-D Drift and Volatility Studies of Various Formulations:
The acid and amine salt formulations of 2,4-D were tested in separate abandoned vineyards that were producing active shoot growth.

An area 16' x 16' was sprayed with 2,4-D acid or 2,4-D amine at the rate of 3 lbs. acid equivalent per acre. After foliage had dried (18 minutes), potted grape plants were placed 25, 50, 100, 150 and 200 feet distance leeward of the sprayed area on 6 radii each 30° from each other.

Diax Trials:
In 1957 Diax was applied at rates of 0, 1 and 2 lbs. acid equivalent in a mature Concord grape vineyard that was infested with C. sepium. Plots consisted of one post length, each post length containing 3 grape vines. Each treatment was replicated 6 times. The same treatments were applied to the same plots in 1958 and 1959.

2,3,6 TBA Studies:
A number of 2,3,6 TBA plots were sprayed with this material in 1957, 1958, 1959. Plots were replicated from 3 to 12 times.

The work in 1957 indicated that the danger due to drift and volatility was of no practical consequence. In 1958 trials were set up in 7 different vineyards using 0.2, 0.4 and 0.8 lbs. of TBA per acre.

In 1959 the applications were restricted to 3 balanced pruned vineyards using 0.6, 0.8 and 1.0 lbs. TBA per acre.

In these tests the following information was recorded - bindweed control reported as % ground cover, berry weight, berry size, cluster weight, soluble solids, crop yield and leaf malformation.

Plots in 1957-58 were usually one post length or about 20 - 24 feet containing 3 vines.

The 1959 plots were 2 to 3 post lengths in size.

Standard Procedure:
1. All work was conducted in mature vineyards of the Concord variety near Fredonia, New York.
2. All material rates are given in lbs. active ingredients per acre sprayed.
3. All sprays were applied with a knapsack sprayer in 60 gallons of water per acre at 30 psi.
4. Bindweed refers to Convolvulus sepium.
5. A band 3 feet wide (18 inches on either side of grape vines) the length of the plot was treated.

RESULTS AND DISCUSSION

2,4-D Drift and Volatility Comparing the Acid and Amine Salt Formulation:

Table 1 shows the results of these studies. A scoring of serious indicates very marked malformation of grape leaves whereas present indicates that 2,4-D symptoms were detectable.

Table 1: Foliage Malformation of Concord Grape Leaves at Several Distances from the Center of a 16' x 16' Sprayed Area. LaPorte Vineyard, Westfield, New York. Application 7/10/58. Scoring 8/19/58. Wind 7-14 mph.

	Sprayed Area	25'	50'	100'	150'	200'
2,4-D Amine 3#/A						
Drift	Serious	Serious	Serious	Present	Present	0
Volatility	Serious	0	0	0	0	0
2,4-D Acid 3#/A						
Drift	Serious	Serious	Serious	Present	Present	0
Volatility	Serious	Serious	Present	0	0	0

The results of this work would indicate that drift is of more danger than volatility. Although there seems to be more danger from volatility of the acid than of the amine, the difference would not be of practical significance since each material caused too much damage in the sprayed area.

Diax Studies:
Table 2 shows grape yield, soluble solids of grapes and bindweed control obtained from plots receiving respectively 0, 1, and 2 lbs. of Diax for 3 consecutive years.

Table 2: Response to Diax applications in a Grape Vineyard. Application Dates 8/26/57, 8/21/58 and 9/5/59.

Rate of Diax Lbs. Active/Acre	Bindweed 5 Ground Cover	Grape Soluble Solids	Grape Yield Lbs. per Vine
0	58	18.1	12.4
1	Trace	18.5	12.9
2	Trace	18.9	12.6

Control of bindweed at the end of the 3 year period was nearly complete. This small infestation is probably from bindweed vines that had invaded the trellis and were not completely sprayed.

No adverse effects on yields or soluble solids resulted from the Diax treatments. Some grape foliage malformation was apparent.

2,3,6 TBA Studies:
Grape Tolerance to TBA: In 1957 TBA was applied at rates of 1, 2 and 4 lbs. per acre to mature grape vines in the vineyard.

The material at 1 lb. per acre produced practically no formative effects on the grape leaves; at 2 lbs. very marked leaf malformation was apparent and the 4 lb. rate of TBA killed the grape plant.

Time of Application: In 1958 TBA was applied at two stages of grapevine growth as follows:

A. July 8 - 9 - a period of very rapid shoot growth when the berries were very small. Grape bloom was about June 25.
B. August 20 - 21 - when shoot elongation had virtually ceased and berries were nearly maximum in size.

Table 3 reports these observations.

Table 3: Malformation of Concord Grape Leaves Caused by 2,3,6 TBA At Two Application Dates

Vineyard	Date of Application	% Foliage Malformed Lbs. 2,3,6 TBA per Acre 0	0.2	0.4	0.8
Dudley	7/8/58	Trace	8	12	14
	8/21/58	Trace	Trace	Trace	Trace
Mead	7/9/58	3	10	19	26
	8/20/58	Trace	Trace	15*	0

*Trailing shoots sprayed.

These data indicate very clearly that early July applications of TBA resulted in considerably more grape leaf malformation than did late August applications.

The freedom from malformation in the check plots that were adjacent to the treated vines emphasizes the relative safety of TBA in grape vineyards from the standpoint of drift and volatility.

In these trials it was noted that where only one leaf of a grape shoot received an application of TBA the berries on that shoot failed to ripen regardless of whether or not leaves were malformed. This pointed out the necessity for training vines in a manner that would avoid direct application of TBA on grape foliage.

There were no clear cut differences in bindweed control in comparing these dates of application except that the 0.2 and 0.4 rates were too low to obtain control.

Effect of TBA on Yield of Grape Vines and Control of Bindweed
Objective of this work was to determine the effect of late August application of TBA at 0.6, 0.8 and 1.0 lbs. per acre on grape yield, berry size and soluble solids; also bindwee control.

Table 4 presents these results.

Table 4: Effect of TBA on Grape Size, Grape Yield, Soluble Solids And Bindweed Control. Sprayed 8/20/59. Data Taken 9/29/59. Dudley Vine Street. Average of 12 Vines.

Lbs.TBA Per Acre	Grams 100 Berries	Soluble Solids	Grapes Lbs/Vine	Bindweed % Ground Cover
0	295.9	18.1	11.2	45.4
0.6	284.8	17.7	14.9	26.3
0.8	296.6	17.7	13.9	11.3
1.0	299.2	18.3	12.4	5.8

These data would indicate that the rates of TBA used in these trials had no adverse effect on size of berries, soluble solids or yield of grapes.

The 0.8 and 1.0 lb. rates of TBA gave significant control of bindweed. A majority of the bindweed in these plots was a result of bindweed that had invaded the grape trellis and not thoroughly sprayed.

Bindweed roots from the treated areas showed considerable decay and malformation of young buds.

Effect of Repeated Applications of TBA on Grapes and Bindweed

In 1957 plots were laid down to determine the cumulative effects of TBA on grapes and bindweed. Plots were treated respectively with 0, 0.35 and 0.7 lbs. of TBA per acre in 1957, 1958 and 1959 with results recorded in Table 5.

Table 5: Cumulative Effect of 3 Applications of TBA on Consecutive Years 1957, 1958 and 1959. Ransom Vineyard. Applications 8/26/57, 8/21/58 and 8/20/59.

	Lbs. TBA Per Acre		
	0	0.35	0.7
Lbs. Crop per 100 Bearing Nodes*	56	50	50
Soluble Solids	18.4	19.1	19.3
Grams per 100 Berries	266	278	255
Bindweed % Ground Cover	58	13	1.5

*Winter injury on the check and treated vines during the winter of 1958-59 makes this a more valid yield comparison than yield per vine.

These data indicate that applications on 3 consecutive years did not adversely affect grape yield, berry size, or soluble solids. Bindweed control at the 0.7 lb. per acre rate was almost complete. The 0.35 lb. rate resulted in a substantial reduction of bindweed.

CONCLUSIONS (PRELIMINARY)

Although these conclusions are preliminary the following observations are pertinent to these experiments.

1. Although 2,4-D showed promise as a control for bindweed, the drift and volatility hazards as it refers to grape injury are too great to allow use of these materials in the method of application employed.

2. Diax applied during 3 consecutive years at rates of 1 and 2 lbs. active chemical per acre gave excellent control of bindweed without affecting yields or soluble solids of grapes.

3. Mid-July applications of TBA resulted in considerable grape leaf malformation;late August applications caused practically no leaf malformation.

4. Late August applications of 0.8 and 1.0 lbs. of TBA gave excellent control of bindweed with no effect on grape yields, berry size or soluble solids.

5. Late August applications of 0.7 lbs. TBA to the same plot for 3 consecutive years gave excellent bindweed control without any adverse effect on grape yield, berry size, or soluble solids.

6. Direct application of TBA on a few leaves of a grape shoot in late August prevented ripening of the berries on that shoot.

7. Best control of bindweed wasoobtained where the entire bindweed plant was covered with the TBA solution.

8. TBA applications resulted in little to no damage to vines adjacent to the sprayed area.

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A Progress Report on the Chemical Weeding of Sweet Corn[1]

Charles J. Noll[2]

Sweet corn has been weeded on a commercial basis with chemical herbicides for many years. The common chemicals used are 2,4-D or a water soluble dinitro. Weeding with these chemicals is not always satisfactory. Some weeds are not killed and sometimes the corn is injured by the treatment. Some of the new chemicals used last year look promising for the weeding of this crop. This is a further trial of the use of these chemicals in comparison with the older commercial treatments.

Procedure

The variety Iochief sweet corn was seeded May 19, 1959. Pre-emergence applications of herbicides were made May 20, and emergence treatments May 26 when the corn was just coming through the soil. Individual treated plots were 44 feet long and 3 feet wide.

Chemicals were used at two rates each, usually what was thought to be the best rate and 1 1/2 time or 2 times this rate. Treatments were randomized in each of five blocks. The chemicals were applied with a small sprayer over the row for a width of 12 inches. Cultivation controlled the weeds between the rows.

An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most effective and 10 being least effective. The growing season was favorable this summer for plant growth. Rainfall was above normal and well distributed throughout the growing season. Corn was harvested August 18th.

Results

The results are presented in tables I and II. . All but three chemicals significantly increased weed control as compared to the untreated check. The best weed controls were obtained with Simazin as a spray or granular in a pre-emergence application or in combination with amino triazole in a post-emergence application, with Atrazine in either a pre- or post-emergence treatment, with other triazines such as Trietazine, Atratone and Prometone in pre-emergence applications, with granular 2,4-D, Randox and TBA in pre-emergence applications and with granular dinitro and Niagara 4556 in post-emergence applications.

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[1]Authorized for publication on November 24, 1959 as paper no. 2420 in the journal series of the Pennsylvania Agricultural Experiment Station.

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Corn stand as compared to the untreated check was significantly reduced by G-31717, a triazine compound and 2,4-D granular in pre-emergence applications and by granular dinitro in a post-emergence application.

The average number of ears and weight of marketable ears at harvest were reduced by the pre-emergence application of Prometone, Atratone, granular 2,4-D, and Urab. The number of ears was also reduced by the post-emergence application of granular dinitro, Amino triazole (ATA) and the combination of Amino triazole and Simazin.

Conclusion

No chemical treatment resulted in an increase in yield in comparison with the untreated check where some weeds were 3 feet tall at time of harvest. If rainfall had not been so well distributed and in excess of normal it is possible that a number of herbicidal treatments would have resulted in increased yields.

The most promising treatments, taking into consideration weed control, corn stand and number and weight of marketable ears were Simazin both as a spray and as a granular in a pre-emergence treatment; Atrazine in both a pre- and post-emergence treatment; Trietazine, Vegadex and Randox in a pre-emergence treatment; and Niagara 4556 in a post-emergence treatment.

Table I. Weed control and plant stand of sweet corn under chemical herbicide treatments.

Chemical	Active Rate Per Acre, lbs. Rate 1	Active Rate Per Acre, lbs. Rate 2	When Applied	AVERAGE PER PLOT: *Weed Control (1-10) Rate 1	*Weed Control (1-10) Rate 2	*Weed Control (1-10) Ave. of 1 & 2	Stand of Corn Rate 1	Stand of Corn Rate 2	Stand of Corn Ave. of 1 & 2
No treatment	—	—	—	7.5	—	7.5	58.6	—	58.6
Simazin	2	3	Pre-emerg.	1.2	1.0	1.1	56.4	57.6	57.0
Trietazine	4	6	"	1.6	2.2	1.9	60.8	57.6	59.2
Atrazine	2	3	"	1.2	1.0	1.1	62.0	57.6	59.8
Prometone	2	3	"	2.0	1.2	1.6	60.8	56.6	58.7
G-31717	2	3	"	7.6	6.4	7.0	56.6	55.4	56.0
Atratone	4	6	"	1.6	1.4	1.5	56.0	53.0	54.5
Simazine (4% Granular)	2	4	"	2.0	1.6	1.8	55.8	57.0	56.4
2,4D Amine	2	3	"	4.2	3.2	3.7	59.4	54.8	57.1
2,4D M-1497 (20% Granular)	4	8	"	2.4	1.6	2.0	50.4	49.4	49.9
Urab	1½	2¼	"	4.2	3.0	3.6	54.4	55.8	55.1
Vegadex	6	9	"	5.0	3.4	4.2	56.6	60.0	58.3
Randox	6	9	"	2.6	2.0	2.3	58.4	60.6	59.5
TBA	2	3	"	2.4	1.2	1.8	56.8	55.2	56.0
Dinitro	3	4½	Spike	4.2	3.4	3.8	56.4	54.6	55.5
Dinitro M-1498 (20% Granular)	4	8	"	2.8	1.0	1.9	50.4	38.6	44.5
2,4D Amine	½	3/4	"	6.2	6.6	6.4	57.6	61.2	59.4
Atrazine	2	3	"	1.6	1.0	1.3	57.0	57.2	57.1
Niagara 4556	4	6	"	3.0	1.8	2.4	60.2	56.2	58.2
ATA	1	1½	"	6.4	4.6	5.5	61.0	58.6	59.8
ATA + Simazine	1 + 2	1½ + 2	"	1.4	1.2	1.3	57.6	56.8	57.2
Dinitro + Dowpon	3 + 1	3 + 1½	"	4.0	3.2	3.6	53.0	57.0	55.0
2,4D + Dowpon	½ + 1	½ + 1½	"	7.0	5.6	6.3	56.8	58.8	57.8
2,4D + Urea	½ + 30	½ + 45	"	5.0	5.2	5.1	56.2	61.6	58.9
Least Significant Difference (P = .05)						1.5			3.9
" " " (P = .01)						2.0			5.1

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

Table II. Number and weight of ears of sweet corn under chemical herbicide treatments.

	Active Rate Per Acre, lbs.			AVERAGE PER PLOT					
				Number of Ears			Wt. of Ears in lbs.		
Chemical	Rate 1	Rate 2	When Applied	Rate 1	Rate 2	Ave. of 1 & 2	Rate 1	Rate 2	Ave. of 1 & 2
No treatment	—	—	—	51.8	—	51.8	27.1	—	27.1
Simazin	2	3	Pre-emerg.	52.4	48.4	5-.4	25.6	24.5	25.1
Trietazine	4	6	"	54.0	52.2	53.1	28.2	27.3	27.8
Atrazine	2	3	"	52.0	46.8	49.4	25.5	24.0	24.7
Prometone	2	3	"	45.6	40.0	42.8	24.4	19.6	22.0
G-31717	2	3	"	53.0	50.0	51.5	29.4	27.7	28.6
Atratone	4	6	"	41.6	30.8	36.2	20.1	15.2	17.6
Simazine (4% Granular)	2	4	"	53.0	50.2	51.6	28.4	26.3	27.4
2;4D Amine	2	3	"	52.0	45.8	48.9	26.6	25.2	25.9
2,4D M-1297 (20% Granular)	4	8	"	44.8	30.8	37.8	23.1	16.6	19.9
Urab	1½	2¼	"	44.6	45.8	45.2	23.7	24.4	24.1
Vegadex	6	9	"	50.4	50.2	50.3	26.4	25.4	25.9
Randox	6	9	"	52.4	52.0	52.2	29.5	27.2	28.3
TBA	2	3	"	49.4	45.4	47.4	24.5	21.8	23.4
Dinitro	3	4½	Spike	48.6	47.4	48.0	25.0	24.5	24.8
Dinitro M-1498 (20% Granular)	4	8	"	38.8	31.0	34.9	21.1	16.4	18.8
2,4D Amine	½	3/4	"	46.6	50.2	48.4	23.1	25.0	24.1
Atrazine	2	3	"	52.2	49.0	50.6	26.9	26.8	26.9
Niagara 4556	4	6	"	50.2	49.4	49.8	25.5	26.6	26.1
ATA	1	1½	"	48.6	43.4	46.0	24.6	20.7	22.7
ATA + Simazine	1 + 2	1½ + 2	"	43.8	41.4	42.6	23.5	22.5	23.0
Dinitro + Dowpon	3 + 1	3 + 1½	"	50.8	46.4	48.6	26.1	23.2	24.7
2;4D + Dowpon	½ + 1	½ + 1½	"	52.0	64.2	53.1	27.7	30.2	28.9
2,4D + Urea	½ + 30	½ + 45	"	51.2	51.4	51.3	26.8	27.5	27.1
Least Significant Difference (P = .05)						5.3			3.3
" " " (P = .01)						7.0			4.4

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

EVALUATION OF SEVERAL HERBICIDES ON TOMATO PLANTS

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The control of weeds, particularly purslane, redroot pigweed, lambsquarters, crabgrass, and barnyard grass, has constituted one of the major production problems with tomatoes from the standpoint of competition for water and nutrients, disease and insect control, and injury from slugs. Several herbicides were applied to established tomato transplants grown in the field to determine their relative effectiveness and the extent of tomato plant injury.

MATERIALS AND METHODS

The herbicides were applied to three varieties of hybrid tomato plants grown on a medium sandy loam at Schubert Gardens, Morgantown, West Virginia. Seven replications were obtained in the following manner: two replications of Hystep Hybrid plants grown in 2 1/2" wooden bands and transplanted into the field on May 10, 1959; one replication of Morton Hybrid also grown in bands and transplanted into the field on May 17, 1959; and four replications of Big Boy Hybrid tomato plants grown in plastic trays and transplanted into the field on June 7, 1959. All plants were irrigated with overhead sprinklers twice before being cultivated with a rotary tiller either the same day or the day before application of herbicides. Irrigations were made after treatment as needed throughout the growing season.

Each plot of Morton Hybrid was 1/100 acre in area and treatments were made on June 23, five weeks after field setting. All other treatments on plots of 1/400 acre each were made on June 26 and 27, nearly six weeks after setting of Hystep Hybrid and nearly three weeks after setting the Big Boy Hybrid tomato plants. All tomato plants were set about 2 feet apart in rows 6 feet apart.

The treatments were:

1. SIMAZINE 50WP, 2 pounds active per acre, applied with a sprinkling can at the rate of about 800 gallons of water per acre.
2. SOLAN (Niagara 4512) 4 EC, 4 pounds active per acre, applied with a sprinkling can on the Morton Hybrid plot for replication 1, but applied to all other Solan plots with a power sprayer at 75 pounds working pressure using a small hand gun at the rate of 200 gallons per acre.
3. EPTAM 5G, 5 pounds active per acre, applied by hand after further dilution with fine sand. The Eptam was mixed into the soil with a rotary tiller.
4. AMIBEN 10G, 4 pounds active per acre, applied to soil surface after dilution with sand.
5. SIMAZINE 4G, 2 pounds active per acre, applied to soil surface after dilution with sand,
6. CHECK, no treatment except the tilling and hoeing that was given to all plots the day of, or the day before herbicide applications.
7. EPTAM 5G, 5 pounds active per acre, tilled into the surface soil plus SIMAZINE 4G, 2 pounds active per acre, broadcast on surface of soil after tilling.

RESULTS AND DISCUSSION

Table 1. Average weed intensity for seven replications of herbicides on July 16 and August 14, 1959, three and seven weeks following application.

Treatment	Average Weed Intensity 1= No Control, 10 = 100% Control July 16	August 14
1. Simazine 50WP - 2 lb/A	9.5	6.0
2. Solan 4 EC - 4 lb/A	7.4	2.5
3. Eptam 5G - 5 lb/A	8.8	3.5
4. Amiben 10G - 4 lb/A	8.9	4.7
5. Simazine 4G - 2 lb/A	8.8	3.5
6. Check	1.4	1.0
7. Eptam 5G - 5 lb/A plus Simazine 4G - 2 lb/A	10.0	9.0

On July 16, an analysis of data showed:
Treatment 7 significantly greater than 6,2,5,3,4.
Treatment 1,4,3,5 significantly greater than 6,2.
Treatment 2 significantly greater than 6.

On August 14, an analysis of data showed:
Treatment 7 significantly greater than 6,2,5,3,4.
Treatment 1 significantly greater than 6,2.
Treatment 4,3,5 significantly greater than 6.

On July 16, the Eptam plus Simazine treatment gave a significantly greater degree of weed control than all other treatments except Simazine 50WP. At this time the Simazine 50WP, Eptam, Amiben and Simazine 4G treatments were significantly better than the check and Solan plots. Solan was better than the check on July 16 but not on August 14.

On August 14, the Eptam plus Simazine treatment gave a significantly greater degree of weed control than all other treatments except Simazine 50WP. Simazine 50WP was better than the Solan and check plots. Eptam, Amiben, and Simazine 4G were all better than the check.

All treatments gave a satisfactory degree of weed control until July 16 but Eptam plus Simazine was the only outstanding treatment on August 14. Simazine 50WP and Amiben were probably acceptable.

Table 2. Average broad-leaved and grassy weed intensity for seven replications of herbicides on August 14, 1959, seven weeks after application.

Treatment	Average Weed Intensity 1 = No Control, 10 = 100% Control Broad-Leaved Weeds	Grassy Weeds
1. Simazine 50WP - 2 lb/A	9.1	6.6
2. Solan 4EC - 4 lb/A	8.5	3.1
3. Eptam 5G - 5 lb/A	4.9	7.4
4. Amiben 10G - 4 lb/A	7.2	6.0
5. Simazine 4G - 2 lb/A	7.8	4.7
6. Check	3.6	3.4
7. Eptam 5G - 5 lb/A plus Simazine 4G - 2 lb/A	9.7	9.2

An analysis of data on broad-leaved weeds showed:

Treatments 7,1,2,5,4 significantly greater than 6,3.

An analysis of data on grassy weeds showed:

Treatment 7 significantly greater than 2,6,5,4.
Treatment 3 significantly greater than 2,6,5.
Treatment 1,4 significantly greater than 2,6.

On August 14, the intensity of broad-leaved weeds (primarily purslane, redroot pigweed and lambsquarters) were recorded. All treatments, except Eptam, gave a significantly better degree of weed control than the check and would be considered promising.

Eptam plus Simazine gave the best control of grassy weeds (primarily barnyard grass and crabgrass) and was significantly better than Solan, Amiben, Simazine 4G and check. Eptam was better than Solan, Simazine 4G, and check while Simazine 50WP and Amiben were better than the Solan and check plots. After seven weeks the grasses were as prevalent in the Solan plots as in the check plots.

In general the degree of grass control would be considered satisfactory in all treatments except Solan and Simazine 4G.

Table 3. Vigor evaluation of tomato plants on July 16 and August 14, three and seven weeks after application of herbicides.

	Tomato Plant Vigor 1 = Plants Dead, 10 = Vigorous Plants	
Treatment	July 16	August 14
1. Simazine 50WP - 2 lb/A	3.3	3.0
2. Solan 4 EC - 4 lb/A	8.8	6.6
3. Eptam 5G - 5 lb/A	8.1	7.3
4. Amiben 10G - 4 lb/A	9.0	7.1
5. Simazine 4G - 2 lb/A	6.7	4.4
6. Check	9.8	5.7
7. Eptam 5G - 5 lb/A plus Simazine 4G - 2 lb/A	4.4	4.5

An analysis of data on tomato plant vigor on July 16 showed:

Treatment 6 significantly greater than 1,7,5,3,2.
Treatment 4 significantly greater than 1,7,5,3.
Treatment 2,3 significantly greater than 1,7,5.
Treatment 5 significantly greater than 1,7.
Treatment 7 significantly greater than 1.

An analysis of data on tomato plant vigor on August 14 showed:

Treatments 3,4,2 significantly greater than 1,5,7.
Treatment 6 significantly greater than 1.

On July 16, the check plants were more vigorous than in any other plots except the Amiben. The Amiben plants were better than all others except Solan. Treatments receiving Solan or Eptam were more vigorous than plots receiving any form of Simazine. In addition Simazine 4G was significantly less harmful to the tomato plants than Simazine 50WP or the combination of Eptam plus Simazine 4G. Eptam plus Simazine 4G was less harmful than Simazine 50WP. In general the tomato plant vigor on July 16 was satisfactory with all treatments except those containing some form of Simazine.

On August 14, the vigor of tomato plants was significantly higher in the Eptam, Amiben and Solan plots than in any of the plots receiving Simazine. The plants in the check plots were retarded by weeds to the extent that they were more vigorous than only the Simazine 50WP plots and not significantly better than the Simazine 4G or Eptam plus Simazine plots. Thus on August 14, as on July 16, the tomato plant vigor was significantly better with all treatments except those containing Simazine.

Since Solan was suggested as an herbicide which could best be applied after weeds are no more than 1 1/2 inches tall, several non-replicated sprays were applied. The degree of grass control was satisfactory only for about a month if the grass was not more than 1 1/2 inches tall at the time of spraying. If the grass was taller than 1 1/2 inches Solan merely tended to stunt the grass for a week or two and then the grass apparently grew more vigorously than in unsprayed plots, presumably because of no competition with broad-leaved weeds. Solan did control redroot pigweed until the plants were about 8 inches tall. If the pigweed was between 8 inches and 15 inches it was generally stunted so severely that it did not constitute a serious weed problem. Purslane was effectively controlled until the plants were large enough to make a solid ground cover. In one application where the 4 pounds of Solan was diluted with more than 200 gallons of water per acre the control was not satisfactory. From these limited trials it appeared that Solan would offer promise if used with another herbicide that would control grasses or by a cultivation just as the grasses were coming into the treated area.

CONCLUSIONS

1. Amiben was considered to be the most satisfactory herbicide used from the standpoint of general weed control and effect on tomato plants for seven weeks. For longer periods of weed control, it appears that repeat applications or perhaps the addition of another herbicide should be considered.

2. Eptam was acceptable for control of barnyard grass, crabgrass, redroot pigweed and lambsquarters but not for control of heavy purslane infestations. The addition of another herbicide, perhaps Solan, might extend the length of time of satisfactory weed control.

3. Solan was acceptable for control of broad-leaved weeds in these trials but not satisfactory for control of grasses. Perhaps the addition of another herbicide to kill grasses would permit the use of Solan and take advantage of a material that can be sprayed onto plants with little or no plant injury.

4. Under the conditions of this trial (with a medium sandy loam and irrigation) all forms of Simazine were too phytotoxic at the 2 lb/acre rate. Simazine 4G did not give uniform weed control and caused erratic plant injury. If Simazine were to be used on a similar soil a lighter rate would be suggested and perhaps another herbicide added.

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PRELIMINARY STUDIES OF SOLAN AS A POST-EMERGENT HERBICIDE FOR TOMATOES

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Competition between weeds and agronomic or horticultural crops for soil water and nutrients and for sunlight may result in significant reduction in plant stand, vigor and yield. Shadbolt and Holm (2) have measured quantitatively some of the effects of weed competition on several vegetable crops.

The control of weeds in transplanted tomatoes is an especially difficult problem. Post-emergent or foliar applications of most herbicides have been found highly toxic to tomato plants. As a result, the chemicals that have been used have been applied as directed sprays pre-emergent to weed growth. In addition, cultivation becomes increasingly difficult as lay-by approaches, necessitating expensive hand labor. Menges and Aldrich (1) have discussed the use of 2,4,5-trichlorophenoxyethylsulfate (2,4,5-TES) for use on tomatoes. Sweet and Rubatzky (3) found Solan to give commercial weed control and to be outstanding in lack of crop damage.

A new herbicide, N-(3-chloro-4-methylphenyl)-2-methylpentanamide, referred to as Solan, has been found toxic to a variety of annual broadleaved and grassy weeds and selective in favor of tomato plants when applied as a foliar spray. The present investigations were made to assess the performance of Solan as an herbicide for use on several varieties of tomatoes as reflected in fruit-set, early fresh market yield and total or seasonal yield.

METHODS AND MATERIALS

Two experiments were conducted at the Niagara Research Farm, Middleport, New York, on an area suitably fitted for transplanting tomatoes. Each trial was made using a randomized complete block design with three replications. Each treatment was applied to a row of tomatoes made up of seven different varieties, namely, Valiant, Longred, Fireball, Moreton Hybrid, Geneva 11, Red Jacket and Glamour. Eight treatments, including cultivated and uncultivated checks, were randomized in each replicate. All chemicals were applied as foliar sprays using a knapsack hand sprayer.

The herbicide used in all experiments was Solan which was applied at rates equal to 2.0, 4.0 and 6.0 pounds of active ingredient in a volume of finished spray equivalent to 50 gallons of water per acre. The above rates were also used in combination with Thiodan, an insecticide, at 0.5 pound of active material plus COCS, a copper fungicide, at 3.0 pounds in a finished spray volume equivalent to 100 gallons of water per acre. Each chemical application was repeated three times in Experiment I. Two applications were used in Experiment II. The plant growth stages varied between the experiments.

Each treatment was assessed by determining fruit-set, early or fresh market yields and all season yields. The herbicidal performance was also recorded.

DISCUSSION OF RESULTS

Experiment I

Each chemical treatment was applied three times during the growing season, thus covering three different stages of growth of the tomato. This resulted in a total of 6.0, 12.0 or 18.0 pounds of Solan per acre. The first was made June 17, three weeks after the plants had been set in the field and when in the 8-12 leaf stage. No blossoms were present. Weeds, mostly pigweed (Amaranthus retroflexus) and lamb's-quarters (Chenopodium album) were two to three inches high. The second of the three applications was made one month later when the plants had set some fruit. The third application was made one month after the second treatment at which time some of the tomatoes had begun to ripen.

Data on fruit ripening were taken by counting and weighing the number of ripe tomatoes during the first five pickings, from July 31 to August 21. This period of picking ended one week after the third treatment. Table 1 gives the number of ripe fruits for the first five pickings for Experiment I. A statistical analysis of these data indicated no differences in numbers of tomatoes ripening in early season for Solan applied alone or in combination with Thiodan plus COCS. Solan alone produced an average of 53 tomatoes per plot while Solan with Thiodan plus COCS produced an average of 55 tomatoes per plot over all rates and varieties. As indicated in Table 1, there was no difference between chemical rates. Solan at 2.0, 4.0 and 6.0 pounds per acre produced 53, 56 and 54 tomatoes per plot, respectively. The cultivated check produced an average of 60 tomatoes per plot, a value which was shown not to vary significantly from the above. Two varieties, Glamour and Longred, were found to produce significantly fewer early fruits than our standard variety, Red Jacket. The variety, Fireball, produced more fruits than the standard. Even in these early season data, it was noted that most varieties in the uncultivated plots produced fewer tomatoes than the respective averages of the treated plots.

The total fresh weight of tomatoes produced by the different varieties was noted for the first five pickings. These data are recorded in Table 2. An analysis of variance revealed no significant differences between the average for chemicals, rates or varieties.

The total number of tomatoes produced for the entire season from each of the treatments is reported in Table 3. No significant difference in the number of tomatoes was obtained over all varieties and rates when treated with either Solan alone or in combination with Thiodan plus COCS. The average number of tomatoes produced for Solan alone was 229 fruits, while combinations with Thiodan plus COCS produced an average of 225 fruits. There was no significant difference between application rates. Solan at 2.0, 4.0 and 6.0 pounds per acre produced 225, 231 and 226 tomatoes, respectively. The average number of tomatoes produced in the cultivated check area was 235, a value which was shown not to vary significantly from the above. There was a significant difference among varieties when the total number of fruit picked was compared to the highest yielding variety, Red Jacket. Treated blocks of all varieties gave better yields than the respective untreated controls.

The total yield in pounds of tomatoes for the season in Experiment I is reported in Table 4. Again, no significant difference is evident in yield, over all rates and varieties, when using Solan alone or in combination with Thiodan plus COCS. The average number of pounds for Solan alone was 48.9 while the combination produced an average of 49.3 pounds. Solan at 2.0, 4.0 and 6.0 pounds per acre gave 50.4, 47.0 and 50.0 pounds of tomatoes, respectively. The cultivated check produced 50.7 pounds on the average, which did not differ significantly from the above values. Again, there was a significant difference in yields between the varieties.

Data on weed control are reported in Table 5. Counts were made at two intervals during the test: The first, on July 14, 27 days after the first of the three chemical applications, the second on August 12, just prior to the third and last chemical application. The first weed count showed no weeds in any of the sprayed areas and an average of 4.3 lamb's-quarters per square foot in the untreated area. The second weed count showed good control of pigweed and lamb's-quarters for each chemical treatment. All weeds in the treated areas were less than two inches high, with the exception of some of the grasses. All plots treated with Solan at 2.0, 4.0 or 6.0 pounds of active material had less than five small pigweeds per plot. Areas treated with Solan alone at 2.0, 4.0 or 6.0 pounds per acre had an average of 18.3, 7.3 and 3.6 small lamb's-quarters plants, respectively, per plot. The untreated check had 334 lamb's-quarters per plot averaging one to three feet tall. Tomatoes in this area were covered with these large weeds. Grass population in the area was very low. Other weeds in the untreated area included ragweed (Ambrosia elatior), purslane (Portulaca oleracea) and unidentified weeds. Miscellaneous broadleaved weeds found in the treated areas were two inches or less in height while those in the check area were large plants.

The third chemical application, applied one day after the final weed count, eradicated all of these small weeds and no additional counts were made. This third application was not necessary for weed control but was of importance in studying the tolerance of tomato to the herbicide.

Experiment II

In the second trial, each chemical treatment was repeated twice during the season thus covering two different plant growth stages. This resulted in a total of 4.0, 8.0 or 12.0 pounds of Solan per acre. The first application was made on July 2, approximately five weeks after the plants had been set in the field. The plants at this time were in heavy blossom. The weeds at this time consisted of pigweed and lamb's-quarters about four to six inches high. The second application was made one month later or 10 weeks after the plants had been transplanted to the field. Many fruit had been set at this time.

Data on fruit ripening were taken by counting and weighing the number of ripe tomatoes during the first five pickings. This picking ended 3 weeks after the last treatment. Table 6 gives the number of ripe fruits for the first five pickings. Solan alone or in combination with Thiodan plus COCS showed no significant difference in the number of early ripe fruits. An average of 55 tomatoes over all rates and varieties was noted in the Solan alone treatment and an average of 51 tomatoes was noted in the combination treatments. There was no significant difference between rates. However, each rate value was significantly less than the cultivated check. This reduction in fruit number probably was due to the fact that the first application was made when the tomato plants were in heavy bloom. As experienced previously, there was a significant difference in fruit numbers among the varieties.

The total yield in pounds of tomatoes produced by the different varieties was taken for the first five pickings. These results are recorded in Table 7. There was a significant difference in the yields between Solan applied alone and Solan in combination with Thiodan plus COCS. Solan alone produced an average of 15.5 pounds for all rates and varieties while the combinations produced 13.3 pounds of tomatoes per plot as an average for all rates and varieties. As in the analysis of the number of tomatoes produced, there was no significant difference in yield among the rates. However, each rate value was significantly less than the cultivated check.

The total number of tomatoes produced for the entire season from each of the treatments is reported in Table 8. The analysis of these values showed no significant difference between the number of tomatoes produced in the plots treated with Solan alone or Solan combined with Thiodan plus COCS over all rates and varieties. Unlike data for early season fruit numbers, the differences between rates of application and cultivated check plots were not found to vary significantly. Solan at 2.0, 4.0 or 6.0 pounds per acre produced 210, 235 and 248 tomatoes per plot, respectively. The cultivated check had an average of 230 tomatoes. It should be noted that even with a reduction of early season ripening in the Solan treated plots, there was no significant reduction in the all-season number of tomatoes. Certain varieties again were found to produce significantly more tomatoes than others.

The total yield in pounds of tomatoes for the season in Experiment II is reported in Table 9. Solan when applied alone produced an average for all rates and varieties of 47.4 pounds of tomatoes while the combination average yield was 45.0 pounds. This difference was not significant. Unlike the early season yields, the seasonal harvest data showed no significant difference for Solan applied at 2.0, 4.0 or 6.0 pounds of active material per acre. Therefore, application of Solan to plants in heavy bloom did not affect the final yield notwithstanding a reduction in early season fruit set.

Weed counts, reported in Table 10, again were made at two intervals during the test. Early season counts made on July 14, twelve days after the first application, showed no weeds in any of the treated areas and only a very few lamb's-quarters present in the untreated check. Data taken August 12, twelve days after the second and last application, showed a poor stand of pigweed in all areas including the untreated check. However, a total of 251 lamb's-quarters, ranging from one to three feet tall, was found covering the tomato plants in the untreated area. Less than 5 lamb's-quarters, smaller than two inches high, were found in any of the Solan treated areas. Control of annual grasses in Experiment II was not outstanding. Good control of other broadleaved weeds such as ragweed and purslane was obtained in all treated areas.

SUMMARY

Two experiments were made using the new herbicide, Solan, at three different rates of application, alone or in combination with the insecticide, Thiodan, plus the fungicide, COCS.

In the first experiment a total of three treatments at three different stages of tomato growth was applied. The stages of growth were: (1) 8-12 leaf stage; (2) just after fruit set, and (3) at initial fruit ripening. None of the treatments significantly delayed ripening or reduced total yield.

In the second experiment, Solan alone or in combination with Thiodan plus COCS was used for a total of two treatments at two different stages of growth. The growth stages were: (1) plants in heavy blossom and (2) plants beginning to produce ripe tomatoes. The results showed a significant reduction in number and weight in the early ripened tomatoes but did not show any significant reduction in the seasonal yield.

Solan at 2.0, 4.0 or 6.0 pounds of active material per acre gave good control of pigweed, lamb's-quarters, ragweed and other broadleaved weeds. Control of the annual grasses was less satisfactory.

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TABLE 1. TOTAL NUMBER OF RIPE FRUITS FOR THE FIRST FIVE PICKINGS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED FOR A TOTAL OF THREE APPLICATIONS. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Fruits per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
Solan 2.0#/A.	55	46	82	47	67	54	41	
Solan 4.0#/A.	54	56	87	56	67	46	42	53
Solan 6.0#/A.	62	43	75	45	50	56	37	
Solan 2.0#/A. plus Thiodan plus COCS(2)	40	42	66	44	59	56	38	
Solan 4.0#/A. plus Thiodan plus COCS	56	66	68	44	70	77	39	55
Solan 6.0#/A. plus Thiodan plus COCS	42	35	83	52	83	55	33	
Avg. Cultivated Check	50	39	108	44	75	55	52	
Avg. Uncultivated Check(1)	32	51	53	28	55	43	35	
Avg. Varieties	49	43*	85**	47	68	57	42**	

(1) Uncultivated check not included in analyses of data in this or succeeding tables.
(2) The insecticide, Thiodan was used at 0.5 lb. active/acre and the copper fungicide, COCS, at 3.0 lbs./acre throughout the experiment.

Average for all Solan at 2.0 lbs. - 53
Average for all Solan at 4.0 lbs. - 56
Average for all Solan at 6.0 lbs. - 54
Average for cultivated check - 60
LSD Varieties 5% - 11.3; 1% - 14.9
LSD between rates and cultivated check N.S.
LSD chemicals N.S.
** Indicates those varieties that differ significantly when using the Red Jacket variety as the standard.

TABLE 2. TOTAL POUNDS OF RIPE FRUITS FOR THE FIRST FIVE PICKINGS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED FOR A TOTAL OF THREE APPLICATIONS. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Pounds of Fruit per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
olan 2.0#/A.	16.0	14.3	18.4	20.4	21.0	13.9	13.2	
olan 4.0#/A.	10.5	10.5	18.0	16.7	16.6	10.6	12.0	
olan 6.0#/A.	17.9	10.1	15.5	14.6	15.1	15.9	10.2	14.8
olan 2.0#/A. plus hiodan plus COCS	13.2	13.1	16.9	15.5	19.5	15.3	12.4	
olan 4.0#/A. plus hiodan plus COCS	13.7	14.1	14.7	14.1	19.4	17.9	11.6	
olan 6.0#/A. plus hiodan plus COCS	12.4	11.3	19.6	17.5	22.9	18.0	10.2	
vg. Cultivated Check	16.4	10.3	19.9	16.0	19.8	11.4	14.0	15.4
vg. Uncultivated Check	7.5	10.1	8.0	7.8	10.1	7.6	9.1	
verage Varieties	14.6	11.8	17.9	16.4	19.3	14.3	12.2	

Average for all Solan at 2.0 lbs. - 15.9
Average for all Solan at 4.0 lbs. - 14.3
Average for all Solan at 6.0 lbs. - 15.1
Average for cultivated check - 15.4
LSD varieties N.S.
LSD between rates and cultivated check N.S.
LSD chemicals N.S.

TABLE 3. TOTAL FRUIT SET FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED A TOTAL OF THREE APPLICATIONS DURING THE GROWING SEASON. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Fruits per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
Solan 2.0#/A.	289	266	170	189	244	233	173	
Solan 4.0#/A.	210	262	170	258	213	284	184	
Solan 6.0#/A.	256	273	160	206	294	328	156	229
Solan 2.0#/A. plus Thiodan plus COCS	233	251	168	210	240	295	189	
Solan 4.0#/A. plus Thiodan plus COCS	277	268	154	174	276	339	164	
Solan 6.0#/A. plus Thiodan plus COCS	187	220	158	185	278	251	211	225
Avg. Cultivated Check	262	224	177	183	278	338	184	
Avg. Uncultivated Check	91	133	67	75	111	97	69	
Average Varieties	247**	249**	167**	199**	263	301	181**	

Average for all Solan at 2.0 lbs. - 225
Average for all Solan at 4.0 lbs. - 231
Average for all Solan at 6.0 lbs. - 226
Average for cultivated check - 235
LSD for varieties 5% - 39; 1% - 52
LSD between rates and cultivated check N.S.
LSD for chemicals N.S.

TABLE 4. TOTAL POUNDS OF FRUITS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIOLAN AND COCS. EACH TREATMENT REPEATED FOR A TOTAL OF THREE APPLICATIONS DURING THE GROWING SEASON. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Pounds of Fruit per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
lan 2.0#/A.	60.8	56.5	29.5	56.3	52.6	44.5	37.6	
lan 4.0#/A.	46.6	49.8	29.1	62.3	44.0	59.3	39.8	
lan 6.0#/A.	60.2	58.0	26.2	51.6	64.5	59.9	38.6	48.9
lan 2.0#/A. plus iodan plus COCS	57.0	57.1	31.1	59.7	59.4	59.5	43.2	
lan 4.0#/A. plus iodan plus COCS	55.0	47.8	27.4	45.1	55.1	58.8	38.3	
lan 6.0#/A. plus iodan plus COCS	40.8	50.9	31.0	52.2	61.5	55.5	49.1	49.3
g. Cultivated Check	59.6	45.7	32.9	57.9	62.6	50.3	45.7	
g. Uncultivated Check	19.2	25.1	9.9	16.6	20.0	16.2	16.2	
erage Varieties	55.0	51.4	30.0**	55.4	57.8	54.8	42.3**	

erage for all Solan at 2.0 lbs. - 50.4
erage for all Solan at 4.0 lbs. - 47.0
erage for all Solan at 6.0 lbs. - 50.0
erage for cultivated check - 50.7
D Varieties 5% - 7.3; 1% - 9.7%
D between rates and cultivated check N.S.
D chemicals N.S.

TABLE 5. WEED COUNTS IN TOMATO HERBICIDE TEST NO. 1

Material	Weeds per sq. foot 7/14/59	Average Number of Weeds per plot 8/12/59				Remarks
	Lamb's-quarters	Pigweed	Lamb's-quarters	Grasses(1)	Others	
Solan 2.0#/A.	0	1.3	18.3	1.6	2.0	Broadleaved weeds, small 2" high
Solan 4.0#/A.	0	0.6	7.3	3.3	1.6	"
Solan 6.0#/A.	0	0.3	3.6	4.3	3.3	"
Solan 2.0#/A. plus Thiodan plus COCS	0	4.0	19.0	3.6	3.6	"
Solan 4.0 #/A. plus Thiodan plus COCS	0	1.0	6.6	5.6	3.6	"
Solan 6.0#/A. plus Thiodan plus COCS	0	0.6	0.6	1.0	1.0	"
Cultivated Check	0	2.0	18.6	5.0	6.0	"
Uncultivated Check	4.3	6.3	334.0	1.3	5.3	Broadleaved weeds, tall- 1-3 feet

Dates of chemical applications - 6/17, 7/16, 8/13

(1) Grasses present -
Barnyard grass = *Echinochloa crusgalli*
Foxtail grass - *Setaria* sp.

TABLE 6. TOTAL NUMBER OF RIPE FRUITS FOR THE FIRST FIVE PICKINGS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED FOR A TOTAL OF TWO APPLICATIONS. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Fruits per plot[1]							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
olan 2.0#/A.	65	59	87	44	55	84	35	
olan 4.0#/A.	50	41	44	49	69	60	42	
olan 6.0#/A.	54	43	50	63	53	79	23	55
olan 2.0#/A. plus hiodan plus COCS	38	42	57	54	38	37	37	
olan 4.0#/A. plus hiodan plus COCS	55	56	75	30	81	59	33	
olan 6.0#/A. plus hiodan plus COCS	41	31	62	49	73	83	40	51
vg. Cultivated Check	50	43	96	61	78	79	49	
vg. Uncultivated Check	36	38	77	47	30	68	48	
vg. Varieties	50**	45**	71	51**	66	70	39**	

verage for all Solan at 2.0 lbs. - 52**
verage for all Solan at 4.0 lbs. - 53**
verage for all Solan at 6.0 lbs. - 53**
verage for cultivated check - 65
SD Varieties 5% - 11; 1% - 14
SD between rates and cultivated check 1% - 5
SD chemicals 5% - N.S.; 1% - N.S.
1) Pickings made on 7/31, 8/4, 8/10, 8/14, 8/21

TABLE 7. TOTAL POUNDS OF RIPE FRUITS FOR THE FIRST FIVE PICKINGS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED FOR A TOTAL OF TWO APPLICATIONS. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Pounds of Fruit per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
Solan 2.0#/A.	17.9	15.3	17.9	17.0	15.8	20.2	9.9	
Solan 4.0#/A.	16.0	12.5	9.6	17.7	21.4	16.5	13.4	
Solan 6.0#/A.	14.9	12.7	12.3	23.1	16.9	16.1	7.4	15.5
Solan 2.0#/A. plus Thiodan plus COCS	11.3	11.7	12.2	19.7	9.2	10.0	11.7	
Solan 4.0#/A. plus Thiodan plus COCS	15.7	11.1	15.7	10.0	17.7	12.9	9.0	
Solan 6.0#/A. plus Thiodan plus COCS	12.6	9.6	15.6	17.0	20.6	14.4	12.0	13.3*
Avg. Cultivated Check	14.8	11.9	20.5	22.1	22.2	18.9	15.4	
Avg. Uncultivated Check	7.8	9.5	9.4	12.2	5.6	8.3	9.7	
Avg. Varieties	14.8	12.1**	15.5	18.6	18.3	16.0	11.8**	

Average for all Solan at 2.0 lbs. - 14.3**
Average for all Solan at 4.0 lbs. - 14.2**
Average for all Solan at 6.0 lbs. - 14.7**
Average for cultivated check - 18.0
LSD Varieties 5% - 2.0; 1% - 2.6
LSD between rates and cultivated check 1% - 1.4
LSD chemicals 5% - 2.1

ABLE 8. TOTAL FRUITS SET FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN PLUS COCS. EACH TREATMENT REPEATED FOR A TOTAL OF TWO APPLICATIONS DURING THE GROWING SEASON. MIDDLEPORT, N.Y.,1959.

Treatment	Variety - Fruit Set per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
olan 2.0#/A.	221	227	159	179	196	294	172	
olan 4.0#/A.	282	240	156	243	232	291	193	228
olan 6.0#/A.	252	295	111	284	218	395	156	
olan 2.0#/A. plus hiodan plus COCS	174	267	114	223	192	304	173	
olan 4.0#/A. plus hiodan plus COCS	254	269	153	227	273	318	156	231
olan 6.0#/A. plus hiodan plus COCS	225	219	150	250	278	478	156	
vg. Cultivated Check	265	232	186	264	218	287	161	
vg. Uncultivated Check	84	115	98	105	69	170	92	
vg. Varieties	242**	254**	152**	242**	228**	332	166**	

verage for all Solan at 2.0 lbs. - 210
verage for all Solan at 4.0 lbs. - 235
verage for all Solan at 6.0 lbs. - 248
verage for cultivated check - 230
SD Varieties 5% - 4.0; 1% - 5.3
SD between rates and cultivated check N.S.
SD chemicals N.S.

TABLE 9. TOTAL POUNDS OF FRUITS FOR TOMATO VARIETIES RECEIVING FOLIAR APPLICATIONS OF SOLAN ALONE OR IN COMBINATION WITH THIODAN AND COCS. EACH TREATMENT REPEATED FOR A TOTAL OF TWO APPLICATIONS DURING THE GROWING SEASON. MIDDLEPORT, NEW YORK, 1959.

Treatment	Variety - Pounds of Fruit per plot							Average Chemical
	Valiant	Longred	Fireball	Moreton Hybrid	Geneva 11	Red Jacket	Glamour	
Solan 2.0#/A.	44.2	50.7	25.8	49.1	44.4	52.2	36.3	
Solan 4.0#/A.	60.9	49.5	28.5	59.4	54.2	59.4	40.3	
Solan 6.0#/A.	51.1	56.8	21.5	73.8	48.2	59.7	28.4	47.4
Solan 2.0#/A. plus Thiodan plus COCS	35.2	51.3	19.5	60.2	35.0	48.2	40.7	
Solan 4.0#/A. plus Thiodan plus COCS	54.6	45.2	28.9	49.6	54.1	55.4	36.3	
Solan 6.0#/A. plus Thiodan plus COCS	42.2	43.0	28.7	57.6	56.6	69.0	34.4	45.0
Avg. Cultivated Check	53.6	49.4	31.3	63.6	47.3	46.3	35.0	
Avg. Uncultivated Check	15.6	21.8	11.7	24.2	11.1	16.6	16.3	
Avg. Varieties	49.1	49.4	26.9**	59.6	48.4	54.6	35.8**	

Average for all Solan at 2.0 lbs. - 42.2
Average for all Solan at 4.0 lbs. - 48.3
Average for all Solan at 6.0 lbs. - 47.9
Average for cultivated check - 46.6
LSD Varieties 5% - 6.3; 1% - 8.4
LSD between rates and cultivated check N.S.
LSD chemicals N.S.

TABLE 10. WEED COUNTS IN TOMATO HERBICIDE TEST NO. 2

aterial	Weeds per sq. foot 7/14/59	Average Number of Weeds per plot 8/12/59				Remarks
	Lamb's-quarters	Pigweed	Lamb's-quarters	Grasses	Others	
lan 2.0#/A.	0	1.6	3.3	3.3	2.0	Broadleaved weeds, small 2" high
lan 4.0#/A.	0	0.3	0.0	11.3	3.0	"
lan 6.0#/A.	0	1.0	0.0	6.0	2.6	"
lan 2.0#/A. plus iodan plus COCS	0	0.0	2.0	5.3	2.3	"
lan 4.0#/A. plus iodan plus COCS	0	2.6	0.3	6.6	2.3	"
lan 6.0#/A. plus iodan plus COCS	0	0.3	0.0	8.6	1.0	"
ltivated Check	0	0.0	0.3	0.3	0.6	"
cultivated Check	3.3	0.0	251	0.6	11.6	Broadleaved weeds, tall 1-3 feet

tes of chemical applications - 7/2, 7/31

asses present -

Barnyard grass - *Echinochloa crusgalli*
Foxtail grass - *Setaria* sp.

PROGRESS REPORT ON WEED CONTROL IN PROCESSING TOMATOES

Charles H. Moran*

The general problems presented by weeds in tomato fields have been reviewed at recent conferences (1,2,3). This past year the weed problems in several areas during the late harvest period were acute. Lambsquarters, ragweed and particularly crabgrass became established after lay-by. Ripening was delayed and fruit were missed by pickers.

This report presents the results of two herbicide experiments in 1959 with tomatoes grown on the Eiselman Farm at Rancocas, New Jersey.

METHODS AND MATERIALS

Southern grown plants of variety Campbell 146 were transplanted for both experiments on May 4. The individual plots consisted of 4 rows, 20 feet long. Plant spacing was 2 feet by 5 feet and yield data were taken from the center 2 rows.

Color, titratable acidity and pH measurements were made on purees from 12-15 fruit from each plot harvest. Color indices were reported as the mean a/2.5b values from the Hunter Color Difference Meter. Titratable acidity was reported as the average number of milliliters of N/10 NaOH required to titrate 10 milliliters of puree filtrate to pH 8.0.

All plots were hand hoed and weed free at the time of treatment. Rates and periods of application are shown in Table 1. Solan was applied as a overall spray. Other chemicals were broadcast in the granular form by hand shaker. No attempt was made to keep the herbicides off the tomato plants. Chemical identities of the materials used were as follows:

Amoben: amino -2, 5 dichlorobenzoic acid
CIPC: isopropyl -n- (3 chlorophenyl) carbamate
EPTC: ethyl di-n-propylthiolcarbamate
Neburon: 1-n-butyl -3-(3,4 dichlorophenyl) -1-methyl urea
Solan: N-(3 chloro -4-methylphenyl)-2 methylpentanamide

EPTC was not worked into the soil in the post-transplanting plots but was mixed in the lay-by treatment plots by means of shallow cultivation.

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Table 1

Rates of Application of Herbicide Used in Post-Transplanting and Lay-by Tomato Treatments

Herbicide	Post-Transplanting June 2, 1959	Lay-By July 9, 1959
	Pounds Per Acre	
Amoben	4	4
CIPC	8	4,8,12
EPTC	4	4
Neburon	-	3
Solan	4	4

Surface soil was very dry when the post-transplanting treatments were applied but 1.87 inches of rain fell during the following 24 hours. Lay-by plots were at 50% available water when treated but received 5.2 inches of water in the next 14 days.

Weed growth on several of the post-transplanting treatment plots was so great that it was necessary to remove all weeds at the time of the first fruit harvest on July 27.

RESULTS

The effects of herbicide treatments one month after transplanting on the yield and quality of tomatoes are shown in Table 2. There were significant reductions in yield on both the Solan and CIPC treatment series. Treatments did not affect either fruit color, titratable acidity or pH of the purees.

Table 2

Effect of Post-Transplanting Herbicide Treatments on Tomato Yields and Quality

Herbicide	Rate Per Acre	Yield Tons/A.	Number Fruit Per 35 Lbs.	Puree Color	Puree Titr. Acidity	Puree pH
Check	-	27.60	105	83.6	5.81	4.3
EPTC	4	23.31	107	81.7	5.32	4.3
Amoben	4	23.38	105	81.6	5.67	4.3
Solan	4	20.08	108	83.7	5.35	4.3
CIPC	8	13.51	123	83.5	5.91	4.3
L.S.D.	.05	5.08	11	N.S.	N.S.	N.S.
	.01	7.13	-	-	-	-

The yield reductions on the CIPC and Solan series were the result of weed competition. The vigor of these competitors was not reflected in the July 12 population counts shown in Table 3. The CIPC plots were covered by ragweed and the EPTC and Solan series covered with mixed ragweed and crabgrass.

Weed suppression by Amoben at 4 lbs. per acre preemergence, approached commercial acceptance.

Table 3

Effect of Post-Transplanting Herbicide Treatments on the Number of Weeds Present 50 Days After Treatment

Herbicide		Number Weeds Per 15 Sq. Ft. Broadleaf	Grasses
Amoben		48	47
CIPC		24	67
EPTC		124	188
Solan		38	168
Check		53	150
L.S.D.	.05	40	82
	.01	56	115

In the lay-by experiment, crabgrass was the principal weed. The high broadleaf weed counts in Table 4 for Amoben, EPTC and Check are due generally to an understory of small carpet weed (Mollugo verticillata L.) plants. CIPC at both 4 and 8 pounds per acre showed a weakness in suppressing ragweed. Amoben as a pre-emergence application at 4 pounds per acre, EPTC at 4 pounds worked in and CIPC at 12 pounds per acre were the only treatments showing promise of being able to control weeds during the late tomato harvest season.

Neither yields, fruit size, color nor acidity were affected by any of the lay-by herbicide treatments, Table 5.

Table 4

Effect of Lay-by Herbicide Treatments on Weed Population
Treated July 9 - Counted August 28

Herbicide	Rate Per Acre	Weed Count Per 15 Sq. Ft. Broadleaf	Grass
Amoben	4	104	42
CIPC	4	39	47
CIPC	8	34	25
CIPC	12	13	40
EPTC	4	148	17
Neburon	3	23	76
Solan	4	57	46
Check	-	92	98
L.S.D. .05		69	-
.01		94	-

Table 5

Effect of Lay-by Herbicide Treatments on Tomato Yields and Quality
1959

Herbicide	Rate Per Acre	Yield Tons/A.	Fruit Count Per 35 Lbs.	Puree Color	Titr. Acidity	pH
Check	-	21.48	103	86.3	5.78	4.3
EPTC	4	22.76	104	86.0	5.73	4.3
Amoben	4	22.31	100	87.0	5.95	4.3
Neburon	3	22.21	105	87.7	5.88	4.3
Solan	4	19.75	111	88.7	5.89	4.3
CIPC	4	20.09	108	85.7	5.72	4.3
CIPC	8	20.33	109	86.2	5.66	4.3
CIPC	12	19.41	112	88.6	5.46	4.3
L.S.D. .05		N.S.	N.S.	N.S.	N.S.	N.S.

SUMMARY

1. Amoben, CIPC, EPTC and Solan were applied broadcast one month after transplanting Campbell 146 tomato plants. The same group of herbicides plus Neburon were used after the last cultivation in a second experiment.

2. There were no treatment effects on tomato color indices, titratable acidities or the pH of the purees in either experiment.

3. Yields were reduced on both the CIPC and Solan series plots in the early treated series. There were no significant yield differences between the lay-by treatments.

4. Granular formulations of CIPC at 4 and 8 pounds per acre did not suppress the broadleaf weeds, principally ragweed. At 12 pounds, weed control was good and tomato plants were not injured.

5. Solan as an aqueous spray at the 4 lb. rate was not effective in controlling emerging weeds.

6. Granular formulations of Amoben at 4 pounds, EPTC at 4 pounds (worked in) and CIPC at 12 pounds per acre, when applied to weed free tomatoes at lay-by, approached the point of commercial acceptance for late season weed control. EPTC, when not mixed with the soil as in the post-transplanting treatments, was ineffective this year.

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PROGRESS REPORT ON WEED CONTROL IN TOMATOES, PEPPERS, CARROTS, ONIONS, AND CAULIFLOWER

Stewart L. Dallyn and R. L. Sawyer

Tomatoes:

Well established transplants of the Moreton Hybrid variety were treated with a number of herbicides on June 3, approximately 3 weeks after transplanting. The application of Eptam was delayed until June 6, to allow soil moisture to decrease somewhat, and then immediately worked into the soil. Ratings were made June 30 and July 18 on weed and crop response. Yield data were taken until August 31, a total of 18 harvests.

Results: Data from this test are given in table 1. None of the treatments had any appreciable effect on plant growth and yields in all cases equalled or exceeded the checks. Early weed control was very good with everything except 1 pound of simazin. Several of the treatments provided good long-lasting control. Niagara 4512 supressed broadleaves very well, but during July crab grass completely took over these plots and had to be controlled mechanically.

Table 1. Performance of a number of herbicides in transplanted tomatoes.

Treatment	Weed Control Rating[1] 6/30	7/18	Crop Injury[2] Rating 6/30	Yield-lbs. per 16 ft. plot
Amibin, 4 lbs. gran.	5.0	3.0	1.5	64
Dinoben, 4 lbs. "	5.0	4.0	1.0	56
Simazin, 1 lb. "	3.5	C-3	1.0	73
Simazin, 2 lbs. "	4.0	3.5	1.0	57
Eptam, 4 " "	4.5	3.0	1.0	75
Eptam, 6 " "	5.0	3.5	1.0	58
Niag.4512, 4 lbs. liq.	5.0	2.5	1.0	75
Niag.4512, 6 " "	5.0	3.0	1.0	57
Check	1.0	C	1.0	56
L.S.D. 5%	-	-	-	14

[1] 1 = no control
5 = excellent

[2] 1 = no injury
5 = severe injury

[3] Cultivated July 5 to control weeds

Peppers:

The same methods and treatments as described above for tomatoes were also used on peppers. Results are given in table 2. The experiment was harvested 3 times - 8/7, 8/13, and 8/27. Early weed control was good with all herbicides, but grass came into the Niagara 4512 plots earlier than in the tomatoes, probably due to less shading. This same material, especially at 6 pounds, caused noticeable stunting and leaf shedding, but apparently did not have much effect on early yield.

Table 2. Performance of several herbicides on transplanted peppers - Calwonder variety.

Treatment	Weed Control Rating [1] 6/30	7/18	Crop Injury[2] Rating 6/30	Yield per plot No.	Lbs.
Amibin, 4 lbs. gran.	4.5	4.0	1.0	22	6.4
Dinoben, 4 " "	5.0	5.0	1.1	30	9.5
Simazin, 1 " "	2.5	C-3	1.0	22	6.9
" 2 " "	3.0	C	1.5	16	4.7
Eptam 4 " "	4.5	2.5	2.0	28	8.9
" 6 " "	5.0	3.5	2.0	23	7.0
Niag. 4512, 4 lbs. liq.	3.5	2.0	3.0	20	6.2
" " 6 " "	4.0	2.0	3.5	13	4.1
Check	1.0	C	1.0	12	4.2
L.S.D. 5%	-	-	-	9	2.9

[1] 1 = no control
5 = excellent

[2] 1 = no injury
5 = severe injury

[3] cultivated July 5 to control weeds

Carrots:

A number of chemicals were used pre and post emergence on Chantenay carrots seeded June 16. Repeat applications which had been planned for half the plot lengths of some treatments had to be dropped because of a prolonged spell of wet weather. The post emergence treatments were applied July 8 to carrots approximately 1.5 inches high and infested with a heavy growth of weeds - primarily purslane plus some lambs quarters. Results are given in table 3.

Amibin and dinoben gave excellent weed control over a prolonged period. Liquid amibin at 4 pounds per acre gave noticeable early stunting of the carrots and its use at this rate would be questionable. The Niagara materials were good on broadleaves but weak on grasses and the plots were soon taken over by these species. Carrots from a few of the plots were rated slightly below the checks because of cracking; differences were small and may well have been due to chance rather than treatment.

Onions

Growers have been able to take care of the early and midseason weed problem in this crop with cultivation and CIPC sprays directed into the row. Summer grass has become increasingly troublesome and many fields have been badly infested by harvest time.

Eptam was applied to Early Harvest and Sweet Spanish onions on July 7. The field at this time was clean and had just recently received the final application of CIPC. Directed sprays of Eptam at 4 and 6 pounds per acre were applied and worked into the soil by hand. Granular material at 6 pounds per acre was also used. The foliage was dry, but the humidity high and some of the granular formulation stuck to the foliage. These areas of the leaves turned light in color and eventually died. Sweet Spanish which had a natural infection of

Purple Blotch, was rendered considerably more susceptible to the disease by this injury.

Early Harvest was harvested August 1 and Sweet Spanish September 1, and ratings made on grass control at those times. Both formulations and both rates of the liquid gave essentially complete control of the problem. No effect of the herbicide on yield or quality was measurable.

Table 3. Results of pre and post emergence herbicides used in carrots.

Treatment	Weed Control[1] Rating 7/10	7/27	Crop[2] Injury	Yield - lbs./10' Total	Roots	Root[3] Rating
Amibin 4 lb. liq. at planting	5	5	2.5	18.7	6.3	5.0
Amibin 4 lb. gran. at planting	5	5	2.0	19.1	6.6	5.0
Dinobin 4 lb. gran. at planting	5	5	2.0	21.5	7.6	4.5
Niagara 4556 2 lb. liq. at planting	3	2	1	22.4	8.2	4.5
Niagara 4556 4 lb. liq. at planting	3	1	1	19.6	7.3	4.5
Niagara 4562 2 lb. liq. at planting	2.3	1	1	20.4	7.4	4.5
Niagara 4562 4 lb. liq. at planting	3	2	1	24.0	8.4	5.0
CIPC 4 lb. liq. at planting	3.5	3	1	26.3	9.4	5.0
Stoddard Solvent 75 gals. post emergence	4.5	3	1	22.6	6.1	5.0
Niagara 4556 2 lb. liq. post emergence		1	1	17.7	6.1	5.0
Niagara 4556 4 lb. liq. at post emergence		2	1	18.7	6.6	5.0
Niagara 4562 2 lb. liq. at post emergence		4	1	23.1	7.8	5.0
Niagara 4562 4 lb. liq. at post emergence		4	1	21.5	7.7	5.0
Check	hand weeded		1	21.1	6.6	5.0
				N.S.	N.S.	

[1] 1 = none 5 = complete [2] 1 = none 5 = severe

[3] 5 = equal to check <5 poorer than check

Cauliflower

The treatments listed in table 4 were applied to Snowball E and Y varieties on August 11, approximately 2 weeks after setting. Simazin appeared unsatisfactory because of stunting and yellowing of the foliage. The same would probably hold true of Eptam because of leaf bloom inhibition, even though this chemical gave good weed control and caused no noticeable stunting. Trietazine at 2 pounds per acre was on the borderline of permissable crop damage. There was no difference in variety reponse, and the two were averaged to obtain the plant weights given in the data.

Table 4. Results from several herbicides used on cauliflower.

Treatment	Weed Control Rating[1] 9/11	9/29	Crop[2] Injury	Ave. Plant Wt. November 10
Simazine, 2 lbs. granular	4.1	4.0	3.2	5.24
Trietazine, 1 lb. granular	3.5	3.0	1.2	6.48
Trietazine, 2 lbs. granular	4.2	3.2	2.0	6.18
Amibin, 4 lbs. granular	4.0	3.0	1.0	5.78
Eptam, 4 lbs. granular	4.2	4.0	2.3	6.82
Eptam, 6 lbs. granular	4.7	4.0	3.0	6.34
Eptam, 4 lbs. liquid	4.0	3.3	1.5	6.37
DAC893, 4 lbs. liquid	3.8	3.7	1.0	6.07
DAC893, 6 lbs. liquid	4.0	3.5	1.0	6.21
Amibin, 4 lbs. liquid	3.8	4.0	1.5	6.79
Check	1.0	1.0	1.0	5.78
L.S.D. 5%	-	-	-	.82

[1] 1 = none, 5 = complete   [2] 1 = none, 5 = severe

Summary

1. Granular amibin and dinoben at 4 pounds, simazin at 2 pounds, Eptam at 4 or 6 pounds and Niagara 4512 at 4 or 6 pounds provided good weed control in tomatoes without noticeable damage to the crop and with no effect on yields. Niagara 4512 did not hold grass which started to come into the plots about one month after treatment.
2. The same treatments mentioned above gave good weed control in peppers though the foliage of this crop showed some injury from Niagara 4512. Yields from the 3 harvests made, however, were not affected.
3. Amibin, dinoben, Niagara 4556 and 4562, and CIPC were all promising herbicides in carrots.
4. Excellent control of summer and early fall grass in onions was obtained by layby application of Eptam.
5. Amibin and DAC893 looked good as cauliflower herbicides. Simazine, trietazine, and Eptam were questionable because of crop injury.

EPTAM FOR NUT GRASS CONTROL IN POTATOES

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Nut grass is becoming a major problem in many Long Island fields where potatoes are grown every year. This work was aimed at finding if Eptam could be applied with normal cultural practices and give nut grass control.

Materials and Methods

Granular Eptam at 4 and 6 pounds per acre was applied to Katahdin vines. The first application was made on May 18 before plants emerged, just prior to when the planting ridges were dragged off. No nut grass had emerged at this time, but sprouted nut grass tubers could be found in the soil. Additional plots were treated prior to the first three cultivations on May 22, 28 and June 10. Nut grass was 1 to 2 inches high at the May 22 application. Soil type was a sassafras silt loam.

Plots were double rows, 15 feet long with 6 replications. One row of each plot was treated with 6 pounds and the other 4 pounds per acre. A two row check strip was left on either side of the treatment strip and treated plots were rated as per cent control of check. Plots were on a growers farm in an area which had previously been selected because of a severe nut grass infestation. All cultrual operations were performed by the grower including cultivating in the Eptam.

Results and Discussion

Significant reduction of nut grass was obtained with all Eptam applications although the drag off application and the second cultivation application gave better results than the other two applications. The second cultivation was a particularly deep cultivation to control the nut grass that had already emerged. The third cultivation had to be shallow to try to keep down root pruning of the potatoes. The early application before nut grass had emerged could account for the better results with the drag off application. The deep cultivation should give a deeper mixing in the soil and account for the better results with the second cultivation application. There were no consistent differences between 4 and 6 pounds per acre. The results on nut grass control are in table 1.

There were no differences between Eptam plots and checks in total yields of Katahdin potatoes. The average yield from all Eptam plots was 240 bushels per acre and from check plots 237 bushels per acre. These yields are low for the Long Island area due to the late planting of this field, excessive cultivation due to the nut grass and late annual grass problem and the excessive soil moisture during June and July which reduced yields in general. Although total yields were not affected by Eptam, less than ten percent of tubers from Eptam plots had grass shoots or nuts growing through or in them. In check plots it was difficult to find a single tuber with no nut grass damage and many had from 6 to 10 grass shoots in the tubers.

Table 1. Effect of application time and dosage of Eptam on nut grass control.

Time of Application	Dosage lbs./acre	Weed Control % of check
Dragg off (5/18)	4	19
" " "	6	14
1st cultivation (5/22)	4	25
" " "	6	29
2nd " (5/28)	4	5
" " "	6	7
3rd " (6/10)	4	29
" " "	6	25
L.S.D. 5%		2
1%		3

Eptam gave good control of annual grasses and broadleaves except smart weed. All growers who visited these plots considered Eptam to have given very satisfactory commercial control under a severe infestation of nut grass and annual grasses.

Summary

1. Eptam at both 4 and 6 pounds per acre gave commercial control of nut grass.

2. The results indicate that both earliness and amount of soil incorporation are important in the application of Eptam.

COMPARISONS OF EPTC AND SEVERAL ANALOGS FOR WEED CONTROL AND VEGETABLE CROP TOLERANCE. 1/ 2/

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In the past several seasons many investigators[a] have reported work with EPTC (Eptam), ethyl di-n-propylthiol-carbamate, for annual weed control in vegetables and agronomic crops. Considerable other work has been reported on this chemical for selective control of nutgrasses. Results from the many experimental plots evaluated show beans and potatoes to be fairly tolerant under a wide range of conditions; other crops such as cucumbers and oats which are almost always damaged at rates needed for weed control; and a third group which is injured only under some conditions.

The purpose of these investigations was to evaluate certain EPTC analogs to see if any could be found which would be safer than EPTC on crops and which at the same time would be satisfactory for weed control.

General Methods.

The majority of tests were conducted on sandy loam soil. A few were on silt loam. A few greenhouse tests were conducted. A wide range of seeded and transplanted vegetable crops were studied; also annual weeds such as barnyard grass *Echinochloa crusgali*, crabgrass *Digitaria sauquinalis*, foxtail *Setaria lutescens*, galinsoga *Galinsoga ciliata*; stinkgrass *Eragrostis cilianensis*, purslane *Portulaca oleracea*, red root pigweed *Amaranthus retroflexus*, and lambs-quarters *Chenopodium album*. Nutgrass *Cyperus esculentus* was the only perennial included. A further aspect of these investigations was to study the relative longevity of the several analogs in the soil.

The chemicals studied are presented below. Each analog, however, was not included in every test. For simplicity sake the analogs will be referred to by number.

a/ The Stauffer Chemical Company lists 259 research references in its report of June 1, 1959.

Designation	Chemical Name
EPTC (Eptam)	ethyl di-n-propylthiol-carbamate
1607	propyl di-n-propylthiol-carbamate
1862	allyl di-n-propylthiolcarbamate
2007	ethyl di-allylthiol-carbamate
2060	ethyl ethyl-n-butylthiol-carbamate
2061	n Propyl ethyl-n-butylthiol-carbamate
2181	ethyl allyl-n-propylthiol-carbamate

1/ Some of this research was made possible by a grant in aid from the Stauffer Chemical Company.
2/ Paper No. 442 of the Department of Vegetable Crops.

Crop Responses

Many investigators have reported differential crop and weed responses to EPTC (1,2,5). In addition there are tests which showed injury to a given crop (6,7,15) and other tests which show the crop to be tolerant (8,9,10, 14). There has been relatively little work reported with the analogs (4).

In 1958 one or more separate experiments were conducted with EPTC, 1607, 1862, 2007, 2061, and 2181 on each of the following crops; snap beans, beets, carrots, sweet corn, cucumbers and potatoes. All treatments were surface applications immediately after planting with no mechanical incorporation. Cucumbers were injured in all tests by all analogs. Potatoes, carrots and snap beans were not injured by any analog in any test. Beets and sweet corn were sometimes injured.

In 1959 only EPTC, 1607, 2060 and 2061 were included because the others were being dropped by the company. The chemicals were incorporated by disking or by raking prior to seeding and by raking or by cultivating post-transplanting. The majority of tests were on a sandy loam soil, with one on silt loam. Table 1 is a composite of crop ratings for the 1959 tests. Ratings are the average rating of crop responses in several tests. Results in 1959 showed much more consistent damage to beets and carrots than in 1958. This is thought to be due to incorporation of the chemical in 1959.(2)

Table 1. Crop responses[1/] to EPTC and analogs in 1959.

Crops[1/]	Analog	EPTC		1607		2060		2061	
	lbs.	3	4-1/2	3	4-1/2	3	4-1/2	3	4-1/2
Beets (seeded)		4.5	4.0	3.0	3.0	7.0	7.5	6.0	6.5
Carrots "		6.0	5.5	4.5	6.5	6.5	6.0	6.5	5.0
Lettuce "		1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.0
Spinach "		4.5	4.0	4.0	2.0	7.0	7.5	6.5	6.5
Tomatoes "		2.5	2.0	5.5	6.0	8.0	8.0	7.5	7.5
Tomatoes (Transp)		9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Cabbage "		7.0[3/]	7.0[3/]	7.0[3/]	7.0[3/]	9.0	9.0	9.0	9.0
Cabbage " [4/]		7.0[3/]	7.0[3/]	7.0[3/]	7.0[3/]	9.0	9.0	7.5[3/]	7.5[3/]

1/ Crop responses; 9 = perfect; 7 = commercially acceptable;
5 = serious damage; 1 = complete kill.

2/ Each crop was tested in a separate experiment.

3/ The plants in these plots did not develop normal bloom, therefore they were graded down.

4/ This test was on silt loam. The others were on sandy loam.

From the data in Table 1 it can be concluded that the analogs have definitely different spectra of activity on crops than does EPTC. It is also apparent that with the seven crops included in the table that two analogs 2060 and 2061 were to beets, spinach or seeded tomatoes less toxic than was EPTC or 1607. However, with an extremely sensitive crop such as seeded lettuce, the analogs were not substantially less toxic.

As a follow-up on the field tests, greenhouse studies were undertaken with snap beans, sweet corn, beets, and seeded tomatoes. These crops were crop sensitivity to EPTC. Small flats were filled to a depth of two inches with unsterilized potting soil and treated with the appropriate analog at several rates. They were then emptied, the soil thoroughly mixed and the flats refilled. Seeding was done immediately after mixing and refilling. Four flats were used for each rate of chemical on each crop. Crop growth was rated for the final time about one month after seeding. Results are presented in Table 2.

It is readily apparent from the data that there was a marked difference in crop response to the analogs 2060 and 2061. The crops showing favorable tolerance in the field exhibited a similar tolerance even in the relatively severe greenhouse test.

Weed Control

Nutgrass

One of the outstanding characteristics of EPTC is its good action against nutgrass under certain conditions (11, 12, 13). In 1958 the several analogs were compared with EPTC. The chemicals were applied about 10 days after a thorough disking of a silt loam soil. The chemicals were left undisturbed on the surface. Some nutgrass shoots were just emerging at the time of treating. From later observations it was determined that about ten per cent of the ultimate stand was in the early spike stage when treated. There were three replicates with each plot 3' x 20'. Results (Table 3) were generally not satisfactory. No plot gave commercial control. There was relatively little difference in performance of the several analogs as compared with EPTC.

In 1959 three materials, 1862, 2007, and 2181 were dropped and 2060 was added. In contrast to the 1958 tests rates were only one-half as heavy and all chemicals were thoroughly disked in immediately after treating rather than being left on the surface. The plots were seeded to corn and beans the following day, June 24. Following final ratings, August 11th the plots were thoroughly disked and buckwheat, rye and ryegrass were seeded. These were rated September 14th. Results are presented in Table 3. It is at once apparent that in spite of the lower rates of chemical, control levels in 1959 were much superior to those of 1958. This is thought to be due to incorporation of the chemicals in 1959 (2).

It is also shown in Table 3 that by early August some nutgrass was beginning to come into the plots. Only EPTC and 1607 continued to show a commercially acceptable degree of control and this occurred only at the five pound rate. From other test results it is believed likely that longer lasting control would have been obtained if the plots had been given normal cultivation.

Table 2. Crop responses[1] to EPTC and analogs in the greenhouse.[2]

	EPTC				1607				2060				2061			
lbs.	4	6	8	10	4	6	8	10	4	6	8	10	4	6	8	10
Tomatoes	4.5	3.5	3.0	2.5	7.5	6.0	5.0	5.5	9.0	8.5	7.5	6.5	9.0	9.0	9.0	9.0
Beets	3.0	5.0	2.0	2.0	4.0	2.0	2.0	2.0	7.0	6.0	4.0	3.0	9.0	5.0	4.0	4.0
Sweetcorn	5.0	5.0	4.0	3.0	7.0	8.0	5.0	2.0	8.0	8.0	6.0	5.0	8.0	7.0	6.0	6.0
lbs.	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20
Snap beans	9.0	8.0	7.0	6.0	8.0	6.0	5.0	4.0	9.0	9.0	9.0	9.0	9.0	9.0	8.0	7.0

1/ 9 = perfect; 7 = commercially acceptable; 5 = damage; 1 = killed

2/ Greenhouse tests were conducted by Marcia Levinson.

Table 3. Ratings[1/] of Nutgrass and crop responses to EPTC and analogs.

Chemical	1958 (Surface) Lbs.	Nutgrass	1959 (Worked in) Lbs.	Nutgrass July 14	Nutgrass Aug. 10	Corn	Beans	Buckwheat	Rye and Ryegrass
EPTC	5	5.3	2.5	7.0	5.5	7	9	6.5	3
	10	6.3	5.0	8.0	8.0	7	9	6.5	5
1607	5	5.7	2.5	8.0	6.5	9	9	5.0	4
	10	6.5	5.0	8.5	8.0	9	9	5.0	6
1862	5	5.0	-	-	-	-	-	-	-
	10	5.0	-	-	-	-	-	-	-
2007	5	5.0	-	-	-	-	-	-	-
	10	5.3	-	-	-	-	-	-	-
2060	5	-	2.5	7.5	5.5	9	9	5.0	7
	10	-	5.0	8.5	6.5	9	9	5.0	7
2061	5	5.0	2.5	8.0	5.0	9	9	6.0	6
	10	5.3	5.0	8.0	6.0	9	9	6.0	7
2181	5	6.3	-	-	-	-	-	-	-
	10	6.7	-	-	-	-	-	-	-
Check	-	2.0	-	2.0	2.0	9	9	6.0	7

1/ Nutgrass Ratings: 9 = complete control; 7=commercial control; 1=100% solid stand.

Crop Ratings : 9 = perfect growth; 7= commercially acceptable; 1 = kill.

Annual Weeds

In every field test with crops in 1958 and 1959 the degree of control of annual broadleaves and grasses was rated. The results for the 1958 tests are summarized in Table 4. They indicate no striking differences between analogs but a slight tendency for slightly better control for EPTC, 1607, and 2061 than for the other three analogs. Test no. 6 showed very poor control. In this case the chemical was applied three days after the soil was fitted. In none of the 1958 tests was the chemical incorporated.

In 1959 the annual weeds were the same species as in 1958, i.e., barnyard grass, crabgrass, foxtail, galinsoga, stinkgrass, purslane, red root pigweed, and lambs-quarters. However, the two most prevalent species were stinkgrass and red root pigweed. Ratings are reported in Table 5.

Table 4. Annual Weed Control Ratings1/ for 1958.

Chemical	Lbs.	1	2	3	4	5	6
EPTC	3	-	6.7	-	-	-	-
	4	8.0	7.0	7.5	7.0	5.5	3.3
	6	9.0	-	8.0	8.0	7.0	2.7
1607	2	-	6.7	6.5	5.0	-	-
	4	9.0	6.5	8.0	6.5	6.5	4.7
	6	9.0	-	8.5	7.5	8.0	3.7
1862	2	-	-	5.0	-	-	-
	4	5.5	6.5	5.5	-	5.0	4.3
	6	8.0	6.5	6.0	-	6.0	5.0
2007	2	-	-	6.0	-	-	-
	4	6.5	6.5	5.0	-	5.0	-
	6	7.5	6.7	5.5	-	5.5	-
2061	2	-	-	5.5	-	-	-
	4	8.0	7.0	7.0	-	6.0	-
	6	9.0	7.0	8.0	-	6.0	-
2181	2	-	-	5.5	-	-	-
	4	8.5	6.5	6.0	-	5.5	-
	6	9.0	6.7	6.0	-	7.0	-

1/ 9=complete control of all species; 7=commercial control; 1=100% heavy ground cover.

Table 5. Annual Weed Control Ratings1/ in 1959.

		Test Number					
Chemical	Lbs.	1	2	3	4	5*	6
EPTC	3	5.0	8.0	8.0	7.0	-	7.0
	4	5.0	-	8.0	8.0	7.5	8.0
	6	-	8.0	-	-	8.5	-
1607	3	8.0	8.0	8.7	8.5	-	7.0
	4	8.0	-	8.3	8.5	8.0	8.0
	6	-	8.0	-	-	8.5	-
2060	3	5.0	5.0	6.7	5.5	-	6.0
	4	5.0	-	7.0	6.0	6.5	6.0
	6	-	5.0	-	-	7.5	-
2061	3	8.0	7.0	8.0	6.5	-	7.0
	4	8.0	-	8.0	8.5	7.0	7.0
	6	-	8.0	-	-	8.0	-

* Galinsoga a problem in this test. No chemical gave good control.

3/ 9=complete control; 7=commercial control; 1=100% complete heavy ground cover.

It can be seen from Table 5 that EPTC, 1607, and 2061 were again somewhat superior to 2060. The latter analog only gave commercially acceptable weed control in two tests and these were at the high rate. On the other hand EPTC gave inferior results at only two rates in one test, and 2061 inferior results at one rate in one test, and 1607 gave commercially acceptable weed control in each rate in every test.

In comparing 1958 and 1959 results it is apparent that in the former tests where the chemical was not incorporated, weed control was much more variable. This agrees with the findings of other workers (2).

Longevity of EPTC and Analogs in Soil

One of the aspects needing investigation is the length of time EPTC and its analogs remain active in the soil. This is particularly true where a wide variety of crops are being grown. To assist in obtaining information on this point, an experiment was started on a fairly well-drained sandy loam soil August 28, 1959.

The materials included were EPTC, 1607, 1862, 2007, 2061 and 2181. Each was applied at 4 and 8 lbs. of active ingredient to the acre. Prior to treating, the area was plowed and disked. Then eight plots of each chemical were sprayed. Immediately following spraying four plots were disked thoroughly and four were left undisturbed. Each plot was 6' x 18'.

The general moisture level at treating time was low. If crop seeds had been planted, it is doubtful that good stands would have been obtained. However, relatively heavy rains were recorded in September and normal rainfall in October and November. The ground remained free of frost until the last week in November, thus permitting leaching for about 10 - 12 weeks.

The ground remained frozen until about April 5th. On April 16th the field had dried sufficiently and one-half of each plot was disked lightly. The remainder of the plot was left undisturbed. By means of a Planet Jr. hand seeder, the entire plot area was seeded to oats and radish. Growth ratings were made at several stages. Then in mid-June the entire area was heavily disked and seeded to cucumbers. These were rated during June and July and reseeded to cukes. Prior to reseeding, one-half of the plots were plowed and one- half were heavily disked. About September 15 the entire area was again disked and seeded with a rye grass cover crop.

Results

Weeds

No fall weeds germinated. Weed growth was light even in the check plots until the June seeding date. At that time the incorporated EPTC and 1607 plots at 8 lbs. were essentially weed free. There were some weeds in the 4 lb. rates of these two chemicals and all others could not be distinguished from the heavily infested checks. In the August seeding all plots were heavily infested. The most prevalent species were red root pigweed, lambs-quarters, stinkgrass and barnyard grass.

Crops.

Radishes showed no response to treatment. Oats germinated well in all plots and grew normally for about two weeks after emerging. In certain incorporated plots they then became an abnormal green color and were stunted. Later they showed some bending and malformed leaves. There was severe damage in the incorporated EPTC and 1607 chemicals at 8 lbs. Much less damage occurred at the 4 lb. rate. Oats in 2181 were slightly less damaged at a given rate than were those with EPTC and 1607. No damage was noted with 1862, 2007, and 2061. No damage occurred in any plot where the chemicals had not been incorporated.

The June seeding of cucumbers was damaged only by incorporated EPTC and 1607 at 8 lbs. The second seeding six weeks later resulted in no crop injury. The rye grass cover crop was not stunted by any treatment.

This study indicated that EPTC, 1607 and 2181 were likely to remain active longer than the other analogs. Incorporation was a very important factor influencing duration of activity. Leaching did not appear to be an important factor in removing these chemicals from the soil. Weed populations returned to normal intensities as soon as sensitive crops no longer showed the presence of active chemical.

Further indirect evidence on longevity was obtained in the nutgrass test. In Table 3, one can see that EPTC and 1607 were slightly more toxic to rye and rye grass cover crops than were 2060 and 2061. On the other hand 1607 and 2060 were more toxic to buckwheat than was EPTC. These results suggest that perhaps at least part of the apparent differences in soil longevity may be due to inherent differences in tolerance of the test crops to a particular analog.

One fact is clear, however, with fall applications EPTC, 1607 and 2181 analogs can remain in sufficient amounts to retard sensitive crops the next spring and early summer. Also, spring applications can remain in sufficient amounts to measurably effect fall cover crops.

Summary

EPTC was compared with analogs 1607, 1862, 2007, 2060, 2061 and 2181. The factors studied were: (1) annual broadleaf and grass control (2) nutgrass control (3) response of red beets, beans, carrots, cucumbers, lettuce, spinach, sweet corn, transplanted cabbage, transplanted and seeded tomatoes. A fourth factor was longevity of activity in the soil.

For annual grass and broadleaf type weeds 1607 was slightly superior to EPTC and the other analogs. 1862, 2007, and 2060 were slightly inferior to the other analogs. No analog controlled galinsoga. All materials gave commercial control of nutgrass when incorporated early in the season. 2181 appeared to be perhaps slightly superior in one test.

There was marked difference in crop tolerance to the several analogs. This was particularly true for those crops which are only occasionally injured by EPTC. 2060 and 2061 were definitely less toxic to beets, spinach, sweet corn and seeded tomatoes than were EPTC and 1607.

Longevity of EPTC and 1607 in the soil was of practical significance for crops that follow either spring or fall applications. The longevity studies also indicated that little practical kill of dormant weed seeds occurs under field conditions. As soon as active analog or EPTC was dissipated from the soil, normal weed populations again occurred.

The authors encourage further intensive work with 2061 (propyl ethyl-n-butylthiol-carbamate) because it: (1) is tolerated by more cultivated crops than EPTC (2) gives as satisfactory control of annual grasses and broadleaves and nutgrass as does EPTC, and (3) is less likely than EPTC to injure sensitive crops which might follow too soon after treating.

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PROGRESS REPORT ON POTATO VINE KILLING

R. L. Sawyer, S. L. Dallyn, G. H. Collin, W. H. Thorne

The use of potato vine killers such as rotobeaters, sodium arsenite, or a combination, give a very quick kill to potato tops and weeds before harvest operation. This quick killing of potato tops is not as desirable as normal maturity from the stand point of total solids in the tubers, or skinning injury to the tubers on handling. This paper covers a continuation of work aimed at finding a material which would induce normal potato maturity.

Materials and Methods

The materials listed in table 1 were applied to Katahdin tubers on August 6. There were no indications of normal senescence in the vines at that time. Ratings on speed of kill were made for both leaves and stems shortly after application and at the end of two weeks. Tubers were harvested on August 31 and total solids and skinning measurements made.

Results and Discussion

The yield results indicate that the applications of sodium arsenite were applied when potatoes were actively growing since yields were decreased by all applications. With 6 pounds of sodium arsenite the yields increased as the activity of the sodium arsenite was decreased by the use of sodium silicate. As the activity of sodium arsenite was slowed up at both the 6 and 8 pound dosage by the use of sodium silicate, the specific gravity of tubers tended to increase. Where the speed of kill was slowest by combining sodium silicate with sodium arsenite, the specific gravity was similar to that of tubers which had been allowed to go to full maturity. The amount of skinning was very small with all treatments and any differences that might have been due to treatments were probably masked by the length of time all treatments were left in the ground before harvesting. Results are given in table 1.

Table 1. Effect of sodium arsenite and sodium silicate applied to potato foliage on factors associated with normal maturity of potatoes.

Materials: Sodium Arsenite Lbs./A.	Sodium Silicate Gals./A.	Vine Kill* After 3 Days	Vine Kill* After 2 Weeks	Specific Gravity	Percent Skinned Area	Bu./A. U. S. No. 1
6	0	6.0	7.7	1.0600	2.8	375
6	2	3.5	4.7	1.0625	2.8	417
6	4	2.0	4.0	1.0647	5.8	435
8	0	6.5	8.0	1.0620	4.8	400
8	2	5.0	7.0	1.0613	3.4	357
8	4	3.5	6.3	1.0633	3.3	388
0	0	1.0	2.7	1.0645	4.5	475
L.S.D. 5%		1.5	2.5	.0027	NS	31
1%		2.1	3.4	.0037	NS	42

This work with vine killers was initiated with the idea that the quick kills used today such as sodium arsenite and rotobeating impaired tuber quality. A slow kill might simulate normal maturity and give benefits in tuber quality. These results indicate that slowing down the action of sodium arsenite is beneficial to quality, but additional work will have to answer the question, can the action be slowed down to advantage and still give the final kill desired at the end of a 10 to 14 day period.

Summary

1. The addition of sodium silicate to sodium arsenite slowed down the killing action and increased the specific gravity of the tubers.

RESULTS WITH EPTAM ON SEVERAL VEGETABLES

Stewart L. Dallyn and R. L. Sawyer

Research workers (1, 2, 3) in the Northeast have reported promising results with Eptam in several vegetable crops - among them potatoes, tomatoes, carrots, and snap beans. The manufacturer of this herbicide, on data collected throughout the country, has reported tolerance for a number of additional crops also[1]. The primary objective of this year's work was to determine tolerance of our most important vegetables to Eptam, incorporated into the soil before planting or transplanting.

Methods: Eptam carried over from 1958 was used since early reports indicated possible contamination of this year's material. In the major experiment it was sprayed on the surface of the ground at rates of 0, 2, 4 and 6 pounds per acre and immediately cross disked thoroughly in to a depth of 3 to 4 inches. All seeded crops and the first transplanted ones went into the field the following day - June 5. Soil moisture was near optimum content at this time, with rainfall well above average during the following 6 weeks (12.6 inches to July 20). The experiment was concluded August 1 on all crops except carrots which were carried through for yield data and harvested September 12. Ratings were made on crops and weed response during the course of the test.

Eptam was used, post-planting and worked into the soil, in other experiments on transplanted tomatoes, peppers and cauliflower, and at lay-by in onions. Tomatoes and peppers were treated with 0, 4 and 6 pounds per acre, granular, on June 6, three weeks after transplanting. Cauliflower received 4 pounds, both liquid and granular, on August 11, 15 days after setting. Early Harvest and Sweet Spanish onions were treated July 7 with directed sprays of 4 and 6 pounds per acre and overall with 6 pounds of the granular material.

Results: Crop injury ratings were made at 25 and 45 day intervals after the start of the experiment - see table 1. The material caused severe stunting and formative effects on tomatoes and peppers. Cabbage and cauliflower suffered complete loss of bloom from the leaves and also showed formative effects, particularly at the 6 pound rate. A number of the other crops were severely injured or killed at 4 pounds and above. Vegetables which appeared tolerant to this method of application of Eptam were snap beans, corn, carrots, and beets; however, snap beans was the only one which did not show at least slight stunting at the 6 pound rate.

Carrots, carried through to harvest, exhibted reduced top growth for a time at the highest rate of treatment, but appeared to even up later in the season. Yields, however, were reduced (table 2) by the two higher rates of Eptam and at 6 pounds root quality was also affected.

[1] Stauffer Chemical Company - brochure on Eptam, February 2, 1959.

Table 1. Effect of soil incorporated Eptam on several seeded and transplanted vegetable crops. Ratings[1] made June 30 and July 18 relative to checks.

	EPTAM POUNDS PER ACRE					
	Two		Four		Six	
CROPS	6/30	7/18	6/30	7/18	6/30	7/18
Beets - seeded immed.	2	2	2	3	3	3
Beans, snap - seeded immed.	1	1	1	2	1	2
Beans, lima - " "	3	3	4	5	5	5
Carrots - " "	1	1	1	2	1	3
Corn - F.M.Cross " "	1	1	1	2	1	2
Corn - Golden Beauty " "	1	1	1	2	1	3
Cucumber " "	5	4	5	5	5	5
Lettuce " "	3	3	3	4	4	5
Muskmelon " "	5	5	5	5	5	5
Onion " "	4	3	5	5	5	5
Pea " "	1	1	2	3	2	3
Spinach " "	3	1	3	2	4	4
Cabbage " "	2	2	2	3	2	3
" seeded 5 days later	2	2	2	3	2	4
" " 10 " "	2	2	2	3	2	4
" transplanted immediately	2	2	2	3	3	3
" " " 5 days later	2	2	2	3	3	3
" " " 10 " "	2	2	2	4	2	4
" " " 15 " "	2	2	2	4	2	4
Cauliflower - seeded immediately	2	2	2	3	3	3
" " 5 days later	2	2	2	3	2	3
" " 10 " "	2	2	2	3	2	3
" transplanted immediately	2	2	2	3	2	4
" transpl. 5 days later	2	2	2	3	2	3
" " 10 " "	2	2	2	3	2	4
" " 15 " "	2	2	2	4	2	3
Tomatoes - seeded immediately	2	3	3	5	4	5
" transplanted immediately	2	3	4	4	4	5
" transpl. 5 days later	2	3	4	4	3	5
" " 10 " "	1	3	2	3	3	4
" " 15 " "	1	3	1	4	2	5
Pepper - seeded immediately	2	4	4	5	4	5
" - transplanted immediately	3	4	4	5	5	5
" " 5 days later	2	4	3	5	5	5
" " 10 " "	2	5	2	5	3	5
" " 15 " "	1	5	2	5	3	5

1 = no injury 5 = severe

Table 2. Effect of Eptam on growth and quality of carrots.

Rate Lbs./A.	Total Wt. of Plants	Wt. of Roots	Root Appearance
0	22.7[1]	10.7	good
2	25.2	11.3	similar to check
4	18.1	8.4	" " "
6	17.2	6.9	some roots rough, hairy, pale in color
L.S.D. 5%	3.5	2.0	

[1] lbs. per 10 feet of row

The experimental area was heavily infested with weeds - mainly purslane, lambs quarters, smartweed, and crab grass. The following control ratings (1 - no control, 5 - complete) were obtained:

	0	2	4	6	lbs. Eptam
June 30	1	3	4	5	
July 18	1	1	3	5	

On June 30 there was a high population of small purslane plants in both the 2 and 4 pound plots, but they appeared to be growing very slowly. By July 18 the retarding effect of 2 pounds had been lost and the plots were being taken over by weeds. The 4 pound plots still looked fairly good and 6 pounds provided excellent control throughout.

The bulk of the experimental area was disked up August 1 and maintained in fallow until August 27 when a rye cover crop was sown. The residual effects of the 4-pound application caused a reduction in the rye stand, and the 6 pound rate essentially inhibited it. These latter plots were resown on September 29. Observations made on November 2 indicated less than 50% stand on these 6 pound plots, though what rye was established appeared to be growing alright. The combined effects of poor stand and late sowing date have made it impossible to obtain a satisfactory cover crop on the 6 pound plots under the conditions of this experiment.

Full details on the work on tomatoes, peppers, onions, and cauliflower are given in another paper in these Proceedings. Very good weed control was obtained with 4 and 6 pounds in tomatoes and peppers. There were no visible effects of the chemical on tomato plants nor were yields affected. Peppers were slightly stunted though yields from the first three harvests, when the experiment was discontinued, were not reduced. Excellent control of a late infestation of summer grass was obtained by layby treatments in onions. Directed sprays were preferable to granular since the latter caused some foliage burning and increased susceptibility to Purple Blotch disease. Liquid and granular applications controlled weeds in cauliflower but caused some loss of bloom from the foliage.

Summary:

Soil incorporation of Eptam injured a number of direct seeded and transplanted vegetables. Of the crops tested snap beans, sweet corn, carrots, and beets showed considerable tolerance and the use of this chemical on them (snap beans especially) may have some potential in particular problem areas.

Eptam applied after transplanting and worked into the soil gave good weed and grass control. Used in this manner it did not harm tomatoes, but did stunt peppers and prevented normal development of bloom on cauliflower foliage. Good rsults were obtained as layby treatment for summer grass control in onions. Eptam, applied broadcast, and worked into the soil, at 4 pounds, and particularly at 6 pounds per acre injured the following rye cover crop.

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LAY-BY WEED CONTROL IN POTATOES

R. L. Sawyer, S. L. Dallyn, G. H. Collin, W. H. Thorne

This report is a continuation of work reported in previous proceedings concerning chemicals applied to potatoes to control the annual grasses which become a problem after the final cultivation.

Materials and Methods

The granular materials listed in table 1 were applied on July 22 just after last cultivation to Katahdin potatoes. On July 10 there was .87 inches of rain and 4.89 inches on July 11. Plots were 2 rows wide and 30 feet long. Two row checks were left to either side of each treament and weed control was rated as per cent control of checks on September 21, 1959. Tubers were harvested October 6.

Table 1. A comparison of several granular herbicides on weed control and potato tolerance.

Materials	Lbs./Acre	Weed Control % of Check	U. S. No. 1 Bu. per acre
Eptam	2	43	249
Eptam	4	28	287
Simazin	1½	20	255
Falone	4	13	267
Diuron	3/4	30	248
Dalapon	1	40	279
Dalapon	3	25	238
Alanap 10G	4	28	248
Amoben	2	10	251
Amoben	4	8	255
Urab	1	35	231
Urab	3	30	94
Check			263
L.S.D.	5%	9	11
	1%	12	16

Granular Eptam was applied at the times indicated in table 2 to Katahdin vines. The first application was on May 21 just prior to dragging down. Other applications were made prior to each cultivation at 2 and 4 pounds per acre. Plots were 30 feet long and 2 rows wide, replicated 4 times. A two row check was left to either side of each treatment and weed control was rated as per cent control of check on August 26.

Using a cyclone seeder four materials were put on a grower farm which contained a severe grass problem. Materials were applied to a 4 row strip which the cyclone seeder would cover with one pass. A 4 row check was left between each pass. Four row passes with four materials were made on several hundred yard strips and replicated four times. Materials were applied on July 7 and weed

Table 2. The effect of time of application on annual grass control on potatoes using Eptam.

Time of Application	Dosage	Weed Control Percent of Check
May 21	2	50
" 21	4	35
May 30	2	40
" 30	4	25
June 10	2	50
" 10	4	15
June 18	2	30
" 18	4	20
L.S.D. 5%		24
1%		34

The grass stand in the experiment for the results of table 1 was light, but sufficient to determine the relative merits of the materials on grass control. Falone and Amoben gave particularly good grass control. Urab reduced the yield of potatoes severely at the 3 pound rate.

The later applications of Eptam gave the best control of late germinating grasses as indicated in table 2. This field had a very severe infestation of weeds. Annual grass had almost hidden the potato foliage in check plots by the middle of August. Four pounds of Eptam gave considerably better results than two pounds per acre at each application period.

Alanap 10G and Falone at 4 pounds per acre applied on a commercial scale with a cyclone seeder gave very promising results. Alanap 10G controlled 95 per cent of the weeds and Falone 70 per cent in fields with severe grass infestation. Dalapon M1501 and Eptam at 2 pounds per acre gave 40 and 50 percent control of checks and were not satisfactory. Eptam was not cultivated in after application.

Materials such as Alanap 10G and Falone applied after last cultivation have consistently given commercial control of late germinating grasses, but seldom if ever show any beneficial effect on yield of U.S. No.1's harvested from small research plots. With commercial combine harvesting of grassy fields, as compared to fields with grass control, the extra mechanical manipulation necessary to separate dirt held together by grass roots from potatoes may readily damage 50 bushels of potatoes more per acre in grassy fields. Control of 70 per cent of the weeds or better can be of considerable economic importance in the combine harvesting of L. I. fields which have a heavy grass population.

Summary

1. Falone and Alanap 10G at 4 pounds per acre applied after late cultivation gave good commercial control of the weeds which appear in potato fields late in the season.
2. Better grass control was obtained with Eptam applied before late cultivation than early cultivation.
3. Amoben looks particularly good as a new possibility for late grass control.

COMBINATIONS OF HERBICIDES FOR WEED CONTROL IN MAPLE TREE NURSERIES

John F. Ahrens 1/

INTRODUCTION

The ability of an herbicide to maintain long residual weed control without affecting plant growth adversely is a quality desired by commercial nurserymen. In the experiment reported here, herbicides were evaluated which show promise of fulfilling these qualifications.

PROCEDURE

The experiment was conducted in a commercial planting of Crimson King maples of about 1" in diameter (at 3' height) located in Rocky Hill, Conn. The trees were growing in a Hartford Sandy Loam soil and were spaced 2 or 4 ft. apart in rows 6 ft. wide. The experimental design was a randomized complete block with three replications and eight to ten trees per plot.

The chemicals were applied with a one-gallon knapsack sprayer in 70 gallons of spray per acre. One teaspoon of household detergent was added to each gallon of spray. All shoots were removed from the base of the trees before spraying and the sprays were directed so as to treat an 18" width on either side of the trees. Pre-emergence sprays were applied after hoeing and removing the existing weeds. Post-emergence sprays were applied to the existing weeds, consisting primarily of lambsquarters (Chenopodium album), chickweed (Stellaria media), pigweed (Amaranthus retroflexus) and groundsel (Senecio vulgaris). These weeds were from 2 to 6 inches tall at the time of treatment. The sparse grass population consisted mainly of yellow foxtail (Setaria lutescens). Purslane (Portulaca oleracea) invaded some plots later in the season.

The treatments were applied on May 16. The chemicals used are indicated in Table I. All rates are given in terms of the active ingredients. Rainfall was negligible in the latter half of May (.13 inches), normal in June (3.64 inches) and July (3.43 inches), and heavy in August (4.87 inches).

All plots were cultivated several times, leaving only about a foot over the row for weed growth.

Weed control was evaluated visually or by the fresh weight of weeds. Effects on trees were evaluated visually and by measurements of increase in diameter and shoot length.

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Table I Chemicals Used

Common Name	Chemical Name	Formulation	Source
Amitrol	3-Amino, 1,2,4 triazole	Liquid, containing ammonium thiocyanate	Am. Chem.
Dalapon	2,2 dichloropropionic acid	Sodium salt	Dow
Diuron	3 (3,4 dichlorophenyl) 1, 1-dimethyl urea	Wettable powder	du Pont
DNBP	3,4 dinitro-o-sec butyl phenol	Alkanolamine salt	Dow
EPTC	ethyl, di-n-propylthiol-carbamate	Liquid	Stauffer
Simazin	2-chloro-4,6 bis (ethylamino) S-trizine	Wettable powder	Geigy

RESULTS AND DISCUSSION

Effects of Treatments on Weed Control

Pre-Emergence Treatments

Visual estimates of weed control taken at 4, 6 and 10 weeks and the weights of all weeds at 17 weeks after treatment are shown in Table II. All pre-emergence treatments controlled weeds satisfactorily for 6 weeks. At 10 weeks, however, plots of DNBP at 6 or 12 lbs./A and EPTC at 4 or 8 lbs./A were becoming quite weedy. The final harvest of weeds in the plots on September 8 revealed the long residual effects of simazin and diuron. Plots of simazin at 4 or 8 lbs./A and diuron at 4 lbs./A were completely free of weeds at this time. All herbicide treatments reduced the weights of lambsquarters and pigweed significantly, compared to controls. Purslane, chickweed, and foxtail were scattered throughout the plots and could not be evaluated accurately.

Post-Emergence Treatments

Combining dalapon or amitrol with DNBP, simazin or diuron accelerated the "knockdown" of the existing lambsquarters-pigweed-chickweed population, as shown in Table III. However, EPTC plus amitrol or dalapon at 4 or 8 lbs./A stunted, but did not kill the broadleaf weeds. At 4 weeks no weeds were alive in plots of the simazin or diuron combinations and over 98% control was obtained with combinations of DNBP-dalapon, DNBP-amitrol, and EPTC-amitrol. The EPTC-dalapon

dalapon alone. Amitrol alone at 3 and 6 lbs./A killed weeds slower than some of the herbicide combinations but resulted in 96% and 99% kills at 4 weeks.

Table II Effects of Pre-Emergence Treatments on Weed Control

		Weed Control Ratings 1/ Broadleafed Weeds			Fresh Weights of Weeds 17 Weeks (Sept. 8)		
		4 Weeks	6 Weeks	10 Weeks	Lambsquarters & Pigweed		Misc. 2/
Treatment	Rate lbs/A	(June 10)	(June 24)	(July 21)	Lbs./ Plot	Percent Control	Lbs./ Plot
DNBP	6	6.7	6.9	3.3	18.2	36	0.1
	12	9.3	9.3	5.8	11.9	58	1.5
Simazin	4	10.0	10.0	10.0	0.0	100	0.0
	8	10.0	10.0	10.0	0.0	100	0.0
Diuron	2	9.0	9.5	8.4	6.6	77	0.2
	4	9.9	9.9	9.8	0.0	100	0.0
EPTC	4	7.0	8.1	4.3	20.7	28	0.6
	8	8.2	8.6	6.3	13.0	55	0.2
Controls		1.0	0.5	0.0	28.6	0	0.2
LSD p=.05					7.4		

1/ 0 = No control
10 = 100% control

2/ Miscellaneous weeds - purslane, chickweed, foxtail.

After removal of weeds at 4 weeks, the post-emergence plots were left untouched. Weights of weeds harvested from these plots at 17 weeks give a comparison of relative residual effects of the treatments. Dalapon or amitrol alone had no effect on subsequent growth of lambsquarters and pigweed. Neither did combinations of DNBP with dalapon and amitrol or EPTC with dalapon. Plots of diuron-dalapon, diuron-amitrol and EPTC-amitrol combinations had about 30% fewer weeds than control plots. All of the simazin plots were completely free of weeds 17 weeks after treatment and continued to prevent chickweed invasion a month later. The generally poorer residual weed control with the combinations than with pre-emergence herbicides alone may be explained by the disturbance of the soil which was inevitable in harvesting weeds at 4 weeks from the post-emergence plots.

Table III Effects of Post-Emergence Treatments on Initial Weed Kill and Residual Control

Treatment	Rate Lbs./A	Weed Control Ratings 1/ 2 Weeks (May 25)	Fresh Weights of All Original Weeds 4 Weeks (June 10) Lbs./Plot	Fresh Weights of All Original Weeds 4 Weeks (June 10) Percent Control	Fresh Weights of All New Weeds 17 Weeks (Sept. 8) Lambsquarters & Pigweed Lbs./Plot	Fresh Weights of All New Weeds 17 Weeks (Sept. 8) Lambsquarters & Pigweed Percent Control	Fresh Weights of All New Weeds 17 Weeks (Sept. 8) Misc.2/ Lbs./Plot
Dalapon	4	0	10.0	53	12.1	0	1.0
	8	0	10.3	52	16.9	0	0.7
Amitrol	3	4.7	0.8	96	11.5	2	1.8
	6	6.0	0.2	99	13.3	0	3.8
DNBP+amitrol	6+3	10.0	0.1	99	11.4	3	0.5
DNBP+dalapon	6+4	8.3	0.5	98	10.2	13	6.8
Simazin+amitrol	4+3	10.0	0.0	100	0.0	100	0.0
Simazin+dalapon	4+4	9.0	0.0	100	0.0	100	0.0
Diuron+amitrol	2+3	10.0	0.0	100	7.8	33	0.1
Diuron+dalapon	2+4	9.7	0.0	100	7.5	36	0.4
EPTC+amitrol	4+3	4.3	0.1	99	8.7	26	0.9
EPTC+dalapon	4+4	1.7	9.1	57	13.9	0	0.7
Weedy Controls		0.0	21.3	0	11.7	0	0.0
LSD p=.05			9.1		7.4		

1/ 0 = No kill
10 = 100% kill

2/ Miscellaneous weeds - purslane, chickweed, foxtail.

Effects of Treatments on Maple Trees

Injury and growth data are shown in Table IV. Pre-emergence treatments of DNBP at 6 and 12 lbs./A, simazin at 4 and 8 lbs./A, diuron at 2 and 4 lbs./A and EPTC at 4 and 8 lbs./A did not cause injury or affect growth adversely

Table IV Effects of Pre- and Post-Emergence Treatments on Injury and Growth of Crimson King Maples.

Treatment	Rate Lbs./A	Type of Application	Injury 1/ Rating (9/4/59)	Diameter 2/ Increase (mm.)	Shoot Length of 2 Longest Plant (inches)	Total Shoots/
DNBP	6	Pre	0.7	9.7	70.1	
	12	Pre	0.7	8.3	74.3	
Simazin	4	Pre	1.0	8.4	76.9	
	8	Pre	1.0	7.7	70.3	
Diuron	2	Pre	1.7	8.5	62.5	
	4	Pre	1.3	8.0	76.7	
EPTC	4	Pre	1.0	8.0	72.1	
	8	Pre	1.7	8.0	69.9	
Pre-emergence Controls			0.7	8.7	74.9	
Weeded Controls 3/			0.3	7.9	52.2	
Dalapon	4	Post	1.0	7.1	56.7	
	8	Post	3.0	6.4	41.1	
Amitrol	3	Post	1.0	8.4	67.8	
	6	Post	0.7	7.8	61.5	
DNBP-amitrol	6-3	Post	1.7	6.5	64.0	
DNBP-dalapon	6-4	Post	1.3	7.6	53.8	
Simazin-amitrol	4-3	Post	1.3	7.4	72.6	
Simazin-dalapon	4-4	Post	3.0	8.0	65.1	
Diuron-amitrol	2-3	Post	1.3	9.1	76.7	
Diuron-dalapon	2-4	Post	3.0	6.9	62.1	
EPTC-amitrol	4-3	Post	0.3	8.8	72.4	
EPTC-dalapon	4-4	Post	1.0	7.7	61.1	
Post-emergence Controls			1.0	7.6	62.6	
Weeded Controls 3/			0.0	8.8	80.8	
L.S.D. p=.05				1.3		

1/ 0 = No injury, 5-very severe.
2/ Measured at 3 ft. height.

Lack of consistent differences in growth between weeded and non-weeded control plots indicates that the existing weed populations did not significantly affect growth of the maples.

Dalapon caused noticeable injury at the 8 lbs./A rate of application and at the 4 lbs./A rate in combination with simazin or diuron. Visual injury with dalapon was observed in early July, following heavy rains; young leaves were distorted and burned on the margins, with many of them never fully expanding. Apparent visual injury in the diuron-dalapon and simazin-dalapon plots did not lead to adverse effects on growth for the season and must be considered minor. Dalapon caused no observable injury in 1958 and may have done so in 1959 because of the heavier rainfall in June.

Amitrol at 3 or 6 lbs./A caused no visible injury and did not affect shoot growth or increase in diameter. Of the amitrol combinations, only DNBP-amitrol showed a decrease in growth, measured by increase in diameter. The most promising treatment - simazin at 4 lbs./A plus amitrol at 3 lbs./A - did not affect the maples adversely.

SUMMARY

1) Normal and twice normal rates of simazin, DNBP, diuron and EPTC were applied alone (pre-emergence) and in combination with amitrol at 3 lbs./A and dalapon at 4 lbs./A (post-emergence) in a planting of Crimson King maples.

2) Simazin at 4 or 8 lbs./A, and diuron at 4 lbs./A maintained weed-free plots for 17 weeks. Diuron at 2 lbs./A controlled weeds for the next longest period. None of the eight pre-emergence treatments affected tree growth adversely.

3) In post-emergence applications, amitrol combinations with simazin, diuron or DNBP accelerated kill of existing stands of annual weeds over amitrol alone. Combinations of dalapon with simazin, diuron or DNBP, killed almost all existing weeds, while dalapon alone at 4 or 8 lbs./A only stunted the broadleaf weeds.

4) Dalapon alone at 8 lbs./A or at 4 lbs./A in combination with diuron or simazin injured maple trees.

5) The combination of simazin at 4 lbs./A plus amitrol at 3 lbs./A resulted in 100% kill of initial weeds and 100% control of weeds for the season, without affecting plant growth.

OBSERVATIONS ON WEED CONTROL EXPERIMENTS IN NURSERY AND CUT FLOWER CROPS DURING 1959

Arthur Bing*

A series of experiments designed to study the effects of several herbicides on the growth of ornamentals and weeds was reported to this conference last year (1, 2, 3, 4). This report is to bring up to date the observations on weed control and crop tolerance in plantings at the Cornell Ornamentals Research Laboratory on Long Island, N.Y.

EXPERIMENTAL PROCEDURE

Several plantings of nursery stock carried over from last year were again treated with the same herbicides. Also newly planted liners were treated with the more promising materials from previous years and with some newer ones. Peonies were treated for a second year in December. Another experiment consisted of treating a one week old planting of asters, chrysanthemums and carnations. Results of treatments on gladiolus are reported in detail in another paper (5). Weed control and crop tolerance were recorded periodically. Plantings in different experimental areas covered a wide range of weed problems. Table 1 lists the more promising materials which will be reported in this paper. A code is used to simplify the tables, the first letter or letters indicate material (S = simazine, D = diuron, etc.) and the last letter either granular or liquid (G or L). All amounts of herbicides discussed in this paper are in pounds of actual material per acre.

DISCUSSION OF RESULTS

Simazine. Simazine granular was not always effective when used at rates below 6 pounds per acre. At the 4 pound rate in two nursery areas the weeds came in badly although in the cut flower and gladiolus tests 2 pounds gave good weed control for a reasonable period. With liquid applications 4 pounds gave good control and in some areas 2 pounds was sufficient. Granular at 6 pounds was necessary to control red root and lambs quarter. None of the rates used controlled nutgrass, chrysanthemum weed, or bind weed. Azaleas may be injured by the 8 pound rate of granular but apparently tolerate the 4 pound rate. Taxus may show marginal yellowing of the leaves from the 8 pound granular rate. Table 2 shows that aster, chrysanthemum, carnation, mock orange, enkianthus, and privet are sensitive to simazine.

Diuron. Diuron gave more positive weed control than simazine but crops are more sensitive. Only bindweed and plantain in our area appear resistent to diuron. Nutgrass is damaged by the higher rates but the amount of permanent control has not yet been determined. Diuron in contrast to atrazine and simazine gives good control of crabgrass. This season newly planted

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Taxus capitata shows yellowing of the needles but Taxus media Hicksii was not affected by the same 3 pound rate. Two years ago, freshly planted Taxus media Hicksii showed injury from 3 and 4 pound applications. Liners planted the previous season and re-treated this season did not show this injury. Boxleafed holly showed yellow leaves last season from a 1.5 pound treatment, but the plants are now normal and at least as large as the untreated plants even after receiving 2 subsequent applications of 1.5 pounds of diuron. Table 2 shows that mock orange, enkianthus, hemlock, andromeda, and rhododendron are sensitive to rates close to that required for good weed control with liquid application. Granular applications are much safer for the crop and just as effective against weeds. Diuron appears very suitable for trees such as sycamore and crab apple.

EPTC. EPTC was one of the better materials this past season as measured by all around weed control including control of nutgrass. Raking in the EPTC doubled its effectiveness. The 3 pound rate raked in was equivalent to the 6 pound rate left on the surface. Some red root and lambs quarter survived the 3 pound treatment. Chrysanthemums, asters, carnations, and the nursery stock grew very well in the EPTC plots where 3 pound and 6 pound rates were used. Gladiolus do not tolerate EPTC. The 6 pound rate raked in reduced the stand of gladiolus to practically nothing.

Atrazine. In 1958 atrazine applied in water was very toxic to ornamentals. In 1959 all atrazine was applied in granular form. The use of granular was not injurious to most plants as seen from the data in Table 2. However, gladiolus, mock orange, and privet were sensitive to the granular atrazine. Nutgrass is controlled by a 4 pound per acre application of atrazine. Crabgrass is not controlled by the 2 or 4 pound rate. In the late spring a nursery block treated with 4 pounds of atrazine granular was clean of all weeds for several weeks. However, when crabgrass seed germinated, a pure stand of very vigorous crabgrass developed in this block. In some tests red root survived the 4 pound rate.

CIPC. Weed control with CIPC has been quite variable in the nursery areas. It fails where perennial weeds have become established. In the cut flower plantings, CIPC at 8 pounds granular has been fairly successful. Spring applications have been very effective against seedling grasses, chickweed, and later applications on purslane. CIPC does not give control of either Galinsoga or henbit and is weak on several other weeds. The main point in favor of CIPC is crop tolerance.

Neburon. Neburon at rates of 2-4 pounds is not a very effective herbicide. At rates of 8-12 pounds it controls most weeds. However, Erigeron, a common weed in the nursery area, was not affected. Most of the crops tested were tolerant to the rates of neburon used. However, neburon does not compare favorably costwise with diuron for effective weed control.

SUMMARY

Simazine and diuron granulars look very good for weed control in ornamentals but some crops can not tolerate concentrations necessary for satisfactory weed control. Atrazine is good for nutgrass but not crabgrass. It should be easier to find a herbicide for crabgrass to supplement the atrazine rather than to find a good herbicide for nutgrass.

Repeat applications and repeat plantings in treated plots are being carried out to study possible cumulative effects of simazine, diuron, and other long lasting materials. More information is necessary on residual effects on ornamentals and cover crops. Some signs of injury may only be temporary so that the treatment would be economically feasible dispite slight temporary foliar discolorations.

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Table 1. Herbicides and rates used on cut flower and nursery crops.

Code	Material	Formulation	Lbs actual/A	Crop
A-G	Atrazine	4% granular on clay	2-4 2-6	gladiolus nursery
CIPC-G	CIPC	5% granular on clay	4-12 8-32	cut flowers* nursery
CIPC-L	CIPC	3 lb/gal	8-32	nursery
D-G	Diuron	2% granular on clay	1.5-3 2-4 1.6	gladiolus peony nursery
D-L	Diuron	80% wettable powder	1.5-3 2-4 1-6	gladiolus peony nursery
E-G	EPTC	5% granular on clay	3-9 3-9 3-9	cut flowers gladiolus nursery
N-G	Neburon	4% granular on clay	8-12 2-12	peony nursery
S-G	Simazine	4% granular on clay	2-4 2-4 6-10 1-8	cut flowers gladiolus peony nursery
S-L	Simazine	50% wettable powder	2-4 6-10 1-8	gladiolus peony nursery

* Cut flowers refer to Aster, Carnation, and Chrysanthemum

Table 2. Tolerance of some ornamentals to herbicides. Figures show minimum rate of pounds actual to cause marked injury.

Crop	S-L	S-G	D-L	D-G	E-G	A-G	CIPC-G	CIPC-L	N-G
Aster	-[a]	2	-	-	+[b]	-	+	-	-
Carnation	-	2	-	-	+	-	+	-	-
Chrysanthemum	-	2	-	-	+	-	+	-	-
Gladiolus	+	+	+	+	3	2	-	-	-
Peony	+	+	+	+	-	-	-	-	+
Andromeda	+	+	3	+	+	+	+	+	+
Azalea, hinocrimson	+	6	+	+	+	+	8	+	+
Crab apple	+	+	-	+	+	+	-	-	-
Enkianthus	6	+	4	2[d]	+	+	+	+	+
Forsythia	+	+	+	+	+	+	+	+	+
Hemlock	+	+	3	+	+	+	+	+	+
Holly, boxleafed	+	+	2[ce]	5	+	+	+	+	+
Leucothoe	+	+	+	+	+	+	+	+	+
Mock orange	4	6	3	2	6	2	+	+	+
Privet	8	+	+	+	+	6	4	+	+
Rhododendron, catawbiense	+	+	3	+	+	+	+	+	+
Sycamore	+	+	-	+	+	+	-	-	-
Taxus, capitata	+	3	+	3	+	+	+	16	+
Taxus, media Hicksii	+	+	4[ce]	+	+	+	+	+	+

-[a] Not tested
+[b] No injury at rates used, see Table II
c Yellowing only
d Winter killed after 1st growing season
e 1st year plants

Crop, Weed and Soil Aspects of Simazine, Atrazine and Other Herbicides in Greenhouse and Field Tests

A. M. S. Pridham, Cornell University

Weed Control in Growing Crops

To date, 1957 through 1959, good weed control has been evident where Simazine or Atrazine have been used at rates up to 10 pounds of active ingredient per acre to control quackgrass, Agropyron repens, and other weeds, mainly annuals, growing in such nursery crops as the following evergreens, including taxus, thuja, juniper, such woody ornamentals as garden roses, and such herbaceous perennials as peonies; also, the ground covers vinca, euonymus and pachysandra. Lesser amounts (2-4 lbs. A/A) have also been useful for annual crops such as gladiolus. Cases are cited in Table 1.

Injury to nursery crops during 3 years of testing at Ithaca has been negligible, particularly with established plants in nursery or field plantings. Unfavorable response includes yellowing of foliage in newly planted and heavily watered pachysandra and other ground covers but no unfavorable response in other crops in dormant condition. Long residual action of the Simazine and Atrazine has been quite consistent where conditions suitable for seed germination have been maintained, though growth of some existing weeds from root or top sections has been noted. Other herbicides exhibiting full season residual action include CIPC, 8 lbs. A/A, and Diuron, 4 lbs. A/A.

Control of Established Perennial Weeds in Sod Prior to Planting

A field of predominantly timothy sod was marked off into plots 10 x 10 feet arranged so that alternate blocks of two rows could be rototilled after treatment. Simazine and Atrazine were used at 5 pounds of active ingredient per acre, and at the 10 pound rate. Both wettable powder and granular formulations supplied by Giegy were used. Untreated controls were used between paired blocks of treatments. Treatments were made in triplicate June 21 and rototilled the following day. Response to liquid sprays on grasses near head stage was evident in two weeks time.

Plots were rated on the stand of major weed constituents, timothy (Phleum pratense), dandelion (Taraxacum officinale), hedge bindweed (Convolvulus sepium), and the annual weeds foxtail (Setaria lutescens) and ragweed (Ambrosia artemisiifolia). Ratings for the three replicates are totaled in Table 2. Rating was the basis of 0 to 10 as a maximum.

Table 1. Cases of prolonged and extensive weed control in nursery crops at Ithaca, New York, 1957-59, include the following already reported at the Northeastern Weed Control Conference.

Crops	Soil Type	Location	Agropyron repens infestation	Seedling (-) & Est. Annual (+)	Simazine lbs. A/A
Evergreens					
Taxus cuspidata	sandy loam	East Ithaca	light	+	10
" "	silty clay	Bool - East	light	+	8 A
" media hicksii	sandy loam	East Ithaca	light	+	10
Thuja occidentalis	silty loam	Bool - West	medium	+	10 A
" " globosa	" "	" "	"	+	10
" " spiralis	" "	" "	"	+	10 A
Juniperus communis stricta	" "	" "	"	+	10 A
" horizontalis	" "	" "	"	+	10 A
" virginiana	" "	" "	"	+	10 A
Rosa delecta, Better Times	" "	" "	light	+	10 A
" multiflora, climbers	gravelly loam	Brooktondale	heavy	-	10
" delecta Fashionette	" "	Rose Garden	light	-	8
Peony varieties	" "	" "	medium	+	8 A
Euonymus fortunei	silty clay	Bool - East	light	+	10
Ground covers, Pachysandra, Vinca, Iberis	" "	" "	"	+	10

\- Seedling at germination to first true leaf stage

\+ Seedlings beyond initial stages of growth, hence with root enough to support turgor in plants where surface soil is dry.

A Atrazine used at this rate also. Plots treated during fall '58 and summer '59 as additional plots.

Table 2. Weed population present in October following treatment of sod covered field in June. Figures are total ratings of three replicates. Plant population rated on basis of 0 to 10, hence maximum total for three plots is 30. Plots rototilled within 24 hours of treatment, weather dry and hot. Grasses head stage.

Atrazine Plots on Sod

	Not rototilled					Rototilled after treatment				
	Control	5L	10L	5G	10G	Control	5L	10L	5G	10G
Timothy	20	0	0	0	0	8	0	0	0	0
Dandelion	8	5	1	11	18	3	1	1	16	18
Bindweed	3	16	20	16	23	4	26	23	23	26
Foxtail and Ragweed	7	7	0	0	0	14	½	0	0	0

Simazine Plots on Sod

	Not rototilled					Rototilled after treatment				
	Control	5L	10L	5G	10G	Control	5L	10L	5G	10G
Timothy	18	2	0	15	13	4	0	0	0	0
Dandelion	4	14	8	13	11	5	4	4	11	8
Bindweed	2	7	14	5	8	1	19	21	11	19
Foxtail and Ragweed	5	0	0	2	1	20	2	0	6	0

L - wettable powder
G - granular - attaclay

Timothy, Phleum pratense. Atrazine at 5 or 10 lbs. of active ingredient virtually eliminated timothy and other grasses. Simazine was effective at the 10 lb. level and in liquid formulation (W.P.). Incorporation of granular formulation was effective at both rates of application as was the wettable powder.

Dandelion, Taraxicum officinalis. Removal of the grass likely permits better growth of dandelion in size; hence, ratings for dandelions were highest in the treated areas. Wettable powder formulation seems more effective than granular in reducing the dandelion population.

Bindweed, Convolvulus sepium. Removal of grass resulted in heavy growth of hedge bindweed. Both chemicals appear to stimulate growth of bindweed.

Annual weeds - foxtail and ragweed. Population increased in frequency following rototilling but chemical removal of the timothy did not result in excessive growth of these two annual weeds. The population rating kept close to zero indicating residual action for at least one season.

Simazine and Atrazine were used in 1959 on evergreens at the 5 lb. and 10 lb. rates as indicated in Table 1. No injury was evident in foliage color by November except in Juniperus horizontalis when Atrazine was used at the 10 lb. active level. As in past treatments, grasses were greatly reduced. Dandelions and hedge bindweed tend to persist for 1 or more seasons.

Prolonged residual action in cultivated soil. Effective control of weeds has lasted for a year or more in these instances. Rototilling and cultivation has not completely destroyed the herbicidal effectiveness of Simazine in sandy loams nor in silty clay loam (Table 1).

During the summer of 1959 prolonged residual action was noted in gravelly loam for the Rose Fashionette which had been treated in July 1958 and later hilled up over winter when rototilled during the spring of 1959. In July and August 1959 crabgrass appeared first along the plot margins and later throughout the Fashionette plots. Actual stand of crabgrass plants was late in appearing and the seedlings few in number with the 8 lbs/A rate. Crabgrass and other weeds appeared first in the untreated control plots.

Growth of Bareroot Liners and Others in Simazine Soil Mixtures Maintained at High Soil Moisture Levels (Simulated Cultivation of Herbicide into Soil)

Using the generalization that an acre of soil to the depth of a furrow slice weighs two million pounds, appropriate amounts of herbicide were weighed for mixing with 30 pounds of steam sterilized, silty clay loam soil. Mixing was done after spreading out the soil on a level surface to a depth of approximately 1 inch and then applying the herbicide. The soil was turned over several times, then placed in a drum and rolled for 5 minutes.

"Market pak" paper containers were filled with a uniform amount of soil and herbicide mixture at four replicates per treatment. Plants used were bareroot from the propagating bed or young plants such as Kurume azaleas and were washed free of soil before planting in the experimental units. The planted containers were placed under intermittent mist till the soil was thoroughly moistened and the plants stabilized for turgor. Soils were then maintained at a high moisture content by misting or hand watering till plant response was marked enough to permit rating or measuring the response, i.e. color or condition of foliage or height of plant. Observations made are given in Table 3.

The culture of bareroot plants in prepared mixtures of Simazine and soil result in varying degrees of crop injury from discoloration of young foliage to general discoloration and death of the plant or weed as noted for crabgrass and for chrysanthemum weed set as rooted stolons. Thus plants set in loose soil and watered heavily show injury similar to that noted in the field when Simazine was used in amounts of 4 pounds or more of active ingredient.

Table 3. Response of selected nursery crops after planting bareroot from the propagating bench in soil-Simazine mixtures when soil moisture was maintained at approximately field capacity.

		lb. A/A Simazine from Granular 8%					
Crop or weed	Response	0	2	4	8	16	32
Gladiolus	ht. inches	13.1	13.3	13.3	3.0 D	3.5 D	4.7 D
Taxus cuspidata	% mortality	0	0	0 x	12	50	75
Thuja occidentalis	"	0	50	12	100	100	100
Forsythia intermedia	% discolora.	0	25	50	50	90	100
Euonymus fortunei	" G	0	0	0	75	62	62
Iberis sempervirens	" G	0	0	0	0	31	31
Pachysandra terminalis	" G	0	0	25	50	62	100
Vinca minor	" G	0	0	0	0	0	0
Chrysanthemum	% mortality	0	100	100	100	100	100
Artemisia vulgaris	"	0	25	6	50	12	40
Digitaria ischaemum	Tot. # plants	105	95	85	90 R	75 R	41 R

D - Gladiolus planted 3/11 and observed 4/30 were dead by 5/15 except the untreated controls still alive 11/1

x - Taxus planted 3/11, observed 11/3 and showed yellowing discoloration of young foliage and in some cases death of the plant.

G - Euonymus, iberis, pachysandra and vinca planted 3/31 observed 4/15 and fertilized weekly through the summer regained green color.

R - Crabgrass seed sown 3/15 germinated and a count of the seedlings made 4/20 when growth was as much as 1" in height. Counts are the totals for 4 replicates. R signifies reddish foliage and later death of the seedlings which seldom exceeded ½" in height for the seedling leaf.

Azalea plants, variety Coral Bells, in lining out size were planted in soil-Simazine mixtures after washing peat and soil from the roots. Mortality ranged from 75% to 100% when granular Simazine was used in the soil mix and from 25% to 75% when wettable powder was used. Both formulations were used at 1, 2, and 4 pounds of active ingredient per acre. Control, bareroot, plants survived after planting in loamy soil free of Simazine.

Residual Action Modifies Growth of Some Cover Crops

During September 1959 oats, rye, wheat and buckwheat were planted in the 1957 rose plots in the nursery and in soil mixes used in the greenhouse during March 1959 and tested five months later.

Germination was prompt and growth normal for these grains planted in uncreated control plots, field and greenhouse. Germination and growth of rye and buckwheat was satisfactory in the field when less than twelve pounds of active Simazine was incorporated into the soil. The 2 year period, 1957 through 1958, of exposure to weather together with the roto-tilling in 1959 was enough to dissipate the smaller amounts of Simazine so that growth of oats, rye, wheat and buckwheat was comparable to that in untreated control plots.

In the greenhouse tests with soil-Simazine mixtures the only grain to grow in the mixtures was rye. The other test crops, buckwheat, oats and wheat all failed to grow in Simazine-soil mixtures. All test crops grew in soil-Atrazine mixtures of 4 lbs. active Atrazine or less per acre.

Summary

Atrazine and Simazine have been used in a number of nursery crops to control some annual and perennial weeds. Residual action, particularly of Simazine, may modify growth of subsequent cover crops and susceptible nursery crops under certain conditions not fully defined. Wheat and oats may be of value as fall indicator plants for field bioassay purposes prior to planting nursery crops in spring.

Growth of hedge bindweed and of dandelion is not promptly controlled by a single treatment with Simazine or Atrazine as used in present tests. Crabgrass, Digitaria ischaemum, is only partly controlled and tends to develop essentially pure stands if not dealt with otherwise than by single treatments of Simazine or Atrazine. Atrazine appears to have less residual effect than does Simazine as measured by growth of buckwheat, oats and wheat in prepared soil herbicide mixes under intermittent mist and greenhouse conditions.

Acknowledgement is given Geigy Agricultural Chemical Company, Ardsley, N. Y. for herbicides used in the experiments reported in this paper.

A COMPARISON OF SOME HERBICIDES ON FLOWERING AND CORM YIELD OF GLADIOLUS VARIETY FRIENDSHIP

Arthur Bing*

Several herbicidal treatments have shown great promise for weed control in gladiolus. Previous experimental work with cormels (1, 2) has shown that diuron, simazine, CIPC and DNBP give very effective weed control. Simazine caused early foliage injury but no significant reduction in corm yield. In New England some gladiolus growers have used DNBP successfully without injury at rates much higher than used in previous experiments on Long Island. Atrazine, a relative of simazine, has shown promise as an herbicide. Additional information on the comparative effects of granular and liquid diuron, liquid DNBP, liquid and granular simazine, and granular atrazine on flower and corm yields were necessary before formulating recommendations for gladiolus weed control for commercial growers.

EXPERIMENTAL PROCEDURE

Gladiolus corms variety Friendship were planted on June 9, 1959 in 10 rows with 10 plots per row. Each plot was split to contain 50 #5 corms in one half of the split plot and 100 #6 corms in the other half of the plot. There were 20 treatments replicated 5 times, each block of 2 plots across 10 rows constituting a replicate. Corms were planted 3-4 inches deep and covered with a mound of soil. Six days after planting the soil was raked level and irrigated. Treatments were made June 16, using a calibrated 24 inch Lawn Beauty spreader for applying granulars. A 1.5 gallon hand pumped pressure sprayer with a flat spray nozzle was used for applying liquids. The materials and rates used are shown in Table 1.

Flowering spikes were cut when the first floret was partially to fully open. A record was made of the number of spikes cut, their weight, and the date of cutting.

Weed growth was evaluated just prior to digging on October 10. There never was much weed growth in any of the hand weeded or chemically weeded plots. Earlier weed counts would only show that all treatments significantly reduced weeds compared to the weedy untreated plots.

Corms were dug, washed, cured for 2 weeks, cleaned, and weighed. A record was made of the number of corms dug from each plot, total weight of corms, and total weight of cormels that adhered to corms at the time of digging. Corms from each treatment are being saved separately for planting next season in the same plots. Corms planted in the same plots and receiving the same treatments may bring out residual effects that could not be detected by using new corms and fresh soil each year.

DISCUSSION OF RESULTS

Control of weeds. All treatments gave very good control of weeds up to the time of flower cutting. The five untreated plots were weedy enough to practically hide the gladiolus from view. Some crabgrass started coming up in most plots in early August. Crabgrass seedlings were pulled and counted on August 10. Weed growth data is shown in Table 2. Atrazine plots receiving 2 pounds per acre had an average of 17 crabgrass plants per 10 square feet, DNBP at 4 pounds had 26.8; and 2 pounds of simazine granular had 22.2 crabgrass plants. Diuron gave fairly good crabgrass control. The untreated plots had an average of over 40 crabgrass plants per plot so all materials gave highly significant although inadequate control. A combination treatment incorporating a good crabgrass killer may be necessary. There were not enough weeds in the treated plots on October 10 to be particularly noticeable or to interfere with the digging of corms. The untreated plots were very weedy and digging was time consuming. Table 2 shows that the average weed control in all plots was highly significant and satisfactory. A rating of 1 is excellent and 2 good. A rating of 4 or 5 would indicate unsatisfactory control.

Cut flower yields. Several of the treatments, as shown in Tables 3 and 4, caused a marked reduction in the yield of cut flowers as measured by number of flowers cut by August 29, from the #5 corms and September 6 from the #6 corms, total number of spikes and total weight of spikes. The reductions were highly significant for practically all the atrazine and most of the simazine treatments. Simazine granular was much less detrimental to cut flower production than the liquid treatments. Diuron caused some reductions in cut flower yield both in numbers and weights. Although some reductions by diuron treatments are significant at the 5% level, other yields actually were higher than from the cultivated plots. There was no trend toward increased injury due to increased concentration of diuron used. There was a more marked trend for a delay in flowering caused by diuron especially on the #5 corms where several delays were highly significant.

DNBP at the 4 and 8 pound per acre rates caused no marked decrease in flower yield. Actually most measurements showed an increase over the cultivated plots. At the 12 pound rate, DNBP caused a significant delay in flowering and a reduction in yield from the #6 corms but not from the #5 corms. There were extreme reductions in cut flower yield from the unweeded plots. The few small flowers from the unweeded plots were badly damaged by insects. This damage was practically unnoticed on plants in either hand or chemically weeded plots adjacent to them.

Corm production. Corms were all dug on October 13 and 15, washed, and cured in a heated workroom for 14 days before cleaning. After cleaning they were cured for one week and then all lots were cooled and weighed. The results are shown in Tables 3 and 4. The yield data corroborates the visual differences apparent on the growing crop. Atrazine killed many plants and caused a highly significant reduction in number and weight of corms produced. The weeds in the untreated plots caused only slight reductions in corm numbers but highly significant reductions in the weight of corms produced. Other materials caused no significant reductions in

Preliminary tests in the guard rows indicated that EPTC will markedly reduce the stand of gladiolus plants. The 6 pound rate raked in and 9 pound rate not raked in just about eliminated the gladiolus plants.

SUMMARY

In the 1959 season most of the herbicides delayed flowering or reduced the yield of flowers. Atrazine at rates necessary for adequate weed control is not suitable for gladiolus because it markedly reduced the stand of plants. None of the other herbicides when used at minimum rates sufficient for weed control affected corm yield. It would seem advisable to incorporate a crabgrass killer with the lower rates of some of the materials tested to secure more practical weed control. Trials in the guard rows showed that EPTC is highly injurious to gladiolus and should not be used. Weeds reduced yield and greatly increased insect damage. The use of herbicides for corm production appears to be safer than for flower production.

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Table 1. Treatments used for controlling weeds on gladiolus.

Code	Material	Formulation	Diluent	Lbs actual/A
A2G	Atrazine	4% granular	Clay	2
A3G	"	"	"	3
A4G	"	"	"	4
D1.5G	Diuron	2% granular	Clay	1.5
D2G	"	"	"	2
D3G	"	"	"	3
D1.5L	"	80% WP	Water 100 gals/A	1.5
D2L	"	"	"	2
D3L	"	"	"	3
DN4L	DNBP	3 lbs per gal	Water 100 gals/A	4
DN8L	"	"	"	8
DN12L	"	"	"	12
S2L	Simazine	50% WP	Water 100 gals/A	2
S3L	"	"	"	3
S4L	"	"	"	4
S2G	"	4% granular	Clay	2
S3G	"	"	"	3
S4G	"	"	"	4
Cult.	Cultivated and hand weeded until Aug. 1			
Untr.	No weed control treatments, cultivation, or weeding.			

Table 2. Weed growth in gladiolus plots. Figures are averages of 5 plots.

Treatment	Crabgrass Counts August 10	Weed Growth October 10
A2G*	17.0	1.8**
A3G	8.4	1.6
A4G	7.8	2.0
D1.5G	9.8	1.6
D2G	13.4	1.4
D3G	2.6	1.4
D1.5L	5.2	1.2
D2L	8.4	1.6
D3L	2.2	1.2
DN4L	26.8	2.0
DN8L	4.8	1.4
DN12L	5.2	1.6
S2L	9.6	1.4
S3L	10.0	1.6
S4L	4.2	1.6
S2G	22.2	2.0
S3G	13.8	1.8
S4G	5.8	1.8
Cult.	0.4	2.6
Untr.	40.0	5.0
L.S.D. 1%	8.8	0.70
L.S.D. 5%	4.4	0.35

* See Table 1 for explanation of code

** 1 No weeds
2 Few weeds
3 Some weeds
4 Weedy
5 Very weedy

Table 3. Flower and corm yields of gladiolus variety Friendship.
Figures are averages of 5 replicates of 50 #5 corms.

Treatment	Cut Flower Yield: No by 8/29	Cut Flower Yield: No	Cut Flower Yield: Wt in oz	Corm Yield: No	Corm Yield: Wt in oz	Cormel Yield: Wt in oz
A2G*	17.8--	32.4-	43.2-	40.8	32.6	2.7-
A3G	7.0--	18.0--	20.8--	25.8--	17.2--	1.4--
A4G	6.8--	14.4--	21.0--	19.8--	15.4--	0.9--
D1.5G	21.6-	35.8	44.0-	43.4	28.2-	3.0
D2G	18.2--	31.6-	44.2-	40.4	30.4	2.7-
D3G	20.8--	34.8	49.4	43.0	31.8	3.5
D1.5L	21.4-	36.8	47.2	45.8	33.0	2.8-
D2L	21.8-	36.0	48.5	40.4	33.4	2.6-
D3L	18.4--	33.2-	43.8-	42.8	31.6	2.8-
DN4L	26.4	39.4	60.4+	43.2	36.8+	3.1
DN8L	24.0-	38.0	53.2	42.6	32.0	3.6
DN12L	23.2	37.8	52.6	44.4	35.4	3.4
S2L	20.4--	34.8	42.6-	41.6	30.0	2.6-
S3L	19.6--	32.4-	42.6-	42.4	34.0	2.8-
S4L	13.4--	27.6--	34.0--	39.6-	30.6	1.8--
S2G	22.2-	37.6	45.4	44.0	33.2	3.2
S3G	22.8-	37.6	51.4	44.8	35.4	3.1
S4G	21.6-	37.0	46.0-	43.6	31.4	3.5
Cult	27.0	37.0	51.4	43.2	32.6	3.4
Untr	7.2--	11.8--	10.2--	39.2-	22.4--	1.5--
L.S.D. 1%	5.6	7.2	13.4	5.6	7.2	1.1
L.S.D. 5%	2.8	3.6	6.7	2.8	3.6	0.6

- Significant reduction from cultivated (5% level)
-- Highly significant reduction from cultivated (1% level)
\+ Significant increase from cultivated (5% level)
* See Table 1 for explanation of code

Table 4. Flower and corm yields of gladiolus variety Friendship. Figures are averages of 5 replicates of 100 #6 corms.

	Cut Flower Yield			Corm Yield		Cormel Yield
Treatment	No by 9/6	No	Wt in oz	No	Wt in oz	Wt in oz
A2G*	16.6--	32.4-	28.4--	70.0-	39.6--	1.8--
A3G	6.8--	15.2--	15.2--	51.0--	31.8--	1.5--
A4G	3.4--	7.0--	7.8--	31.8--	16.4--	0.6--
D1.5G	25.2-	41.0	34.6-	87.6+	46.4	2.6-
D2G	22.4-	34.4-	33.2-	82.8	47.4	3.0
D3G	28.4	37.2	38.6	77.2	47.8	3.6
D1.5L	23.4-	34.0-	31.0-	84.4	46.0	2.8
D2L	28.0	45.8	42.4	86.6+	51.6	2.7-
D3L	23.8-	44.2	38.2	88.6+	48.2	2.6-
DN4L	31.6	46.4	46.6	84.4	53.0+	3.1
DN 8L	26.6	40.2	38.0	87.2+	46.4	3.1
DN12L	21.6-	33.2-	33.0-	85.4	31.4--	3.5
S2L	18.0--	31.8-	28.6--	84.8	44.8	2.8
S3L	15.6--	28.8--	27.8--	73.0	42.2	2.2-
S4L	12.8--	28.2--	23.6--	72.6	41.4-	2.0--
S2G	19.0--	32.6-	28.6--	79.6	45.0	2.9
S3G	28.6	41.2	40.0	85.2	46.8	2.8
S4G	21.6-	35.4-	33.2-	78.8	45.2	2.9
Cult	30.2	41.6	42.0	79.2	47.0	3.2
Untr	0.6--	1.6--	1.6--	75.2	27.6--	1.3--
L.S.D. 1%	8.6	12.2	11.0	14.2	8.2	1.0
L.S.D. 5%	4.3	6.1	5.5	7.1	4.8	0.5

- Significant reduction from cultivated (5% level)
-- Highly significant reduction from cultivated (1% level)
+ Significant increase from cultivated at 5% level
* See Table 1 for explanation of code

CHEMICAL CONTROL OF WEEDS IN TAXUS LINERS

John F. Ahrens 1/

INTRODUCTION

One of the greatest needs for chemical weed control in nursery plantings is in lining-out stock where hand hoeing can be injurious as well as expensive. Preliminary work in 1958 indicated that varieties of Taxus liners may differ in their response to herbicide treatment. This work was continued in 1959 to evaluate more carefully the effects of herbicides on growth of a few varieties of Taxus liners.

PROCEDURE

Two experiments were conducted in East Windsor, Conn., on an Enfield Silt Loam soil. The experimental design in both cases was a split plot with three replications. Two to three control plots were included in each replication. Three varieties of 2-year old Taxus liners were transplanted into the field on April 28, in such a way that the first three plants in each plot were T. Browni, the second three T. Capitata, and the last three T. Hatfield. Plants were spaced 18" apart in rows 42" wide. A plot consisted of two center rows containing 6 plants of each variety, with a border row of Taxus on each side.

Sprays were applied with a one-gallon knapsack sprayer, in 70 gallons of solution per acre. Granular formulations were applied with a 24" Lawn Beauty fertilizer spreader. Treatments were applied over the whole plot area, without regard to plants. The chemicals used are shown in Table I. All rates are given in terms of the active ingredients.

The pre-planting treatments were applied on April 22 (6 days before planting) to moist soil in a good state of tilth. The field had been plowed, fertilized and disced according to normal practice. EPTC and CDEC were applied as sprays and raked into the soil. Simazin at 3 lbs./A was applied as a spray, but because of nozzle clogging, the 6 lbs./A rate was applied as a granular formulation. Both rates were applied on the surface. The broadleafed weed population in both experiments was almost entirely smartweed (<u>Polygonum</u> <u>pennsylvanicum</u>) and lambsquareters (<u>Chenopodium</u> <u>album</u>). The grasses were foxtail (Setaria lutescens) and crabgrass (<u>Digitaria</u> <u>spp</u>.). Distribution of these weeds was erratic, however.

The post-planting treatments were applied on May 4, six days after transplanting. EPTC and CDEC were applied before cultivation and the other herbicides were applied after cultivation. The soil was moist before cultivation but dried out rapidly on the surface during the warm day. With the exception

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TABLE I CHEMICALS USED

COMMON NAME	CHEMICAL NAME	FORMULATION	SOURCE
CDEC	2-chloroallyl diethyldithio carbamate	10% granular, 46% liquid	Monsanto
CIPC	isopropyl N (3 chlorophenyl) carbamate	5% granular	Niagra
DNBP	3,4 dinitro-O-sec-butyl phenol	20% granular	Dow
EPTC	ethyl di-n-propylthiol-carbamate	5% granular	Stauffer
Falone	tris-(2,4 dichlorophenoxethyl) phosphite	10% granular	U. S. Rubber
Neburon	1-n-butyl-3,4-dichlorophenyl)-1-methyl urea	4% granular	du Pont
NPA	N-1 naphthyl phthalamic acid sodium salt	10% granular	U. S. Rubber
Sesone	2,4 dichlorophenoxyethyl sulfate	10% powder	Carbon & Carbide
Simazin	2-chloro-4,6-bis-(ethylamino) S-triazine	4% granular	Geigy

of sesone, all of the post-planting herbicides were applied as granular formulations, selected to avoid injury to the Taxus.

About 0.7 inches of rainfall occurred in the four days following transplanting. May was one of the driest on record, however, and the post-planting treatment received no appreciable moisture until the area was irrigated on May 23, nineteen days later. Rainfall in June was normal (3.64 inches).

Weed control was evaluated visually and by fresh weights of weeds. Lambsquarters and smartweed were grouped because they were not independently or uniformly distributed. The grasses could not be easily separated in their vegetative states and were also grouped.

Injury evaluations of each Taxus variety were made in July on a scale from 0 to 5 by five qualified persons. Growth evaluations were made by measuring the two longest shoots on each plant in September. The plants were dormant when transplanted in April and were trimmed to uniform sizes at that time.

RESULTS & DISCUSSION

Pre-planting Treatments

Data on weed control and Taxus growth in the pre-planting plots are given in Table II. At 5 weeks after transplanting, all treatments maintained effective control of the grasses. However, many plots were infested with smartweed and lambsquarters. EPTC at 4 lb./A apparently controlled the broadleafed weeds better than EPTC at 8 lbs./A. Poor weed distribution is the only explanation for this occurrence. Only fair control of broadleafed weeds was obtained with CDEC at 12 lbs./A and practically no control with CDEC at 6 lbs./A. Neither EPTC nor CDEC was satisfactory as a pre-planting treatment to control smartweed and lambsquarters, when incorporated into moist soil and followed by dry conditions. The spray of simazin at 3 lbs./A was more effective in controlling weeds than the granular at 6 lbs./A. When rainfall is low, simazin sprays sometimes are more effective than granular applications. However, comparisons of granular and spray applications of simazin under varying conditions of soil moisture deserve further investigation.

Table II Effects of Pre-Planting Treatments on Weed Control and Taxus Growth

Treatment	Rate Lbs./A	Method 1/	Percentage Weed Control 2/ 5 Weeks (June 5)		Taxus Growth Length of 2 Longest Shoots Per Plant (cm.)		
			Bdlf.	Grass	Browni	Capitata	Hatfield
EPTC spray	4	Inc.	79	96	19.6	19.3	18.0
	8	Inc.	35	96	18.3	13.3	14.0
CDEC spray	6	Inc.	16	83	22.8	20.2	18.6
	12	Inc.	68	92	18.2	19.8	19.6
Simazin spray	3	Surface	99	97	17.9	19.4	17.8
Simazin 4% Gr.	6	Surface	53	76	19.0	21.2	15.7
Controls			0	0	21.5	19.9	18.8
L.S.D p=.05					4.2	4.2	4.2

1/ Surface application or incorporated by raking in.
2/ Percentage control based on fresh weights of weeds.

The response of the liners to the pre-planting treatments was varied. Browni liners in plots of simazin at 6 lbs./A and EPTC at 8 lbs./A showed very slight injury in July, but growth was not affected significantly by any treatment. However, Capitata and Hatfield liners in plots of EPTC at 8 lbs./A showed slight injury in July, and produced significantly less growth than control plants. No injury or significant depression of growth was evident at the low rates of application of the three herbicides.

Post-planting Treatments

Results of the weed control ratings and Taxus growth data are shown in Table III. Weed weights corresponded closely with the visual estimates. Excellent weed control for the 6-week period was obtained with CIPC at 8 and 10 lbs./A and simazin at 6 lbs./A. Good to excellent control was obtained with EPTC at 4 and 8 lbs./A. DNBP at 5 or 10 lbs./A controlled lambsquarters and smartweed, but not the grasses. CDEC was fairly effective only at the 12 lbs./A rate. Sesone, falone, and NPA were only fairly effective at 3 or 6 lbs./A. Simazin at 3 lbs./A and neburon at 3 and 6 lbs./A were both unusually poor in this test. Low soil moisture in the period following application probably contributed to the poor performance of these treatments, even though poor distribution of weeds made accurate evaluation of weed control questionable.

Residual control of grasses was evident in most treated plots a month after weed harvest. The best residual control of grasses was obtained with simazin at 6 lbs./A, CIPC at 8 or 12 lbs./A and EPTC at 8 lbs./A. Simazin at 6 lbs./A prevented germination of oats seeded in the plots in September.

Results of the visual estimates of Taxus injury made in July, indicated only slight injury in three cases. These were EPTC at 8 lbs./A in Browni, and simazin at 6 lbs./A and falone at 6 lbs./A in Capitata. In no instance was there any large effect on growth of the Taxus. Although varieties differed significantly in amounts of growth, differences between treated and control plots were significant only in the Browni variety. In some cases, growth of treated yews, especially Browni, was considerably greater than yews in the weedy control plots. This may have been due in part to control of the competing weeds. Unfortunately, no weeded control plots were available for comparison. Neburon at 6 lbs./A depressed growth slightly in Capitata and Hatfield yews, but not Browni. It is expected that any true differences will be more apparent the second year of treatment since growth during the first season after transplanting is limited.

Since only three herbicides were included in the pre-planting experiment, only limited comparisons can be made between pre- and post-planting treatments. When applied before transplanting at 8 lbs./A, EPTC injured Hatfield and Capitata liners. This was avoided by treating after planting. Although post-planting treatments in this experiment were applied 6 days after transplanting, even greater safety might be achieved by increasing this time or irrigating heavily prior to treatment.

Post-planting treatments offer the most promise in practice. Post-planting treatments can be applied in bands over the row, thus reducing the chemical costs.

TABLE III Effects of Post-planting Treatments on Weed Control and Taxus Growth

Treatment	Rate Lbs./A	Method 1/	Weed Control Rating 2/ 6 Weeks (June 20) Bdlf.	Grass	Taxus Growth Length of 2 longest shoots per plant (cm) Browni	Capitata	Hatfield
EPTC	4	inc.	8.0	8.0	25.8	17.2	17.7
5% Gr.	8	inc.	8.5	8.7	22.7	17.4	18.3
Simazin	3	surface	6.3	5.0	19.2	17.8	20.2
4% Gr.	6	surface	9.7	8.3	29.1	22.2	25.6
CIPC	8	surface	9.3	9.0	23.9	17.7	22.0
5% Gr.	12	surface	9.3	9.0	31.4	24.6	21.0
Sesone	3	surface	7.3	7.0	31.0	18.3	20.4
Spray	6	surface	6.3	7.8	26.7	24.2	19.2
Neburon	3	surface	6.7	3.7	25.2	18.4	20.3
4% Gr.	6	surface	5.8	2.3	25.8	16.0	16.4
Falone	3	surface	7.0	7.5	22.1	17.9	19.8
10% Gr.	6	surface	5.3	6.3	23.1	22.4	18.6
DNBP	5	surface	8.0	4.3	17.8	17.1	18.9
20% Gr.	10	surface	9.3	2.7	25.1	19.8	20.2
NPA	3	surface	5.5	5.2	25.7	20.7	19.1
10% Gr.	6	surface	7.3	6.3	23.2	23.1	19.4
CDEC	6	inc.	4.6	5.5	19.4	16.6	16.7
10% Gr.	12	inc.	7.8	7.0	29.2	21.2	24.4
Controls			2.0	1.0	20.6	19.4	21.3
L.S.D. p=.05					6.3	5.6	4.7

1/ Surface application or incorporated by cultivating after treatment.

2/ 0 - No control, 10 - 100% control.

SUMMARY

Several herbicides were applied before or after the transplanting of three varieties of Taxus liners. In pre-planting treatments, CDEC and EPTC effectively controlled grasses for a 5-week period after transplanting but did not control lambsquarters and smartweed. Simazin at 3 lbs./A as a spray was more effective than 6 lbs./A as a granular application, under the dry conditions following treatment. EPTC at 8 lbs./A stunted Hatfield and Capitata yews but not Browni. Growth was not affected by the simazin or CDEC treatments.

The post-planting treatments were applied on moist soil and were followed by dry soil conditions. Control of lambsquarters, smartweed and foxtail was most effective with EPTC at 4 or 8 lbs./A, CIPC at 8 or 12 lbs./A and simazin at 6 lbs./A. DNBP at 5 or 10 lbs./A controlled the broadleafed weeds but not the grasses. No significant decrease in Taxus growth resulted from any post-planting treatment. In the Browni variety growth was generally better with better weed control. The varieties Capitata and Hatfield seemed to be more susceptible to certain herbicides than the Browni variety but further testing is needed to clarify this difference.

CONTROL OF ANNUAL WEEDS IN AZALEAS WITH GRANULAR HERBICIDES

Malcolm R. Harrison,[1] William F. Meggitt[2] and
Charles A. Dupras[3]

Azaleas which are forced in greenhouses for winter and spring sale as potted plants are usually grown in outdoor beds during some stage of their development. Normally plants propagated from soft wood cuttings in the summer are planted in outdoor beds the following spring. These plants are grown without shade, and permanent irrigation equipment is used. They are usually dug and returned to a greenhouse or storage area in the early fall. Some plants are protected with boards and mats in the field and allowed to remain out for a second year.

The beds in which these plants are grown are high in organic matter as a result of yearly additions of peatmoss. It is not uncommon for the same bed to be used for a period of 20 years or more. No successful mechanical method of controlling weeds in these plants has yet been devised. Steam and some soil fumigants have been used, but fumigation is difficult because the azaleas are planted in the early spring and taken out late in the season. The high organic content of the soil also creates a problem with some fumigants.

Data on cost of weed control are difficult to establish, and costs vary depending on the size of the plants but estimates by several growers average $1000 per acre per year. The purpose of this study was to evaluate herbicides presently available to find one which could be applied safely to azaleas and would not build-up in the bed area.

MATERIALS AND METHODS

Plots were established in South Jersey at Fischer Flowers, Linwood, in Atlantic County. The soil in this area is light and has been used for azaleas for a few years. Although one to three inches of peatmoss is added each year, the organic content of this soil was much lower than the soil in plots in North Jersey. The northern plots were located at the Julius Roehrs Company, Rutherford, in Bergen County and their fields have been used for azaleas for many years. Further some of the plants at Fischer's were left in the field over winter while those in North Jersey were taken in each fall.

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[3][illegible]

The following materials and rates were used in the trails at both locations: ethyl N, N-di-n-propylthiocarbamate (EPTC) 5 lbs. per acre; 4,6-dinitro-ortho-secondary butyl phenol (DNBP) 5 lbs. per acre; isopropyl-N-(3-chlorophenyl) carbamate (CIPC) 8 lbs. per acre; and 2-chloroallyl diethyl dithiocarbamate (CDEC) 6 lbs. per acre.

All of the above materials were applied in the granular form with attaclay as the carrier. The CIPC and EPTC were 5% active ingredient. DNBP and CDEC were each a 6% granular formulation active. In addition DNBP was applied as a 22% material, and EPTC as a 1% on vermiculite.

Four randomized replications of 40 square foot plots were used. A total of 8 different series was set up. One in 1957, 3 in 1958, and 4 in 1959. Materials were applied with a hand shaker immediately after planting in late May or June. Materials were applied when the foliage was dry, and the plants were brushed after treatment. In some of the treatments, the plants were not watered until after the herbicides were applied.

The varieties treated included five kurume varieties, Coral Bells, Hexe, Hexe De Seffalere, Hinodegiri, and Snow; one indica variety, Triemphe; and one pericat, Rose Pericat.

The soil was without visible weeds at the time of treatment. Weeds which subsequently developed in the check plot included crabgrass, lambsquarter, ragweed, purslane, and pigweed.

Plots were evaluated after a 4- to 5-week period. Weed ratings were made and foliage and growth noted. At the same time some plants were lifted, and the roots examined.

Plants from one area were tagged at digging time and stored in the same manner as the florist's operation. These plants were flowered under greenhouse forcing conditions and the flower development observed.

One series of plants in a bed which was to remain in a field over winter was treated in October for chickweed control. Rates of 2, 4, and 6 pounds of Chloro IPC were used on the variety Hexe.

RESULTS AND DISCUSSION

Weed control from CIPC and DNBP was good in all plots in all tests and lasted for 5 to 6 weeks. Control obtained with CDEC and EPTC was somewhat poorer. After 6 weeks, the weed population was not great, but existing weeds grew to considerable size and required some hand weeding. Beds which required 16 man hours per weeding operation to weed without chemicals could be weeded in 1½ hours 5 to 6 weeks after the treatment. Where chemicals were not used hand weeding was required at frequent intervals throughout the season. Table 1 is a summary

Table 1. Weed control obtained from granular applications of herbicides on azaleas, New Jersey. 1958-59.

Chemical	Plots Treated June 16 Evaluated July 18 Weed Control Per Cent	Plots Treated May 23 Evaluated June 25 Weed Control, Per Cent	Plots Treated May 23 Evaluated June 25 Weeds Per Sq. Ft.
DNBP	90.0	90.9	2.0
CIPC	94.5	92.1	0.8
CDEC	65.0	76.2	5.0
EPTC	73.8	86.0	41.0

Weed control with the 22% DNBP on vermiculite was not as good as the 6% material on attaclay which is included in the table. This was probably due to uneven distribution and lack of uniformity of particle size.

Only one case of plant injury was observed in the treatments. This occurred on the variety Hinodegiri in the EPTC plots. These plants were slightly chlorotic, but the most striking effect of the herbicide was found in the root system. Check plants had many surface roots while plants in the treated area had a deep root system with few roots near the surface.

Although there was no root retardation in the Chloro IPC experimental plots, this material applied by the grower in adjacent beds at the same rate did cause slight root retardation in one instance. In this case where injury occurred an extremely heavy rain (greater than 4 inches) followed the treatment. No chlorosis or other injury was observed on the foliage. At the end of the season it was impossible to differentiate between the treated and untreated plots. Roots at the end of the season on treated plants had outgrown the slight retardation and a root ball equal to that on untreated plants had been formed.

Plants which were dug, stored, and flowered under greenhouse conditions produced flowers similar in size and number to the check plants. Plants from only one series of plots were flowered in this way.

The Chloro IPC plots treated for winter chickweed control showed very good control of chickweed from the 4 pound rate even when the chickweed had germinated before treatment in late October.

The application of granular herbicides to azalea beds requires the development of some mechanical equipment. To this end one grower is using a Cyclone distributer driven by an electric motor run from the tractor battery. A plastic hood is used to prevent drift. Other growers are distributing

CIPC and DNBP do not present a problem of residual build-up in soil and control is usually for from 4-6 weeks. However, until more information is available, only one application per year seems advisable.

SUMMARY

1. Eight series of plots were established to determine the value of granular herbicides for weed control in azaleas. Plants were in two locations; one in northern New Jersey and one in southern New Jersey.

2. EPTC (5 lbs. per acre), DNBP (5 lbs. per acre), CIPC (8 lbs. per acre), and CDEC (6 lbs. per acre) were applied to randomized replicated plots immediately following the planting of the azaleas.

3. Varieties treated include five kurume varieties, Coral Bells, Hexe, Hexe De Seffalere, Hinodegiri, and Snow; one indica variety, Triomphe, and one pericat, Rose Pericat.

4. Weed control was best with DNBP and CIPC and lasted 5 to 6 weeks.

5. There was no injury with DNBP, CIPC, or CDEC in treated plots. EPTC did cause chlorosis and root injury. Slight root retardation was observed in adjacent beds treated with CIPC by the grower and followed by heavy rainfall.

6. In one series of trials 4 lbs. per acre of CIPC applied on a granular carrier in October gave excellent chickweed control the following spring even where chickweed had emerged before treatment.

NURSERY WEED CONTROL

George F. Runge, Jr.*

Weeding is one of the most expensive maintenance operations in a nursery. Any method which reduces the cost or frees men for other work is worth investigating and, if possible, trying on a limited scale. Chemical herbicide materials are becoming more important as the cost of weeding operations increases Selected herbicides were applied to established nursery weed control demonstration plots to determine their effectiveness.

Simazin

Simazin (8.5% granular and 1% granular) was applied on clean cultivated soil at 4, 6, and 8 pounds of actual material per acre to established nursery stock. Applications were made November 6, December 3, 1958, April 1 and 3, and June 6, 1959.

A 24 inch Lawn Beauty spreader with 36 inch wooden wheels was used for granular applications. The plywood wheels were attached in order to clear taller plants.

The following plant materials were tested with simazin at 4, 6, or 8 pounds of actual material per acre with no apparent plant injury to September, 1959.

Berberis julianae, Buxus sempervirens, Chamaecyparis juniperodies, Enkianthus campanulatus, Ilex crenata convexa, Juniperus chinensis, Juniperus chinensis pfitzeriana, Leucothoe catesbaei, Mahonia aquifolium, Paeonia sp., Picea abies, Picea pungens, Pieris japonica, Pinus mugo mughus, Rosa sp., Taxus baccata repandens, Taxus cuspidata (capitata), Taxus cuspidata expansa, Taxus media 'Brown', Taxus media 'Flushing', Taxus media 'Hatfieldi', Taxus media 'Hicksi', Taxus media 'Kelsey', Taxus media 'Stricta', Thuja occidentalis globosa, and Tsuga canadensis.

Weed control with simazin at rates of 4, 6, and 8 pounds of actual material was commercially acceptable. At 6 and 8 pounds of actual material per acre, excellent weed control (90-100%) was obtained. Plots treated during November and December, 1958, showed excellent weed control through September, 1959. Purslane (Portulaca oleracea) was not controlled by 2 and 4 pounds of actual material per acre after July, 1959; however, was controlled by 6 and 8 pounds of actual material per acre.

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Simazin applied during the winter months gave somewhat better weed control than spring or summer applications. It may be that the chemical had more time to distribute itself in the soil before weeds germinated. Because of its mode of action, it may be feasible to work simazin into the top layer of the soil. Some weed species controlled with simazin include:

Butter and Eggs (Linaria vulgaris), Carpet weed (Mollugo verticillata), Common chickweed (Stellaria media), Common knotweed (Polygonum aviculare), Curly Dock (Rumex crispus), Foxtail (Setaria lutescens), Galinsoga (Galinsoga parviflora), Grass sp., Groundsel (Senecio vulgaris), Knawel (Scleranthus annuus), Lady's Thumb (Polygonum persicaria), Mouse-ear chickweed (Cerastium vulgatum), Pigweed (Chenopodium album), Ragweed (Ambrosia artemisiifolia), and Spotted Spurge (Euphorbia supina). Purslane (Portulaca oleracea) was controlled at 6 and 8 pounds of actual material per acre.

Weeds not controlled: Bindweed (Convolvulus arvensis), Chrysanthemum weed (Artemisia vulgaris), Nutgrass (Cyperus esculentus), and Purslane (Portulaca oleracea), at 2 and 4 pounds of actual material per acre.

Atrazine

Atrazine (4% granular) was applied on clean cultivated soil to Tsuga canadensis, Taxus media 'Robusta', and Leucothe catesbaei at 4 pounds of actual material per acre in June, 1959. No plant injury was noted. Good weed control (80-90%) followed including most Purslane to September, 1959.

Diuron

Diuron (2% granular) was applied on clean cultivated soil to Tsuga canadensis, Taxus cuspidata densiformis, Taxus media 'Hicksi', and Juniperus horizontalis wiltoni during early June, 1959, at 2 pounds of actual material per acre. Good weed control (85-90%) resulted without plant injury to September, 1959. Purslane (Portulaca oleracea) was controlled. This material slightly injured Taxus sp. liners which were newly planted. These liners were in the soil for approximately one week when treated. Chlorotic symptoms appeared on the needles. The rate used was 1½ pounds of 2% actual material per acre. Plots were applied June 6, 1959.

Neburon

Neburon granular was applied at 2, 4, 5, and 8 pounds of actual material per acre. No plant injury was noted. (See plant list for simazin.) Weed control was poor to fair, at 8 pounds of actual material per acre.

Amino-triazole

Amino-triazole was applied by spraying densely growing chrysanthemum weed on a plot approximately 200 square feet. Azalea mollis plants were treated with 8 pounds of actual material per acre when the new flush of growth of chrysanthemum weed was 4 to 6 inches high. Azalea plants were dormant; however, some were purposefully soaked with spray. None of the treated azalea plants became injured, but the chrysanthemum weed (Artemisia vulgaris) and wild onion (Allium vineale) was almost totally (95-100%) killed. Later in the season a heavy growth of bindweed took over.

Summary

Simazin and atrazine granulars gave commercially acceptable weed control with no injury to the plant species tested. Diuron granular gave good weed control without injury to established nursery plants treated. Newly transplanted taxus liners showed slight chlorotic symptoms. Amino-triazole is an excellent herbicide for the control of chrysanthemum weed (Artemisia vulgaris).

Acknowledgments

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THE STATUS OF WEED CONTROL IN RED BEETS[1/]

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INTRODUCTION

Table beets are of relatively minor importance in terms of total acreage and value. However, where grown, they are an intensive high value per acre crop. Small acreages are grown for fresh market in scattered areas throughout the country. For processing, New York and Wisconsin have relatively large concentrated production areas.

Weed removal constitutes one of the major production expenses. The two most serious weed species in New York are lamb's quarters, *Chenodium album* and red root pigweed, *Amaranthus retroflexus*. Of much lesser importance are purslane, *Portulaca oleracea*, foxtails, *Setaria glauca* and *S. viridis*, and barnyard grass, *Echinochlea crusgali*.

The purpose of this paper is to bring together the research by many workers in the past several years, including current research by the authors, and to point-up the pressing needs of the table beet industry for a better herbicide.

PARTIAL REVIEW OF LITERATURE

Salt Sprays

The early attempts to find a selective herbicide for beets involved a study of chemicals particularly salts which would have a high osmotic effect and which would be toxic to many plant species. Beets were known to be relatively tolerant of this type of chemical activity. Warren (1946) reported fair success with NaCl. Dearborn (1949) reported somewhat more effectiveness from mixtures of NaC 1 and $NaNO_3$ than from either material used separately. Lamb's quarters is very similar to beets in botanical relationship and in morphology. It was not surprising, then, that this weed was not controlled by salt sprays. Although some refinements have been made in the last ten;years, on the use of salt sprays, they still have the serious weakness of being ineffective against one of the major weeds of New York beet fields.

Na TCA, Endothal and Dalapon

In the late 40's the sodium and ammonium salts of Trichloroacetic acid were introduced. They quickly found favor as grass killers. In 1948 workers with sugar beets reported crop tolerance to Na TCA. In 1950 Tibbits and Holm reported tolerance of red beets to this chemical. Sweet, *et al*,(1952) confirmed the experience of other workers that Na TCA was relatively ineffective against lamb;s quarters at rates which could be tolerated by red beets.

About the same time as Na TCA was being investigated, Endothal was also under test. Barnard and Warden (1950) reported tolerance of beets to this compound. It was found to be variable in its behavior on crops and weeds. Sweet, *et al* (1952) showed red beets to be tolerant of Endothal under a wide range of soil conditions.

Smartweed, Polygonum spp, proved to be especially susceptible to Endothal. Excellent annual grass control was generally obtained, but control of lamb's quarters proved very uncertain. Further work by many researchers confirmed these early results.

A few years after Na TCA and Endothal were first tested, Southwick (1958) reported dalapon to be very effective against annual and perennial grasses and that the chemical was tolerated to a certain extent by sugar beets. The following several seasons red beets were included in the test work with dalapon. Where annual grasses such as watergrass or barnyard grass, Echinochloa crusgali, were important problems, dalapon proved to have a definite usefulness. However, as with the many other chemicals already mentioned, lamb's quarters was not readily controlled.

Substituted Ureas

In the early 1950's substituted ureas monuron, diuron, and fenuron were introduced as herbicides which might have selective uses in crops as well as other herbicidal potentials. Sweet, et al (1952) showed that monuron (CMU) had excellent potential in weeding red beets. Since that time numerous workers have reported variable results both as to crop injury and weed control. Ries, et al (1953) showed that soil organic matter under New York conditions was a much more important factor than clay content in determining the activity of monuron onweeds and crops. These findings were substantiated by Dallyn (1954) and by Feddema (1959).

Two analogs, diuron and fenuron, are considerably less soluble and more soluble respectively than monuron. Under field conditions the former is safer on beets in wet years and less effective on weeds in dry years in comparison to monuron. Fenuron is just the opposite.

Due to the variability from field to field in activity of the substituted ureas at low rates and the low differential between crop injury and weed kill, these compounds have had relatively little commercial acceptance for red beets.

Carbamates

IPC (Isopropyl-N-phenylcarbamate) was reported as an active grass killer in the late 40's. It was tried by several investigators for selective weeding of cultivated crops with little success, primarily because of poor weed control. The 3- chloro derivative of IPC (CIPC) was soon introduced and it quickly showed promise for certain crops including red beets.

Crop response and weed control for both IPC and CIPC were variable. Ries (1952) and Danielson (1953) showed that much of this variability could be accounted for by temperature differences at and shortly after time of application. They believed the lowered effectiveness at higher temperatures could be at least partially explained by the volatility of the carbamates as reported by Anderson, et al (1952).

Although IPC and CIPC have become widely used for weeding of several crops they have the weakness of not consistently controlling lamb's quarters and red root pigweed.

In 1956 several investigators reported red beets tolerant of EDEC, another carbamate. As with the other carbamates, however, variable results were obtained.

These ranged from excellent weed control to none, and from perfect crop growth to nearly complete damage.

Danielson (1957) emphasized the need for applications immediately after planting for good weed control. He also indicated rates should be slightly higher when temperatures were above 60°F than when below 60°F. Unpublished research in New Jersey indicated that under summer temperature conditions CDEC might be toxic tored beets. Unpublished research in New York covering 1955-58 growing seasons showed red beets to be tolerant of CDEC under a wide range of soil types. No critical temperature relationships were noted.

Antognini (Jan. 1957) reported that EPTC (ethyl-di-n-propylthiolcarbamate) had possibilities for red beets. Since that time many studies have been reported with this compound on beets. Both weed control and crop response have shown extreme variability. Many of the erratic results on weeds can be eliminated, however, if the chemical is harrowed in thoroughly immediately following treating.

In those tests where annual broadleaves have been completely controlled, there has been some injury noted on table beets. Where annual grasses are the problem, there seems to be a somewhat greater margin of safety between weed control and crop damage.

1959 Field Tests

EPTC.

Since EPTC showed considerable promise for weed control in red beets, but did not have a wide safety margin, it was decided to investigate several analogs. As a result of 1958 field testing, utilising analogs 1607, 1862, 2007, 2060, 2061 and 2181 it was determined that 1607, 2060 and 2061 warranted intensive study in comparison with EPTC.

In 1959 these analogs were compared with EPTC in the field and the greenhouse in regard to crop tolerance, weed control, and longevity in the soil. Details of this study are reported in the current NEWCC Proceedings. Red beet response to the analogs is presented in Table 1.

Table 1. Ratings* of red beet response to EPTC and its analogs.

	Pounds of chemical			
	4	6	8	10
EPTC	3.0	5.0	2.0	2.0
1607	4.0	2.0	2.0	2.0
2060	7.0	6.0	4.0	3.0
2061	9.0	5.0	4.0	4.0

*9 = no effect; 7= commercially acceptable; 5= damage; 1= complete kill.

The data in table 1 are from a greenhouse test in which the appropriate amount of chemical on an area basis was sprayed on the soil surface in a small 6" x 10" flat containing about 2" of potting soil. Immediately after spraying, the soil was thoroughly mixed and, beets seeded. There were 4 replications. Ratings reported were obtained about 1 month after seeding.

The results show a decided difference in crop tolerance to the analogs, with

As far as longevity in the soil is concerned, both 2060 and 2061 were less likely to effect succeeding crops than were EPTC or 1607.

From these tests it appears that 2061 (propyl-ethyl-n-butylthiolcarbamate) warrants further intensive study for selective use in red beets.

CDEC.

In 1959 grower experience with CDEC was poor. Treatment did not influence sprouting of the beets but seriously damaged the seedlings shortly before or after emergence. The symptoms were very similar to those resulting from damping-off fungi.

Most beet plantings in New York are made in May and early June. By mid-June crop damage had been reported on several soil types including muck. The unfavorable reports came from widely separated areas. Investigations showed that crop injury was not likely to be due to faulty equipment or incorrect dosages. The trouble existed in almost every field where the chemical was used, although no trouble had been reported in previous seasons. This indicated that the chemical had been changed or the formulation altered; or that a general climatic change had occurred in 1959.

In table 2 it can be seen that temperatures were much above normal many days in 1959 during the beet planting season. In fact, on half the days between the 19th of May and the 11th of June the mean temperature was 5 or more degrees above normal. On 4 days in this period the mean temperature was mor than 10 degrees above normal.

Table 2. 1959 temperature comparisons for beet planting season.

Date	Max.	Mean	Normal	Difference
May 19	73.0	64.0	59	+ 5.0
20	89.2	78.1	59	+19.2
21	82.0	74.3	59	+15.3
22	81.5	67.3	60	+ 7.3
23	59.0	51.5	60	- 8.5
24	61.2	50.1	60	- 9.9
25	73.0	54.5	61	- 5.5
26	75.5	65.8	61	+ 4.8
27	84.5	74.0	61	+ 13.0
28	83.2	70.4	62	+ 8.4
29	81.0	68.2	62	+ 6.2
30	78.7	67.4	62	+ 5.2
31	80.0	66.5	62	+ 4.5
June 1	74.0	65.5	63	+ 2.5
2	59.1	57.0	63	- 6.0
3	74.2	62.7	63	- 0.3
4	82.0	64.5	63	+ 1.5
5	83.0	67.1	64	+ 3.1
6	79.4	66.1	64	+ 2.1
7	76.0	61.4	64	- 2.6
8	87.7	69.9	64	+ 5.9
9	87.4	72.5	65	+ 7.5
10	89.5	74.0	65	+ 9.0
11	89.5	75.4	65	+ 10.4

Although the above data stongly suggest that high temperatures could have caused the trouble in 1959, they do not eliminate the possibility that temperatures were only correlative rather than causal. If for example the chemical or its formulation were changed, these same results might have been obtained.

Several field tests on sandy loam soil were undertaken to determine the influence of formulation. Fortunately, samples were on hand from the experimental lots used in the previous years" tests starting in 1955 (none for 1957). In addition, samples from commercial 1959 usage, a granular formulation, and a special sample of liquid low in solvent were obtained. The 6 samples were compared in two factorial experiments on sandy loam soil. The rates were 4,6, and 8 lbs. of active ingredient, and were applied either on the surface immediately after seeding, or incorporated shallowly with a rake or a hand cultivator immediately before seeding. In the first test, there was good soil moisture but no additional rain fell for about 1 week after treating. In the second test light to moderate irrigation was given at frequent intervals for 2 weeks following treating. In table 3 are reported a summary of the data from test number 2.

Table 3. Summary of beet and weed response ratings to CDEC formulations.

	Average Ratings*		
Formulation	Application	Beets	Weeds.
1959 liq.	Inc.	2.2	7.0
" clay	"	2.5	6.7
" no solvent	"	2.5	6.5
1958 liq.	"	2.0	7.2
1956 "	"	2.5	6.0
1955 "	"	2.5	6.5
1959 "	Surface	6.0	5.0
1959 clay	"	5.7	4.2
1959 no solvent	"	7.2	4.7
1958 liquid	"	5.0	6.1
1956 "	"	4.2	6.7
1955 "	"	4.2	6.2
Check		9.0	1.0

*Beets: 9= normal growth; 7= commercially acceptable; 1= kill
Weeds: 1 = normal growth; 7= commercial control; 9= complete kill.

In neither test was there any correlation between formulation and crop or weed response. It is clearly evident however that performance was greatly altered by incorporation. Beets were severely damaged in these instances, and weed control was somewhat enhanced.

The formulations were also tested1/ under summer greenhouse conditions. In these tests the normally high temperatures of the greenhouse were supplemented by directing the heat from small electric radiant heaters on some of the flats. Others were shaded. Several series of tests were conducted. All rates of CDEC were more or less toxic to beets. Injury was least in the shaded flats, intermediate in the "check" flats and all plants were killed where supplemental heat was applied. Untreated flats were stunted with extra heat, but stands were good.

1/ Much of the greenhouse testing was done by Marcia Levinson.

SUMMARY

A partial review of literature is presented with special emphasis on salt sprays, TCA, endothal, dalapon, monuron, CIPC, CDEC, and EPTC for weeding red beets selectively.

Research has shown several materials to be satisfactory for annual grass control, but only limited success has been reported in controlling lamb's quarters, Chenopodium album, without risk of damage to beets.

One of the more promising compounds CDEC was extremely toxic to red beets in 1959 in New York state. Research presented tends to show that much higher than normal temperature rather than formulation, poor application or other factors was the cause of damage.

Stauffer 2061 (propyl ethyl-n-butylthiolcarbamate) proved to be as effective against weeds but much less toxic to red beets than the related EPTC.

Further work is needed in finding a safe and consistently effective herbicide where broadleaved weeds are the dominant species.

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Chemical Weeding of Carrots[1]

Charles J. Noll[2]

The use of Stoddard Solvent for weeding of carrots is a recognized commercial practice. When properly timed and used at the recommended rates weed control has been excellent and almost fool proof. The three disadvantages in the use of Stoddard Solvent are the high gallonage that must be used for each acre, its potential danger as a fire hazard and the cost. Sweet (1) reported that a number of herbicides other than Stoddard Solvent offer promise for the weeding of this crop. On the basis of his work and other reports an experiment was set up to re-evaluate Stoddard Solvent in a comparison with the more promising chemicals reported in the literature for the weeding of carrots.

Procedure

The variety Chantenay was seeded May 6, 1959. The pre-planting treatments were applied just before planting and were worked into the soil with a small cultivator. The pre-emergence treatments were applied the day after planting May 7 and the post-emergence treatments were applied May 29 at the time the carrots had their first true leaves. Individual plots were 28 feet long and 2 feet wide. Treatments were randomized in each of 8 blocks.

The chemicals were applied with a small sprayer over the row for a width of 12 inches. The growing season was favorable with rains in excess of normal and well distributed over the growing season. 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. Carrots were harvested August 27.

Results

The results are presented in table I. A number of chemicals gave as good weed control as Stoddard Solvent. These included EPTC in a pre-planting application at 6 lb., Urab at 2 1/4 lbs. in a pre-emergence application, Niagara 4512 at 4 and 6 lbs., Niagara 4556 at 4 and 6 lbs. and Niagara 4562 at 6 lbs. in a post-emergence applications.

Only with the Niagara 4512 treatment at the 6 lbs. rate was there a significant increase in the stand of carrots as compared to the plots treated with Stoddard Solvent. The only chemical to significantly reduce the stand was EPTC at the 6 lb. rate.

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Yields were significantly increased with CIPC at the 6 lb. rate in a pre-emergence application and with Niagara 4512 at 4 and 6 lbs. Niagara 4556 at 4 lb. and Niagara 4562 at 4 and 6 lbs. in the post-emergence application as compared to the plot receiving Stoddard Solvent.

A number of chemicals look promising in comparison to Stoddard Solvent for the weeding of carrots. The most promising material used in the experiment was Niagara 4512 used at the 6 lbs. rate at the time that carrots have their first true leaves.

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Table I. Weed control, plant stand and weight of carrots under chemical herbicide treatments.

Chemical	Active Rate per Acre lbs.	When Applied	AVERAGE PER PLOT *Weed Control (1-10)	Stand of Plants	Wt. Carrots lbs.
EPTC	4 lb.	Pre-planting	4.0	33.1	3.6
"	6 lb.	"	2.6	18.4	2.8
Urab	1 1/2 lb.	Pre-emergence	4.9	35.5	3.9
"	2 1/4 lb.	"	2.1	24.8	3.5
CIPC	4 lb.	Pre-emergence	4.0	54.9	7.4
"	6 lb.	"	3.3	70.8	9.9
Dinoben	3 lb.	Pre-emergence	5.3	46.6	5.5
"	4 1/2 lb.	"	4.9	44.9	5.3
Vegadex	4 lb.	Pre-emergence	6.9	53.1	3.9
"	6 lb.	"	5.6	38.8	3.7
Propazine	1 lb.	Post-emergence	5.0	41.6	3.0
"	1 lb.	"	3.4	49.9	2.7
Niagara 4512	4 lb.	Post-emergence	1.5	71.8	11.8
"	6 lb.	"	1.4	84.3	14.9
Niagara 4556	4 lb.	Post-emergence	1.3	47.8	9.3
"	6 lb.	"	1.1	31.1	5.8
Niagara 4562	4 lb.	Post-emergence	3.5	68.9	9.0
"	6 lb.	"	2.1	65.3	9.3
Stoddard Solvent	90 gal.	Post-emergence	2.0	45.5	5.5
Least Significant Difference (P = .05)			1.0	26.6	3.1
" " " (P = .01)			1.4	35.1	4.1

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

ANNUAL WEED CONTROL IN CARROTS

M.F. Trevett and William Gardner[1]

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on the control of annual broadleaf weeds and annual grasses in carrots.

Procedure

Danvers 126 carrots were planted June 12, 1959 in a sandy loam soil in rows 36 inches apart. Treatments were replicated seven times in a randomized block. Sprays were applied with one pass of a small plot sprayer, at 40 pounds pressure and 50 gallons per acre volume. All plots were cultivated throughout the season, but during cultivation the soil was not disturbed six inches on either side of the crop row. The principal weeds were: Lambs-quarters (Chenopodium album L.), Red-root pigweed (Amaranthus retroflexus L.), Wild rutabaga (Brassica rapa L.), and Barnyard grass (Echinochloa crusgalli Beauv.). Smartweed (Polygonum pensylvanicum L.) was present in the field.

Weed counts were made eight weeks after planting.

Results and Discussion

Four pounds of Karsil applied either at the cotyledonary stage or at the first true leaf stage of carrots, and the hand weeded check, produced significantly higher yields of topped carrots than planting or preplanting applications of 4, 5, or 6 pounds of DAC-893, 4 or 6 pounds of EPTC, or 4 or 6 pounds of CDEC, and the unweeded check, Table 2.

Four pounds of Karsil applied at either the true leaf stage or the cotyledonary stage of carrots, planting applications of 4 or 6 pounds of DAC-893, or 6 pounds CDEC, and both the hand weeded and unweeded check treatments, did not differ significantly

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in effect on number of carrots per 25 feet of row, Table 3. Plots receiving preplanting applications of 4 or 6 pound acre rates of EPTC had significantly fewer carrots per 25 feet of row than plots receiving either 4 pound rates of Karsil at the true leaf stage, or 4 or 6 pound rates of DAC-893 applied at planting.

The effect of treatment on weight of topped carrot is shown in Table 4. The 4 pound rate of Karsil applied at the cotyledonary stage, produced significantly larger carrots than all other treatments. Four pounds of Karsil applied at planting and the handweeded check treatment produced carrots significantly larger than planting applications of 4 or 6 pounds of DAC-893, 4 or 6 pounds of CDEC, preplanting applications of 4 or 6 pounds of EPTC, and the handweeded check.

The reasons is not immediately apparent for the low eight per topped carrot for DAC-893, EPTC, and CDEC treatments compared to the handweeded check and Karsil treatments. Presumably, the difference in weight per carrot existing between these groups of treatments resulted from either weed competition consequent to inadequate control by DAC-893, EPTC, and CDEC, or from direct growth inhibition by these herbicides. In this test the cause cannot be unequivocally isolated because weeds that survived treatment were permitted to grow to maturity. For example, although 6 pounds of DAC-893 reduced the number of broadleaf weeds by 83.1 percent, Table 5, 7.4 weeds per square foot survived to compete with the carrots, reducing weight per topped carrot from .253 pounds for the handweeded check to .083 pounds for 6 pounds DAC-893, Table 4. Six pounds DAC-893 and the unweeded check treatment did not differ significantly in effect on carrot weight, Table 4. Apparently, therefore, 7.4 broadleaf weeds per square foot are sufficient to saturate the competitive potential of carrots.

Four pounds of Karsil applied either at the cotyledonary stage or at the true leaf stage of carrots gave significantly higher broadleaf weed control than all other chemical treatments except 6 pounds DAC-893 applied at planting, Table 5. Four pounds of Karsil applied at the true leaf stage gave significantly better control than planting applications of 6 pounds DAC-893; four pounds of Karsil applied at the cotyledonary stage did not differ significantly from 6 pounds of DAC-893 applied at planting.

Preplanting application of 4 or 6 pounds of EPTC, planting application of 4 or 6 pounds of DAC-893, or 6 pounds of CDEC, and true leaf stage application of 4 pounds of Karsil, did not differ significantly in percent annual grass weed control. Preplanting application of 4 or 6 pounds of EPTC, and planting application of 6 pounds of CDEC, gave significantly better annual grass control than either 4 pounds of Karsil a pplied at the cotyledonary stage or 4 pounds of CDEC applied at planting.

In a test of three rates of Karsil and one rate of Solan, 2, 3, and 4 pounds of Karsil, 4 pounds of Solan, and the hand-weeded check treatment did not differ significantly in effect on carrot yield and produced significantly higher yields than the unweeded check treatment, Table 7.

Conclusions

Karsil applied at the rate of 4 pounds per acre either at the cotyledonary stage or at the first true leaf stage of carrots, did not differ significantly in effect on yield from hand weeding and produced significantly higher yields than preplanting applications of 4 or 6 pounds per acre of EPTC, and planting applications of 4 or 6 pounds of either CDEC or DAC-893.

Planting applications of 2, 3, or 4 pounds per acre of Karsil or 4 pounds of Solan did not differ significantly in effect on yield of carrots.

Table 1. Herbicides Used in Carrots.

Designation	Active Ingredient
CDEC	2-chloroallyl diethyldithiocarbamate
DAC-893	dimethyl 2,3,5,6-tetrachloroterephthalate
EPTC	ethyl N, N-di-n-propylthiolcarbamate
Karsil	N-(3,4-dichlorophenyl)-2-methylpentanamide
Solan	N-(3-chloro-4-methylphenyl)-2-methylpentanamide

Table 2. Carrot Yields Following Spray Application of Various Herbicides, Block A.1/

Acre rate of active ingredient	Date	Yield Pounds per acre	Rank: Yield	Rank: Annual weed control Broadleaf	Rank: Annual weed control Grasses	Rank: Number carrots per 25' row	Rank: Wt. per "topped carrot pounds
4# Karsil	True leaf 2/	22959 4/	1	2	6	1	3
4# Karsil	Coty	22262	2	3	8	7	1
Check, handweeded	--	19563	3	1	1	6	2
6# DAC-893	PL	7884	4	4	5	3	4
4# DAC-893	PL	4472	5	5	7	2	5
6# EPTC	PRE-PL	3712	6	7	3	10	6
Check, unweeded 5/	--	3654	7	10	10	5	7
6# CDEC	PL	3048	8	6	4	4	9
4# EPTC	PRE-PL	2801	9	8	2	9	8
4# CDEC	PL	1450	10	9	9	8	10
L.S.D. 5%		3576.2					

1/ Variety: Danvers 126. Planted 12 June, 1959, in a sandy loam soil.

2/ True leaf = herbicide applied at first true leaf 6 July '59; PL = applied at planting; PRE-PL = worked into top inch of soil before planting; Coty = applied at cotyledonary stage, 30 June '59.

3/ Carrots topped before weighing.

4/ Means included within brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

5/ Plots were neither handweeded nor chemically treated.

Table 3. Effect of Herbicides on Number of Carrots Per 25' of Row, Block A.

Acre rate of active ingredient		Number carrots per 25'
4# Karsil	True leaf 1/	174.6 2/
4# DAC-893	PL	152.0
6# DAC-893	PL	150.7
6# CDEC	PL	143.1
Check, unweeded 3/	--	139.2
Check, hand weeded	--	135.9
4# Karsil	Coty	134.4
4# CDEC	PL	119.9
4# EPTC	PRE-PL	113.6
6# EPTC	PRE-PL	103.1
	L.S.D. 5%	38.4

1/ Applied when carrots had developed at least one true leaf; PL = applied at planting; PRE-PL = applied before planting and worked into top inch of soil; Coty = applied at cotyledonary stage.

2/ Percent was converted to angles for statistical analysis.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 4. Effect of Herbicide on Weight Per Topped Carrot, Block A.

Acre rate of active ingredient		Weight per topped carrot pounds
4# Karsil	Coty 1/	.316 2/
Check, handweeded	--	.253
4# Karsil	True leaf	.230
6# DAC-893	PL	.083
4# DAC-893	PL	.060
6# EPTC	PRE-PL	.053
Check, unweeded 3/	--	.042
4# EPTC	PRE-PL	.039
6# CDEC	PL	.033
4# CDEC	PL	.019
	L.S.D. 5%	.050

1/ Applied when carrots had developed at least one true leaf; Coty = applied at cotyledonary stage; PL = applied at planting; PRE-PL = applied before planting and worked into top inch of soil.

2/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test.).

3/ Plots were neither handweeded nor chemically sprayed.

Table 5. Percent Annual Broadleaf Weed Control in Carrots Following Spray Application of Various Herbicides, Block A.

Acre rate of active ingredient	Date 1/	Annual broadleaf weed control Angles 2/	Annual broadleaf weed control %	Rank: Annual Grass control	Rank: Yield
Check, handweeded	--	-- 3/	100.0	1	3
4# Karsil	True leaf	83.72	98.8	6	1
4# Karsil	Coty	79.95	97.0	8	2
6# DAC-893	PL	65.72	83.1	5	4
4# DAC-893	PL	60.26	75.4	7	5
6# CDEC	PL	59.05	73.5	4	7
6# EPTC	PRE-PL	52.17	62.4	3	6
4# EPTC	PRE-PL	50.81	60.1	2	8
4# CDEC	PL	33.80	30.9	9	9
	L.S.D. 5%	12.29			

1/ Coty = applied at cotyledonary stage; True leaf = applied when first true leaf appeared; PL = applied at planting; PRE-PL = applied before planting and worked into top inch of soil.

2/ Percent was converted to angles for statistical analysis. In untreated plots: 41.5 broadleaf weeds per square foot.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 6. Percent Annual Grass Control in Carrots Following Spray Application of Various Herbicides, Block A.1/

Acre rate of active ingredient	Date1/	Annual grass control Angles2/	Annual grass control %	Rank Annual broadleaf control	Rank Yield
Check, handweeded	--	--	3/ 100.0	1	3
6# EPTC	PRE-PL	90.00	100.0	8	8
4# EPTC	PRE-PL	90.00	100.0	7	6
6# CDEC	PL	90.00	100.0	6	7
6# DAC-893	PL	72.76	91.2	4	4
4# Karsil	True leaf	60.00	75.0	2	1
4# DAC-893	PL	57.94	71.8	5	5
4# Karsil	Coty	51.35	61.0	3	2
4# CDEC	PL	44.43	49.0	9	9
L.S.D. 5%		29.46			

1/ Coty = applied at cotyledonary stage; True leaf = applied when first true leaf appeared; PL = applied at planting; PRE-PL = applied before planting and worked into top inch of soil.

2/ Percent was converted to angles for statistical analysis. In untreated plots: 1.2 annual grass plants per square foot.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 7. Carrot Yields Following Post Emergence Application of Solan and Karsil.

Acre rate of active ingredient1/	Carrots: Pounds per acre2/
4# Karsil	33684 3/
4# Solan	32625
3# Karsil	29213
Check, handweeded	29158
2# Karsil	25940
Check, unweeded4/	3654
L.S.D. 5%	11362

1/ Applied when carrots had developed at least one true leaf.

2/ Carrots "topped" before weighing.

3/ Means included within brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

4/ Plots were neither handweeded nor chemically sprayed.

CONTROL OF ANNUAL WEEDS IN SWEET CORN

M.F. Trevett and W.E. Gardner 1/

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on the control of annual broadleaf weeds and annual grasses in sweet corn.

Procedure

Carmel Cross sweet corn was planted June 2 and June 11, 1959, one to two inches deep in a sandy loam soil. Treatments were replicated seven times in randomized blocks of single row treated plots paired with untreated plots. Sprays were applied with one pass of a small plot sprayer, at 40 pounds pressure and 50 gallons per acre volume. Granular materials were applied with a Gandy small plot applicator. 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.), Red-root pigweed (*Amaranthus retroflexus* L.), and Lambs-quarters (*Chenopodium album* L.). Annual grasses present were: Barnyard grass (*Echinochloa crusgalli* Beauv.), and Foxtail (*Setaria viridis* L Beauv.). Counts of annual grass and annual broadleaf weeds were made 8 weeks after herbicides had been applied.

Rainfall data are found in Table 5.

Results

A. Spray application of herbicides.

Yields of snapped ears are in Table 2, percent broadleaf weed control in Table 3, and percent annual grass control in Table 4. On the basis of Duncan's Multiple Range Test, only the 4 and 8 pound rates of DAC-893 applied at planting produced significantly lower yields at the 5 percent level than 6# of DNBP applied

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1/ Associate Agronomist and Technical Assistant, respectively, Department of Agronomy, University of Maine.

at emergence, Table 2. No treatment produced significantly higher yields than 6# of DNBP. Two pounds per acre of Fenac M 673 A applied at planting, did not differ significantly in effect on yield from 6# of DNBP.

The results of comparisons of the herbicides tested on annual weed control are conveniently presented as follows:

Treatments Resulting in Significantly Higher Weed Control than 6# DNBP Applied at Emergence1/

Annual Broadleaf Weeds		Annual Grasses	
2# Simazin (50%)	PL2/	2# Atrazine	PL
2# Atrazine	PL	2# Simazin (50%)	PL
2# Simazin (80%)	PL	8# DAC-893	PL
		2# Simazin (80%)	PL

Treatments Resulting in Significantly Lower Weed Control than 6# DNBP Applied at Planting.

Broadleaf Weeds		Annual Grasses
1.5# DNBP + 1# Dalapon	EM1/	--
8 # DAC-893	PL	--
4 # DAC-893	PL	--

1/ Duncan's Multiple Range Test, Tables 3 and 4.

2/ EM = applied at emergence, PL = applied at planting, Spike = applied at spike stage of corn.

The low percent control of broadleaf weeds in DAC-893 plots resulted from the relative ineffectiveness of this herbicide on Brassica species which were present in abundance in this block. Treatments not significantly different from 6# DNBP in broadleaf weed control were: 2# Fenac M-673A, and 2# of Trietazine. Treatments not significantly different from 6# of DNBP in percent annual grass control were: 4# DAC-893, 2# Fenac M-673A, 2# Trietazine, and a combination of 1.5# DNBP and 1# Dalapon.

B. <u>Granular application of herbicides</u>.

On June 4, 1959, two days after planting, granular herbicides were applied in paired plots in a field in which mustards (Brassica species) and Northern Nutgrass (<u>Cyperus esculentus</u> L.) were the dominant weeds. In one series of plots the granules were worked into the soil one-half to one-inch deep with a lawn rake; in the other series the granules were left on the soil surface.

Weed control ratings were made seven weeks after herbicides were applied. Although the difference was not great, poorer weed control was obtained in "worked in" plots than in plots in which the herbicides were left on the soil surface. Because differences in weed control were not great between tillage treatments, ratings in Table 6 are the averages for all plots receiving a given herbicide irrespective of tillage treatment. CDEC, CDAA, Falone, and Amoben, at the rates used, gave extremely poor control of both mustards and nutgrass. Atrazine at 2# of active ingredient per acre gave outstanding control of both mustards and nutgrass. The greater solubility of Atrazine compared to Simazin may account for the greater effectiveness of Atrazine.

Conclusions

Two pounds per acre of Simazin, Atrazine, or Trietazine, 6# per acre of DNBP, or a combination of 1.5# DNBP and 1# Dalapon applied as sprays were statistically equivalent in effect on yield of Carmel Cross sweet corn in a field with a moderate infestation of broadleaf weeds (20 and 30 per square foot) and a low infestation of annual grasses (less than 5 per square foot). Fenac M 673A and DAC-893 were less effective in controlling Brassica species than the other herbicides.

In a test of granular herbicides, Atrazine gave better control of both Mustards and Northern Nutgrass than Amoben-M-728, Dalapon, Simazin, EPTC, Trietazine, CDEC, CDAA, Falone, or DNBP.

Table 1. Herbicides Used in Sweet Corn.

Designation	Active Ingredient
Amoben-M-728	3-amino-2,5-dichlorobenzoic acid
Atrazine	2-chloro-4-ethylamino-6-isopropylamino-s-triazine
CDAA	2-chloro-N,N-diallylacetamide
CDEC	2-chloroallyl diethyldithiocarbamate
DAC-893	dimethyl 2,3,5,6-tetrachloroterephthalate
Dalapon	2,2-dichloropropionic acid
DNBP	dinitro-o-sec-butylphenol
EPTC	ethyl N, N-di-n-propylthiolcarbamate
Falone	tris-(2,4-dichlorophenoxyethyl) phosphite
Fenac-M-673A	2,3,6-trichlorophenylacetic acid
Simazin	2-chloro-4,6-bis(ethylamino)-s-triazine
Trietazine	2-chloro-4-diethylamino-6-ethylamino-s-triazine

Table 2. Yield of Carmel Cross Sweet Corn Following Spray Application of Various Herbicides.1/

Chemical and acre rate of active ingredient	Date2/	Tons snapped ears per acre3/ 4/	Rank: Broadleaf weed control	Rank: Annual grass contr
2# Simazin (50% wettable powder)	EM	7.38	1	2
2# Simazin (80% wettable powder)	PL	7.22	3	4
2# Atrazine	PL	7.14	2	1
1.5# DNBP + 1# Dalapon	Spike	6.86	7	8
2# Trietazine	PL	6.80	6	9
6# DNBP	EM	6.62	5	7
2# Fenac M-6734	PL	5.77	4	6
4# DAC-893	PL	5.21	9	5
8# DAC-893	PL	5.06	8	3
Check	-	4.25	-	-
L.S.D.	5%	1.13		
	1%	1.50		

1/ Planted 2 June '59.

2/ EM = emergence; PL = planting; Spike = spike stage of corn.

3/ Harvested at soft dough stage of maturity.

4/ Means included within brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 3. Percent Annual Broadleaf Weed Control in Carmel Cross Sweet Corn Following Spray Application of Various Herbicides.

Chemical and Acre Rate	Date1/	Broadleaf weed control Angles2/	%	Rank Annual grass control	Yield
2# Simazin (50% wettable powder)	PL	90.00 3/	100	2	1
2# Atrazine	PL	90.00	100	1	3
2# Simazin (80% wettable powder)	PL	89.17	100	4	2
2# Fenac M-673A	PL	81.50	98	6	7
6# DNBP	EM	77.09	95	7	8
2# Trietazine	PL	72.16	91	9	5
1.5# DNBP + 1# Dalapon	Spike	54.78	67	8	4
8# DAC-893	PL	30.61	26	3	9
4# DAC-893	PL	24.04	17	5	8
L.S.D. 5%		10.07			

1/ Applications made at: Em = emergence, PL = planting, Spike = spike stage of corn.

2/ Percent was converted to angles for statistical analysis.
~~Average number of annual broadleaf weeds per square foot in untreated plots: 27.9.~~

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test.).

Table 4. Percent Annual Grass Control in Carmel Cross Sweet Corn Following Spray Application of Various Herbicides.

Chemical and Acre Rate	Date 1/	Annual grass control 2/ Angles	Annual grass control 2/ %	Rank Broadleaf control	Rank Yield
2# Atrazine	PL	83.49 3/	99	2	3
2# Simazin (50% wettable powder)	PL	80.23	97	1	1
8# DAC-893	PL	75.14	93	8	9
2# Simazin (80% wettable powder)	PL	68.20	86	3	2
4# DAC-893	PL	57.52	71	9	8
2# Fenac-M-673A	PL	54.26	66	4	7
6# DNBP	EM	34.86	33	5	6
1.5# DNBP + 1# Dalapon	Spike	26.29	20	7	4
2# Trietazine	PL	25.34	18	6	5
L.S.D. 5%		23.12			

1/ Applications made at: EM = emergence, PL = planting, Spike = spike stage of corn.

2/ Percent was converted to angles for statistical analyses. Average number of annual grass plants in untreated plots: 2.04.

3/ Means included in brackets are not significantly different at 5% level (Duncan's Multiple Range Test).

Table 5. Rainfall, Monmouth, Maine, June 1959.

Date	Inches of Rain	Date	Inches of Rain
June 1	.20	June 16	.19
2	.30	17	.51
7	.25	18	.81
8	.80	20	.07
9	.05	22	.02
12	.20	25	.05
13	.63	28	2.10
14	.92		
15	.20		

Table 6. Granular Herbicides Applied and Percent Control of Mustards and Nutgrass.

Herbicide and acre rate of active ingredient			Percent control[1/] Mustards	Nutgrass
Atrazine	2	pounds	95	50
DNBP	6	"	80	--
Simazin	2	"	70	15
Trietazine	2	"	55	--
EPTC	6	"	20	40
Dalapon	2.22	"	--	55
Amoben-M-728	6	"	--	--
CDEC	6	"	--	--
CDAA	6	"	--	--
Falone	3	"	--	--

1/ Average of all plots for each herbicide.

WEED CONTROL IN CERTAIN VEGETABLE CROPS - 1959*
(A Progress Report)

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This paper reports the results of a continuing search for satisfactory pre-emergence or selective weed killers for certain vegetable crops.

Spinach

Plots were well prepared and seeded to America spinach on May 7, 1959. The soil, a Scarborough very fine sandy loam, was relatively dry at the time of planting; only 1.04 inches of rain fell during May and 0.9 inch of this fell during the period May 11 to 14. The temperature was about normal for this period. The weed killers with their respective rates of application are listed in Table I.

Treatments were replicated four times and 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, purslane pigweed, galensoga and annual grasses.

Of the chemicals used in the test, Vegadex at 4 pounds per acre controlled weeds reasonably well and this treatment resulted in the highest yield of spinach. Applications of Chloro IPC did not control weeds well and yields were among the poorest in the test. Mixtures of Chloro IPC and Vegadex controlled weeds very well but yields of spinach were affected adversely.

Lettuce

Here again it was clear that Chloro IPC was not very effective in controlling weeds. Yields were affected adversely more apparently from weed competition than toxicity from the chemical. Vegadex treatments promoted excellent weed control resulting in some of the highest yielding plots in the test. Amoben M-729 at 2 to 4 pounds per acre promoted acceptable weed control but yields were not impressive. Where Zytron was used at rates high enough to give good control of weeds, plot yields were reduced very markedly. Mixtures of Chloro IPC and Vegadex controlled weeds very well, but unlike the results with spinach, yields of lettuce were not affected adversely by these treatments.

Set Onions

Under conditions in these tests 4 to 8 pounds of Chloro IPC per acre was not very effective in controlling weeds in plots of set onions. Weed control was not enhanced where 2 pounds of this chemical was followed by subsequent 2-pound treatments ten and twenty days following the original application. A mixture of 4 pounds of Chloro IPC and 6 pounds of Vegadex, and experimental lots of Randox T-15 and T-25 at 3 and 5.25 gallons per acre respectively resulted in fair commercial weed control with good crop yields.

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* Miscellaneous Contribution No. 1012 of the University of Massachusetts,

Table I

EFFECT OF CHEMICALS ON WEED CONTROL AND GROWTH OF SPINACH

Planted May 7, 1959-Sprayed May 8, 1959-Recorded June 6, 1959

Plot	Treatment	Weed Control 1-Poor to 9-Excellent	Height Tallest Weed Inches	Height Spinach Inches	Diameter Spinach Inches	Spinach Stand 1-Poor to 9-Excellent	Yield Lbs.
1	1.0 Lb. CIPC	2.3	4.8	3.6	6.0	7.3	14.6
2	2.0 Lbs. CIPC	4.3	4.1	3.9	6.1	3.0	17.7
3	3.0 Lbs. CIPC	4.0	4.0	3.4	5.6	7.0	12.7
4	4.0 Lbs. CIPC	5.8	3.4	3.4	5.8	5.8	15.1
5	3.0 Lbs. Vegadex	5.5	3.1	3.1	6.3	7.5	20.9
6	4.0 Lbs. Vegadex	7.3	3.1	3.8	6.6	7.3	22.9
7	5.0 Lbs. Vegadex	8.0	2.1	3.3	5.9	6.8	18.1
8	6.0 Lbs. Vegadex	8.3	1.4	2.4	5.1	5.5	13.6
9	1.0 Lb. CIPC/3 Lbs. Vegadex	7.5	2.6	3.5	6.8	7.0	19.1
10	1.0 Lb. CIPC/4 Lbs. Vegadex	8.0	2.3	2.9	6.4	6.3	16.8
11	2.0 Lbs. CIPC/3 Lbs. Vegadex	7.5	2.8	3.3	5.9	6.5	18.5
12	2.0 Lbs. CIPC/4 Lbs. Vegadex	8.0	2.0	2.4	6.0	5.5	15.9
13	3.0 Lbs. CIPC/3 Lbs. Vegadex	7.8	2.3	2.6	6.0	6.5	16.9
14	4.0 Lbs. CIPC/4 Lbs. Vegadex	8.5	1.4	2.9	5.75	6.3	14.6
15	Check	1.3	4.8	4.0	6.1	9.0	14.6
	L.S.D. @ .05	1.4	1.0	0.9	0.8	1.5	5.6
	L.S.D. @ .01	1.9	1.4	N.S.	N.S.	2.0	N.S.

TABLE II

EFFECT OF CHEMICALS ON WEED CONTROL AND GROWTH OF LETTUCE

Planted May 7, 1959-Sprayed May 8, 1959-Recorded July 15, 1959

Plot	Treatment	Weed Control 1-Poor to 9-Excellent	Height Tallest Weed Inches	Height Lettuce Inches	Diameter Lettuce Inches	Lettuce Stand 1-Poor to 9-Excellent	Number Marketable Heads	Yiel Marketa Heads-I
1	2.0 Lbs. CIPC	3.3	4.1	4.1	5.3	6.8	33.8	40.4
2	3.0 Lbs. CIPC	4.0	3.8	4.1	5.5	7.3	39.5	57.2
3	4.0 Lbs. CIPC	5.5	3.8	4.1	5.0	7.0	35.5	51.2
4	4.0 Lbs. Vegadex	7.0	2.9	4.3	5.6	7.5	40.3	66.8
5	6.0 Lbs. Vegadex	8.5	1.1	4.1	5.3	6.0	39.3	62.0
6	8.0 Lbs. Vegadex	8.8	0.6	3.6	5.5	6.5	38.0	61.8
7	2.0 Lbs. Amoben (M-729)	6.8	2.5	3.4	4.9	7.0	36.0	52.5
8	3.0 Lbs. Amoben (M-729)	7.5	2.4	3.6	4.8	6.3	35.8	49.5
9	4.0 Lbs. Amoben (M-729)	7.8	2.3	3.4	5.0	5.0	35.0	53.1
10	5.0 Lbs. Zytron	5.8	3.1	3.6	4.9	6.5	37.5	55.5
11	10.0 Lbs. Zytron	7.8	2.1	2.3	3.3	3.3	24.3	35.4
12	15.0 Lbs. Zytron	8.5	1.5	2.0	3.3	1.5	20.3	29.8
13	2.0 Lbs. CIPC/3 Lbs. Vegadex	7.8	2.3	4.0	5.6	6.3	38.3	64.3
14	2.0 Lbs. CIPC/5 Lbs. Vegadex	8.3	1.4	3.6	5.6	7.0	40.3	62.2
15	Check	1.0	5.8	4.3	5.8	9.0	30.5	38.4
	L.S.D. @ .05	1.1	1.1	0.8	0.9	1.4	5.9	15.7
	L.S.D. @ .01	1.4	1.4	1.1	1.2	1.8	7.9	21.0

TABLE III

EFFECT OF CHEMICALS ON WEED CONTROL AND GROWTH OF SET ONIONS
Planted May 5, 1959-Sprayed May 6, 1959-Recorded June 12, 1959

Plot	Treatment	Weed Control 1-Poor to 9-Excellent	Height Tallest Weed Inches	Marketable Yield Lbs.
1	4.0 Lbs. CIPC	4.3	6.1	29.6
2	6.0 Lbs. CIPC	4.8	6.0	33.3
3	8.0 Lbs. CIPC	6.3	4.9	28.6
4	2.0 Lbs. CIPC Repeat in 10 Days	5.0	6.5	28.2
5	2.0 Lbs. CIPC Repeat in 10 & 20 Days	6.3	4.9	28.9
6	2.0 Lbs. CIPC/3 Lbs. Vegadex	4.8	5.1	32.7
7	4.0 Lbs. CIPC/6 Lbs. Vegadex	7.3	3.8	32.2
8	6.0 Lbs. Randox	4.8	5.4	28.3
9	0.75 Gals. Randox T-15	3.0	7.0	30.5
10	1.50 Gals. Randox T-15	6.0	4.8	29.5
11	3.00 Gals. Randox T-15	7.8	2.5	32.1
12	1.30 Gals. Randox T-25	2.5	8.4	28.7
13	2.625 Gals. Randox T-25	3.8	5.8	32.4
14	5.250 Gals. Randox T-25	7.0	3.8	28.6
15	Check	1.0	12.4	16.6
	L.S.D. @ .05	1.2	1.3	5.9
	L.S.D. @ .01	1.6	1.8	7.9

TABLE IV

EFFECT OF CHEMICALS ON WEED CONTROL AND GROWTH OF ASPARAGUS
Plots Disced May 11, 1959-Sprayed May 12, 1959-Recorded June 8, 1959

Plot	Treatment	Weed Control 1-Poor to 9-Excellent	Yield Marketable Spears
1	1.6 Lbs. CMU	3.0	2921
2	2.4 Lbs. CMU	3.5	2812
3	3.2 Lbs. CMU	4.8	2732
4	2.5 Lbs. Atrazine	3.8	2268
5	5.0 Lbs. Atrazine	6.3	2566
6	7.5 Lbs. Atrazine	7.5	2867
7	4.0 Lbs. Eptam	6.3	2754
8	8.0 Lbs. Eptam	7.0	2877
9	15.0 Lbs. Eptam	8.5	2652
10	4.0 Lbs. Simazine	5.5	2897
11	8.0 Lbs. Simazine	7.3	2443
12	Check	1.0	2703
		1.6	N.S.
		2.1	N.S.

Asparagus

Results of the tests with asparagus are presented in Table IV. It is clear that CMU was not very effective in controlling annual weeds even at 3.2 pounds per acre. CMU has been applied to these plots for four consecutive years. It seems possible that bacterial decomposition of the chemical may account for its present poor weed killing properties. Atrazine at 7.5 pounds, Eptam at 8.0 and 15.0 pounds and Simazine at 8.0 pounds per acre all gave fairly good weed control. Weeds that were not controlled in these plots consisted mainly of volunteer asparagus seedlings and crabgrass.

Carrots

Several early plantings of carrots were washed out by heavy rains and the results described here were obtained from a late planting where the season was too short to mature the crop. The following post emergence treatments were employed; Geigy-30031 at 1.0, 1.5, and 2.0 pounds, Niagara 4562 at 2.0, and 4.0 pounds and Stoddard Solvent at 100 gallons per acre. Practically all annual broad leafed weeds were controlled well by all of the treatments. Crabgrass was the only weed which presented a problem in these tests except where repeat applications of Niagara 4562 were made thirteen days after the original treatments. These showed excellent control of crabgrass up until two months after planting time. The Stoddard Solvent treatment also gave comparable control of crabgrass. None of the treatments appeared to effect the stand or top growth of the carrot crop adversely.

Beets

Beets seeded on July 1 with Vegadex, Randox, Endothal and Urab were subjected to very heavy rains and soil washing so that yield records were not taken. Urab at 1.5 and 3.0 pounds pre-emergence per acre gave perfect weed control but decimated the crop. It appeared that Vegadex at 6 pounds, Randox at 6 pounds and Endothal at 9.0 pounds per acre were worthy of further trials on beets.

Tomatoes

Post emergence tests at lay-by indicate that Niagara 4512 provides a very promising herbicide for tomatoes. Applications of 2.0 and 4.0 pounds per acre just after cultivation prevented weed growth for about one month. Treatments with Kloben, 4-8 pounds; Amoben, 4 pounds; Eptam, 4 pounds; and Neburon, 4-8 pounds gave poor weed control but did not reduce yields.

Pre-emergent and Post-hilling Weed Control Tests with Katahdin Potatoes, 1958-59[1]

R. S. Bell and Erling Larssen[2]

Progress in scientific chemical weed control in Irish potatoes demands the testing of new materials as they are developed, although satisfactory herbicides now exist for pre-emergent applications. Economical post-hilling weed control is yet to be attained but new materials look promising. Cultivation continues to be a satisfactory way of controlling annual weeds before hilling the potatoes.

Among the herbicides in the pre-emergent testconducted in Rhode Island were Amiben, Dinoben, Fenac, Atrazine, Propazine, Simazine, Trietazine, Falone and its derivative B528, Urab, DNBP, Dalapon, Eptam and Emid. Chemical names and sources of these chemicals are listed in the appendix. Percentage of active toxicant is included in the yield tables.

Soil in test plots is Bridgehampton silt loam. Potatoes were planted in mid-April with one ton per acre of 8-12-12-2, low chloride fertilizer, in bands. Four replicates of each treatment were randomly located in the experimental area. Each plot was five rows wide and 40 feet long. Pre-emergent and post-hilling tests were adjacent to each other. Post-hilling tests received regular tractor cultivation during late May and June. This allowed an excellent comparison of standard cultivation versus chemical control. In the pre-emergent test four hand-hoed checks were also maintained. Both pre-emergent herbicides were applied May 15, about five days before the potatoes came up. Application of post-hilling potato plots were hilled about July 1.

Pre-emergent herbicides were applied May 15, about five days before the potatoes came up. Application of post-hilling herbicides occurred soon after the hilling operation.

Amounts of herbicide necessary for each plot were measured and sprayed individually onto the proper plot with a knapsack sprayer. Fifty gallons of water per acre were used with the slightly soluble chemicals, while 30 gallons were sufficient for the readily soluble herbicides. Dry materials were mixed with coarse sand to allow more even distribution by hand.

Pre-emergent Tests - 1958

Table 1 shows amounts of herbicides, yields of potatoes, and weed control ratings.

At the time of application soil was cool and moist. In some areas the field spurry, (Spurgula arvensis), and common chickweed, (Stellaria media), had germinated. Eptam, Emid and Dinoben slowed the growth of these seedlings only temporarily. Eptam and Dinoben delayed further germination of seeds and ultimately were more effective than Emid under conditions of this experiment. No particular difference in weed suppression was obtained with 3, 6 or 9 pounds of Dinoben per acre.

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[1]Contribution No. 986. Rhode Island Agricultural Experiment Station.
[2]Associate Professor and Graduate Assistant, respectively.

Table 1. Average Yields of Katahdin Potatoes, Pre-emergent Weed Control Test, Corn Acre, 1958.

Herbicide	Concentration	Pounds Active Toxicant/A	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	Rating July 1*
No cultivation			289	28	1.071	0.0
Dinoben	80% W	7.2	316	24	1.070	7.3
Propazine	50% W	2.0	316	22	1.065	9.7
Emid	75% W	1.5	332	30	1.072	2.8
Dinoben	80% W	4.8	350	29	1.071	8.3
Eptam	6 lbs./gal.	6.0	372	34	1.070	8.1
Dinoben	80% W	2.4	386	31	1.074	7.5
DNBP	3 lbs./gal.	3.0	404	34	1.070	9.2
DNBP + Dalapon		2.0+1.7	407	32	1.067	9.5
Trietazine	50% W	2.0	409	39	1.071	9.9
Hand-hoed Check		-	425	37	1.071	8.9
Tractor Cultivation		-	500	-	-	-
L.S.D. at 0.05			86			

*0 = no control; 10 = complete control - Mostly broad leaved weeds such as spurry, common chickweed, Lady's thumb and purslane with a trace of hairy crabgrass.

Propazine, DNBP, DNBP+Dalapon, and Trietazine were highly effective in weed suppression. Annual grasses were not a problem in any of the plots.

Lowest yield of potatoes, 289 bushels of U.S. #1 tubers per acre, was obtained from plots not cultivated until July 1. Highest yield was 500 bushels from plots which were cultivated three times by a tractor and standard 2-row cultivator. Since a difference of 86 bushels per acre is necessary for significance at the 5 percent level, it cannot be said that increasing amounts of Dinoben decreased the yields. But a trend must exist for the yields for 2.4, 4.8 and 7.2 pounds active toxicant per acre were 386, 350 and 316 bushels per acre, respectively. Propazine at the 2 pound rate also depressed yields, but the low yields where Emid was applied was probably due to poor weed suppression. The tractor cultivated checks averaged 500 bushels U.S. #1 potatoes per acre which is significantly more than from the chemical treatments, DNBP, DNBP+ Dalapon and Trietazine. These averaged 404, 407 and 409 bushels per acre, respectively.

Pre-emergent Tests - 1959

The area selected for weed control tests in 1959 had a past history of heavy infestation with barnyard grass, (Echinochloa crus-galli), and lady's thumb, (Polygonum persicaria). In addition, a mixture of Hungarian and Japanese millet were broadcast over the area and stirred in with a weeder before application of the herbicides.

Table 2 presents herbicides used, yields per acre and weed control ratings. The Fenac compounds caused severe epinasty of potato plants and allowed yields of only 60-69 bushels per acre. At the same time control of grass and dicot weeds was unsatisfactory. Falone gave good control of grasses but the potatoes were smothered by lady's thumb, (*P. persicaria*). Similar results were obtained from the Falone derivative, B528. Weed suppression with Urab was fairly good but potato yields were depressed.

Table 2. Average Yields Pre-emergent Weed Control Tests in Katahdin Potatoes, 1959.

Herbicide	Concentration	Active Toxicant Lbs./A	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	June 24 Weed Rating* Dicots	June 24 Weed Rating* Annual Grasses
Fenac W-673	1½ lbs./gal.	2	60	17	1.061	5.5	5.2
Fenac M-816A	10% on clay	2	69	12	1.058	7.8	5.8
Falone	4 lbs./gal.	4	191	10	1.062	0.8	9.0
Urab	2% on clay	2	204	12	1.064	8.5	8.0
Delayed Cultivation		-	246	10	1.066	0.0	0.0
B528	4 lbs./gal.	4	251	14	1.064	1.0	8.2
Amiben 729	2 lbs./gal.	2	276	13	1.067	6.8	3.0
Simazine	50% W	2	348	15	1.065	10.0	9.5
DNBP	3 lbs./gal.	3	350	11	1.065	10.0	4.5
Hand-hoed check		-	361	15	1.065	10.0	10.0
Trietazine	4% on clay	2	368	16	1.068	9.2	7.5
Atrazine	50% W	2	383	13	1.065	9.8	9.0
Trietazine	50% W	2	388	15	1.066	8.5	6.5
DNBP+Dalapon	10% Dal. on clay	2+2.46	434	14	1.069	9.8	9.3
DNBP+Radapon	Dalapon 82%	2+2.46	440	12	1.064	9.8	9.5
Tractor Cultivation		-	486	13	1.070	10.0	10.0
L.S.D. at 0.05			64				

*0 = no control; 10 = complete control.

Amiben and DNBP did not satisfactorily suppress the growth of annual grasses. DNBP gave excellent control of the broad leaved weeds but Amiben was only fair in this respect.

Average yield from the hand-hoed checks was only 361 bushels per acre of U.S. No. 1 potatoes, while those receiving 3 cultivations by tractor yielded 486 bushels. This amount was very close to the 500 bushel yield in 1958. Soil in the hand-hoed checks appeared more compact in 1959 than in 1958 when less difference was found between the two methods of cultivation.

Potatoes sprayed with DNBP and Dalapon yielded significantly more than hand-hoed checks. Control of dicots and grasses was satisfactory. Control with Trietazine spray was not quite as good as during the two previous seasons. The granular preparation was somewhat more effective than the spray. Excellent weed control was achieved with Simazine and Atrazine with yields comparable to those

Summary of Pre-emergent Tests, 1958-59

DN3P alone, or accompanied by Dalapon, where annual weeds were a problem, produced satisfactory weed control without depression of potato yields. Three tractor cultivations produced high yields of potatoes andexcellent control of annual weeds. Of the newer materials Atrazine, Simazine and Trietazine produced satisfactory suppression of the annual weeds and at the rates used yields were similar to those from the hand-hoed checks.

Post-hilling Tests - 1958

Table 3 gives amounts of herbicides, bushels per acre of U. S. No. 1 potatoes and grassy weed rating on September 8. There were very few annual weeds, except crabgrass, even in the check plots. Diuron, Trietazine and Falone produced good suppression of the crabgrass. Emid and Simazine did not rate as high.

Table 3. Average Yields, Katahdin Potatoes, Post-hilling Weed Control, Corn Acre, 1958.

Herbicide	Concentration	Pounds Active Toxicant	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	Rating Sept. 8*
Diuron	80% W	1.6	433	25	1.069	8.8
Sesone	80% W	2.4	436	25	1.066	8.0
Trietazine	50% W	2.0	444	24	1.068	8.8
Emid	85% W	1.5	463	30	1.073	7.0
Simazine	50% W	2.0	463	26	1.069	7.5
Falone	2 lbs./gal.	4.0	464	23	1.069	8.5
Falone	10% Verm.	4.0	477	26	1.070	8.8
Check	-	-	500	31	1.071	6.8
L.S.D. at 0.05			39			

*0 = no control; 10 = complete control.

Potatoes sprayed with Diuron at the rate of 1.6 pounds of active toxicant showed foliar yellowing for about three weeks after treatment. The difference necessary for significance at the 5 per cent level is 30 bushels of U. S. No. 1 potatoes. Statistically, the yields from plots sprayed with Diuron, Sesone or Trietazine were lower than the checks, which averaged 500 bushels per acre. Falone, used either as a spray or on vermiculite, reduced the crabgrass stand considerably without significantly lowering the potato yields.

Post-hilling Tests - 1959

Immediately after hilling, a mixture of Japanese and Hungarian millets were broadcast over the area to insure the presence of some annual grasses. Much of the millet seed did not germinate until after potatoes were dug in September.

Table 4 shows amounts of herbicides, bushels per acre of U. S. No. 1 tubers and the grass ratings. Atrazine at 2 pounds of active toxicant per acre severely repressed potato yields and the weeds. The Atrazine spray yellowed some of the older leaves. These disintegrated quickly and signs of the damage disappeared. Atrazine on clay was not as damaging as the spray form. Potatoes in this later treatment averaged only 233 bushels per acre of U. S. No. 1 tubers compared to 486 bushels from the check plots.

Table 4. Average Yields Post-hilling Weed Control Test in Katahdin Potatoes, 1959.

Herbicide	Concentration	Active Toxicant Lbs./A	Bu/A U.S.#1	Bu/A U.S.#2	Specific Gravity	Control* Annual Grasses
Atrazine	50% W	2	223	14	1.063	9.2
Atrazine	4% on clay	2	331	12	1.061	9.0
Urab	2% on clay	2	362	12	1.064	8.0
Fenac M 816A	10% on clay	2	374	19	1.064	7.8
Radapon	82% Dalapon	2.46	391	15	1.069	8.5
B528	10% on clay	4	394	19	1.068	8.0
B528	4 lbs./gal.	4	403	22	1.070	8.0
Dalapon	10% on clay	2.46	413	15	1.071	8.8
Simazine	50% W	2	424	18	1.069	9.5
Amiben	2 lbs./gal.	2	426	12	1.069	7.8
Falone	10% on clay	4	433	15	1.067	7.8
Trietazine	50% W	2	456	15	1.069	9.5
Trietazine	4% on clay	2	475	15	1.071	9.5
No Treatment	—	—	486	13	1.070	6.2
Falone	4 lbs./gal.	4	508	16	1.067	8.8
L.S.D. at 0.05			20			

*0 = no control, 10 = complete control.

Potatoes from plots treated with Urab, Fenac, Dalapon, B528, Simazine, Amiben and Falone on clay suffered moderate depression in yields compared to the check. Plots receiving Trietazine on clay yielded 475 bushels compared to 486 from the check. Yields from potatoes sprayed with Falone was 508 bushels per acre. In 1959 Trietazine on clay at rates of 2 pounds of toxicant per acre and Falone spray at 4 pounds produced satisfactory control of crabgrass without suppressing potato yields.

Summary of Post-hilling Tests, 1958-59

Good control of grassy weeds with Falone and Trietazine occurred during both seasons with none to slight depression of yields. While dictos were not numerous to be rated during the past two years, it is known from pre-emergence tests that Trietazine will suppress both broad-leaved and grassy weeds while Falone principally effects the grasses. Some other herbicides such as Amiben, Simazine, B528, Dalapon, Fenac, Urab, and Atrazine produced from slight to severe

Concluding Statement

Pre-emergent herbicides such as DNBP+Dalapon will satisfactorily control weeds up to time of hilling. In the Bridgehampton silt loam soil mechanical cultivation still produces satisfactory weed control and maximum yields of tubers. Potatoes in Rhode Island are normally cultivated three to four times before hilling. It is possible that with an inexpensive pre-emergent herbicide one cultivation in mid-June would be sufficient to improve soil tilth. This point needs investigation since heavier equipment and increased compaction is the trend in commercial potato growing areas.

Post-hilling weed control is a more pressing need in commercial fields. Trietazine at 2 pounds toxicant per acre has produced good control of broad-leaved and grassy annual weeds with none to slight depression of yields. Falone has performed satisfactorily on weedy grasses.

Appendix: Chemical Constituents of Herbicides for Potatoes.

1. DNBP (Dow Premerge) Alkalamine salt dinitro - o-sec-butylphenol
2. Eptam (Stauffer) Ethyl N,N-di-n-propylthiolcarbamate
3. Diuron (DuPont) 3-(3,4-dichlorophenyl)-1,1 dimethyl urea
4. Emid (Am. Chem.) 2-4-dichlorophenoxyacetamide
5. Dalapon (Dow) 2, 2-dichloropropionic acid
6. Simazine (Geigy) 2-chloro-4,6 bis (ethylamino)-S-triazine
7. Sesone (Carbide) sodium 2-(2,4-dichlorophenoxy ethyl sulfate)
8. Trietazine (Geigy) 2-chloro-4,6-ethylamino-o-diethylamino-s-triazine
9. Propazine (Geigy) 2-chloro-4,6-bis-(isopropylamino)-S-triazine
10. Falone (Naugatuck) Tris-(2,4-dichlorophenoxyethyl phosphite)
11. Dinoben (Am. Chem.) 3-nitro,2,5-dichloro benzoic acid
12. Amiben (Am. Chem.) 3-amino, 2,5-dichlorobenzoic acid
13. Fenac (Am. Chem.) 2,3,6-trichlorophenylacetic acid
14. Atrazine (Geigy) 2-chloro-4 (isopropylamino)-6-(ethylamino)-S-Triazine
15. 3528 (Naugatuck) A Falone Derivative.

CONTROL OF ANNUAL WEEDS IN POTATOES

M.F. Trevett, H.J. Murphy, and William Gardner[1/]

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on the control of annual broadleaf weeds and annual grasses in potatoes.

Procedure

Katahdin potatoes were planted in a loam soil May 26, 1959. Seed pieces were spaced 12 inches in rows 42 inches apart. Treatments were replicated nine times in a randomized block of single row treated plots paired with untreated plots. Sprays were applied with one pass of a small plot sprayer at 40 pounds pressure and 50 gallons per acre volume. Potatoes were hilled three times. The final hill was 22 inches wide at the base, 10 inches high, and 8 inches wide at the top.

The principal broadleaf weeds were: Wild Rutabaga (Brassica rapa L.); Red-root pigweed (Amaranthus retroflexus L.); and Lambs-quarters (Chenopodium album L.). Annual grasses present were: Barnyard grass (Echinochloa crusgalli L.) and Foxtail (Setaria viridis L.). Counts of annual grass and annual broadleaf weeds were made the week of July 20, 1959, 8 weeks after herbicides had been applied.

Results and Discussion

Three pounds DNBP plus 2.22 pounds dalapon per acre applied at emergence, gave significantly higher yields than all other treatments except planting applications of 6 and 8 pounds of DAC-893 and 2 and 4 pounds of trietazine, Table 2. Although a difference in plant size was not reflected in a significant reduction in yield, potato plants in plots that had received 4 pounds of trietazine were smaller than potato plants in plots that had received either 2 pounds of trietazine or 6 or 8 pounds of DAC-893, or 3 pounds DNBP plus 2.22 pounds of dalapon. Rank in

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yield corresponds, in general, to the rank for broadleaf weed control for the various treatments, Table 2. Treatments that gave excellent broadleaf control produced the highest yields, whereas, treatments that gave excellent annual grass control but low broadleaf control produced the lowest yields. This relation is a consequence of the dominating role of broadleaf weeds in determining yields in this particular field. In untreated plots, broadleaf weeds averaged 31 per square foot; annual grasses averaged 1.1 per square foot.

Three pounds of DNBP plus 2.22 pounds of dalapon resulted in better broadleaf weed control than all other treatments except 4 pounds of trietazine and 6 pounds of DAC-893 (8 pounds of DAC-893 did not differ significantly from 6 pounds of DAC-893), Table 3. One pound of trietazine did not satisfactorily control either red-root pigweed or lambs-quarters; at all rates, DAC-893 did not adequately control the Brassica species present. Three and one-third and 6.5 pounds of HCA; 4, 6, and 8 pounds of DAC-893; 6 pounds of EPTC; 3 pounds DNBP plus 2.22 pounds of dalapon; and 4 pounds Falone did not differ significantly in annual grass control, Table 4.

Yields and percent weed control for Fenac-673-A applied at planting, and for Amoben-M-728 applied at planting and worked into the top inch of soil, have not been included in the tables. Fenac-673-A at rates of 1 and 2 pounds of active ingredient per acre applied at planting, gave poor control of Brassica and excellent control of other broadleaf weeds present (99%), and mediocre control of annual grass (43.0%). Both the 1 pound and the 2-pound rates of Fenac-673-A severely injured the crop, resulting in yields numerically but not statistically lower than check (154.9 bushels per acre for check, 127.2 bushels per acre for 1 pound Fenac-673-A). Six pounds active ingredient of Amoben-M-728 applied at planting and worked into the soil, gave 39.0 percent control of broadleaf weeds and 43.5 percent control of annual grasses. Crop injury was not detected in Amoben plots; yields were numerically but not statistically lower than for check plots (148.7 bushels per acre for Amoben, 154.9 bushels per acre for check).

Weed counts were made the week of July 20, 1959 (eight weeks after planting). On August 23, 1959 (thirteen weeks after planting) weeds that had germinated since the week of July 20, 1959, were from 1 to 6 inches tall in the 3 pound DNBP plus 2.22 pounds dalapon plots and were 1 inch or less in height in the 4 pound trietazine and 6 and 8 pounds DAC-893 plots. At these rates, trietazine and DAC-893 have a longer residual period of control and inhibition than DNBP plus dalapon.

Conclusions

To adequately control the relatively broad spectrum of weeds present in most fields, many candidate as well as many established herbicides need reinforcing. The usually satisfactory total control of annual weeds obtained in potatoes with a mixture of DNBP and dalapon, for example, results from combining the effectiveness of DNBP on broadleaf weeds with the effectiveness of dalapon on grasses.

To ensure adequate, total control of annual weeds in fields in which both annual broadleaf weeds and annual grasses are present, HCA and EPTC in most situations, and DAC-893 where Brassica species are present, need reinforcement with a predominantly broadleaf herbicide. Trietazine needs reinforcement with a graminicide.

Six and 8 pounds of DAC-893 and four pounds of trietazine, in the test reported in this paper, gave a longer period of residual control and inhibition of annual weeds than 3 pounds of DNBP plus 2.22 pounds of dalapon.

Table 1. Herbicides Used in Potatoes.

Designation	Active Ingredient
Amoben-M-728	3-amino-2,5-dichlorobenzoic acid
DAC-893	dimethyl 2,3,5,6-tetrachloroterephthalate
Dalapon	2,2-dichloropropionic acid
DNBP	dinitro-o-sec-butylphenol
DOW M-1329	O-2,4-dichlorophenyl-o-methyl isopropyl-phosphoramidothioate
EPTC	ethyl N,N-di-n-propylthiolcarbamate
Falone	tris-(2,4-dichlorophenoxyethyl) phosphite
Fenac-M-[illegible]73-A	2,3,6-trichlorophenylacetic acid
HCA	hexachloroacetone
Trietazine	2-chloro-4-diethylamino-6-ethylamino-s-triazine

Table 2. Yield of Katahdin Potatoes Following Planting and Emergence Spray Application of Various Herbicides.1/

Acre rate of active ingredient		Bushels per acre 3/	Rank: Yield	Rank: Annual weed control, Broadleaf weed	Rank: Annual weed control, Grasses
3# DNBP + 2.22# Dalapon	EM 2/	426.0	1	1	5
6# DAC-893	PL	389.6	2	3	6
8# DAC-893	PL	380.9	3	4	2
2# Trietazine	PL	364.7	4	5	11
4# Trietazine	PL	356.2	5	2	9
1# Trietazine	PL	315.8	6	7	12
4# DAC-893	PL	296.9	7	6	3
4# Felone	PL	283.9	8	8	7
6# EPTC	PL-W	246.7	9	9	4
6.5# HCA	EM	236.7	10	12	1
3# DOW 1329	PL	213.4	11	10	10
3.3# HCA	EM	206.8	12	11	8
Check	--	154.9	13	13	13
L.S.D. 5%		68.8			

1/ Planted 26 May, 1959.

2/ EM = applied at emergence; PL = applied at planting; PL-W = worked into top inch of soil immediately after planting.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 3. Percent Annual Broadleaf Weed Control in Katahdin Potatoes Following Pre-Emergence Spray Application of Various Herbicides.

Acre rate of active ingredient	Date 1/	Annual broadleaf control: Angles 2/	Annual broadleaf control: Percent	Rank: Annual grass control	Rank: Yield
3# DNBP + 2.22# Dalapon	EM	83.36 3/	98.6	5	1
4# Trietazine	PL	81.54	97.8	9	5
6# DAC-893	PL	67.57	85.4	6	2
8# DAC-893	PL	66.62	84.2	2	3
2# Trietazine	PL	61.95	77.9	11	4
4# DAC-893	PL	55.45	67.8	3	7
1# Trietazine	PL	39.46	40.4	12	6
4# Falone	PL	33.12	29.8	7	8
6# EPTC	PL-W	30.12	25.2	4	9
3# DOW 1329	PL	29.12	23.7	10	11
3.3# HCA	EM	18.06	9.6	8	12
6.5# HCA	EM	17.29	8.8	1	10
L.S.D. 5%		13.22			

1/ EM = applied at emergence; PL = applied at planting; PL-W = worked into top inch of soil immediately after planting.

2/ Percent converted to angles for statistical analysis.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 4. Percent Annual Grass Control in Katahdin Potatoes Following Pre-Emergence Spray Application of Various Herbicides.

Acre rate of active ingredient	Date 1/	Annual grass control: Angles 2/	Annual grass control: %	Rank: Annual broadleaf control	Rank: Yield
6.5# HCA	EM	77.35	95.2	12	10
8# DAC-893	PL	71.03	89.4	4	3
4# DAC-893	PL	65.35	82.6	6	7
6# EPTC	PL-W	63.72	76.8	9	9
3# DNBP + 2.22 Dalapon	EM	59.20	73.8	1	1
6# DAC-893	PL	56.95	70.3	3	2
4# Falone	PL	55.72	68.3	8	8
3.3# HCA	EM	49.46	57.7	11	12
4# Trietazine	PL	29.77	24.7	2	5
3# DOW 1329	PL	26.35	19.7	10	11
2# Trietazine	PL	25.10	18.0	5	4
1# Trietazine	PL	21.54	13.5	7	6
L.S.D. 5%		23.26			

1/ EM = applied at emergence; PL = applied at planting; PL-W = worked into top inch of soil immediately after planting.

2/ Percent was converted to angles for statistical analysis.

3/ Means included in brackets are not significantly different at the 5% level (Duncan's Multiple Range Test).

CONTROL OF NORTHERN NUTGRASS WITH EPTAM AND ATRAZINE*

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In the past few years Northern Nutgrass (Cyperus esculentus) has become a serious weed pest, by reducing yields and increasing production costs in fields of potatoes, corn and vegetable crops.

Recent experimental work by Rhan in Delaware (2) has shown that Eptam at 5 and 10 pounds per acre gave significant control of Northern Nutgrass.

Atrazine (2-chloro-4-isopropylamino-6-ethylamino-5-triazine), a new triazine compound, was found to be more active on emerged weeds than Simazine in New York by Flanagan (1).

Accordingly tests were made to determine the effect of Eptam and Atrazine on nutgrass growing in Massachusetts.

The results of testing these two chemicals are presented in this paper.

Materials and Methods

The plots were located on a fine sandy loam with a pH of 4.5 and an organic matter content of 4 to 5 per cent. All treatments were replicated four times in a randomized block design. The plot size was 12 feet by 15 feet. Eptam, a 6 pounds/gallon emulsifiable concentrate, and Atrazine, a 50 per cent wettable powder, were diluted with water and applied at the rate of 100 gallons per acre. The sprays were applied with a Brown Open-Head No. 4 hand pressure sprayer fitted with a No. 8004 Spraying Systems Tee Jet, fan-type nozzel. The methods and time of application, together with the rate of active material used per acre, will be found in Tables I, II, and III.

The soil was quite dry at the time of applying the weed killers in the pre-emergence tests. In the post-emergence test, however, a moderate rain occurred just following application of the chemicals. In both pre-emergence tests the soil was thoroughly disced in two directions immediately after the chemicals were applied.

The area was populated with a very dense stand of Northern Nutgrass.

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* This project was financed in part by funds from Northeastern Regional Project NE-42, "Studies of the Life History of Northern Nutgrass (Cyperus esculentus) as Related to Possible Methods of Control".

** Thanks are due to the Geigy Chemical Corp. and the Stauffer Chemical Co. who supplied the herbicides.

Miscellaneous Contribution No. 1006 of the University of Massachusetts,

Results

The effects of the 1958 Eptam applications on the development and control of nutgrass during the 1959 growing season are presented in Table I.

Table I. Effects of Eptam on Northern Nutgrass When Applied on September 4, 1958 Incorporated into the soil.
(Four Replications)

Herbicide	Rate/Acre Lbs. Active	Control Ratings 1 Poor to 9 Excellent 5/28/59	7/15/59	8/21/59
Eptam	10.0	2.25	1.00	1.00
"	20.0	6.00	6.00	5.00
"	40.0	8.75	8.50	8.25
Check	--	1.00	1.00	1.00
L.S.D. .05		1.36	0.45	0.77
.01		1.95	0.65	1.10

It is clearly seen that significant control was not obtained with Eptam at the 10 pound rate. Here numerous tubers sprouted throughout the plots early in the year producing a heavy stand of nutgrass. The 20 pound rate gave highly significant control while 40 pounds resulted in practically complete control.

Table II. Effects of Atrazine on Northern Nutgrass When Applied on June 24, 1959 as a Post-Emergence Spray.
(Four Replications)

Herbicide	Rate/Acre Lbs. Active	Control Ratings 1 Poor to 9 Excellent 7/15/59	8/21/59
Atrazine	5.0	7.0	5.0
"	10.0	8.0	9.0
"	20.0	9.0	9.0
Check	--	1.0	1.0
L.S.D. .05		1.6	1.6
.01		2.3	2.3

Table II shows that Atrazine was very effective when applied as a post-emergence spray to nutgrass plants which averaged 10 inches in height. Nearly all the top growth of these plants was dead or dying two weeks after treatment. Shortly after this time, however, newly sprouted basal lateral plants began appearing in the plots that received the 5 pound application. This sprouting continued as the season progressed, but the plots treated with 10 and 20 pounds of Atrazine showed no such basal growth or recovery of the nutgrass. Control appeared to be maintained completely throughout the remainder of the summer.

Table III. Effects of Atrazine and Eptam on Northern Nutgrass When Applied on May 21, 1959 and Incorporated into the Soil and Cultivated on June 22, 1959. (Four Replications)

Herbicide	Rate/Acre Lbs. Active	Control Ratings 1 Poor to 9 Excellent 8/ 7/59	8/21/59
Eptam	6.0	7.50	7.00
"	10.0	8.50	7.50
Atrazine	4.0	7.00	6.75
"	8.0	8.50	8.75
Check	--	1.00	1.00
L.S.D. .05		1.54	1.89
.01		2.16	2.65

Table III shows that the Eptam and Atrazine treatments gave highly significant nutgrass control over the check during the 1959 season. There was little or no significant difference between treatments with the two chemicals at either rate, although the 8 pound application of Atrazine looked the most promising. These treatments were certainly effective on a seasonal basis, but information on the potential recovery of the nutgrass must await 1960 observations.

Summary

Applications of 20 to 40 pounds of Eptam per acre resulted in excellent control of Northern Nutgrass when incorporated thoroughly with the soil. At 40 pounds per acre recovery of this weed was practically nil the year following treatment. Excellent seasonal control was also obtained at rates of 6 and 10 pounds per acre.

Atrazine appeared to be especially effective in post-emergence treatments (10 to 20 pounds per acre) as well as in pre-emergence treatments (4 to 8 pounds per acre) when incorporated with the soil. Potential recovery of nutgrass the year subsequent to Atrazine treatment has not been ascertained.

Literature Cited

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WEED CONTROL STUDIES IN YOUNG APPLE ORCHARDS

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During the first three or four years of growth, young apple trees require considerable attention in order to keep weeds under control until they are large enough to offer enough shade for competition. Often, orchards are established on hillsides that make clean cultivation difficult. Very frequently periennial weeds and grasses that cannot be controlled adequately by cultivation become established and may severely stunt young apple trees. The studies reported herein are one year's results from various chemical applications around young apple trees. Experiment I was carried out on first year trees and Experiment II on three year old trees.

Experiment I was conducted in a planting of young trees that were set out in the early spring of 1959. The entire area was cross disced several times after planting, leaving about four square feet undisturbed around the base of the trees. Chemical treatment for weed control was applied after removing all weeds by hand on a 100 square foot (10' x 10') area around each tree. All spray treatments were applied with a knapsack sprayer using 50 gallons of spray solution per acre. Granular applications were made with a small hand duster. Three replicates of one tree each were made of each treatment. The treatments used and the resulting weed control are shown in table 1.

TABLE 1-FIRST YEAR APPLE TREES

Treatment 6/4/59	*Av. Weed Control 8/2/59
1. Simazine 3# + Amino triazole 1#/A, spray	2.50
2. Simazine 3# + Dalapon 5#/A, spray	1.50
3. Simazine 3# + Dalapon 10#/A, spray	9.25
4. Diuron 2#/A, granular	9.25
5. Simazine 3#/A, granular	6.25
6. Amino triazole 8#/A liquid, spray	9.25
7. Dalapon 10#, Amino triazole 5#/A spray	9.25
8. Check	1.00

* 1 = No Weed Control
10 = 100% Weed Control

Four of the treatments resulted in excellent weed control, but the other three did not control the weeds satisfactorially under the conditions of the experiment. None of the treatments resulted in any observable injury to the apple trees when final notes were taken in September.

In experiment II several chemical treatments were applied as directed sprays to a 10' x 10' area around the base of three year old apple trees. Previous to applying the treatments, an area of 6 feet on either side of the row of trees was disced, but some weeds and grass were present when the treatments were made. The presence of weeds and grasses made it necessary to apply only those chemicals that were known to possess herbicidal activity on contact when applied. The chemicals used in Experiment II and results obtained are given in table 2.

TABLE 2-THREE YEAR OLD TREES

Date	Treatment	Av. Weed Control & Grass 8/2/59
5/20/59	Dalapon 10# + Amino triazole 5#/A in 50 gal. water	5.66
6/4/59	1-chloro-N'-(3,4-Dichlorophenyl)-N,N-dimethylformenmicine (Dupont 685) 8#/A in 60 gal. fuel oil/A	9.33
6/4/59	DNOSBP, Dow General 1½ pts. in 5 gal. oil + 45 gal. water/A	5.33
6/4/59	DNOSBP, Dow General 1½ pts. in 5 gal oil + 45 gal. water/A + Amino triazole liquid 1#/A	7.00
5/20/59	Amino trizole 2,8# + Simazine 7.4#/A (Weedone Xall) in 50 gal. water	10.00
6/4/59	Amino ttiazole liquid 4#/A in 50 gal. water	6.33
6/4/59	Amino triazole liquid 4# + Dalapon 5#/A in 50 gal. water	7.33
	Check	1.00

Of the chemicals used in Experiment II, the Dupont 685 and Weedone Xall were the only two that resulted in good weed control throughout the summer. None of the treatments resulted in any damage to the trees that could be observed when final notes were taken in September.

SUMMARY

Preliminary experiments on one year and three year old apple trees indicated that certain herbicides can be applied safely around young apple trees. Several chemicals appeared equally effective, but the treatments should be repeated on a larger scale at several locations and on other varieties before they can be suggested for grower usage.

EVALUATION OF FIVE HERBICIDES FOR KILLING ESTABLISHED POISON IVY IN AN APPLE ORCHARD ONE AND TWO YEARS FOLLOWING A SINGLE TREATMENT

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This study was initiated to evaluate the length of time a single application of a herbicide would maintain an area relatively free of poison ivy after an apparent complete kill for the first season. Only herbicides having a known ability to kill poison ivy were used. More complete details of the study were reported in the Proceedings of the 13th Annual Meeting NEWCC; pages 57-59, 1959.

In August, 1957, ATA, Ammate, 2,4,5-T Ester, 2,4,5-TP, and 2,4,5-T Amine were applied to well established poison ivy in a mature apple orchard. All herbicides, except Ammate, were applied at the rate of 4 pounds active per acre. Ammate was applied at the rate of 150 pounds of formulated Ammate per acre. The herbicides were applied in water at the rate of 200 gallons per treated acre.

The application equipment consisted of a 50-gallon power sprayer with a three-nozzle boom delivering the spray in a flat fan pattern. The pressure was maintained at 75-80 pounds while spraying.

The 1/100th-acre plots were classified according to the relative density of poison ivy, and then grouped into twelve replications, each with similar poison ivy stands. Six replications consisting of six plots each were laid out around trees, and another six replications were laid out in spaces between tree plots in the tree row. The herbicides were applied at random within each replication between August 13 and 17, 1959.

All treated plots were free of poison ivy when observations were made in October, 1957. In September, 1958, and 1959, the density of poison ivy was recorded for each plot as the number of leafy stems that were visible. Since a count of 20 to 50 leafy stems of poison ivy may be obtained in an area of 10 square feet or less, and inasmuch as 435 square feet were treated in each plot, a plot with a stem count of 50 would be considered relatively free of poison ivy.

In Table 1, the numbers of leafy poison ivy stems are tabulated for each replication and treatment. In 1958 and 1959, all herbicide treatments differ significantly from the check plot, but herbicides do not differ significantly from each other. From the analysis of data, ATA, Ammate, 2,4,5-T Ester, 2,4,5-TP, and 2,4,5-T Amine were all effective in reducing the amount of poison ivy in an apple orchard for a period of two years following a single application.

The author is indebted to Dr. R. S. Dunbar, Associate Statistician, for technical assistance in the analysis of data.

Table 1. Number of poison ivy stems in 1/100th-acre plots one and two years following a single herbicide application August 1957 to established poison ivy in an apple orchard.

Replicate Number	And Year	ATA 4 lb/A[a]	2,4,5-T Ester 4 lb/A	2,4,5-TP 4 lb/A	Ammate 150 lb/A	2,4,5-T Amine 4 lb/A	Check
				Around Trees			
1	1959	69	114	148	89	138	589
	1958	(0)	(28)	(46)	(4)	(8)	(128)
2	1959	78	20	58	171	55	717
	1958	(2)	(0)	(3)	(18)	(5)	(182)
3	1959	0	56	156	61	262	396
	1958	(0)	(26)	(15)	(4)	(35)	(172)
4	1959	1	5	55	102	89	709
	1958	(0)	(1)	(0)	(3)	(3)	(168)
5	1959	6	56	41	48	29	318
	1958	(0)	(20)	(8)	(0)	(14)	(104)
6	1959	2	2	0	72	96	133
	1958	(0)	(0)	(0)	(6)	(10)	(66)
Av.	1959	26.0	42.2	76.3	90.5	111.5	477.0
	1958	(0.3)	(12.5)	(12.0)	(5.8)	(12.5)	(136.7)
				Between Trees			
7	1959	8	33	99	62	89	449
	1958	(0)	(3)	(24)	(0)	(8)	(115)
8	1959	89	134	85	40	14	246
	1958	(1)	(3)	(33)	(3)	(2)	(53)
9	1959	11	21	63	67	68	246
	1958	(0)	(3)	(5)	(0)	(11)	(64)
10	1959	43	10	2	72	12	58
	1958	(0)	(6)	(2)	(10)	(1)	(32)
11	1959	0	9	1	4	68	237
	1958	(0)	(2)	(0)	(0)	(9)	(38)
12	1959	14	3	27	20	38	162
	1958	(1)	(0)	(3)	(0)	(7)	(28)
Av.	1959	27.5	35.0	46.2	44.2	48.2	233.0
	1958	(0.3)	(2.8)	(11.2)	(2.2)	(6.3)	(55.0)

[a]Herbicides were applied at the rate of 200 gallons per treated acre.

CONTROL OF SWEET FERN AND POPLAR IN LOWBUSH BLUEBERRIES BY CONTACT APPLICATION OF 2,4-D AND 2,4,5-T.[1/]

M. F. Trevett[2/]

In lowbush blueberry fields, woody weeds that grow in clumps (alder, birch, oak, and red maple), or densely branched, leafy weeds growing in thick stands (sweet fern) can be selectively controlled. Selective control of clump growing weeds can be obtained by stub or basal methods of application which permit accurate placement of herbicides on weeds without wetting adjacent blueberry plants. Thick stands of densely branched weeds intercept most of a foliage spray enabling nearly selective control. Woody weeds like poplar, however, which cannot be controlled either adequately or economically by stub or basal methods, and which are so sparsely leaved that they cannot be foliage sprayed without wetting a band of blueberry plants two to three feet wide, or scattered small clumps of sweet fern that have survived foliage sprays require for safe control other methods of herbicide application.

A solution to this problem was suggested by a contact method of applying herbicides tried by cranberry growers in Massachusetts. Cross (1) summarized grower experience to 1951 as follows: "In denser stands of weeds, the best mode of attack seems to be that of carrying a sheet of cloth or burlap stretched on a wooden framework and saturated with a 20% solution of 2,4-D salt across the bog above the tops of the cranberry vines but low enough to brush the leafy tips of the weeds." In 1952, Trevett (2), on the basis of observations of exploratory tests made in 1949 and 1950 and plot data for 1951-1952, Table 1, suggested trial use of the contact method in lowbush blueberry fields.

Subsequent to 1952 the contact method has been mechanized for sweet fern control. In 1956, R.B. Rhoads, Department of Agricultural Engineering, University of Maine, built a prototype mechanical contact applicator. The applicator consisted essentially of a cloth-covered drum mounted on the axle of a hay rake frame. As the applicator was hauled across a field a water solution of 2,4-D was sprayed onto the absorbent cloth covering. The drum revolved at a height high enough to miss most blueberry stems but

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1/ Comptonia peregrina (L.) Coult. (Sweet Fern), Populus tremuloides Michx. (Poplar) and Populus grandidentata Michx. (Large-toothed Poplar).

2/ Associate Agronomist, University of Maine.

low enough to forcibly brush against the tops and sides of sweet fern plants. Since 1956 a half-dozen growers have built contact applicators patterned after the Rhoads prototype. An estimated 1,500 acres have been treated to date (October, 1959).

As with other methods of application, results with contact applicators have not been consistent--whether from the standpoint of adequacy of sweet fern control or from the standpoint of the frequency of excessive injury to blueberry plants. Further, although current (1959) contact applicators are somewhat safer to use for initial treatment of dense stands of sweet fern than conventional boom sprayers, there is sufficient drip from the cloth absorbent to make hazardous the use of these machines for routine treatment of scattered clumps of sweet fern that have survived initial treatment or for the repeated applications required to control weeds more resistant than sweet fern to 2,4-D or 2,4,5-T.

This paper reports the results of tests designed to evaluate the effect of changes in percent weed coverage, concentration of herbicide, and carrier characteristics on control of sweet fern and poplar (<u>Populus tremuloides</u>).

Procedure

Two types of tests were made. In one type, herbicides were applied to plots 6 feet wide and 50 feet long with a small plot applicator made by tacking flannel blanketing over a wooden frame 8 feet long and 3 feet wide. The blanket was wet with the solution to be tested. Herbicides were applied to weeds by two men walking abreast down a plot swinging the applicator forward and backward, low enough to contact most weeds but high enough to miss most blueberry bushes. In the second type test, stems were tagged for identification and solutions were applied to leaves and stems with either a hand operated automatic pipette or a small paint brush.

Results

Effect of Date of Application on Weed Control

The later in the growing season the contact application was made, the poorer the control of sweet fern and poplar. Treatments applied the first week in July, for example, gave 40% control of poplar, but gave only 25% control when applied the second week in August, and gave no control when applied the first week in September. This relation between date of application and percent control for contact application is identical with results reported for spray application.

Effect of Amount of Solution Applied on Control

As in spray application, sufficient solution must be applied by the contact method to wet the stems as well as the leaves of brush. In tests in which only sufficient solution was applied to wet the leaves without appreciable rundown on stems, only 25% control of poplar was obtained with a solution containing 20 pounds of 2,4-D acid per 100 gallons of water. When, however, leaves and stems were wet to runoff, percent control was doubled.

Relation Between the Amount of Foliage Wet and Concentration of Solution on Percent Control of Sweet Fern

Control of sweet fern was improved either by increasing the concentration of 2,4-D or by increasing the portion of foliage wet with solutions of 2,4-D esters, Table 2.

Injury to blueberry plants increased as the portion of sweet fern foliage wet was increased. The higher concentrations of 2,4-D vapors associated with increasing amounts of solution applied, may account for part of the increased injury. Field observations, however, indicated that most of the injury resulted from a fine spray jarred out of the small plot applicator when "all" of the foliage was wet. Less spatter occurred when the applicator was merely brushed over the tops of sweet fern giving "top one-third" coverage.

Relation Between Carrier and Control of Sweet Fern and Poplar

Tests made to determine whether or not the carrier could be changed so as to obtain both the low order of injury to blueberry plants associated with "top one-third" application, Table 2, and the high percent of control associated with complete "all" coverage of weed foliage. Esters of 2,4-D and 2,4,5-T were applied in both #2 fuel oiland in water in mid July to the "top one-third" of poplar. It was assumed that oil placed on the top third of a plant would run down the stem to give nearly complete stem coverage. At the degree of wetness of the blanketing required to ensure minimum spatter from the applicator as it was swung over the tops of weeds, however, an insufficient amount of solution was deposited to result in adequate rundown on stems. As a consequence, both 2,4-D and 2,4,5-T were relatively ineffective. Water solutions, however, were more effective than oil solutions. Four, 8 and 20 pounds of 2,4-D acid in 100 gallons of water, gave 14.2, 14.2, and 25.2 percent control of poplar; 4, 8 and 20 pounds of 2,4,5-T gave 15.0, 24.4, and 23.2 percent control. In oil the 4, 8, and 20 pound concentrations of 2,4,5-T gave 8.7, 2.4, and 0.0 percent control.

The poor control obtained in this test may have resulted from both inadequate coverage and the inherent phytotoxicity of the oil. The oil presumably, interfered with absorbtion of 2,4-D and 2,4,5-T by rapidly killing leaf tissues. In a companion study in which oil was applied to leaves of poplar (Populus tremuloides Michx), maple (Acer rubrum L.), gray birch (Betula populifolia Marsh.), and sweet fern, observations indicated that poplar was more sensitive to oil than the other species. Within five hours of treatment poplar leaves had become water soaked. Evidence of injury was not apparent in the other species. Two days after treatment, maple leaves developed brown margins; four days after treatment, sweet fern showed some discoloration and marginal burn; birch was intermediate between poplar and sweet fern.

In further tests, carriers more viscous than either water or #2 fuel oil were used to reduce spatter and drip from the applicator. Methocel (Dow Chemical Company), a phytotoxically inert compound, was added to water solutions of 2,4-D to increase viscosity so that the entire foliage and stems of poplar and sweet fern could be wet without spattering blueberry bushes. Good coverage was obtained without drip during application with 1 to 4 percent concentrations of Methocel. However, although the Methocel film dried immediately, the film rehydrated during night fogs and heavy dews and sloughed off.

Oils of higher viscosity than #2 fuel oil were used as carriers for 2,4-D and 2,4,5-T esters. Two, 4, and 20 pounds of total acid from 2,4-D and 2,4,5-T (10 pounds each) per 100 gallons of SAE #40 motor oil applied to sweet fern the first week in September 1952, gave a top kill the following June of 35, 45, and 75 percent, respectively. Esters of 2,4-D in SAE #40 motor oil applied to poplar in mid June 1956, gave a satisfactory root kill whether the top half only, one side, or all sides of the plant were wet, Table 3. As with #2 fuel oil, discoloration of poplar leaves occurred rapidly after treatment. It appears, therefore, that the excellent root kill with motor oil resulted in part, at least from good stem coverage. Minimum spattering of blueberry bushes occurred with SAE #40 oil-compared to water and #2 fuel oil.

Conclusions

Control of sweet fern and poplar by contact application of 2,4-D and 2,4,5-T is most effective if treatments are applied early in the growing season. In Eastern Maine, June applications appear to be best.

To reduce herbicide injury to lowbush blueberries, carriers more viscous than either water or #2 fuel oil are needed to limit drip and spatter of solutions during application. If phytotoxic oils (SAE #40 motor oil) are used as carriers, stem coverage is essential to insure satisfactory control.

Percent control obtained is determined by the interaction between the concentration of the herbicide solution applied and the portion of individual weeds wet with the solution. The higher the concentration, or the greater the portion of weeds wet with a given concentration, or both, the higher the percent control obtained.

Table I. Comparison of Rates of 2,4-D (D) Amines and 2,4-D + 2,4,5-T (D + T) Esters on Poplar Control, 1951-1952.

Pounds of D or T per 100 gallons solution[1]	Percent Control: Poplar (*Populus tremuloides*)	Percent Control: Large Leaved Poplar (*Populus grandidentata*)
2 # D amine	23.0[3]	--
4 # D "	47.7	--
20# D "	95.0	--
2 # D + T[2] esters	45.5	16.6[3]
4 # D + T "	37.1	28.9
20# D + T "	95.0	61.1

1/ Water solution applied July, 1951.

2/ 50%, 2,4-D; 50% 2,4,5-T.

3/ Counts made August 1952.
Percent control = percent kill of roots or rhizomes.

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Table 2. Relation Between Concentration of Herbicide Solution, Portion of Sweet Fern Foliage Wet, and Percent Control.

Pounds 2,4-D acid (ester formulation) per 100 gal. water	Percent control when the following portions of sweet fern foliage was wet to incipient runoff1/		
	Top one-third	Top half	All
2	42	75	95*
4	47	95	79*
8	88	91*2/	100*
20	91	90*	100*

1/ Test of significance: Chi square analysis of numbers of sweet fern plants killed and not killed indicated:

(1) Highly significant increase in number of dead plants (rhizomes killed) with increasing portion of plant sprayed.

(2) Highly significant increase in number of dead plants with increase in pounds of 2,4-D per 100 gallons of solution.

(3) 2# concentration: No significant difference when "all" of plant is wet, compared to top half.

(4) 8# and 20# applied to "top one-third" only, compared to 8# and 20# applied to "top half" only: No significant difference in control.

2/ Treatments with asterisks resulted in excessive injury to blueberry plants.

Table 3. Relation Between Placement of 2,4-D Ester in SAE #40 Oil and Percent Control of Poplar (*Populus tremuloides*).

Placement 1/	Percent Control
1. Stem only wet thoroughly 2/	100.0
2. All sides of plant wet thoroughly 3/	96.7
3. One side only of plant wet thoroughly 4/	96.4
4. All sides of plant wet sparingly 5/	82.3
5. Top half only of plant wet thoroughly	78.5

Test of significance: Chi square analysis of number of plants killed and not killed indicated:

(1) A highly significant difference between treatments. Treatments 1, 2, and 3 gave significantly better control (root kill) than treatments 4 and 5. Treatments 4 and 5 did not differ significantly.

1/ Twenty pounds 2,4-D acid per 100 gallons SAE #40 motor oil Applied 23 June, '56; evaluation made August 1957.

2/ Wet thoroughly; heavy film of solution visible.

3/ Plot applicator brushed front and back of weed.

4/ Plot applicator brushed against front of weed only.

5/ Plot applicator brushed against both front and back of weed but applicator not as near saturation as in treatments 2 and 3. Thus, only a very light film of solution was deposited on leaves and stems.

INFLUENCE OF PRE-EMERGENCE WEED CONTROL ON CORN GROWTH UNDER DROUGHTY CONDITIONS

T. R. Flanagan[1]

Coupled with an increased interest in pre-emergence herbicides for weed control in corn is a mounting awareness that yield decreases are more pronounced with failure to control weeds during the first few weeks of corn growth and that aggrevated weed competition for soil moisture occurs under dry season conditions (1, 2).

The purpose of the study undertaken was to evaluate time of planting applications of several pre-emergence herbicides under Vermont conditions for yields of both sweet corn and field corn for silage. However, local drought conditions aborted this purpose, while at the same time made evident the serious nature of weed competition.

PROCEDURE

Three varieties of field corn and three of sweet corn were planted on May 27, 1959 on a fine sandy loam. Adequate moisture was present in the soil at planting. Fertilizer treatment was uniform with 300 pounds per acre of 10-10-10 topdressed and worked in prior to planting, and 300 pounds per acre 10-10-10 used in the planter.

All treatments were applied on May 28, 1959 with a tractor-mounted sprayer with 20 foot boom using 730308 T-jet tips applying a rate of 20 gallons per acre. Spray treatments were random with varieties as split plots. Each subplot consisted of two rows of corn spaced 34 inches, and 20 feet in length. Spray treatments were replicated.

Materials and rates used were as follows:

> 2,4-dichlorophenoxy acetic acid, low volatile ester, 1½ pounds acid equivalent per acre; simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) as 2 pounds actual per acre of 50W and 1.4 pounds actual per acre of 80W, and atrazine (2-chloro-4-(isopropylamino)-6-(ethylamino)-s-triazine at 2 pounds actual per acre, hand weeded check and untreated control.

Weed ratings were recorded in midseason, heights reported in early September and green weight yields determined during the second week of September. Temperatures during the growing season were moderate, but rainfall was below normal (Figure 1). Cultivated plots were hand weeded.

[1]Assistant Agronomist, Vermont Agricultural Experiment Station

TABLE I.

Average heights and yields of silage corn under several treatments, 1959.

Treatment	Average Height Inches	Average Yield Tons Per Acre
Simazin 50W	57.1	14.4
Simazin 80W	55.8	13.5
Atrazine 50W	61.3	13.4
2,4-DLVE	45.4	6.9
Cultivated	56.0	10.6
Unweeded	46.0	5.0

SUMMARY

An experiment designed to compare the herbicidal effectiveness of several pre-emergence weed killers on the stand and yield of field and sweet corn was seriously impaired by local drought conditions. However, the severe competition of weeds for soil moisture, where not adequately controlled, was reflected in corn heights and yields in great contrast to corn growing where such competition was eliminated. Some inference may be gained that effective herbicidal control of weeds permits a crop which otherwise might be a total failure.

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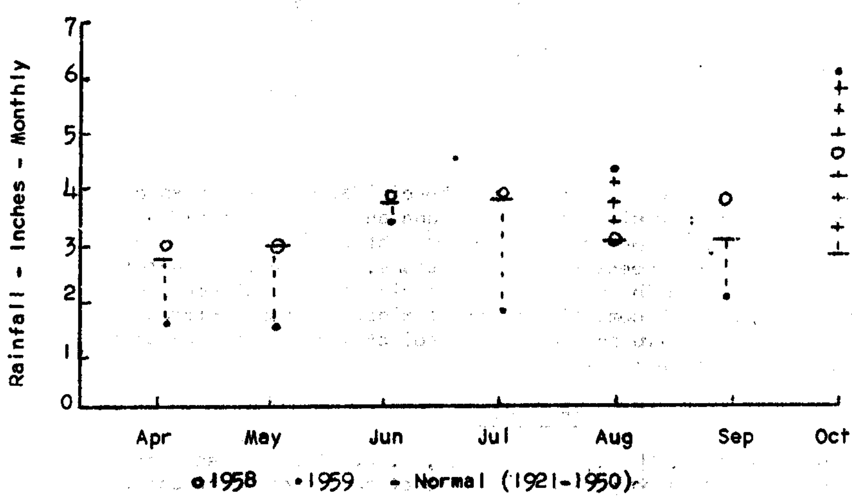
Weed growth was excellent; species predominant were foxtails (Seteria species), pigweed (Amaranthus retroflexus), and lambsquarter (Chenopodium album).

FIGURE I.

Rainfall - Burlington, Vermont, 1958 and 1959



RESULTS AND DISCUSSION

Although corn germination and emergence was uniform throughout the test site, lack of moisture soon became evident. Where weed control was ineffective weeds soon became dominant. Corn growth was suppressed to such a degree on such affected plots that the experiment was considered a failure, and no further herbicidal or cultural practices were applied. However, by late summer it became apparent that certain plots had developed well and consequently yields were determined for all plots. That moisture was lacking and weed competition was severe under such conditions is readily reflected by the corn height measurements (Table I).

Yield determinations were not made for the sweet corn plots as most treatments resulted in complete failure. The only treatment surviving was that where atrazine was used. Yields of green fodder from the corn plots are significantly different for treatments, due entirely to the extreme differences in yields between the 2,4-D and unweeded controls, and the triazine compound treated plots (Table I). Good residual weed control lasted throughout the season for both simazine and atrazine.

A Report on Atrazine Post-Emergence In Corn - Weed Control and Corn Plant Residue Analyses

Dr. Richard P. Gigger and James H. Flanagan
Geigy Agricultural Chemicals

It has been apparent for many years that a need existed for an effective herbicide which could be safely applied post-emergence to corn for the control of annual broadleaf weeds and grasses. In 1957 the results of screening trials indicated that several substituted amino triazines possessed these properties. Evaluation of these compounds under both pre- and post-emergence conditions led to the choice of Atrazine (G-30027), principally because of its greater activity per pound of active ingredient.

Chemically, Atrazine is closely related to Simazine, being 2-chloro-4, ethylamino-6, isopropylamino-s-triazine, but differing greatly in solubility; Atrazine has a water solubility of 70 ppm at 20-23° C compared to 5 ppm for Simazine.

Experimental Objectives

(1) To establish a dissipation curve for Atrazine when applied to corn foliage in actual field use.

(2) To establish by the use of the logarithmic sprayer an effective dosage rate in relation to the height of the weed growth and differential weed response along the course of the logged plot.

Weather Conditions

Rainfall was more than adequate during the growing season for good corn growth and activation of the chemical. The rainfall pattern was such that rain occurred every week during the season and possibly affected the experiment in two ways.

(1) By masking the contact action of the chemical by hastening the movement of the chemical deposit on the weed foliage to the soil.

(2) Increasing the rate of plant reaction by root absorption.

Procedure

For the weed control study, logged spray plots were established in duplicate, using a starting rate of 4 lbs/a in 35 gallons of water. Applications were made (1) pre-emergence, (2) at weed emergence, (3) when weed growth was 1 to 1½ inches tall, (4) 2 to 3 inches tall, and (5) 3 to 4 inches tall. Conventional sprayed plots were sprayed when weed growth was 1 to 2 inches tall and 3 to 5 inches tall at dosage rates of 2, 2.25, 2.5 and 3 pounds per acre (active) in 35 gallons per acre.

Foxtails (<u>Setaria viridis</u>, <u>S. lutescens</u>) were the most prevalent weedy grasses present. However, Barnyard grass (<u>Echinochloa crusgalli</u>) was prevalent and was included in Chart I because it showed some tolerance at rates used for the control of Foxtails. The broadleaf weeds present, in the order of their population, were Lambsquarters, Pigweed, Ragweed, and Smartweed.

In addition to the above, two 3 acre fields were sprayed using 2 pounds of 50% wettable powder Simazine and Atrazine in 12 inch bands.

For the plant residue work, plots 15 x 75 feet were sprayed at 2, 4, and 8 pounds (active) per acre in 35 gallons of water, replicated three times in a checker board pattern. The corn was planted on May 25 and treated on June 9 when the corn was 5 inches high. Randomized samples of Atrazine treated corn were obtained at 0, 3, 7, 15, 21, 29, and 50 days after application. Table II represents corn residues taken from corn plants grown in Duchess County, New York. Table III represents corn residues taken from corn plants grown in Jerseyville, Illinois. Sample S-1 was applied 13 days after planting, P-1 applied 12 days after planting, and P-2 applied 19 days after planting.

Results

Pre-Emergence

Atrazine at a dosage rate of 1.75 to 2 lbs. active per acre was more effective against broadleaf weeds than against grasses. Pigweed was the most susceptible of the broadleaf weeds, being more than 50% controlled at 1.5 lbs. per acre, followed in order of susceptibility by Ragweed, Lambsquarter and Smartweed. However, all broadleaf weeds were completely controlled at a dosage rate of 2 lbs. active per acre.

Atrazine at a dosage rate of 2.25 lbs. active per acre yielded 90% control of Foxtails; it was necessary to apply 2.5 lbs. active per acre of the compound to obtain 90% control of Barnyard grass.

Weed Emergence

Similar control of broadleaf weeds was obtained with Atrazine applied at weed emergence as previously described for pre-emergence applications. However, for control of Foxtails and Barnyard grass, it required approximately 0.25 lbs. less herbicide when applied at emergence than when applied pre-emergence.

Weeds 2 to 3 inches and 3 to 4 inches tall

Control obtained with Atrazine at these two stages of growth indicated that broadleaf weeds had become slightly more tolerant at rates used in earlier applications. A dosage rate of 2.25 lbs. was necessary to produce 100% control. Barnyard and Foxtail grasses showed a similar effect particularly at the 3 to 4 inch stage and required 2.5 lbs. for complete control. However, a rate of 3 lbs. per acre (active) showed no increased tolerance on weeds and grasses up to 12 inches in height.

In all cases. conventional sprayed plots produced slightly better control than the logged plots at equivalent dosage rates of the compound.

In the two fields treated with Simazine and Atrazine at 2 lbs. of 50W in 12 inch bands, Atrazine controlled grass for three weeks. Three weeks after application, grasses appeared on the ridges made by the planter press wheel and matured without showing symptoms of the Atrazine treatment. However, broadleaf weeds were controlled for the season. Atrazine gave some degree of grass control where the press wheel firmed the soil. The Simazine treatment gave excellent control of grasses and broadleafs for the season.

In the plots sprayed with Atrazine for the plant residue studies, good seasonal control was obtained with the 2 lbs. dosage rate and excellent control at the 4 and 8 lbs. dosage rates. Quackgrass was completely controlled at the 4 lb. dosage rate. Field Horsetail (*Equisetum arvense*) and Milkweed (*Asclepias syiaca*) were not controlled even at the 8 lbs. dosage rate.

The residues of Atrazine remaining on the corn plant were determined as follows:

Samples of corn plants of from 50 - 200 gms. were stripped by shaking for one-half hour with equal amounts of chloroform. The chloroform extract was filtered, and aliquots taken for analysis. The aliquot of chloroform stripping was passed through an alumina column, and the column washed with 25-30 ml of chloroform. To the combined extract and washings in a separatory funnel is added 1 ml of 50% sulfuric acid. The funnel contents are shaken periodically over a period of two hours. Then 9 ml of water are added, the funnel shaken well, and upon separation of the layers, the chloroform is drawn off. The aqueous layer is washed by shaking with 10 ml of ether, and is then read at 240 mμ against a reagent blank carried through the same procedure. The Atrazine content of the corn is estimated from a standard curve prepared by carrying known amounts of Atrazine through the above procedure.

Conclusions

(1) Atrazine was more effective against broadleaf weeds than grasses when applied at rates of 1-3/4 to 2 lbs. active/a.

(2) Foxtail grasses required dosage rates of 2 to 2-1/4 lbs/a for control.

(3) Barnyard grass was the most tolerant of the grasses in this experiment and required dosage rates slightly more than 2-1/4 lbs./a.

(4) Applications made at weed emergence and up to the 1-1/2 inch height stage of growth were the most effective treatments at comparable rates.

(5) Atrazine provided seasonal control at dosage rates between 2-1/4 and 2-1/2 lbs./a.

(6) No injury to corn was noted at rates up to 8 lbs/a.

(7) It was observed that Atrazine exhibited some degree of foliage contact activity against broadleaf and grassy weeds. However, faster kill of broadleaf weeds and grasses occurred when Atrazine was applied post-emergence followed by rainfall than when little or no rainfall occurred after application of the compound.

Table I

Percent Weed Control at Different Stages of Weed Growth.

	Pre-Emergence			Emerging			Weed 1-1½"			Weed 2-3" tall			Weed 3-4" tall		
lbs./A	BL	Grass	Barn-Yard Grass	BL	Grass	Barn-Yard Grass	BL	Grass	Barn-Yard Grass	BL	Grass	Barn-Yard Grass	BL	Grass	Barn-Yard Grass
1 1/2	40			55			60			30			35		
1 3/4	80	40		80	50		90			60			60	30	
2	100	60	30	100	60	35	100	70	30	100	50	50	80	60	40
2 1/4		90	70		100	90		95	80		100	70	100	85	65
2 1/2		100	90			100		100	95			90		100	95
2 3/4			100									100			100

Table II

Geigy Sprayed

Atrazine residues on Corn

Atrazine Treatment lbs./A	Days after Spray: 0 ppm	4 ppm	7 ppm	15 ppm	21 ppm	29 ppm	50 ppm
0	0.10	0.10	0.09	0.11	0.10	0.02	0.03
2	156.00	16.00	8.00	0.22	0.05	0.04	0.07
4	427.00	27.00	16.00	0.38	0.05	0.06	0.07
8	560.00	35.00	27.00	0.61	0.07	0.09	0.07

Table III

Atrazine Residues on Corn

Sample	Replicate	Atrazine Treatment lbs.	Residue Days After Spray 0 ppm	3 ppm	7 ppm	14 ppm	21 ppm	28 ppm
S-1	1	0	0.07	0.10	0.14	0.14	0.15	0.08
S-1	1	1	48.00	5.40	1.50	0.16	0.11	0.09
S-1	1	2	104.00	6.50	1.75	0.14	0.14	0.11
S-1	1	4	161.00	15.40	3.25	0.12	0.13	0.12
S-1	3	0	0.12	0.11	0.08	0.18	0.09	0.10
S-1	3	1	39.60	4.90	0.20	0.15	0.11	0.11
S-1	3	2	74.00	6.20	0.26	0.14	0.12	0.14
S-1	3	4	306.00	15.90	0.30	0.19	0.13	0.09
P-1	1	0	0.16	0.17	0.15	0.19	0.09	0.10
P-1	1	1	98.00	5.60	0.96	0.19	0.10	0.08
P-1	1	2	155.00	9.80	1.60	0.14	0.14	0.11
P-1	1	4	312.00	40.00	2.56	0.14	0.20	0.18
P-2	1	0	0.07	0.20	0.23	0.20	0.09	0.07
P-2	1	1	45.00	4.40	0.34	0.16	0.11	0.09
P-2	1	2	74.00	12.50	0.41	0.18	0.10	0.07
P-2	1	4	282.00	22.20	0.62	0.21	0.09	0.10

S1 = 13 days after planting
P1 = 12 days
P2 = 19 days

The Effectiveness of Simazine and Atrazine as Pre-emergence Herbicides on Corn in Delaware in 1959[1]

Frank B. Springer, Jr.[2]

The results obtained with Simazine as a pre-emergence herbicide on corn in Delaware in the years 1957 and 1958 indicated that Simazine might be the ideal chemical for the control of both broadleaf weeds and grasses. In 1959, however, the results obtained were not as encouraging.

Simazine and Atrazine along with several other chemicals were evaluated as pre-emergence treatments on corn grown on light textured soil at the Substation Farm, Georgetown, Delaware.

Procedure

Simazine and Atrazine were evaluated as pre-emergence treatments on corn at Georgetown, Delaware, at the rates indicated in Table 1. The soil in the experimental area was a Norfolk loamy sand. Individual plots consisted of 4 rows, each 18 ft. long and spaced 3 ft. apart. The hybrid Conn. 870 was planted May 12, 1959, at a depth of 1.5 inches at a population of approximately 14,000 plants per acre. The chemical treatments were applied the day after planting. A modified bicycle-type experimental plot sprayer was used at a pressure of 30 psi. The low concentration of each herbicide was applied in solution at the rate of 20 gal./A. and the double concentration at 40 gal./A. The double concentration was applied by sparying the designated plots twice using the single rate calibration on the sprayer.

The predominant broadleaf weeds were pigweed (Amaranthus retroflexus), ragweed (Ambrosia artemisiifolia), and lambsquarters (Chenopodium album). The predominant grasses were crabgrass (Digitaria sanguinalis), yellow foxtail (Setaria lutescens), and a light but well distributed infestation of nutgrass (Cyperus esculentus).

The corn population count and weed control ratings were taken 5 weeks after the chemical applications. All plots received one cultivation after weed ratings were taken. The plots were harvested in the fall for yield data.

1/ Miscellaneous Paper No. 353 Delaware Agricultural Experiment Station.

2/ Assistant Agronomist, University of Delaware, Newark, Delaware

Results and Discussion

At the time of planting soil moisture was adequate for germination of corn and weeds. However there was no rainfall for a period of eight days after planting and then only .68", then another five day period with no rainfall. The total rainfall for the five week period after planting was 4.79". The temperature was slightly above normal for this period. In 1958 for the same period of time rainfall was 6.72" and temperature was about normal. There was a difference of 1.93" less rainfall in 1959 than for the same period in 1958. Table 2 summarizes average rainfall and maximum, minimum, and average temperature for months of May and June, 1958.

The performance of the herbicides Simazine and Atrazine are summarized in Table 1. These data indicate that Atrazine was superior to Simazine for control of all weed growth under the prevailing conditions. The two pound rate was nearly as effective as the four pound rate. The two pound rate of Simazine was more effective than the four pound rate. There was no injury observed by either chemical at either rate during the growing season.

Both broadleaf weeds and grasses were satisfactorily controlled by Atrazine at the 2 pound rate and the 4 pound rate. Simazine at the 2 pound rate gave good control of broadleaf weeds but only fair control of grasses. At the 4 lb. rate there was still good control of broadleaf weeds but very poor control of grasses.

There was no significant reduction in yield at either the low or high rate of application for either Simazine or Atrazine. There was no significant difference in yield between either herbicide treatment.

Nutgrass, a serious weed problem in corn fields in some areas of Delaware, was satisfactorily controlled with Atrazine at both the low and the high rates.

These data would indicate that Simazine is not as effective under conditions of low rainfall and above normal temperatures as Atrazine.

Table 1. The effect of Simazine and Atrazine as pre-emergence herbicides on weed control, corn stand, and corn yield at Georgetown, Delaware - 1959

Treatment	Lbs./A.	Weed Control Rating[a/] Broad-leaves	Weed Control Rating[a/] Grasses	Corn Stand Reduction	Corn Yield Bu./A. at 15.5% Moisture
Simazine	2	8.0	5.4	0	115.5
Simazine	4	8.0	5.1	0	118.1
Atrazine	2	9.5	10.0	0	119.2
Atrazine	4	10.0	10.0	0	112.8
Check[1/]	0	0	0	0	111.5

Yields not statistically significant

a/ Weed control rating: 0 - no control, 10 - perfect control.
1/ Check - cultivation identical to chemically treated plots.

Table 2. Average rainfall and maximum, minimum, and average temperature for months of May and June, 1958 and 1959, Georgetown, Delaware.

	Rainfall 1958	Rainfall 1959	Temperature 1958 Max.	Temperature 1958 Min.	Temperature 1958 Ave.	Temperature 1959 Max.	Temperature 1959 Min.	Temperature 1959 Ave.
May	4.06"	1.44"	74.4°	52.5°	63.5°	80.3°	54.4°	67.4°
June	5.00"	3.63"	80.8°	58.1°	69.5°	86.3°	59.9°	73.1°
Total	9.06"	5.07"						

Summary

Simazine and Atrazine were evaluated for pre-emergence weed control in corn at Georgetown, Delaware, during 1959.

Excellent control of broadleaves and grasses was obtained with Atrazine at 2 and 4 lbs. per acre. Simazine was satisfactory at 2 lbs. per acre on broadleaf weeds but not as effective on grasses. At 4 lbs. per acre Simazine gave good control of broadleaves but very poor control of grasses.

Atrazine appears to be much more effective on both broadleaf weeds and grasses than Simazine when moisture is limited.

The use of Atrazine for control of nutgrass looks encouraging.

THE INFLUENCE OF CULTIVATION ON CORN YIELDS WHEN WEEDS ARE CONTROLLED BY HERBICIDES*

William F. Meggitt[1]

With the development of herbicides that will provide weed control throughout the entire growing season, it is important to evaluate and determine the effectiveness of cultural practices. In corn, for example, it has been necessary to cultivate two to four times during the growing season in order to control weeds. Since there are herbicides presently available to maintain the area weed-free, the question arises as to how many cultivations are necessary for maximum corn yields.

Cates and Cox (1) as early as 1912 concluded that cultivation was not beneficial to the corn plant except for removing the weeds. Wiemer and Harland (2) in a review of literature on corn cultivation tests presented information which supported the view of Cates and Cox. However, many of these early investigations involved some method of scraping or handhoeing in order to eliminate weeds. Only with the development of some of the newer herbicides, namely, simazin and atrazine, have we had at our hand materials which would give full season control without the need for some form of cultural practice. In order to obtain maximum benefits from any weed control practice it is imparative to eliminate those practices such as excessive tillage which are unnecessary.

These investigations were initiated to study the effect of cultivations when used in conjunction with herbicides on the yield of field corn grown on different soil types. The effect of cultivations was also studied in areas where corn was grown following row crops and where corn was grown following an alfalfa sod.

Materials and Methods

In 1958, New Jersey #9 field corn was planted on a Nixon loam soil. The herbicide treatments used to provide weed control were simazin pre-emergence at 2 pounds active ingredient per acre and 2,4-D low volatile ester at 1½ pounds per acre. A post-emergence application of 2,4-D amine salt at ½ pound per acre was also included. Four levels of cultivation: 0, 1, 2 and 4, were used in conjunction with each of the previously mentioned herbicidal treatments. Cultivations were made at approximately 10 day intervals starting at the 3-leaf stage of corn growth.

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The area selected for the 1958 study had been in corn in the two previous seasons. In 1959, two locations were selected, one being a Nixon loam and the other a Sassafras sandy loam (welldrained). The Sassafras sandy loam area had been in alfalfa the two previous seasons, and the Nixon loam had been planted to tomatoes in the two previous seasons.

At the first location in 1959 atrazine at 2 pounds active ingredient per acre as a pre-emergence application and 2,4-D amine at ½ pound as a post-emergence application were the two herbicidal treatments involved. At the second location, simazin at 2 pounds per acre pre-emergence as an over-all treatment and in 12- and 24-inch bands, and 2,4-D amine at ½ pound per acre post-emergence were included.

Again, in 1959, the numbers of cultivations were 0, 1, 2 and 4. In 1958 and at one location in 1959, the one cultivation was made at approximately 10 days after emergence of the corn (3-4 leaf stage). In 1959 at one location, this one cultivation made at the 3-4 leaf stage was compared to one cultivation made at lay-by in addition to the 2- and 4-cultivation levels.

The experimental design in each case was a split plot with four replications. All cultivations were made with a tractor-mounted shovel-type cultivator.

Results and Discussion

The results of these investigations using corn yields as a criteria are shown in tables 1, 2 and 3. Height measurements of corn throughout the season substantiated results shown by yields. In both years, simazin and atrazine provided nearly 100% weed control throughout the growing season. In 1958, 2,4-D low volatile ester as a pre-emergence treatment also provided excellent weed control throughout the entire season. In both seasons the 2,4-D amine application made as a post-emergence treatment eliminated the broadleaf weeds but a grass problem developed in those situations where no cultivation was performed. One or more cultivations removed this grass problem.

It is shown in table 1, in 1958, where weeds were controlled throughout the entire growing season, yields of corn were significantly increased by one cultivation, and there was no further increase provided by two or four cultivations. In the case of the check plots in which no herbicidal treatment was applied one cultivation was not sufficient to reduce weed competition to the point where it did not interfere with corn yields. Corn yields were increased by each level of cultivation where no herbicide was applied due primarily to the additional weed control provided by the additional cultivations.

In 1959 in the area where corn followed 2 years of tomatoes, yields were significantly increased by one and two significantly greater than those provided by one cultivation. Again, there was no advantage of additional cultivations beyond two.

Table 1. The effect of cultivations used in conjunction with herbicides on yield of field corn. New Brunswick, New Jersey. 1958. (Nixon loam.)

Herbicide	Rate lbs. per acre	Application method	Yield, Bushels per Acre				
			No. of Cultivations				
			0	1	2	4	Mean
Simazin	2	Pre-emergence	92.6	104.2	102.3	101.4	100.1
2,4-D LVE	1½	Pre-emergence	88.4	101.8	101.1	103.5	98.7
2,4-D Amine	½	Post-emergence	78.1	98.9	100.6	96.4	93.5
No treatment			66.2	82.1	96.3	102.5	86.8
Mean			81.3	96.8	100.0	101.0	
LSD for treatment means .05							5.3
.01							7.0
LSD for cultivation means .05							5.9
.01							8.6

Table 2. The effect of cultivation used in conjunction with herbicides on yield of field corn. New Brunswick, New Jersey. 1959. (Nixon loam.)

Herbicide	Rate lbs. per acre	Application method	Yield, Bushels per Acre				
			No. of Cultivations				
			0	1	2	4	Mean
Simazin	2	Over all	76.8	81.2	90.9	93.5	85.6
	2	24" band	66.7	82.3	89.2	84.6	80.7
	2	12" band	54.7	71.3	89.8	94.0	77.5
2,4-D Amine	½	Post-emergence	57.7	82.8	87.0	83.1	77.6
No treatment			49.4	79.3	91.7	90.0	77.6
Mean			61.1	79.4	89.7	89.0	
LSD for treatment means .05							5.1
.01							6.7
LSD for cultivation means .05							5.7
.01							8.7

In a comparison of a broadcast or over-all application of simazin with 12- and 24-inch bands over the row, the data in table 2 suggest a weed-free 12-inch band over the row was not sufficient to completely eliminate weed competition even though one cultivation was provided to remove weeds which grew in the center of the rows. A 24-inch band when used in conjunction with one cultivation was sufficient to eliminate weed competition. As in 1958, the maximum yields were obtained in those situations where weeds were adequately controlled either by cultivation or by herbicides.

The data in table 3 shows those yields which were obtained from corn following 2 years of alfalfa. In this situation on a sandy loam soil where weeds were adequately controlled by herbicides, there was no significant increase in yield due to cultivation. Here in an area where the soil was apparently in good tilth, cultivation did nothing to increase yields. The comparison of one cultivation made early or made at lay-by did not show any difference.

Table 3. The effect of cultivations used in conjunction with herbicides on yield of field corn. Jamesburg, N. J. 1959. (Sassafras sandy loam.)

Herbicide	Rate lbs. per acre	Application method	Yield, Bushels per Acre					
			No. of Cultivations					
			0	1E*	1L*	2	4	Mean
Atrazine	2	Pre-emergence	77.1	79.8	79.8	78.9	80.2	79.2
2,4-D amine	½	Post-emergence	76.9	75.7	72.6	83.0	81.2	77.9
No treatment			67.6	79.8	77.2	75.0	76.5	75.2
Mean			73.9	78.4	76.5	79.0	79.3	

*1E - cultivated 2 weeks after emergence (4 leaf stage)
1L - lay-by cultivation

In comparing cultivations and herbicides in each of the first three tables, it is apparent that one or two cultivations and no herbicide will provide yields equal to those given through the use of a herbicide in conjunction with cultivation or when used alone.

Table 4 shows the influence that the timing of the cultivation operation has on the yields of corn. The yields in table 4 show that if a cultivation operation is timely and is effective in removing weeds, that yields will not be reduced significantly. However, if cultivation is delayed due to inclement weather or due to the press of other farm work, then the reduction in yield from weed competition is will provide corn yields equal to those obtained with herbicide and no cultivation or with herbicide and one cultivation, there is a decided advantage in the use of a herbicide if the cultivation cannot be made on time and cannot be made properly to effect maximum weed control. There are also areas in which weeds cannot be effectively controlled by cultivation alone.

Table 4. Yields of field corn as influenced by time of weed removal. New Brunswick, N. J. 1959.

Time Weeds Removed from Emergence	Yield, Bu. per Acre
Weed-free from beginning	94.9
" " after 2 weeks	84.7
" " " 4 weeks	70.8
" " " 6 weeks	65.7
Simazin plus one lay-by cultivation	85.4
LSD .05	4.6
.01	6.7

It is apparent from these data that on heavier soils or in situations where soil is in rather poor tilth as a result of continued previous row cropping that there is an advantage or an increase in yield as a result of cultivation. However, there appears to be little or no benefit from cultivation beyond the initial one or two. Certainly where weed control is provided by herbicides, in most cases two, three and four cultivations are not required for maximum corn yields. On the lighter soil types and in situations such as corn following a meadow crop where the soil is in good tilth, then there appears to be no yield advantage from cultivation as long as weeds are controlled by other means. In all cases, it is important that the weeds are controlled at a very early stage of growth.

Summary

The effect of cultivations when used in conjunction with herbicides on the yield of field corn were evaluated under two soil types and under conditions where corn followed row crops and conditions where corn followed a sod crop. The following points can be concluded from these investigations:

1. One and in some cases two cultivations are needed to provide maximum corn yields on most soil types with the exception of those which are of a light texture and are in excellent tilth as a result of the previous cropping. In most cases there is no advantage of additional cultivations beyond

2. There is no difference whether the one cultivation is made early in the growth of the plant or at lay-by as long as weeds are adequately controlled early in the season.

3. Simazin, atrazine, and 2,4-D provided excellent weed control throughout the entire growing season even if no cultivation is performed.

4. A 12-inch weed-free band over the row plus one cultivation was not sufficient to eliminate weed competition.

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PRELIMINARY RESULTS ON THE USE OF HERBICIDES IN LEGUME ESTABLISHMENT IN SMALL GRAINS

S. N. Fertig 1/

The acreage of small grains grown annually in the Northeast approximates 4.5 million acres. Their use by farmers as a "companion crop" for the establishment of forage seedings is standard practice.

In following this practice, most farmers desire to obtain the optimum from two competing situations: (a) the highest yield of oats, and (b) an excellent legume stand. Under field conditions, it is the unusual combination of climatic, soil and management factors which enables a farmer to achieve both.

Since the introduction of 2,4-D in 1946, research workers have tested hundreds of herbicides on small grains underseeded to legumes. The goal is a degree of selectivity between the common weed species and adapted high yielding legumes including alfalfa and birdsfoot trefoil.

EXPERIMENTAL METHOD AND PROCEDURE

In April 1959 an area of corn stubble was selected on the Agronomy Research Farm at Aurora, New York. The soil was a Honeoye-Lima Silt Loam, high in lime and well to moderately drained.

The experimental design was a split plot with four replications of each treatment for both alfalfa and birdsfoot trefoil underseeded in the oats.

Two identical experiments were established adjacent to each other. They will be reported as Experiments I and II as different herbicides were used on each. All other procedures were identical.

On April 24, certified Garry oats at 2 bushels per acre were drilled in plots 6 x 24 feet with a 2-foot alleyway between plots and a 10-foot alleyway between replicates. On April 25 one-half of each replicate was seeded to Viking birdsfoot trefoil and the other half to DuPuits alfalfa using a 6-foot Brillion seeder. The seeding rate was 8 pounds per acre. The legumes were seeded at right angles to the drilled oats. Immediately following the seeding of the legume, mustard seed at the rate of 12 pounds per acre was broadcast over all plots using a wheel-barrow type seeder.

The treatments included 8 different chemicals involving 25 combinations of rates and mixtures (Tables 1 and 2).

On May 30 when the legumes had 2 to 4 trifoliate leaves, the chemicals were applied using an Allis Chalmers Model "G" tractor especially adapted for plot work. The oats were 6 - 8 inches tall and in the tiller stage of development.

The predominate weed species was mustard with an average stand of ragweed and lamb's-quarters also present.

1/ Professor of Agronomy, Cornell University, Ithaca, New York.

Table 1. Chemicals Used and Source. Experiment 1.

Treat. No.	Common Name or Number	Chemical	Rate/A. Lbs. A.E.	Source*
1	4(2,4-DB)	4(2,4-dichlorophenoxy) butyric acid, di-methyl amine salt	1.0	AmChem
2	4(2,4-DB)		2.0	"
3	4(2,4-DB)		3.0	"
4	4(2,4-DB)		4.0	"
5	MCPA	2-methyl-4-chlorophenoxy-acetic acid	1/8	Dow Chemical
6	2,4-D Amine	2,4-dichlorophenoxyacetic acid	1/4	" "
7	4(2,4-DB) + MCPA		1½ + 1/16	
8	4(2,4-DB) + 2,4-D		1½ + 1/32	
9	4(2,4-DB) + 2,4-D		1½ + 1/16	
10	ACP M-360	4(2,4-dichlorophenoxy) butyric acid butyl ester	1.0	AmChem
11	ACP M-360		2.0	"
12	ACP M-360		3.0	"

Table 2. Chemicals Used and Source. Experiment II.

Treat. No.	Common Name or Number	Chemical	Rate/A. Lbs. A.E.	Source*
1	ACP M-820	4(2,4-dichlorophenoxy) butyric acid, butoxyethanol-ester	1.0	AmChem
2	ACP M-820		2.0	"
3	ACP M-360		3.0	"
4	CMPP		1.0	Upjohn
5	CMPP		2.0	"
6	CMPP		3.0	"
7	ACP M-119	4(2-methyl-4-chlorophenoxy) butyric acid, diethanol-amine salt	1.0	AmChem
8	ACP M-119		2.0	"
9	ACP M-119		3.0	"
10	ACP M-820 + 118		3/4 + 3/4	
11	ACP M-820 + 118		1½ + 1½	
12	Sinox P.E.	4,6-dinitro-o-sec butyl phenol, triethanolamine salt	1¼	Standard. Ag.
13	Check		0	

* The chemicals used in these experiments were provided by the source indicated. The cooperation of these companies is gratefully acknowledged.

The oats were harvested on July 31 using a self-propelled combine Modified for plot harvest. The total harvest of oats from each plot was cleaned weighed, a moisture determination made and test weights taken.

RESULTS AND DISCUSSION

Experiment I

The data were statistically analyzed by the analysis of variance and the Duncan multiple range test. The data are presented in Tables 3 and 4.

The analysis of data by the Duncan multiple range test (Table 4) shows treatments 5, 6 and 7 to be significantly higher than treatments 2, 3, 4, 11, 12 and 13. This means that MCPA and 2,4-D at ¼ pound (treatments 5 and 6) and 4(2,4-DB) + MCPA at 1½ + 1/16 pounds (treatment 7) gave the highest yields. These treatments along with 4(2,4-DB) + 2,4-D (treatments 8 and 9) also resulted in the best control of the weed species present.

Table 3. Yields of Oats and Test Weight. Experiment I

Treat. No.	Chemical	Rate/A. Lbs. A.E.	Seeded to Alfalfa Yield/A. Bu.	Seeded to Alfalfa Test Wt.	Seeded to Birdsfoot Yield/A. Bu.	Seeded to Birdsfoot Test Wt.
1	4(2,4-DB)	1.0	88.2	33.5	101.9	34.1
2	4(2,4-DB)	2.0	88.3	34.0	93.3	34.6
3	4(2,4-DB)	3.0	88.5	33.9	93.7	32.2
4	4(2,4-DB)	4.0	86.3	33.0	92.4	33.4
5	MCPA	¼	102.6	33.4	102.8	33.8
6	2,4-D Amine	¼	99.4	34.5	99.3	33.5
7	4(2,4-DB) + MCPA	1½ + 1/16	106.7	34.1	91.0	33.2
8	4(2,4-DB) + 2,4-D	1½ + 1/32	91.9	33.1	100.2	34.2
9	4(2,4-DB) + 2,4-D	1½ + 1/16	99.3	33.0	97.2	33.1
10	ACP-360	1.0	84.9	34.1	102.1	34.5
11	ACP-360	2.0	90.6	33.6	87.1	34.1
12	ACP-360	3.0	87.3	33.6	86.6	33.5
13	Check		97.6	34.0	83.4	34.2

Analysis of Variance

Source	ss	df	ms	F
Reps.	2,892.61	3		
Legumes	56.57	1	56.57	----
RL (a)	938.67	3	312.89	
Treatments	2,239.65	12	186.64	1.95*
LT	2,557.12	12	179.76	1.88*
Error (b)	6,880.19	72	95.56	

LSD_{05} for treatments - 9.9 bushels

Table 4. The Effect of Herbicides on the Yield of Oats. Experiment I.

Treat No.	Chemical	Rate/A. Lbs. A.E.	Yield in Bu./A., 15% moisture
5	MCPA	¼	102.7
6	2,4-D Amine	¼	99.3
7	4(2,4-DB) + MCPA	1½ + 1/16	98.8
9	4(2,4-DB) + 2,4-D	1½ + 1/16	98.2
8	4(2,4-DB) + 2,4-D	1½ + 1/32	96.0
1	4(2,4-DB) Amine	1.0	95.0
10	ACP M-360	1.0	93.5
3	4(2,4-DB) Amine	3.0	91.1
2	4(2,4-DB) Amine	2.0	90.8
13	Check	0.0	90.5
4	4(2,4-DB) Amine	4.0	89.3
11	ACP M-360	2.0	88.7
12	ACP M-360	3.0	86.9

Statistical Significance -- Duncan's Multiple Range Test 5% Level.

Treatments 5, 6 and 7 were not significantly higher than treatments 1, 8, 9 and 10 at the 5 percent level.

All treatments except the 4(2,4-DB) amine at 1.0 pound per acre gave effective control of mustard which was the predominate weed species. The control of lamb's-quarters and ragweed was variable with the amine formulations of 4(2,4-DB) but was comparable to MCPA and 2,4-D where the esters of butyric were used.

An evaluation of the legume stands in October showed more damage from the MCPA and 2,4-D treatments than from the 1-3 pound rates of 4(2,4-DB) amine formulations. The injury was more severe on both alfalfa and birdsfoot trefoil from the 3-pound rate of 4(2,4-DB) ester than from MCPA or 2,4-D.

Test weight per bushel made on all samples show no effect due to treatment.

Experiment II.

The data from Experiment II was also analyzed by the analysis of variance and the Duncan multiple range test. The data are presented in Tables 5 and 6.

4, 5, 6, 8 and 9 to be significantly higher than the other treatments but not significantly greater than the check. Only Treatments 6 and 8 are significantly higher than the check at the 5 percent level using the analysis of variance.

All treatments except the ACP-119 at 1.0 pound gave satisfactory control of mustard. The control on ragweed and lamb's-quarters was variable with ACP-119 and Sinox P. E. The most effective weed control was with CMPP. Also the injury to legume stand was most severe from CMPP, followed by the ACP-820. Visual rating of the plots would indicate birdsfoot trefoil to be more susceptible than alfalfa to the ACP-820. The least damage to the legume stands occurred with Sinox P. E.

Test weight per bushel values show no significance due to treatment.

Table 5. Yield of Oats and Test Weight. Experiment II

Treat No.	Chemical	Rate/A. Lbs. A.E.	Seeded to Alfalfa Yield/A. Bu.	Seeded to Alfalfa Test Wt.	Seeded to Birdsfoot Yield/A. Bu.	Seeded to Birdsfoot Test Wt.
1	ACP-820	1.0	89.8	35.2	97.1	35.0
2	ACP-820	2.0	85.5	35.4	85.3	34.6
3	ACP-820	3.0	85.8	35.4	86.8	35.5
4	CMPP	1.0	91.3	34.9	103.0	35.4
5	CMPP	2.0	97.8	34.8	101.7	34.8
6	CMPP	3.0	102.4	35.2	102.9	35.1
7	ACP-119	1.0	89.5	36.1	98.9	34.4
8	ACP-119	2.0	105.0	35.9	101.2	35.1
9	ACP-119	3.0	89.7	36.1	105.4	35.8
10	ACP-820 + 118	3/4 + 3/4	92.6	36.0	88.2	34.5
11	ACP-820 + 118	$1\frac{1}{2}$ + $1\frac{1}{2}$	80.8	36.0	89.3	35.4
12	Sinox P.E.	$1\frac{1}{2}$	91.1	35.8	96.4	35.2
13	Check	0.0	91.8	34.1	95.9	35.0

Analysis of Variance

Source	ss	df	ms	F
Reps.	1169.94	3		
Legumes	534.63	1	534.63	2.94
RL	545.01	3	181.67	
Treat.	3503.18	12	291.93	4.41**
LT	851.95	12	71.00	1.07
Error (b)	4764.25	72	66.17	

LSD_{05} for treatments equals 8.2 bushels

Table 6. The Effect of Herbicides on the Yield of Oats. Experiment II.

Treat No.	Chemical	Rate/A. Lbs. A.E.	Yield in Bu/A. at 15% moisture
8	ACP M-119	2.0	103.0
6	CMPP	3.0	102.6
5	CMPP	2.0	99.7
9	ACP M-119	3.0	97.5
4	CMPP	1.0	97.1
7	ACP M-119	1.0	94.2
13	Check	0.0	93.8
12	Sinox P.E.	1¼	93.7
1	ACP M-820	1.0	93.4
10	ACP M-820 4(2,4-DB)	3/4 + 3/4	90.4
3	ACP M-820	3.0	86.3
2	ACP M-820	2.0	85.4
11	ACP M-820 4(2,4-DB)	1½ + 1½	85.0

Statistical Significance Duncan's Multiple Range Test at 5% Level.

SUMMARY

The chemicals most effective in controlling the weed problem were: CMPP, 2,4-D Amine and MCPA. The ester formulations of 4(2,4-DB) were more effective than the amine formulations, with the 4(2,4-DB) formulations being more effective than 4(MCPB).

The highest yield of oats were obtained from the CMPP, 4(MCPB), 2,4-D amine and MCPA treatments. The yields increased with rate of chemical used for both CMPP and 4(MCPB). With theester and amine formulations of 4(2,4-DB) the yields decreased with increasing rate of chemical.

From these and other experiments, the evaluation of legume stands after the removal of the small grain or late in the fall is not a good criteria on which to base forage yields the following year. The combination of competition from the small grain and the herbicide is far more serious than either condition alone. Also, the competition from the small grain is more severe than the rate of herbicide treatment necessary for weed control.

The late fall evaluation of the legume stands showed the highest percentage of legumes both alfalfa and birdsfoot, in the Sinox P. E. treatments.

Weed Control in Maryland Soybeans [1]

John A. Meade and Paul W. Santelmann [2]

The increasing demand for clean soybeans at time of harvest provides the necessary impetus for testing new herbicides in soybeans. Along with the search for new ones, the old ones must be evaluated under a different set of environmental conditions. The clamor from farmers is to find something which will provide clean beans at harvest time. The feeling is that proper cultivation and use of a rotary hoe will give early season control, but the major difficulty is the presence of green weeds at time of harvest. This should be one of the primary requirements for a soybean herbicide.

Procedure

Table 1. The conditions of application of herbicides in soybeans for 1958 and 1959.

		Date of:			At treatment:	
	Experiment	Seeding	Tmt.	Harvest	Air Temp (F)	Soil Moisture
1958	Marlboro Pre-Em.	June 13	June 17	Oct. 31	78°	dry
	Hopkins Pre-Em.	June 6	June 10	Oct. 28	90°	moist
	Hopkins Post-Em.	June 6	A*- 6/11	Oct. 28	A-88°	moist
			B - 6/16		B-70°	moist
			C - 6/24		C-70°	wet
			D - 7/1			
1959	Pre-Em.	June 6	June 8	Oct. 29	86° F	moist
					soil @ 1" 96°	
	Post-Em. granulars	June 6	June 23	Oct. 29	80° F	moist

* A-stage was early crook, B-single pair of leaves, C-first trifoliolate, D-second trifoliolate

The conditions under which the soybean experiments were carried out are listed in table 1. It was decided, in view of the poor yields at the Hopkins Farm in 1957 and 1958, to conduct soybean weed trials only at the Upper Marlboro Tobacco Research Farm in 1959. Its soils are similar to those in our soybean growing area. All plots were 3 rows wide by 20 feet long, replicated 3 or 4 times. The center row was harvested for yield determinations.

1/ Scientific Article No. A816, Contribution No. 3090 of the Maryland Agricultural Experiment Station, Department of Agronomy.

2/ Assistant Professors, Department of Agronomy, Maryland Agricultural Experiment Station, College Park, Maryland.

All liquid applications were made with a bicycle sprayer delivering 30 gpa. The granular materials were applied with a calibrated spreader. The post-emergence granulars in 1959 were applied immediately after cultivation except for one of the EPTC treatments which was applied just prior to the cultivation (incorporated). The incorporated EPTC in the Marlboro 1959 pre-emergence test was worked in with a garden rake. The beans had already started to germinate and it was evident that some beans were pulled out.

The following chemicals were used:

DNBP - Amine form supplied by The Dow Chemical Co.

CDAA - 2-chloro-N,N-diallylacetamide supplied by Monsanto Chemical Co.

NPA - N-1-naphthylphthalamic acid (sodium salt) supplied by the Naugatauck Chemical.

2,4-D - granular form supplied by The Dow Chemical Co.

EPTC - ethyl N,N-di-n-propylthiolcarbamate supplied by Stauffer Chemical Co.

Emid - 2,4-dichlorophenoxyacetamide supplied by Amchem Products, Inc.

Amoben - 3-amino-2,5-dichlorobenzoic acid supplied by Amchem Products, Inc.

DAC-893 - dimethyl 2,3,5,6-tetrachloro tere-phthalate supplied by Diamond Alkali Co.

Zytron - 0-2,4-dichlorophenyl 0-methyl isopropylphosphoramidothioate supplied by The Dow Chemical Co.

Discussion

The results of the Marlboro 1958 and 1959 pre-emergence experiments are shown in table 2.

NPA at 4 lb/A, CDAA at 4 lb/A, and Emid at 3/4 and 1½ lb/A showed good weed control and resulted in yield increases over the check. Granular CDAA at 4 lb/A was not essentially different from the liquid form.

Three new herbicides performed rather well in 1959. Amoben at 2 and 4 lb/A, DAC-893 at 4 lb/A, and Zytron at 12 lb/A all resulted in good weed control. Amoben 4 lb/A was still showing good weed control on July 23, while the 2 lb/A rate was not holding as well.

Table 2. Yield of soybeans and injury ratings of broadleaf and grass weeds from pre-emergence experiments in soybeans for the years 1958 and 1959. Marlboro Tobacco Research Farm. (0 = no injury, 10 = complete kill)

			1958					1959				
	Rate		6/30		7/30		Yield	6/23		7/23		Yield
Chemical	lb/A	Form	Br.	Gr.	Br.	Gr.	(bu/A)	Br.	Gr.	Br.	Gr.	(bu/A)
CDAA	3	liq.	4	4	3	0	27.7	-	-	-	-	-
	4	"	7	7	2	2	22.3	9**	10	4	7	36.3
	4	gran.	-	-	-	-	-	9**	10	6	6	31.0
NPA	2	liq.	3	3	3	2	26.8	-	-	-	-	-
	4	"	6	5	4	7	31.1	-	-	-	-	-
EPTC - un*	2	liq.	2**	4	3	1	27.1	7	9	0	1	23.9
"	4	"	8**	9	7	7	25.6	9**	9	2	5	28.0
"	6	"	9**	8	8	9	31.8					
"	2	gran.						8**	9	2	3	34.2
"	4	"						9**	10	5	8	31.8
EPTC - inc	2	liq.						9**	9	3	7	22.1
"	4	"						10**	10	7	8	31.1
"	2	gran.						10**	10	5	7	28.1
"	4	"						10**	10	9	9	29.7
Amoben	2	liq.						9	7	1	3	31.8
	4	"						9	9	5	7	30.5
DNBP	4	liq.	7	8	2	4	25.6	9	8	8	1	35.4
	6	"	9	8	1	4	27.8	10	9	8	0	36.3
	4	gran.						9	7	3	1	32.2
	6	"						9	9	4	3	34.5
Emid	3/4	liq.	7	6	2	8	28.7					
	1½	"	8**	6	3	7	27.6					
2,4-D	1	gran.						9**	8	4	6	29.4
DAC-893	4	liq.						6	7	0	4	26.0
Zytron	12	"						9	9	2	7	32.4
Ck - no tmt.							19.4					19.7
Ck - cult.							21.5					17.6
Ck - scraped												29.7
					LSD .01 -		7.6					8.6
					LSD .05 -		5.7					6.5

* - "un" and "inc" indicates whether EPTC was unincorporated or incorporated.
** - soybean injury occurred.

Dinitro in 1958 and 1959 resulted in good weed control and showed considerable residual effects in 1959 on broadleaved weeds. DNBP granular at rates equal to the liquid gave similar weed control and yields. The use of 2,4-D granular at 1 lb/A gave very good weed control with only slight early injury symptoms to the soybeans. The yield was significantly increased over the check.

EPTC at all rates and methods of application showed soybean injury ranging from mild to severe but in no instance was yield reduced below the check. In 1959, several of the treatments show significant increases above the check. Weed control initially was excellent and where EPTC was incorporated, this control seemed to hold through the season better than where it was not incorporated.

Granular vs liquid formulations did not show any wide differences in weed control or yield, except that the granular material seemed to give longer weed control than the liquid form.

The results of a post-emergence trial in 1958 are listed in table 3. It appears that timing is critical when using DNBP as a post-emergence treatment. Treatment at single leaf and through the first and second trifoliolate leaf stage causes severe yield reduction.

The Amine form of 2,4-D at 1/8 and 1/4 lb/A resulted in poor weed control (as the main weed was millet) resulting in low yields in both cases. 2,4-DB was also unsatisfactory at the rates used.

The results listed in table 4 indicate the weed control and yields obtained in an experiment to increase the period of weed control. In an attempt to do this, various granular herbicides were applied over the entire plot after the first cultivation (18 days after seeding). Variability in the experiment led to non-significance among treatment yields. The soybeans were 3-5 inches tall at time of treatment.

The EPTC treatments gave fairly good weed control with little lasting injury to the beans. The 2,4-D is of interest since no bean injury was evident and yield was considerably higher than the check. The DNBP did not do a satisfactory job of controlling weeds.

Summary

Various herbicides were applied to soybeans, both pre-emergence and post-emergence in 1958 and 1959. From the date presented, several items may be deduced.

1. The use of DNBP in 1958 and 1959 resulted in good weed control and increased yields.

2. CDAA at 3 and 4 lb/A and NPA at 2 and 4 lb/A gave fair initial weed control but this control did not hold to the second rating except in the case of CDAA granular in 1959.

3. Some new compounds are becoming available and they may have a place in soybean weed control. Amoben at 2 and 4 lb/A is a promising material as is DAC-893 at 4 lb/A or perhaps slightly higher and Zytron at 12 lb/A.

4. The use of EPTC resulted in very good weed control and highly significant increases in yield. The initial injury and some stand reduction did not carry through to the yield.

5. The use of granular herbicides gave the same results generally as their liquid counterparts. The exception was 2,4-D granular at 1 lb/A which resulted in good weed control and a highly significant increase in yield.

6. The benefits of granulars applied after the first cultivation are still problematical but should receive more investigation.

Table 3. Broadleaved and grass weed control ratings and yield data from post-emergence experiment in soybeans. Hopkins Research Farm. 1958. (0 = no injury, 10 = complete kill)

Treatment	Rate (lb/A)	Stage*	Ratings 7/15 Beans	Brlv.	Grass	Yield (bu/A)
DNBP	1½	A	0	3	6	11.4
	3	A	2	10	7	7.4
	1½	B	3	6	1	4.1
	3	B	4	10	7	6.6
	1½	C	3	10	3	2.4
	3	C	8	10	8	2.1
	1½	D	2	6	0	3.4
	3	D	9	6	2	0
2,4-D amine	1/8	B	1	0	0	5.1
	1/4	B	2	7	1	3.2
	1/8	C	4	7	0	1.7
	1/4	C	10	10	1	0
	1/8	D	7	7	0	0
	1/4	D	10	5	0	0
2,4-DB	½	B	4	6	2	3.7
	1	B	5	7	3	1.0
	½	C	9	8	1	0
	1	C	10	10	1	0
	½	D	9	7	0	0
	1	D	10	10	3	0
Cultivated check	-	-	-	-	-	8.3

LSD .01 - 4.4
LSD .05 - 3.2

*A - 6/11 - early crook
B - 6/16 - single leaf (1")
C - 6/24 - 1st trifoliate
D - 7/1 - 2nd trifoliate

Table 4. Broadleaved and grass weed control rating and yield data from a soybean experiment in which all materials were applied in the granular form at the first cultivation. Marlboro Tobacco Research Farm. 1959. (0 = no injury, 10 = complete kill)

Chemical	Rate (lb/A)	7/7/59 Soys	7/7/59 Br.	7/7/59 Gr.	7/23/59 Soys	7/23/59 Br.	7/23/59 Gr.	Yields (bu/A)
EPTC-uninc.	2	0	5	1	1	6	7	23.8
	4	3	0	3	0	2	7	14.5
inc.	2	2	3	5	0	2	5	25.1
	4	3	3	0	1	3	5	21.0
2.4-D	1	3	6	3	0	7	2	24.6
DNBP	4	0	1	0	0	3	2	18.6
	6	0	0	0	0	3	3	17.6
CDAA	4	4	2	5	1	1	4	28.3
Check-cultivated		0	0	0	0	0	0	15.4

PROGRESS REPORT ON HERBICIDES FOR WEED CONTROL IN CORN AND SOYBEANS[1]

William F. Meggitt[2]

There is a continuing search for pre-emergence herbicides that will control both broadleaf and grass weeds in many of our field crops. There is also a search for more efficient means of applying herbicides which are presently available to increase their effectiveness. As each of these new materials or methods is introduced, it is necessary to evaluate it under a variety of environmental conditions. In soybeans there is need for an economical herbicide that will provide control in soybeans, but which will also prevent the presence of weeds at harvest. There is also need for practices which will eliminate the cultivations presently required for weed control in soybeans as this increases the cost of production and the farm work load.

The purpose of this investigation was to further evaluate some of the new herbicides and new formulations for pre-emergence weed control in field corn and soybeans and to further compare these materials with present weed control practices.

PROCEDURE

<u>Corn</u> -- New Jersey #9 field corn was planted in a Sassafras sandy loam on May 26 in hills 42 x 42 inches with 5 seeds per hill. On May 28 plots 4 hills by 11 hills (14 x 38½ feet) were treated with the following herbicides pre-emergence:

2,4-dichlorophenoxy acetic acid (2,4-D)	2 lbs. per acre
2-chloro-4-isopropylamino-6-ethylamino-s-triazine (Atrazine)	2 & 4 lbs. per acre
2-chloro-4,6-bis-(ethylamino)-s-triazine (Simazin)	2 lbs. per acre
Ethyl di-n-propylthiolcarbamate (EPTC)	5 lbs. per acre
n-propyl di-n-propylthiolcarbamate (R-1607)	5 lbs. per acre
ethyl ethyl n-butylthiolcarbamate (R-2060)	5 lbs. per acre
propyl ethyl-n-butylthiolcarbamate (R-2061)	5 lbs. per acre

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[1]Paper of the Journal Series, New Jersey Agr. Exp. Sta., Rutgers--the State University, New Brunswick, N. J.

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Simazin was applied as the 50% and 80% wettable powder and on a granular carrier at a 4% and 8% concentration. 2,4-D was applied as a low volatile ester and as a 6% granular formulation on attaclay. In addition to the pre-emergence application, atrazine as a 50% wettable powder was applied at emergence (spike stage) and 10 days after emergence of the corn (3-4 leaf stage). 3-amino-1,2,4-triazole plus ammonium thiocyanate (Amitrol-T) was also applied at emergence.

The experimental design was a randomized block with 4 replications. All aqueous spray treatments were applied at 40 gallons per acre with a bycycle type plot sprayer as an over-all application. The granular herbicides were applied with a hand shaker by applying the measured amount of material on each plot. Rainfall occurred in this area on June 2 (.47 inch), June 3 (1.41 inch) and June 13 (.97 inch).

Stand counts of corn were made on June 15 and the stand was then thinned to 4 plants per hill. An estimate of the per cent control of broadleaf and grass weeds and a count of broadleaf and grass weeds were made on July 9. Corn height measurements were made on July 24.

The primary weed species in the experimental area were redroot pigweed, ragweed, lambsquarter, barnyard grass, crabgrass. There was no cultivation throughout the growing season except in the handweeded check plots in which two hand-hoeings were made to eliminate weed competition. The plots were harvested on October 13 and moisture samples taken. All yields were then corrected to 15½% moisture.

Soybeans -- On June 7 soybeans (var. Clark) were drilled into a Sassafras sandy loam soil. On June 9 the following herbicides were applied as pre-emergence treatments:

4,6-dinitro-o-sec-butyl phenol (DNBP)	5 lbs. per acre
isopropyl N-(3-chlorophenyl) carbamate	8 lbs. per acre
N-1-naphthylphthalamic acid (NPA)	6 lbs. per acre
dimethyl 2,3,5,6-tetrachloro teraphthlate (DAC-893)	4, 8, 12 lbs.per acre
O-2,4-dichlorophenyl O-methyl isopropylphosphoro amidothidate (M-1329)	5 & 10 lbs. per acre
3-amino,2,5-dichlorobenzoic acid (Amoben)	2, 4, 6 lbs. per acre
EPTC, R-1607, R-2060, R-2061	4 lbs. per acre

Plots were 7 x 30 feet, and the experimental design was a randomized block with 4 replications. The spray and granular applications were made the same as previously mentioned in corn.

Stand counts were made on July 6 and an estimate of the per cent weed control of both broadleaf and grass weeds was made on July 7 by three evaluators independently. The major weed species in the experimental area were ragweed, crabgrass,

RESULTS AND DISCUSSION

The degree of control of broadleaf and grass weeds from the various pre-emergence herbicides applied in corn are shown in table 1. Atrazine at all stages of application provided excellent weed control throughout the entire growing season. The broadleaf weeds that had emerged at the time of the at-emergence and post-emergence applications of atrazine were more readily killed than the grass weeds which had emerged. This indicates the importance of getting the atrazine on the emerged weeds at a very early stage of growth to obtain maximum control. Atrazine was generally slightly more effective in weed control than simazin at a comparable rate.

Table 1. Weed control by several herbicides in field corn. New Brunswick, N. J. 1959.

Herbicide	Formulation	Rate lbs. /A.	Weed Counts July 9 Bd.Lv. per sq. ft.	Weed Counts July 9 Grass per sq. ft.	Weed Control August 15 Bd.Lv. %	Weed Control August 15 Grass %
Atrazine	50% w.p.					
Pre-emergence		2	0.2	1.2	98	92
		4	0.0	0.7	100	95
At emergence		2	0.1	4.2	100	89
		4	0.0	1.4	100	90
10 days post-emergence		2	0.0	2.1	100	91
		4	0.0	0.6	100	95
Simazin	50% w.p.	2	0.2	2.9	95	88
	80% w.p.	2	0.6	4.7	94	85
	4% gran.	2	1.7	17.6	86	52
	8½% gran.	2	2.1	18.9	82	58
2,4-D	LVEster	2	0.7	18.7	90	50
	6% gran.	2	0.4	7.1	90	76
EPTC	Emulsifiable	5	2.2	0.0	81	98
R-1607		5	4.8	0.1	75	97
R-2060		5	5.0	1.7	68	92
R-2061		5	5.2	0.1	70	99
Amitrol-T (at emergence)		3/4	10.9	67.7	20	0
Cultivated Check		-	13.7	68.2	--	--

In a comparison of the 50% wettable powder with the 80% wettable powder applications of simazin there was no difference. Aqueous spray applications of simazin were more effective than equal rates of granular formulations especially in the control of grass weeds. It is felt that the poorer control obtained with the granular applications was due primarily to poor distribution of the material on the soil surface. This poor distribution can partially be accounted for by lack of uniformity

EPTC when incorporated in the soil provided very good weed control throughout the season. The three analogs of EPTC (R-1607, R-2060, R-2061) which were evaluated gave excellent control of grass weeds but gave only fair control of broadleaf weeds when applied as pre-emergence herbicides and incorporated. Amitrol-T at 3/4 pound per acre applied to the corn at the spike stage gave no control of weeds.

The effects of the herbicides on the growth and yield of field corn are shown in table 2.

Table 2. The effect of herbicides on yield of field corn. New Brunswick, N. J. 1959.

Herbicide	Formulation	Rate per acre	Stand count 2 x 10 hills	Height inches, 7/24	Yield Bu. per A.
Atrazine	50% w.p.				
Pre-emergence		2	97.0	97.7	74.1
		4	97.0	95.2	74.3
At emergence		2	91.5	96.1	75.6
		4	88.0	93.0	74.7
10 days post-emergence		2	92.0	98.5	82.7
		4	95.5	93.7	75.8
Simazin	50% w.p.	2	94.7	94.1	77.4
	80% w.p.	2	90.5	91.4	78.0
	4% Gran.	2	93.7	94.9	72.2
	8½% Gran.	2	96.0	99.0	74.2
2,4-D	LVEster	2	89.2	88.7	67.1
	6% Gran	2	84.5	90 1	67.3
EPTC	Emulsifiable	5	80 C	97 8	65 3
R-1607		5	86.7	97.7	72.0
R-2060		5	95.6	94.7	73.1
R-2061		5	88.7	96.2	74.4
Amitrol-T (At emergence)		3/4	88.5	94.6	71.9
Cultivated Check		--	94.7	96.6	73.6
LSD .05			10.1	NS	5.1
.01			14.4		6.7

A consideration of the stand counts shows a significant decrease in stand from EPTC and a trend toward a decrease in stand from 2,4-D granular. There was no significant difference in the height measurements. EPTC, 2,4 D ester and 2,4 D granular gave a highly significant reduction in yield. There was no apparent effect on yields from any other compounds with the exception of 2 pounds of atrazine as a post-emergence application in which the yield was significantly higher and for which there is no apparent explanation. It is apparent from these data that the yield reduction coupled with the apparent reduction in stand from EPTC and possibly 2,4-D, that these two materials applied pre-emergence provided some injury to the corn. There is apparently no added safety factor from the use of 2,4-D granular as might be expected when consideration is made of the possible decreased leachability of the 2,4-D when applied on a granular carrier.

The effects of the herbicide applications in controlling broadleaf and grass weeds and on the yield of soybeans is shown in table 3. DNBP both as a spray and granular formulation at 5 pounds per acre, Amibin at 4 and 8 pounds per acre, and DAC-893 at 8 and 12 pounds per acre provided satisfactory weed control with no reduction in yield. Ragweed was not completely controlled by 4 and 8 pounds of DAC-893. CIPC at 8 pounds per acre provided excellent control of grass weeds but there was a severe infestation of ragweed which was not controlled by CIPC. NPA was only fair in its control of both broadleaf and grass weeds when applied as a granular formulation. Dow M1329 at 5 and 10 pounds gave good control of grasses but it would appear that the rate was not sufficiently high to provide maximum control of broadleaf weeds. In this experiment where EPTC and its derivatives were not incorporated into the soil, 4 pounds per acre of these materials did not provide satisfactory weed control with the exception of EPTC where it controlled annual grasses very satisfactorily.

Table 3. The effect of herbicides on weed control and yield of soybeans. New Brunswick, N. J. 1959.

Herbicide	Rate lbs. /A.	Yield Bu./ Acre	Stand plants per 8 row ft.	Weed Control, per cent Bd.Lv.	Grass
DNBP (Spray)	5	20.4	19	98	92
DNBP (Gran.)	5	23.5	17	97	92
CIPC	8	23.7	20	62	95
NPA (Gran.)	6	25.3	22	62	52
Amibin	2	25.0	21	65	67
"	4	22.7	18	85	87
"	8	25.9	23	95	92
M-1329	5	24.7	20	55	85
"	10	21.6	22	35	80
DAC-893	4	20.5	19	40	53
"	8	29.4	20	78	78
"	12	27.2	17	84	85
EPTC	4	22.2	20	55	85
R-1607	4	23.6	20	27	35
R-2060	4	28.0	22	57	47
R-2061	4	20.0	20	57	37
Check	-	24.0	20	-	-
LSD .05		N.S.	N.S.		

There was no significant reduction in stand or yield of soybeans from any of the herbicidal treatments. NPA produced some observable stunting at the very early stages of growth, however, the beans very rapidly outgrew this stunting effect.

From these studies in 1959 in soybeans it is apparent that no herbicide provided more effective control than the presently used DNBP. However, there have been some rather inconsistent weed control results in the past with this material and it may develop that some of the newer compounds will provide more consistent weed control results year by year and under varying environmental conditions.

Rainfall following treatment with these pre-emergence herbicides was such that it benefited the results obtained.

SUMMARY

Eight herbicides were evaluated for weed control in field corn and 10 herbicides were evaluated for pre-emergence weed control in soybeans.

In field corn several of these materials were evaluated at different stages of growth of the corn. The differences between varying per cent concentrations of both wettable powders and granular formulations were also investigated, as well as comparison between aqueous sprays and granular applications.

The following conclusions can be drawn from these investigations:

1. Atrazine at 2 and 4 pounds per acre provides excellent weed control throughout the season without injury or reduction in yield of field corn.

2. Simazin provided satisfactory weed control when applied pre-emergence with no difference existing between the 50% and 80% wettable powder or between the 4 and 8½% granular formulations. However, poorer control did result from the granular formulation as compared to the wettable powder.

3. In 1959, 2,4-D ester and granular formulation both reduced yields of field corn and provided only moderate control of weedy grasses.

4. Application of 2,4-D on a granular carrier did not improve the safety factor from the standpoint of crop injury.

5. EPTC when incorporated into the soil provided excellent weed control but gave a reduction in corn yield. The analogs gave somewhat poorer weed control than EPTC, especially on

6. In soybeans, DNBP both spray and granular, amibin and DAC-893 provided very satisfactory control of both broadleaf and grass weeds with no reduction in stand or yield.

7. CIPC and Dow M1329 and EPTC gave good control of annual grasses but fair to poor control of broadleaf weeds. Poor weed control was experienced from the analogs of EPTC in situations where they were not incorporated into the soil.

THE EFFECTS OF 2,4-D, 4-(2,4-DB), 2-(2,4-DP), AND SILVEX ON WHEAT AND SPRING OATS

R. D. Ilnicki[1]

Within the last few years several new herbicides in the phenoxyalkylcarboxylic acid family have become available and because of their specificity and activity are finding a place in weed control. 4-(2,4-dichlorophenoxy)butyric acid [4(2,4-DB)], 2-(2,4-dichlorophenoxy)propionic acid [2(2,4-DP)], and 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) are effective in controlling certain weeds that are resistant to 2,4-D.

The stage of growth of a crop at time of spraying for weeds has been recognized as an important factor by many research workers. Critical periods in the development of wheat and oats have been determined when these small grains are injured by herbicidal rates of 2,4-D. Little information is available on the susceptibilities or tolerances of small grains to the phenoxybutyric and phenoxypropionic acids.

Experiments were undertaken (1) to determine if wheat and oats are as susceptible to injury from gamma-phenoxybutyric and alpha-phenoxypropionic acids as they are to the phenoxyacetic acids; and (2) to determine if these newer herbicides can be used on small grains at stages of growth that would be highly susceptible to injury from phenoxyacetic acids.

Wheat was treated with 2,4-D, 4-(2,4-DB), and 2-(2,4-DP) at $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, and 4 pounds per acre and silvex at $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 pounds per acre at the following growth stages: pre-emergence, 3-5 leaves, tillered, fully tillered-early joint, early heading, and early bloom.

Oats were treated with 4-(2,4-DB), 2-(2,4-DP), and silvex at $\frac{1}{2}$, 1, 2, and 4 pounds per acre and 2,4-D at 1, 2, and 4 pounds per acre at the following stages of growth: pre-emergence, 2-leaves, early tiller, tillered-early joint, and early head.

Reductions in stand, tillering, height, and yield, and delays in heading and maturity were recorded.

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Wheat was especially sensitive to all herbicides at rates of 2 pounds and more applied at any stage. 2,4-D effected greater yield reductions than any of the other compounds. The most sensitive period was the pre-emergence stage followed by the 3-5 leaves stage. Pre-emergence applications of all herbicides at 1 pound and more caused significant yield reductions. However, the alpha-phenoxy-priopion acids produced the greatest reductions. 2-(2,4-DP) was more toxic than silvex. Rate for rate, 4-(2,4-DB) was the least toxic and safest material. At the 3-5 leaves stage 2,4-D was the most toxic material followed by 4-(2,4-DB), 2-(2,4-DP), and silvex.

Reductions in oat yield were produced by 2,4-D and silvex at 1 pound and more and with the other herbicides at 4 pounds applied at any growth stage. The most critical period of growth was the early joint stage followed by the early head and pre-emergence stages. At these sensitive stages both 4-(2,4-DB) and 2-(2,4-DP) caused no serious injuries at any rate whereas 2,4-D and silvex produced severe reductions in yield.

Other quantitative measurements will be discussed for wheat and spring oats.

Pre-emergence Crabgrass Results in Pennsylvania - 1959

J. M. Duich [1]

Two important factors in considering the value of a pre-emergence crabgrass control chemical are the period of effective toxicity and residual effect. This study was designed primarily to test the effect of various materials applied just prior to crabgrass germination.

Materials and Methods

The test was conducted on a 3-year old stand of common Kentucky bluegrass. Crabgrass (*D. sanguinalis* and *D. ischaemum*) was seeded into the area following thorough aerification on March 30 to insure a uniform heavy stand. On May 1, the area received a 10-5-5 fertilizer, containing 75% ureaform, at the rate of 25 lbs. per thousand, except for the Pax plots. These plots received 1.7 lbs soluble nitrogen contained in the treatment. The area was maintained at a 1" height of cut.

The experimental design was a split plot with three replications. Individual plots were 4.5' x 15'. The calcium arsenate,Pax, lead arsenate and chlordane treatments were applied by hand following mechanical mixing with 6 quarts of soil. The other treatments were applied with a plot sprayer at 35 p.s.i with 90 gallons of water per acre.

Single treatments were applied on April 15, April 30 and May 18. The first crabgrass seedlings were observed on May 22. For the previous five years, records show that crabgrass germinates in State College under turf between May 13 and 18.

Materials, rates and dates of application are shown in Table 1.

Data were recorded on August 25 and 26. Three random square foot counts were made of each of three replicated plots. The counts were made by actually cutting out every crabgrass plant in the quadrate.

Results and Discussion

The results of the test are shown in Table 1 as surviving crabgrass plants per square foot and percent survival based on the average of nine control plots. It is apparent that percent survival can be a misleading figure since 90% control resulted in 6 surviving plants per square foot under a medium stand of crabgrass. Without competition between crabgrass plants the surviving 10% plants showed evidence of greater spread and seed production.

Zytron and calcium arsenate gave excellent control for all treatment dates. The Pax and arsenate of lead treatment results showed an influence of the date of application, with better control for the earliest date, April 15,

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and poorer control for the following two periods. This may be due to the effect of time on the solubility of the arsenicals they contain.

The chlordane, Fenac, Lilly and simazin treatments showed an opposite effect to the date of application. Better control resulted from the treatments applied just prior to crabgrass germination. This may be an indication of the longevity of the toxic period for these materials.

Simazin resulted in complete kill of the Kentucky bluegrass. The only other material to produce injury was Fenac. It resulted in a wilted appearance of the bluegrass for approximately three weeks following application.

The plots were infected by leafspot, dollarspot and red thread diseases following the period of treatment. None of the herbicides showed evidence of disease control, although the first two Pax treatments contributed to greater leafspot infection due to over-stimulation of the turf from the soluble nitrogen they contain.

Conclusions

1. Zytron and calcium arsenate gave very satisfactory pre-emergence control of crabgrass from single spring applications without injury to common Kentucky bluegrass.

2. Pax and calcium arsenate treatments resulted in better than 75% control, but this was not satisfactory on the basis of plant survival per square foot.

3. Evidence is submitted to show that toxicity of chemicals is affected by date of application in relation to crabgrass germination.

Table 1. Results of pre-emergence crabgrass control test during 1959

Treatment	Rate	Date Applied	Plants Per Sq. Ft.	% Survival *
Zytron (Emulsion)	13 lbs act./acre	4-15	0.3	0.52
		4-30	0.4	0.70
		5-18	0	0
Calcium Arsenate (85%)	16 lbs/M	4-15	0.4	0.70
		4-30	0.6	1.03
		5-18	0.3	0.52
Pax	25 lbs/M	4-15	6	10.34
		4-30	9	15.52
		5-18	13	22.41
Arsenate Lead (90%)	24 lbs/M	4-15	16	27.58
		4-30	20	34.48
		5-18	21	36.20
Chlordane	60 lbs act./acre	4-15	34	58.62
		4-30	18	31.03
		5-18	17	29.31
Fenac M-673A	4 lbs act./acre	4-15	48	82.75
		4-30	28	48.27
		5-18	9	15.52
Lilly AIT-30	8 lbs act./acre	4-15	48	82.75
		4-30	44	75.86
		5-18	26	44.82
Simazin. 50W	3 lbs/acre	4-15	37	63.78
		4-30	34	58.62
		5-18	25	43.10
Control	----	---	58	---

* Based on average of nine control plots

Pre-emergence and Post-emergence Crabgrass Control

Robert G. Mower and John F. Cornman*

Over the past several years, considerable interest has been shown in the use of chemicals for the pre-emergence control of crabgrass. Results have been variable. In some cases, excellent control has been attained, while in others, there have been only mediocre results. Reasons for this variability have not been well established. The purpose of this investigation was to continue our studies of 1958 (1) on the effectiveness of several commercially available materials as well as new experimental products, when applied at two seasons of the year for pre-emergence control of crabgrass. The results of post-emergence trials are also included in this paper in order that the effectiveness of the two methods might be compared.

Materials and methods

The experimental area was located at the Cornell Turf Research Plots, Nassau County Park, East Hempstead, Long Island. The area was rather heavily and uniformly infested with crabgrass during the summer of 1958 and as no chemical treatments had been applied to this area previously, it was selected for pre-emergence crabgrass control studies for 1959. The turf was a good uniform stand of mixed Kentucky bluegrass and red fescue maintained at approximately 1 inch height, well fertilized, and adequately irrigated.

The pre-emergence chemicals were applied at two seasons. Fall treatments were made on October 21, 1958 and the spring treatments on April 8, 1959. Materials received too late for the fall applications were included in the spring treatments only.

The experimental design for both the fall and spring treatments was a complete randomized block. Fall treatments were replicated four times with four plots serving as checks. Spring treatments were replicated three times with seven plots serving as checks. Individual plots were 7 x 7 feet.

At the time of the fall treatment, October 21, 1958, the soil was moist with temperatures in the middle 50's. Cool but clear weather prevailed for one week after treatment. The 1958 crabgrass plants had already been killed by early frosts. Only plant remains were evident.

At the time of the spring treatment, April 8, 1959, the soil was moist from rain showers which occurred over the week preceding treatment. Occasional rain showers continued for one week after treatment. The temperature was in the high 40's.

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The following pre-emergence crabgrass control chemicals were used.

Material	Source
1. Lead arsenate	Allied Chemical and Dye Corp. General Chemical Div. 40 Rector St., New York 6, N. Y.
2. Calcium arsenate - powder	Niagara Chemical Division Food Machinery and Chemical Corp. Middleport, N. Y.
3. Arsenical + fertilizer proprietary "PAX"	Kelly Western Seed Div. of Coop. Assoc. 580 West 13th St., South Salt Lake City, Utah
4. Chlordane (72% emulsion)	Velsicol Chemical Corp. 330 East Grand Ave., Chicago, Ill.
5. Chlordane (10% granular)	"
6. Chlordane-vermiculite proprietary "HALTS" (chlordane 19.7%, related cpds. 7.88%)	O. M. Scott & Sons Co. Marysville, Ohio
7. Fenac - 2,3,6-trichlorophenylacetic acid, sodium salt (Experimental ACP-M-673)	Anchem Products, Inc. Ambler, Pa.
8. DAC-893 - Experimental 50% wettable powder (dimethyl 2,3,5,6-tetrachloro terephthalate	Diamond Alkali Co. Painesville, O.
9. Zytron - Experimental Dow 1481, 8% granular, O-2,4-dichlorophenyl, O-methyl-isopropylphosphoroamidothioate.	Dow Chemical Co. Midland, Mich.
10. Lilly 13489 - Experimental 50% w.p., diphenylacetonitrile	Eli Lilly & Co. Greenfield, Ind.
11. Lilly 13489 - Experimental 8% granular, diphenylacetonitrile	"

Dry formulations (1, 2, 3, 5, 6, 9, 11) were broadcast by hand without diluent. The liquid formulations (4, 7) and wettable powders (8, 10) were applied with a sprinkling can in water at the rate of about 10 gallons per 1,000 sq. ft.

Crabgrass control estimates were made on August 12, 1959. Percent crabgrass control was calculated on the basis of estimated area occupied by crabgrass foliage in the treated plot compared to the amount present in the check

Results and discussion

Fall treatment. Under the conditions of these trials, a number of chemicals used in the fall treatment (Table 1) gave good pre-emergence crabgrass control.

Table 1. Pre-emergence crabgrass control. Cornell-Nassau County Turf Plots. Results of fall treatments applied October 21, 1958, observations, August 12, 1959

Treatment	Rate #/A	Est. % control Av. of 4 reps.	Turf injury
1. Lead arsenate	800	91	0
2. Calcium arsenate	480	90	0
3. Arsenical + fertilizer proprietary	1000	89	Patches of dead turf; some overall browning
4. Chlordane (72% emulsion)	60# a.i.	73	0
5. Chlordane (granular)	60# a.i.	72	0
6. Chlordane and vermiculite proprietary	250# a.i.	53	0
7. Fenac (liquid)	4# a.i.	7	Overall browning; thin turf
"	6# a.i.	15	Appeared to be injury to grass root systems
8. DAC-893 (w.p.)	12# a.i.	100	90% injury to red fescue; bluegrass appeared normal
Crabgrass in check		60%	

Among the commercially available materials, the arsenical compounds were the most effective. Lead arsenate, calcium arsenate and the proprietary arsenical formulation gave approximately 90% reduction in crabgrass. The only evidence of any turf injury occurred in plots treated with the proprietary formulation. In these plots there were small random patches of dead turf. These may have been the result of uneven application or from localized accumulations in small depressions by washing.

The chlordane formulations gave an intermediate level of control. The liquid and granular formulations gave 73% and 72% control respectively. The proprietary formulation was the least effective of the three tested, with only 53% reduction of crabgrass. There was no evidence of any injury to the desirable turf grasses from any chlordane formulation.

Two experimental compounds were included in the fall treatments. Fenac gave only negligible control of crabgrass at the two rates tested. Turf injury was characterized by a rather thin turf, with an overall brown appearance. Many of the existing plants appeared to have stunted root systems. DAC-893 gave complete control of crabgrass. However, severe injury occurred to the red fescue in the plots. After resumption of growth in the spring, the DAC-893 plots were conspicuous because of their somewhat darker green and coarser appearance. Comparison with the check plots showed that the treated plots had only a small percentage of red fescue remaining. There was no apparent injury to the Kentucky bluegrass.

<u>Spring treatments.</u> The results of spring treatments of pre-emergence chemicals are summarized in Table 2.

Table 2. Pre-emergence crabgrass control. Cornell-Nassau County Turf Plots. Results of <u>spring</u> treatments applied April 8, 1959, observations August 12, 1959.

Treatment	Rate #/A	Est. % control Av. of 4 reps.	Turf injury
1. Lead arsenate	800	86	0
2. Calcium arsenate	480	98	0
3. Arsenical + fertilizer proprietary	1000	83	Some patches of dead turf in some reps.
4. Chlordane (72% emulsion)	60# a.i.	83	0
5. Chlordane (granular)	60# a.i.	68	0
6. Chlordane + vermiculite proprietary	250# a.i.	68	0
7. Fenac (liquid)	4# a.i.	46	Root injury to turf grasses; browning
"	6# a.i.	73	"
8. DAC-893 (w.p.)	12# a.i.	98	Injury to red fescue. Little remaining in plots
9. Zytron (granular)	20# a.i.	98	0
10. Lilly (w.p.)	8# a.i.	10	0
"	16# a.i.	50	0
11. Lilly (granular)	16# a.i.	68	0
"	32# a.i.	68	0
Crabgrass in check		60%	

As in the fall, the arsenical compounds were still the most effective. Calcium arsenate gave nearly complete control (98%) of crabgrass. Lead arsenate and the proprietary arsenical formulations were somewhat less effective than they had been in the fall treatments, giving 86 and 83% control, respectively. Again some patches of dead turf were evident in some of the replicates of plots that had been treated with the proprietary formulation.

Crabgrass control with chlordane in spring applications averaged a bit better than from fall treatments but, at the rates used, the chlordane was again less effective than the arsenicals.

Fenac (ACP-M-613), one of the experimental compounds, was considerably more effective in controlling crabgrass in these spring treatments than it had been in the fall but the tolerance range on desirable turf grasses was not improved. Turf injury was rather extensive, with little or no recovery evident during the growing season. As in the fall treatments, the brown, thin turf was apparently the result of injury to the root systems of the existing plants

Zytron (Dow-1481), another experimental product, was included only in the spring treatments. At the rate used it gave nearly complete control of crabgrass. There was little or no turf injury. Under the conditions of these trials, Zytron was the most promising of the new materials tested because of its high degree of crabgrass control in combination with the complete lack of turf injury.

The experimental product of the Lilly Company gave only intermediate to poor crabgrass control. The low rate (8# a.i.) was apparently too low for effective control. The higher rates (16 and 32# a.i.) were more effective but the degree of control was still not as high as that attained with some of the other materials. No turf injury was evident.

Two of the chlordane formulations (granular and emulsion) and the proprietary arsenical-fertilizer formulation used in 1959 had been used in 1958. A comparison of the 1959 results reported here with those reported in our 1958 trials (1) shows that each of these formulations was about 3 times as effective in 1959 as in the previous year. This suggests that results in succeeding years with such successful materials as calcium arsenate and Zytron may also be quite variable and that conservative recommendations for pre-emergence crabgrass control cannot be made based on the results of a single year's experience.

Post-emergence Crabgrass Control

In addition to the pre-emergence crabgrass control investiations, post-emergence control tests were also established. The results of these trials are included here to permit comparison of pre-emergence and post-emergence materials during the 1959 growing season on Long Island.

Materials and methods

The experimental area was located at the Cornell Turf Research Plots, Nassau County Park, East Hempstead, Long Island. The areas selected had a natural seed source of crabgrass. The turf was a good, uniform mixture of Kentucky bluegrass and red fescue essentially like that used in the pre-emergence trials.

Seven plots, each 4 x 30 feet, were laid out in each of two areas. Three-foot check plots were left between adjacent plots. Each chemical was applied to one strip in each area so that each treatment was replicated twice. The following post-emergence chemicals were used in these trials.

Material	Source
1. DMA - Linck's Di-Met (disodium monoethyl arsonate, 15.7%)	O. E. Linck Co., Clifton, N. J.
2. AMA - Artox Crabgrass Killers (octyl ammonium methyl arsonate, 8% and dodecyl ammonium methyl arsonate, 8%)	Nott Manufacturing Co. Mt. Vernon, N. Y.
3. PMA (phenyl mercuric acetate, 10%)	W. A. Cleary Corp. New Brunswick, N. J.
4. PM 2,4-D (phenyl mercuric acetate, 6.7%, and 2,4-D acetic acid, 4.4%)	"
5. Potassium cyanate	American Cyanamid Co., Agricultural

The crabgrass plants were in late two-leaved stage at the time of first application of chemicals on June 23, 1959. A rather dry, cool period in June delayed the usual germination period about one month. Successive applications were made on June 29, July 9, July 23, and July 29, 1959 for a total of five applications on each plot during a five week period. In each instance the rate of application was as recommended by the manufacturer. The soil was moist at the time of each application, either from previous rainfall or irrigation. The temperature at the time of the first application was in the low 80's. Subsequent applications were all made when the temperature was near 90°F.

Estimates of control were made on July 3, July 13 and August 13, 1959. Estimates of control were based on reduction in area occupied by crabgrass foliage when compared to adjacent untreated check strips. The results of these trials are shown in Table 3.

Table 3. Post-emergence crabgrass control. Cornell-Nassau County Turf Plots. Treated June 23, June 29, July 9, July 23, July 29. Plots 4 x 30 feet, duplicated.

Treatments	oz./1,000 sq. ft. Formulation	a.i.	Est. % control Av. of 2 reps. 7/3	7/13	8/3	Turf injury* 7/3	7/13	8/3
1. DMA	10.0	1.57	68	87	96	0.5	0.5	0.0
2. AMA	7.5	0.60	68	89	96	0.0	0.0	0.0
3. PMA	2.0	0.20	60	86	86	2.0	2.0	1.5
4. PMA + 2,4-D	3.0	0.20	75	90	94	3.0	3.0	3.0
5. KOCN	5.0	5.00	60	60	70	3.0	2.5	0.0
Crabgrass in check			80%	80%	90%			

* Turf injury ratings: 0 - none; 1 - slight; 2 - moderate; 3 - severe; 4 - complete browning

Results and discussion

It was interesting to note during the course of these trials that, as the crabgrass plants in the test plot were dying following several applications of chemical, new seedling plants became evident in the test plot. This reinfestation process continued throughout the summer months and accounted, in part, for the number of applications necessary for satisfactory control of crabgrass. The original crabgrass plants had been effectively controlled but the successive flushes of new plants necessitated frequent applications of chemical to keep them in check.

As shown in Table 3, disodium methylarsonate and ammonium methylarsonate gave the most satisfactory control of crabgrass of any of the materials used in these trials. Disodium methyl arsonate produced slight discoloration of the turf but no discoloration was evident in plots treated with ammonium methylarsonate. This was the reverse of 1959 results; then the ammonium methylarsonate produced moderate turf discoloration.

Phenyl mercuric acetate gave fairly good control of crabgrass but produced rather severe turf discoloration. Also, some plants were not affected by the early applications and as they matured were quite resistant to any subsequent applications of chemical. The phenyl mercuric acetate and 2,4-D combination gave excellent control of both crabgrass and other broadleaved species that were in the plot, but turf discoloration was quite severe and recovery was slow after each treatment. The red fescue in the plots was most severely affected.

Potassium cyanate gave an intermediate level of control in these trials. This fits in with other studies where observations have indicated that potassium cyanate is more effective on mature crabgrass plants.

Summary

Under the conditions of these trials, a number of the pre-emergence crabgrass control chemicals tested gave good control of crabgrass. Among the arsenicals, calcium arsenate gave excellent crabgrass control (98%) with no turf injury. Spring treatments were more effective than fall treatments (98% vs. 90%). Lead arsenate and the arsenical-fertilizer proprietary formulation were less effective and treatments with the latter were injurious to the turf. Chlordane formulations ranked third in effectiveness. Spring treatments with chlordane appeared to be somewhat more effective than those in the fall but no extreme differences were observed. Of the experimental products, Zytron appeared to be the most promising. Nearly complete control of crabgrass was attained with no evidence of turf injury. DAC-893 gave equally good crabgrass control but caused serious injury to red fescue. Fenac and the Lilly compound were less effective.

Several post-emergence chemicals gave satisfactory control of crabgrass. The most effective materials were disodium methylarsonate, ammonium methylarsonate and phenyl mercuric acetate. The PMA-2,4-D combination produced excessive turf injury. Potassium cyanate was relatively unsatisfactory in controlling seedling crabgrass.

In general, post-emergence treatments seem to offer the surest means of crabgrass control on the basis of results to date. Results by various investigators over a period of years show that complete or nearly complete crabgrass control may reasonably be expected when treatments are spaced properly and good judgment is used in choosing rates and times of application. The extra labor of repeated treatments and the difficulties of the judgments involved for success with post-emergence materials make the single treatment, pre-emergence materials especially attractive. However, variabilities from year to year indicate that more experience is needed before the most satisfactory pre-emergence materials can be determined and their relative effectiveness estimated with confidence.

Literature Cited

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CRABGRASS CONTROL STUDIES IN TURF

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The reported effective use of herbicides for crabgrass control has created a need to evaluate these materials under local ecological conditions at Blacksburg, Virginia. Two pre-emergence herbicidal crabgrass control studies were conducted during the fall and winter of 1958 and the spring of 1959.

These tests were established on the number one V. P. I. golf course fairway which is of a Groseclose silty loam soil type. A substantially uniform crabgrass infestation was evident from the previous season. The established turf consisted of a mixture of Kentucky bluegrass and creeping red fescue that was maintained at a 1-1/4 inch height. Supplemental irrigation was applied as needed during the summer months. Fertilizer at the rate of 600 pounds of a 10-10-10 was applied in the fall of 1958 and again in the spring of 1959.

The first experiment to be established was one that included Neburon and Chlordane, both of which had been observed to give previous erratic crabgrass control. Also included in this experiment was an experimental material, 2,3,6-Trichlorophenylacetic acid (M-673). Three rates of these materials were applied in November 1958, January 1959, and again in April 1959. The experimental plots were 10 x 6 feet and were arranged in a randomized block design and replicated three times.

Turf density ratings (Table 1) of the seasonal pre-emergence treated plots recorded on May 12 and July 2, 1959, indicated that of the three chemicals used only the 2,3,6-Trichlorophenylacetic acid caused any appreciable reduction in turf density when compared to the check plots.

Under the conditions of this experiment the plots treated with 2,3,6-Trichlorophenylacetic acid, Neburon, and Chlordane were rated as giving poor crabgrass control regardless of the rate or time of treatment. (Table 2)

In the second experiment three rates of Diphenylacetonitrile (L-13489); (p-chlorophenyl) phenylacetonitrile (L-09729); 2,3,5,6 Tetrochlorateréphthate (DAC 893); 0-2,4-Dichlorophenyl-o-methyl, isopropyl-phosphoroamidothioate (Dow M-1329); Calcium arsenate, Chlordane, Neburon, Potassium gibberellate, and Urea-formaldehyde were applied on April 1, 1959. Experimental plots were 10 x 6 feet and arranged in a randomized block design that was replicated three times.

* Instructor in Agronomy and Plant Physiologist, respectively.

Table 1. --Relative turf density ratings under various pre-emergence crabgrass control treatments applied April 1, 1959.

Materials	Rate of Actual Toxicant	Turf Density Ratings* 5/12/59	7/2/59	9/23/59
Diphenylacetonitrile (L-13489)	4 lbs. /A	5.3	8.6	9.3
50% W. P.	8 lbs. /A	6.6	9.3	9.3
	12 lbs. /A	4.6	9.3	9.3
	16 lbs. /A	6.0	8.0	9.0
(p-chlorophenyl) phenylacetonitrile	4 lbs. /A	6.0	8.0	9.3
(L-90729) 50% W. P.	8 lbs. /A	6.6	8.6	10.0
	12 lbs. /A	5.3	8.0	9.0
	16 lbs. /A	8.0	9.3	9.6
0-2,4-Dichlorophenyl-o-methyl,	5 lbs. /A	4.6	10.0	9.6
isopropyl-phosphoramidothioate	10 lbs. /A	4.6	9.3	10.0
(Dow M-1329) 2 lbs./gal. emulsifiable	15 lbs. /A	5.3	8.6	9.3
	20 lbs. /A	7.3	9.3	10.0
Calcium arsenate	215 lbs. /A	6.6	10.0	9.6
73% granular	430 lbs. /A	4.6	8.0	7.3
	645 lbs. /A	6.6	9.3	9.6
	860 lbs. /A	5.3	9.3	9.0
2,3,5,6 Tetrochlorate rephthate	3 lbs. /A	5.3	9.3	9.3
(DAC 893) 50% W. P.	6 lbs. /A	5.3	9.3	9.3
	9 lbs. /A	6.6	9.3	9.6
	12 lbs. /A	6.6	8.6	9.6
Chlordane	50 lbs. /A	6.0	8.0	9.0
78% emulsifiable	60 lbs. /A	6.6	8.6	10.0
	70 lbs. /A	6.0	8.6	9.0
	80 lbs. /A	7.3	10.0	10.0
Neburon	2 lbs. /A	4.6	8.6	10.0
50% W. P.	4 lbs. /A	5.3	9.3	9.6
	6 lbs. /A	8.0	8.6	9.0
	8 lbs. /A	6.0	8.6	8.0
Potassium gibberellate	5 gms/A	5.3	9.3	9.0
25%	10 gms/A	6.0	8.0	9.6
	15 gms/A	6.6	8.6	9.0
	20 gms/A	7.1	10.0	10.0
Urea-formaldehyde	174 lbs N/A	6.6	8.0	9.6
38% N granular	261 lbs N/A	6.6	8.6	10.0
	358 lbs N/A	7.1	9.3	10.0
	522 lbs N/A	8.0	7.3	9.3
Check		6.0	9.5	9.9
LSD .05		2.65	1.84	1.49

* Ratings: 1 = very poor density, 10% or less
10 = excellent density, 90% or better

Table 2.--Relative crabgrass control ratings under various pre-emergence crabgrass control treatments applied April 1, 1959.

Materials	Rate of Actual Toxicant	Crabgrass Control Ratings*	
		8/24/59	9/23/59
Diphenylacetonitrile (L-13489)	4 lbs. /A	1.0	1.6
50% W. P.	8 lbs. /A	8.0	5.6
	12 lbs. /A	4.6	4.0
	16 lbs. /A	3.3	4.3
(p-chlorophenyl) phenylacetonitrile	4 lbs. /A	2.6	4.0
(L-90729) 50% W. P.	8 lbs. /A	3.0	5.3
	12 lbs. /A	4.6	3.6
	16 lbs. /A	5.6	5.0
0-2,4-Dichlorophenyl-o-methyl,	5 lbs. /A	5.6	7.0
isopropyl-phosphoramidathioate	10 lbs. /A	8.0	8.3
(Dow M-1329) 2 lbs. /gal. emulsifiable	15 lbs. /A	8.0	7.3
	20 lbs. /A	9.6	9.3
Calcium arsenate	215 lbs. /A	8.0	7.3
73% granular	430 lbs. /A	9.0	7.0
	645 lbs. /A	8.6	9.3
	860 lbs. /A	9.6	9.6
2,3,5,6 Tetrochlorateregphthate	3 lbs. /A	3.0	2.6
(DAC 893) 50% W. P.	6 lbs. /A	5.6	5.3
	9 lbs. /A	8.0	7.0
	12 lbs. /A	9.6	10.0
Chlordane	50 lbs. /A	5.6	4.3
78% emulsifiable	60 lbs. /A	5.3	[illegible]
	70 lbs. /A	6.6	6.6
	80 lbs. /A	4.0	4.3
Neburon	2 lbs. /A	3.3	3.0
50% W. P.	4 lbs. /A	2.3	5.0
	6 lbs. /A	6.6	6.3
	8 lbs. /A	6.0	5.6
Potassium gibberellate	5 gms/A	2.0	2.0
25%	10 gms/A	3.3	2.0
	15 gms/A	4.0	4.3
	20 gms/A	1.6	2.3
Urea-formaldehyde	174 lbs N/A	6.0	4.0
38% N granular	261 lbs N/A	2.3	2.6
	358 lbs N/A	2.6	5.0
	522 lbs N/A	5.0	5.3
Check		3.1	3.1
LSD .05		5.13	2.55

* Ratings: 1 = very poor control, [illegible]

Table 3.--Relative turf density ratings under various pre-emergence crabgrass control treatments applied during the fall of 1958 and the winter and spring of 1959.

Materials	Actual Toxicant Lbs./A	Season Applied	Turf Density Ratings* 5/12/59	7/2/59	9/23/59
2,3,6-Trichlorophenylacetic acid	3	Fall	5.3	7.3	9.3
1-1/2 lbs./gal. emulsifiable	3	Winter	6.0	7.3	8.3
(M-673)	3	Spring	6.6	9.3	8.3
	6	Fall	4.6	6.6	6.6
	6	Winter	4.0	6.0	8.0
	6	Spring	6.0	8.0	9.3
	9	Fall	3.3	4.0	9.0
	9	Winter	4.6	4.6	9.0
	9	Spring	4.0	5.3	9.3
Neburon - 50% W.P.	4	Fall	6.6	8.6	10.0
	4	Winter	8.0	10.0	10.0
	4	Spring	7.3	9.3	10.0
	6	Fall	7.3	8.6	7.3
	6	Winter	7.3	10.0	9.6
	6	Spring	6.6	9.3	9.3
	8	Fall	6.6	8.0	8.3
	8	Winter	7.3	9.3	9.3
	8	Spring	7.3	10.0	8.0
Chlordane - 75% emulsifiable	30	Fall	7.3	10.0	9.3
	30	Winter	6.0	9.3	9.6
	30	Spring	7.3	9.3	7.6
	60	Fall	8.0	10.0	10.0
	60	Winter	8.0	10.0	9.3
	60	Spring	8.0	10.0	8.3
	90	Fall	6.6	9.3	10.0
	90	Winter	8.0	10.0	6.0
	90	Spring	7.3	9.3	10.0
Check			7.3	9.5	8.7
LSD .05			2.16	1.46	3.10

* Ratings: 1 = very poor density, 10% or less
10 = excellent density, 90% or better

Table 4. --Relative crabgrass control ratings under various pre-emergence crabgrass control treatments applied during the fall of 1958 and the winter and spring of 1959.

Materials	Actual Toxicant Lbs. /A	Season Applied	Crabgrass Control Ratings* 8/24/59	9/23/59
2,3,6-Trichlorophenylacetic acid	3	Fall	3.3	5.3
1-1/2 lbs. /gal. emulsifiable	3	Winter	3.0	4.3
	3	Spring	1.6	3.6
	6	Fall	1.0	3.0
	6	Winter	1.3	2.6
	6	Spring	3.3	5.0
	9	Fall	3.0	3.3
	9	Winter	1.0	3.3
	9	Spring	1.6	2.0
Neburon - 50% W. P.	4	Fall	2.6	4.3
	4	Winter	1.0	3.0
	4	Spring	1.0	3.3
	6	Fall	3.6	4.0
	6	Winter	3.0	4.0
	6	Spring	5.3	6.6
	8	Fall	3.6	3.6
	8	Winter	4.6	4.6
	8	Spring	1.6	2.6
Chlordane - 75% emulsifiable	30	Fall	3.6	5.0
	30	Winter	2.0	4.6
	30	Spring	2.6	4.6
	60	Fall	4.0	4.6
	60	Winter	1.6	3.0
	60	Spring	2.3	3.3
	90	Fall	2.3	3.0
	90	Winter	2.6	3.0
	90	Spring	1.0	3.0
Check			2.1	4.7
LSD .05			2.04	2.80

* Ratings: 1 = very poor control, 10% or less
10 = excellent control, 90% or better

Data obtained from these treatments are given in Tables 3 and 4. The Dow M-1329 material at 20 pounds per acre, the DAC 893 material at 12 pounds per acre, and Calcium arsenate at 645 pounds and 860 pounds per acre were rated on August 24 and September 23 as giving excellent crabgrass control.

The others did not control crabgrass satisfactorily. The Potassium gibberellate and the Urea-formaldehyde treatments did not reduce crabgrass significantly and may require several yearly applications before satisfactory results are obtained. No chemical included in this test was rated as seriously reducing turf density.

Although only one year's results of these materials have been obtained under conditions at Blacksburg, Virginia, the Dow M-1329 and DAC 893 materials have shown promise of excellent pre-emergence crabgrass control properties. Further studies are now underway to investigate higher rates and the effects of seasonal applications. Other tests, including the evaluation of the toxic effects of these new materials on creeping bentgrass will be initiated in the spring of 1960.

Post-Emergence Crabgrass Control with Chemicals in Lawn Turf[1]

E. J. Mace and J. A. DeFrance[2]

Crabgrass has always been a difficult weed to control. The material that has proven most successful for several years at the Rhode Island Agricultural Experiment Station has been phenyl mercuric acetate (1) (2) (4). The use of disodium methyl arsonate (2) (3) (4) and ammonium methyl arsonate (4) have received attention recently.

Materials and Methods

This post-emergence crabgrass experiment was conducted on the turfgrass experimental plot area at the University of Rhode Island. The turf consisted mostly of Rhode Island Colonial bentgrass which was maintained at a 1-inch cut and received no other attention during the year. Smooth crabgrass (*Digitaria ischaemum*) and Hawkweed (*Hieracium* sp.) infested the area fairly uniformly.

The experimental area was 100 feet by 25 feet and was divided up into 50 plots, each having an area of 50 square feet. The plots or treatments were replicated 3 times and 5 check plots were randomized throughout the area.

The herbicidal materials used, the percent active ingredient in each compound, and the rates of application were as follows:

1. PMA — (10% phenylmercuric acetate) at 2.5 ounces per 1000 square feet.
2. AMA — (8.0% octyl ammonium methyl arsenate plus 8.0% dodicyl ammonium methyl arsenate) at 4 and 8 ounces per 1000 square feet.
3. DMA — (44% disodium methyl arsenate) at 2.7 and 5.3 ounces per 1000 square feet.
4. DMA — (2.5% disodium methyl arsenate hexahydrate) applied with a mechanical spreader at 3.6 and 7.2 pounds per 1000 square feet. The chemical is impregnated on vermiculite.
5. N-butyl-2 propoxybenzoate — (85% active) at 3.0 and 6.0 ounces per 1000 square feet.
6. N-butyl-2 propoxybenzoate plus 12.6% DMA applied at rates of 3 and 1 ounce, and at 6 and 2 ounces per 1000 square feet, respectively, for the first and second treatments.

The first treatment was applied July 17, 1959, when the crabgrass was in the 3 and 4-leaf stage. Twelve days later, July 29, the second treatment was

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[1]Contribution No. 991 Rhode Island Agricultural Experiment Station.

applied. The temperature was 85 and 88°F on both dates. Rainfall for July was 4.23 inches and rainfall from January to October 31.5 inches. Control was determined by taking visual observation of percent crabgrass before treatment and comparing that to the amount of crabgrass remaining in the plots after treatment. Final crabgrass readings were taken September 29, 1959. Discoloration of basic turfgrass is rated on the basis of a 0 to 5 scale which is indicated at the bottom of Table I. The discoloration readings were taken 7 days after each treatment was applied.

All materials were applied with a power sprayer in 5 gallons of water except the 2.5% DMA which was applied with a mechanical spreader. All rates referred to are on the 1000 square feet basis.

Results and Discussion

Table I shows the results obtained with the various chemical materials used in this experiment.

PMA (10%) at 2.5 ounces provided 90 percent control after the first application and 92 percent control after two applications. Discoloration was slight after the first application and increased slightly more after the second application.

AMA (16.0%) gave 54 and 73 percent control with one and two applications respectively, at the 4 ounce rate. At the 8 ounce rate 99 percent control resulted after both applications. There was only a trace of discoloration from both treatments.

DMA (2.5%) was 91 and 100 percent effective after one and two applications respectively at the 3.6 pound rate. The 7.2 pound rate gave 97 percent control with one application, and 100 percent control from two applications. (There was only a trace of discoloration at the lower rate. Moderate discoloration resulted after two applications at the heavier rate.) There were comparable results from both DMA materials although one was applied in solution and the other was applied in the granular form.

N-butyl-2 propoxybenzoate gave no control at either the 3- or 6-ounce rate. The slight discoloration at the heavy rate after the first application may have been caused by the high temperature.

Three ounces of propoxybenzoate plus one ounce of DMA (12.6%) gave no control with either one or two applications. At the double rate there was 6 percent control after one application and 64 percent control after the second treatment. The slight discoloration that resulted from the first treatment may be attributed to the high temperature.

No permanent injury was observed on any of the treated plots at the end of the experiment and when final notes were recorded.

It is interesting to note that there was a visual increase of 300 percent crabgrass in the check plots.

Summary and Conclusions

Post-emergence crabgrass control tests were conducted at the Rhode Island Agricultural Experiment Station in the summer of 1959. Chemicals used included PMA, DMA, AMA, and N-butyl-2 propoxybenzoate. Two applications were applied, the first on July 17, and the second on July 29. The crabgrass was in the 3 and 4-leaf stage at the time of the first treatment. The temperature was between 85° and 88°F on both days. All rates referred to are on the 1000 square feet basis.

PMA, DMA, and AMA gave very effective control in this experiment. PMA was 92 percent effective after two applications at the 2.5 ounce rate but slight to moderate discoloration resulted. An 8.0 ounce rate of AMA gave 99 percent control and was more effective than a 4.0 ounce rate with no increase in discoloration.

DMA (44%) gave 100 percent control with one application at 2.7 ounces. One hundred percent control was obtained with two applications of 2.5 percent DMA granular material at a 3.6 pound rate. Discoloration was very slight for both DMA material at these rates.

N-butyl-2 propoxybenzoate was not effective at the rates used. However, when 2 ounces of a 12.6 percent DMA was added to 6 ounces of this material 64 percent control was obtained with 2 applications. No discoloration was visible after the second treatment.

Discoloration of the turf was transitory and could not be noticed at the end of the experiment.

Acknowledgements

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Table 1. Post-emergence Crabgrass Control in Lawn Turf with Chemicals. Rhode Island Agricultural Experiment Station. 1959.

Material	% Active Ingredient	Rate per 1000 Sq. Ft.	% Crabgrass Before Trt	% Crabgrass After 1st Trt	% Crabgrass After 2nd Trt	% Control After 1st Trt	% Control After 2nd Trt	Discoloration* After 1st Trt	Discoloration* After 2nd Trt
PMA	(10)	2.5 oz.	23	2.2	1.8	90	92	1.2	1.5
AMA	(16)	4.0	16	7.3	4.3	54	73	T	T
AMA	(16)	8.0	11	T**	T	99	99	.4	T
DMA	(44)	2.7	9	0	0	100	100	.5	T
DMA	(44)	5.3	16	0.5	0	97	100	.7	1.8
DMA	(2.5)	3.6 lbs.	17	1.5	T	91	100	0	T
DMA	(2.5)	7.2 lbs.	21	0.66	0.07	97	100	T	1.7
N-butyl-2 propoxybenzoate	(85)	3.0 oz.	19	41.6	42.3	0	0	0	0
N-butyl-2 propoxybenzoate	(85)	6.0	13	27.3	16.7	0	0	1.2	0
N-butyl-2-propoxybenzoate + DMA	(12.6)	3.0 1.0	17	30.7	19.3	0	0	0	0
N-butyl-2-propoxybenzoate + DMA	(12.6)	6.0 2.0	13	12.3	4.7	6	64	.7	0
Check		–	13	39.4	33.0	–	–	0	0

*Discoloration Index: 0 = none, T = trace, 1 = slight, 2 = moderate, 3 = severe, 4 = very severe, 5 = permanent injury.

**T = Trace, less than 0.1 percent.

Treatments were applied: July 17 and 29.

Discoloration readings: July 24 and August 5.

Pre-Emergence Crabgrass Control in Lawns [1]

Paul W. Santelmann and John A. Meade [2]

In recent years there has been increased interest in the use of pre-emergence herbicides for the control of crabgrass in lawns. In 1958 and 1959, trials were established to determine the usefulness of these herbicides to Maryland home-owners. Chlordane treatments have received considerable interest from lawn owners in this area, with the accompanying question as to the effect of this herbicide on newly seeded grasses. Seedings of Kentucky bluegrass and perennial ryegrass were made 2 to 3 weeks before and after chlordane treatments to determine seeded grass susceptibility.

Procedure

The herbicides used in 1958 and 1959 were as follows:

Chlordane - either 10% granular or 72% emulsifiable concentrate of the Velsicol Chemical Corp., used at 60 lb/A in 1958, 70 lb/A in 1959. In 1959, the O. M. Scott & Son 20% granular chlordane (Halts) was used.

Fenac - 2,3,6 trichlorophenylacetic acid, sodium salt, of Amchem Products, Inc.

DAC-893 - dimethyl 2,3,5,6 tetrachloro tere-phthalate of the Diamond Alkali Company.

Zytron - O-2,4-dichlorophenyl O-methyl isopropylphosphoramidothioate of the Dow Chemical Co. The Zytron emulsifiable is 2 lbs per gallon active ingredient, the Zytron granular is 8% active on vermiculite.

PAX - a trade product containing various forms of arsenic, nitrogen and chlordane.

The pre-emergence treatments in 1958 were applied on April 28. Treatments for 1959 were made on two different dates. The first was on November 25, 1958, the second on March 20, 1959. All of these treatments were made in a well established Kentucky bluegrass lawn on the University campus. Liquid materials were

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1/ Scientific Article No. A815, Contribution No. 3089, of the Maryland Agricultural Experiment Station, Department of Agronomy.

2/ Assistant Professors, Department of Agronomy, Maryland Agricultural Experiment Station, College Park, Maryland.

sprayed in ½ gallon of water per 100 square feet. Granular materials were applied with a calibrated spreader. The plots were 100 square feet in size and replicated 3 times.

In the trials in which Kentucky bluegrass and ryegrass were seeded, there were either 2 or 3 dates of application. The following shows the herbicide application dates and the seeding dates for each treatment.

1. Grasses seeded 16 to 21 days before application of herbicide. In 1958, the seeding was on April 9, herbicide applied on April 25. In 1959, seeding on March 24, treatment on April 14.

2. Herbicide applied prior to seeding of grasses. 1958 - application on April 17, seeding on May 2. 1959 - application on March 24, seeding on April 14.

3. Grasses seeded and raked in, then the herbicide applied the same day - March 24, 1959.

Thus, the grasses were seeded either 15 days before or after the chlordane was applied in 1958. In 1959, the grasses were seeded at the same time the chemicals were applied, or else 21 days before or after the chlordane was applied. The plots were 50 square feet in size replicated 3 times. Two forms of chlordane were used at 60 to 70 lb/A, Fenac at 6 lb/A in 1959.

On July 7, 1958 and May 25, 1959, estimations of the percent of grass stand as compared to the untreated check were made by 3 people.

Results

Crabgrass control with chlordane was quite variable, both within and between experiments. In general, the 10% granular formulation appeared to be more effective than the 72% emulsifiable concentrate. No treatment in the experiments resulted in perfect crabgrass control. In all experiments, the degree of control dropped off somewhat as the season progressed. Spring treatment with chlordane appeared preferable to fall treatment where the 10% granular form was used, but not with the emulsifiable concentrate.

Fenac and PAX were the only treatments that resulted in turf injury. It was particularly severe with the PAX, the bluegrass being severely thinned-out. Injury with the Fenac at 6 lb/A was noticable but light.

Both the D.A.C.-893 and the Zytrons resulted in good crabgrass control with no turf injury. The liquid form of the Zytron appeared to be slightly superior to the granular.

Table 1. Percent control of crabgrass by herbicides applied on one of 3 different dates in 1958 or 1959. Rating on 7/25/58 or 7/20/59.

Chemical	Rate (lb/A)	Date of treatment 5/28/58	11/25/58	3/20/59
Chlordane - 10%	70	60	62	78
- 72%	70	35	50	40
- 20%	*	-	30	30
Fenac	4	-	10	37
	6	-	17	38
D.A.C.-893	5	-	-	83
	10	-	-	88
Zytron emuls.	15	-	-	67
	20	-	-	85
Zytron gran.	15	-	-	70
	20	-	-	72
PAX	1080	-	87	80

* at spreader setting recommended by the manufacturer.

Table 2 shows the effect of chlordane & fenac on seeded grasses. The fenac was toxic to bluegrass whether applied 21 days before or after seeding. Ryegrass was more resistant. Ryegrass in general appeared to be more resistant to chlordane than bluegrass, perhaps due to its much faster rate of growth. If the grasses were seeded 16 to 21 days before the herbicide was applied, they were not killed by granular chlordane. Bluegrass was partially injured if the liquid form was used. If the chlordane was applied 16 to 21 days before the grasses were seeded, most of the bluegrass was killed. In 1958, the ryegrass was also killed, but a large part of it survived in 1959. The same results were found if the two treatments (seeding & treating) were done on the same day.

Summary

Pre-emergence crabgrass control plots were established in a Kentucky bluegrass lawn in 1958 & 1959. The control obtained with chlordane was quite variable, but in general better results were obtained with a 10% granular form than with the 72% emulsifiable concentrate. The degree of control varied from 35 to 78%. Fenac was not as satisfactory as the chlordane. D.A.C.-893 and Zytron appeared to be very promising. PAX did well but injured the turf.

In another experiment, Kentucky bluegrass and perennial ryegrass were seeded before or after chlordane or fenac treatments were applied. Both grasses survived to a large degree if seeded 15 to 21 days before chlordane treatment. Ryegrass was less susceptible to fenac than bluegrass. When seeded 15 to 21 days after chlordane treatment, both grasses were severely reduced in stand. However, the grass showed some resistance.

Table 2. Effect of chlordane and fenac on seedling establishment of Kentucky bluegrass or perennial ryegrass, given as the % of stand as compared to the untreated check.

Tmt. No.	First treatment	Chemical	1958 Bluegr.	1958 Ryegr.	1959 Bluegr.	1959 Ryegr.
1	Grasses seeded	Chlordane 10%	100	100	100	100
		Chlordane 72%	30	100	75	100
		Fenac	-	-	0	100
2	Chemical applied	Chlordane 10%	0	0	20	70
		Chlordane 72%	0	30	20	80
		Fenac	-	-	45	75
3	Grass & chemical together	Chlordane 10%	-	-	5	95
		Chlordane 72%	-	-	15	100
		Fenac	-	-	5	75

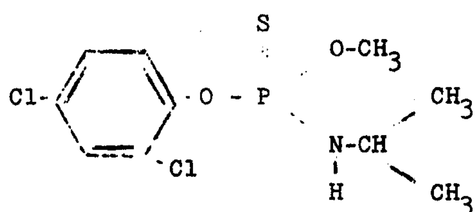
A NEW HERBICIDE FOR TURF - ZYTRON*

by

Mark G Wiltse
The Dow Chemical Company

The Dow Chemical Company has discovered a new herbicide which has proved to be unusually selective for the control of some annual grasses and weeds in turf. Seasonal control of crabgrass (Digitaria spp.) has been obtained with a single pre-emergence treatment without injury to bluegrass turf.

This new herbicide is known chemically as O-(2,4-dichlorophenyl) O-methyl phosphoramidothioate and has the following structure:



Zytron is formulated as an emulsifiable concentrate containing two pounds of the active ingredient per gallon or as a granular upon an inert carrier. such as vermiculite or clay.

Safety to the User

Zytron is a safe herbicide to use. While tests have shown that it can be absorbed through the skin, it has very low toxicity by this route. The LD_{50} for dogs and cats is greater than 1.0 gram per kilogram of body weight and thus has a moderate to low acute oral mammalian toxicity. Ordinary

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*Zytron is a trademark for Dow O-(2 4-dichlorophenyl) O-methyl phosphoramidothioate.

precautions necessary when handling any agricultural chemical are sufficient for the safe use of Zytron.

Some Experimental Results

Zytron has been extensively tested by The Dow Chemical Company in several areas of the country. It was made available for test work by cooperators outside of the company in 1959 and several tests were conducted in the Northeast.

Control of Crabgrass

A single pre-emergence application of 20 lbs/A has given season-long control of crabgrass. Applications after crabgrass emergence have generally been less effective than pre-emergence treatments. Emulsifiable sprays of 20 to 40 lbs/A have given better control than lower rates in early post-emergence treatments.

A summary of some of the tests conducted in the Northeast in 1959 is presented in Table I. Control ratings were made in August or September. These tests were conducted in ten locations and represent a variety of soils and turf grasses, as well as rainfall and temperature conditions. Although individual ratings were not entirely consistent, the averages are of interest from the standpoint of generally excellent results under a variety of conditions. The average ratings include plots which showed relatively poor control where applications were made under continuous drought conditions. Treatments applied under similar drought conditions, but sprinkler irrigated, gave excellent crabgrass control. These results indicate the possible importance of rainfall or watering shortly after application of Zytron. Certainly, one effect of such water addition is to get the chemical in close contact with the soil, and hence the germinating crabgrass seedlings. In general, Zytron gave better crabgrass control on properly managed, healthy turf.

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Table II. Crabgrass Control Ratings on Turf Treated with Zytron Emulsifiable at Three Dates and Rates.

0 = no control
10 = complete control

Date of Treatment	Rate per acre lbs	Stage of Growth	Crabgrass Control Ratings	
			9/17/58	9/15/59
5/10/58	5	2-leaf stage	7	0
	10		9	4
	20		9	6
8/7/58	5	Boot stage	1	1
	10		2	5
	20		4	8
9/6/58	5	Seeds in milk	3	2
	10		6	8
	20		9	9

Effect on Other Turf Weeds

Applied pre-emergence, Zytron also appears to be effective on the following small seeded annual grasses and broadleaved weeds:

Annual Grasses

Foxtails (*Setaria* spp.)
Barnyard grass (*Echinochloa crusgalli*)
Goose grass (*Eleusine indica*)
Tickle grass (*Panicum* spp.)

Broadleaved Weeds

Red-root pigweed (*Amaranthus retroflexus*)
Purslane (*Portulaca* spp.)
Lambsquarters (*Chenopodium album*)
Annual morning glory (*Ipomoea* spp.)

Post-emergence sprays have shown promise in the control of nimblewill (*Muhlenbergia schreberi*), common chickweed (*Stellaria media*), mouse-ear chickweed (*Cerastium vulgatium*), henbit (*Lamium amplexocaule*), oxalis (*Oxalis stricta*) and with early post-emergence sprays on dooryard knotweed (*Polygonum*

Table III presents the control ratings on several weeds treated in the early spring with Zytron emulsifiable at 20 lbs/A. Observations were made June 9 on these plots applied in the vicinity of Washington, D. C.

Dooryard knotweed has been controlled most effectively with applications in the early stages of seedling growth. Chickweed was controlled while flowering.

Nimblewill control has been most effective with Zytron emulsifiable at 20 to 40 lbs/A applied in July. Some areas have required repeat treatment to maintain control.

Table III. Control Ratings from March Applications of Zytron Emulsifiable at 20 lbs/A.

0 = no control
10 = complete control

Weed Species	Application Dates and Control Ratings	
	March 11	March 27
Dooryard knotweed	10	9
Common and Mouse-ear chickweed	10	10
Henbit	10	10
Crabgrass	9	8

Tolerance of Turf Grasses and Ornamentals

Merion and Kentucky bluegrass are especially tolerant to Zytron treatment. The fescues (*Festuca* spp.) are less tolerant and slight burning or temporary retardation has been observed from Zytron sprays. The stoloniferous grasses have occasionally shown some temporary injury. Recovery usually has been rapid, however, and injury symptoms were normally outgrown within a few weeks. Granular formulations have caused little or no injury.

Established ornamentals and garden plants are not highly sensitive to Zytron and there is little if any danger from small amounts of spray drift. Cultivated iris, however, is fairly susceptible and care should be used in applications close to iris.

Zytron is not ordinarily effective for the control of perennial weeds in turf and does not control such weeds as dandelion (*Taraxacum officinale*), dock (*Rumex* spp.), established tall fescue (*Festuca elatior*), dallis grass (*Paspalum* spp.) or quackgrass (*Agropyron repens*).

Control of Insects

At rates used for crabgrass control, Zytron appears to be an effective insecticide for several soil inhabiting insects. Japanese beetle grubs; June beetle grubs and ants have been controlled with rates used for pre-emergence crabgrass control. More information is needed to establish optimum rates on these and other lawn pests. Whether the recommended application time for best crabgrass control is satisfactory for effective turf insect control needs further confirmation.

Effect on Turf Grass Seedings

Tests have indicated that Zytron can adversely affect new bluegrass seedings, unless an interval of 10 weeks is allowed between Zytron application and seeding. Spring treated areas can be safely seeded in the fall, which is a good time for establishing new lawns or reseeding old ones.

A fall seeding that is well established can normally be treated safely in the spring. Spring seedings probably should not be treated until the following spring.

Summary:

Zytron, a new herbicide developed by The Dow Chemical Company, has provided effective control of crabgrass and several other turf weeds including chickweed, dooryard knotweed, henbit and oxalis from early spring pre-emergence application. There is limited evidence indicating that rain or sprinkler irrigation shortly after application may be helpful in assuring uniform results.

Physiologically, its activity is as a root toxicant to germinating seedlings, and as a selective foliar contact herbicide, where used as a post-emergence spray. Systemic seedicidal activity has been indicated in limited tests on maturing crabgrass plants.

Excellent crabgrass control for the season has been obtained with pre-emergence treatment using 15 to 20 lbs/A, either as a spray or granular application. Early post-emergence application on emerging crabgrass has also been

Applications in the early fall when the crabgrass seed is developing have shown promise in controlling crabgrass infestations the following season.

Kentucky and Merion bluegrasses are especially tolerant to Zytron, while other established turf grasses have occasionally exhibited temporary foliage injury after treatment. Usually recovery of affected grasses is rapid. Reseeding treated areas should be delayed probably for at least 10 weeks.

Zytron has shown considerable promise as an insecticide for certain turf insects.

PRE-EMERGENCE CONTROL OF CRABGRASS AND OTHER WEEDS IN TURF BY DAC-893

L. E. Limpel, Paul H. Schuldt, and David Lamont

Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y.

Abstract 1/

Two years' field trials of DAC-893 (dimethyl 2,3,5,6-tetrachloroterephthalate), for pre-emergence control of crabgrass in established turf, indicate that the chemical possesses great promise. This unique herbicidal compound is the result of a coordinated research program of the Diamond Alkali Company and the Boyce Thompson Institute.

In 1958, a series of small plot field tests was undertaken to compare various pre-emergence crabgrass control agents. Very good to excellent seasonal control was obtained by a single application of 12 pounds of DAC-893 per acre before crabgrass germination. Both species (Digitaria sanguinalis and D. ischaemum) appeared equally susceptible. The best commercial materials were neburon at 6 pounds per acre, which, however, caused severe turf damage, and chlordane at 60 pounds per acre. Highland bentgrass and Kentucky bluegrass were not injured by DAC-893, but red fescues were sometimes thinned.

In the 1959 field trials, DAC-893, pound for pound, was the most effective material tested. Fenac was nearly as active against crabgrass, but caused extremely severe turf injury. The best commercial material was granular calcium arsenate at 444 pounds per acre. Two DAC-893 granular formulations (1.25% active), applied at 10 pounds active per acre, provided crabgrass control equivalent to that of the 50% wettable powder at the same rate. There was no evidence of antagonism between DAC-893 and a lawn fertilizer when the two were applied in combination. In a December 1958 application, DAC-893 was appreciably less effective than applications made the following spring. Goosegrass (Eleusine indica) and milky spurge (Euphorbia maculata) were both found to be moderately susceptible. Newly established Kentucky bluegrass, Merion bluegrass, Astoria bentgrass, and perennial ryegrass were treated two months after spring seeding and were tolerant to excessive rates of the chemical. However, newly established Chewing's fescue was thinned. In both years, fall seeding of turf grasses, in spring treated plots, was done without subsequent damage to the seedling grasses. For use in turf, DAC-893 will be recommended at 10 to 12 pounds per acre.

Under greenhouse conditions, annual chickweed (Stellaria media) is quite susceptible and annual bluegrass (Poa annua) is moderately susceptible to DAC-893.

Generally good to excellent crabgrass control by DAC-893 was reported by workers at state and federal experiment stations. An enlarged program is planned for 1960.

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1/ Paper to be submitted for publication in the CONTRIBUTIONS FROM BOYCE

Chickweed Control in Lawn Turf with Chemicals[1]

P. M. Giordano and J. A. DeFrance[2]

Mouse-ear chickweed Cerastium vulgatum L., a perennial, is one of the most serious weeds encountered in turfgrass areas. Because of its stolon-like habit of growth, dense, matted foliage, and prolific seeding ability, it is a difficult pest to control by ordinary treatment.

Reference material concerning the control of mouse-ear chickweed is rather meager. In recent years, however, work done at the Rhode Island Agricultural Experiment Station by J. A. DeFrance and J. A. Simmons gave indication that 2,4-D and several of the arsonates were effective in controlling this weed.

This experiment was designed to evaluate the effectiveness of several chemical materials for the control of mouse-ear chickweed in established lawn turf.

Materials and Methods

An area established with a mixture of Chewings fescue, Kentucky bluegrass and Astoria bentgrass, designated as the Kingston Mixture, provided a suitable location for this study. Mouse-ear chickweed was abundant and rather uniformly distributed. Other weeds present were smooth crabgrass, plantain and dandelion, but no attempt was made to evaluate the effectiveness of the various chemicals upon these plants.

The area was fertilized May 8, 1959 with an 8-6-2 formulation containing 30% natural organic at the rate of 15 pounds per 1,000 square feet. No water was applied during the season other than that supplied by rainfall.

Plots 4 feet by 25 feet were used and all treatments were duplicated. Only one application was made of each treatment with the hope of finding a material which would be effective in this manner.

The chemicals used and the active material are as follows:

1. Kansel (2,4,5-trichlorophenoxy acetic acid) impregnated on vermiculite)
2. Kansel F_2 (2- (2,4,5-trichlorophenoxy) propionic acid) impregnated on vermiculite)
3. Bonus (2,4-dichlorophenoxy acetic acid) impregnated on vermiculite
4. 4-XD (2,4-D impregnated on vermiculite)
5. 4562 (N- (3,4-dichlorophenyl) 2-methyl pentanamide)
6. 4512 (N- (3 chloro-4-methylphenyl) -2-methyl pentanamide)

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[1]Contribution No. 992. Rhode Island Agricultural Experiment Station.
[2]Graduate Assistant in Agronomy and Agronomist, respectively.

7. ML-342 (ammonium methyl arsonate + 2,4,5-TP)

8. ML-343 (ammonium methyl arsonate + 2,4,5-TP+2,4-D)

9. ML-254 (ammonium methyl arsonate + 2,4-D)

Kansel, Kansel F_2 and Bonus were all applied with a calibrated Scott's spreader at recommended settings to ensure uniform distribution. ML-254, ML-342 and ML-343 were applied at the rate of one pound in 5 gallons of water per 1000 square feet, using a high pressure sprayer. Materials 4512 and 4562 were applied at the rate of one gallon in one hundred gallons of water per acre. (95 ml. in 2½ gallons of water per 1,000 square feet).

All treatments were applied May 15, 1959 in the early afternoon. The temperature was 55 F., the humidity high and the grass damp. Prior to applying the materials, the percent of chickweed in the plots was estimated and recorded as the percent total area covered by the weed.

Discoloration notes were taken May 19, 1959 in order to ascertain any effects upon the basic turfgrass by the chemicals. This index is given at the end of Table 1.

Results and Conclusions

Several of the materials used proved to be effective and non-injurious to the established turf. Results of the treatments are presented in Table 1.

Control ranged from 0 to 100 percent. There was no permanent or serious injury caused by any material at the rates tested thus indicating that certain chemicals which did not give satisfactory control probably could be used at higher concentrations.

ML-254, ML-342 and ML-343 gave the most consistent and the best control with only slight discoloration to the turf. There was little deviation in the degree of control between these three materials. The presence of the ammonium methyl arsonate with the growth regulating substances, 2,4-D and 2,4,5-TP, seemed to provide a superior herbicide to either of the two growth substances when used alone or together.

Kansel F_2 gave satisfactory control when used at the higher rate. There was no injury to the basic turfgrasses at either rate.

Kansel applied at the setting of 4½ gave a control of 55 percent. This material did not appear to be as efficient as the experimental derivative, Kansel F_2.

4-XD, a proven broad-leaf weed herbicide, gave inconsistent readings (for some reason or other). In subsequent study, however, it should be considered for it did exhibit herbicidal effects upon the chickweed.

Bonus, a fertilizer-herbicide formulation, also provided reasonably good control. This type of material is rapidly gaining in popularity due to the time and labor-saving aspect of its application.

Experimental materials 4512 and 4562 did not give satisfactory control at the rates used. Increase in the rate might make these compounds effective against mouse-ear chickweed.

Summary

During the early summer of 1959, an area containing an abundance of mouse-ear chickweed, *Cerastium vulgatum* L. was treated with various chemicals.

Only one application was made during the season in hopes of finding a quick and efficient method of eradication which would also be permanent. Several of the materials tested seemed to be very promising in this respect and none proved to be injurious to the turfgrasses.

Those giving best control were ML-254, ML-342, ML-343 and Kansel F_2 at the #6 spreader setting. Bonus, a weed and feed material, also was effective in controlling the chickweed.

Acknowledgements

The authors wish to express their appreciation to the following for their aid and contribution to this study: California Spray-Chemical Corporation, Niagara Chemical Division and O. M. Scott and Sons.

Table 1. Chickweed Control In Lawn Turf with Various Chemicals Using Only One Application, Rhode Island Agricultural Experiment Station, 1959.

Material	Rate*	% Chickweed Before	% Chickweed After	Average % Control	Discoloration**
ML-254	1#/M	4.5	T****	97.8	0.75
ML-342	1#/M	3.5	T	98.6	1.0
ML-343	1#/M	6.5	0	100	0.5
Kansel F_2	No. 4½	5.0	1.5	70	0
Kansel F_2	No. 6	4.5	0.25	94.5	0
Kansel	No. 4½	6.5	3.0	55	0
4-XD	No. 4½	5.0	1.5	70	0
Bonus	No. 5½	6.5	1.3	80	0
4512	4#/A	5.0	2.0	***	0.6
4562	2#/A	3.5	1.25	64.3	1.0
None		6.0	6.0	0	0

*Rates indicated by setting numbers are based upon manufacturer's recommendations.

**Discoloration Index: 0 = No discoloration, 1 = Sl. discoloration, 2 = Med. discoloration, 3 = Sev. discoloration, 4 = Temporary injury, 5 = Permanent injury.

***Average is not indicative of effectiveness due to inconsistency of replicates.

****T = trace, less than 0.1 percent.

A PROGRESS REPORT OF PRE-EMERGENCE CRABGRASS CONTROL ON LAWNTURF[1]

Ralph E. Engel and William F. Meggitt[2]

Promising results with pre-emergence crabgrass control in previous seasons and the appearance of new chemicals prompted additional study in this field. Until 1959, chlordane and the arsenates stimulated most of the interest and activity. Good inhibition of crabgrass in turf has been demonstrated with these chemicals, but further information on consistency of performance and safety to the turfgrasses was imperative. Tests were conducted in New Jersey in 1959 to obtain some of these answers on chlordane and the arsenates by testing an additional season. In conjunction with this several new chemicals were tested.

PROCEDURE

Chlordane, two sources of calcium arsenate*, lead arsenate, Dacthal (dimethyl 2,3,5,6-tetrachloroterephthalate), Fenac (2,3,6-trichlorophenylacetic acid), L-13489**, L-09726**, and Zytron (O-(2,4-dichlorophenyl) o-methyl isopropylophosphoramidothioate) were used on a lawn turf which was predominantly Kentucky bluegrass with a moderate amount of red fescue and traces of bentgrass. The Dacthal treatments were confined to test I and the L-13489, L-09726, and Zytron treatments were confined to test II. Tests I and II were adjacent and had very similar conditions. Treatments were made on March 25, in triplicate. Dry treatments were made with a mechanical fertilizer spreader (3 x 18 feet) and aqueous spray treatments were made with a pressure sprayer (4½ x 18 feet) at a rate of 100 gallons per acre.

The dry weather of May and June gave very little crabgrass germination. July rains gave a good stand of crabgrass and seedling counts were made in a 2 x 10 foot area of each plot on July 29. Crabgrass coverage on each plot was estimated on September 23 by four individuals. Clipping weights were taken for several treatments in October and November to measure grass growth.

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[1]Paper of the Journal Series, New Jersey Agr. Exp. Sta., Rutgers, the State University, New Brunswick, New Jersey.

[2]Research Specialist in Turf Management and Assistant Research Specialist in Weed Control, respectively, Department of Farm Crops.

*Calcium arsenate preparations of 73 and 70 per cent from Chipman Chemical Company and Acme Quality Paints, Inc., respectively.

**Experimental materials from Eli Lilly and Company.

RESULTS AND DISCUSSION

Control

Chlordane at 80 pounds per acre in tests I and II gave 69 and 85 per cent reduction in crabgrass seedlings for the July counts and 72 and 81 per cent crabgrass control on the basis of estimates made in September for the respective tests (tables I and II). The 40 and 60 pound rates of chlordane of test I gave poorer control on both evaluation dates. The best 1959 results with chlordane do not equal some of the best obtained in previous years.

Lead arsenate at 871 pounds per acre in tests I and II gave 58 and 53 per cent reduction in crabgrass seedlings on the July counts and 82 and 58 per cent control on the estimates made in September for the respective tests. These results are better than obtained in previous years with lead arsenate.

Application of both preparations of calcium arsenate gave crabgrass control ratings that ranged from 81 to 100 per cent for the evaluations made in July and September. The degree of control appeared to increase with increasing rates of application from 350 to 700 pounds per acre.

Dacthal at 6, 9 and 12 pounds per acre (table I) gave 80, 91 and 100 per cent control of crabgrass seedlings in July and estimated crabgrass control of 68, 81 and 91 for September ratings. Zytron applied at 20 pounds per acre as a spray (table II) gave 11 per cent control of seedling crabgrass in July and estimated control of 16 per cent in September. A dry preparation of Zytron at 20 pounds per acre gave 92 per cent control of seedling crabgrass in July and an estimated crabgrass control of 88 per cent in September.

Fenac, L-13489 and L-09726 did not give appreciable crabgrass control. It appeared higher rates could be tried for the two latter compounds since they gave no damage to the turfgrasses.

Turfgrass Injury

Fenac was the only material tested which gave readily observable injury. Clipping weights, which are a more precise measure of thinned or weakened growth, were taken in October and November on chlordane and arsenate treated plots. These showed growth was as good or better on the chlordane and lead arsenate treated plots as the check. With calcium arsenate the 525- and 700-pound per acre rates gave 18 to 25 per cent reductions in clipping weights. No attempt was made to check reseeding of turfgrasses in the test plots since a turf cover remained.

SUMMARY

A series of herbicides were applied to a Kentucky bluegrass type turf in March 1959. Some crabgrass germination occurred during mid- to late-spring, but the major part of the crabgrass germination occurred in July. Crabgrass seedling counts were taken in late July and crabgrass control estimates were taken in September.

Results with chlordane, calcium arsenate, and lead arsenate gave further support to previous reports that these chemicals can reduce or control crabgrass in lawn turf when applied prior to germination of this weed. Individual treatments of chlordane and lead arsenate gave better than 80 per cent control while one individual treatment of calcium arsenate gave 100 per cent control.

Dacthal and Zytron looked very promising and merit intensive study for pre-emergence crabgrass treatments. Fenac at 6 pounds per acre gave poor control and too much turf injury. L-13489 and L-09726 showed no crabgrass control of turfgrass injury from rates up to 12 pounds per acre with spray application and rates up to 30 pounds per acre with dry application.

Serious turfgrass injury was generally lacking on the pre-emergence crabgrass treatments of these tests. This is a very encouraging factor but it does not eliminate the need to make a thorough study of the potential dangers for each chemical.

Table I. Crabgrass control obtained with pre-emergence herbicides applied to Kentucky bluegrass type turf in March. New Brunswick, New Jersey. 1959.

Chemical	Application method	Rate per acre	Crabgrass July	% Control September 23
Check		--	254	15
Chlordane (clay)	Dry	40	263	36
"	"	60	137	65
"	"	80	79	72
Lead arsenate	"	871	107	82
Ca arsenate (73)	"	350	47	90
"	"	525	5	98
"	"	700	0	99
Ca arsenate (70)	"	525	0	100
Dacthal	Spray	12	0	91
"	"	9	24	81
"	"	6	51	68

Table II. Crabgrass control obtained with pre-emergence herbicides applied to Kentucky bluegrass type turf in March. New Brunswick, New Jersey. 1959.

Chemical	Application method	Rate per acre	Crabgrass July	% Control September
None	--	--	245	--
Calcium arsenate	Dry	700	0	99
Lead arsenate	"	871	115	58
Chlordane (clay)	"	80	36	81
Zytron (emulsion)	Spray	20	219	16
Zytron (vermiculite)	Dry	20	20	88

THE CONTROL OF PERENNIAL WEEDS IN ESTABLISHED BIRDSFOOT TREFOIL STANDS

S. N. Fertig 1/, M. W. Meadows and G. Bayer 2/

One of the major problems in the production of birdsfoot trefoil seed is the control of perennial weeds. In the seed producing areas of New York, the use of grass control chemicals has opened up the birdsfoot stands, resulting in a marked increase in the perennial species: yellow rocket (Barbarea vulgaris), cinquefoil (Potentilla recta), chicory (Cichorium intybus), dandelion (Taraxacum officinale) and fleabane (Erigeron spp.). Since strict regulations for seed quality are employed by the certification agency, growers must do the best job possible in maintaining weed-free fields.

With the selectivity shown by some of the newer herbicides on birdsfoot trefoil establishment, it seemed desirable to determine their effectiveness on the control of perennial weeds in seed producing fields.

EXPERIMENTAL METHOD AND PROCEDURE

In the fall of 1958 and spring of 1959, a series of experiments were initiated on growers' fields in Essex County, N. Y., to determine the susceptibility of birdsfoot varieties and the associated weed problem to some of these newer herbicides.

A randomized plot design was used in all experiments with 2 - 4 replications of each treatment. The plots were 6 x 30 feet with 2-foot alleyway between plots. All treatments were applied using a CO_2 - hand boom type sprayer. The chemicals used, rates per acre, variety of birdsfoot and dates applied are shown in Tables 1, 2 and 3.

RESULTS AND DISCUSSION

Experiment I

During the 1959 growing season, three different weed control and birdsfoot injury ratings were made on all treatments. The dates were May 13, June 11, and July 9. An average of these ratings show all treatments were effective in reducing the cinquefoil stand. The most effective chemical was 2,4,5-TP with 85-100 percent control. The least effective was 2,4-D amine (65 percent).

The results on chicory, yellow rocket and dandelion were highly variable. The mixtures of 2,4-D and 2,4,5-TP or 2,4- D alone resulted in the best control of these species. The 4(2,4-DB) was intermediate in effectiveness with 2,4,5-TP showing very poor control on chicory and dandelion.

The injury to the legume stand was least with the 2,4-D, 4(2,4-DB) and 2,4,5-TP alone (treatments 2, 3, 4 and 5) (Table I). However, the 1½-pound rate of 2,4,5-TP reduced the stand 25-30 percent more than the 3/4-pound rate. The mixtures resulted in greater stand reductions than either chemical alone, even where the same total amount was applied per acre. The mixture of 3/4 pound of 2,4-D plus 3/4 pound 2,4,5-TP reduced the stand 90-95 percent, whereas 1½

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Table 1. Chemicals Used on Fall Treatments of Birdsfoot

Experiment No. 1

Chemical	Rate/A. Lbs. A.E.
1. Check	0
2. 2,4-D	3/4
3. 4(2,4-DB)	6
4. 4(2,4-DB)	9
5. 2,4,5-TP	3/4
6. 2,4,5-TP	1½
7. 2,4-D plus 4(2,4-DB)	3/4 + 6
8. 2,4-D plus 2,4,5-TP	3/4 + 3/4
9. 4(2,4-DB) plus 2,4,5-TP	6 + 3/4
10. 2,4-D + 2,4,5-TP	3/8 + 3/4
11. 2,4-D + 2,4,5-TP	3/8 + 1½
12. 2,4-D + 2,4,5-TP	3/4 + 3/8
13. 2,4-D + 2,4,5-TP	1½ + 3/8

Birdsfoot variety - Viking
Date treated - September 23, 1958
Primary weeds - Cinquefoil and chicory
Plot size treated - 6 x 30 feet
Replications - 3

Table 2. Chemicals Used on Fall Treatments of Birdsfoot Trefoil

Experiments 2 and 3*

Chemical	Rate/A. Lbs. A.E.
1. Check	0
2. 2,4-D Amine	½
3. 4(2,4-DB) Amine	4
4. 4(2,4-DB) Amine	6
5. 2,4,5-TP	½
6. 2,4,5-TP	1
7. 2,4,-D + 4(2,4-DB)	½ + 4
8. 2,4-D + 2,4,5-TP	½ + ½
9. 4(2,4-DB) + 2,4,5-TP	4 + ½
10. 2,4-D + 2,4,5-TP	¼ + ½
11. 2,4-D + 2,4,5-TP	¼ + 1
12. 2,4-D + 2,4,5-TP	½ + ¼
13. 2,4-D + 2,4,5-TP	1 + ¼

Birdsfoot variety - Empire
Dates Treated - Early - September 23, 1958
(Experiment 3 only) - Late - October 31, 1958
Primary weeds - Chicory and cinquefoil
Plot size treated - 6 x 30 feet
Replications - 2

*The same treatments were applied at two locations. Experiment 2 contained a good stand of chicory, Experiment 3, a good stand of cinquefoil. Treatments were applied on Experiment 3 at two dates: Early fall, September 23; late fall, October 31, 1958.

Table 3. Chemicals Used on Spring Treatments of Birdsfoot Trefoil

Experiments 4 and 5*

Treat No.	Chemical	Rate/A. Lbs. A. E.
1.	Check	0
2.	2,4-D Amine	$\frac{1}{2}$
3.	4(2,4-DB) Amine	4.0
4.	4(2,4-DB) Amine	6.0
5.	2,4,5-TP	$\frac{1}{2}$
6.	2,4,5-TP	1.0
7.	2,4-D + 4(2,4-DB)	$\frac{1}{2}$ + 4.0
8.	2,4-D + 2,4,5-TP	$\frac{1}{2} + \frac{1}{2}$
9.	4(2,4-DB) + 2,4,5-TP	4.0 + $\frac{1}{2}$
10.	2,4-D + 2,4,5-TP	$\frac{1}{4} + \frac{1}{2}$
11.	2,4-D + 2,4,5-TP	$\frac{1}{4}$ + 1.0
12.	2,4-D + 2,4,5-TP	$\frac{1}{2} + \frac{1}{4}$
13.	2,4-D + 2,4,5-TP	1.0 + $\frac{1}{4}$

*The same treatments were applied at 2 locations, one on Empire variety, the other on Viking variety.

pounds of 2,4,5-TP reduced it only 70 percent.

Experiments 2 and 3

The results on chicory, cinquefoil and dandelion control are comparable with Experiment 1 regarding the response to chemicals. However, the percentage control was higher in Experiments 2 and 3. It is possible that some error was introduced into the ratings on Experiment 1 due to rather severe winterkilling of the legume stand.

In comparing date of treatment, the October 30th treatments ranked higher in percentage control of weeds and lower in injury to the birdsfoot stand than the September 23rd date. The weed control ratings average 15-20 percent higher and the legume injury 20-25 percent lower.

The difference in susceptibility of birdsfoot varieties was also evident in comparing these experiments. The Empire variety showed less stand thinning and more rapid spring recovery than the Viking. This could be due to differences in growth habit, amount of foliage present at time of treatment or to genetic differences in the two varieties.

Experiments 4 and 5

The treatments in these two experiments were applied on May 13, 1959. Experiment 4 was on Empire and Experiment 5 on Viking.

The stand of cinquefoil was reduced by all treatments, with 2,4,5-TP averaging better than 90 percent kill.

The control of chicory was highest with 2,4-D and lowest with 2,4,5- TP. Where the mixtures contained more than ½ pound of 2,4-D, the control on chicory exceeded 85 percent.

In comparing fall *vs.* spring treatments, the spring applications resulted in better weed control but were also more damaging to the legume stands.

The legume injury from spring treatment was severe. The Viking stands were reduced 70-100 percent. The Empire variety was more tolerant and varied from 40 to 90 percent. The least damage to either variety was from 4(2,4-DB), followed by 2,4-D Amine and then 2,4,5-TP. The mixtures were particularly effective on the Viking variety, with no treatment or replicate averaging lower than 80 percent kill.

SUMMARY

Fall treatments of 2,4,5-TP on Empire and Viking birdsfoot trefoil were effective in controlling cinquefoil (*Potentilla recta*) but did not control chicory (*Cichorium intybus*) or dandelion (*Taraxacum officinale*). 2,4-D amine at ½ pound or more per acre resulted in good control of chicory and gave a marked reduction in the stand of dandelion. Where these weed species occur in birdsfoot stands, the combination of 2,4-D + 2,4,5-TP may be the most effective.

The effectiveness of weed control on spring treated plots rated slightly higher than fall treatments. However, the injury to birdsfoot was severe on the spring treatments on both Empire and Viking varieties.

Based on these studies, late fall treatments would be more desirable than early fall and definitely safer than spring. Empire is more tolerant than Viking (European type) to either fall or spring treatments.

Observations on the Use of Herbicides For Renovation of Non-Tillable Pastures

R. A. Peters[1]

Long term experiments at the Storrs Station by Brown et al (1, 2) have shown that productivity of permanent pastures can be greatly increased by surface application of lime and fertilizer. Regardless of the initial botanical composition of the sward, Kentucky Bluegrass and, frequently, common white clover became the dominant species. Inherent limitations in productivity and seasonal distribution of a maximum density stand of Kentucky Bluegrass and common white clover has led to an increasing use of semi-permanent pastures using such hay type species in Ladino clover, birdsfoot trefoil, orchard grass and timothy. Attempts at establishing Ladino clover or birdsfoot trefoil in permanent pastures have been generally unsatisfactory (Brown,2). Reduction of sod competition and preparation of a favorable seedbed is a necessary prerequisite in consistently obtaining satisfactory stands of these species. Since attempts of establishing Ladino clover or birdsfoot trefoil without tillage is not possible on many of the rocky, permanent pastures of New England, a large acreage of permanent pastures have been essentially abandoned in favor of the more productive semi-permanent pastures on tillable land. A considerable acreage of rocky land has been cleared by bulldozer but a larger acreage of potentially productive land is reverting to brush and trees.

Conventional tillage serves two primary purposes, 1) to eliminate competition of existing vegetation and 2) to prepare a seedbed resulting in sufficient soil-seed contact. Brown et al (2) recognized the potential in using herbicides as a complete or partial substitute for tillage in subduing existing vegetation. Using 14 herbicides then available, the most satisfactory results were obtained with 200 pounds per acre rates of ammonium thiocyanate or sodium chlorate applied in the fall or spring. Satisfactory stands of Ladino clover were obtained from broadcast seedings made in June following the year of application (1944). Work with herbicides in pasture renovation has also been more recently reported by Sprague et al (3, 4) and by Vengris (5).

PROCEDURE

Experiments were started in 1951 by the author in the use of herbicides for preparing an adequate seedbed for broadcast seedings of forages on rocky, permanent pastures not amenable to tillage. Each experiment employed a replicated, randomized block experimental design. All chemical applications were applied in 40 gallons of water per acre unless otherwise specified. Adequate fertility was established prior to each seeding thru surface broadcasting of lime, superphosphate and muriate of potash. All forage seedings were broadcast seedings with no attempt at coverage except in one instance.

RESULTS

Experiment I

Dominant species on the experimental area were colonial bent (Agrostis tenuis), poverty grass (Danthonia spicta), sweet vernal (Anthoxanthum

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odoratum) and red fescue (Festuca rubra). Applications of $NaClO_3$, NH_4SCN, TCA, monuron and CIPC were made on December 11, 1951. The vegetation was inactive but the top growth was still partically green. As observed in October, 1952 the only chemicals giving a sod kill of significant duration was CIPC or monuron at 50 pounds per acre. TCA at 50, 100 and 200 pounds per acre rates gave control for a short time only. Seedings of Ladino clover and birdsfoot trefoil made in April, 1952 did not establish presumably due to residual toxic effects of the herbicides. Establishment was obtained, however, on the CIPC plots from a seeding made in June.

Experiment II

The following chemicals were applied each at three rates: TCA, monuron, NH_4SCN, $NaClO_3$, endothal, CIPC, Esso 180, fuel oil plus TCA, and fuel oil fortified with DNBP (Dow General). All applications were made in November, 1952. The sod on the experimental area was a thin stand of colonial bent, poverty grass and meadow fescue. Numerous perennial forbs in the stand included wild carrot, yarrow, buckhorn plantain, red sorrel, hawkweed and potentilla.

Good grass control was realized only from the following treatments: Endothal 40 at 80 pounds per acre; monuron, 20 pounds or over; CIPC, 40 pounds or over, and Esso 120 at 160 gallons per acre.

Seedings of Ladino clover and birdsfoot trefoil were made on April 1, 1953 on all plots. As observed in August, 1953, legume establishment was not satisfactory. Toxic residues from the high rates of some chemicals used prevented germination. Perennial broadleaf weed control was generally poor except on the monuron plots. The forbs became increasingly competitive to the legume seedings as they proliferated once released from the competition of the grass sod.

Experiment III

On April, 1953 application was made of the same chemicals mentioned above. The predominating bluegrass sod in the experimental area was relatively heavy with a mat of dead top growth accumulated from the previous season. A satisfactory sod kill, as noted in June 25, 1953, required at least 20 pounds TCA, 40 pounds CIPC, 10 pounds monuron, and 320 pounds $NaClO_3$ per acre. The only plots in which broadleaf weeds did not become dominant by midsummer were the monuron plots and the 320 pound rate of $NaClO_3$.

A surface seeding of Ladino clover and orchard grass was made on August 20, 1953. Satisfactory establishment was not obtained due to poor germination and competition from the established perennial herbs.

Experiment IV

The introduction of dalapon in 1953 provided an herbicide of obvious promise for renovation work. Applications made of 7.5 pounds acid equivalent were made on an established sod on August 4 and October 5, 1954. Grass control from the August application was not adequate but the October treatment was quite effective. Heavy rainfalls of 7.3 and 6.9 inches in August and September did not favor the effectiveness of the very soluble dalapon.

Broadcast seedings of Ladino clover and birdsfoot trefoil made on March 29, 1955 became established but did not persist. Competition was severe during the seeding year from numerous annual braodleaf weeds and by the end of the growing season the bluegrass sod which appeared completely dead in the spring had recovered.

Experiment V

Further evaluation of dalapon was initiated in the fall of 1955. Dalapon alone and in combination with amizol, was applied on October 27. As judged by vegetation control on June 5, 1956 grass control was satisfactory at rates of 10 and 20 pounds acid equivalent of dalapon. Amizol alone at rates up to 20 pounds acid equivalent per acre gave only limited grass control. When amizol was used in combination with dalapon, grass kill was enhanced. A further advantage in the inclusion of amizol was a significant reduction in perennial forbs.

Experiment VI

A treatment designed to give control of both perennial grasses and perennial forbs consisting of dalapon; 7.5 pounds acid equivalent, and 2,4-D; 4 pounds acid equivalent was applied on a typical sparse, weedy stand on May 2, 1956, as the spring flush of growth was starting.

As observed in mid-summer the grass kill was much better than the forb kill. Among the species which persisted the 2,4-D treatment were yarrow (Achillea millefolium), wild carrot (Daucus carota), buttercup (Rananculus acris), heal-all (Prunella vulgaris), Canada thistle (Cirsium arvense), wood sorrel (Oxalis stricta), sheep sorrel (Rumex acetosella) and cinquefoil (Potentilla spp.). Canada thistle growth was considerably greater on the plots with grass kill than on the check plots presumably because of reduced competition from the grass sod. On June 18, 1956 an application of amizol, 2.5 pounds active ingredient per acre, was applied to control the thistle. A broadcast seeding of Viking birdsfoot trefoil and Ladino clover was made on separate areas on March 25, 1957. Part of the area was dragged with a spike tooth harrow to increase soil-seed contact. By June 1, a good stand of trefoil was obtained but the Ladino stand was quite poor. To obtain control of Canada thistle and other forbs which were becomming quite competitive to the legume, 1 pound of 2,4-D amine, acid equivalent, per acre was applied in June 21, 1957 when the thistle was in the bud stage. The 2,4-D had little apparent effect on Ladino clover or on some of the forbs, notably, wood sorrel and red sorrel.

By 1958 both perennial grasses and forbs were re-established in the experimental area resulting in poor trefoil growth despite an adequate stand.

Experiment VII

An area previously grazed closely was sprayed in September, 1957 and a mixture of dalapon, 10 pounds acid equivalent per acre, and amizol, 5 pounds active ingredient per acre. Grass kill was satisfactory. Seedings of Ladino clover and Viking birdsfoot trefoil were made on April 18, 1958. Seedings of clover with orchard grass and of trefoil with timothy were also made. The seedbed resulting from this treatment was very favorable for a frost crack seeding. The dead sod had yielded to frost heaving resulting in scattered, small bare patches alternating with a mulch of dead vegetation. A week-long period of rainy weather favored the germination of the legumes. The favorable conditions also resulted in the germination of weed seed. The forages were all doing well by June but weeds were becoming quite competitive. Part of the area was sprayed with 2,4-D amine, 1 pound per acre, acid equivalent, and the other part with 2,4-DB, 3 pounds per acre, acid equivalent on June 12 to control the competing broadleaf weeds.

Both 2,4-D and 2,4-DB causedepinasty of trefoil and Ladino clover, the severity being greater with 2,4-D. No permanent injury resulted from the use of the 2,4-DB. The 2,4-D decreased the stand of both species, however.

On the 2,4-DB sprayed area establishment and growth of the Ladino was excellent as was the growth of timothy and orchard grass. The birdsfoot trefoil stand was erratic but growth of the existing stand was good. The growth of the first three species mentioned was equal to most stands established on a convential seedbed.

First cutting yields the second year of growth are given below based on hand separations made from samples cut from two square foot quadrats.

Table 1. Yields of Forages Following Renovation of a Permanent Pasture

lb. Dry Matter Per Acre

Ladino clover	2625
Ladino clover + Orchard grass	4255
Birdsfoot trefoil	
Trefoil component	1600
Weed component	1870
Birdsfoot trefoil - Timothy	
Birdsfoot trefoil component	290
Timothy component	5570
Weed component	175

Ladino yields were satisfactory both alone or in mixture with orchard grass. Trefoil yields seeded alone yielded five times as much as when seeded in mixture with timothy. The rank growth of timothy was highly competitive to the trefoil.

Experiment VIII

An area similar to that in the previous experiment was treated November 5, 1958 with 7.4 pounds acid equivalent of dalapon and 2 pounds active ingredient of amizol per acre. Grass kill was very good, but control of broadleaf weeds was imcomplete. A frost crack seeding was made on March 25, 1959 of 8 pounds per acre of Mansfield birdsfoot trefoil, and 3 pounds per acre of Ladino clover. A satisfactory stand of both species was obtained. The stand was poorer where the grass was long at the time of treatment resulting in a dead grass mat.

Since weed growth was becoming competitive by June, the area was sprayed with a 2,4-DB ester-dalapon mixture using 1 1/2 and 1 pound acid equivalent per acre rates respectively. No injury was noted on the trefoil or Ladino clover, however, severe injury was noted on volunteer red clover. Weeds were sufficiently depressed to permit establishment of both legume species. As in the previous experiment, Ladino clover growth was able to compete more successfully with the remaining weed growth and with the grass which did regrow during the establishment period.

DISCUSSION

Of the many chemicals tested dalapon has proven the most satisfactory for subduing established sod grasses. CIPC and monuron are needed at uneconomically high rates and have a further disadvantage of leaving long term residues.

Satisfactory sod control has been obtained with dalapon and dalapon-amizol mixtures applied in the spring, late summer or late fall. The fall treatment has the advantage of allowing time for disappearance of the dalapon residue by seeding time in the spring.

Under Connecticut conditions, a 7.5 - 10 pound, acid equivalent, per acre application of dalapon will usually subdue an established sod for a period sufficiently long to permit the establishment of seeded legumes. These legumes, or forage grasses seeded with them, will further delay the recovery of the sod thru their competitive effect.

The addition of 2 - 4 pounds acid equivalent per acre of amizol with dalapon will decrease the amount of dalapon required and also give a measure of control of forbs present.

Reference has been made to the presence of several species of broadleaf forbs widely associated with permanent pastures in New England, especially on those areas having sparse sods due to low fertility levels. Adequate means of permanently controlling these forbs was not found in the experiments discussed where no tillage was used to supplement the chemicals. When a grass specific herbicide such as dalapon is used, the forbs proliferate once released from competition of the sod grasses. A striking example was cited in the prolific development of Canada thistle. A further complication is the relative resistance to present herbicides of many species associated with permanent pasture sods. Most of these species have the common characteristic of propagating by vegetative means. Included in this group in Connecticut permanent pastures are red sorrel, wood sorrel, yarrow, Canada thistle and heal-all. Wild carrot propagates from seed only but is a pasture associated species quite tolerant to most translocated herbicides. Amizol has given a greater degree of forb control than the usual 2,4-D rates, especially on Canada thistle, but it is not effective on all species and is quite expensive.

Assuming that control of perennial species is adequate and that a forage stand is obtained, the ubiquitous annual weed problem must be considered. Since the rockiness of the fields under consideration precludes mowing, chemicals frequently are needed to selectively control the annual weeds in the establishing stands. Either 2,4-D or 2,4-DB has been used for this purpose on Ladino clover and birdsfoot trefoil with the 2,4-DB providing a wider margin of legume selectivity.

A further uncontrolled variable is the weather following seeding. A "frost crack" seeding as early in the spring as feasible will enhance the chances of obtaining a stand but any surface seeding is risky since a continuously moist surface condition is needed during the critical germination period. The chances for successful germination, however, are greater on a short, dead sod which has gone through the winter than in conventional frost crack seedings. The dead sod readily heaves, exposing pockets of bare soil while providing a surface mulch. The sod must be short at the time of treatment if adequate soil-seed contact is to be realized when "frost crack" seeding the following spring.

Before the procedure described can be recommended as a farm practice, a chemical or chemicals must be found which will give adequate control of the existing vegetatively propagating broadleaf species as well as the grasses. The chemical treatment must remain economical and must not present a residue problem.

Recent work by Sprague (4) indicates that a mixture of dalapon and cacodylic acid is quite promising for complete vegetative control at a nominal cost and without a significant residue problem.

SUMMARY

The series of experiments reported indicate that it is possible to substitute chemicals entirely for tillage in killing or at least subduing established sods in non-tillable permanent pastures during renovation.

Adequate stands of surface seeded Ladino clover, birdsfoot trefoil, timothy and orchard grass have been obtained when control of existing vegetation was sufficient to expose bare soil and when environmental conditions were favorable.

Of the numerous herbicides evaluated, dalapon has proven to be the most satisfactory for control of the colonial bent, sweet vernal and Kentucky bluegrass associated with New England permanent pastures.

Application of the herbicide in late fall to closely grazed sod followed by broadcast "frost crack" seeding of forage species early the following spring is suggested.

The persistence of vegetatively propagated forbs continues to be a frequent problem when no supplemental tillage is employed.

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Chickweed Control in Alfalfa Seedings[1]

R. C. Wakefield and R. J. Hull[2]

Introduction

Chickweed (Stellaria media) is one of the more serious weeds that compete with forage seedings made during the late summer in the Northeast. As legumes become dormant during the fall months, chickweed grows luxuriantly and may continue to grow and even re-seed well into the winter. Control of chickweed with herbicides has been shown to be practical following dormancy of well-established seedings of alfalfa (1) (5) (6) (7).

Recent research with newer herbicides has shown that effective control of many weeds is now possible with little or no injury to actively growing legume seedlings (2) (3) (4). Additional work has shown that pre-emergemce control of weeds is possible and suggests that this is particularly beneficial to the developing legume seedlings (3).

These experiments were designed to evaluate the use of pre- and early post-emergence chemicals for the control of chickweed in summer-seeded alfalfa.

Procedure

Experiments were conducted during 1957-58 and 1958-59 on the University dairy farm. The area selected had a history of heavy chickweed infestation.

Narragansett alfalfa was seeded on August 1, 1957 and September 2, 1958 at 10 lbs. per acre. Treatments were randomized within each of four blocks with individual plot size being 6 x 16 feet.

Chemicals were applied in 30 gallons of water per acre using a bicyle-mounted compressed air sprayer. EPTC was incorporated in 1958 by raking the material into the soil to a depth of 2 inches. Chemicals and rates of application (active material) were:

1. 3-(3,4-dichlorophenyl-1-methyl-1-n butylurea) 18.5% active (Neburon) 1,2 and 4 lbs. per acre.

2. Ethyl n,n-di-n-propylthiolcarbamate 6 lbs. A.E./gal. (EPTC); 4 and 8 lbs. per acre.

3. 4(2,4-dichlorophenoxy) butyric acid, dimethylamine salt, 2 lbs. A.E./gal. 4(2,4-DB); 1,2 and 4 lbs. per acre.

4. 3-(3,4-dichlorophenyl)-1,1 dimethylurea, 80% active; (Diuron) ¼, ½ and 1 lb. per acre.

5. Dinitro-o-sec-butyl-phenol, alkanolamine salt, 3 lbs. A.E./gal. (DNBP) ½, ¾, 1 and 1½ lbs. per acre.

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[1]Contribution No. 988. R. I. Agricultural Experiment Station, Kingston, R. I.

6. Isopropyl-n-(3-chlorophenyl) carbamate 4 lbs. A.E./gal. (CIPC); 1 and 2 lbs. per acre.

All materials were not applied at all rates during both experiments. The major changes after the first experiment in 1957 were the elimination of 4(2,4-DB) at all rates of application, inclusion of EPTC as an incorporated pre-emergence herbicide as well as a surface spray, a lowering of the rates of application of diuron, and inclusion of CIPC as a post emergence material.

The time of application of herbicide and stages of plant development were:

a. Pre-emergence - August 1, 1957; September 4, 1958

b. Early post emergence - August 16, 1957; September 18, 1958
alfalfa, 1-2 leaves

c. Late post emergence - August 30, 1957; October 3, 1958
alfalfa 3-6 leaves

The date of seeding was delayed approximately 4 weeks in 1958 to more nearly duplicate farm practice. This changed the relative growth stage of both alfalfa and chickweed at the various treatment dates. Although moisture was adequate both years, growth of alfalfa was much slower in 1958 and plants were smaller at time of dormancy than in 1957. Germination of chickweed continued after the time of early post emergence treatments in 1957 (August 16). Very little germination of chickweed occurred after mid-September during 1957 and 1958.

During the fall, plots were rated for herbicidal effectiveness. Stand counts were made using a 2-square foot quadrat at two locations in each plot. Two check plots were maintained in each block, one of which was handweeded.

Plots were harvested for determination of yields on June 30, 1958 and June 23, 1959. A 38-inch by 14-foot strip was removed from each plot and weighed. Sub-samples were taken for dry matter determinations. Botanical composition was estimated and checked by occasional hand separations.

Results and Discussion

Experiment I (1957-58)

A summary of data obtained during the first of two experiments is presented in Table 1.

Neburon and EPTC applied immediately after seeding effectively controlled chickweed for a considerable period. Only scattered small seedlings of chickweed were evident in November at the time ratings were made. EPTC provided nearly complete control of chickweed at both 4 and 8 lbs. per acre. Neburon was satisfactory as a post emergence spray also, although killing of the chickweed was very slow, extending over a period of 6-8 weeks.

Table 1. Chickweed control in late summer seedings of alfalfa. Rhode Island Agricultural Experiment Station. Experiment I (1957-58).

Treatment	Rate Lbs./A.	Percent Weed Control 11-11-57	Alfalfa Plants/ Sq. Ft. 10-11-57	Alfalfa Plants/ Sq. Ft. 7-6-58	Alfalfa Yield 6-30-58 Tons/A Dry
Pre-Emergence					
Neburon	2	77	13.0	11.0	1.28
Neburon	4	79	13.0	10.6	1.37
EPTC	4	95	13.8	11.0	1.47
EPTC	8	98	13.8	11.4	1.70
4 (2,4-DB)	2	15	7.1	6.7	1.16
4 (2,4-DB)	4	19	5.2	5.4	1.20
Early Post Emergence					
Neburon	1	84	14.0	11.0	1.40
Neburon	2	80	13.6	11.2	1.59
Diuron	1/2	100	3.5	2.8	0.92
Diuron	1	100	0.9	0.3	0.00
DNBP	3/4	88	13.0	10.1	1.34
DNBP	1 1/2	91	8.1	7.8	1.07
4 (2,4-DB)	1	12	13.4	11.3	1.26
4 (2,4-DB)	2	14	12.4	11.0	1.38
Late Post Emergence					
Neburon	1	88	12.9	11.1	1.55
Neburon	2	87	13.4	11.6	1.34
Diuron	1/2	77	13.9	11.4	1.23
Diuron	1	89	12.8	9.3	1.32
DNBP	3/4	91	13.1	9.7	1.40
DNBP	1 1/2	96	12.4	11.0	1.48
4 (2,4-DB)	1	20	11.2	11.0	1.21
4 (2,4-DB)	2	17	13.2	11.1	1.39
Check	-	-	12.6	10.6	1.49
Check-Weeded	-	-	14.8	9.9	1.86
LSD .05			2.2	1.7	.31
LSD .01			3.0	2.3	.41

4(2,4-DB) was not satisfactory as a pre- or post-emergence material. Very little control of chickweed was noted at any of the three times of application. Serious injury to alfalfa resulted from pre-emergence applications indicating that germinating alfalfa was quite susceptible to this chemical. No injury was noted when 4(2,4-DB) was sprayed on very small alfalfa seedlings only 15 days later.

Diuron completely controlled chickweed at the early post emergence date but was somewhat less effective at the later date. Alfalfa was seriously injured at the early date but scarcely injured later.

DNBP substantially controlled chickweed at $\frac{3}{4}$ lbs. at both dates of application. Slightly greater control was gained at $1\frac{1}{2}$ lbs. but proved injurious to alfalfa at the early date.

Alfalfa yields the following spring reflected the completeness of weed control and the effect of chemicals, if any, on the legume. Highest yields were obtained from the hand weeded check plots indicating that chickweed can significantly lower yields of alfalfa although plant populations were not decreased. In fact, percentage-wise a greater loss of plants occurred through the winter in the hand weeded plots than in the check plots that were heavily infested with chickweed. Treatments resulting in substantially reduced yields were those of 4(2,4-DB) applied prior to emergence, diuron applied at early post emergence and DNBP at $1\frac{1}{2}$ lbs. at early post emergence. Other treatments while reducing alfalfa stands did not result in yields significantly different from that of the unweeded check treatment.

Experiment II (1958-59)

As pointed out previously there were several changes made in Experiment II; therefore, only a generalized comparison may be made with Experiment I. Results are presented in Table 2.

Both neburon and EPTC applied as sprays before emergence provided excellent weed control with little or no injury to alfalfa. Incorporated EPTC at the 8 lb. rate caused some injury to alfalfa seedlings. Neburon was effective as a post emergence spray also and gave good chickweed control at both dates of application.

Diuron, which was used at a lower rate in 1958, gave good weed control with far less injury to alfalfa than that recorded in 1957. DNBP gave excellent weed control at both dates of application, although some injury resulted from $1\frac{1}{2}$ lbs. at the later date.

CIPC, which was used only in 1958 gave good chickweed control, at 1 lb./A. Some injury was noted at 2 lbs. at the early date.

Plant counts made following the winter revealed a loss exceeding 50 percent in all plots. This loss was much greater than during the winter of 1957-58 and was undoubtedly due to the fact that plants were not as large and as well-established as in 1957. In addition, the winter was more severe with heaving of legumes being serious and widespread in the area. Lowered plant counts generally resulted in lower yields of alfalfa.

Table 2. Chickweed control in late summer seedings of alfalfa. Rhode Island Agricultural Experiment Station. Experiment II (1958-59).

Treatment	Rate Lbs./A	Percent Weed Control 11-18-58	Alfalfa Plants/ Sq. Ft. 11-18-58	Alfalfa Plants/ Sq. Ft. 7-28-59	Alfalfa Yield Tons/A Dry 6/23/59
Pre-Emergence					
Neburon	2	83	17.0	6.2	1.48
Neburon	4	87	16.2	3.9	1.17
EPTC (Surface)	4	90	15.0	5.2	1.27
EPTC (Surface)	8	92	15.0	6.1	1.55
EPTC (Incorp.)	4	97	17.5	4.0	1.32
EPTC (Incorp.)	8	96	17.2	2.1	0.94
Early Post Emergence					
Neburon	1	86	15.2	5.5	1.54
Neburon	2	87	15.5	3.2	1.27
Diuron	1/4	83	16.2	3.2	0.85
Diuron	1/2	97	15.0	2.3	0.67
DNBP	1/2	80	15.5	6.5	1.71
DNBP	1	87	16.8	5.8	1.52
CIPC	1	85	16.5	4.8	1.68
CIPC	2	87	17.0	3.0	1.25
Late Post Emergence					
Neburon	1	87	11.0	6.7	1.20
Neburon	2	83	12.0	7.2	1.41
Diuron	1/2	94	13.0	7.0	1.50
Diuron	1	98	13.8	6.7	1.46
DNBP	3/4	85	12.5	3.8	1.39
DNBP	1 1/2	97	12.0	2.4	0.89
CIPC	1	84	12.5	5.9	1.27
CIPC	2	80	12.0	6.0	1.35
Check	-	-	10.8	6.8	1.39
Check-Weeded	-	-	12.2	7.8	-
LSD .05			5.2	2.7	.33
LSD .01			6.8	3.5	.43

Highest plant counts were obtained from handweeded plots. Significantly lower counts as a result of chemical injury and/or chickweed occurred with several treatments. This did not always result in decreased yields of forage however since surviving plants differed in size and vigor. Comparison of yields with the hand weeded check plot is not possible, since only small areas of these plots were weeded for plant counts. No treatment resulted in yields significantly greater than the check. Yields were significantly lower in several cases, notably EPTC at 8 lbs. (incorporated), diuron at $\frac{1}{4}$ and $\frac{1}{2}$ lb. applied at the early post-emergence date and DNBP at $1\frac{1}{2}$ lbs.

Data obtained from both experiments would seem to indicate that control of chickweed is possible with both experimental and presently approved herbicides considerably before the dormancy period of alfalfa. Although no dormant applications of herbicides were made in these experiments for purposes of comparison, there would seem to be advantages in early control of chickweed in alfalfa seedings.

Summary

Pre- and post-emergence herbicides were applied to late summer seedings of alfalfa in 1957 and 1958 to control chickweed (Stellaria media). Applications were made at the following times: (1) pre-emergence, (2) early post emergence (2 weeks after emergence) and (3) late post emergence (4 weeks after emergence).

Excellent control of chickweed was obtained with several materials with little or no injury to the alfalfa. Most satisfactory treatments were:

a. Neburon 2 lbs. pre-emergence; 1 lb. early or late post emergence.

b. EPTC 4-8 lbs. (surface application) or 4 lbs. (incorporated) pre-emergence.

c. Diuron $\frac{1}{2}$-1 lb. late post emergence.

d. DNBP $\frac{3}{4}$-1 lb. early or late post emergence.

In addition, CIPC was satisfactory at 1-2 lbs. early or late post emergence during the 1958 test.

Treatments that were least satisfactory were 4(2,4-DB) applied at any time and diuron applied at the early post emergence stage.

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THE ACTIVITY OF CACODYLIC ACID AS INFLUENCED BY ENVIRONMENT, SURFACTANTS, AND COMBINATIONS WITH OTHER HERBICIDES

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ABSTRACT

The use of chemicals as pasture renovating agents has proved successful in research trials and is becoming an accepted practice in some areas. Within the last few years dimethylarsenic acid or cacoydlic acid has proved to be a promising chemical, but its behavior is sometimes inconsistent. Results suggest that this compound behaves somewhat as a growth regulator. If so, those factors enhancing activity of a growth regulator would also enhance the activity of cacodylic acid. Bluegrass sod taken from an established field was used as the test species.

The effect of temperature on the activity of cacodylic acid was studied under controlled conditions in a growth chamber. Two pre- and post-conditioning temperatures were maintained. The high temperature was 85°F. and the low temperature was 62°F. Various rates of cacodylic acid were applied to plugs of bluegrass grown in the two temperature regimes. After spray applications, half of each lot was returned to the opposite temperature for post-conditioning. This resulted in four combinations of pre- and post-conditioning, i.e., high to high, low to low, low to high, and high to low. Periodic ratings of activity, or degree of kill were made. As early as 3 days after treatment, activity was more pronounced in the groups returned to the high temperature, but more so in the group grown and returned to the higher temperature regime. Although at the end of 2 weeks the difference in kill between the post chemical conditions was not as marked as earlier, there was, however, some difference in favor of the high temperature.

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The use of a surfactant to enhance activity was also studied. Regardless of the rate of cacodylic acid used, the addition of an anionic surfactant did not increase sod kill. This was expanded still further in the field to include other surfactants of still different ionic structure. The activity of cacodylic acid was enhanced with the use of an anionic and non ionic surfactants. Activity by the cationic surfactant was not as pronounced as the others. It is worthy of note that additions of the effective surfactants reduced the activity of cacodylic acid-dalapon (2,2-dichloropropionic acid) combinations. Cacodylic acid in combination with other herbicides was also evaluated.

EFFECTIVENESS AND PERSISTENCE OF CERTAIN HERBICIDES IN SOIL

by

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The rate at which the phytotoxic properties of a herbicide disappear from treated soil has been the subject of several investigations. It is apparent that environmental conditions such as temperature, rainfall, soil type, and cultivation are involved. The present study was undertaken in an effort to provide further information on the persistence of certain herbicides that have been investigated by others, as well as on newer chemicals.

Both chemical (1) and biological (2, 3) tests have been used to measure the residual activity of herbicides. A technique similar to that reported by Sweet _et al_ (3) in which indicator plants were seeded into the treated area at various times after treatment was used in the experiments reported below.

Experiment I

In June 1957 Burford loam soil was sprayed with a variety of herbicides at the rate of 75 gallons of solution per acre. The soil was moist at the time and had been thoroughly cultivated and raked smooth before application. Weed and grass counts were made at weekly intervals beginning July 24, and percentage plot cover was estimated September 5, eleven weeks after treatment (Table 1).

Marked reduction in the weed population for eleven weeks was brought about by all rates of Simazine, Monuron, Alanap, and CIPC. Dalapon inhibited grass growth well, but had little effect on other weeds. All other chemicals tested reduced weed growth only slightly.

Another series of plots was sprayed in September 1957 with the same materials as in June except that Fenuron-TCA (Urab) was added at rates of 1, 2 and 4 lbs/A. Effects on weed growth in both this experiment and the one set up in June 1957 were noted in April, July and September 1958. In addition, weeds of oats, turnips and sugar beets, and seedlings of tomato were planted in all plots in July 1958.

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On April 30, 1958, all plots treated with Monuron-4 or Simazine-2 or 3 in June of the preceeding year were bare of vegetation. Weed stands in the Monuron-1 or 2 and the Simazine-1 plots were about 50% of control. By July only the

Table 1: Effect of various herbicides on the weed population eleven weeks after surface treating freshly cultivated soil (1957).

Herbicide	Rate[1]			Weeds/sq.ft.[2]			Herbicide Rating[3] Weeds			Annual Grasses		
2,4,5-T	0.5	1	2	72	73	50	0	0	0	2	0	1
2,4-D Amine	0.5	1	2	51	45	41	0	0	0	1	6	0
2,4-D Ester	0.5	1	2	53	66	28	0	0	0	0	0	1
Simazine	1	2	3	0	0	0	10	10	10	10	10	10
CIPC	4	8		31	11		6	6		0	6	
EPTC	4	10	15	38	91	90	0	0	0	0	4	0
DNBP	1	4	6	85	76	73	0	0	0	0	0	6
Monuron	1	2	4	23	3	0	0	8	10	10	10	10
Dalapon	5	10	15	93	68	50	0	0	0	6	6	6
Alanap-3	3	5	10	11	9	5	6	7	7	4	5	8
Amino Triazole	1	2	4	63	63	59	0	0	0	0	0	0
Randox (CDAA)	4	6	8	58	68	60	0	0	0	0	0	5
Control				93			0			0		

[1]All rates are pounds of active material per acre.
[2]Average of 6 one square foot areas.
[3]0 = no effect; 10 = no vegetation in plot.

highest rate of Simazine showed any effect on either weed population or indicator plants. Oats planted in these Simazine-3 plots in July became chlorotic soon after emergence but most plants recovered.

All Simazine plots (1, 2 and 3 lbs/A) treated in September 1957 remained bare of weeds throughout the summer of 1958. Turnips and tomatoes planted in late July in the Simazine-1 plots survived; oats and sugar beets were 80-90% killed. All indicator crops were killed in the Simazine-3 plots. There was little growth in any of the Monuron treated areas on April 30, 1958, but by July the Monuron-1 plots had weed stands equal to the controls. The higher rates suppressed weed growth throughout most of the summer of '58 but by September weeds were beginning to grow in the Monuron-2 treatments. All of the indicator plants seemed normal in the Monuron-1 and 2 plots. In the Monuron-4 treated area, oats, turnips and tomatoes were killed in July but sugar beets survived and appeared normal in September. The Urab treatments applied in September 1957 suppressed most weed growth early in the spring but by July even the highest rate was no longer toxic to either weeds or indicator crops. None of the other herbicides applied to the soil in 1957 had any noticeable effect on the growth of plants in that soil in 1958.

Experiment II

An experiment similar to the 1957 investigation was carried out in 1958. Duplicate 3 x 15 foot plots were sprayed on May 23 by means of an Oxford Precision sprayer. The soil (Burford loam) had been freshly cultivated and was moist as the result of rain on May 22. All chemicals (except Urox) were applied in water at the rate of 30 gal/A. The effectiveness of each chemical as a herbicide was estimated and weed counts were taken on June 26, July 23 and September 26. In addition, seeds of oats, turnips and sugar beets, and tomato seedlings, were planted on July 7 and July 25. No cultivation was carried out after the chemicals were applied. other than that involved with planting seeds. The data obtained are summarized and presented as a "herbicide rating" in Table 2.

Table 2: Effect of various herbicides on weeds and indicator plants at intervals after treating freshly cultivated soil (1958).

Herbicide	Rate[1]				Herbicide Rating[2] — Weeks After Application: 4				8				16			
Simazine	1	2	4	6	5	7	7	9	3	8	10	10	2	8	10	10
Atrazine	1	2	4	6	7	7	9	9	5	9	10	10	1	9	10	10
Ipazine	1	2	4	6	5	5	8	7	2	2	8	10	1	1	3	9
Trietazine	1	2	4	6	4	4	6	7	1	2	4	7	0	0	2	2
Monuron	1	2	4	6	7	8	9	9	2	7	9	8	0	4	10	10
Diuron	1	2	4	6	4	8	8	10	0	1	5	9	0	0	4	10
Neburon	1	2	4	6	4	4	6	7	0	1	1	4	0	0	0	0
Endothal	4	8	12		3	3	5		0	0	1		0	0	0	
CIPC	2	4	8		4	2	6		0	0	0		0	0	0	
Urox	10	20	30		9	9	10		10	10	10		10	10	10	
Urab	10	20	30		7	8	9		7	10	10		5	10	10	

[1]Pounds active material per acre.
[2]0 = no effect; 10 = bare plot.

Toxic amounts of chemical (as shown by lack of vegetation) evidently remained for 4 months in the plots treated with the following chemicals: Simazine-4 and 6, Atrazine-4 and 6, Monuron-4 and 6, Diuron-6, Urox-10, 20 and 30. Simazine-2, Atrazine-2 and Ipazine-6 had only sparse plant cover at this time. Simazine-1, Atrazine-1, Monuron-1, Ipazine-4, and Diuron-2 gave good weed control for about one month and only slightly damaged the indicator crops planted early in July (6 weeks after treat-

CIPC-8, controlled weeds only for the first month and had no effect on the indicator plants. All other treatments were relatively ineffective.

The further persistence of the herbicides in the soil of those plots showing toxicity in late September 1958 was investigated in 1959 by planting indicator crops. Rototilling (3-4" deep) was carried out May 14 prior to planting turnips, oats, sugar beets and millet. A second area was planted (to barley, soybeans, oats and wheat) on June 5 after another rototilling. Effects on the indicator crops were noted June 3, June 22, and June 30. Table 3 gives the data obtained for oats only, as this plant appeared to be the most sensitive and was included in both dates of seeding.

Table 3: Effect of various chemicals applied in May 1958 on oats planted in June 1959.

		Herbicide Rating[2]				
		Planted May 14			Planted June 5	
Herbicide	Rate[1]	June 3	June 22	June 30	June 22	June 30
Simazine	1	0	0	0	0	0
	2	2	0	0	0	0
	4	6	8	8	1	1
	6	9	10	10	3	8
Atrazine	1	2	0	0	0	0
	2	2	0	0	0	0
	4	8	10	10	3	2
	6	10	10	10	5	9
Ipazine	2	1	0	0	0	0
	4	3	9	9	2	2
	6	7	8	8	3	4
Monuron	4	0	0	0	0	0
	6	0	0	0	6	9
Urab	20	0	0	0	0	0
	30	0	0	0	0	0
Urox	10	10	10	10	5	10
	20	10	10	10	10	10
	30	10	10	10	10	10

[1]Pounds active material per acre.
[2]0 = no effect; 1-2 = mild chlorosis; 3-6 = severe chlorosis; 7-9 = plants dying; 10 = plants dead.

The lower rates of Simazine, Atrazine and Ipazine (1 and 2 lbs/A) brought about mild chlorosis early in the growth of the oats but all plants had recovered within one month after emergence. There was no damage to the test plants in these plots in the second planting. The 4 and 6 pound rates of the triazines severely damaged, or killed, oats in the early planting, but only the highest amount remained toxic to oats planted in June. Other species were only damaged in the Simazine-6 and Atrazine-6 plots with Atrazine producing the greatest damage. The order of susceptibility of the test plants to these chemicals was oats, wheat, barley, soybeans. Ipazine-6 damaged only oats in the late planting.

None of the May 14 plants growing in the Monuron-5 or 6 plots showed injury. However, oats and wheat planted June 5 in the Monuron-6 plots were severely damaged. This unexpected result is difficult to explain although the additional cultivation received before the second planting might be important.

Toxic amounts of Urox evidently remained even at the lowest rate used as all plants were killed in both plantings.

Experiment III

All obtainable s-triazine compounds were included in an experiment set up in 1959 to compare pre-planting and pre-emergence application of 25 widely used herbicides. Treatments were applied in duplicate to the surface of freshly cultivated soil on July 8. Seeds of indicator crops (oats, barley, turnips and red kidney beans) were planted one day before, one day after, one week after and 8 weeks after spraying. Irrigation was used throughout the summer as required.

Data on injury to oats brought about by the triazines are presented in Table 4.

Toxic (to oats) amounts of all chemicals, except Methoxy Propazine (25% emulsion), had disappeared from plots treated with one pound of active herbicide, within eight weeks. The 2-pound rate of Simazine still caused chlorosis but there was no injury in the 2-pound Atrazine plots. Apparently even the highest rate (5 pounds) of Ipazine and Chlorazine were no longer injurious although this rate of all other herbicides was highly toxic to all the test plants.

Table 4: Injury to oats planted at various times relative to herbicide application to the soil (1959).

Herbicide[1]	Rate[2]	Herbicide Rating[3] — Date of Oat Seeding: July 7	July 9	July 16	Sept 8
Simazine	1	10	10	8	0
	2	10	10	10	3
	3	10	10	10	3
	4	10	10	10	8
	5	10	10	10	8
Atrazine	1	10	10	10	0
	2	10	10	10	0
	3	10	10	10	5
	4	10	10	10	9
	5	10	10	10	9
Chlorazine	1	0	0	0	0
	3	0	0	0	0
	5	8	8	6	0
Ipazine	1	0	0	0	0
	3	6	6	-	0
	5	10	10	8	0
Trietazine	1	0	0	0	0
	3	0	0	0	0
	5	10	10	10	0
Propazine	1	6	6	6	0
	3	7	8	7	4
	5	10	10	10	9
Methoxy Propazine 25% emulsion	1	10	10	10	2
	3	10	10	10	9
	5	10	10	10	9
Methoxy Propazine 50% wettable	1	0	0	0	0
	3	10	10	10	9
	5	10	10	10	9

[1]All chemicals sprayed on soil surface July 8, 1959.
[2]Pounds active material per acre.
[3]0-10 (see footnote Table 3).

SUMMARY

Both Simazine and Atrazine have been shown to lose their toxicity at rates of 2 pounds active per acre within 8 weeks (Table 4) under conditions of relatively high moisture (irrigation as required to maintain good growth) and summer temperatures. However, under dry conditions (summer of 1958) enough remained even after 12 months to bring about marked chlorosis in oats (Table 3). The more soluble Atrazine appeared to disappear from the soil faster than Simazine at low rates but at 5 or 6 lbs/A it was as persistent. The other triazines could be rated in order of activity and persistence as follows: Methoxy Propazine, Propazine, Ipazine, Trietazine and Chlorazine.

Urox appeared to be the most persistent of all herbicides studied. A rate of 10 lbs/A suppressed all growth throughout two growing seasons. Monuron was similar to Simazine in its rate of disappearance with Diuron losing toxicity somewhat more quickly. Urab suppressed growth for 4 months after application but had no effect the following season.

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LIFE HISTORY STUDIES OF HORSE NETTLE (Solanum carolinense)

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Horse nettle is a persistent perennial weed having a very extensive and deeply penetrating root system which permits storage of large food reserves. It is normally spread by means of seed and by roots and root cuttings.

Effective, economical control measures for horse nettle have not been found. The purpose of this study is to learn more about the growth habits of the weed in the hopes of finding a vulnerable point in the life cycle at which controls may be more effective.

SEED STUDIES

In order to investigate the emergence of this weed from seed, mature, over-wintered horse nettle seed pods were obtained from a corn stubble field near Newfield, N. Y. in April, 1958. In May, 60 seeds were planted at four different depths: ¼ inch, ½ inch, 1 inch and 2 inches. The substrate was Lima Silt Loam. The flats were placed outdoors and watered when necessary. After 34 days, come-up from the ½-inch depth was 62%, 1-inch depth - 60%, 2-inch depth - 53% and at the ¼-inch depth - 21%. This lower emergence figure may have been due to poor seed coverage caused by heavy rains following seeding.

Because of the relatively high emergence level demonstrated at the 2-inch depth, 60 seeds were planted in July at a 3-inch depth and 60 seeds at 4 inches. Twenty-nine days later, 38% had emerged from 3 inches and 20% from 4 inches. There was no emergence from 6- and 8-inch depth in a similar test conducted in the greenhouse in 1959.

Seeds from the same source planted in outdoor 2 x 2 ft. concrete frames at 3/4-inch depths resulted in a 68% emergence at the end of 1 month from a total of 120 seeds planted.

Soil from the horse nettle infested field mentioned above was obtained in November 1958. Three depths of soil (two replications each of the surface 0 to 3 inches, 3 to 6 inches and 0 to 6 inches) were placed in wooden flats in the greenhouse on February 3, 1959. The average seedling emergence of 2 replications at each soil depth was: 9.2 per sq. ft. - 0 to 3 inches; 0.9 per sq. ft. - 3 to 6 inches and zero emergence - 0 to 6 inches.

To investigate the germination of seed under field conditions, the field, from which soil samples had been taken, was surveyed in the spring of 1959. The field was seeded to oats, alfalfa and timothy in April, 1959. On May 15, about 5,000 square feet of this 4-acre field were surveyed by walking back and forth along the rows of oats. In this area, 15 seedling locations were found. The distribution of seedlings at the several locations was from 1 to 15 to 20. A total of about 200 seedlings were observed. At the last observation in September, it was estimated that 50 percent of the seedlings had survived the summer.

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On March 14, 1959 an experiment was initiated in the greenhouse to determine the emergence from seed when planted in different soil types and at varying depths from 1 to 3 inches. The soils were:

1. Collamer Silty Clay Loam - pH 6.5, a heavy lake-laid clay, somewhat poorly drained.
2. Lima Silt Loam - pH 6.8, from calcareous glacial till, naturally moderately well drained but the well drained surface 6-8 inches was used.
3. Palmyra Gravelly Silt Loam - pH 5.6, from glacial outwash, well to excessively drained. This soil was used under two conditions: surface 6 yo 8 inches-unscreened; same soil screened through ½ inch mesh wire.

Counts were made at approximately 7-day intervals from April 1 to May 20. Twelve seeds were used per replication with 4 replications for each soil type and each depth. The seed used was harvested in October 1958 in Tompkins County, N. Y. The results are summarized in Table I.

Table 1. Emergence from Seed Planted in Different Soil Types at Two Depths

Counting Dates and Depths of Seed	Palmyra Grav. S.L.-Screened	Palmyra Gr. Silt Loam - Unscreened	Lima S.L.-Screened	Collamer Silty Clay Loam Unscreened
		Per Cent Emergence*		
Apr. 1 - 1 inch	35	48	44	8
3 "	2	0	0	0
Apr. 4 - 1 "	65	67	69	21
3 "	2	0	0	0
Apr.10 - 1 "	65	71	77	27
3 "	6	4	6	0
Apr.15 - 1 "	67	73	81	29
3 "	8	6	6	0
Apr.27 - 1 "	67	75	81	29
3 "	10	6	17	0
May 20 - 1 "	67	77	81	29
3 "	10	8	21	0

* Each figure represents the average of 4 replications of 12 seeds each.

The most rapid rate of emergence was at the 1-inch depth and occurred during the first 3 weeks after planting. Seed planted at the 3-inch depth showed practically no emergence until about 4 weeks after planting. Emergence of seed from the 1-inch depth in the well drained soils was about 5 times greater than from the 3-inch depth. The percent emergence in the heavier Collamer soil was less than one-half that in the well drained soil at the 1-inch depth. No seedlings emerged from the 3-inch depth in the heavy soil. Therefore, it would appear that the chances of a horse nettle infestation starting from seed is considerably better on lighter textured, well drained soils than on heavy, somewhat poorly drained soils.

The above series of investigations indicate that: Horse nettle seed from a single source is capable of germinating and producing seedlings over a period of at least 4 months (May through August); seed can emerge from depths of 4 inches below the soil surface; horse nettle infestations can be initiated from seed under field conditions.

SEED-GERMINATION TESTS

A number of horse nettle seed emergence tests carried out in the greenhouse and outdoors had indicated the high degree of potential for the spread of horse nettle from seed. To determine the factors influencing germination under more closely controlled conditions, tests were conducted at the Division of Seed Investigations, N.Y.S. Agricultural Experiment Station at Geneva.

The first test was started on June 26, 1959. A single lot of seed harvested in April 1958 in Tompkins County was used. The experiment was set up as follows:

1. Three pre-germination treatments - no cold treatment; 5 degrees C. for 5 days; 5 degrees C. for 10 days.
2. Three temperature treatments for each pre-germination treatment- 20 - 30 degrees C. alternating (20 degrees C. for 15 hours, 30 degrees for 9 hours); 10 - 30 degrees C. alternating (10 degrees C. for 15 hours, 30 degrees C. for 9 hours); 20 degrees C. constant.
3. Dark germinators used - Seeds were exposed to daylight for short periods when germination counts were made. In order to get an indication concerning the effect of long periods of light, one sub-treatment in the 20-30 degree C. condition was exposed to light during the high temperature period.
4. Substrate - Filter paper over cotton in covered petri dishes.
5. Two substrate moistening agents for each condition - tap water and 0.2% potassium nitrate solution (only potassium nitrate was used in the "light" treatment).
6. Four replications of 25 seeds each for each treatment.

All seed was dusted with a 50% Arasan seed disinfectant prior to placement in the petri dishes. Counts were made at intervals of 5-6 days. Table II summarizes the results. The germination percentages are the averages of 4 replications.

RESULTS AND DISCUSSION

Pre-germination cold treatments had no effect in this lot of seed. In general, the potassium nitrate treatments resulted in slightly greater percentage germination than the tap water moistening agent. The temperature treatment of alternating 20-30 degrees C. gave the most rapid and highest percentage of germination. Most germination occurred in the first 20 days.

Although the 10-30 degree C. treatment resulted in a slower rate of germination, the total approached that of the 20-30 degree C. treatment.

At 20 degree C. constant temperature, potassium nitrate greatly increased germination. This may have been due to (1) the effect on breaking dormancy or (2) on increasing the permability of the seed coat or (3) both.

Table II. First Horse Nettle Germination Test - June 26, 1959
Lackner Seed - Harvested April 12, 1958

	0-10 days H_2O	0-10 days KNO_3	0-15 days H_2O	0-15 days KNO_3	0-20 days H_2O	0-20 days KNO_3	0-25 days H_2O	0-25 days KNO_3	0-40 days H_2O	0-40 days KNO_3
NO COLD TREATMENT										
	Percent Germination*									
20-30 C. Dark**	28	29	51	55	59	64	61	67	62	69
10-30 C. "	3	1	24	29	42	44	49	52	56	59
20 C.	0	10	0	33	0	40	0	41	0	42
20-30 C. Light***	--	29	--	44	--	49	--	51	--	51
5 DEGREES CENT. FOR 5 DAYS, THEN:									0-42 days	
20-30 C. Dark	34	33	50	57	56	63	56	65	58	67
10-30 C. "	0	1	25	28	41	40	49	54	52	60
20 C. "	1	15	2	36	3	45	5	47	5	47
20-30 C. Light	--	35	--	45	--	50	--	52	--	52
5 DEGREES CENT. FOR 10 DAYS, THEN:									0-37 days	
20-30 C. Dark	25	32	47	55	56	61	56	66	58	67
10-30 C. "	2	0	15	13	36	33	51	47	57	56
20 C. "	0	24	0	35	3	48	3	49	3	49
20-30 Light	--	33	--	53	--	57	--	58	--	58

* Average of 4 replications of 25 seeds each.
** Seeds in dark germinator - counts made in daylight.
*** Seeds exposed to light for at least 9 hours a day.

In this test, the light treatments might indicate a slight inhibitory effect on germination. However, a later test showed no effect.

In over-wintered mature seed, the best germination conditions used were that of alternating temperatures of 20-30 degrees C., in a dark germinator, using a 0.2% potassium nitrate solution as the initial moistening agent.

EFFECT OF LIGHT ON HORSE NETTLE SEED GERMINATION

Since in previous tests seeds in the dark germinators were exposed to daylight for brief periods while counts were made, a test was initiated to include a complete dark treatment.

The same source of seed harvested April 9, 1958, one temperature treatment (20-30 degrees C., alternating) and substrate moistening agents (tap water and potassium nitrate) were used under the following conditions: complete dark; dark, except during the periods when counts were made; light for 9 hours and no light for 15 hours.

For the complete dark treatment, petri dishes were wrapped in aluminum foil and 4 sets of dishes were opened and counted at 10, 17, 24, and 31-day intervals. Four replications of 25 seeds each were used in all tests. Table III shows the results.

Table III. The Effect of Light on Germination of Horse Nettle Seed. (20-30 Degree Alternating Temperature)

Time Intervals	Complete Darkness H_2O	Complete Darkness KNO_3	Partial Darkness H_2O	Partial Darkness KNO_3	Light for 9 hrs./day H_2O	Light for 9 hrs./day KNO_3
0-10 days	5	11	1	5	13	22
0-17 days	37	57	56	53	52	58
0-24 days	41	54	66	59	61	64
0-31 days	54	71	67	60	61	66

The results indicate that light was not an important factor affecting the germination of this lot of seed.

ROOT STUDIES

Reproduction From Root Cuttings

The horse nettle root system consists of a tap root and secondary roots with associated root hairs. On June 2, 1958, an entire root system was excavated, and measured. The main root was cut into sections and the sections planted horizontally in flats at a 2-inch depth in soil. See Table IV.

Table IV. Reppoduction of Horse Nettle From Root Cuttings

Cutting No. (Top of Root to bottom)	Length in mm.	Diameter in mm. Largest-	Smallest	Original Depth of Root Section in Soil in mm.	No. of Plants Developed
a	140	8.0	3.0	0-140	5*
b	216	8.0	6.0	140-356	4
c	203	8.0	6.0	356-559	4
d	305	6.0	5.0	559-864	6
e	254	5.0	2.0	864-1118	3
f	254	5.0	2.0	864-1118	2

* Includes the number of shoots emerged at time of planting.

It is of interest to note the number of plants which developed from cuttings grown at depths down to 112 cm. For example, cuttings "e" and "f" originally growing at depths of 860 - 1120 mm., when planted horizontally at 5 cm. below ground surface, developed an average of 1 plant per 10 cm. length of cutting. There was no correlation between the length and thickness of cuttings and the number of plants produced.

Influence of Length and Diameter of Root Cuttings on Reproduction

On July 7, 1959, one plant, which had developed from seed in a wooden flat in 1958, was dug up and the roots cut into varying lengths: 5, 10, 20, 30, 40, and 60 millimeters. The lengths varied in diameter from 3.0 to 3.5 mm. These cuttings were planted in 2 x 2 ft. outdoor concrete frames containing a well drained silt loam soil at the rate of 8 cuttings per frame and at a depth of 1 inch. Table V. shows the results.

Table V. Influence of Length and Diameter of Root Cuttings on Reproduction

Length of Cutting mm.	Diameter of Cutting mm.	No. of Plants Developed *
5	3.5	0
10	3.5	0
20	3.5	8
30	3.0	8
40	3.0	8
60	3.0	8

*8 Cuttings per frame.

The indications are that horse nettle can reproduce from very small root cuttings-slightly less than one inch in length and about 3/16ths of an inch indiameter. This is an important factor to be kept in mind with regard to the use of cultural practices as a means for control.

Influence of Depth of Planting on Reproduction

On July 7, 1959, several plants which had been grown from seed in wooden flats in 1958 were dug up and the roots cut into length of 150 millimeters. These were planted in concrete frames, as above, at the rate of 6 cuttings per frame and at depths of 3, 6, 12, and 18 inches (Table VI).

Table VI. Influence of Depth of Planting on Reproduction

Depth of Planting in inches	Length of Cutting in mm.	Diameter of Cutting in mm.	No. of Cuttings* Reproducing
3	150	2.5-4.0	6
6	150	2.5-4.0	6
12	150	3.0-5.0	6
18	150	3.5-5.0	4

*6 cuttings per frame.

All cuttings produced at least one shoot each from depths down to 12 inches. Four out of six cuttings produced plants from the 18-inch depth.

The rate of emergence varied directly with depth of planting. At the 3-inch depth, emergence was completed 23 days after planting; at the 6-inch depth, 32 days and at the 12-inch depth, 46 days. At the 18-inch depth, 4 out of 6 cuttings had produced plants 67 days after planting.

It would be safe to assume that one could not expect an appreciable reduction in stand of this weed by deep tillage as is normally practiced on farms in the northeast. Fallowing - the frequent cultivation of land over a period of time, with no crop present, would gradually reduce the infestation by constantly depleting the root reserves over a period of time.

Effect of Length of Drying of Roots on Reproduction

On July 18, 1959, a number of roots were cut into 150 millimeter lengths ranging from 3.0 to 5.0 millimeters in diameter. These were placed on the soil surface to dry. Six cuttings were planted at a 2-inch depth each day for a period of 9 days. There was no precipitation during the first 4 days after planting. Daytime temperatures ranged up to 85 degrees Fahrenheit.

No shoots were produced from cuttings exposed on the soil surface for as long as 3 days.

SUMMARY

Horse nettle can be disseminated by seed, especially on light textured, well drained soils.

Deep tillage alone cannot be expected to control established horse nettle infestations.

Since the weed can be propagated by small root cuttings, it appears that half-hearted attempts to control the weed by cultural practices can readily increase its spread. Cultural operations must be timely and thorough to prevent the replenishing of root reserves from top growth.

1959 RESULTS OF CHEMICAL TREATMENTS ON QUACKGRASS (Agropyron repens) CONTROL.

S. N. Fertig 1/

Quackgrass (Agropyron repens) is the most prevalent and competitive weed problem in the agriculture of the Northeastern region. It is a problem in row crops, grain crops, rotated hay and pasture, permanent grass, vegetables, fruit, brambles, vine crops and turf. It is estimated to be present to some degree of infestation in 60 percent of the total acreage devoted to the above uses in the Northeast.

EXPERIMENTAL METHOD

A uniform stand of quackgrass was selected at the Agronomy Mt. Pleasant Research Farm near Ithaca, N. Y. The soil type was Mardin silty clay loam, moderate drainage, at pH 6.2. The elevation, approximately 1,450 feet.

The area had not been plowed for two years and no hay was removed from the area during the growing season of 1958.

The experimental design was a split plot with four replications of each treatment based on fall vs. spring plowed and on two replications based on mowed vs. not mowed before the chemical treatments were applied. The plot size was 20 x 65 feet based on mowed vs. not mowed and 20 x 15 feet based on fall vs. spring plowed.

In September 1958, after the quackgrass had gone to seed, one-half of the total plot area was mowed and the forage removed. The other half of the area was not disturbed, being treated with the heavy mat of quackgrass standing on the plots.

On October 4, 1958, 22 different treatments comprising 11 different chemicals or combination of chemicals were applied (Table 1). All treatments were applied in 30 gallons of water per acre, using a jeep mounted sprayer.

On October 25, one-half of each 20 x 30-foot plot was plowed. These were left rough over winter to reduce possible erosion across plots.

On May 2, 1959, the remainder of each plot was plowed. The entire area was disced twice and harrowed (spring-tooth) once on May 18. All fitting operations were parallel with the treatments to reduce movement of chemical to adjacent plots.

On May 20, Robson 170 hybrid corn was planted across all plots using a Ferguson 2-row corn planter with 200 pounds of 13-13-13 fertilizer per acre.

All plots received two cultivations during the growing season. No effort was made to control the weed growth in the row or to control the broadleaved weed problem by use of a selective herbicide. Identification and stand counts were made on all weed species during the week of June 22. These counts showed 31 different weed species present, which included: 11 annual, 8 biennial and 12 perennial species.

During the growing season, data was collected on the following: (a) corn germination and emergence, (b) weed species present and controlled, (c) quackgrass development and shoot counts, (d) effect of chemicals on stand of corn, (e) corn yields as silage and (f) quackgrass shoot counts in early November after corn removal.

To investigate the effect on crop growth of chemical residues remaining in the soil, soil samples were taken from all treatments in late June. Each plot was sampled at three depths: 0-3, 4-6 and 7-10 inches. These soils were potted in 4-inch plastic greenhouse pots and planted to red kidney beans, oats, ryegrass and wheat. Four replicates of each soil depth and each crop were used.

To determine the effect of the treatments on yield, all plots were harvested as silage on September 10-11. The yields of silage were based on the total harvest from four rows, 5 feet long, from each replicate of all treatments and is reported in tons per acre of silage at 75 percent moisture.

To stimulate quackgrass shoot development, after the corn was harvested in September, a uniform application of Nitrogen at 50 pounds actual N per acre was applied over all treatments.

RESULTS AND DISCUSSION

Fall Observations

Observations during the fall of 1958 following treatment and before plowing showed foliage activity for Fenac, Amitrol, Weedazol, Dowpon and the mixture of these with Simazine. There were no visual changes in the foliage of the Simazine and Propazine treated plots. Due to the late date of plowing and cold weather, there was no fall regrowth on the fall plowed plots.

Spring Observations

The order of appearance of regrowth in the spring was Weedazol, Amitrol, Dalapon, Simazine, Propazine and the 4-pound rate of Fenac. The quackgrass foliage on both the Amitrol and Weedazol formulations exhibited the characteristic chlorosis on regrowth from fall and spring plowed plots.

The development of quackgrass on the Dalapon, Simazine and Propazine plots appeared normal up to May 12, when the spring plots were plowed and May 18 when the seedbed was fitted on all plots.

No spring growth of quackgrass was evident on the 8- and 12-pound rates of Fenac. The 4-pound rate reduced the stand of quackgrass but did not prevent the early emergence of shoots on fall plowed plots or on the plots to be spring plowed.

On treatment numbers 21, 22 and 23 where the mixtures were used, fall and spring observations paralleled the results of the Simazine alone plots at the 5-pound rate.

The germination of broad-leaved weed species in the spring was evident on all treatments. The residual carry-over of chemical in the soil was most striking with Fenac. The annual broad-leaved species exhibited curled, thickened leaves on emergence and developed a maximum of 1 to 2 inches in height before dying-off. The same sequence of events followed for the weed species which germinated following each cultivation. The only other treatments showing a residual to germinating weeds were Propazine and Simazine. In contrast to Fenac, the grasses and broad-leaved species on these treatments developed to a height of 4-6 inches before showing any effects. The action of the chemical was slow but the first crop of most weed species, including quackgrass, was controlled.

Fenac

Analysis of the yield data, though not significant, shows a trend in yield response in favor of not mowed vs. mowed and spring plowed vs. fall plowed (Table 2)= The silage yields for all rates of Fenac were significantly higher than the highest check treatment. The Duncan multiple range test (Table 5) shows the significance between yields in the experiment.

The height measurements on corn made July 30, did not show any reduction in rate of growth due to the rates of chemical used. The average height of the treated plots was 86 inches compared to 67 inches for the check treatments.

The corn stalks on the 8- and 12-pound rates of Fenac were smaller in diameter and visual observations would have suggested lower yields than were obtained. However, the mean yields for these treatments, fall plus spring plowed, in order of increasing rate of chemical were: 21.9, 22.2 and 20.9 tons.

Shoot counts made on all plots during the week of June 22 showed the same number for fall vs. spring plowing at the 4-pound rate (292 vs. 292); 54 compared to 154 at 8 pounds; 42 compared to 132 at 12 pounds. (See Table 3). The number of total shoots increased on both fall and spring plowed plots between June and November, with the greatest increase occurring on spring plowed plots (Table 4). The spring plowed plots increased a total of 514 shoots while the fall plowed increased only 134.

The shoot counts made in early November indicate a trend just the opposite of the yield results. The lowest shoot counts were on the mowed, fall plowed plots. Observations before and after the fall nitrogen treatment showed marked stimulation to shoot emergence on all plots, which poses the question of just how effective any of the chemicals were in actually killing quackgrass rhizomes. Also, shoot counts made following harvest, particularly where nitrogen is applied to stimulate shoot growth, may not be indicative of the competition offered by the quackgrass during the seasonal development of the corn. This may account for the reversal of trend between yields and the November shoot counts.

Comparing the mean yield of the Fenac plots with the checks, the yields at the 4- and 8-pound rates were significantly higher at the 5 percent level. The yields of all spring plowed plots were significant, as was the 8-pound

Amitrol and Weedazol

Here again, though not significant, the yield data would support not mowed vs. mowed and spring plowed vs. fall. The yield differences are greater between spring vs. fall plowed on the not mowed plots compared to the mowed. In no instance were the yields significantly greater than the highest check at the 5 percent level. The significance of the yields at the 5 percent level by the multiple range test are shown in Table 5.

Comparing the 1958 Amitrol formulation (M-569) with the 1959 material (M-569-A), the silage yields averaged higher and the shoot counts lower for the M-569 formulation. The total shoot count made in June for all rates of the three formulations showed a definite retarding effect on the quackgrass on the mowed plots. The shoot counts averaged 1148 on the mowed plots and 2176 on the not mowed. The counts in November averaged 2926 for the mowed and 2909 for the not mowed.

Comparing the rates of chemicals used, the 8-pound rate of all three compounds was the most effective in reducing the June shoot counts on both fall and spring plowed plots.

Dalapon

The yields of silage were consistently higher on the mowed vs. not mowed plots, with the 10-pound rate giving higher yields than the 15-pound. This is consistent with previous results obtained from fall treatments, The yields from fall vs. spring plowed are almost identical and average about the same as the check plots. The yields of silage on the Dalapon treated plots were not significantly greater than the check.

The shoot counts in June and November are not greatly different for mowed vs. not mowed nor fall fall vs. spring plowed. The total shoot count on all plots of both rates of chemical was 3,488 in June and 5,254 in November.

Simazine

The yield data would show some advantage for spring over fall plowing. There were no differences in yield as regards mowed vs. not mowed. The 10-pound rate of chemical resulted in higher silage yields in all plots. The fall plus spring plowed averaging 18.9 tons at the 5-pound rate and 23 tons at 10 pounds. The yield at both the 5- and 10-pound rate were significantly higher than the checks.

The change in the number of shoots between June and November was much less with Simazine than for the other chemicals except Propazine. Also, there was a smaller increase at the 10-pound rate compared to the 5-pound rate. This may indicate a benefit from the longer residual of these compounds in the soil.

Propazine

The yield trend on the Propazine plots favored mowed vs. not mowed and the fall plowed plots yielded higher than the spring. This is just the opposite of the Simazine treatments. The individual replicate yields were more uniform with this compound than any other used in the experiment. Corn development on the plots during the season was uniformally good. The highest yields obtained in the experiment were at the 10-pound rate of Propazine.

The yields from both rates of chemical on fall and spring plowed plots were significantly higher than the checks.

The change in quackgrass shoot counts from June to November was comparable to Simazine, with the total shoots per plot being less in many cases.

Combination of Chemicals

Where Amitrol, Weedazol or Dalapon were included as mixtures with Simazine, the trend on yields favored spring plowing. There were no yield differences between mowed *vs.* not mowed using the combinations. The yield values were significantly higher than the check on both fall and spring plowed plots for all combinations and the Dalapon and Simazine on both fall and spring plowed.

The shoot count data taken in June and November were about the same for mowed *vs.* not mowed and fall *vs.* spring plowed.

Soil Residue Study in Greenhouse

In the greenhouse soil residue studies, injury from Fenac on red kidney beans was pronounced at all rates of chemical and at the three depths of soil. The degree of injury was increasingly severe with the increased rates of chemical but was uniform for the depths of soil used.

During the period June - September, three crops of beans were grown on these soils. The third crop exhibited as severe injury as the first. The oats, ryegrass and wheat were stunted and the stems smaller in diameter but they did not show serious injury at any rate of chemical.

The red kidney beans grown on the Simazine and Propazine soils exhibited normal development up to pre-bloom stage. At this point, the older leaves developed chlorotic margins which progressed rapidly toward the midrib. The condition progressed rapidly to the younger leaves. The injury occurred at both rates of chemicals used and on the three depths of soil.

No injurious effects were observed on any of the crops from the different rates of Amitrol, Weedazol or Dalapon.

SUMMARY

Several compounds show promise for the reduction of quackgrass stands by fall application. Significant yield increases were obtained as measured by corn silage yields from Fenac, Simazine, Propazine and combinations of other chemicals with Simazine.

The data would suggest that foliage may be a factor in chemical control of quackgrass. The yields of silage are in favor of the not mowed areas.

Fall *vs.* spring plowing was not a significant factor in control for any of the treatments used. There were yield differences favoring fall or

Soil residue may be a factor with some chemicals depending upon the interval between corn removal and the following crop and the kind of crop to be grown.

Table 1. Chemicals Used in Experiment

Treat. No.	Common Name or No. of Chemical	Rate/A. Lbs. A.E.	Source*
1.	Fenac	4	AmChem Products
2.	Fenac	8	
3.	Fenac	12	
4.	ACP M-569	4	AmChem Products
5.	ACP M-569	8	
6.	ACP M-569	12	
7.	ACP M-569-A	4	AmChem Products
8.	ACP M-569-A	8	
9.	ACP M-569-A	12	
10.	Weedazol	4	AmChem Products
11.	Weedazol	8	
12.	Weedazol	12	
13.	Dalapon	10	Dow Chemical Co.
14.	Dalapon	15	
15.	Simazine	5	Geigy Chemical Co.
16.	Simazine	10	
17.	Check	0	
18.	Check	0	
19.	Propazine	5	Geigy Chemical Co.
20.	Propazine	10	
21.	ACP-569 and Simazine	4 plus 4	
22.	Weedazol and Simazine	4 plus 4	
23.	Dalapon and Simazine	4 plus 4	
24.	Check	0	
25.	Check	0	

* The chemicals used in this study were made available by the companies listed.

Table 2. Yield of Silage Corn Grown on Fall Treated Plots. 1958 - 59
(Tons per acre - 75 percent moisture)

			Mowed		Not Mowed			
Treat. No.	Chemical	Rate/A. Lbs. A.E.	Fall Plowed	Spring Plowed	Fall Plowed	Spring Plowed	Fall Plowed	Spring Plowed
1	Fenac	4	17.55	23.8	24.75	22.2	20.88	22.97
2	Fenac	8	22.05	23.90	22.00	20.85	22.04	22.38
3	Fenac	12	17.90	17.95	21.85	25.75	19.90	21.85
4	ACP M-569	4	15.35	14.85	16.80	21.40	16.08	18.11
5	ACP M-569	8	12.75	10.40	13.10	13.85	12.96	12.13
6	ACP M-569	12	15.40	15.20	18.55	21.85	17.00	18.56
7	ACP M-569-A	4	17.00	17.70	16.55	9.90	16.79	13.82
8	ACP M-569-A	8	17.90	19.20	15.30	19.55	16.58	19.36
9	ACP M-569-A	12	7.65	11.25	14.45	5.40	11.06	8.35
10	Weedazol	4	15.15	15.00	18.80	19.85	16.96	17.43
11	Weedazol	8	9.30	9.75	18.95	10.05	14.12	9.89
12	Weedazol	12	9.85	8.15	18.05	17.15	13.97	12.66
13	Dalapon	10	19.70	19.75	12.65	14.55	16.16	16.93
14	Dalapon	15	15.70	13.95	9.60	11.80	12.64	12.90
15	Simazine	5	17.00	16.25	20.15	22.05	18.60	19.15
16	Simazine	10	26.80	23.80	16.55	24.80	21.69	24.30
17	Check	0	14.80	14.20	13.20	12.65	13.51	13.44
18	Check	0	5.35	12.20	9.25	11.50	7.32	11.86
19	Propazine	5	24.75	20.40	22.45	18.65	23.62	19.54
20	Propazine	10	26.90	28.50	24.4	21.55	25.63	25.03
	ACP M-569 and	4						
21	Simazine	4	22.4	21.85	19.65	19.75	21.02	20.80
	Weedazol and	4						
22	Simazine	4	21.35	21.65	20.25	28.60	20.81	25.15
	Dalapon and	4						
23	Simazine	4	22.0	28.20	22.45	22.30	22.23	25.27
24	Check	0	11.15	14.95	8.95	9.90	10.04	12.43
25	Check	0	10.2	12.75	14.25	12.30	12.23	12.54

Partial Analysis of Variance

Source	ss	df	ms	F
Mowing	8.49	1	8.49	4.45
Error (a)	1.91	1	1.91	
Plowing	13.42	1	13.42	----
Error (b)	63.39	1	63.39	
MP	4.14	1	4.14	1.91
Error (c)	2.17	1	2.17	
Chemicals	4386.30	24	182.76	8.93**
MC	758.82	24	31.62	1.55
PC	263.66	24	10.99	----
MPC	387.67	24	16.15	----
Error (d)	1964.19	96	20.46	

LSD at 5 percent level for chemicals = 4.05 bushels.

Table 3. Total Quackgrass Shoot Counts Comparing Mowed *vs.* Not Mowed and Fall *vs.* Spring Plowed*

Treat. No.	Chemical	Rate/A. Lbs. A.E.	Treatment: Mowed**	Not mowed**	Fall plowed**	Spring plowed**
1	Fenac	4	313	272	292	293
2	Fenac	8	91	156	92	154
3	Fenac	12	110	64	42	132
4	ACP M-569	4	228	930	588	570
5	ACP M-569	8	218	105	200	123
6	ACP M-569	12	366	665	637	394
7	ACP M-569-A	4	615	306	453	468
8	ACP M-569-A	8	382	423	499	306
9	ACP M-569-A	12	658	617	580	675
10	Weedazol	4	429	498	416	511
11	Weedazol	8	335	282	301	316
12	Weedazol	12	229	527	560	196
13	Dalapon	10	561	400	548	413
14	Dalapon	15	320	463	415	368
15	Simazine	5	303	382	459	226
16	Simazine	10	82	293	225	150
17	Check	0				
18	Check	0				
19	Propazine	5	203	260	235	228
20	Propazine	10	112	126	154	84
21	ACP M-569 and Simazine	4 4	212	204	235	181
22	Weedazol and Simazine	4 4	209	320	240	289
23	Dalapon and Simazine	4 4	239	217	240	216
24	Check	0	890	760	862	788
25	Check	0	379	689	526	542

* Shoot counts made week of June 22, 1959.

** Each figure in the table represents the total of 3 - 2 sq. ft. quadrat counts in each plot. To determine average shoots per swuare foot, the mowed *vs.* not mowed should be divided by 6. On the fall *vs.* spring plowed, the values would be divided by 12.

Table 4. Total Quackgrass Shoot Counts Comparing Mowed vs. Not Mowed and Fall vs. Spring Plowing*

Treat No.	Chemical	Rate/A. lbs. A.E.	Treatment Mowed**	Not Mowed **	Fall Plowed **	Spring Plowed**
1	Fenac	4	455	511	283	683
2	Fenac	8	140	284	176	248
3	Fenac	12	94	169	101	162
4	ACP M-569	4	627	770	777	620
5	ACP M-569	8	638	234	409	463
6	ACP M-569	12	538	703	555	686
7	ACP M-569-A	4	701	517	742	476
8	ACP M-569-A	8	580	466	484	562
9	ACP M-569-A	12	939	1081	1041	979
10	Weedazol	4	617	916	728	805
11	Weedazol	8	595	675	576	692
12	Weedazol	12	618	456	682	395
13	Dalapon	10	549	609	472	686
14	Dalapon	15	684	785	806	663
15	Simazine	5	432	354	373	413
16	Simazine	10	189	258	247	200
17	Check	0	969	597	753	813
18	Check	0	833	1093	1115	811
19	Propazine	5	199	478	331	346
20	Propazine	10	91	95	81	105
21	ACP-569 and Simazine	4 4	219	284	188	315
22	Weedazol and Simazine	4 4	441	388	427	402
23	Dalapon and Simazine	4 4	303	306	309	300
24	Check	0	1332	762	1204	890
25	Check	0	799	875	849	805

*Shoot counts made in early November 1959.

**Each figure in the table represents the total of 4 - 2 sq. ft. quadrat counts in each plot. To determine average shoots per square foot, the mowed vs. not mowed should be divided by 8. On the fall vs. spring plowed, the values would be divided by 16.

Table 5. Effect of Quackgrass Control on the Yield of Corn Silage.

Treatment No.	Chemical	Rate/A. Lbs. A.E.	Yield: Tons of silage per acre at 75% H_2O	Statistical Significance
20	Propazine	10	25.3	
23	Dalapon + Simazine	4 4	23.7	
16	Simazine	10	23.0	
22	Weedazol + Simazine	4 4	23.0	
2	Fenac	8	22.2	
1	Fenac	4	21.9	
19	Propazine	5	21.6	
3	Fenac	12	20.9	
21	ACP M-569 + Simazine	4 4	20.9	
15	Simazine	5	18.9	
8	ACP M-569-A	8	18.0	
6	ACP M-569	12	17.7	
10	Weedazol	4	17.2	
4	ACP M-569	4	17.1	
13	Dalapon	10	16.5	
7	ACP M-569-A	4	15.3	
17	Check		13.5	
12	Weedazol	12	13.3	
14	Dalapon	15	12.8	
5	ACP M-569	8	12.5	
25	Check		12.4	
11	Weedazol	8	12.0	
24	Check		11.2	
9	ACP M-569-A	12	9.7	
18	Check		9.6	

Duncan's Multiple Range Test; Statistical Significance at 5% Level.

F 8.93 ** Treatments Significant at 1% Level.

Concentration of a Growth Inhibitor from *Agropyron repens* (Quackgrass)**

C. W. LeFevre and C. O. Clagett*

The concept that plants are capable of producing toxic substances which enable them to compete successfully in the biotic struggle for existence is rather old (Osvald (1), but the number of chemicals isolated remains small. Evenari (2) in 1949 reviewed the literature to that time. Several workers (3) have reported inhibition of gorwth of seedlings of a variety of economic plants and weeds by extracts of dried quackgrass (*Agropyron repens*) rhizomes. Kommendahl (3) reported that the residue of extracted rhizomes were inhibitory as well as the water extract. This was explained on the basis of incomplete extraction of the toxic factor(s). If the soil did not remain sterile it is possible that the toxicity observed in pots treated with the extracted rhizomes may have been due to the type reported by Patrick (6) from decomposing residues from a number of crops such as timothy, rye, tobacco and corn. That such inhibitors may be formed was evident from some observations made during the course of the work described below, although no attempt was made to investigate further this type of inhibition.

Experimental Procedure

The quackgrass used in this study was obtained from local fields and gardens, growing under a variety of conditions. Samples were obtained in the dormant state, during a period of active growth and late in the growing season. Preliminary trials showed little effect of stage of rhizome growth on the inhibition of corn or alfalfa elongation. The rhizomes were washed in tap water to remove the occluded soil, dried in an 80° C. moving air oven for 24 hours, ground through a 40 mesh sieve in a laboratory Wiley mill and stored in a glass jar until used.

Water extracts were prepared by use of shake flasks or by percolation of water through a column of ground quackgrass.

Seeds of the desired varieties were germinated in petri dishes and transferred to dishes containing filter paper wetted with the test solution. After a selected period of time (usually 48 hours) growth was measured and percentage inhibition calculated.

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Results

The results of growth inhibition studies on seeds of eight crop plants are shown in Table I. The degree of inhibition varied from 50 percent to 84 percent. In the milo samples the roots were inhibited more than the shoots. In all plants the root tips were thickened. Birdsfoot trefoil, alfalfa, cow peas and sunflower showed excessive browning of tips in the treated plant. Among the seeds tested, corn and alfalfa gave the most uniform results with the least trouble with molds.

Table I Comparison of growth inhibition of germinated seeds.+

Test seed	Growth-mm. Control	Quackgrass extract	% inhibition
Alaska field peas	17	8	53
Cow peas	26	12	54
Corn	45	10	78
Sunflower seed	25	8	68
Milo	13	2	84
Birdsfoot trefoil	17	9	47
Alfalfa	31	9	67
Sweet Clover	12	6	50

+ Extract prepared by extracting 10 g. dried, ground rhizomes in 100 ml. distilled water for 20 minutes on shaker. Supernatant recovered by centrifugation.

Letourneau *et al.*(3) reported nonadsorption on cation and anion exchange resins. We found that when the extract had passed through a cation exchange resin (Dowex 50) followed by anion exchange resin (Dowex 1) the effluent was totally inactive. Failure of LeTourneau (7) to absorb it on the anion exchange resin was attributed to inefficient absorption due to presence of cations (Table II).

Table II Inhibition of corn seed prior to and following treatment with anionic and cationic resins.

	Growth-mm.	% inhibition
Control	82	0
Extract	22	73
Eluate from Dowex-50 resin	18	78
Eluate from Dowex- 1 resin	84	- 2

To evaluate separation techniques a micro assay was used consisting of 5 alfalfa seeds in a 5 ml beaker containing a filter paper wetted with the solution being checked. Usually the samples were checked in triplicate.

The inhibitory fraction could be eluted from the anion absorbing column by displacement with formic acid or with ammonium hydroxide, with considerable loss of activity. Mineral acids and bases led to complete destruction of the inhibitor.

The active fraction can also be separated by means of paper or column chromatography. In most experiments the descending method was employed, using S and S 470A heavy paper sheets with a Whatman No. 1 wick to control the rate of flow. Solvent systems containing ethyl alcohol - acetic acid - water or ethyl alcohol - ammonia - water (80-4-20 V/V) were employed. The active fraction was detected by sectioning paper, eluting with water, concentrating to the desired volume and testing with the alfalfa seed assay. The active fraction is located in the region of R_f 0.5. Succinic acid (R_f 0.32) and malic acid (R_f 0.28) appear in high concentration in the Duolyte eluate but do not influence the rate of growth. Succinate and malate were identified chromatographically and by preparation of the naphthyl-methyl-thiuronium salts.

Key and Galitz (8, 9.10) reported the separation of a growth inhibitor from immature soybean seeds and from young 2,4-D treated soybeans. This inhibitor showed a maximum absorption at 260 mu. The instability and other chemical properties resembled those of the inhibitor under discussion. Although earlier investigations had shown little ultra-violet absorption, a detailed study was made of the absorption of fractions separated by ion exchange chromatography and of paper chromatography. (Table III).

Table III A comparison of growth inhibition with ultra-violet absorption of eluates of paper chromatographic fractions

Section	Relative absorbancy + 290 mu	260 mu	% inhibition	$RA_{260/I}$
4	7.1	11.2	73	.15
5	21.5	40.5	84	.48
6	12.6	27.9	18	1.55

+ Relative absorbancy is absorbancy/gm quackgrass extracted per ml solvent.

Discussion

The difference in ratios of relative absorbance to inhibition Table III are greater than those expected from experimental error. Therefore, the major activity does not appear to be directly associated with the 260 mu absorbing peak, but the active section of the chromatogram does contain a compound (s) absorbing in that range. Eluates from section 1, 2 and 3 were relatively inactive.

The 290 mu absorption data are included because fractions collected from duolyte 4A columns with acetic acid as the eluting agent showed such absorption in the tubes containing the greatest amount of inhibition. None of the portions of the paper chromatogram developed from the initial extract showed this peak. Whether the 290 peak is associated with destruction of the inhibitor on the column cannot be answered at this time. One tends to lose the 260 mu absorption during the column separations. At present we are inclined to believe the inhibitor from quackgrass differs from the factor isolated from soybeans by Keys, et al., although the two factors are similar in many respects. Both are anionic in nature, are unstable to strong acids and bases and unstable to freezing in water system.

Summary

A growth inhibitor extracted from dried quackgrass rhizomes has been concentrated by use of paper chromatographic and ion-exchange column techniques. It is anionic in nature, soluble in polar, insoluble in nonpolar solvents and is unstable in strong acids and bases. Although no structure can be suggested at the present time, solubility, absorption, and stability data differentiate it from the coumarin type of inhibition reported by Misera and Patnaik (10). The inhibition must be classified as a growth inhibitor and not a germination inhibitor (2).

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RELATIONSHIPS BETWEEN CONTROL OF QUACKGRASS (*Agropyron repens*) AND CARBOHYDRATE CONTENT OF RHIZOMES *

Homer M. LeBaron and S. N. Fertig**

INTRODUCTION

Traditionally, quackgrass has been one of the more difficult weeds to eradicate or control. In spite of the many control measures used in the past, the costs and losses to agriculture and industry due to this pest have increased.

The development of organic herbicides effective for quackgrass control has been slow. They have generally been too costly and with too little selectivity for wide use. However, in recent years several new chemicals possessing considerable selectivity have been developed which are effective against quackgrass.

In the past, most of the research carried out to study the effect of dalapon (Na 2,2-dichloropropionate) and other herbicides upon quackgrass, has been by applications, observations, and measurements in the field. This has led to considerable variation in the results and recommendations, especially when comparing results obtained from widely different climatic and environmental conditions. There is need to supplement this work with research of a more fundamental nature. It would be a real asset in interpreting results, in making recommendations, and in following more efficient control practices if some basic answers to the physiological nature of quackgrass response to chemical and cultural treatments were available.

Since the recovery of quackgrass following treatment is dependent on the survival of rhizomes in the soil, and since the extent of vigor and regrowth is correlated to their food reserve content (6, 7), the authors felt it important to study the effects of numerous combinations of chemical and cultural treatments on the storage carbohydrates of rhizomes growing under various physiological conditions. It was hoped that some information would thus be obtained on the mode of action of the herbicides, e.g. whether the below-ground parts of the grass affected are irradicated, or merely become dormant. It seemed also desirable to determine, if possible, whether the reported increases in effectiveness of quackgrass control following nitrogen applications (7) were due to increased vigor and density of top-growth, thereby absorbing and translocating more herbicide, or if they may have been principally induced as a result of food reserve depletion in the rhizomes.

MATERIALS AND METHODS

In the fall of 1957 a split-plot factorial field experiment was initiated to study the responses of quackgrass to chemical and cultural treatments under various levels of fertility. This was accompanied by laboratory analysis of the rhizomes to determine any correlations and interactions that may exist

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*This includes part of the work done on the Ph. D. study.

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between the response of quackgrass to treatment and its level of food reserve.

The location selected was a medium fertility Dunkirk silt loam soil that had not been cropped on previous year due to the heavy stand of quackgrass. The density and growth of the quackgrass was very uniform.

The treatments applied and the basic experimental design were as follows:

Whole plots --- Cultural treatments
I - Fall chemical, fall plow
II - Fall chemical, spring chemical, spring plow
III - Spring chemical, spring plow
IV - Spring chemical, fallow
V - Check (spring chemical, no plow)

Split plots --- Nitrogen treatments
A - 0 lb. N/acre
B - 50 lb. N/acre
C - 100 lb. N/acre

Split-split plots - Chemical treatments
1 - 7½ lb./acre of dalapon
2 - 15 lb/acre of dalapon
3 - 10 lb/acre of polychlorobenzoic acid (ACP M-103-A)
4 - check

All possible combinations of treatments were replicated four times, making a total of 240 plots.

The matured grass was mowed, raked, and removed from the field on August 16, 1957. The nitrogen was applied on August 28 in the form of NH_4NO_3. The purpose of these treatments was to stimulate differentials in density and vigor of top growth and also in levels of carbohydrate reserve in the rhizomes. The fall applications of chemicals were made on October 26, by which time the increased top-growth and vigor of the grass in response to the nitrogen had become very pronounced. The fall plowing was carried out two weeks later on November 11. The spring chemical applications were made on May 10, 1958. Spring plow and fallow plots were plowed two weeks later on May 24. The fallow plots were disced periodically during the year as required to prevent appreciable top growth.

Samples of quackgrass rhizome were taken periodically for laboratory analysis, according to the following schedule:

1st harvest - October 19, 1957
2nd harvest - November 9, 1957
3rd harvest - April 2, 1958
4th harvest - May 29, 1958
5th harvest - July 24, 1958
6th harvest - August 27, 1958
7th harvest - March 20-28, 1959

Initially and for the first six sampling periods, the procedure used was to obtain samples as uniform in size and depth as possible by digging up rhizomes in two locations within each plot. The plant material was immediately washed to remove all soil, partially dried between paper towels, the above-ground parts were removed, and the rhizomes put in a paper bag which, in turn, was placed in a portable refrigerator containing dry ice. They were then transferred to a storage freezer where they remained until analysis could be made. The samples were then dried in a forced-air oven at 70° C., and ground in a Wiley mill through a 40-mesh screen. The plant material was again dried at 70° C. to uniform moisture, sealed in air-tight bottles, and shaken well to ensure thorough mixing.

For the seventh and final harvest, a steel cylinder having an area of one square foot was used to obtain the samples. An area in the plot which had not previously been sampled was selected at random and any weeds or top growth of quackgrass were removed. The cylinder having sides constructed of 3/8 inch thick steel and 12 inches high, with a one-inch steel plate top, was placed over this area and pounded into the soil to a depth necessary to obtain all rhizomes. A cement mixer was used to separate the rhizomes from the soil. After all soil, foreign plant material, etc., were removed the clean rhizomes from each sample were placed in a bag and dried in a forced air oven at 70° C. After drying the rhizomes were weighed, ground, and stored in air-tight bottles until analysis was to be made. They were then re-dried to constant moisture, mixed well, and analyzed for carbohydrate content.

The food storage material of quackgrass rhizomes consists primarily of the rather heterogenous class of polysaccharides known as fructosans (1, 2, 5). The most satisfactory procedure for routine quantitative analysis of this carbohydrate seemed to be McRary and Slattery's modification of the method of Roe (3, 4). This is based on the familiar Seliwanoff test for ketoses by the development and measurement of a colored compound formed by the interaction of fructose and resorcinol.

The procedure used in the quantitative determinations of fructose was as follows:

> Sufficient plant material is weighed into a test tube so that after digestion and dilution to 100 ml. the fructose content does not exceed 0.08 mgms. per ml. Beer's law holds up to this concentration (8 mgm. per cent fructose) for most instruments.
>
> Following digestion in water for one hour at 90° C., the sample is filtered and brought to a volume of 100 ml. One ml. of this extract is pipetted into a test tube. To this is added four ml. of water, five ml. of 0.1% alcoholic resorcinal and 15 ml. of 30% HCl. After the contents are mixed, the tubes are placed in an 80° C. water bath for 20 minutes to develop color, cooled to room temperature, and the color density is determined in a Bausch and Lomb Spectronic 20 colorimeter at 540 mu.

The fructose content of quackgrass rhizomes was found to be so high that only 50 milligrams of the ground plant material gave sufficient color intensity so that all samples fell within the optimum range of the colorimeter when using a wave length of 540 mu.

In an attempt to minimize experimental variation, the samples were processed in batches of complete replications and a new standard curve using C. P. fructose was prepared each time. Since the water extraction of the samples was not preceded by an alcohol extraction to separate out free fructose, sucrose or other alcohol soluble saccharides, the data obtained represent total fructose, and not merely polymers of fructose. Consideration was given to running separate extractions and determinations on the alcohol-soluble and water-soluble saccharides present in the rhizomes. However, since the seasonal and diurnal fluctuations in the free fructose and sucrose contents of under-ground storage organs of perennial grasses are generally small, and due to the time and expense involved in such a large number of samples, the reported procedure was used. Determinations will be made to check the relative concentrations of these fractions in some samples. In considering the objectives of the study, it was felt that the total fructose values would be more meaningful than the fructosan content alone.

This study has been continued and enlarged to include several new herbicides which have appeared promising for the control of quackgrass since the first experiment was initiated. All later sampling has been done using the steel cylinder.

RESULTS AND DISCUSSION

Quackgrass rhizomes were found to contain a rich supply of carbohydrate reserves as measured by the total fructose content. Although the seasonal variations of food reserve tend to follow a pattern from a minimum in early spring to a maximum in late fall, there was relatively little change found throughout the year in the percentage of fructose from undisturbed or untreated rhizomes. The percentage of fructose values ranged from a high of 64.3% to a low of 1.0% of the total dry weight of rhizomes. While the differences were generally related to treatment response, sampling errors and variation were also quite large, particularly in the first six harvests.

The main effects of nitrogen resulted in an early decrease of food reserve. However, this effect tended to diminish or disappear with time, especially where no further treatment was superimposed or where considerable regrowth occurred later.

The main effects of cultural treatments showed a gradual but relatively small decrease in carbohydrates due to plowing, while fallowing was much more severe and its effects continued throughout the experiment.

The main effects of chemical treatments tended to result in a marked decrease in food reserve due to dalapon, but little or no effect from polychlorobenzoic acid.

While the results strongly suggest that there may be significant interactions between the main effects, (e.g. nitrogen levels versus dalapon treatments, and fallow versus dalapon treatments), the statistical analysis of these data has not yet been completed, so further evaluation is not possible at this time but will be presented at the 1960 meetings in New York.

It became obvious after beginning this study, especially after most of the quantitative determinations had been completed on samples from the first six harvests, that the absolute levels of food reserve in the rhizomes obtained by our sampling methods, failed to represent a true and complete picture of the total effects of the treatments. It appeared evident that as the food reserve of the rhizomes falls below a certain level and/or as a result of other physiological effects of treatments, the rhizomes die and are readily decomposed. The samples obtained for analysis by the procedure used in the first six harvests primarily represent live rhizomes which have survived the deleterious effects of treatments. Thus they may yet retain considerable food reserve, especially when any renewal of top growth has taken place, and are not representative of the average carbohydrate depletion. It was principally for this reason that the rather laborious procedure of obtaining samples with the steel cylinder was found necessary. This gave a measure of the total quantities of rhizome and fructose on an area basis. It was found that the effects of treatments were accentuated considerably as a result of this procedure.

CONCLUSIONS

An experiment was designed and initiated in 1957 to obtain information regarding some physiological aspects of quackgrass control under chemical and cultural treatments. Samples of rhizome from treated quackgrass were taken periodically and analyzed quantitatively for reserve carbohydrates to determine if the treatments were effective killing the rhizomes or if they merely remained in a state of dormancy. Correlation between fructose content of rhizomes and response of quackgrass to treatment as well as interactions between treatments were evaluated.

The rapid response of top growth to fall nitrogen applications resulted in a simultaneous decrease in fructose content of the rhizomes.

Plowing either in the fall or spring tended to give slight decreases in fructose, while fallowing resulted in continuous and extreme depletion.

Dalapon treatments resulted in considerable decrease in fructose although when no further treatment was applied or even with plowing, some rhizomes survived in apparently healthy condition. Differences in effectiveness of control and content of fructose between $7\frac{1}{2}$ lbs. per acre and 15 pounds per acre of dalapon did not appear very great. There was little or no effect due to polychlorobenzoic acid.

There were indications that nitrogen applications followed by application of dalapon gave significantly better control and depletion of rhizome reserves than dalapon alone. The interaction between dalapon treatment and fallow also seemed to be important.

The results based on the statistical analysis of these data will be presented and discussed in greater detail at the 1960 meetings.

Further work is underway which includes several new chemicals of interest in the control of quackgrass.

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ABSTRACT

THE ACTIVITY OF SEVERAL SUBSTITUTED BENZOIC AND PHENOXY-ALKYLCARBOXYLIC ACIDS ON SMALL GRAINS AND DOG FENNEL

R. D. Ilnicki[1]

Several families of herbicides were evaluated in an effort to find an effective post-emergence herbicide for selectively controlling dog fennel in barley and wheat. Particular attention was paid to the relationship of molecular structure to activity and selectivity. Of the families studied certain phenoxyalkylcarboxylic and substituted benzoic acids appeared to possess the required specificity.

A number of phenoxyalkylcarboxylic acids were evaluated and it was evident that 4-(2,4-dichlorophenoxy)butyric acid, [4-(2,4-DB)], was relatively inactive on the test species. Several alpha-phenoxypropionic acids were effective in controlling dog fennel with little or no significant injury to small grains if used within a certain dosage range. 2-(2,4,5-trichlorophenoxy)propionic acid, [silvex], was the most active followed by 2-(2,4-dichlorophenoxy)propionic acid, [2-(2,4-DP)], and 2-(2-methyl,4-chlorophenoxy)propionic acid, [2(MCPP)]. Several phenoxyacetic acids including 2,4-dichlorophenoxyacetic acid (2,4-D) were slightly active on dog fennel but they were not as effective for the control of dog fennel as the alpha-phenoxypropionic acids.

Of the six variously substituted benzoic acids studied chlorine substituted in the 2-, 3-, and 6-positions gave the most effective control of dog fennel but caused some injury to the small grains. Consequently, all other analogues were compared to 2,3,6-trichlorobenzoic acid (2,3,6-TBA). Substituting a methoxy group in the 2-position resulted in a marked increase in activity on the test species. The 2-methoxy-3,6-dichlorobenzoic acid was highly active on small grains and dog fennel. Still more injury was produced to the small grains when a methyl group was substituted in the 2-position. Increased injury to dog fennel with no apparent injury to the small grains resulted from a methoxy substitution in the 2-position and an additional chlorine in the 5-position [2-methoxy-3,5,6-trichlorobenzoic acid]. It is worthy of note that 2-methoxy-3,5-dichlorobenzoic acid and 3-amino-2,5-dichlorobenzoic acid were relatively inactive on dog fennel and small grains.

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Pre-emergent Weed Control in Silage Corn, 1958-59[1]

R. S. Bell and Erling Larssen[2]

Results of newer herbicides tests for weed control in corn conducted at the Rhode Island Agricultural Experiment Station in 1958 and 1959 are reported in this paper. The sources of herbicides and their chemical names are listed in the appendix. Percentage of active toxicants are included in the yield tables.

Penn. 602A silage corn was planted during the third week of May on the Agronomy farm. The soil is a Bridgehampton silt loam. One thousand pounds per acre of 8-12-12-2 fertilizer was used, one-half being disked in before planting, the other half banded by the planter. The plots were five rows wide and 36 feet long. There were three replicates of each treatment.

The amount of herbicide for each plot was measured and applied individually using knapsack sprayers. The amount of water used was equivalent to 30 gallons per acre for soluble materials and 50 gallons for slightly soluble ones. Dry preparations were mixed with coarse sand to facilitate spreading by hand.

One set of untreated plots was hand-hoed as needed. This occurred on June 14 and 25 in 1958 and on June 11 and 19 in 1959. All plots were cultivated just before layby, July 1. Another set of plots was not treated chemically nor cultivated until July 1. This is called the delayed cultivation treatment.

1958 Results

Table 1 shows amounts of herbicides used in 1958, yields of silage corn and weed ratings on June 30. The spring of 1958 was cool and wet. Very few annual weeds germinated. Weed competition was not a factor in production and no statistically significant differences in yields were found. The weight of green silage corn varied from 16.5 tons where 5 pounds of Eptam was used to 20.5 where DNBP was applied. The amount of DNBP used was too large and the seedlings were damaged, so some replanting became necessary. During 1957 Eptam sprayed on the soil surface was not particularly effective in suppressing weed seed germination. Working this material into the soil improves its effectiveness, but increases the cost of production.

Simazine rates of 2, 4 and 6 pounds per acre were equally effective in weed inhibition without damage to corn. No residual toxicity symptoms were produced on rye following any applications of the herbicides.

There were plants of northern nutgrass scattered throughout the plots. Simazine was the only herbicide that damaged nutgrass. It became yellowed and stunted. However, only a small percentage of the nutgrass plants was killed.

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[1]Contribution No. 987. Rhode Island Agricultural Experiment Station.
[2]Associate Professor and Graduate Assistant, respectively.

Table 1. Yields of 602A Silage Corn in Weed Control, 1958.

Materials	Concentration	Pounds Toxicant/ Acre	Tons/Acre Green	Dry	Weed Rating*
DNBP	3 lbs./gal.	6	20.6	3.94	10.0
Simazine	50% W	6	19.7	3.78	10.0
Emid	75% W	2	19.2	3.67	9.3
Eptam	6 lbs./gal.	10**	19.1	3.67	9.0
Simazine	50% W	2	18.6	3.57	10.0
Simazine	50% W	4	18.2	3.50	10.0
Delayed Cultivation	—	—	17.6	3.37	8.3
Hand-hoed Checks	—	—	17.5	3.38	9.6
Emid (pre & post)	75% W	2 pre 2 post	17.3	3.32	9.6
Eptam	6 lbs./gal.	5**	16.5	3.17	9.3
L.S.D. at 0.05			NS		

*0 = no control, 10 = complete control.
**Raked by iron rake.

In this particular test no further advantage was found from an additional application of Emid at layby.

1959 Results

To insure a stand of grassy weeds the experimental area was over seeded with a mixture of Hungarian and Japanese millets containing a small amount of pigweed seeds. The annual grass population consisted chiefly of the millets plus hairy and smooth crabgrass. There was a natural population of wild radish, pigweed, lambs-quarters, spurry and purslane seedlings present in the area.

Table 2 indicates herbicides applied, pounds of toxicant per acre, yields of silage corn and weed ratings on July 1. The green weight of silage ranged from 14.0 tons per acre where Fenac on clay was used to 22.7 tons for granular Atrazine. Average yield from the hand-hoed checks was 18.7 tons per acre, while only 15.4 tons were harvested where cultivation was delayed to July 1. The difference necessary for statistical significance at the 5 percent level is 2.3 tons.

Some replanting of corn was done due to damage by birds and woodchucks. It is believed that the trend for lower yields with Fenac, B528 and possibly Falone was partially due to mixing of herbicide treated soil with the seed in the replanting operation. This is a hazard which should be considered when selecting a pre-emergent herbicide as some replanting is often required.

The granular preparation of Simazine was not as effective as the spray application for weed suppression. On the other hand granular Atrazine was equal to the spray in effectiveness. It was noted that smooth crabgrass seemed resistant to Atrazine - the plots treated with this material could be detected by the presence of the smooth crabgrass seedlings. This was also noted on a demon-

Table 2. Average Yields of Silage Corn, Pre-emergent Weed Control Tests, 1959.

Materials	Concentration	Lbs./A Active Toxicant	Type	Tons/A Green	Tons/A Dry	July 1 Weed Control* Grass	July 1 Weed Control* Dicots
Fenac M 816A	10% on clay	2	Granular	14.0	3.2	9.0	9.8
B528	10% on clay	4	Granular	15.1	3.4	8.7	7.3
Delayed Cultivation		-	—	15.4	3.5	0.0	0.0
B 528	4 lbs./gal.	4	Spray	16.7	3.8	8.5	7.7
Fenac M 673A	1½ lbs. AE/gal.	2		17.2	3.9	8.3	10.0
Falone	4 lbs./gal.	4	Spray	18.2	4.1	8.3	7.5
Hand-hoed Check		-	—	18.7	4.3	8.5	9.3
Simazine	8½% on clay	2	Granular	19.5	4.4	5.0	5.7
Atrazine	50% W	2	Spray	20.1	4.6	9.5	10.0
Simazine	50% W	2	Spray	20.7	4.7	9.7	9.8
Atrazine	4% on clay	2	Granular	22.7	5.2	9.3	10.0
L.S.D. at 0.05				2.3			

*0 = no control; 10 = complete control.

It does not seem that there is any real difference in weed control between the granular preparations and spray applications of Fenac and B528. The granular preparation of these materials were associated with the lowest yields of silage corn which may ind ate more residual toxicity.

Summary

Weed competition in 1959 was sufficient to reduce yields of Penn. 602A silage corn, but not in 1958. Replanting where corn was destroyed by preditors indicated some hazard to the new seedlings where Fenac and B528 were used. Atrazine, granular or spray, produced excellent weed control, except for a trace of smooth crabgrass. Simazine spray was more effective than the granular preparation. Simazine retards the growth of Northern nutgrass. Corn treated with granular Atrazine yielded significantly more than that from hand-hoed checks. It must be pointed out that while Simazine and Atrazine produce excellent weed control, sprayers used for their application need to have excellent agitation and the proper size nozzles to prevent clogging.

Appendix: Chemical Constituents of Herbicides.

1. DNBP. (Dow Premerge) Alkalmine salt dinitro-s-sec-butylphenol
2. EPTC. (Stauffer) Ethyl N, N-di-n-propylthiocarbamate
3. Simazine. (Geigy) 2-chloro-4, 6-bis (ethylamine-S-triazine)
4. Emid. (Am. Chem.) 2-4-dichlorophenoxyacetamide.
5. Fenac. (Am. Chem.) 2, 3, 5-trichlorophenylacetic acid
6. Falone. (Naugatuck) Tris-(3,4-dichlorophenoxyethyl) Phosphite
7. B528. (Naugatuck) A falone derivative
8. Atrazine. (Geigy) 2-chloro-4 (isopropylamino-6-ethylamino-S-triazine

WEED CONTROL IN FIELD CORN[1]

Jonas Vengris[2]

The main objective of the 1959 field corn weed control trials was to compare the effectiveness of new herbicides with Dinitro and 2,4-D, herbicides which are now widely accepted.

Procedure:

The experiment was conducted on a fine sandy loam with only fair drainage. A randomized block design with four replicates was used. Each plot consisted of four corn rows 25 ft. long. EPTAM treatments were applied on May 15, and immediately mixed with the soil by rotovating ca 4-6 inches deep. The same day, Ohio M-15 corn was planted. Three days later on May 18, pre-emergence treatments were applied. Post-emergence treatments, DNBP 3 lb/A II and Atrazine 2 lb/A II were applied on May 25 when corn was in spike stage. In the "Randox 4 lb/A + 2,4-D 1/2 lb/A amine" treatment, Randox was applied as a pre-emergence treatment on May 18, and 2,4-D applied on June 10 as a post-emergence treatment. At that time the corn was ca 8 inches tall.

When making the pre-planting and pre-emergence treatments, the soil was moist but there was no more rain for fifteen days. Thus the effectiveness of some pre-emergence treatments (e.g. DNBP, triazines, diuron) was significantly decreased. During the growing season the corn was not cultivated.

The effect of different treatments on weeds and corn was observed during the whole growing season. The weed population consisted mostly of crabgrass (Digitaria sanguinalis), barnyard grass (Echinochloa crus-galli), pigweed (Amaranthus retroflexus), lambsquarters (Chenopodium spp.) and purslane (Portulaca oleracea).

Results and Discussion:

Observations made seven weeks after planting are recorded in Table I. Two middle rows of each plot were harvested as silage corn on September 9. All yields were adjusted to 15% moisture content. The rates presented in the table are expressed in pounds of acid equivalent or active ingredient per acre.

All treatments significantly controlled broadleaved weeds. It is interesting to note that under the conditions of the test, the addition of 1 1/2 lb/A of 2,4-D to Randox did not increase significantly the control of broadleaved or grassy weeds. Randox 4 lb/A as a pre-emergence treatment plus 1/2 lb/A of 2,4-D as a post-emergence treatment was one of the best treatments

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in the trial. With the exception of 1/2 lb/A of 2,4-D as a post-emergence treatment, all herbicides effectively controlled mono-cotyledonous weeds. Weed control obtained with the two Dinitro treatments once again proves that it is more satisfactory to apply this herbicide as a post-emergence than as pre-emergence treatment. A 3 lb/A rate applied at spike stage gave significantly better weed control than 6 lb/A applied three days after planting.

Table I. Field Corn Weed Control and Corn Yields
Relative Values. Checks - 100

	Treatments	Weed Stands 7/3/59 Dicot	Mono-cot	Corn Yields
1.	Check	100	100	100
2.	Check, clean	0	0	134
3.	EPTAM 2 lb/A, pre-planting	16	6	125
4.	EPTAM 4 lb/A, pre-planting	5	2	134
5.	EPTAM 6 lb/A, pre-planting	1	2	134
6.	Simazine 1 lb/A, pre-emergence	26	34	124
7.	Simazine 2 lb/A, pre-emergence	14	9	128
8.	Atrazine 2 lb/A, pre-emergence	11	33	127
9.	Atrazine 2 lb/A II, spike stage	4	25	129
10.	2,4-D 1 1/2 lb LVE, pre-emergence	20	25	120
11.	2,4-D 1/2 lb/A amine, corn 8" tall	16	89	130
12.	DNBP 6 lb/A, pre-emergence	40	47	122
13.	DNBP 3 lb/A II, spike stage	11	24	124
14.	Diuron 1 lb/A, pre-emergence	34	38	123
15.	Diuron 2 lb/A, pre-emergence	28	24	124
16.	Fenac 1 lb/A, pre-emergence	27	26	130
17.	Fenac 2 lb/A, pre-emergence	14	19	121
18.	Fenac 4 lb/A, pre-emergence	8	12	117
19.	Randox 4 lb/A, pre-emergence	20	7	139
20.	Randox* 4 lb/A + 2,4-D 1 1/2 lb/A, pre-emergence	13	11	133
21.	Randox* 2 lb/A + 2,4-D 1 1/2 lb/A, pre-emergence	16	10	128
22.	Randox+ 4 lb/A + 2,4-D 1/2 lb/A	3	8	125
23.	Urab 1 1/2 lb/A, pre-emergence	15	28	134
24.	Urab 4 1/2 lb/A, pre-emergence	1	5	89
25.	Zytron (Dow M-1329) 5 lb/A pre-emergence	78	75	121
26.	Zytron (Dow M-1329) 10 lb/A pre-emergence	42	58	122
	L.S.D. at 5% level	14	13	14
	L.S.D. at 1% level	18	18	19

* Mixed before application

+ Randox applied as pre-emergence May 18, 1959; 2,4-D applied as post-emergence June 10, 1959.

In general, the best weed control was obtained with EPTAM 4 lb/A and 6 lb/A. All these plots remained relatively free of weeds during the whole growing season. The experimental area, although not uniformly so, was infested also with nutgrass (Cyperus esculentus). Both the above mentioned EPTAM rates gave excellent control of nutgrass. On plots where EPTAM 4 lb/A and 6 lb/A were applied, corn was stunted the first six weeks but later regained normal growth and yields were not affected. Simazine and atrazine at 2 lb/A gave very good annual weed control but were not so good as one year ago when weather conditions were more favorable (1). At the rates used, no significant differences were obtained between atrazine applied as a pre-emergence and as an emergence treatment. Fenac at 4 lb/A gave excellent weed control but corn plants were stunted and remained so all through growing season. However, relatively good weed control was obtained and corn yields were increased. Urab especially at the 4 1/2 lb/A rate was very effective but injury to corn plants was also extensive and yields were significantly decreased. It seems that this chemical may be promising as a soil sterilant. Least effective of all pre-emergence herbicides applied was Zytron at the rates used.

Summary and Conclusions:

1. A weed control experiment with corn was conducted on a fine sandy loam soil. Ten different herbicides at various rates and times of application were used. Corn was planted on a naturally moist soil on May 15 but no rain occurred until June 2 fifteen days later. The weed population consisted of: crabgrass, barnyard grass, red root pigweed and lambsquarters. Nutgrass was present but was not uniformly distributed.

2. All chemicals and rates were effective in controlling broadleaved weeds. With the exception of 2,4-D 1/2 lb/A post-emergence application, all herbicides effectively controlled grassy weeds also. Best weed control was obtained with 4 lb/A and 6 lb/A of EPTAM and Randox 4 lb/A as pre-emergence plus 1/2 lb/A 2,4-D amine when corn was eight inches tall. Under conditions of dry weather after planting, it seems that most promising material for controlling weeds in corn is 4-6 lb/A of EPTAM applied before planting and mixed 4-6 inches with the top soil. These rates also effectively controlled nutgrass.

3. EPTAM treatments at 4 lb/A and 6 lb/A for six weeks stunted corn. Later on corn regained normal appearance and yields were as high as from check plots which were kept clean of all weeds. Fenac at 4 lb/A stunted corn. Observations showed that corn remained so until harvest. However, due to the good weed control, Fenac at 4 lb/A rate did increase corn yield. Most injurious to the corn was Urab applied at 4 1/2 lb/A rate.

References:

1. Vengris, Jonas Weed Control in Field Corn. Proc. 11th Annual NEWCC, pp. 93-96. 1957

QUACKGRASS CONTROL IN FIELD CORN[1]

Jonas Vengris[2]

This is a progress report of work in 1958-59 with herbicides applied before corn planting for quackgrass (Agropyron repens) control.

Leverett, Mass. Experiment:

Trials were conducted on a well drained gravelly sandy loam. The area had good uniform stand of quackgrass. Plots were 12 ft. by 25 ft. in size. Two replicates were used. Applications of dalapon, simazine and atrazine were made in the fall of 1958 and spring of 1959. Fall treatments were applied October 2 on a lush, 8 inch growth of quackgrass. No rain fell until October 23rd. On that date no observable response was found on the simazine or atrazine plots. On the dalapon plots, the quackgrass was stunted and chlorotic. Somewhat later in November and December some injury was noticable on the atrazine plots where the plants were somewhat chlorotic. Injury on the simazine treated plots was first observed in early spring of 1959. Quackgrass stand estimates were made on May 8, 1959. The results are shown in Table I. The best quackgrass control was obtained from dalapon 10 lb/A, 15 lb/A; atrazine 8 lb/A rate and a mixture which consisted of dalapon 5 lb/A and atrazine 4 lb/A.

Spring treatments of dalapon were applied on an 8-10 inch growth of quackgrass on April 24th. Three weeks later, all experimental areas were plowed, disked, fertilised and the seedbed prepared for corn planting. Simazine and atrazine treatments were applied on May 12 and on May 14. Ohio M-15 silage corn was planted. To control annual weeds, 4.5 lb/A DNBP was applied uniformly on May 25. Seven weeks after corn planting, on July 7, quackgrass stand estimates were made (Table I).

Of the fall applications, the best control was obtained from atrazine and the 8 lb/A simazine treatment. The addition of dalapon did not increase the effectiveness of simazine or atrazine. Of the spring treatments, the best quackgrass control was obtained from 5 lb/A dalapon early in the spring plus 4 lb/A simazine or atrazine 3 weeks later just before planting. Dalapon, simazine and atrazine, when applied alone in the spring, were not as effective as when applied in the fall. It is interesting to note that fall applied dalapon appeared to give excellent control when surveyed on May 8th. Later observations, however, showed considerable quackgrass recovery. None of the treatments caused any injury to the corn plants.

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Table I. Quackgrass Control in Field Corn
Leverett, Mass.
Relative Values.-Check - 100

	Treatments	Quackgrass on 5/8/59	Stand on 7/7/59
1.	Check	100	100
2.	Dalapon 5*lb/A on 10/2/58	27	55
3.	Dalapon 10 lb/A on 10/2/58	13	40
4.	Dalapon 15 lb/A on 10/2/58	10	35
5.	Simazine 4 lb/A on 10/2/58	70	36
6.	Simazine 8 lb/A on 10/2/58	30	15
7.	Atrazine 4 lb/A on 10/2/58	30	16
8.	Atrazine 8 lb/A on 10/2/58	10	11
9.	Dalapon+ 5 lb/A + Simazine+ 4 lb/A on 10/2/58	20	30
10.	Dalapon 5 lb/A + Atrazine+ 4 lb/A on 10/2/58	9	17
11.	Dalapon 5 lb/A on 4/24/59		78
12.	Dalapon 10 lb/A on 4/24/59		68
13.	Simazine 4 lb/A on 5/12/59		45
14.	Simazine 8 lb/A on 5/12/59		45
15.	Atrazine 4 lb/A on 5/12/59		52
16.	Atrazine 8 lb/A on 5/12/59		30
17.	Dalapon 5 lb/A 4/24/59 + Simazine 4 lb/A 5/12/59		20
18.	Dalapon 5 lb/A 4/24/59 + Atrazine 4 lb/A 5/12/59		22

*Rates as acid equivalent or active ingredient.
+Applied as a mixture.

Granby, Mass. Experiment:

In this experiment, trials were conducted on a fine sandy loam with only fair drainage. The area was heavily and uniformly infested with quackgrass. Plots 12 ft. by 45 ft. with three replications were used. Dalapon treatments were applied on April 17 on 2-3 inches growth of quackgrass and again on May 6 together with ATA and Fenac when the quackgrass was 6-8 inches tall. On May 19 the whole area was plowed and seedbed prepared. On May 20, EPTAM, simazine, atrazine and Fenac II were applied on a prepared seedbed and EPTAM was mixed with 4-6 inches of soil with a rotovator. The same day Ohio M-15 corn was planted. To control annual weeds, the whole area was sprayed on May 25 with 6 lb/A DNBP. The first good rain occurred on June 2. Estimates of quackgrass control were made on July 1. These are reported in Table II. All herbicide rates are acid equivalent or active ingredient.

Table II. Quackgrass Control in Field Corn
Granby, Mass.
Relative Values.-Check - 100

	Treatments	Quack-grass Stand 7/1/59	Corn Yields
1.	Check	100	100
2.	Dalapon 4 lb/A on 4/17/59	65	99
3.	Dalapon 8 lb/A on 4/17/59	62	100
4.	Dalapon 4 lb/A on 5/6/59	65	104
5.	Dalapon 8 lb/A on 5/6/59	63	101
6.	ATA liquid 4 lb/A on 5/6/59	59	107
7.	ATA powder 4 lb/A on 5/6/59	60	100
8.	Fenac 2 lb/A on 5/6/59	73	101
9.	Fenac 4 lb/A on 5/6/59	53	98
10.	Fenac II 4 lb/A on 5/20/59	43	88
11.	Simazine 4 lb/A on 5/20/59	38	100
12.	Simazine 8 lb/A on 5/20/59	25	92
13.	Atrazine 4 lb/A on 5/20/59	37	97
14.	Atrazine 8 lb/A on 5/20/59	19	99
15.	Dalapon 4 lb/A 5/6/59 + Simazine 4 lb/A 5/20/59	38	96
16.	Dalapon 8 lb/A 5/6/59 + Simazine 4 lb/A 5/20/59	32	110
17.	Dalapon 4 lb/A 5/6/59 + Atrazine 4 lb/A 5/20/59	32	109
18.	Dalapon 8 lb/A 5/6/59 + Atrazine 4 lb/A 5/20/59	28	110
19.	EPTAM 4 lb/A on 5/20/59	22	98
20.	EPTAM 6 lb/A on 5/20/59	8	96
	L.S.D. at 5%	15	N.S.
	L.S.D. at 1%	20	

The best quackgrass control was obtained with both rates of EPTAM and 8 lb/A of atrazine and simazine. Even 4 lb/A of simazine or atrazine gave satisfactory control. Contrary to the results from the Leverett experiment, the addition of 4 lb/A or 8 lb/A dalapon did not increase the effectiveness of the triazines. After corn was harvested on September 9, quackgrass stands on all treatments were surveyed. The most effective treatment was EPTAM 6 lb/A, followed in turn by siamzine 8 lb/A, atrazine 8 lb/A, simazine 4 lb/A, atrazine 4 lb/A and EPTAM 4 lb/A.

On plots treated with 6 lb/A of EPTAM, corn was slightly stunted but later on regained normal appearance. Corn also was injured by Fenac 4 lb/A but yields were not significantly decreased. No injury was observed with dalapon. In general, no significant yield differences were found between the various herbicidal treatments.

Summary and Conclusions:

1. One year field tests indicate that EPTAM is effective in controlling quackgrass. A rate of about 5-6 lb/A of EPTAM is suggested. Applications should be made in spring on a prepared seedbed and immediately mixed 4-5 inches deep with the soil. Simazine and atrazine are also promising for controlling this perennial weedy grass. Suggested rates are ca 5 lb/A. Applications can be made either in fall or spring. With dry soil and dry weather conditions, atrazine is more effective and more reliable than simazine.

These three rather new herbicides gave better quackgrass control than 8 lb/A of dalapon. More tests should be conducted.

ANNUAL WEED CONTROL IN NEW GRASS-LEGUME SEEDINGS[1]

Jonas Vengris[2]

In establishing new grass-legume seedings, annual weeds are most troublesome. Trials conducted at Amherst, Mass., as well as elsewhere, indicate that herbicides may give control of these weeds without significantly effecting crop plants. It is possible that chemicals can be substituted for companion crops widely used in new grass-legume seedings in the northeast. The objective of these trials was to determine the effectiveness and value of different herbicides in controlling broadleaved weeds and weedy grasses in new grass-legume seedings.

Procedure:

On April 23, 1959 on a well drained fine sandy loam soil heavily infested with barnyard-grass, lamb's quarter and other annual weed seeds, strips were seeded to alfalfa, ladino clover, birdsfoot trefoil, orchard grass and timothy. Across these parallel strips, plots were laid out. Chemicals in 30 gal/A of water were applied as pre-seeding, pre-emergence and post-emergence treatments. Four replicates were used. EPTAM was applied one day before seeding on a prepared seedbed and immediately mixed with the soil with rakes to a depth of 3-4 inches. Pre-emergence treatments were applied on April 24 the day after seeding. A light rain two days later favored the action of the pre-emergence treatments. Post-emergence treatments were applied on May 26 when legume seedings were 2-3 inches tall. Barnyard grass and lamb's quarters, 3-5 inches tall, were prevalent and provided a canopy over the grass and legume seedlings. No rain fell between May 11 and June 2, so on June 2 the area was irrigated with 2 inches of water. The same day it rained and one inch more water was added.

Results and Discussion:

Twenty days after application of the pre-seeding, pre-emergence and post-emergence herbicides, the stands of cultural plants as well as weeds were estimated. The results are shown in Table I.

EPTAM: both rates gave excellent control of grassy weeds as well as broadleaved weeds. However, orchard grass and timothy were almost eliminated. All legumes showed some slight injury such as malformation and stunting. Trefoil was the least injured and ladino clover the most. Later on all legumes regained normal growth and without exception were the best looking plots.

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Table I. Chemical Weed Control in New Grass-Legume Seedings
Relative Values. Check - 100

Treatments	Alfalfa Stands		Ladino Stands		Trefoil Stands		Orchard Stands		Timothy Stands	
	20 D. after treat.	10/19	20 D. after Treat.	10/19	20 D. after treat.	10/19	20 D. after treat.	10/19	20 D. after treat.	10/19
1. Check	100	100	100	100	100	100	100	100	100	100
2. EPTAM 2 lb/A pre-seeding	86	124	63	114	88	113	13	41	12	53
3. EPTAM 4 lb/A pre-seeding	84	124	52	114	91	113	4	20	8	33
4. TCA 6 lb/A pre-emerg.	70	111	35	107	93	105	78	117	56	256
5. TCA 9 lb/A pre-emerg.	66	115	21	111	78	110	38	113	36	236
6. RANDOX 4 lb/A pre-emerg.	91	119	48	111	85	92	66	113	24	236
7. RANDOX 8 lb/A pre-emerg.	71	90	31	124	55	115	29	116	6	78
8. NEBURON 2 lb/A pre-emerg.	88	102	24	108	86	81	72	118	27	111
9. NEBURON 4 lb/A pre-emerg.	86	98	12	102	62	92	40	108	8	44
10. DALAPON 2 lb/A post-emerg.	98	110	62	101	91	108	92	124	93	180
11. DALAPON 4 lb/A post-emerg.	83	111	61	78	93	107	90	89	81	125
12. 2,4-DB 1½ lb/A post-emerg.	100	112	100	114	100	93	100	106	100	206
13. 2,4-DB 3 lb/A post-emerg.	100	122	100	106	100	80	100	99	100	192
14. DALAPON 2 lb/A + 2,4-DB 1½ lb/A post-emerg.*	100	99	62	109	87	99	87	100	74	180
15. DALAPON 4 lb/A + 2,4-DB 1½ lb/A post-emerg.*	83	114	50	112	90	75	77	98	67	128
16. DNBP 1 lb/A post-emerg.	74	94	92	108	63	81	69	105	78	161
17. DALAPON 2 lb/A + DNBP 1 lb/A post-emerg.*	49	75	50	102	34	21	55	118	59	136
18. DIURON 2 lb/A + 2,4-DB 1½ lb/A post-emerg.*	69	99	59	40	75	83	85	66	81	42
19. Clipping 5/27/59 and 6/25/59	71	75	96	111	75	100	90	118	93	233
L.S.D. at 5%		26		15		21		20		51
L.S.D. at 1%		34		20		27		26		67

* Applied as a mixture.

TCA was effective in controlling annual weedy grasses, principally barnyard grass. No significant injury to trefoil occurred, especially at the lowest rate. Alfalfa and ladino clover were significantly injured. Alfalfa was the first one to regain normal growth later in the season. Although this herbicide injured orchard grass and timothy, both grasses recovered and growth was normal. TCA is promising for annual weedy grass control in mixtures where orchard grass and even timothy are included (2). Broadleaved weeds were only slightly affected by TCA.

Randox and Neburon effectively controlled broadleaved and grassy weeds. Randox was superior in controlling weedy grasses and Neburon was better in controlling broadleaved weeds. Orchard grass and timothy were injured but, at least with the lowest rate, regained normal growth and stands were comparable with the checks. Of the legumes, again alfalfa and trefoil were injured least and ladino most. Due to its stoloniferous growth habit, ladino clover filled in bare areas rapidly and growth was normal.

Barnyard grass was suppressed by both rates of Dalapon. With the elimination of weedy grasses, lamb's quarters built up a very thick stand and caused serious smothering of seedlings of cultural plants. The contrary situation developed on plots treated with 2,4-DB. Here broadleaved weeds were controlled but seedlings were smothered by barnyard grass. Combination treatments of Dalapon plus 2,4-DB effectively suppressed both broadleaved and grassy weeds and weed competition was eliminated at least temporarily. At the time of surveying, both rates of dalapon alone and in mixture with 1 1/2 lbs/A of 2,4-DB did not significantly injure alfalfa or trefoil. Seriously injured was ladino clover and also both seeded grasses. Later as the growing season progressed, these plants fully recovered (Table I).

Dinitro 1 lb/A, mixtures of dinitro with dalapon, and diuron with 2,4-DB were very effective but thinned stands significantly. It appears that the action of dalapon and dinitro may be synergistic.

Two extra mowings for the "clipping" treatment significantly injured alfalfa and trefoil seedlings.

Observations in the first part of June revealed that EPTAM, TCA and Randox treated plots became infested with broadleaved weeds. On June 10, all these plots were treated with 1 1/2 lb/A of 2,4-DB. At that time lamb's quarters and red root pigweed plants were 10-15 inches tall. Control was good.

On July 6, all plots were mowed but no yield data were taken. In the aftermath, the most prevalent and dominant weed was barnyard grass and this strongly competed with seeded legumes and grasses. Plots treated with EPTAM, TCA and dalapon alone were the cleanest. It is interesting to note that dalapon alone controlled barnyard grass more effectively than dalapon and 2,4-DB. This was probably due to the heavy stand of lamb's quarters in the dalapon which smothered out the barnyard grass. On August 12, all plots were mowed except alfalfa and birdsfoot trefoil. Again barnyard grass, mostly from crown buds, produced new shoots and was the only weed in all treatments and again competed strongly with cultural plants. The degree of infestation was the same as after the first cutting. Due to favorable weather conditions, barnyard grass grew 4-5 feet tall and seeds for the most part were mature on September 14, when all plots were mowed uniformly before winter. Now the aftermath consisted of mostly legumes or grasses. In order to evaluate the effect of all treatments on the establishment of legumes and grasses, stand estimates were made on October 19.

Although statistical analysis does not show significant differences between various alfalfa treatments, by far the best stands were on the EPTAM plots. The poorest stands were on plots treated with dalapon plus dinitro and plots which were mowed four times during the growing season; i.e. the "clipping" treatment. All other alfalfa treatments were mowed twice only.

Ladino, even after heavy injury by pre-emergence or post-emergence herbicidal treatments, was able to regain normal growth and to build stands comparable to the checks or treatments where no injury occurred. Diuron plus 2,4-DB almost eliminated ladino clover and the stands did not recover normal growth and appearance.

At the end of the first season, trefoil stands on the check plots were as good as any of the treatments. In some cases, injury was evident. Most injurious was the combination treatment: dalapon and dinitro almost eliminated trefoil.

Orchard grass as well as timothy were significantly injured and almost eliminated by EPTAM and diuron plus 2,4-DB treatments. Timothy did not recover to form satisfactory stands on Randox 8 lbs/A or Neburon 4 lbs/A treatments. Both grasses withstood the dalapon and TCA rates well.

<u>Summary and Conclusions</u>:

1. EPTAM 2-4 lbs/A as a pre-seeding treatment, controlled annual broad-leaved and weedy grasses in new legume seedings effectively. Plots were free of all annual weedy grasses all the season. No serious injury to legumes was observed. Ladino clover was affected early but soon recovered. Orchard grass and timothy were severely injured and did not recover normal growth.

2. Pre-emergence applications of 6-9 lbs/A of TCA and 4-8 lbs of Randox controlled weedy grasses in new grass-legume seedings. Barnyard grass was effectively controlled by TCA. To control broadleaved annual weeds , a post-emergence application of 2,4-DB, 1 1/2 lbs/A, is advisable. Orchard grass and timothy were hurt by TCA and Randox at the rates applied but these grasses regained normal growth and produced satisfactory stands.

3. Neburon 2-4 lbs/A as pre-emergence treatments were good for broad-leaved weed control. Barnyard grass control was not satisfactory.

Alfalfa was most resistant to Neburon. Ladino clover, trefoil and seeded grasses were significantly injured by rates used. A mixture of 2 lbs/A diuron and 1 1/2 lbs/A of 2,4-DB was noticeably toxic to all cultural plant species. Again alfalfa was the least affected.

4. Dalapon 2-4 lbs/A as a post-emergence treatment suppressed barnyard grass seedlings. Ladino clover was injured by dalapon but because of its creeping form of growth, recovered and produced good stands. Timothy and especially orchard grass showed good tolerance to dalapon.

2,4-DB at 1 1/2 lbs/A rate was very effective in controlling lamb's quarters and red root pigweed seedlings. The control was satisfactory even when these weeds were about one foot in height.

5. After the first cutting, barnyard grass became the dominant weed in the aftermaths in all treatments. Dalapon treated plots were also heavily infested with this weedy grass. By far the cleanest plots were treated with EPTAM and TCA. As the growing season progressed, the variation and differences between various treatments tended to disappear. One gets the impression that the herbicidal value of different materials should be measured by the improved quality and quantity of the hay produced in the seeding year.

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APPLICATION OF "DYBAR" FENURON WEED AND BRUSH KILLER TO A RIGHT-OF-WAY IN NORTHERN MAINE

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Up in northern Maine some of our power lines run through land comparable to "wild lands" (unorganized townships). The areas we are talking about in this paper run generally north and south and are within 15 or 20 miles of the Canadian border (show map). Of course, Aroostook County is noted for its 140,000 acres of potato fields. In addition, we have hundreds of thousands of acres of commercial pulp wood. The terrain could be classified as generally hilly with swamps between the hills. Very little right-of-way spraying has been done in this part of Maine.

In 1958, we did some brush control for the Maine Public Service Company using 2,4,5-T in oil applied as a basal stem treatment with knapsack sprayers. This was applied during the growing season on 400 acres along a 40-mile right-of-way running from Presque Isle south to Houlton. This treatment gave satisfactory performance, but there were some disadvantages which we thought might be overcome with a pelleted material. This has been borne out in our experience during 1959. We used "Dybar" fenuron weed and brush killer on over 300 brush acres of 100-foot right-of-way running from Fort Kent., Me., to New Sweden. From New Sweden, south through Caribou to Presque Isle we used 2,4,5-T and oil on a 50-foot right-of-way.

These lines, for the most part, were built seven to nine years ago, and of course, the right-of-way was cut at that time. But practically nothing had been done to the brush anywhere along the right-of-way since.

The northern part of this system presents a much more difficult problem than the southern end. As you go north, you run into swamps and rough terrain. For example, there was one ravine 200 feet deep and 1,000 feet across, where we were glad to be using pellets rather than trying to operate knapsack sprayers.

A good deal of this land is classified as spruce-fir forest, and is valuable pulpwood country. In the lowlands you run into peat soil and alders and conifers. The ridges are mixed growth, mostly hardwoods -- poplar, maple, tamarack, beech, mountain maples, box maples, mountain ash, but very little white pine. The northern line runs through swamps where beavers have built dams. There are relatively few access points as compared to central and southern Aroostock County where farm lanes are plentiful.

The brush to be controlled was eight to 15 feet high. We calculated, on the basis of the amount of "Dybar" fenuron weed and brush killer pellets finally used (at one teaspoonful per clump), that there must have been an average of nearly 5,000 clumps to the acre. This was on the 30-mile right-of-way from Fort Kent to New Sweden. There was also as much brush on the lines from New Sweden to Caribou and Caribou to Presque Isle.

Our choice of "Dybar" was made after a good deal of study of data on the economics and performance of the pellets in other northeastern areas.

Because of the "border effect" of "Dybar" fenuron weed and brush killer, we organized our work crew to treat 70 feet down the center of the 100-foot right-of-way, leaving a 15-foot untreated border on each side. As you will see from the slides in a few minutes, this border is not as serious as it sounds.

We used a 10-man crew plus a tractor driver and a foreman. The only tools the workmen needed were a 10-quart pail and a plastic teaspoon.

The tractor was a two-ton crawler pulling what we call a "scoot." The "scoot" is similar to a sled, it has steel runners six inches wide and has about a 24-inch clearance. We installed a box seven and one-half feet long and four feet wide on the "scoot" to hold the bags of chemical. To start the day we put 20 bags of "Dybar" in the box, the tractor and "scoot" then moved along the right-of-way with the men. At this point I might mention we used a one-ton truck to transport the men and a fresh supply of chemical to the job each morning. We measured and marked the 10-pound level on each pail so the men would have some gage as to the amount of chemical they were using. The 10-man crew spread out across 70 feet of right-of-way, and just walked along throwing a teaspoonful of "Dybar" beside each brush cluster as they went. On clumps with eight to 10 stems they were using a teaspoonful on each side. This was the way we started out, but it turned out that with this application technique and the heavy stand of brush we were using more "Dybar" than we needed. So we adopted a grid system of application, where brush was heavy, with each man throwing a teaspoonful every three feet. This gave us a distribution rate of about 50 pounds to the acre. With this method of application, we covered 300 acres between June 15 and July 15, in spite of 10 days of rain.

When we got down to the 50-foot right-of-way from New Sweden on to Caribou and Presque Isle, we had a good opportunity to compare the pellet application with what we had been using -- a basal stem application of 2,4,5-T in oil with a knapsack sprayer. The 50-foot right-of-way ran along a railroad track for part of its length, so we did a 35-foot width with pellets and the 15-foot border with 2,4,5-T in oil. Four men working with 2,4,5-T in oil on a 15-foot width could just keep up with another six men working with pellets on 35 feet. Ideal, we thought, would be five men working with 2,4,5-T in oil and six men working with pellets.

We found that 50 pounds of pellets to the acre performed as well as 100 gallons of basal-spray mixture to the acre, which would weigh approximately 800 pounds.

Pellets are cleaner to work with than 2,4,5-T in oil. They are easier to carry and easier on the men's clothes. There is no smell to them and crews can continue to work through light showers.

Furthermore, with pelleted materials, it is easier to keep track of the amount of chemical used, because each man is using a 10-pound pail. The foreman can keep track of the distance, by counting the number of structures passed. Also, we have noticed that it is not absolutely necessary to hit every stem with the pellet treatment. Obviously, we are not doing this with the grid method of application. One spoonful of the pellets will be carried by rainfall to the roots of all plants in the underlying soil. In contrast, the basal-stem treatment is not effective except on the stem treated.

Additionally, when you're using 2,4,5-T in oil, it is not possible to get chemical control of conifers. These have to be cut with an axe. However, "Dybar" fenuron weed and brush killer appears to give good control of conifers, as well as deciduous trees.

As for costs, in the past year the cost of chemicals was $50 an acre for "Dybar" fenuron weed and brush killer, and $63 an acre for 2,4,5-T in oil. The big savings, however, comes from efficiency. The pellet application goes twice as fast in comparable terrain.

Another comparison of efficiency shows up in the record of 250 acres treated with "Dybar" fenuron weed and brush killer at an average rate of 1.4 acres per man per day. On 135 acres of right-of-way treated with 2,4,5-T in oil, a man averaged six-tenths of an acre per day. This was on ground which averaged well over 5,000 stems to the acre ranging in size from the diameter of a man's thumb to a man's wrist -- and eight feet to 15 feet high.

Some other details about this job might be interesting. The Caribou weather station reported 15.51 inches of rainfall for the 1959 summer season. This includes the months of June, July, August, and September. August totalled 6.52 inches.

The main line which we treated -- Fort Kent to New Sweden -- is a 69,000-volt transmission line with two-pole wooden "H" frames on 100-foot right-of-way for the entire distance. On the 50-foot right-of-way we had some "H" frames and some single poles.

To sum it up, we found the pellets cheaper than 2,4,5-T in oil. The initial performance -- that is the kill visible at the end of the season -- was equal to 2,4,5-T in oil, and we expect these pellets to show a lasting effect with kill into the second and third years. Another advantage is the "bonus" effect which we get by not having to treat individual stem. We don't expect many "misses" to show up when the leaves come out next spring. Finally, there is no spray equipment to purchase and maintain. (Maintenance on 10 tanks requires about six to eight man-hours per eight-hour day.)

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LATE SEASON FOLIAGE APPLICATIONS OF AMINO TRIAZOLE AND AMINO TRIAZOLE - BENZOIC COMBINATIONS ON BLACK LOCUST

W. A. Jeffers[1]

Preliminary Evaluation of Amino Triazole on Black Locust

The initial plot work with 3-amino-1,2,4-triazole (ATA) was on mixed brush in July, 1954. Foliage applications at rates of 3, 6 and 9 pounds of active materials in 100 gallons of water did not indicate the chemical to be a general brush killer. The most effective kill in this series was on white ash.

It was not until the 1957 tests that amino triazole was applied to brush which was predominantly black locust. The rates put down as foliage sprays in the black locust plots were 2, 3 and 4 pounds of ATA in 100 gallons of water, plus a spreader-sticker. The formulation used was Weedazol which contained 50% 3-amino-1,2,4-triazole. The plots applied were as follows:

Ohio - approximately 1/2 acre plots
August 13, 1957 - 200 gallons applied - ATA 2 lbs./100
August 14, 1957 - 200 gallons applied - ATA 4 lbs./100

Pennsylvania - approximately 1/4 acre plots
August 27, 1957 - 100 gallons applied - ATA 3 lbs./100
August 27, 1957 - 100 gallons applied - ATA 4 lbs./100

The tests in Ohio were part of a series which also included foliage applications of standard hormone sprays with and without the addition of amino triazole.

Evaluation of the 1957 Ohio tests during the first week in August, 1958, indicated that amino triazole alone was more effective in controlling black locust under the conditions of these tests than standard ester and amine water-borne sprays with or without the addition of ATA at 1 pound per 100 gallons.

The complete stem kill on locust was 100% for both the 2 and 4 pound rates of amino. In several representative areas in both plots, samplings were taken of the number of dead stems and the number of new lateral root suckers which were just starting to come up. The percentage of stem reduction was 60% in the plot treated with ATA at the 2 pounds per 100 concentration and 88% in the plot treated at the 4 pounds per 100 concentration.

By the first of August, 1958, the black locust in the 1957 tests in Pennsylvania was killed out completely, both at the rate of 3 and 4 pounds of amino triazole per 100 gallons. By October, 1959, there was just one new locust stem in each plot treated at the above concentrations.

[1]The Davey Tree Expert Company, Kent, Ohio

1958 Tests on Black Locust

Since the maximum control of black locust was achieved in the initial tests with the minimum concentration of 3 pounds of ATA per 100 gallons, this dosage was used entirely for the test work in 1958. The following three formulations were evaluated in the new series:

1.	Weedazol (Trade Name)	-	50% 3-amino-1,2,4-triazole Dry formulation - Completely water soluble
2.	ACP-981	-	100% 3-amino-1,2,4-triazole Dry formulation - Completely water soluble Trade Name: Amizol - (90% ATA)
3.	ACP-M-569	-	2 lbs. 3-amino-1,2,4-triazole per gallon Liquid formulation for use in water, only Trade Name: Amitrol T

In addition to the straight amino triazole applications, a combination spray with 2,3,6-trichlorobenzoic acid (TBA) was worked into the 1958 series to further investigate the possibility of finding a chemical that could be mixed with amino to give a less specific brush killer material. The formulation used was Benzac 1281 which contained 2 pounds of 2,3,6-trichlorobenzoic acid per gallon as the dimethyl amino salt. The combination spray as used in the tests consisted of 2 pounds ATA and 2 pounds TBA per 100 gallons. To complete the evaluation of the ATA-TBA mixture, several plots of TBA alone were put down at the rate of 4 pounds of acid per 100.

A spreader-sticker was used in all the sprays at the rate of 6 ounces per 100 gallons. This addition may or may not have been necessary but it was used since the foliage of black locust is generally so difficult to wet satisfactorily. In all the tests both the foliage and the entire stem were wet down (stem-foliage spray). The gallonage per plot was as follows:

50 gallons	200 gallons	400 gallons
# 1 - 8	# 9	# 12
10	15	
11		
13		
14		
16 - 19		

The gallonage per acre varied with the height and density of the black locust. An almost solid stand of locust about 10' in height required between 400 - 500 gallons of spray per acre for proper coverage.

In waiting to evaluate the results from 1957 before proceeding with additional tests, the 1958 applications again were made in late summer. The plots were put down on utility company rights of way in Ohio and Pennsylvania, from August 21st to September 9th, to determine when the kill of black locust from foliage sprays would start to taper off. In all the test areas, black locust was the predominant species. Most of the locust was 10' - 15' in height except in plots #9 and #15 where the growth was nearer 20' and in plots #12 and #14 where the growth was under 10'. The black locust in the latter two plots was resurge from the previous year's hormone sprays. The locust in the other plots either had never been treated chemically or at least two years had elapsed since the last chemical spray had been applied.

Generally the foliage on the black locust had not suffered adversely from dry weather or insects, with several exceptions. There was scattered leaf miner injury in plots #9 and #13 and heavy leaf miner injury to some of the tallest clumps in plot #15A.

Initial Locust Foliar Response to the Late Summer Sprays of the Chemicals Tested in 1958

Since the 1958 tests were scattered, no attempt was made to record the progress of the initial response of the black locust to the chemicals in all the plots. A few observations were made in some of the plots after the applications, however.

Following the late summer ATA sprays of Weedazol and ACP-981, the black locust foliage stayed green until the end of the season unless there was contamination in the spray tank from the previous use of a hormone spray. Flushing out the tank, pump and hose with a little clear water after a hormone application seemed to reduce the contamination to a level where it did not affect the final results even though the foliage did not remain green. The liquid ATA formulation, ACP-M-569, did brown up the foliage more than the dry powder formulations because of special additives.

The ATA-TBA and TBA late summer sprays browned up the locust foliage within two weeks.

1959 Evaluation of Results of 1958 Tests on Black Locust

In October, 1959, a detailed stem check was made of all the locust stems in each plot except the largest, #12, where only a representative area was checked thoroughly. The results are given in Table No. 1 (August applications) and Table No. 2 (September applications). Several 1958 tests were not included in these Tables because the brush was cut following the treatments or a rain storm came up before the chemical spray was completely dried on the foliage. The percentage of stem reduction in the last column of the Table was determined by the following formula:

$$\frac{\text{No. of original living stems} - \begin{array}{l}\text{No. of}\\ \text{old living stems}\\ \text{new basal sprouts,}\\ \text{and lateral root suckers}\end{array}}{\text{No. of original living stems}} \times 100 = \begin{array}{l}\text{\% of stem}\\ \text{reduction}\end{array}$$

In the Tables the term, AHG, refers to the amount of active ingredient or acid in 100 gallons of water.

TABLE NO. 1: AUGUST FOLIAGE SPRAYS ON 10' - 15' BLACK LOCUST WITH THREE FORMULATIONS OF 3-AMINO-1,2,4 - TRIAZOLE AT THE RATE OF 3 LBS./AHG, WITH ONE FORMULATION OF 2,3,6 - TRICHLOROBENZOIC ACID AS THE DIMETHYL AMINE SALT AT THE RATE OF 4 LBS./AHG AND WITH A COMBINATION OF AMINO TRIAZOLE AND TRICHLOROBENZOIC ACID AT THE RATE OF 2 LBS. EACH/AHG

PLOT NO.	DATE OF APPLICATION / CHEMICAL FORMULATION	NUMBER OF STEMS CHECKED, OCTOBER 1959	STEMS DEAD TO GROUND. NO BASAL SPROUTS	STEMS DEAD TO GROUND. SPROUTING NEAR BASE	STEMS STILL GREEN. NO SPROUTING	STEMS STILL DEVEL-OPING STUNTED WHITE LEAVES	STEMS SPROUT-ING ALONG STEMS. FOLIAGE GREEN	NUMBER OF LATERAL ROOT SUCKERS IN TREATED AREA	NUMBER OF BASAL SPROUTS NEAR STEMS CHECKED	STEM REDUC-TION IN TREATED AREA
			GROUND-LINE KILL		ADDITIONAL POS-SIBLE STEM KILL		NEW GROWTH			
1	8/21/58 Benzac 1281-TBA	48	100%	0%	0%	0%	0%	0	0	100%
2	8/21/58 ACP-981-ATA & Benzac 1281-TBA	247	100%	0%	0%	0%	0%	11	0	96%
3	8/21/58 ACP-981-ATA	292	95%	0%	2%	3%	0%	0	0	95%
4	8/21/58 Weedazol-ATA	239	100%	0%	0%	0%	0%	6	0	97%
5	8/21/58 ACP-M-569-ATA	185	100%	0%	0%	0%	0%	20	0	90%
6	8/22/58 Weedazol-ATA	149	100%	0%	0%	0%	0%	3	0	98%
7	8/22/58 ACP-981-ATA & Benzac 1281-TBA	105	85%	8%	0%	0%	7%	7	11	76%
8	8/22/58 Weedazol-ATA	255	100%	0%	0%	0%	0%	9	0	96%
9	8/25/58 ACP-981-ATA	422	97%	0%	1.5%	0%	1.5%	11	0	95%
10	8/29/58 Weedazol-ATA	124	41%	0%	44%	11%	4%	0	0	41%

TABLE NO. 2: SEPTEMBER FOLIAGE SPRAYS ON BLACK LOCUST WITH THREE FORMULATIONS OF 3-AMINO-1,2,4-TRIAZOLE AT THE RATE OF 3 LBS./AHG, WITH ONE FORMULATION OF 2,3,6 - TRICHLOROBENZOIC ACID AS THE DIMETHYL AMINE SALT AT THE RATE OF 4 LBS./AHG AND WITH A COMBINATION OF AMINO TRIAZOLE AND TRICHLOROBENZOIC ACID AT THE RATE OF 2 LBS. EACH/AHG

PLOT NO.	DATE OF APPLICATION CHEMICAL FORMULATION	NUMBER OF STEMS CHECKED, OCTOBER 1959	STEMS DEAD TO GROUND. NO BASAL SPROUTS	STEMS DEAD TO GROUND. SPROUTING NEAR BASE	STEMS STILL GREEN. NO SPROUTING	STEMS STILL DEVEL-OPING STUNTED WHITE LEAVES	STEMS SPROUT-ING ALONG STEMS. FOLIAGE GREEN	NUMBER OF LATERAL ROOT SUCKERS IN TREATED AREA	NUMBER OF BASAL SPROUTS NEAR STEMS CHECKED	STEM REDUC-TION IN TREATED AREA
			GROUND-LINE KILL		ADDITIONAL POS-SIBLE STEM KILL		NEW GROWTH			
11	9/2/58 ACP-981-ATA Benzac 1281-TBA	69	94%	0%	3%	0%	3%	50	0	22%
12	9/2/58 ACP-M-569-ATA	123	100%	0%	0%	0%	0%	88	0	29%
13	9/3/58 Weedazol-ATA Benzac 1281-TBA	94	62%	22%	0%	0%	16%	19	23	39%
14	9/8/58 Weedazol-ATA	104	79%	2%	0%	0%	19%	13	2	67%
15A	9/8/58 ACP-981-ATA	47	70%	19%	0%	0%	11%	33	9	0%
15B		31	97%	0%	0%	0%	3%	53	0	*Increased 74%
16	9/9/58 Weedazol-ATA	69	23%	0%	75%	0%	2%	0	0	23%
17	9/9/58 ACP-981-ATA	84	12%	0%	73%	8%	7%	3	0	8%
18	9/9/58 ACP-981-ATA Benzac 1281-TBA	120	62%	13%	2%	0%	23%	4	20	55%
19	9/9/58 Benzac 1281-TBA	54	76%	17%	0%	0%	7%	9	11	56%

<u>Discussion of August Applications on Black Locust</u>: Before discussing the results in the individual plots, certain terminology to be used will be defined. The expressions "complete stem kill" and "stems were completely killed" will indicate that the stems were dead to the ground and had not resprouted from the base.

Plots #1 - #5 were put down at one location in Ohio on 8/21/58. This series included a plot of each of the three ATA formulations, a plot of the ATA-TBA combination, and a plot of the TBA formulation. The complete stem kill was 100% in four plots and 95% in that of the ATA formulation, ACP-981. The 5% of the stems which were not dead to the ground in the latter plot have not developed normal foliage and may still die. The percentage of stem reduction in these five plots ranged from 90% - 100% due to the varying number of new lateral root suckers which have come up in the individual plots. At this time there is no decided difference in the results from the three ATA formulations.

Plots #6, #7 and #8 treated on 8/22/58 were in the same general location as the first five plots. An ATA formulation, Weedazol, was applied in plots #6 and #8. In plot #7, the ATA-TBA combination was used. The results with the ATA formulation were superior to those with the ATA-TBA on the black locust. The ATA sprays gave 100% complete stem kill in both plots and 98% and 96% stem reduction. The ATA-TBA application resulted in 85% complete stem kill and 76% stem reduction.

Plot #9 was put down in Pennsylvania on 8/25/58. Instead of dividing the area into a number of small plots just one ATA formulation, ACP-981, was applied here. This application produced a 97% complete stem kill of 422 stems checked and a 95% stem reduction.

Plot #10 was the last application of an ATA formulation, Weedazol, in August. It was put down in Pennsylvania, on the 29th. The stem count for this plot as shown in Table No. 1, actually only includes part of the original stems since one-half of the area was cut off sometime after the chemical was applied. There were no locust sprouts in the cut off section. Only 41% of the standing stems were completely killed. Another 55% were still alive but had not leafed out with green foliage. There were no lateral root suckers in this plot. It is still possible for the stem kill to increase to 96% by the end of the next growing season.

<u>Discussion of September Applications on Black Locust</u>: Plot #11 was adjoining plot #10. This application of an ATA-TBA combination was delayed until 9/2/58 due to a shift in the wind direction. The complete stem kill was 94% but the stem reduction was only 22% because of the numerous lateral root suckers which came up in the plot.

Both plots #10 and #11 were applied on days with comparable weather conditions. The response of the black locust at this location was the first indication of a decided difference between an ATA formulation and the ATA-TBA combination. With the ATA alone, 55% of the stems were still alive but had not sprouted at the end of the next growing season. Also, there was no suckering from the root area of the treated stems. On the other hand, with the ATA-TBA application, 94% of the stems were completely killed but there was heavy lateral root suckering.

Plot #12 was treated with the ATA formulation, ACP-M-569, on 9/2/58. This spray was applied to a section of right of way where the black locust was sprouting from the lower stems and base following a hormone foliage spray the previous year. The complete stem kill was 100% for the entire area but numerous lateral root suckers were coming up by the end of the 1959 season. Generally the new growth was quite some distance from the old dead stems. A stem check was taken in a representative area of the right of way, 120' x 50'. The figures as shown in Table No. 2 indicate a stem reduction of only 29%. This was the first decided decrease in the control of lateral root suckering by an ATA formulation.

Plot #13 treated with ATA-TBA was put down in Pennsylvania on 9/3/58 and was originally just one of the two plots at this location. The other plot of an ATA formulation, Weedazol, was not included in this series because a violent shower fell before most of the spray had dried on the foliage. In the first 1/3 of this Weedazol plot, 29 out of 30 black locust stems were killed to the ground but had resprouted heavily from the base. After this point, a gradually increasing number of stems leafed out along their upper branches.

The spray in plot #13 had been dried about one-half hour before the shower. In this plot, only 62% of the locust stems were completely killed and the stem reduction was 39%. There were three unfavorable factors here that could have contributed to the poor results; lateness of season, rain, and scattered leaf miner injury on the foliage.

Plot #14 located in Pennsylvania was sprayed with an ATA formulation, Weedazol, on 9/8/58. This treatment was applied to black locust which had sprouted along scattered stems from a late summer hormone foliage spray in 1957. After the two sprays, 79% of the stems were completely killed. By the end of the 1958 season, 16% of the stems checked were just starting to put forth a few green leaves somewhere along the stems. The stem reduction was 67%.

Plot #15, treated on 9/8/58, was in the same general location as #14. The ATA formulation used here was ACP-981. In Section A, the locust growth consisted of numerous stems of varying heights with foliage in the densest area confined to the upper sections of the stems. The foliage near the top of the tallest stems had considerable leaf miner injury. In Section B, the locust was taller and scattered. The foliage was much more extensive and free from leaf miner injury. The complete stem kill was 70% in Section A, and 97% in Section B. In both areas there were numerous lateral root suckers. The stem reduction was 0% in A. In B, there was a stem increase of 74%.

The last plots #16 - #19, were sprayed at one location in Ohio on 9/9/58. In plot #16, treated with ATA formulation, Weedazol, 23% of the locust stems were completely killed and 75% were still alive but not sprouting. There were no lateral root suckers in this plot. The stem reduction is now only 23% but it could be 98% by the end of the next growing season.

About the same general results on black locust were observed in plot #17 treated with another ATA formulation, ACP-981. The complete stem kill in this plot was only 12%. The greatest number of stems, 81%, were still alive and had not developed any green foliage. There were only 3 lateral root suckers. Here again, the stem reduction is now only 12%, but the final amount could be as high as 93%.

The ATA-TBA combination in plot #18 produced a complete locust stem kill of 62%. Another 13% of the stems were killed to the ground but had resprouted from near the base. There was also normal green sprouting from 23% of the stems. The percentage of stem reduction for this plot was 55%.

The TBA application in plot #19 gave a complete stem kill of 76%. An additional 17% of the stems were killed to the ground but had resprouted near the base. Only 7% had started to leaf out somewhere along the stems. The final stem reduction was 56% or about the same as for the combination of ATA-TBA.

Until the black locust treated with the ATA formulations in September either die or overcome the effects of the chemical in their stems and root systems, no final evaluation of kill or comparison of results with the ATA-TBA or TBA alone can be made.

August Vs September Applications on Black Locust: Even though some of the results with the ATA formulations are not conclusive, only the August applications made before the 29th, consistently produced about 100% complete stem kill with a high percentage of root kill, as evidenced by the small numbers of new lateral root suckers in the plots by the end of the next growing season. The progress of the stem kill on locust with the August applications closely followed the pattern of complete stem kill before the next mid-summer as experienced with the initial promising results in 1957. Until a final evaluation can be made on the results with all the ATA applications, no conclusion can be reached as to when the kill on locust definitely falls off.

The use of the ATA-TBA combination in August did not produce any better results on locust than either ATA or TBA alone. In September, the kill with the mixture was not as good as in August, but it did give a more rapid stem kill than some of the last ATA sprays.

The only August TBA application resulted in as good kill on locust as with the ATA. A September spray with this same chemical on the same species did not produce the 100% control as in August. Additional testing will be necessary to completely evaluate TBA for controlling black locust since this series included too few plots treated with TBA alone.

Control of Miscellaneous Species in the 1958 Plots

Generally in any one plot the species other than black locust, blackberry and elderberry were not numerous enough to provide much data for evaluation. By considering the results on a given species in scattered plots treated with the same chemical, it is possible to gain helpful information on the response of other species to the chemicals used in this series. Even in the aggregate, some species are only numerous enough to provide a hint as to what the response to a given spray might be. In the following discussion, those species which number over 10 stems or clumps will be marked by an *. Promising control will be considered as at least an average of 80% possible or actual complete stem kill with at least an 80% stem reduction for root suckering species.

With the ATA formulations, the only species found in any number that showed consistent promising control at the concentration used were *white ash, *wild black cherry, and staghorn sumac. Neither the ash or cherry had leafed out but some of the stems were still green at the base. There were not many stems of sumac in these plots but they were all killed to the ground with little or no lateral root suckers. *Blackberry was killed to the ground in all the plots but in 6 out of 9 plots, the new sucker growth from the roots was about as numerous as the original stand. There was no consistent promising control on the following species:

*Aspen, Largetooth	Hazelnut	Oak, Red
Birch, Black	Hawthorn sp.	Oak, White
*Cherry, Choke	Hickory, Shagbark	*Sassafras
*Elderberry	*Maple, Red	Shadbush
Gum, Black	Mulberry, White	Tuliptree

The ATA-TBA combination did not show any effective control on most of the species not killed by the ATA alone. In cutting the concentration of the ATA and adding TBA, the kill on the ash and cherry was poorer than with the ATA alone. The combination did give more complete ground-line kill on the sassafras and the *elderberry, but the new lateral root suckers were more numerous than the original stems with one exception. In one out of 4 plots there were no lateral root suckers on the elderberry. *Blackberry and *raspberry were killed to the ground but the sucker growth from the root area was as numerous as the original stems. There was no promising control on the following species with the ATA-TBA:

*Ash, White	Hazelnut	Oak, Red
*Aspen, Largetooth	Hawthorn	Oak, Shingle
*Cherry, Choke	Hickory, Shagbark	*Oak, White
*Cherry, Wild Black	*Maple, Red	Tuliptree
Gum, Black	*Maple, Sugar	

The 1958 series of tests included only two TBA plots. Based on limited observations, the late summer applications of TBA are not effective on many species of brush other than the black locust. It did show some promise on red maple. This chemical killed *blackberry, *elderberry and *raspberry to the ground but the sucker growth from the root area was heavy, except for the elderberry in the September plot. No promising control was secured on the following species:

*Ash, White	*Hazelnut	Oak, White
*Cherry, Choke	Hickory, Bitternut	Poplar sp.
*Cherry, Wild Black	Oak, Red	
Elm, American	Oak, Shingle	

Summary

An evaluation was made in October, 1959, of the August and September 1958 foliage-stem applications of water-borne sprays of ATA (3 pounds per 100). ATA-TBA (2 pounds each per 100) and TBA (4 pounds per 100).

The results of 95% - 100% complete stem kill and 90% - 98% stem reduction from the August applications of ATA on black locust were just as promising as the initial results in 1957. There was no appreciable difference between the 3 ATA formulations used. Some of the ATA sprays could not be fully evaluated at this time.

One out of two August treatments of the ATA-TBA mixture was as effective on black locust as either ATA or TBA. In the same plots the combination did not look as promising on the few white ash and wild black cherry as the ATA alone. It also did not prove effective against the species such as largetooth aspen, choke cherry, hickory, red maple, oaks, tuliptree, etc., which were not controlled by the straight ATA sprays. The stem kill on the black locust from the September applications of ATA-TBA was more complete than with the ATA alone up to this time.

The only late August TBA application gave complete control on a light stand of black locust. A September application at a different location resulted in a ground-line kill of 93% of the stems checked with the remaining 7% starting to sprout weakly somewhere along the stems. Of the stems checked, 76% still appeared to be completely killed out. With the new lateral root suckers and basal sprouts, the stem reduction amounted to 56%. The late summer TBA sprays did not look promising for controlling white ash, choke cherry, wild black cherry, American elm, hazelnut, bitternut hickory, shingle oak, red oak, white oak and poplar sp.

Acknowledgment is made to Amchem Products, Inc., for supplying the chemicals used in these tests.

ADVANTAGES OF MIST BLOWER APPLICATION OF "AMMATE" X FOR BRUSH CONTROL

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Use of chemicals for control of brush has become an established practice along rights-of-way, watersheds, roadsides, and elsewhere. The chemical industry has given us a variety of specialized herbicides to fit different brush control situations.

These chemicals have been widely adopted primarily because of increased efficiency in brush control, especially savings in manpower. But there is always room for improvement. One of the goals has been greater efficiency in the use of the chemicals themselves. Large expensive sprayers represent a substantial investment in equipment which can only be used during a small part of the year. Even the most versatile power equipment cannot get over all kinds of terrain, and often a good deal of spray time is lost in moving power sprayers from place to place, getting relocated, and running hoses out to the point where the spray is to be applied.

Water supply, too, may also be a problem in isolated areas. With conventional spray methods, where there is a water shortage, it is necessary to make frequent trips for refilling high-volume sprayers, or else operate tank trucks to bring water to the sprayers. Then, too, the chemicals themselves represent a cash outlay which has to be figured in the contract. If this cash outlay can be reduced, then there is room in the job to absorb increasing costs, or else pass the savings on to the customer.

We tackled all these problems at once in a contract for the Algonquin Gas Transmission Company where we used "Ammate" X weed and brush killer along 90 miles of their pipeline running from Lexington, Mass., to Providence, R. I. This line runs through swamps and highlands, with substantial sections of the right-of-way virtually inaccessible to power equipment.

The line was built five to seven years ago and some brush cutting had been done before 1957, but nothing much has been done since. As a result, about 75 per cent of the pipe-line right-of-way was covered with typical re-growth three to five feet high. In the swampy areas predominant species were red maple and alder. In the highland areas, there were oak, birch, some ash, and hickory. Even though the right-of-way itself is more or less isolated, it is close enough to towns and farms so that the gas company had specified "Ammate" X weed and brush killer to avoid any liability problem from volatility injury to crops. Just looking the line over, we drove about 200 miles to see the whole 90 miles. That gives you an idea of how inaccessible some portions of it are to wheeled equipment.

When the job came up for bids, we reviewed the experience of Archie W. Paine of the Hartford Water Company, which was reported at the Northeastern Weed Conference last year./1

In 1959, Archie Paine reported on taking a leaf out of the fruit growers' book and using a mist blower -- not a giant orchard sprayer, but a little knapsack-style blower that straps on a man's back and runs with a gasoline engine. This unit weighs about 35 pounds, and holds two and one-half to two and three-quarter gallons of spray. It is a simple air-blast unit, so there is no appreciable pressure in the tank. The mist is created by blowing air at a velocity of 250 miles an hour through a stream of spray solution. The air orifice is one and three-quarter inches, and the orifice for liquid is three-thirty-seconds of an inch. At full throttle the unit will give good coverage of brush at a distance of 12 to 15 feet from the operator.

Paine used eight pounds of a special formulation of "Ammate" weed and brush killer in two gallons of water with an ounce of Spreader-Sticker. This special formulation is the same as "Ammate" X weed and brush killer without the sodium bichromate. Since his work was confined to metropolitan watershed areas, he was limited on what he could use in the spray mixture.

Since we did not have the same limitations, we aimed to economize on chemical by using "Ammate" X in an oil mixture in the mist blower.

Use of an oil mixture to reduce the amount of "Ammate" X without reducing performance was reported by W. I. Boyd at the Northeastern Weed Control Conference in 1958 /2, and there has been a good deal of similar experience elsewhere.

However, all of these have been at rates of 40 to 50 pounds of "Ammate" X in 100 gallons of spray, for use in hydraulic sprayers. With a little experimenting, we found we could get a good mist mixture with nine times as much "Ammate" X in 100 gallons of spray.

The difference in the mixtures is clear from the following table:

	Amount Per 100 Gallons	
	Hydraulic Spray	Mist Mixture
"Ammate" X weed and brush killer	40 pounds	360 pounds
Spreader-Sticker	6 ounces	1 quart
No. 2 fuel oil	4 gallons	5 gallons
Emulsifying agent A	2/3 pint	1 pint
Add water to make 100 gallons		

The contract called for spraying 50 feet of right-of-way on the main pipeline and 30 feet of right-of-way on the laterals. We set our crew up at first with two men operating mist blowers and one man operating a nurse unit consisting of a Jeep, trailer, and 100-gallon hydraulic sprayer which was used for transporting and mixing the water and chemicals. We later increased the number of men on the job to five, and broke up into two crews served by the one nurse unit.

We found that 100 to 150 gallons of water was enough to keep the two crews operating all day, whereas in our experience it had taken 1,000 gallons or more to keep the same number of men operating with a hydraulic sprayer. It took about three months to do the whole 90 miles or 308 acres.

We found some definite advantages in the concentrated mist application over the more dilute hydraulic spray. For one thing, it is possible to direct the spray application more carefully and to apply only the amount of spray mixture needed to cover the brush without runoff. Control of coverage is more accurate than with the high-volume hydraulic sprayer. On light, low brush, seedlings and more susceptible species, a broadcast sweep of the spray with the motor at half-throttle is adequate. Full throttle proved necessary for penetrating thick brush, especially where there were more resistant species of maple, ash, and elm. The operators stood far enough away from the brush to allow the mist to roll and spread -- usually 10 to 15 feet. For dense brush we sprayed from two sides for better coverage. More skill is required to cover dense and tall clumps than with the hydraulic method. Moderate winds did not interfere with the mist application. But like almost any other spray application, we found the crews had to stop when the wind got strong.

There were so few different species to be sprayed in this particular area that it was easy to train the operators to recognize the ones to be treated, so that they did not waste time or materials on weeds and low-growing species that did not need to be killed. As with most other foliage sprays, we found that the best results were obtained on the most uncomfortable, hot, humid days. But light rains at the time of application or soon afterwards did not seem to have any unfavorable results.

We have found it to be a good practice to take our operators back over the work a few days after application, and then again two weeks or more later so they can see their errors and misses.

To sum up the advantages of this program:

(1) The mist blower equipment represents about one-third the investment that would be required for hydraulic power equipment to do the same kind of job.

However, the mist droplets are heavy enough so that there is no more uncontrollable drift than is experienced when solution of "Ammate" X weed and brush killer is applied with a conventional hydraulic sprayer. There were no complaints of spray damage on abutting property.

(2) The mist blower crews are much more mobile than hydraulic sprayer crews so they can spend more of their working time actually spraying.

(3) Use of the mist blower with the mixture which we used permits an 80 to 90 per cent reduction in the amount of water needed to do the job. No run-off saves precious chemical from dripping off the foliage and being wasted on the ground.

(4) Use of the oil emulsion instead of the straight water mixture brought the per-acre rate of chemical application down to about the same total quantity that is used in the

oil emulsion formula for hydraulic spraying. Preliminary tests indicate that this quantity of chemical can be brought even lower in mist blower application.

Obviously the mist blower may not replace hydraulic wheeled equipment where it is possible for the sprayer to move over the ground faster than a man can walk. But where the spray operation is limited to what men can do on foot, we feel that the program we used on the Algonquin Gas Transmission Company contract offers a good deal of promise for similar jobs in the future.

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/1 "Chemical Brush Control on Public Watersheds and Supply Lines," by Archie W. Paine, General Superintendent, Sources of Supply, Metropolitan District Water Bureau, Hartford, Conn., Northeastern Weed Control Conference, 1959.

/2 "Brush Control on Secondary Roads," by William I. Boyd, Technical Service Representative, E. I. du Pont de Nemours and Company, Northeastern Weed Control Conference, 1958.

BRUSH CONTROL WITH SPOT APPLICATIONS OF FENURON IN THE NORTHEAST

By
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This is the third successive report on brush control studies begun with monuron in 1953, and continued since 1955 with fenuron. Previous reports on this work (/1 and /2) have shown that these compounds are very effective for control of woody plant growth common to the Northeast. Data in this report were obtained from 90 test plots established since the spring of 1956. The first plots were located on the right-of-way of the Worcester County Electric Company in Ayer, Mass. Other plots were later established on a similar right-of-way in Leominster, Mass., and also on roadside areas near North Brookfield, Mass.

The program has not lent itself to statistical analysis, but it has produced a good deal of practical data to show what can be expected of fenuron when used for commercial brush control in the Northeast.

By way of background, both monuron and fenuron are effective for brush control. But fenuron is preferred because of its more rapid action due to its greater solubility. Fenuron is now being commercially formulated into an extruded, cylindrical pellet, one-eighth of an inch in diameter, containing 25 per cent active fenuron. This pelleted material is "Dybar" fenuron weed and brush killer.

When these studies were started, monuron and fenuron were available only in wettable powders. So the first plots were established with wettable powder formulations diluted to about 10 per cent with soil, sawdust, and various grades of vermiculite. These mixtures were applied to the ground at the base of each brush cluster with a standard one-quarter cup measure.

With the development of the 25 per cent fenuron pelleted formulation, a smaller amount of the commercial product provides enough fenuron, so standard measuring spoons were adopted. A mean of 20 weighings showed that one tablespoon of "Dybar" fenuron weed and brush killer pellets contained approximately 3.3 grams of fenuron, and one teaspoonful contained 1.13 grams.

All applications were made by placing a measured quantity of material on the ground at the base of each woody plant. A standard plot of 1/40 acre was used for all treatments.

At the time of application, a count was made of the number and species of all brush in each test plot. At each later observation date, a similar count was made. The value and significance of this work becomes evident as these successive observations are compared.

Data from the 90 test plots have shown conclusively that the various inert carriers used to extend the chemicals had no effect on the results. So, for the sake of brevity, all treatments have been compared on an active ingredient basis.

Table I shows observations after one, two, and four growing seasons respectively in plots located in Ayer, Mass. This is the oldest group of plots in the program. Species uniformly present at the time of treatment were oaks, grey birch, maple, poplar, hazel, white pine, pitch pine, and wild cherry. The data show substantially more kill after the second growing season than after the first.

The effect levels off after the third season, partly because of the fact that there is so little growth still living. This is even more evident in the charts (Figures I and II).

Since oaks are so common on rights-of-way in the Northeast, separate counts were made at the same intervals for oaks. The varieties were predominantly white, scrub, and red, with some chestnut oak. There was relatively little difference in the way the different varieties responded. Oaks were killed at almost the same rate as the entire brush population.

When counts were made in September, 1959, it was noted that among the few oaks still alive, there were many characteristic symptoms of the effects of fenuron. Marginal necrosis and interveinal chlorosis were obvious. This suggests that kill of the remaining oaks may continue at least into the next season.

In all the test areas, there were about 20 species of woody plants to be controlled. None of them were found to be actually resistant to fenuron at the higher rates used. However, at the lower rates, some variation in susceptibility was evident. Ash, maple, and shadbush were least susceptible, while hazel, poplar, hawthorne, and grey dogwood were easily the most susceptible. The others ranged in between these two groups.

Comparisons were also made of applications at different times of year -- November, March, July, and April. No significant difference in results could be seen in plots observed at equal times after application. In other words, kill seemed to depend on the elapsed time rather than the original season of application. This is shown in Table II.

With observations indicating that original growth is well controlled after the four growing seasons, the next question is "What about new growth in the treated areas?"

Examination of 1959 data from the plots at Ayer, Mass., indicated that there was virtually no difference in population of new seedlings in plots treated with fenuron at different rates in 1956. So Table III is a comparison of the original growth population by species with the new growth population. To determine the commercial significance of this new growth, the number of total seedlings is shown in Column 4, and the number over two feet tall is shown in Column 5. Only 11 per cent of the new seedlings were more than two feet tall, and nearly two-thirds of these were grey birch. A marked reduction is noted in the population of oaks and maple when the two counts are compared. Oaks constituted 60 per cent of the original growth, but only three per cent of the new growth. Maples constituted seven per cent of the original stand and only two per cent of the seedling stand four seasons after treatment.

It is also interesting to note that good ground cover became established in the test area. This ground cover consisted of grasses, loosestrife, bracken fern, blueberries, goldenrod, and other low growing species.

Most of the effect on trees off the plot area was within five feet of the outer edge. An occasional tree, as much as 25 feet away from the point of application, showed signs of injury. The species that showed chemical injury the greatest distance from the treatment area were oak and white pine.

Individual plant response to spot treatment with fenuron varies considerably. Most plants show response within a few weeks after treatment; however, some do not respond for one or two years after treatment. The reason for this variation in response may be due to the relationship of the roots to the spot where the treatment was made. Because of the high concentration of fenuron at the point of application, the chemical remains in the soil for an extended period of time.

SUMMARY

1. Brush control with fenuron applied as a spot treatment was effective on all species of woody plants at rates as low as 1.13 grams per cluster.

2. Higher dosages of 3.3 grams fenuron per brush cluster gave almost twice the kill at the end of the first year; however, at the end of four growing seasons, the difference in kill between the low and high rates was negligible.

3. Fenuron may be applied as a spot treatment at any time of the year with comparable results.

4. Low growing ground cover consisting of grasses, blueberries, bracken fern, and various weeds becomes established soon after treatment.

5. The data indicate that re-treatment of rights-of-way with fenuron as spot treatments may not be necessary more often than every six or eight years.

# # # #

References:

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2. Poulos, P. L. and Boyd, W. I., "A New Approach to Brush Control." Northeastern Weed Control Conference, 1959.

Acknowledgement:

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TABLE I

Woody plant control with fenuron applied as spot treatments (14, 26, and 40 months after treatment). Worcester County Electric Company right-of-way, Ayer, Mass.

Grams fenuron per stem or cluster applied May 11, 1956	Per Cent Kill Woody Plants					
	14 Months July 7, 1957		26 Months July 7, 1958		40 Months Sept. 8, 1959	
	All Species	Oaks	All Species	Oaks	All Species	Oaks
1.13	39	36	72	73	83	87
1.7	51	50	67	71	80	97
2.26	63	43	79	71	86	82
3.3	67	62	96	94	98	96

TABLE II

Date of application vs. per cent kill of mixed brush by spot treatment with approximately two grams of fenuron per cluster. Worcester County Electric Company right-of-way, Leominster, Mass.

Date of Application	Date of Observation	Months After Treatment	Per Cent Kill
Nov. 29, 1956	July 7, 1958	19	74
March 27, 1957	July 9, 1958	15	72
July 24, 1957	July 22, 1959	24	83
April 21, 1958	July 22, 1959	15	77

TABLE III

Ecology of the Ayer, Mass., test site at the time of and three years following spot treatment with fenuron. Worcester County Electric Company, Ayer, Mass. (Total of all plots)

Species	Plants at time of treatment		New seedlings four seasons after treatment		
	Number	Per Cent of total	Number	Per Cent of seedling population	Number of seedlings over two feet tall
Oak	977	60	215	26	3
Grey Birch	175	11	304	36	58
Maple	107	7	19	2	2
Hazel	99	6	126	15	2
Cherry	52	3	37	5	8
Poplar	101	6	54	7	2
Pine	95	6	49	6	16
Shadbush	16	1	16	2	1
Willow	10		3	0.4	
Hickory	4		1	0.1	
Chestnut	1				
Vibirnum			4	0.5	1
Sumac			4	0.5	
Hawthorne			1	0.1	1
Arrowwood			2	0.2	
Total	1,637		835		94

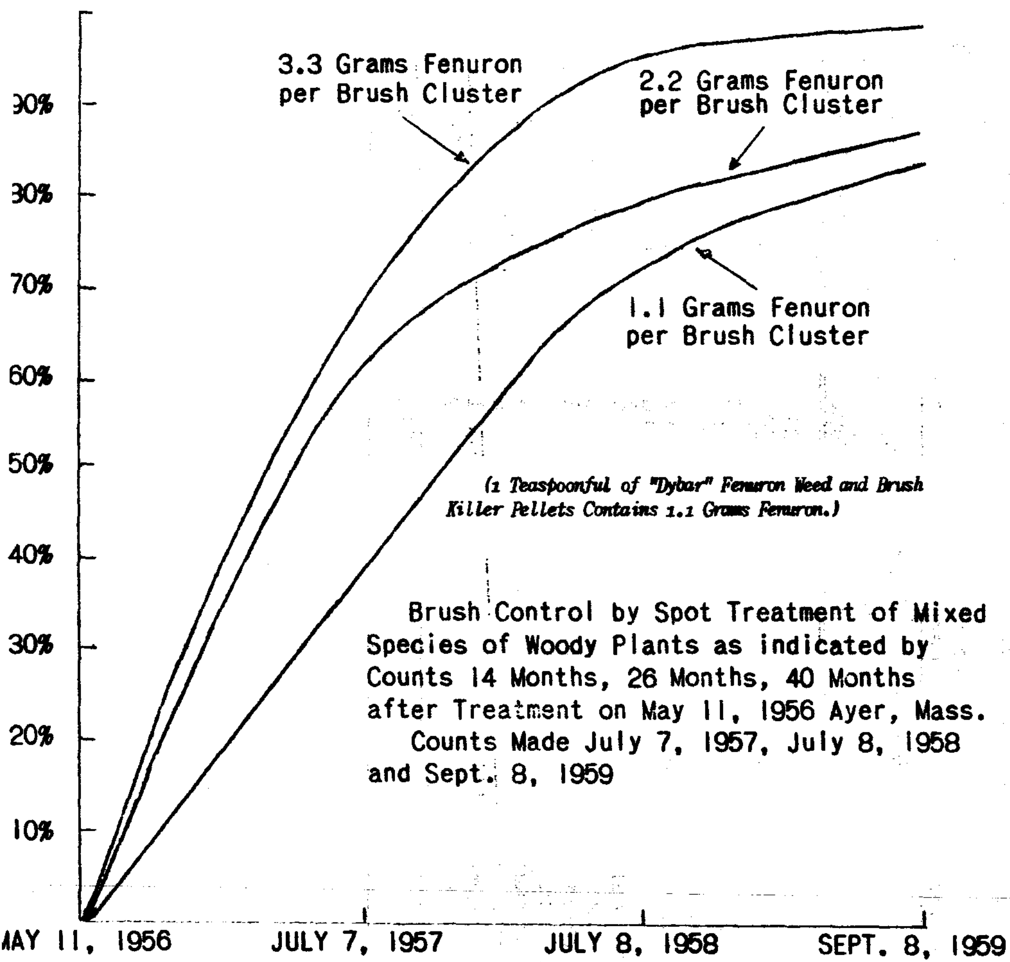
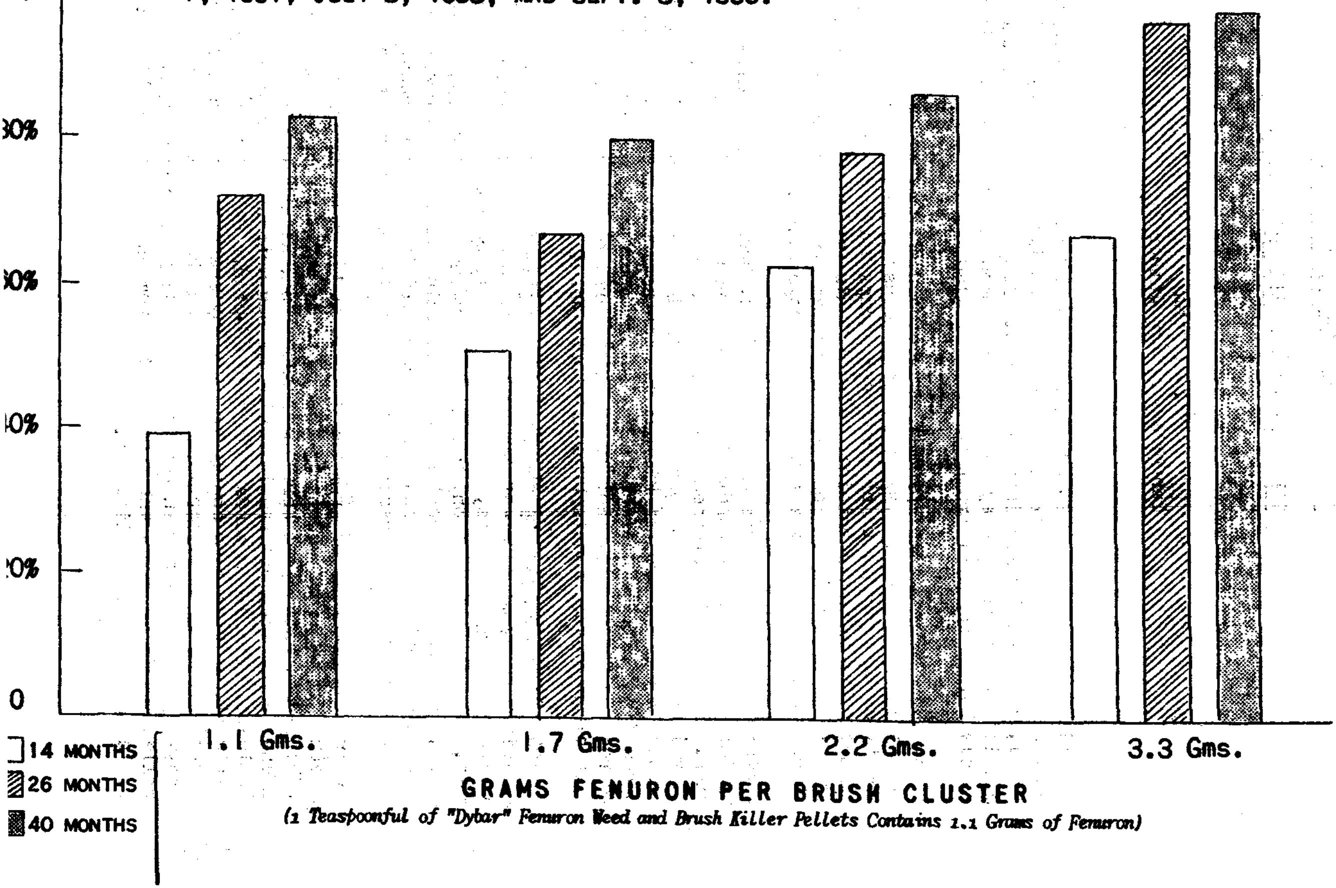


Figure 1

PERCENT OF WOODY PLANTS WITHOUT GREEN LEAVES AT TIME OF INSPECTION

Figure 2

BRUSH CONTROL BY SPOT TREATMENT WITH FENURON OF MIXED SPECIES OF WOODY PLANTS AS INDICATED BY COUNTS 14, 26, AND 40 MONTHS AFTER TREATMENT ON MAY 11, 1956 AYER, MASS. COUNTS MADE JULY 7, 1957, JULY 8, 1958, AND SEPT. 8, 1959.



RIGHT-OF-WAY SPRAY APPLICATION

BY AUTOMATIC SPRAY NOZZLE AND HELICOPTER

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The TVA power system included 11,728 miles of energized transmission lines at the end of fiscal year 1959, and it is estimated that this will increase to 11,933 miles during fiscal year 1960. About 60 percent of the transmission line rights-of-way run through wooded areas, resulting in approximately 80,000 acres of brush to be controlled.

Brush control is a major problem connected with the transmission of electrical energy in the Tennessee Valley region because of the numerous species of brush and types of terrain, which vary from swamps and rolling uplands to high plateaus and rugged mountains. Also in this region the average annual rainfall is more than 50 inches and the average annual temperature is above 60° which contribute to luxuriant growth of vegetation.

During the first 15 years of TVA operation, brush was periodically cleared by large crews, using handtools such as brush hooks, Kaiser blades, and axes. Because of increased labor costs, the cost of hand cutting continually increased. Hand or mechanical methods have the same basic disadvantage, because the roots are not killed; and the regrowth from stubble and stumps becomes more prolific after each clearing operation, making it necessary to reclear frequently. Rotary brush cutters, bushwackers, and power saws with clearing attachments have also been used.

In 1949 TVA started using chemicals for right-of-way maintenance. For an efficient chemical right-of-way maintenance program it is necessary to evaluate the requirements, such as equipment, methods, materials, and cost. For this evaluation, you must determine the following; size of brush, density, predominant species, terrain and what equipment can be used, length of growing season, drift hazard to adjacent crops, percentage of kill or control desired, and materials or chemicals to be used.

The initial chemical program was limited to spraying during the foliage season. It was realized that other methods and techniques must be developed to extend the spraying season; and, as a result of an extensive research program in exploring new methods, techniques, and chemicals, some new methods have been adopted. One of these is basal treatment, which can be applied during any season. This method was adopted during fiscal year 1954. It lifted the seasonal restrictions on spraying, virtually eliminated the possibility of crop damage, and controlled or killed resistant species that remained on the right-of-way after the initial foliage application.

The stump treatment method was perfected and adopted during January 1957, after 3 years of study. This method, which is one of our most effective, is used after the initial clearing of new rights-of-way.

Other methods resulting from the research program include the use of the automatic spray nozzle and the helicopter. During 1959 these two methods were used extensively in certain areas to replace ground crews, who were using hand spray guns with conventional spray equipment. Both methods require fewer employees and trucks for the spraying program, thus reducing the application cost and at the same time increasing the progress over the conventional method. However, these methods will not completely eliminate ground crews.

The automatic spray nozzle was developed in 1958 for applying a semi-concentrated mixture of esters and water on transmission line rights-of-way. Available literature was reviewed; and two Boomjet, or automatic spray, nozzles were purchased. These are single, compact nozzles for mounting at the rear of a truck or tractor, made in different capacities, to cut a swath 38 to 66 feet wide, depending upon the pressure and capacity. The nozzle assembly produces a uniform flat spray pattern. A telescope attachment was designed for mounting the nozzle at a vertical angle of 35° to 40° to the rear of the truck tank, permitting the nozzle to give a vertical spray pattern. Atomization of each jet is as fine as possible in relation to the distance the spray mixture must travel to complete the spray pattern. The nozzle is brass, with 5 fixed-position tips. It has a 1/4-inch brass plug, in the top, which is an ideal location for a pressure gauge.

The automatic spray nozzle was mounted on a military-type 6x6 truck equipped with no-spin differential, mud-grip tires, and an 800-gallon tank. We have been using these trucks for right-of-way maintenance work for several years, and our experience indicates that a skilled driver can cover a high percentage of our transmission line rights-of-way with very few acres of brush skipped. We estimate that the acres skipped will be less than 10 percent of the total acreage sprayed by the automatic spray nozzle.

A pump with 6 full floating nylon rollers to force the spray mixture through the pump is mounted on the truck frame under the tank and operated by a power takeoff. The normal operating speed is 500 rpm, and at 20 psi the pump delivers 30 gallons a minute. These pumps have been used for basal and stump treatment for 3 years and have given excellent service. A pressure gauge, strainer, and adjustable bypass or pressure relief valve are installed. Since no agitator is installed in the tank, the bypass will keep the chemical and water mixed. When a tank of mixed spray solution has set overnight or for several hours, it should be reagitated. This can be accomplished by running the pump for several minutes, allowing the material to circulate through the bypass or an open spray gun spraying back into the tank.

The original clearing width of our transmission line rights-of-way varies from 50 to 600 feet. However, the vast majority of them are cleared 100 feet wide. On a 100-foot right-of-way the truck is driven down one side, directing the spray to the outside edge of the cleared right-of-way. At a pressure of 20 psi the effective swath is 50 to 56 feet wide, which normally gives some overlapping in the middle of the right-of-way after both sides have been sprayed. We normally enter the right-of-way and drive until about one-half of the mixture in the tank has been used or until some obstacle, such as a fence, crops, or a creek, has been encountered. The truck is turned around, and the other side of the right-of-way is sprayed. The truck speed is 2 miles an hour, resulting in the spraying of 6 acres of brush an hour and the application of 50 gallons of mixture an acre. The 800-gallon tank will spray 16 acres of brush.

Approximately 300 acres was sprayed in June and July 1958 with the automatic spray nozzle (Boomjet nozzle No. 5880-3/4-2TOC40), using various combinations of chemicals, oil, and water to establish test plots as follows.

Herbicide	Acid Rate (Pounds/Acre)	Carrier
2,4-D and 2,4,5-T	4	Water
2,4-D and 2,4,5-T	8	Water
2,4-D and 2,4,5-T	10	Water
2,4-D and 2,4,5-T	4	10% oil in water
2,4,5-T	4	Water
2,4,5-T	8	Water
2,4,5-T	4	5% oil in water
2,4,5-T	8	5% oil in water
2,4,5-T	4	10% oil in water
2,4,5-T	8	10% oil in water
2,4,5-T	4	20% oil in water
2,4,5-T	8	20% oil in water
2,4,5-T P	8	Water
2,4,5-T P	4	10% oil in water

Numerous species were present in these plots, such as oak, hickory, maple, ash, redbud, sourwood, persimmon, elm, prickly ash, black gum, huckleberry, crataegus, cherry, dogwood, sumac, cedar, and sassafras. The kill varies from plot to plot, depending upon the species present and the materials used.

The plots were visited frequently until frost, when several of us felt that 40- to 50-percent root kill would be obtained and that the cost per acre would be about $20, which is about one-fourth the cost of coventional methods. We felt that the automatic spray nozzle, using a semiconcentrated mixture of esters, could be used in 1959; and our program was planned to begin spraying about May 10 and to complete the work with the automatic spray nozzle by July 15. The mixture of 2,4,5-T esters and water was applied at the rate of 50 gallons an acre, using 1-1/2 gallons, or 6 pounds of acid. The spray truck picks up water at desirable streams or lakes.

A normal crew consists of a foreman, a truckdriver, and a laborer. The transportation consists of an IHC 6x6 truck with tank and a 1-ton panel truck with dual wheels and no-spin differential. Seventeen crews sprayed 6,600 acres of brush at at cost of approximately $25 an acre. This cost was slightly higher than we estimated; however, we experienced some equipment troubles during the first week. Rust scale on tanks that had been used for several years was locking the pump rollers and clogging the nozzle jets. Also, we had above-normal rainfall in some areas in June, which restricted our truck movememts. Some of the crews moved the truck less than 2 miles an hour, which caused the mixture to be applied at a higher rate than required and resulted in an additional cost for chemicals. In some instances the rate an acre was almost doubled; however, the majority of the crews applied the mixture at the proper rate.

The spray nozzle is mounted so that it may be raised or lowered. The nozzle should be kept as close to the brush height as possible, since this procedure will help eliminate drift which might damage susceptible crops. None of the crew members had observed spraying by the automatic spray nozzle, and unusual caution was exercised by the crews. We had only 6 minor damage claims, which resulted in a total payment of less than $500. This figure is considerably less than we have experienced with crews using conventional spray equipment with hand guns.

The use of the helicopter for brush control is relatively new to most utilities. We had observed brush control work done by some other utilities for the past six years and were not too impressed with some of the results of the early years. However, in 1958 we inspected some right-of-way spraying that had been done in 1956 and 1957 which looked good. After this work was inspected, a contract was negotiated; and in July 1958 the contractor sprayed 382 acres by helicopter. A mixture of 1 gallon of 2,4,5-T esters, containing 4 pounds of acid, in 4 gallons of diesel oil was applied initially. We were concerned about the volatility of the oil; and about one-half of the acreage was sprayed using only water as a carrier, since all this work was on an experimental basis.

We can see very little difference between the spraying done with an oil carrier and the spraying done with water, except on some species of brush. The brush sprayed was 4 to 20 feet in height, with the majority 10 to 12 feet. Our general rule was to apply the oil on pole lines, since the helicopter would not have to fly very high. The water mixture was applied to tower lines, which required the helicopter to fly at a greater height. The spraying was done on rights-of-way in remote, mountainous areas, where spraying by ground crews was almost impossible. Real flying techniques must be used to get coverage on the uphill sides of lines, with steep slopes at right angles to the line of flight.

The spraying was done late in the season; however, we felt that adequate moisture was in the soil for continued plant growth to aid in the translocation of the chemical.

The species sprayed during our experimental work in 1958 indicate that good control was obtained on sweet gum, black gum, sassafras, wild cherry, sumac, persimmon, and the majority of oaks; that fair control was obtained on red oak, chestnut oak, redbud, and hickory; and that poor control was obtained on pine, cedar, maple, ash, elm, and sourwood.

In June and July 1959 a contractor sprayed 4,750 acres of brush by helicopter, using 23,750 gallons of spray mixture. The average flying time was 3 hours a day, and an average of 150 gallons of mixture an hour was used. We used 1 gallon of 2,4,5-T esters, containing 4 pounds of acid, in 4 gallons of oil or water, making a total of 5 gallons of the mixture an acre. The chemical mixture used for helicopter application, because of the low volume applied, should offer the maximum in qualities necessary for translocation per gallon of material applied; and techniques and equipment to afford the most uniform coverage possible should be used.

Both the materials and techniques are important. We believe that low-volume esters containing 2 pounds of 2,4,5-T esters a gallon at the rate of 2 gallons, or 4 pounds, an acre, mixed with water, give an adequate oil with nonphytotoxic base, since an extra gallon of esters is used. This mixture eliminates field mixing with diesel oil and provides a better balance of built-in carrier, emulsifier, and acid spreader-sticker. We believe that this is more important in low-volume aerial application of oil-water emulsion than in high-volume ground application. Application rates vary from one section of the country to another, depending upon the species, size, and density of the brush.

The helicopter is especially adapted to difficult terrain, such as mountains, and swamps. In these areas it can operate at a cost far below any other brush control method. The downward movement of air created by the rotor, of the helicopter causes the chemical to penetrate the growth to ground level for coverage necessary to kill the brush. The downwash of the helicopter, or rotor, aids in confining the chemical mixture to the right-of-way, helping to minimize damage to adjacent crops. Contrast this with the necessity of turning a high-pressure power-sprayer gun skyward for tall growth, and you can see why damage claims are minimized.

Drift hazard is affected by particle size of the discharged spray material, horizontal air motion, vertical air motion and diffusion rate, and quantity of active material applied in a given area. The nozzle with a smooth tapered orifice entrance gives the largest average drop size with the fewest number of very fine-range particles. The pressure should be as low as possible, about 25 psi; and the helicopter speed should be approximately 30 mph. Positive liquid control systems are required.

The landing locations for chemical loading are usually in fields or on trails along the rights-of-way in order to keep nonspraying time to a minimum. These locations are selected in advance by the supervisor. A normal crew consists of a supervisor, a pilot, a mechanic, and a truckdriver. The supervisor is responsible for the entire operation. He surveys the line for suitable access roads, susceptible crops, and suitable landing areas. He oversees the mixing and loading, determines spray equipment and chemical requirements, and makes daily reports of the operation. The pilot should be a specialist in transmission line right-of-way spraying in mountainous areas. The mechanic assures continuous operation of the helicopter through constant servicing and maintenance. The truckdriver drives the supply-tank truck, keeps the chemical mixed, and loads the chemical in the helicopter with the least possible delay.

The applicator should comply with Government and state regulations and the provisions of the workmen's compensation laws. Adequate insurance should be carried to cover automobile public liability, aircraft public liability, and property damage (including crop damage).

The lines remain energized while they are being sprayed. The pilot normally flies 10 to 20 feet above the tower, following the sag of the conductors. Spraying begins at daybreak, weather permitting, and ceases when the wind speed is 3 mph. Spraying begins again late in the afternoon, when the wind speed is below 3 mph, and continues until dark.

Some companies have been experimenting with invert materials for several years; however, very little of this material has been applied to transmission line rights-of-way until recently. We have applied it by the basal and foliage methods, using the hand gun and the orchard blower. With these methods, however, our results were not promising. A contractor, using a helicopter equipped with a whirling, variable-speed disk that throws the chemical out, applied 1,000 gallons of invert material. It was applied at the rate of 2 gallons of esters, containing 2 pounds of 2,4,5-T acid a gallon, in 8 gallons of water, making a total of 10 gallons of material an acre.

Invert emulsion is formed by mixing esters, already properly blended in oil, and adding the water slowly while the mixture is agitated. The invert cannot be formed by circulation with a pump, especially under pressure, while the water is being added. We have experienced difficulties in mixing this material for all types of application; however, we are sure that these are only minor problems and will be overcome. When properly mixed, invert is a viscous spray mixture with a consistency like mayonnaise. The droplets are two or three times larger and more stable than material normally used for spray purposes. These qualities result in a greater control over drift and permit the use of the helicopter with wind speeds of 3 to 8 mph higher, allowing more flying time per day.

The line sprayed with invert were inspected by plane about 1 month after spraying. There was no evidence of drift, and the line of demarcation was very distinct and positive. The pilot sprayed some fence rows and ditch-banks without dumping the chemicals into adjacent crops and pasture areas. The line sprayed was a 69-kv line with a 50-foot right-of-way having considerable overhang which appeared to have been burned back.

Further studies with respect to percentage of kill and drift control will be needed to determine the full value of invert emulsions for right-of-way brush control.

Right-of-way brush control is a continuing maintenance problem for trouble-free operation. In most instances it is the greatest and most expensive problem in the maintenance of transmission lines. Today we know that chemical brush control is not a one-shot cure-all for the majority of our rights-of-way. Chemical brush control may be accomplished by several means, from the ground as well as from the air, depending upon the specific problem. After the specific brush control problem has been determined, a successful right-of-way maintenance program at a reasonable cost will depend upon selecting the proper materials and equipment and making certain that the crews are thoroughly trained in their proper use.

We do not claim that the automatic spray nozzle and the helicopter are the universal answers to the application of chemicals, and they will not eliminate the use of ground crews for conventional foliage and basal treatment. However, they serve a real need in a right-of-way maintenance program. We have observed that the automatic spray nozzle gives a slightly higher percentage of root kill than the helicopter. The helicopter is especially adaptable for areas inaccessible to ground crews.

Chemical spray can be applied by the automatic spray nozzle with almost no damage claims and with less than 10 percent of the brush being skipped because of susceptible crops.

Through chemical treatment and new methods of application 25 percent more transmission line right-of-way was cleared last year. The increase in right-of-way cleared was achieved while right-of-way clearing expense was reduced more than 10 percent through the use of improved methods and materials.

At the present time our right-of-way program includes almost every known method of chemical treatment, with a small amount of mechanical clearing. We are always seeking new ideas or methods for improving techniques and reducing the unit cost.

THE INVERT EMULSION - A PROMISING TOOL FOR RIGHT-OF-WAY MANAGEMENT

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The increased use of helicopters to apply herbicides to utility rights-of-way has brought into sharp focus the serious hazard of drift encountered when this method of application is used. The purpose of this paper is to present information on a herbicide formulation designed to reduce drift.

When water is added to this formulation a thick, viscous water-in-oil emulsion results. This is the reverse of the more familiar oil-in-water emulsions used today. In the two phase water-in-oil emulsion, droplets of the inner water phase are surrounded by a continuous outer oil phase containing the active herbicide. Since this "inversion" is the opposite of conventional oil-in-water spray the new type material acquired the name "invert emulsion". Invert emulsions are used as the basic carrier for herbicides such as 2,4-D, 2,4,5-T, 2,4,5-TP, 4-(2,4-DB) and others.

When sprayed, the invert emulsion droplets are larger and heavier than droplets of water, oil, or oil-in-water sprays. This has resulted in much greater control of drift than has been obtained with standard emulsions. Also, there is less loss due to thermal current interference or evaporation when these heavier oil-coated droplets are applied from aircraft.

A considerable amount of woody plant research has been done to determine the biological effectiveness of the invert emulsion as a carrier for 2,4,5-T and/or 2,4-D and to establish the best means of applying it to gain maximum benefit from the low drift characteristics inherent in these thicker emulsions. (1)(2)(3)(4)(5).

Although today the greatest potential use of the invert emulsion appears to be in aerial application work, this did not become apparent until many experiments had been conducted with ground equipment. Before discussing the more recent aerial applications, a brief summary of some of the results obtained with various techniques of ground application is presented here as background information.

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Review of Ground Spray Tests

The following three ground application techniques were employed in the initial testing of the invert emulsion formulations of 2,4,5-T alone and in mixture with 2,4-D. Plots were applied throughout the Appalachian Mountain region from New York to Florida.

1) Modified basal spray: In these experiments spray was concentrated at the base of the plant as in ordinary basal treatment, then brought up over the stems and foliage of plants until approximately four-fifths of the plant was covered. Sprays were applied in July using a mix of 6 pounds of acid in 15 gallons of oil and 83½ gallons of water.

A good ground-line kill was produced by both the straight 2,4,5-T and the 2,4-D/2,4,5-T formulations. However, the most striking result of the test was the root collar resprouting which occurred late in the second growing season after application. Nearly 60% of the oak, hickory, red maple, persimmon, white ash, locust and tulip poplar had resprouted at or below the root collar. Sprouts were vigorous and showed no lingering effect from treatment.

It was apparent that the herbicide had not translocated into the root collar zone, perhaps because the deposit of spray on the stem was so heavy that immediate kill of the cells capable of translocation occurred before any translocation could take place. Bark penetration of the external oil phase of the invert emulsion is very rapid, particularly on smooth barked species such as red maple.

It was also apparent that no material had reached the root collar zone from external run-down on the bark surface. This indicated a possible shortcoming of the invert emulsion applied by the modified basal technique. The more viscous water-in-oil invert emulsion stayed where it was applied and did not run down under the ground litter as is the case with a standard oil-in-water emulsion. The satisfactory use of conventional oil-in-water emulsions relies on heavy run-down to the root collar zone to kill dormant buds and prevent resprouting.

2) Dormant cane broadcast sprays: Spray was applied to dormant stems so as to wet them completely to ground line. A broadcast spray was applied with no effort being made to concentrate on the base of the plants. The herbicide concentration was the same as that used in the modified basal spraying. Sprays were applied in November.

Results were very similar to those obtained from the modified basal sprays. Nearly 100% of the stems were dead to ground line, but resprouting from the root collar zone and below was vigorous the second growing season after spraying.

3) Basal sprays: Spray was concentrated at the base of each plant, special care being taken to remove leaf litter and expose the root collar zone to complete coverage.

Sprays were applied in June using a mix of 12 pounds of acid in 30 gallons of oil and 67 gallons of water. Compared to the modified basal spray, only ½ the volume of solution was needed to cover an acre of brush by this technique.

Results from these tests were excellent. 95 to 100% complete kills were obtained on red maple, scrub oak, red oak, white oak, black cherry and white ash. It is interesting to note that later tests of the basal spray technique applied during the dormant season in November were not as effective as the basal sprays applied in June. Complete kills on the same species dropped by nearly 20%.

With the exception of the promising results obtained with the summer basal spray, results from these three ground application techniques were generally discouraging.

It should not be concluded from these experiments that the invert emulsion, as such, inhibits herbicide translocation. Quite the contrary seems to be true. The problem is one of getting the proper amount of the emulsion on the plant without destroying the cells involved in translocation.

In greenhouse studies, treatment of single leaves has resulted in complete kill of some seedling woody plant species. At present the weight of the experimental data is against high volume application of invert emulsions to foliage and stems. Instead of 400 gallons per acre, lighter applications of 10 to 25 gallons per acre appear more appropriate. This theory led to the application of inverts through aerial equipment at rates and volumes considerably lower than those used through ground equipment. The initial data obtained from these aerial tests, and presented below, has been very encouraging.

Aerial Tests

Methods and materials:

In applying the aerial tests, the standard booms and nozzles normally found on helicopters did not handle the thick invert emulsion satisfactorily. Pumps were clogged, droplet distribution was not uniform, and swath widths were too narrow. To overcome these problems a centrifugal sprayer operating on the principles of gravity flow and centrifugal force was designed.

To describe this sprayer briefly, invert material flows by gravity from the saddle tanks of the helicopter to a spinning disc which is located between the skids and below the front of the helicopter bubble. Controls for operating the disc consist of two switches located on the control stick of the helicopter. As the disc spins, material is released through 8 nozzles around the perimeter of the disc. Swath width and droplet size are controlled by varying the speed of the helicopter and the revolutions per minute of the disc. Effective swaths from 20 to 45 feet wide can be flown.

To test aerial application of the invert emulsion for the centrifugal sprayer, 2-acre plots were treated on a Central Virginia Electric Cooperative right-of-way in Lovingston, Virginia. Brush on these plots was 15 to 25 feet high, dense, and in vigorous growth. Applications were made in June, 1958.

For these experiments, a swath width of 40 feet was chosen. Helicopter speed was maintained at 35 miles per hour. A concentration of 6 pounds of acid per acre was applied in a total of 10 gallons of invert emulsion per acre. Two formulations were tested, one a straight 2,4,5-T and the other a 50:50 mixture of 2,4-D and 2,4,5-T. The invert emulsion was made up of 3 gallons of concentrate and oil, and 7 gallons of water.

Results and Discussion:

Two 1/10 acre sample plots were installed on each of the aerial plots. All stems on this sample area were tallied before spraying. When final evaluation was made, all stems were counted again and recorded as either dead or alive. From these base figures, the percentage of original stems dead to ground line and the percentage of stem reduction per acre were calculated and recorded in the table below.

Table 1. Percentage of stems dead to ground line and percentage of stem reduction from aerial application of two invert emulsion formulations at 6 pounds per acre in 10 gallons total volume.

Date applied: June 1958
Final evaluation: September 1959.

Species	2,4-D/2,4,5-T Invert Emulsion		2,4,5-T Invert Emulsion	
	% dead to ground	% stem reduction	% dead to ground	% stem reduction
I	II	III	IV	V
Black gum	100	100	100	100
White oak	91	85	71	62
Tulip poplar	98	91	none present	
Red oak	72	41	40	40
Sassafras	100	100	none present	
Scrub oak	none present		0	0
Locust	100	100	100	100
Cherry	45	0	25	25
Red maple	70	15	77	65
Sumac	96	84	100	100
Hickory	64	50	62	62
Am. elm	100	100	78	78
Dogwood	90	84	96	96
Persimmon	90	60	88	77
Hornbeam	none present		100	100
Serviceberry	70	30	none present	
Virginia pine	29	29	0	0
Cedar	0	0	none present	
Witch hazel	100	100	none present	
Black oak	none present		50	50
Total all species	77	62	65	63

A glance at the total stem reduction figures in columns III and V of the table shows essentially no difference between the 2,4-D/2,4,5-T mixture (62%) and the 2,4,5-T alone (63%). Since stem reduction is the goal of a right-of-way maintenance program these two figures are the indicators of the success of the application. However, it is interesting to note that a greater proportion of stems (77%) were killed to ground line with the 2,4-D/2,4,5-T mixture than with the 2,4,5-T alone (65%). This fact is reflected in the better overall appearance of the 2,4-D/2,4,5-T plot. If canopy reduction as well as stem reduction were the goal, the 2,4-D/2,4,5-T mixture would be the better one to try according to this experimental data.

There are other facts to be observed in comparing these two formulations. A study of the stem reduction figures indicates a differential species response to each of the formulations. The 2,4-D/2,4,5-T formula is significantly better on white oak, american elm, and virginia pine. The 2,4,5-T formula is more effective on red maple, sumac, hickory, dogwood and persimmon.

Both formulations are particularly effective on the root-suckering species such as locust and sumac. The complete kill with no resprout of these two species and sassafras by the 2,4-D/2,4,5-T formulation was one of the most outstanding results of these tests. These three species plus black gum seem to be particularly susceptible to the invert emulsion formulas applied aerially.

It can be seen from this data that proper analysis of the predominant species on a given right-of-way is essential to selecting an aerial spray formulation. For example, if red maple is the primary problem 2,4,5-T would be the better choice. If pine is a problem the 2,4-D/2,4,5-T mixture should be used.

A comparison of these tests with commercial helicopter application of conventional emulsions to rights-of-way in the vicinity indicates better stem reduction with the invert formulas. It should be noted that most of these areas contained brush which was much shorter (6-8') than that used in the experiments. This could be a factor in the superior control obtained with the invert emulsion. Generally, in the area of central Virginia, a stem reduction of less than 50% of the brush (depending on species) is expected from a single aerial application using conventional emulsions of 2,4-D and 2,4,5-T.

A good comparison between aerial invert applications and ground applications of conventional material could not be made in this test. However, on nearby areas where a commercial foliage application of 4 pounds of 2,4-D/2,4,5-T per 100 gallons of water had been applied, a marked difference in control occurred on the root suckering species, sassafras, locust, and sumac. On these three species, kill by the aerial invert application was much superior. Heavy resprouting had occurred after the ground application.

Stem reduction of all species was better from aerial applications than from ground applications of inverts by the modified basal technique described earlier.

From the standpoint of drift reduction no visible damage occurred off the rights-of-way in any of the test applications. Sharp lines were cut on either side of the right-of-way by the spray pattern. Wind velocities were approximately five miles per hour during application.

Considerably more work needs to be done to determine the safe limits of the invert material at various wind velocities. From field observations it appears to reduce drift substantially and when applied by helicopters through the centrifugal sprayer it should be safer to use than conventional emulsions through boom equipment. However, there are still some fine particles present in the pattern which can cause trouble if care and common sense are not used in making the applications.

Summary and conclusions:

With the possible exception of basal spraying, the best potential of the invert emulsion as a low-drift carrier of oil-soluble herbicides appears to be aerial application. When applied through a centrifugal sprayer, there is greater safety than with conventional emulsions applied through booms. There was greater stem reduction from experimental aerial invert applications than from boom application of conventional emulsions in adjacent commercial spraying. In the invert aerial test plot, stem reduction of black gum, sassafras, locust and sumac was markedly greater than from commercial high volume water-borne foliage sprays applied with ground equipment in nearby areas.

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THE USE OF CERTAIN COMBINATIONS OF HERBICIDES FOR BRUSH CONTROL[1]

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Many of the root suckering species of woody plants such as black locust, summac and sassafras are not usually completely killed by applications of 2,4-D and 2,4,5-T. The tops of the plants usually die when sprayed with these chemicals, but new sprouts almost always appear. Often these sprouts will come up several feet from the base of the original stem that has been killed to the ground level.

Of the species mentioned above, black locust is the most serious pest in that new sprouts will often grow to a height of ten feet the first season after spraying. Previous experiments have shown that this species is very sensitive to amitrol (ATA). This chemical along with others and certain combinations thereof were included in Experiment I. This experiment was conducted in a 100 foot wide right-of-way that was predominately covered in black locust having a height of ten to fifteen feet. All treatments were applied in late June and early July 1958. The individual treatments were mixed in 50 gallons of water and applied at a rate of 300 to 500 gallons per acre. The entire plants were thoroughly wetted with the mixture by means of 7 1/2 gallon per minute John Bean pump operated at 400 PSI to which a 3/8 inch hose and Spraying Systems Gunjet Nozzle with a number 8 disc was attached. Plot size ranged from one fourth to one tenth acre depending on the density of the brush. Individual plots were separated by cutting a three foot path across the right-of-way. Soon after the treatments were applied, all stems were counted and recorded by species.

Table 1 - Treatments and Results in Experiment I
June 15 - July 15, 1958

Treatments per 100 Gallons of Water	% Resprouts	% Original Stems Alive
Amine D&T 4/100	60	6
Amine D&T 4 + ATA 1/100 (ACP 329)	21	0

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Table 1

Treatments per 100 Gallons of Water	% Resprouts	% Original Stems Alive
236 TBA amine (duPont) 8/100	15	1
236 TBA amine (duPont) 2 + ATA 2/100	20	0
236 TBA amine (duPont) 4 + ATA 2/100	2	2
236 TBA amine (duPont) 4 + ATA 4/100	5	5
236 TBA amine (duPont) 8 + ATA 2/100	0	1
236 TBA amine (duPont) 8 + ATA 4/100	10	1
236 TBA amine (duPont) 8 + ATA 8/100	6	0
236 TBA esters (ACP) 4 + ATA 1/100	4	0
236 TBA esters (ACP) 8/100	7	0
ATA 8/100	6	0
Butoxy ethanol esters of D&T 4/100	35	4
Butoxy ethanol esters of D&T 4-10-90 (10% oil)	36	4
Ethyl Hexyl esters of D&T 4/100	25	2

The ATA used in the experiment was a liquid formulation (ACRM569) containing two pounds of active ingredient per gallon. The 236 TB esters and amines contained two pounds of active ingredient per gallon. The 2,4-D and 2,4,5-T formulations contained 4 pounds of active ingredient per gallon.

In September 1959, all resprouts and living stems (those not killed to within 6 inches of ground level) were recorded by species. The treatments used and the results obtained are presented in table 1.

All treatments killed the tops of the brush by more than 90%. Black locust was apparently killed almost 100% when ATA was used in any of the mixtures as very little resprouting occurred in this species. Sassafras, on the other hand, was not completely killed by any of the treatments as there was a considerable amount of resprouting in this species. The relatively high amount of resprouting in treatments other than those containing ATA resulted mainly from black locust as this was the dominant species.

Experiment II was conducted on the same right-of-way in another location where there was a greater abundance of oaks, maples, and other species in addition to black locust. The treatments were applied in late July and early August in the same manner as described in Experiment I. The treatment used and results obtained are given in table 2.

In this experiment the addition of ATA had less effect on the total amount of resprouting than in Experiment I where black locust was the predominant species. This species was controlled in those plots receiving amitrol however.

Table 2 - Treatments & Results in Experiment II
July 15 - August 15, 1958

Treatments (per 100 gallons of water)	% Resprouts	% Original Stems Alive
Cyanamid 6249 10 + 2,4,5 TP 4/100	44	2
Cyanamid 6249 10 + ATA 8/100	24	18
Cyanamid 6249 10/100	26	14
Butoxy ethanol esters of 245 TP 4/100	44	10
Butoxy ethanol esters of 245 TP 6/100	28	3.
236 TBA ester 8 + ATA 8/100	23	9
236 TBA amine 6 + ATA 8/100	48	17
236 TBA ester 8	29	13
ACP 908 4/100	22	13
ACP 472 4/100	16	9
D&T acid paste 4/100	36	10
Amine D&T 4 + NH_3NO_3 35/100	22	12
Amine D&T 4 + NaH_2PO_4 10/100	31	6
Butoxy ethanol ester of D&T 6-15-85	46	5
Ethyl Hexyl ester of D&T 6-15-85	37	7

Summary

In locations where black locust is the dominant species, amitrol and combinations of ATA and 236 TBA are very effective. Since this situation often occurrs in rights-of-way that have been sprayed several times with 2,4-D and 2,4,5-T it appears that these chemicals will be very effective. Combinations of ATA and 236 TBA were more effective than were ATA and 2,4-D and 2,4,5-T combinations.

Long Term Evaluation of Chemical Brush Control On A Power Line Right-Of-Way

by
William R. Byrnes 1/

In the spring of 1953, a cooperative study 2/ was initiated on a newly created power line right-of-way in central Pennsylvania to determine the effect of chemical brush control on game food and cover. The study also involved an evaluation of thorough chemical applications on the control of woody brush and observations on subsequent plant community development. In order to ascertain the long term effectiveness of treatments applied and to follow ecological changes in the plant community comprising the ground layer vegetation, the investigation was designed to cover a 10-year period.

Progress reports on this project have been presented periodically in various sections at previous Northeastern Weed Control Conferences. This report briefly describes observations recorded during the first 7 years of the study in regard to degree of brush control and floristic changes occurring in the ground layer vegetation. For additional information on game species present and the utilization of vegetation by game animals, you are referred to the publications listed in the bibliography.

The six commercial treatments applied, which were replicated four times in a randomized block design, are still in common use today. These treatment techniques are:

A - Unsprayed control to serve as a comparison with chemical treatments. Hand cut in April 1958, six growing seasons after the initial capital clearance, by a commercial crew using brush saws and axes.

B - Broadcast foliage spray of 2,4-D plus 2,4,5-T butoxy ethanol esters, half and half, at a concentration of 4 pounds combined acid equivalent per 100 gallons of water. Applied June 1953.

C - Oil water, semi-basal spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half; 3 gallons of spray material to make a concentration of 6 pounds of combined acid equivalent per 100 gallons spray in an oil-water carrier consisting of 10 gallons of No. 2 fuel oil in 87 gallons of water. Applied June 1953.

D - General summer basal spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half, at a concentration of 12 pounds of combined acid equivalent per 100 gallons of spray, No. 2 fuel oil being used as a carrier. Applied June 1953.

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2/ Cooperating agencies: (1) The Pennsylvania State University, (2) Asplundh Tree Expert Company, (3) AmChem Products, Inc., (4) DuPont Chemical Company, (5) The Pennsylvania Electric Company, and (6) The Pennsylvania Game Commission.

E - Selective winter basal spray of 2,4,5-T butoxy ethanol esters at a concentration of 12 pounds of acid equivalent per 100 gallons of spray, No. 2 fuel oil being used as a carrier. Applied February 1954.

F - Broadcast spray of ammonium sulfamate at a concentration of 3/4 pound per gallon of water; 4 ounces of sticker-spreader were added per 100 gallons of spray. Applied June 1953.

Degree of Brush Control

In respect to topkill or death of the woody brush to the ground line, a progressive dying of original plants was observed for all treatments during the first two seasons following chemical treatment. Topkill was most gradual following the broadcast 2,4-D plus 2,4,5-T, oil-water semi-basal, and broadcast ammonium sulfamate treatments. However, by the end of the second season, highly satisfactory topkill results, ranging from 94 to 99 percent, were obtained for all treatments (Figure 1).

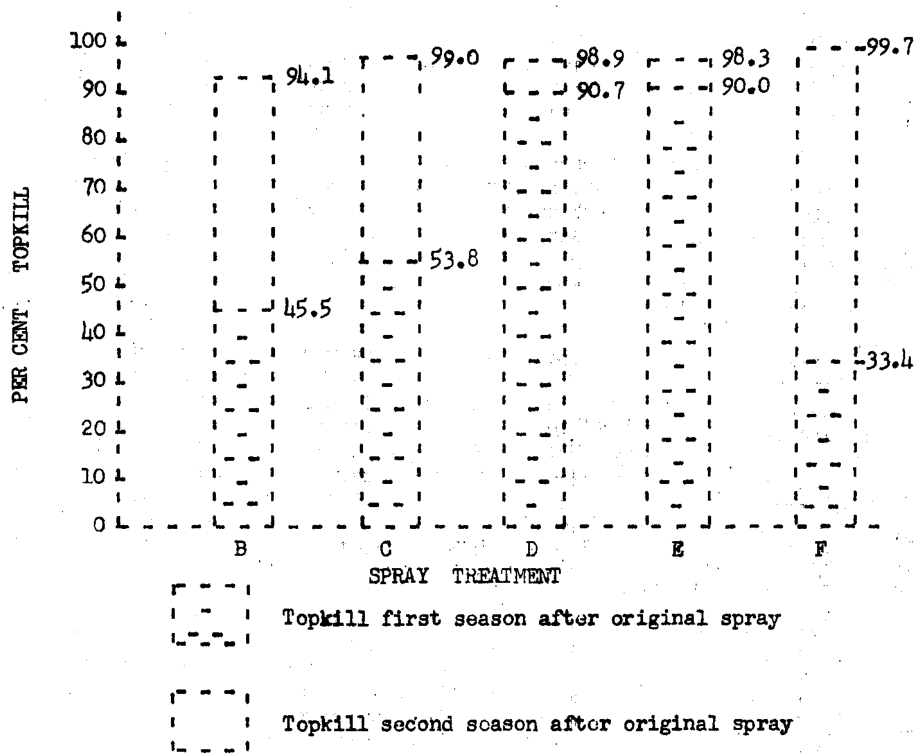

Fig. 1.-- Progressive topkill for all species combined, one and two growing seasons after original spray.

Resurge, in the form of sprouts and suckers from topkilled plants and seedlings missed during the initial spray, was evident in varying magnitude on all treatment areas in 1954, two growing seasons after spraying. The amount of resurge at this time, calculated as a percent of original number of stems per acre, ranged from a high of 27 to a low of 5 percent as shown below:

	Treatment	Percent Resurge
B	Broadcast D + T	21
C	Semi-basal	8
D	Summer basal	7
E	Winter basal	5
F	Broadcast ammonium sulfamate	27

A follow-up summer basal spray was then applied in July 1954 to this resurging brush on one-half of each plot. This quick follow-up has resulted in practical elimination of the woody shrub layer on all treatment areas, so that in 1959, only a very few scattered clumps over 3-feet in height remain. It is evident that no additional treatment will be necessary for many years to come.

On the remainder of each plot, that portion which did not receive subsequent chemical treatment, resurging woody plants were permitted to develop normally. Many of the weak stump sprouts have died and many plants have been kept under control by browsing animals, particularly deer and rabbits. Even with this natural mortality and animal control, however, a considerable number of plants had emerged and were prominent in the ground and shrub layers in 1957 (Table 1).

Sassafras, due to its prolific root-suckering habit, was one of the major problem species in the study area. As seen in Table 1, this species was adequately controlled by the initial semi-basal and broadcast foliage (D + T and ammonium sulfamate) treatments and by a combination of initial and follow-up basal sprays on all plots. Since sassafras is a single-stemmed plant, it has not presented a distinct appearance on the right-of-way, except on two of the winter basal replicates where extensive thickets have occurred. By 1959, the status of sassafras as a brush component had very little change. This was mostly due to the killing action of late frosts and severe browsing in early summer by deer.

The multiple-stemmed oak and maple species on the other hand, although fewer in number, have grown in height and density and at the present time are very prominent on certain treatment areas. This is particularly true for red maple on the broadcast ammonium sulfamate plots and mixed oak on the broadcast D + T plots. Many of these clumps have now grown out of the reach of deer and presumably will, in the near future, constitute a hazard to line operation, thus requiring additional treatment.

Table 1. Status of woody brush on the test areas in August 1957, five growing seasons after initial treatment.

Treatment	Bear Oak	Other Oaks	Red Maple	Misc. Hardwoods	Sass-afras	Total	Total Minus Sass-afras
	. . . Number of Living Plants Per Acre Over 3 Feet in Height . . .						
Single Sprays							
A Unsprayed	126	408	158	288	1,282	2,262	980
B Broadcast (D + T)	24	14	0	2	4	44	40
C Semi-basal	2	2	8	14	2	28	26
D Summer basal	14	4	8	8	124	158	34
E Winter basal	8	28	2	4	1,182	1,224	42
F Broadcast (Ammonium Sulfamate)	2	0	10	16	0	28	28
Sprays with Follow-up Basals							
BD Broadcast (D + T)	0	0	0	2	0	2	2
CD Semi-basal	0	0	0	12	0	12	12
DD Summer basal	0	0	0	26	4	30	26
ED Winter basal	0	2	0	4	2	8	6
FD Broadcast (Ammonium Sulfamate)	0	0	0	2	2	4	2
	. . . Number of Living Plants Per Acre Under 3 Feet in Height . . .						
Single Sprays							
A Unsprayed	112	660	480	614	4,652	6,518	1,866
B Broadcast (D + T)	130	88	36	96	536	886	350
C Semi-basal	94	26	66	134	1,084	1,404	320
D Summer basal	162	128	192	718	7,052	8,252	1,200
E Winter basal	156	458	710	430	15,124	16,878	1,754
F Broadcast (Ammonium Sulfamate)	52	56	278	258	1,316	1,960	644
Sprays with Follow-up Basals							
BD Broadcast (D + T)	60	16	16	78	906	1,076	170
CD Semi-basal	38	28	64	88	552	770	218
DD Summer basal	62	78	126	540	1,010	1,816	806
ED Winter basal	48	152	92	72	1,252	1,616	364
FD Broadcast (Ammonium Sulfamate)	70	48	88	180	1,132	1,518	386

After seven years of growth, a shrub layer edge effect is beginning to develop along either side of the right-of-way on the winter basal spray plots. This is a result of the peculiar method of herbicide application at the time of treatment. By this method, the low-growing woody shrubs; such as scrub oak and witch hazel, were left unsprayed on a 30-foot strip along each side, while all woody brush in the center of the right-of-way under the wires was sprayed. The theoretical resulting profile is then tree layer, shrub layer and ground layer forming a U-shaped right-of-way. Further studies will be conducted to determine the effect of this border on wildlife food and cover.

Unsprayed control plots, on which the unwanted brush was to be handcut as needed, were used in the test as a comparison with the five chemical treatments. Following creation of the right-of-way in 1951-52 and initiation of the test in 1953, the vegetation on these plots was left undisturbed. By 1957, the tree species present had attained a height of 6 to 15 feet and at this time threatened to interfere with transmission line operation and maintenance.

In April 1958, all woody brush on the control plots was handcut. The resultant slash was piled near the edge of the right-of-way and burned when weather conditions permitted. During the ensuing growing seasons (1958 and 1959) the brush on these plots made a quick comeback to form a dense layer on the right-of-way 2 to 6 feet tall. It is evident that this cycle will have to be repeated every four to six years.

A summary of initial chemical treatments with follow-up summer basal sprays and handcutting operations is given in table 2.

Table 2. Summary of initial chemical treatments with follow-up sprays and handcutting operation applied on the power line right-of-way.

Treatment	Total Acreage Treated	Average gallons per acre	Average man hours per acre	Aver. brush saw hours per acre	Average truck hrs. per acre
A Unsprayed (handcut once)	8.60	---	39.45	9.39	8.40
B Broadcast (D + T)	8.43	460	7.23	--	2.41
BD Follow-up basal	3.48	48	5.20	--	1.30
C Semi-basal	10.08	345	7.11	--	2.37
CD Follow-up basal	4.06	20	3.26	--	.81
D Summer basal	9.82	140	11.61	--	3.87
DD Follow-up basal	4.15	21	3.13	--	.78
E Winter basal	10.05	137	16.90	--	3.30
ED Follow-up basal	4.47	138	19.91	--	4.75
F Broadcast (ammonium sulfamate)	12.65	415	7.05	--	2.35
FD Follow-up basal	4.25	40	4.33	--	1.08

Floristic Changes In The Ground Layer

In addition to the effect of various treatment techniques in controlling undesirable woody brush, which is the major objective of vegetation management on utility rights-of-way, they may also have an effect on plants existing in the ground layer. By ground layer is meant the low vegetative cover, usually under two-feet in height, which is composed of annual and perennial herbs, grasses, and low-growing woody shrubs. A consideration of the effect of chemical sprays on these plants is important from the standpoint of aesthetic appearance, wildlife habitat, and resistance of the plant community to future invasion by tree species.

On the right-of-way test area, a dense layer covering 73 to 87 percent of the ground surface had developed by 1953, 1-1/2 years after the forest cover was removed. This layer was composed predominantly of bracken fern, vernal sedge, mixed woodland herbs and grasses, and the common shrubs blueberry, huckleberry, and deerberry. (Table 3).

Table 3. Dominant species of the ground layer.

Bracken:
- Bracken fern (*Pteridium aquilinum*)

Sedge-Grass:
- Vernal Sedge (*Carex pensylvanica*)
- Broad-leaved Panic-grass (*Panicum latifolium*)
- Changeable Panic-grass (*Panicum commutatum*)
- Upland Bent (*Agrostis perennans*)
- Harsh-leaved Mountain Rice (*Oryzopsis asperifolia*)
- Meadow fescue (*Festuca elatior*)

Mixed Herb:
- Fireweed (*Erechtites hieracifolia*)
- Loosestrife (*Lysimachia quadrifolia*)
- Barrens Violet (*Viola fimbriatula*)
- Goldenrod (*Solidago spp.*)
- Cinquefoil (*Potentilla canadensis*)
- Pearly Everlasting (*Anaphalis margaritacea*)
- Sheep Sorrel (*Rumex Acetosella*)

Woody Shrub:
- Low Blueberry (*Vaccinium vacillans*)
- Low Blueberry (*Vaccinium angustifolium*)
- Deerberry (*Vaccinium stamineum*)
- Huckleberry (*Gaylussacia baccata*)
- Sweetfern (*Comptonia peregrina*)

Following chemical treatment in June 1953 (January 1954 for the winter basal), definite changes were observed in cover value and floristic composition of the ground layer in relation to type of spray applied. Characteristic differences recorded over the 7-year period, 1953 to 1959, are summarized for each treatment as follows:

A - Unsprayed, Brush Handcut in April 1958:

Vegetation comprising the ground layer on these plots fluctuated very little during the 7-year period. A dense compact Bracken-Sedge-Mixed Herb-Woody Shrub Community has persisted and in 1959 covered approximately 93 percent of the surface area. The only disturbance to this ground cover occurred with the burning of slash piles, which followed cutting of the woody brush in 1958. On these restricted areas, about 15 feet in diameter and 25 to 50 feet apart along each side of the right-of-way, all vegetation was killed. These spots were invaded in 1958 by fireweed which was still prominent in 1959.

B - Broadcast Foliage 2,4-D + 2,4,5-T:

Within two weeks following this treatment, a complete brown strip was evident on the right-of-way. Plants of the ground layer were severely affected, reducing their cover value to 10 percent. By August 1954 the ground cover had increased from 10 to 79 percent and consisted predominantly of a Sedge-Grass Community with some fireweed and bracken fern. Most of the woody shrubs in this layer, such as blueberries and huckleberries had been eliminated by the spray. Bracken fern remaining on these plots made a slow steady comeback and by 1959 had again become a major component. The plant composition is gradually returning to the original Bracken-Sedge-Grass-Mixed Herb Community with blueberries present but of small cover value. The woody shrub sweetfern is also invading and is expected to be a major component in the future.

C - Semi-basal:

The semi-basal technique was somewhat more selective in removing woody brush than the broadcast foliage treatments and therefore resulted in less disturbance to ground layer plants. In August 1953, after spraying, sufficient vegetation was left to cover 25 percent of the surface as compared to only 10 percent following the broadcast sprays. By August 1954, the cover had increased from 25 to 95 percent. A temporary plant community consisting of Fireweed-Bracken-Sedge-Grass had developed and was prominent for three years. With the disappearance of fireweed; bracken fern, sedge, and the herb loosestrife encroached on the vacated area. These species increased in density and by August 1959 formed a compact layer covering 98 percent of the surface. A Bracken-Sedge-Loosestrife Community with scattered blueberries now dominates the area.

D - Summer Basal:

The summer basal spray, which was highly selective in removing unwanted brush, resulted in a minimum disturbance of ground layer vegetation. The only kill of ground layer plants occurred in the immediate vicinity of sprayed sprout clumps. The original plant community of Bracken-Sedge-Mixed Herb-Woody Shrub has been maintained as a tight compact cover throughout the study. The one major change that occurred was an increase in abundance of the herb loosestrife, which in 1959 dominated the mixed herbs category.

E - Winter Basal:

The winter basal, as with the summer basal, was extremely selective, removing the woody brush layer while retaining a dense ground cover. Again, the original plant community was maintained. The only change evident in 1959 was a notable increase in loosestrife.

F - Broadcast Ammonium Sulfamate:

The broadcast ammonium sulfamate treatment, like the broadcast D + T, was non-selective in its application resulting in a 90 percent topkill of the ground layer vegetation. These denuded areas were quickly invaded by fireweed to form an almost pure Fireweed Community covering 71 percent of the surface in 1954. By 1957, cover on these areas had increased to 95 percent with Bracken-Sedge-Loosestrife dominant in the ground layer. Fireweed, which was the leading component for three years, had decreased in abundance and at this time existed only in small patches. Two years later in 1959, the trend to return to a facsimile of the original plant community of Bracken-Sedge-Mixed Herb-Woody Shrub was expressed. The major differences, however, were the pronounced dominance of loosestrife in the mixed herb category and sweetfern in the woody shrub category replacing blueberries and huckleberries which were practically eliminated by the spray.

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NEW HAMPSHIRE RAGWEED CONTROL

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The Bureau of Occupational Health, New Hampshire Department of Health, inaugurated a hayfever study on conditions throughout the state in 1947 and continued this study up through 1954. This study was undertaken to determine existing conditions relative to the occurrence and extent of growth of plants which cause hayfever and the resulting density of pollen in the atmosphere. Studies also included ecological, geological and climatological conditions affecting the growth of hayfever plants. The Bureau felt that results of such a study could provide the basis for control of the various plants inducing hayfever in the state.

During the course of the study, pollen collecting stations were placed at 47 locations for periods of from one to six years. These locations were planned to present a zonal or regional picture rather than that of a specific locality. This collection pattern located stations not more than 25 miles apart and made available excellent data on which to map ragweed pollen occurrence and to indicate to ragweed-hayfever sufferers where they might go to receive relief from ragweed pollen.

The work was done in collaboration with the Pollen Survey Committee, Council on Aero-allergens of the American Academy of Allergy. Pollen collection equipment was that developed by Dr. O. C. Durham, and methods and techniques of the Committee were followed without deviation. Pollen counts were all made by the same person, who had the biological background and experience to identify the offending allergens. In addition, sample slides were sent to Dr. Durham to check the counts made by the New Hampshire Bureau. Pollen counts as they were found were also sent to Dr. Durham, who computed the average pollen index for the Bureau to release to the public and in the preparation of its various folders which were issued on "Ragweed Free Areas in New Hampshire."

The Bureau published the description and discussion of its work in two booklets, one in 1947 and one in 1948. After that, results were published in inexpensive folders which are more suitable and better served a larger group of people. The last folder was published in April, 1955, and included work through the 1954 growing season. These folders were sent on request to people writing for information and the demand was continuous during the vacation season, beginning as early as March or April.

After the 1954 ragweed season, it was found necessary to discontinue the pollen count survey program. This Bureau has a small staff and is charged with industrial health in all industries in the state, logging and migratory labor camps, radiological work and Civil Defense on the nuclear weapons. Funds were curtailed for travel and the money necessary for the publication of the folders.

The pollens of the ragweeds only were identified on the slides, except for the year 1948, when studies ran from March 15 to October 15. Since authorities estimate that 85 to 90 percent of all hayfever is caused by ragweed, it was not considered feasible to continue season-long study of all of the pollens. The giant or tall ragweed (Ambrosia trifida) has not been found in New Hampshire, so the conclusions of the study were based on common or short ragweed (Ambrosia elatior).

The evidence of the actual airborne pollen as measured at the collection stations was supplemented by reconnaissance survey of the entire state to determine the stand of ragweed in the various areas. Growth density was evaluated as observed along highways, in vacant lots, cultivated fields and the waste areas in cities and towns. The density was estimated and classified in four categories from "Negative" to "Heavy." Actual measurement of stand density was not made, results being based entirely upon visual estimates. Estimates were made by the same observer who counted the pollens. Density growth categories were arbitrarily established according to maximum growths as found in New Hampshire, and will not parallel results in other states where ragweed growths are more extensive.

Ragweed growths were not found in any instances to exceed 1/10 of an acre and these were rare. Areas classified as "Heavy" consisted of a one or two-foot width of ragweed growth on the road shoulder, running continuously along highways and along town or city streets. Ragweed attained its heaviest growths in centers of the larger cities and towns. Many resorts and hotels in an otherwise ragweed-free area had the plant growing beside buildings and throughout the service areas. Therefore, the problem of ragweed control was greatly simplified and required only a small amount of effort to achieve almost complete elimination of the plants. Pollen collection stations and reconnaissance surveys indicated that ragweed had a probable habitat in New Hampshire of less than 2 percent of the state's area. A large percentage of this area is at an altitude in which ragweed does not appear to grow and 85 percent of the state is timberland, where ragweed does not grow. The study also indicated that the ragweed growths occurring in New Hampshire were generally strictly local and that airborne pollens carried any distance seemed to have a small part in the problem. Ragweed growths rarely seemed to affect other areas at a distance of more than a mile. Therefore, the ragweed growths along highways, sidewalks, and other areas released pollens into the air in the breathing zone of the individuals immediately adjacent to them.

Due to the fact that ragweed hayfever was a strictly local problem, the Bureau adopted a selective herbicide spray control program using 2,4-D, and proceeded to contact the towns in the state to convince them that a control program was feasible. These herbicides were selected as being the most efficient and inexpensive for use on large areas.

The Bureau was successful in having a ragweed control program adopted by the various townships in much of the upper half of the state. In addition, several Division engineers of the Public Works and Highways Department put on a control program along the main roads. This was pioneered in 1949 by a Division engineer in the northern part of the state, who put in an experimental control area of approximately 100 miles of highway. By using local or State highway personnel and equipment already available to these agencies, as fire tank trucks or forest fire backpack pumps, to spray the solutions, it was felt that good coverage could be obtained at the lowest possible costs. A program with a large spray truck and crews put on by the State, working out of Concord and covering the entire state, would entail the costs of rooms, meals, transportation, etc., whereas the local communities could do this without these additional costs. Schools were put on throughout these areas by selecting a key town and having highway personnel from the surrounding towns come to this area for a training session. This method was very effective and resulted in good control in the areas which adopted the program.

This type of control program has been both effective and inexpensive; one of the larger communities in the state reduced its pollen index figure from more than 16 in 1948 to less than 1 in 1953. Several communities continued this program for five years and an examination of the attached table will indicate some dramatic results in the reduction of pollen counts. This was done by a continuous effort with fairly good coverage of area and at a cost of less than $2.00 per mile of street or highway control. In fact, the average per mile for eight municipalities in New Hampshire during 1953 was approximately $2.00 per mile to control both sides of the city streets, with the result of lowering the ragweed pollen index.

Due to the necessity of economizing on the State government level, funds were not made available after the 1954 season to continue this ragweed control work. Pollen counts, reconnaissance surveys, and contacts with the communities were discontinued. A few of the communities continued the spray program for another year or two and then stopped, with the exception of one community which has long been known as a haven for hayfever sufferers.

It was found during the period of time when the communities were being urged to spray-control ragweed, that letters and publications to the town authorities had little effect, as they were mostly selectmen receiving small salaries and spending long hours on town affairs. A visit to the typical selectman's office revealed piles of documents and letters from various State and Federal agencies, most of which had been opened and put down with only a cursory inspection, with the sincere intention of spending some time in a thorough examination of all this literature, which time never seems to come. Therefore, the only effective method of having this spray control continued was an actual personal contact with the town authorities previous to the Town Meeting time, which is in March. These town authorities were found to be cooperative and amenable to suggestion and very willing to spray for the control of ragweed if they had been properly contacted in the time indicated. However, lack of this approach resulted in the complete discontinuance of the program in all except the noted community, which has been for a great many years vitally interested in the control of these weeds causing hayfever. Many other communities in the upper third of the state achieved spectacular control with a very inexpensive spray program and could continue to do so in the future with the proper approach.

A reconnaissance type survey made this fall during the course of other duties, particularly in the northern section of the state, indicated that ragweed growths as found at the initiation of this program in 1947 had reappeared along the highways and in many locations where they had been found previous to that time. In fact, in many areas, these growths had increased from light to heavy. The Dixville Notch area is a case in point; in 1947, only occasional ragweed plants were found along the highways in this area. The control program by the State Highway Department and by the communities reduced the ragweed population to the point where it was unusual to see a plant. These growths have now increased to the typical one- to two-foot width along both sides of the highway until one gets into the Notch proper and into the forested areas. Various highways through the White Mountain recreation areas are also supporting heavy growths of ragweed along both sides of the road. These growths of course are in the location where the visitor and resident has them readily available to his breathing zone to induce hayfever from the pollens. This is occurring even though there are thousands of acres on either side of the road in the forested and wilderness areas in which no ragweed occurs and the areas could afford complete relief with a small amount of effort.

NEW HAMPSHIRE RAGWEED POLLEN INCIDENCE

Indices tabulated to indicate annual occurrence trends. Calculated by Dr. O. C. Durham, Chairman, Pollen Survey Committee, Council on Aero Allergens, American Academy of Allergy, January, 1955.

Location	1947	1948	1949	1950	1952	1953	1954
Bath	-	2.56	2.38	- *	-	-	-
Berlin	5.87	16.26	6.76*	- *	- *	0.87*	2.0*
Bethlehem	-	-	4.51*	- *	- *	- *	-
Blue Job	-	-	-	-	-	-	2.0
Carroll	0.18	0.67	0.41	0.21*	0.92	1.68	-
Charlestown	-	0.07	17.55	-	-	-	-
Claremont	-	-	-	-	-	7.08*	5.0*
Colebrook	0.18	1.68	0.52*	0.00*	-	3.01	-
Concord	5.25	4.58	9.41	10.52	-	-	-
Conway	1.41	5.21	5.03	0.51*	2.85	2.56*	0.23*
Crotched Mt.	-	-	-	-	-	-	5.0
Derry	-	-	-	-	-	-	2.0
Dixville	-	-	2.99*	- *	-	-	-
Dover	-	-	-	-	-	4.32	5.0
Errol	-	0.41	0.78	0.00*	-	-	-
Exeter	7.05	38.72	9.96	-	-	-	-
Federal Hill	-	-	-	-	-	-	7.0
Franklin	-	-	-	5.28*	-	-	-
Groveton	-	1.93	3.69	- *	-	-	-
Hampton	-	-	-	-	-	9.92	10.0
Hillsboro	-	4.45	4.87	-	-	-	-
Hinsdale	-	6.12	15.49	-	-	-	-
Holderness	-	-	4.62	- *	-	-	-
Jeremy Hill	-	-	-	-	-	-	17.0
Keene	4.82	10.19	9.37	5.15*	-	-	-
Laconia	-	17.30	2.56*	0.43*	6.46	2.46*	2.2*
Lancaster	-	- *	0.75*	- *	- *	- *	-
Lebanon	-	31.72	16.36	-	-	-	-
Lincoln	-	3.44	2.60*	0.16*	-	-	-
Littleton	-	-	0.65*	- *	-	-	0.53*
Manchester	-	9.52	13.24	4.40*	- *	7.97*	5.83*
Mt. Moosilaukee (Ravin Camp)	-	--	0.45	-	-	-	-
Nashua	-	33.38	41.26	30.95	-	-	-
New Ipswich	-	6.13	11.41	-	-	-	-
New London	0.00	2.21	12.78	0.47*	-	-	-
Ossipee	-	1.85	4.18	-	-	-	-
Pawtuckaway	-	-	-	-	-	-	0.56
Peterboro	-	-	-	-	36.15	14.99	-
Pittsburg	-	0.61	4.27	0.16*	-	-	-
Plymouth	-	4.43	-	- *	-	-	-
Rochester	-	19.31	14.73	-	-	-	-
Rye	-	13.16	15.88	14.89	-	-	-
Warren	0.42	2.15	2.54	- *	1.93	3.20	-
Weirs	-	-	9.35*	- *	-	-	-

WEED CONTROL POLICY IN CONNECTICUT

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for presentation at
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The definition of the word policy as used in the title of this paper would seem to be "a settled course adopted and followed" in the control of weeds. Weed, in this instance would properly be called "a useless or troublesome plant" that occurs in areas that causes injury to another plant or is detrimental to the health, welfare, and/or aesthetic environment where it exists. Control is undoubtedly the method by which the weed is either eradicated or checked.

In the formulation of a policy numerous items must be taken into consideration. The legislation that is existent in the statutes, the objectives that are to be realized, and the methods that can be followed that will safely and satisfactorily cope with the situation so that the objectives can be achieved.

In the preparation of this paper investigation was made of the legislation that is now in our statutes. From the national picture, there is Public Law 518 (the Miller Amendment) that controls the use of chemical weed killers on food crops that is administered by the U. S. Pure Food and Drug Administration. (You are all familiar with this in the recent "cranberry crisis"). The only laws in the State of Connecticut dealing with weeds is that contained in Chapter 141 sections 3094 to 3098, inclusive, dealing with the control of weed seed found in vegetable and lawn grass seed sold for agriculture and produced for consumer use. This is administered by the Connecticut Commissioner of Agruculture. (The thoughts behind this legislation being that prevention is the cheapest, most effective method of control and there are no substitutes for weed-free seed).

Legislation on the local level is existent in some communities throughout the state, similar to that found in the ordinances of the City of Hartford. Section 10-24 of the Hartford City Code reads as follows:

"It shall be unlawful for any person to allow grass to grow more than one foot in height, unless such grass is to be harvested as hay, or to allow any weeds or similar growth to grow more than one foot in height, or to allow any weed or other plant which may, in the opinion of the director of health, cause hay fever or similar diseases to grow or to allow any wild and untrimmed bushes to grow or remain on any land fronting on a macadamized or paved street in the city, or on any interior lot bounded on three or more sides by land fronting on any such street." Section 10-25 concerns Poison Ivy and Poison Sumac which is as follows:

"It shall be unlawful to allow any poison ivy or poison sumac to grow or remain on any premises in the city within twenty-five feet of a street line or to grow or remain within twenty-five feet of adjoining property, except with the written consent of the owner of such adjoining property."

These two ordinances, which are similar to those on the books in a few other communities, are the only laws that were found dealing with mandatory control of weeds from the health aspect. Undoubtedly there may be and, perhaps there should be, more in the future.

The Connecticut State Board of Fisheries and Game has a policy and suggested methods for the control of "Water Weeds" and suggested methods of "Vegetation Management" on public utility rights of way. The Connecticut Department of Aeronautics together with the Connecticut Agriculture Experiment Station, the State Board of Fisheries and Game, and the State Department of Health, control the aerial application of insecticides, fungicides, herbicides and fertilizers under Sections 245-3-1 through Section 245-3-12.

Also the State Health Department has the control of the chemicals used in or adjacent to public water supplies.

So much for the legislative angle which now seems rather meager in this day and age.

The Connecticut State Highway Department has for many years realized that there is an obligation on its part to do something in the control of weeds. This department probably has more land under its jurisdiction than any other agency - certainly more people come in contact with the highways and their environs in each of their daily lives than with any other locale.

The obligations on the part of this agency may be briefly summarized as follows:

1. Protection of the health of employees acting as public servants.

2. Protection of the health, safety, and welfare of the highway user, abutting owner, and taxpayer.

3. Effecting economies in operations.

4. Improving the aesthetics by the elimination of the obnoxious.

Continued research goes into our program of weed and brush control so that we may attempt to do the most good for the greatest number at the lowest possible cost for the benefit of the safety, health, and welfare of our people.

Our program and policy of weed control had its origin in the health aspects of our faithful employees. There was too much lost time, pain and suffering among our men as a result of contact with poison ivy and poison sumac. With the advent of effective, selective, chemical tooks, an eradication program was instituted and now, combined with inoculations, rare indeed is the lost day from poison ivy. And too, the abutting property owner and highway user has much to be thankful for because of the program to eradicate toxic plant materials.

Ragweed is another prevalent weed (both the regular and the giant type) that grows in the disturbed soil along the edges of our highways. Not only does it produce pollen that is detrimental to the health of many thousands of our people, but if left to flourish it impedes sight-lines, blocks drainage channels, creates a fire hazard, and it presents an ugly, unkempt appearance. You all know of the difficult, costly, mowing operation to keep it in check. Now, with a few drops of chemical, inexpensively and easily applied at the right time, this health menace can be easily controlled. "What a boom are these chemicals that have been developed for our use!"

Our highway policy and program, however, does not stop with these two problems. It consists of numerous other uses of these chemicals in the vegetative maintenance operations.

The entire program is briefly outlined as follows:

1. Control of weeds on intensively mowed areas (medians, interchanges, etc.) for the better development of turf cover.

2. Roadside application to eliminate early herbaceous weeds.

3. Seasonal removal of grass and weeds under guide rails at the base of signs, delineators, etc.

4. Eradication of poison ivy and poison sumac.

5. Control of ragweed and other annual weeds.

6. Late summer application on brush regrowth.

7. Basal spray on cut brush.

8. Soil sterilization under guide rails with a bitumen cap.

9. Special treatment on difficult to kill species harmful to agriculture and a detrimental nuisance in maintenance operations. (Japanese bamboo and milkweed are examples).

Not a part of the overall 1959 program but it will probably be in 1960 as the result of research, is the selective application of chemicals in functional plantings and the use of pre-emergence sprays in such areas.

With more and more success in our work with growth inhibitors, continued research in this field will go forward with emphasis.

But what about the policy on the part of the many thousands of miles of town highways not directly under the jurisdiction of the department.

1. Education is the first step and our Connecticut Agricultural Experiment Station has issued an excellent bulletin for this purpose.

2. Our headquarters and district offices are always willing and eager to lend a hand.

3. Funds for the materials and application costs can be used from State allotments if the town so elects.

4. Specifications have been written and contracts let for the application of chemicals to control weeds and brush. This program is administered by the Town Aid Agent in our headquarters.

Now you may ask what about the use of herbicides in connection with public utility maintenance along our highway rights of way. A definite policy has been established that is on a permit system. In other words, this policy prescribes the use of chemical tools for the benefit of the utility companies (and in turn the consumer) without creating an unsightly condition along our highways.

It is also our concern in the formulation of our policy and the execution of the program that consideration be given the naturalists, the botanists, the garden clubs, and the many people who appreciate the natural flora of our countryside. The greatest use of our highways is for recreation and it is essential that the traveler have a pleasing outlook. Therefore, it is our policy to effect weed control as selectively as possible to enhance the roadsides rather than brown it during the growing season.

It is very disturbing to travel along a highway and observe our valuable and beautiful flora needlessly damaged or destroyed by the indiscriminate application of chemicals.

To summarize, the weed control policy in Connecticut is based on the health of our people, the economy of operations and the beauty of our countryside with the judicious and selective use of agricultural chemicals.

VEGETATION CONTROL ON NAVAL FACILITIES SERVED BY THE AREA PUBLIC WORKS OFFICE, NEW YORK

By

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INTRODUCTION

The Area Public Works Office, New York, has responsibilities, specified by the Navy Department through the Bureau of Yards and Docks, for planning, design, construction and maintenance on naval activities in a defined territory, which includes New York State, Northern New Jersey, Connecticut, Newfoundland, Iceland, Bermuda and the Azores. In this area, there are about 60 naval activities with land holdings of approximately 30,000 acres where vegetation control, in varying degrees, is a part of maintenance operations.

On some of the small activities, the problems, naturally, are minor, but on naval stations with a large acreage, vegetative control is of major importance. An example is the 11,000 acre Naval Ammunition Depot at Earle, New Jersey, which has 100 acres of ammunition magazines and barricades, 89 miles of roadway, 126 miles of railroad track, 50 miles of utility right of way, 373 miles of drainage ditches, and 58 miles of perimeter fence.

In this paper, these and other situations will be discussed to point up the place of vegetation control on naval land. The comments deal primarily with the nature of the problems. Detailed information on herbicidal treatments will not be emphasized because in most cases standard recommendations are used. Where treatments are mentioned, the purpose is to reaffirm the adequacy of the commonly accepted practices or to indicate a slight variation to meet special requirements on naval land.

There are at least six reasons for vegetation control on naval land: (1) for appearance and general upkeep, (2) for security reasons, (3) for fire protection, (4) as a safety measure, (5) for public health, and (6) to maintain good communications. These will be briefly discussed:

PUBLIC HEALTH ASPECTS OF VEGETATION CONTROL

Many weed control measures benefit Public Health. One that has a particular relation is the control of phragmites in swamp areas and drainage ditches. Opening up these areas and improving drainage definitely aids in mosquito control. Good results in control of this weed have been obtained with dalapon applied at the rate of 20 to 25 gallons per 100 gallons of water, thoroughly wetting the foliage. About 40 to 50 pounds of material is required per acre. A particular problem in one area was to establish a low growing grass shortly after the eradication of phragmites. The point in question was how long a waiting period is required for the dalapon to lose its temporary soil sterilization effect. A delay in seeding of six weeks following the application of dalopon was found to be adequate and a good stand of grass resulted.

Poisonous plants, principally poison ivy, are a problem to some extent. This has been successfully controlled with amino triazol. Another plant, not so well known, is wild parsnip (pastinaca sativa), which is a biannual weed. One activity recently reported severe skin irritation to workmen from this weed. Upon checking, it was found that poisoning resulted from hand pulling of this weed from plant beds of a housing area. Applications of 2-4D, which will control this weed, could not be used because it would damage other desirable plants. Trial use of pre-emergent materials such as CIPC, Neburon or Simazin have been suggested as a control measure for this situation next year.

A variation in treating a lake with copper sulfate was of interest. In the bathing area, copper sulfate was applied to control algae and microscopic plant life. The remainder of the lake was left untreated. In this part of the lake, plant life remained and provided food for fish so that the lake served two purposes. Technicians doing this work thus recognized that the requirements for swimming and fishing are not exactly the same.

In another lake, which is a potable water supply, the submerged weed Potamogeton is a problem. So far, no one has been willing to recommend a herbicide to control it for fear of contaminating the water supply. The present plan is to drain the lake, deepen it, and at the same time, remove the weed growth.

WEED CONTROL FOR APPEARANCE AND GENERAL UPKEEP

Naval activities have a considerable amount of improved grounds. Attempts to secure weedless turf are costly and generally not warranted. The use of herbicides is not recommended except where the quality of the existing cover is greatly affected by weed growth. Instead, emphasis is given to good turf management by timely, proper fertilization, correct mowing heights (usually 2 to 2½ inches), and grub proofing. These measures consistently carried out, year after year, greatly minimize the weed and crab grass problem.

A question frequently asked is how to keep grass from growing? Such a herbicide, when perfected for use on lawn areas, should result in substantial savings in mowing improved areas. This is really our biggest vegetative control problem.

Personnel on activities are rapidly learning the labor-saving benefits from using herbicides to eradicate vegetation in parking areas, along curbs, building foundations, guard rails and other hard-to-mow areas. Various materials have been tried but granular soil sterilants are preferred because of their ease of application.

On roadways, spray applications of 2-4D have been used to improve appearance, and cut down on the number of mowings required. It also reduces pollen bearing weeds such as rag weed and golden rod. This phase of weed control has no unusual aspects except to emphasize the importance of periodic, consistent programming of applications. If neglected for only a year or two, woody growth quickly comes in, the eradication of which is much more expensive than the annual control measures would have been.

The control of vegetation on railroad tracks is practiced on several activities. Diuron, Simazin, and Sodium Arsenite have all been used effectively. The only failure was the application of diuron when applied in mid July during a dry year. This experience emphasized the importance of early spring applications. In fact, to even out the labor load, late fall applications of soil sterilants are now being used on one activity.

Personnel on the activity where sodium arsenite is used have had training in the application of pesticides and understand the proper handling of this type of material. Sodium arsenite has not been recommended, however, for any situation where there is the remotest possibility that livestock or wild life such as deer, will eat the treated grass. It is reported that animals have a particular craving for the salty taste of vegetation sprayed with this chemical.

In the treatment of railroad tracks, naval activities with small areas are programming applications annually, but where the amount is large such as the Naval Ammunition Depot at Earle, New Jersey, with 125 miles of track, treatment every third year is about all that funds and labor permit. Here it is preferred to apply a heavier application less frequently rather than a light application annually.

VEGETATION CONTROL FOR SECURITY

Most naval activities have a perimeter cyclone fence for security. It is necessary to keep this fence clear both to insure vision and to prevent rusting of the wires. Many activities have a perimeter road just inside the perimeter fence, that is patrolled. This road must be kept open.

In applying herbicides to control woody growth and weeds to these areas, special precautions are taken to avoid danger to adjacent vegetation, especially in agricultureal areas. In fact, one activity prefers to do brush cutting and herbicide applications during the non-growing seasons to eliminate the possibility of damage to crops. The usual practice in these cases is to cut the brush and treat stumps with 2 gallons of 2-4D and 2 gallons of 2-45T (4 lbs. acid equivalent low volatile ester), in 100 gallons of oil. Vine growth is similarly controlled. A particular problem developed in one instance where contract specifications required clearing a fence of vines and woody growth, and repainting it during the dormant period. Herbicidal treatment was required but the application of an oil spray on the vines, in advance of their removal, was objected to since it might affect the paint job. This made it necessary to prolong the contract time to the next growing season and apply a herbicide spray to the regrowth.

Soil sterilants also are used for vegetation control along security fences where ground cover is not needed for erosion control. For this purpose soil sterilants are needed that will not spread outside the area treated. Some activities are adopting the practice of treating only about two or three feet on each side of the fence. For this purpose, the use of granular soil sterilants is favored by workmen. This is easier to apply in areas not accessible to power spray equipment.

VEGETATION CONTROL FOR FIRE PROTECTION

Herbicides are an effective way of achieving control of vegetation that is a fire hazard. Examples are ammunition magazines and barricades, fuel tank areas, and isolated building sites not regularly maintained. On magazines, a maximum vegetative height of 12 to 18 inches is specified and woody shrub growth is not permissible. Spray applications of 2-4D to control weed growth is indicated as an effective way to reduce the amount of hand cutting required. Magazine slopes are too steep for machine mowing. In fact, where low growing grasses are seeded, such as creeping red fescue, the use of selective herbicides may eliminate grass cutting entirely.

Where the magazines are surrounded by woodland, tree seedlings sprout on the magazine slope and create a maintenance problem. Spray applications of systemic herbicides can control this brush but a more likely method to be tried where this brush now exists is to use spot treatments of the new granular brush killers such as fenuron. This is much easier to apply and more positive on hard to kill species.

Around ventilators of ammunition magazines, the vegetation must be kept low or eliminated. Here an area 5 feet in diameter is treated with a soil sterilant. Station personnel prefer the granular soil sterilants here also because of the ease of application.

Building sites, shipyard grounds, and similar areas create vegetation problems that are fire hazards. Where elimination of grass is permissible, the use of soil sterilants or spray applications of 2-4D and dalapon are an easy solution, but where it is not desired to kill the grass, maintenance mowings are about the only solution. This is another situation where a growth retardant would be very useful.

Tall vegetation around firebanks of fuel tank areas, (earthen dikes 3 feet or more in height), is undesirable and it must be controlled. However, complete eradication is not possible because of the resulting erosion to the dike. So far, there has been no good way of controlling vegetation for this situation except hand cutting. In some instances, the dikes are covered with slag to control erosion and soil sterilants are applied if vegetations come in.

VEGETATION CONTROL FOR SAFETY

On airfields, tall growing vegetation must not obscure the view of runways or taxiways from the control tower. The control of phragmites to insure proper vision, was a problem at Floyd Bennett Field. This has now been eradicated by spray applications of dalapon. Large areas of phragmites occurring in the outlying portions of airfields, also constitutes a safety hazard. If an aircraft crash lands into one of these areas, it would be very difficult to get to the areas with a crash truck through the dense vegetation and in addition when the vegetation is dry the fire hazard is greatly increased. Spray applications of dalapon have helped to somewhat reduce the amount of this growth.

Another safety problem on airfields is vegetation obscuring runway lights. Soil sterilization for one or two feet around the light has greatly simplified maintenance. Here again granular soil sterilants are preferred for this job by men at the activity levels.

VEGETATION CONTROL FOR COMMUNICATIONS

On radio stations, it is necessary that the height of vegetation be controlled. This varies with the type of antenna. In some cases, the growth must be maintained only a few inches high while on others it may be 2½ to 3 feet. Many of these areas are marshy and they will not support mowing equipment. The use of brush killers or soil sterilants to control vegetation for these conditions is indicated for future use on these situations.

SITUATIONS NOT APPLICABLE TO VEGETATION CONTROL

Sometimes the killing of brush is not the proper answer. This condition existed at Oswego, New York, at a Reserve Training Center on the banks of Lake Ontario. A heavy brush growth on a steep slope next to the building was a fire hazard. Brush eradication by soil sterilization was requested. However, removal of the brush may have created a land slide and a serious erosion problem endangering the building site. The solution recommended was to not use a soil sterilant, rather it was suggested that the brush be hand cut annually so that the roots, essential to soil stabilization, would not be killed.

VEGETATION CONTROL, A PART OF OVERALL LAND MANAGEMENT

The control of vegetation is only one phase of an overall program of land management on naval properties. On major activities land management plans are prepared in which recommendations are given for all aspects of land problems including erosion control, drainage, irrigation, woodland improvement, establishment, maintenance and control of vegetation and wildlife management. The areas where vegetation control is needed are indicated in the plan and specific measures for control are given together with rates of application. These herbicidal recommendations are based on the best known practices mainly those reported in the transactions of the Northeast Weed Control Society. The herbicide work done on naval activities is not one of experimentation for it is felt that agricultural experiment stations, and others specifically engaged in research, are in a better position to try out new materials. Rather, the work is practical application of research findings and results.

PROGRAMMING WEED CONTROL WORK

There was a time just a few years ago when the biggest problem in vegetation control was to find out what herbicides to use for a particular problem. However, thanks to the research work by public institutions and chemical companies and the dissemination of the information by this society, we have answers to most of our problems. This has enabled us to make specific recommendations to the activities.

Emphasis now is given to programming vegetative control measures so that the work will be timely and effective. Programming on naval activities requires considerable advance planning. It involves inspections to determine the areas where treatment is needed and their size; a decision of what control measure to use, an estimate of the cost, requesting funds, and when they are made available, job orders, requisitions for materials or preparation of contract specifications. All of this must be timed so that the applications will be made at the optimum season.

The carrying out of herbicide work is normally done by the naval activity. It may be done either with station forces or by contract, depending on the availability of station labor and equipment, proficiency of the local crew in herbicide work, and adequacy of funds. The Area Public Works Office acts in an advisory role. Two types of contracts have been used: those where the herbicides are specified, and those where the trectment is left up to the contractor but the results guaranteed. For naval contracts, experience indicates that better control is obtained where material and the treatment is specified.

In summary, it may be said that herbicides in vegetation control on naval properties, is becoming more widely practiced and better understood every year and its use extended as a labor-saving tool in the management and upkeep of grounds.

RAGWEED POLLEN SAMPLING IN NEW YORK STATE

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As defined in Article 12-A of the Public Health Law, pollen is defined as an air contaminant. In past years, pollen sampling was carried out within the state to define the areas that were relatively free. In 1958 and 1959, the sampling program was extended to include other areas of the state, for which there was no previous data. In 1959, the network consisted of 16 stations, operated by volunteer personnel, 13 of which reported the pollen counts on a daily basis. The data obtained was reported to a central point, and then released to the public information media. There was wide acceptance of this activity as indicated by the newspaper coverage and by the number of requests received, 161. In 1958, 42 were received.

In 1959, a sociological study was carried out in Erie County to determine attitudes towards air pollution. Of 943 people interviewed, 62 or 6.6% stated that they had been treated for hay fever, and 30 or 3.2% had been treated for asthma. These data, though limited to Erie County, indicate that the number of sufferers is high.

Successful Killing, But No Chemi-peeling, Using Certain Amines in Frills During Early Summer

Lawrence S. Hamilton (Cornell University)

In economy, effectiveness and speed of getting results, sodium arsenite has proved to be a potent weapon in the arsenal of dendrocides. For several years it has been used with singular success though on a limited scale in chemical debarking (3) (4). The use of arsenite has not proceeded at a rate commensurate with its dendrocidal qualities largely due to the attendant hazards. While this compound is toxic to animals in relatively small amounts, it is the author's contention that the hazards are vastly overrated. The danger to wildlife (10), risk of "backflash" (5) hazard to workers (1), and threat of insect build-ups (7) have been studied and found not to be serious deterrents if proper precautions and techniques are used. Evenso, the search for effective, less toxic dendrocides or chemi-peeling agents continues.

It was in the process of testing less toxic materials for chemi-peeling that the interesting results herein reported, were obtained. This work was undertaken following reports of successful aspen debarking using undiluted alkanolamine salt of 2,4-D (8) and the butoxy ethanol ester of 2,4,5-T (2).

Materials and Methods Employed

Five trees each of sugar maple, red maple, beech, and basswood and from three to five trees of yellow or black birch were treated by each of six different chemicals. The trees ranged in diameter from 3 to 12 inches d.b.h., with the majority between 3 to 6 inches. Treatments were made on June 21, 1957, applying a water solution of the chemicals to a complete waist-high frill using a pump-type oilcan. The chemicals used[1] and the concentrations follow:

3-amino 1,2,4-triazole (amino triazole) 20 pounds per 100 gallons water
Dimethyl amine salt of polychlorobenzoic acid (PB amine), 40 a.h.g.
Dimethyl amine salt of 2-methyl-4-chlorophenoxyacetic acid (MCP amine), 40 a.h.g.
Dimethyl amine of 2,4-dichlorophenoxyacetic acid (2,4-D amine), 40 a.h.g.
Triethyl amine of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T amine), 40 a.h.g.
Equal mixture of above amines of 2,4-D and 2,4,5-T, 53 a.h.g.

Probably extra care was taken to assure that the incisions in the frill overlapped because of past experience with "green streaks" in chemi-peeling. Inspections were made in September, 1958, and in September, 1959, 15 months and 27 months respectively following treatment.

1/ Chemicals used in these tests were supplied by Amchem Products, Inc., of Ambler, Pennsylvania.

Observations and Discussion

None of the treatments was effective in achieving chemical debarking. The rapid and complete top killing achieved by this early growing season treatment with certain of the chemicals however, was deemed worthy of reporting. The results of the 1958 and 1959 inspections are presented in Table I.

Table I

Results following June, 1957, chemical frilling using six chemicals in a water carrier.

Chemical*	September 24, 1958 Killed	Partially Killed	No Effect	September 23, 1959 Killed	Partially Killed	No Effect
	percent	percent	percent	percent	percent	percent
Amino triazole	19	16	65	29	29	42
PB amine	48	12	40	80	7.5	12.5
MCP amine	73	16	11	90	--	10
2,4-D amine	50	39	11	50	39	11
2,4,5-T amine	79	17	4	100	--	--
2,4-D plus 2,4,5-T amines	76	24	--	100	--	--

*Concentrations as follows: 40 a.h.g. for all except amino triazole (20 pounds salt per 100 gallons water) and 2,4-D plus 2,4,5-T amines (53 a.h.g.).

Fifteen months after treatment only 33 of the 144 trees exhibited no effect from the chemical frilling. Red maple represented almost half of these, with 15 trees remaining unaffected. This resistance has been pointed out in work by McQuilkin (9) for July chemical frills using both oil and water solutions of the butoxy ethanol esters of 2,4-D and 2,4,5-T. Sugar maple ranked second in slowness to show effects of chemi-frilling, a result which is also in agreement with McQuilkin's work. Basal or girdle sprouts had been produced by 44 percent of the affected trees, though rarely could these sprouts be classified as vigorous. At this point the treatment involving an equal mixture of amines of 2,4-D and 2,4,5-T appeared highly successful since all trees were seriously affected (76 percent completely top killed and 24 percent partly top killed). The 2,4,5-T amine treatment had also shown swift and promising results, since only 4 percent of the trees were not damaged.

Twenty seven months after treatment, complete kill had been achieved by the 2,4,5-T amine and the 2,4-D plus 2,4,5-T amines. At this juncture the MCP treatment also appears to have reasonable effectiveness, with the only holdouts being a red maple and a sugar maple. The sprouts had deteriocould not be considered a significant factor limiting the effectiveness of the chemicals. Deer browsing has undoubtedly helped in this respect.

The outstanding feature of the test herein reported is the rapidity of complete killing obtained with the dimethyl amines of 2,4,5-T, and 2,4-D plus 2,4,5-T. Westing (11) has also reported on rapid killing using 2,4-D amine. He used undiluted esters and amines of both 2,4-D and 2,4,5-T, and found that the 2,4-D alkanolamine salt was superior not only to the propylene glycol butyl ether esters of both 2,4-D and 2,4,5-T but also to the triethyl amine salt of 2,4,5-T. Gleason and Loomis (6) also report on the superiority of 2,4-D amine over both the 2,4,5-T amine and the esters of these chemicals in spaced cuts. In the present study which employed complete frills, June treatment, and water solutions of dimethyl amines, different results were obtained; namely the superior performance of 2,4,5-T over 2,4-D and the mixture of each (D-T) over 2,4-D alone. The MCP amine has also performed better than 2,4-D amine in this study.

The concentration of amine applications may be important in determining the rapidity of kill. McQuilkin (9) obtained better results in his amine treatments at 24 pound a.h.g. over the 8 pound a.h.g. level. Morrow at Cornell is testing dormant season application of 2,4-D amine and in a preliminary report[1/] reports rapid killing of white oak and hickory. He used a concentration of 100 a.h.g. In the present study concentrations of at least 40 a.h.g. were used.

Summary

This test was initiated to assess the effectiveness of six dendrocides in effecting chemical debarking. Only three trees out of 144 exhibited any degree of successful bark separation. While the number of trees treated by species, for each of the treatments is not large, it is felt that the rapid and complete kills attained with chemical frills using water solutions of the amines of 2,4,5-T and 2,4-D plus 2,4,5-T, merits their increased use for these species. It is also felt that on the basis of a high percentage kill using MCP amine, this compound warrants attention and further testing.

The reported superiority of 2,4-D amine over the amines of 2,4,5-T and MCP is not borne out in this study, although the season of treatment, amine salt used, concentration, and method of application were not all identical with previous tests. Apparently further testing of these variables is necessary before the most economically effective of these compounds can be identified with certainty. Meanwhile, for chemi-peeling in northern hardwoods, sodium arsenite is still without peer.

[1/] Report presented at New York Section meeting, Society of American Foresters, Ithaca, New York, September 1959.

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SPOT TREATMENT OF FENURON AND MONURON TO CONTROL GROUND JUNIPER

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The use of fenuron and monuron for controlling unwanted woody vegetation has been tested on a variety of species. Ground juniper (*Juniperus communis* L.) commonly found in the Northeast, is a weed species which frequently takes over recently abandoned pastures as a stage in plant succession. Growing space occupied by ground juniper varies with age of the plant, soil, climatic and other conditions, but single specimens have been noted in Hampshire County, Massachusetts, to exceed twenty feet in diameter in crown or foliage spread.

Because ground juniper is such a problem in many areas utilizing the soil surface that could otherwise be devoted to production of valuable tree species as well as grasses, it was decided to test the two chemicals mentioned for its specific control. A basic intent in conducting trials with fenuron and monuron on ground juniper was to provide examples of the results of different dosages and methods of application for landowners who wished to rid their properties of this species. These results could be cbserved at field demonstration type meetings by farmers or others who might want to reclaim land for pasture or the production of Christmas or timber type tree species.

Four farms were selected in widely separated sections of Hampshire County, Massachusetts, upon which to conduct this work. Three of the four areas were actively grazed. Soil types varied from dry, sandy loams to moist loams. Two of the test areas have run through two growing seasons and two through one growing season.

Chemical applications were measured as follows:

(1) by individual pellets, (2) by approximately level teaspoons for pellets and slurry. (Slurry was composed of equal parts by volume of wettable powder and water). (3) by squirts from a timber marking paint gun for slurry. (Approximately one teaspoon per squirt). Pellets were made to contain 25% fenuron (3-phenyl--1, 1-dimethylurea) and the slurry was composed of 70% fenuron wettable powder. Monuron slurry contained 80% monuron wettable powder, (3-(p-chlorophenyl)-1, 1-dimethylurea).

Applications in all instances were made within the root zone area of the plant and within one to three feet of the base of the trunk. When liquid chemical was applied as a one teaspoon or one squirt dose, each application was in one spot and always within a foot of the base of the trunk. When more than one teaspoon or squirt was applied per plant, applications were made at random as spot doses of one teaspoon, etc., but always within three feet of the base of the trunk.

A single teaspoon dose of pellets was always directed at the base of the trunk. When additional amounts of pellets were used, they were applied at random within three feet of the base of the trunk. No attempt was made to apply the chemicals directly on the soil, and in numerous instances, pellets or slurry hit a mat of leaves or other vegetation. An attempt was made to apply the chemicals as they would be applied in actual practice.

Numbered aluminum tags were fastened to each plant treated, and records kept as to chemical used, dosage, size of plant (height to top of crown and average diameter of crown), time of application and type of soil.

Acknowledgment is made at this time to those assisting in this project. Cooperating landowners are Messrs. Richard Tracy, Westhampton; Olaf Dyer, Middlefield; Frank Davis, Cummington, and Hubert Green, Belchertown. Associate County Agent (Hampshire County), Roger Harrington, and District Forester, Charles Orsi, Massachusetts Department of Natural Resources, assisted in the conduct of the field work while Mr. William I. Boyd of E.I. DuPont DeNemours Company made valuable suggestions for the conduct of the tests.

Results

Effectiveness of chemical application was noted as the per cent of foliage completely dead and per cent showing discoloration, based on ocular estimate. The noticeable yellowing or mottling of foliage of treated plants was indicative of chemical action and injury in the leaf tissues.

The following table shows per cent of individual plants dead or showing symptoms of injury after one and two growing seasons at different treatments for plants of varying sizes.

Forty-four (44) additional plants treated November 13, 1958, have gone through one growing season. These are in addition to those shown in the following table. Fenuron pellets were applied to 30 plants in amounts ranging from 1 to 18 teaspoons. The average kill or symptoms of injury to needles in these plants is 91%. Monuron slurry was applied to the remaining 14 plants in 4 to 12 teaspoon amounts with an average kill or symptoms of needle injury of 90%. Slightly higher dosages were used on these plants than those shown in the table. (See next page).

GROUND JUNIPERS WITH DEAD OR INJURED NEEDLES NOVEMBER 5, 1959
RESULTING FROM MAY 13, 1958, TREATMENTS
(Separate plants used for each treatment)

Treatment	Grams Active Chemical	Plant Size: Feet: Height	Plant Size: Feet: Crown Diam.	Plant Size: Cubic Units[x]	% of Foliage with Dead or Injured Needles: After 1 Growing Season	% of Foliage with Dead or Injured Needles: After 2 Growing Seasons
Fenuron Pellets						
3 pellets	--	1	1	1	75	85
4 "	--	2	2	8	0	0
6 "	--	3	2	12	80	100
1/4 teasp.	.28	3	5	75	50	50
1/2 "	.56	5	8	320	25	25
1/2 "	.56	3	6	108	20	60
2 "	2.26	8	10	800	40	70
2 "	2.26	4	10	400	50	80
3 "	3.39	4	8	256	95	100
4 "	4.52	3	8	192	100	100 xx
4 "	4.52	5	5	125	98	100 xx
4 "	4.52	4	8	256	90	100
6 "	6.78	4	10	400	100	100 xx
Fenuron Slurry						
1 squirt(s)	1.5	2	4	32	100	100 xx
2 "	3.0	3	5	75	85	100 xx
2 "	3.0	3	8	192	25	85
4 "	6.0	4	6	144	95	100 xx
4 "	6.0	4	5	100	45	80
4 "	6.0	4	18	1296	75	95
5 "	7.5	5	10	500	95	100
6 "	9.0	2	4	32	100	100 xx
1/2 teasp.	.8	3	4	48	80	100
1 1/2 "	2.3	5	5	125	45	90
4 "	6.0	3	5	75	100	100 xx
4 "	6.0	2	4	32	100	100 xx
Monuron Slurry						
1/2 teasp.	.8	3	2	12	90	100 xx
1/2 "	.8	2	4	32	100	100 xx
1 1/2 "	2.3	3	6	108	40	100
4 "	6.0	5	5	125	95	100 xx
4 "	6.0	6	4	96	85	100
8 "	12.0	5	6	180	100	100 xx

x Height times crown diameter squared
xx 100% dead

Conclusions

An insufficient number of tests were conducted to cover all the variables of soil conditions, sizes of plants and chemical applications. Replications were not set up as a detailed experiment was not contemplated. Certain conclusions are made, however, from the data gathered.

(1) No appreciable difference was noted between moist and dry sites as to per cent of plants dead or showing injury after either the first or second growing seasons following treatment.

(2) A minimum of approximately three (3) grams--three (3) teaspoons--of fenuron pellets per plant produced relatively high kill or symptoms of injury two growing seasons following treatment.

(3) Fenuron slurry produced a high degree of kill or injury after two growing seasons when applied in one-half (1/2) to six (6) teaspoon amounts per plant. (.8 grams to 9.0 grams).

(4) Monuron slurry produced a high degree of kill or injury after two growing seasons when applied in one-half (1/2) to eight (8) teaspoon amounts per plant. (.8 grams to 9.0 grams).

(5) Per cent of plant killed or showing symptoms of injury seems to have little relation to plant size when dosages are applied above the minima mentioned above.

(6) Complete kills have not occurred to date with less than four (4) teaspoons of fenuron pellets, one (1) teaspoon of fenuron slurry or one-half (1/2) teaspoons of monuron slurry per plant.

(7) Of the 13 plants completely dead at the end of two growing seasons, 5 of them were dead at the end of the first season. Of the 26 plants still alive at the end of the first growing season, only 3, all treated with low dosages, failed to show additional injury the second year.

(8) The November 13, 1958, treatment with fenuron pellets resulted in 33% complete kill while the May 13, 1958, treatment with fenuron pellets resulted in 15% complete kill at the end of one growing season. These percentages are based on 16 and 13 plants, respectively, which were treated with six or fewer teaspoons of pellets per plant.

(9) Ground juniper plants of the sizes shown in the table were completely killed by the end of two growing seasons for approximately \$.05 to \$.10 per plant based on present costs of fenuron pellets.

(10) The three methods of treatment are easily accomplished except that slurry must be agitated constantly to keep it in suspension.

TECHNIQUES INVOLVED IN THE USE OF CHEMICALS FOR ESTABLISHING WILDLIFE CLEARINGS[1]

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Wildlife clearings and/or food patches are essential management tools for a number of game bird and animal species. Such areas are valuable from several standpoints, i.e., attractiveness, simply as an open area or "playground", to provide more "edge" or shruby growth, and those planted to agricultural crops as a source of supplementary foods.

Bulldozing and hand labor are the foremost methods of establishing and maintaining such wildlife clearings. Although these methods have been quite successful, they are also costly; the two main categories of cost are labor and equipment, with a number of factors contributing to each one.

A number of herbicides had been used successfully in the past and were considered worthy for further experimental work in the establishment of wildlife clearings. After preliminary experiments at V.P.I. in 1956 and 1957, the use of new herbicides appeared to be economically feasible. Monuron pellets applied in June or October resulted in good control of woody plants. In June, an average kill of 81% was obtained on major tree species on three replications of a monuron treatment. The same experiment conducted in October showed a 70% kill. A December treatment applied at a rate of 5 gms./clump of brush showed good promise. There was no root sprouting in this experiment. Earlier work by Darrow[3] showed that large trees could be killed by as low as 10 lbs. (active) monuron per acre.

PROCEDURE

Two field experiments were set-up on U.S. Forest Service and Virginia Commission of Game and Inland Fisheries lands to make the following evaluations:

1. The effectiveness of herbicidal treatments as a method of establishing wildlife clearings.

2. Comparison of cost of herbicidal methods to bulldozing and manual labor.

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[1]Virginia Cooperative Wildlife Research Unit Release No. 60-4. These studies were supported in part by grants from the duPont Company and Amchem Products, Inc.

[2]District Game Biologist, Virginia Commission of Game and Inland Fisheries; and Plant Physiologist, Virginia Agricultural Experiment Station, Research conducted with the senior author was graduate fellow with the Virginia Cooperative Wildlife Research Unit, V.P.I., Blacksburg, Virginia.

[3]Darrow, Robert A. and Wayne G. McCully. Proceedings of the Tenth Annual Meeting of the Southern Weed Conference, pp. 24-28, 1957.

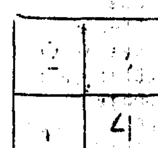
<u>Craig County Experiment</u>

The area selected was one of approximately 2,000 acres adjoining a series of four (4) study areas equally as large and of approximately the same ecological composition. These areas or compartments were designed to study the response of game species to various methods of habitat manipulation such as agricultural food plots and timber management practices. Clearings had been established in two of these compartments by bulldozer and were planted to various agricultural crops such as clovers, grasses and small grains.

The topography of the experimental area varies from relatively level areas to those that are quite steep; bounded on the southeast by a very prominent mountain range. Predominant tree species are red oak, white oak, chestnut oak, red maple, sourwood, table mt. pine, and black gum. The chestnut oaks and pines occur on the higher and drier slopes along with several shrubs species, i.e., mountain laurel, blueberries and huckleberries. Stem sizes vary from seedlings to trees with a d.b.h. of 18 inches.

Ten approximately one-acre areas were selected with the same criteria used in selecting the sites in the adjoining compartments. Plot boundaries were established and each clearing was divided into quarters (Figure 1). Each quarter of each clearing was treated with a different herbicide. The selection of quarters to receive a particular treatment was randomized. The four herbicides chosen were: (1) monuron on a vermiculite carrier, (2) fenuron clay pellets, (3) ammonium sulfamate, and (4) 2,4,5-T ester. Control areas one chain square were established at each clearing.

Figure 1 Design of wildlife clearings, Broad Run Project.



Monuron and fenuron were applied in June (first application June 5) to two quarters of each clearing at the rate of 5 to 10 gms./stem. Stems 5 in. d.b.h. and under were treated with 5 gms. and those above 5 in. were treated with 10 gms. Applications were fairly evenly distributed around the base of each stem at a distance of several inches from the stem.

Ammate and 2,4,5-T were used in frill treatments which began August 4, 1958, and were completed that month. In the use of Ammate, overlapping axe cuts were made at waist height around all tree species 1 in. d.b.h. and above (shrubs and trees species under 1 in. d.b.h. were not treated). A solution of 7 lbs. per 2 gal. water was applied to these cuts by Knap Sack sprayers.

It was decided to vary the frill somewhat with the use of 2,4,5-T from the one used in the Ammate treatment. Axe cuts were made at approximately 4 in. intervals on stems 4 in. d.b.h. and above. Those from 1 to 4 in d.b.h. were cut on two sides. All frills were made at approximately waist height. Tree species under 1 in. d.b.h. were stem-foliage sprayed. 2,4,5-T at a rate of 12 lbs. per 100 gal. oil

(#2 fuel oil) was applied with the same sprayers used in the Ammate treatment.

Observations

Three weeks after applying fenuron, it was observed that an over-all "brown out" had developed and on July 30, 1958, eight weeks after application, all species were defoliated and dead in appearance. On this date a browning effect was noted on areas treated with monuron, but few leaves had been shed prematurely. There was a general browning effect on areas treated with ammate but no change was indicated where 2,4,5-T was used.

Results

A second stem count was made on July 19, 1959, after one growing season, on all situations.

Table 1 shows the average percentage of kill on 10 replications of each herbicide on the Broad Run Project.

	Fenuron* % kill	Monuron % kill	Ammate % kill	2,4,5-T % kill
Red Oak	97	90	90	2
White Oak	99	87	93	4
Chestnut Oak	95	90	90	1
Chestnut	-	100	100	35*
Sassafras	82	52	87	15*
Black Gum	82	60	96	21*
Dogwood	78	91	92	27*
Black Locust	-	-	100	0
Red Maple	86	61	89	29*
Hickory	84	76	82	3
Sumac	100	100	63	7
Pine	100	99	-	-
Cherry	-	100	-	-
Thornapple	100	-	-	-
Serviceberry	86	31	87	53*
Sourwood	67	80	88	3
Witchhazel	78	53	97	17*
Red Cedar	-	100	-	-

*Small stems - axe cuts may have killed stems

It can be noted in the tables that fenuron is highly toxic to practically all species treated. Results were equally as good on other experimental areas. Living stems were determined by the presence of foliage, but this appeared to be severely affected. The leaves that were present were either quite small (approximately one-fifth normal size) or turning brown. A stem count after another growing season would probably indicate a higher percentage of kill.

Although monuron shows a lower percentage of kill than fenuron, A greater amount of foliage was present than in areas treated with fenuron, but this too was not normal either in size or shape and showed a dying effect. A test plot established in 1955 on a utility right-of-way in Bath County, Virginia, showed a dying effect after two complete growing seasons.

A good top-kill was obtained on the Ammate frill-treatment areas. Table Mt. Pine (Pinus pungens) was least affected by this treatment. In six of the ten treated areas the percentage of kill on this specie range from 53 to 77 per cent. The author believed this was due to shallow axe cuts in the thick, rough bark which is characteristic of this specie. These areas are characterized by prolific sprouting, particularly among the oaks, red maple and sourwoods. The succulent sprouts attained a height of as much as five feet.

In the 2,4,5-T frill-treatment practically no top-kill was obtained except where stems were less than two inches in diameter. The percentage of kill was below 50 per cent in most plots. Apparently the limiting factor in this treatment was the spaced axe cuts, which were about four inches apart. The stemfoliage treatment of stems under one (1) inch d.b.h. was very successful and these areas are practically devoid of any undergrowth.

Roanoke County Experiment

An additional field experiment was set-up on a tract of State forest land on Fort Lewis Mountain, Roanoke County, Virginia, to evaluate different levels of concentration (1,2, and 4 gms./stem) of fenuron. Two replications of each concentration were made on areas approximately 1-chain square. Treatments were made July 24 and 25, 1958.

Part of this area was heavily burned in October, 1953. Although there are a number of stems on each plot ranging in size from 4 to 18 inches d.b.h., a majority is a low growth 5 years old. Except for buffalo nut (Pyrularia pubera), which is parasitic, the variation in species is slight from those on the Broad Run Project Area.

Observations and Results

By October 4, 1958, all species except Table Mountain Pine had been defoliated. Although the pines had not shed their needles, they were completely brown. The plots treated with 1 gm. contained a large number of buffalo nut which had been defoliated but showed a rebudding tendency. The results of a stem count after one growing season are shown in table 2.

Table 2. Average percentage of kill on areas trated with 1,2 and 4 gms/stem of Fenuron (2 replications each)

	1 Gms. % kill	2 Gms. % kill	4 Gms. % kill
Red Oak	89	91	98
White Oak	95	97	99
Chestnut Oak	91	95	96
Chestnut	-	-	100

	1 Gms. % kill	2 Gms. % kill	4 Gms. % kill
Sassafras	-	98	96
Black Gum	91	88	86
Dogwood	40	100	100
Black Locust	97	96	97
Red Maple	70	88	91
Hickory	85	100	100
Pine	100	100	100
Cherry	-	-	100
Yellow Poplar	-	100	-
Serviceberry	85	70	95
Sourwood	34	65	87
Witchhazel	100	80	83
Buffalo Nut	55	100	-

Table 3. Cost comparison per acre of the four herbicides used on the Broad Run Project

	Ammate	2,4,5-T	Fenuron/1	Monuron*	Bulldozing
Labor	$17.70	$17.10	$11.50		
Chemical	22.50	9.66	95.00		
Oil		9.78			
Dozer & Operator					$90.00**
Totals	$40.20	$36.54	$106.50		$90.00

*Cost not available /1 Based on 5-10 active per stem.
**Does not include time spent by resident game manager on hand clean-up work necessary to condition areas for tilling.

The cost of each bulldozed clearings on the adjoining compartments was approximately $90.00. This is an approximation due to the fact nine and one-fourth (9¼) miles of access road were constructed in the same operation.

The cost shown in Table 3 for fenuron is quite misleading since it was shown that the same species can be killed with 1 gm./stem of fenuron. Had a one-gram treatment been used, the cost per acre would have been about $21.00 for fenuron.

A number of factors must be considered in selecting a herbicide (s) for establishing clearings.

1. Accessibility of areas
2. Density and size of vegetation
3. Species present
4. Equipment used in application
5. Cost of herbicides

Summary

It is apparent that fenuron and monuron are the most effective herbicides for killing a greater proportion of the tree species; fenuron being more desirable because quicker results are obtained. Both of these herbicides can be easily transported into inaccessible areas in knap sacks and no other equipment is necessary. Areas treated with these chemicals could be left until the stems have partially decayed then remove them or leave undesturbed for their value as an open area. A considerable number of annual and perennial plants invaded these areas during the first growing season after treatment. Oak and sassafras seedlings were present in limited numbers.

Due to the great number of sprouts produced by the use of Ammate, this method of treatment might be used to produce browse in areas where it is desired, but because the original stems must be frilled and treated or cut and stump treated (not carried out in this exp.) and equipment necessary, Ammate would probably be used on a limited scale.

The use of 2,4,5-T in spaced axe-cut frills is not a satisfactory method of creating an opening such as might be used for a wildlife clearing or removing undesirable tree species. Perhaps a frill consisting of overlapping axe cuts would be more effective.

Herbicides as a wildlife management tool shows great promise for creating wildlife clearings and controlling undesirable tree and shrub species. It is improbable that they will replace bulldozing as a method of creating clearings; what is to be accomplished and accessibility of areas will be the determining factors.

THE USE OF CHEMICALS IN FOREST SITE PREPARATION

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Much of the Piedmont and lower eastern slopes of the Appalachian Mountains from Central Pennsylvania to South Carolina were originally covered with what foresters call the Oak-Pine forest type. White and red oaks, hickory, red maple, red and black gum and other hardwoods were predominant. On the poorer and drier soils, ridges, bluffs and knolls, loblolly, shortleaf and Virginia pines were found. Much of this area, even steep hillsides, has been cleared of forest for agricultural uses at least once during the past 200 years. Improper farming practices led to erosion of the soil in varying degrees over the years.

As the land became more and more unsuited to agriculture, many of the fields of the piedmont and lower mountains were abandoned. One or more of the three pines mentioned above became established on much of the abandoned land, as well as on land that had been burned by serious and uncontrolled fire. The result was that 30 or 40 years ago there was a great deal of piedmont and lower mountain land in pine. It occurred either in pure stands or in a mixture of pine and hardwoods.

Pine has long been in demand for lumber. The development some thirty odd years ago of a method for making paper out of southern pine started a great expansion of the pulp and paper industry in the south, predicated upon the extensive stands of yellow pine. From then until the present the principal species sought after by sawloggers and pulpwood cutters in this region have been the pines.

Since much of this region had been covered with hardwoods, there always seems to be a certain amount of hardwood in or adjacent to the pine stands. As the pine was cut and the hardwood left, the cutover areas grew back either to solid stands of hardwood or to a much greater proportion of hardwood than in the previous stand.

Soils studies have shown much of this region to be suitable for the growing of pine although a poor stand of hardwoods may now occupy the area. A 30 to 40 year rotation of pine will yield a larger volume of pine than hardwood pulp and pine is in much greater demand. Since pine grows slowly and irregularly, if at all, in competition with or under a canopy of hardwoods, our problem is how to eliminate or greatly reduce the hardwood competition in order to establish a uniform stand of fast-growing pine. At least three different methods can be used for this purpose, namely fire, mechanical means and chemicals.

Fire has proven of doubtful value because there is most often not enough really dry fuel on the forest floor of a hardwood stand to carry a fire hot enough to kill the roots of the hardwoods. The result is generally a very lush growth of sprouts which add more hardwood competition at the very place where it isn't wanted - close to the ground where it will shade out the pine seedlings. Then too, fire, especially in hilly country, not only burns valuable soil nutrients but results in erosion of topsoil, of which there is precious little in these reforested abandoned fields.

Mechanical clearance of hardwoods has been done quite extensively. After removing all merchantable hardwoods, the rest is piled and burned. Then a large crawler tractor equipped with a bulldozer or KG blade pushes out all growth, taking most of it out by the roots. This results in a bare field with all hardwoods and brush which hasn't been burned piled in windrows across the field. Aside from the very high expense of such an operation, much humus and topsoil is pushed into the windrows. While it has been demonstrated that pines planted on such an area will grow and be free from hardwood competition, it is quite likely that the site quality of the plantation has been considerably impaired, reducing the height and volume growth of the pines.

Another system of mechanical clearance of hardwoods has been to bulldoze the area after removing all merchantable trees with a heavy bush and bog harrow being pulled behind the bulldozer. This eliminates the need for bulldozing below ground level, so the topsoil remains. The harrow cuts up the roots and exposes them to some drying. However, such a method may very likely produce a very heavy stand of sprouts, especially on the better sites. This might create more severe competition to the planted pine than if no harrowing were done. The cost of planting is also higher where a tangle of tops and roots covers the ground.

The third method of preparing a hardwood-covered area for successful planting of pine is to kill the hardwood chemically. Here I will mention four distinct methods of application of the chemical. They are (1) aerial spraying, with fixed wing aircraft or helicopter, (2) root collar application, (3) ground application by high gallonage sprayer and (4) ground application with mist blower.

AERIAL SPRAYING

A great deal has been written and reported on the aerial spraying of chemical, both for the release of planted conifers from hardwood brush and sprouts and for killing hardwoods prior to planting the area to conifers. Costs of some of this work have been very attractive, in the neighborhood of $10.00 per acre or less. We have tried it on our company lands in South Carolina with varying degrees of success. In cases where the forest is multi-storied we have obtained good kills on the overstory with poor or spotty results on the smaller trees in the stand. This is because the chemical droplets have been intercepted for the most part by the leaves of the taller trees. According to Duncan Harkin, our research forester who has conducted tests of chemical application on our southern woodlands, aerial spraying would be useful in areas where red and black gum are the only problem species or where other species comprise such a small portion of the stand that it does not matter whether they are killed or not. Harkin mentions another important factor in aerial spraying - the inherent variation in susceptibility of individuals within a species. This point deserves a good deal of research because it implies that while aerial spraying may be used effectively once, results may be considerably less favorable a second time due to the genetic selectivity of the chemicals.

A definite limitation to aerial spraying is that it is not applicable to small ownerships. It is expensive when used to treat small areas. Also there is the ever-present danger of killing trees of adjoining owners through drift of the chemical.

Our present feeling on aerial spraying is that it has a definite place in site preparation where the area to be treated is large, where it is well within the boundaries of ownership and where no more than one or two hardwood species are present, and they of known high susceptibility to chemical.

ROOT COLLAR TREATMENT

Root collar treatment is a modification of the basal spray method. Instead of spraying the stems from the ground line to a height of one foot with 2,4,5-T in fuel oil, the mixture is poured on the stem several inches above ground line in sufficient quantity to run down and soak the root collar under the ground. In our work on this in South Carolina (I am again quoting from Harkin's experience) the root collar treatment was effective on most stems up to 6 " d.b.h., and in some cases to 8". It was most effective on blackjack and turkey oaks. It was only moderately successful in the pine-hardwood type because of species composition. In the flatwoods pineland of the coastal plain red gum, red maple, post oak, blackjack oak and turkey oak were effectively controlled by this method. Excellent results were obtained on all species but ash in the piedmont. He found a mixture of 2,4,5-T acid in 20 gallons of fuel oil (1:20 by volume), costing about 52¢ per gallon to be most effective.

The root collar treatment kills stems which are not affected by basal spray, frilling or girdling because the chemical gets down on the buds around the root collar under the ground, which the chemical doesn't reach by the other methods. Stands up to 1,000 stems per acre can be treated by this method for $10.00 or less per acre. Where the hardwoods are fewer than 1,000 per acre, which is often true in the scrub oak type, the root collar treatment is economical. Where there are over 1,000 stems per acre, particularly on dry sites where competition for soil moisture demands complete hardwood control, the cost of root collar treatment tends to become prohibitive.

HIGH GALLONAGE SPRAYER

We have had one season's experience with a high gallonage sprayer in South Carolina. Therefore, the results which I have to report on this method are based on purely subjective evaluation. The chemicals tested were 2,4,5-T and Forron 245, in quantities of 50 and 100 gallons per acre. Water only and a 10% emulsion were used as carriers. 100 gallons per acre showed better results than 50, and Forron 245 gave the quickest browning of the leaves. Whether those results will hold up or whether the quicker brownout was caused by the chemical killing the leaves but not translocating to the stems or roots cannot be determined until another growing season has passed.

MIST BLOWER

We became interested in the mist blower for killing hardwoods in Virginia because of two possibilities which it seemed to afford. First, since our Virginia woodlands were in relatively small blocks, we expected to get the advantage of a mist type application such as obtained from aerial application, with its low cost, and yet have greater control since it would be applied from ground-based equipment. Second, and perhaps more important, the mist blower offered an opportunity to get good coverage with a total mixture of only 3 - 5 gallons per acre instead of the 50 to 100 gallons per acre needed with a high gallonage machine. Water is a very scarce commodity in much of the piedmont and foothills, especially in the late spring and summer when the work is usually done. For instance, we had to haul water 1-3/4 miles from a stream to the tract where we tested the mist blower. Had we treated the entire 260 acre tract, we could have hauled the water in 55 gallon drums in two trips of the truck used for hauling tractor, chemical and water. But with a high gallonage sprayer we would have needed 26,000 gallons of water, a considerably more complex and expensive problem.

We decided that rather than use just one kind of chemical to test the mist blower's ability to do the job of eliminating hardwood, we would at the same time test various chemicals for their effectiveness on the hardwoods of that section. We therefore established eight 2-acre plots. I have included in this paper a table showing the chemicals used, dosages applied and preliminary results obtained, as shown from a 10% cruise of each plot in which we checked leaf condition on all stems on transects running opposite to the line of travel of the mist blower.

The mist blower was mounted on rear of a small crawler tractor and operated by the tractor operator. The only other person used was a flagman to show the operator where his last path was so he would be sure to cover the plot. Only one nozzle was used and it was kept at from 45 to 60 degrees up from horizontal, pointing to the right. The operator drove across plot from on boundary to the opposite side, turned around and returned on the same path. He then moved 30 feet down the boundary, and repeated the operation. This gave a misting of each thirty foot swath from each side.

The first check, made four months after application and reported in the accompanying table, indicates that Kuron, Forron and M-414 gave the best results considering the amount of acid and total solution per acre. M-414 is an invert solution of 2,4,5-T. Kuron and M-414 were in an oil and water carrier while the Forron was used with water only. I might point out that on plot 2S, which was treated with 2,4,5-T, we mistakenly used only one-half the intended amount of chemical. It is possible that if we had used the full amount, the results would have been much better. The 2,4,5-T with oil only did not show up too well, however.

Since these tests were on only two-acre plots and since we used a variety of chemicals of different concentrations, we have no definite costs to report. But I am willing to hazard an educated guess that good results can be achieved with the mist blower on a production job in a dense stand of hardwood cutover land at less than $10.00 per acre. There were from 975 to 1475 stems per acre on the plots we treated. This in spite of the fact that all merchantable hardwood had been removed prior to the tests.

We also tested the mist blower in South Carolina coastal plain hardwoods. There we used 2,4,5-T and Forron in diesel oil at rates of 3 and 5 gallons per acre. Again it is too early to accurately forecast results, but in our opinion the mist blower looks to be much better than the high gallonage sprayer on our land. Distribution of chemical was better and it reached higher into the crowns. This ability of the mist blower to reach and kill leaves over 50 feet high was a very pleasant surprise to us. And since the chemical was applied from the ground droplets came out of the mist from the nozzle up, giving better coverage of low trees and sprouts while still reaching the taller trees than was experienced with aerial spraying.

COMBINATION MECHANICAL AND CHEMICAL TREATMENT

Our latest experiments in site preparation in heavy concentrations of hardwood plus various species of woody shrubs has been a combination of mechanical and chemical methods. We tried this in South Carolina last summer. A D-7 tractor equipped with KG blade in front and mist blower mounted behind over the winch enabled us to get the job done with one operator and integral equipment. The tractor cleared a ten foot swath through the woods, skipped ten feet and repeated the process. In other words 50% of the area was cleared of trees and brush. This is much less costly than a 100% clearing job. However, since the understory remaining on the unbrushed strips would arch over and seriously compete with pines planted there, the unbrushed strips were given a mist blowing at the same time as the alternate strips were being cleared.

The results look very encouraging at present. As will be the case in Virginia, this tract will be planted to pine during the coming winter. We will check growth and survival of the pine as well as the extent of hardwood competition which will develop. It is quite probable that the pine plantation will need a second chemical treatment to reduce the hardwoods until the pines can get to growing and get ahead of the remaining hardwood. We of course do not know this yet, or when such treatment might be called for. We hope it will not be necessary at all. To date we can say that we are very encouraged as to the efficiency of the mist blower for site preparation work in hardwood areas and the potential of getting a good job done cheaply with this machine, either alone or in combination with mechanical brushing.

Our future plans call for a continuation of mist blowing with the tractor mounted model and also with the back-pack type. We believe the latter has possibilities for insuring a good stocking of pine after logging the present stand of pine by treating the advance growth of hardwoods which is often already growing in a pure overstory of pine

EVALUATION OF CHEMICAL TREATMENT 4 MONTHS AFTER APPLICATION

Plot #	Mixture	Total Gal. Per Acre	Acd Equiv Per Acre Pounds	Leaf Condition by Percent, All Species: All Dead	Mostly Dead	Few Dead	Spotted	No Effect	Total
1S	1 gal. 245-TP, 1 gal. #2 oil, 8 gal. water	8.5	3.0	47	23	15	11	4	100
2S	½ gal. 245-T, 1½ gal. #2 oil, 8 gal. water	3.5	0.7	46	13	6	30	5	100
3S	1 gal. Kuron, 1 gal. #2 oil, 8 gal. water	4.5	1.8	68	11	7	13	1	100
4S	1 gal. 245-OS, 1 gal. #2 oil, 8 gal. water	9.0	3.6	70	14	6	8	2	100
5S	2 gal. Forron, 8 gal. water	6.5	1.3	69	13	4	14	0	100
6S	1 gal. M-414, 2 gal. oil, 8 gal. water	3.0	1.2	64	8	8	17	3	100
2N	1 gal. 245-T, 9 gal. #2 oil	7.5	3.0	66	20	7	7	0	100
3N	1 gal. Kuron, 9 gal. #2 oil	6.5	2.6	47	24	16	11	2	100
Average				60%	16%	9%	14%	1%	100%

HELICOPTER APPLICATIONS OF 2,4,5-T SHOW DIFFERENCES IN HARDWOOD CONTROL

by

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Comparisons of different chemicals for effectiveness in controlling hardwoods have been reported rather often in forestry literature. So have comparisons of different species in relative susceptibility to chemical treatment. But comparisons of chemical applications in successive years are not so common.

This paper is a report on the degree of control obtained over hardwoods--especially red maple--when 2,4,5-T was applied by helicopter at the same rate in two successive years.

THE STANDS TREATED

These treatments were made on the U. S. Forest Service's Massabesic Experimental Forest in southwestern Maine. The stands are even-aged, having originated after the severe forest fire of 1947. The stands are made up mostly of gray and white birch seedlings, northern red oak, white oak, and red maple sprout clumps. There is some black oak sprout growth as well as some aspen and pin cherry. White pine is the principal softwood species; and there is enough hemlock, balsam fir, red pine, and red spruce to show the relative resistance of these species to aerial applications of 2,4,5-T. The hardwood growth needs to be controlled both to release established softwood reproduction and to facilitate plantation establishment.

THE APPLICATIONS

Yearly applications of 2,4,5-T have been made from 1954 through 1958, but this report covers only treatments made in 1954 and 1955. The low volatile ester of 2,4,5-T--4 pounds acid equivalent per gallon --was the only chemical used. The same rates were used both in 1954 and 1955: 3 pounds acid equivalent, plus 1-3/4 gallons of No. 2 fuel oil per acre--a total volume of 2-1/2 gallons. Thirty acres were treated in 1954 and eighty acres in 1955.

WEATHER CONDITIONS

Although the same treatment was made each year, there were marked differences in weather conditions. The 1954 application was made on July 14, a sunny, rather windy morning. The 1955 application was made on August 16, a calm, overcast morning changing later into a sunny day.

There were also differences in general weather these two summers. In 1954 there were 18 inches of rain between May 1 and mid-July. An additional 15 inches fell between then and the end of September. It rained all summer at frequent intervals. In 1955, there were only 8-1/2 inches of rain between May 1 and August 16 and 3 inches from then until the end of September (11-1/2 inches for the entire period as contrasted with 33 inches in the previous year). Less than 1/3 inch of rain fell between July 4 and 28. There was a similar dry period from August 25 to September 23.

EXTENT OF HARDWOOD CONTROL

The word "control" is used rather than "kill" because something less than total kill can frequently be accepted in forestry work. One aspect of this control is progressive mortality and retarded recovery in absence of kill. The other aspect is total kill, or total reduction in stand density.

Progressive Kill

Progressive kill is covered as a separate topic to point out the need for delayed evaluation of control. Extent of resprouting is particularly uncertain for a few years. There are indications that it takes as long as 5 years to determine the final extent of control by helicopter applications.

Partial top-kills will be mentioned. As used here, a partial kill means reduction in foliage area, usually of a sprout clump. This can be either the total kill of some of the stems in a clump; partial kill of all stems; or a combination of the two.

Observations have been made several times on the area treated in 1954. The trees were first examined in the fall of 1955. Practically all the birch had been killed back. The tops of practically all the white oaks were killed and so were 70 percent of the red oaks; but only a few of the red maple tops were killed. Sprout clumps were tagged then for later examination. Examined again in the fall of 1956, red maple sprout clumps showed little change. A few more oak clumps were dead. Half of those with about one-tenth of their tops green in the fall of 1955 were dead; most of those with more than two-tenths of their tops green seemed to be recovering.[1]

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[1] McConkey, Thomas W. Helicopter spraying with 2,4,5-T to release young white pines. U.S. Forest Serv., Northeast. Forest Expt. Sta., Sta. Paper 101. 1958. 14 pp., illus.

The 1959 examination showed a marked increase in mortality, particularly for red maple. There was much better control of red maple and only those which were less than 1/4 killed had recovered. Few of the recovered trees were more than a foot taller than they had been in 1954. Only occasional oaks were still alive.

Similar periodic examinations showing changes in mortality were made on the area treated in 1955. About 1/10 of the oaks that had new living stump sprouts in the fall of 1957 were dead in 1959. In the same interval, proportion of red maple sprout clumps entirely dead increased from one-third to nearly one-half.

Extent Of Kill

A lot of the birch killed in 1954 can no longer be found. The stems have been broken down by snow and broken into small pieces so individual trees can no longer be identified. Probably some of the smaller oaks and maples have also been lost.

For all practical purposes, there is a total kill of birch. Stand tallies show that there are only 2 birches alive now for every 1,000 at time of treatment. The birches found in 1959 started as low stem sprouts on trees that were short and well protected at the time of treatment. Most of these are still less than 3 feet tall.

For oaks, total top-kill and kill with no resprouting is very good on both areas. Where there was top-kill but resprouting, most of the new growth is still less than 2 feet tall.

Red maple kill varies. Most of the trees have been top-killed on the area treated in 1955 and somewhat more than one-third on the area treated in 1954. There is new sprout growth on about half these trees on both areas. Most of them are only 1 or 2 feet tall (table 1).

Positive identification of dead red and black oak could not be made when the trees were examined in 1959. However, most of the new living stump sprouts are black oak: 12 of 13 tallied on the 1954 treatment area and 3 of 4 on the 1955 area.

Table 1.--Comparison between hardwood kills of 1954 and 1955 applications, in percent

Degree of kill	Birch		Red and Black oak		White oak		Red maple	
	1954	1955	(38)* 1954	(15)* 1955	(53)* 1954	(12)* 1955[1]	(73)* 1954	(65)* 1955
Killed; no new sprouts	99+	99+	58	80	83	75	12	49
Top-killed; new sprouts	1-	1-	34	20	13	17	24	49
Crowns more than 3/4 dead	--	--	2	--	2	8	37	2
Crowns 1/4 to 3/4 dead	--	--	3	--	--	--	8	--
Crowns less than 1/4 dead	--	--	3	--	2	--	19	--

*Basis: number of sprout clumps examined. Sprout clumps consisted of 2 to 5 or more stems per clump dating from 1948. The extent of kill is total reduction in foliage area in the summer of 1959.

[1]There is not much white oak on this area and a more representative sample would certainly show a better kill. This is based on the fact that portions of the 1954 area show results comparable with those indicated for 1955.

Pin cherry seems to be killed as readily as birch. It may develop thrifty sprouts under much the same conditions as birch. Aspen is usually top-killed but new crops of root suckers will make even denser stands. There were not enough trees of either species in the stands treated to create any real problem in management of the area.

Present Stands

The 1954 application, which gave the poorest results, the reduced hardwood stocking from several thousand stems per acre completely dominating the site (8,000 or more) to an open stand of scattered sprout clumps and seedlings. There are less than 125 oak and maple sprout clumps per acre. Most of these are less than 3 feet tall and none are over 10 feet. There are another 125 single hardwood stems, all shorter than 3 feet.

The application released some 450 well-distributed softwoods per acre. About two-thirds of these range from 3 to 6 feet in height. On the area treated in 1955, there is only an occasional stem more than 3 feet tall and only 200 sprout clumps and seedlings to the acre.

Softwoods were fairly resistant to the applications. Damage was limited to the occasional kill of the current year's terminal growth, or to some distortion of the terminal. Hemlock was the more severely damaged.

White pine response to release has been confounded by adverse weather and insect attack since release. A late frost in the spring of 1956 severely retarded height growth that year. Heavy infestations of white pine aphid in 1956 and 1957 reduced height and diameter growth through 1958.

A comparison, using trees of comparable height in 1954, between white pine on the treated area and those on an adjoining untreated area, shows marked response to release. The trees that were not released, but were similarly retarded by weather and insects, averaged 14 inches tall in 1954 and 31 inches in 1959. Those on the treated area averaged 13 inches tall in 1954 and 55 inches in 1959.

OBSERVATIONS

Certain observations are included as part of this report although no supporting data have been taken.

Progressive kill is probably not due solely to action of 2,4,5-T. There are indications that trees are severely weakened by the chemical but that final kill is due to adverse weather conditions. Some dead red maples noted in 1959 looked as though they were alive in 1958 and probably recovering from effects of treatment. The severe 1958-59 winter may have finished them off.

It is doubtful that birch kill would be so good if treatment had been delayed at least for a few years. As crown differentiation develops in the dense birch stands, some stems will become suppressed and well protected. Aerial applications would then probably release these smaller trees rather than kill them.

Sprout growth may be increased if the stands are disturbed within the first few years after aerial applications of 2,4,5-T. This is based on observations of two areas treated in 1957 and planted in 1958, using a crawler tractor equipped with a V blade and heavy-duty tree planter. Red maple sprout growth is denser and more vigorous on both areas than on undisturbed sites. It is probably better to control hardwoods a few years after planting than to use chemical treatment as a site-preparation measure before planting.

Although the 1954 and 1955 applications were made at the rate of 3 pounds acid in enough fuel oil to make 2-1/2 gallons per acre, more recent treatments have been made at lower concentrations. Trials in 1957 and 1958 indicated that applications of 1 pound acid of 2,4,5-T in 3 gallons of fuel oil per acre should provide adequate hardwood control on these areas. Some 2,000 acres were treated at this rate in Maine and New Hampshire in 1959.

SUMMARY

Helicopter applications of 2,4,5-T were made at the rate of 3 pounds of acid (3 quarts) plus 1-3/4 gallons of fuel oil per acre in 1954 and 1955. There are marked differences in degree of red maple control obtained and some difference in oaks, particularly in percent of resprouting. Time of year, amount of summer rainfall, and weather at time of application could have been contributing factors.

Both applications adequately controlled hardwood growth for the management needs. At this time there seems to be no more variation between other rates of application tested than between these two applications at the same rate. Applications at the rate of 1 pound (1 quart) acid in 3 gallons of fuel oil per acre appear adequate for the needs of these stands. Measure of success is more one of degree of softwood release secured per dollar invested than percent of hardwood kill attained.

Variations reported in degree of hardwood control; the fact that these cannot be adequately explained; and lack of information on the best application to make for specific purposes all points to the need for further study in this field of aerial chemical applications for forestry purposes.

PROGRESS REPORT OF THE EFFECT OF KURON UPON THE BIOTA OF LONG POND, DUTCHESS COUNTY, N. Y.

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The purpose of this paper was to continue the study of experiments carried out on Long Pond in the summers of 1957 and 1958*. During the summer of 1959, the main experiment was the application of Kuron to the same 2-acre plot whichhad been treated in 1958. An attempt was made to determine the effect of Kuron upon the plankton and benthic organisms, as well as upon the weeds, when a limited area of the pond is sprayed. The dates of the study extended from June 1 to September 22, 1959.

I wish to thank Mr. John Gould of the New York State Department of Conservation for his continued encouragement and practical assistance. Again to Mr. Otto Johnson I am indebted for the constant use of his boat and his dock as my base of operation. The Shell Companies Foundation gave me a small grant under their program of aid for summer research of college faculty. The Zoology Department of Vassar College, as always, stretched the budget to supply me with equipment, student assistance, and film. Dow Chemical Company provided the Kuron.

Long Pond as a whole has been described in detail (Pierce, 1958), and so have the two acres upon which the application was made in 1958 (Pierce, 1959).* It is sufficient to record that on June 1, 1959 the same two acres were staked out as in 1958; that the depth varied from 1-2 feet along the shoreward boundary up to 6 feet along the inner boundary; and that the area was choked with pond weeds.

On June 1-3, the preliminary or basic sampling was done. After the application of Kuron on June 22, this routine sampling was repeated at intervals, namely June 23, July 6, July 21, and Sept. 12. Since the experimental plot was roughly 200' x 400', stakes were placed at 100' intervals from 0' to 400'. The samples were taken at two definite stations along the 100' line and along the 300' line, and designated as K 100 and K 300. The same simple technique was used as in the past. At each

* Pierce, 1958. 12 Ann. Meet. Northeast. Weed Control Conf. 338-343.
1959. 13 Ann. Meet. Northeast Weed Control Conf. 310-314.

station the bottom temperature was recorded, a water sample from the bottom was obtained, and two dredges for benthic forms from the mud were made with an Ekman dredge. One plankton haul for each half of the 2-acre plot was standardized as well as possible by careful rowing. In the field, the contents of the dredges were identified and counted. In the laboratory, the plankton was identified under a binocular dissecting microscope, and determinations of pH and O_2 in ppm were made by use of the Hellige Testing Apparatus. Duplicate water samples have been sent to the Dow Chemical Company, Midland, Michigan, for analysis of the Kuron content.

The control area was selected at a point somewhat south of the treated area, and sufficiently removed to be unaffected by diffusion of Kuron.

The application of Kuron at a concentration of 1.2 ppm was made by a hand sprayer on June 22, 1959.

Before spraying, the pondweeds of the plot were carefully observed and compared with those in surrounding untreated areas, and with the official control of the previous summer. The treatment in 1958, at 2 ppm, had been successful in clearing surface forms such as Nymphaea, Nuphar, Brasenia and Pontederia. By mid-June 1959, the surface was still quite clear of the weeds, although a scattering of Nymphaea and Nuphar appeared. Along the shallow margin of the plot, where the application of 1958 had decreased the Utricularia and Chara, the bottom was still fairly clear of these plants. The treatment of 1958 at 2 ppm had not been successful in deeper water on the Potamogetons which formed a dense carpet over a large fraction of the bottom of this plot. In 1959, these weeds were as thick as before.

The results of the 1959 application of Kuron at 1.2 ppm were as follows. The few scattered surface plants which had returned, Nymphaea and Nuphar, were killed. The Nymphaea responded in the usual way with elongated and coiled stems, broken stems and leaves, decomposition, and death. By July 6, two weeks after spraying, the surface was entirely clear of the Nymphaea pads, and Nuphar plants were very sick. The surface remained clear of the plants for the season. It is difficult to judge about the submerged plants along the shallow margin of the plot. While the 1959 application did not remove them entirely, it certainly held in check Utricularia and Chara. This was evident from comparison with the control.

Upon the Potamogetons (P. amplifolus, P. crispus, P. Robinsii, and P. natans) the 1959 application at 1.2 ppm had no observable effect. The flowers of these submerged plants appeared above the surface like tiny trees and the plants below flourished. It must be said that so thick were the Potamogetons that even if a large fraction had been removed it would have been difficult to determine this loss.

The summer of 1959 was extremely hot as is reflected by the temperatures recorded. From June 1 - September 22, the temperature varied from 66° - 80° F. For most of July and August the water remained at a level of 78° - 80° F. The pH remained as usual, fairly constant, but reflected the seasonal change. In early June it was 8.0 falling to 7.1, and returning to 7.8 in September. The dissolved oxygen content also reflected the summer conditions, in early June showing 8.0 - 8.5 ppm, falling to 5.0 ppm during the heat of summer and returning to 7 ppm in September. Neither the pH nor the dissolved oxygen content showed any change which could be interpreted as due to the presence of Kuron. Any variations were comparable to the control area.

The benthic organisms identified in 1959 represented the same large groups as those found in 1958; Annelida, Mollusca, Crustacea, Insecta. In no sample did any one group show any significant variation which was different from the normal seasonal change exhibited by the control.

As in the previous year, no exact counts were made upon the large aquatic vertebrates such as fish, frogs, turtles, but all three groups were abundant in treated as well as control areas. It was very obvious that Kuron had no harmful effect upon either adult or young fish.

The plankton identified in the 1959 season was practically identical with previous studies in the pond. (Pierce 1958, 1959). Again, on the first day after spraying there appeared a noticeable decrease in numbers of individuals. They were not "sick", as last year, but did show less activity. There was a tendency for the filamentous green algae (except Spirogyra) to disappear temporarily. By July 6, two weeks after spraying the plankton population had returned to its normal abundance and activity.

A brief comment on the small plots treated in 1957 is appropriate here. In that year, they were treated with Kuron in concentration of 1.3 ppm. The surface was cleared of Nymphaea and Pontederia for that season. In 1958, since a substantial number of pads were appearing, an unmeasured but concentrated dose of Kuron was applied. This cleared the surface of all pads for the season. In 1959, this entire portion of shoreline was vastly improved. The surface was clear of pads, and even the submerged weeds (particularly Utricularia) were reduced. No further application was made in 1959.

The cottage owners and fishermen are beginning to see the improvement in these experimental plots and often comment favorably upon it.

SUMMARY

1. The same experimental area of two acres, treated in 1958, was selected to be treated again in 1959.

2. The study extended from June 1 - September 22, 1959.

3. Preliminary study of the following conditions and organisms was carried out on June 1: bottom temperature, pH, dissolved oxygen content, plankton, benthic organisms, large aquatic vertebrates, and aquatic plants. Similar routine observations were repeated at intervals on June 23, July 6, July 21, and Sept. 12-20.

4. The experimental plot was sprayed once with Kuron on June 22, at a concentration of 1.2 ppm.

5. The few scattered Nymphaea odorata from the 1958 population succumbed within a few days. The occasional Nuphar succumbed, but more slowly. These plants did not reappear during the season.

6. The submerged weeds of the shallow area were at least held in check. Utricularia responded more successfully than Chara. In the deeper area where several species of Potamogeton form a dense carpet, no decrease was observed.

7. The temperature of the bottom water varied between 66° - 80° F.

8. The pH varied from 8.0 - 7.1.

9. The dissolved oxygen content varied from 8.5 - 5.0 ppm.

10. Plankton was continuously represented by the same forms as in preceding summers. For a few days after spraying, the plankton suffered a decrease in numbers and vigor but by two weeks had regained the condition observed before spraying and similar to the control.

11. Benthic forms were continuously represented by the same forms as in the preceding summer. Their numbers were not effected by Kuron. They varied as did the control.

12. Fish of all ages were observed swimming in the treated and control area alike.

13. The experimental plot first treated in 1957, again in 1958, showed during the summer of 1959 a vast improvement in reduction of certain weeds. Pontederia was completely nonexistent. Nymphaea was present only in scattered patches, and submerged Utricularia was definitely decreased.

CONTROL OF VARIOUS AQUATIC WEEDS WITH SILVEX

By William C. Hall

Although chemicals to control aquatic vegetation have been used for several decades, a need has existed for an herbicide that would effectively do so without side effects on other biological aspects of the treated water: SILVEX, the common name for 2(245 trichlorophenoxy) Propionic acid, partly fills this need, as established by successful control of many of the common aquatic weeds of the northeastern states with commercial applications to seven lakes in 1959.

These lakes ranged in surface size from one-eighth acre to thirty acres, with various depths up to twelve feet that were weed-infested. Surface temperatures ranged from sixty to eighty degrees Fahrenheit. The earliest application date was on May 28th, and the last was on July 27th. Concentration used was two parts per million (1.3 gallons of SILVEX per acre foot of water), using SILVEX emulsion containing four pounds of technical material per gallon. A Propylene Glycol Butyl Ether Ester was used in three lakes, and an Iso-Octyl Ester was used in four lakes. Applications were made by a centrifugal pump which sucked SILVEX directly from a drum and deposited it on the lake surface from a spray boom, an exception being certain shallow areas and the smallest lake, where a spray gun was used. The pump, drum, etc., were mounted in an aluminum barge powered by an air propeller. Output on surface was controlled by valves and by barge speed. All applications employed the crisscross method to avoid skips.

Submersed Aquatic weeds successfully controlled for the 1959 growth season included Anacharis (water weed), Ceratophyllum (coontail), and Myriophyllum (water milfoil). Nuphar (yellow water lily), Pontederia (pickerel weed), Sagittaria (arrowhead), and Typha (cattail), all emergent rooted weeds, were also controlled for the 1959 growth season.

At various periods following each application, samples of the treated weeds from each lake were collected. It was noted that resistance to effect of the chemical occurred from three causes: water temperature, high weed count, and maturity of the weed. Low water temperature appeared to slow up effectiveness; high weed count caused a marked and easily noticed delay in effectiveness; and plant maturity also appeared to cause some slight delay in effectiveness. These factors did not in any way limit observed effectiveness, but only delayed it.

Each of the SILVEX Esters used was equally successful in controlling the weeds to which it was applied. Propylene Glycol Butyl Ether Ester was applied to Anacharis, Ceratophyllum, Myriophyllum, and Pontederia, and was successful with each. Iso-Octyl Ester was applied to Anacharis, Ceratophyllum, Myriophyllum, Nuphar, Pontederia, Sagittaria, and Typha, and was successful with each.

Repeated observations for biological side effects failed to find any at the two parts per million rate used in these applications.

Summary and conclusions - A new chemical weed killer, SILVEX, has been proved effective in the control of many common Aquatic weeds infesting lakes and ponds of the northeastern states. It has been successful without observed deleterious side effects to other non-microscopic biological aspects of the treated water.

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SILVEX APPLICATION DATA TABLE FOR 1959

LAKE	ACRE FEET OF WATER	SILVEX ESTER USED	SILVEX QUANTITY USED	DATES	FAHRENHEIT SURFACE TEMPERATURE	WEEDS CONTROLLED
A	130	PROPYLENE GLYCOL ETHER ESTER	170 gal.	5/28/59 & 6/8/59	68, 71	CERATOPHYLLUM & MYRIOPHYLLUM
B	.67	PROP. GLY. BU. ETH. EST.	1 gal.	5/29/59	60	ANACHARIS PONTEDERIA
C	2.25	PROP. GLY. BU. ETH. EST.	3 gal.	6/8/59	73	MYRIOPHYLLUM
D	40	ISO-OCTYL ESTER	55 gal.	6/29/59	70	ANACHARIS MYRIOPHYLLUM PONTEDERIA SAGITTARIA TYPHA
E	20	ISO-OCT. EST.	25 gal.	7/13/59	80	ANACHARIS CERATOPHYLLUM MYRIOPHYLLUM NUPHAR
F	70	ISO-OCT. EST.	90 gal.	7/13/59 & 7/23/59	73, 72	ANACHARIS CERATOPHYLLUM MYRIOPHYLLUM
G	200	ISO-OCT. EST.	250 gal.	7/23/59, 7/24/59, 7/27/59	71, 71, 70	ANACHARIS CERATOPHYLLUM NUPHAR

RE-EVALUATION OF THE CONCENTRATIONS REQUIRED FOR EFFECTIVE AQUATIC WEED CONTROL WITH SILVEX

by

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It has become apparent, as a result of the work done in the past few years, that SILVEX, a formulation of 2, 4, 5-Trichlorophenoxy propionic acid, has given indications of being a promising aquatic herbicide. Results from field tests throughout the country with particular reference to this area, have placed SILVEX high on the list of effective agents for the control of certain forms of aquatic vegetation.

SILVEX, which is now available for aquatic weed control under a registered label, is recommended for use at 5 quarts per acre-foot of water, or approximately 2 parts per million.

In recent years, several workers have reported field trials with SILVEX at concentrations of 2 ppm. Pierce[1] reported successful use of SILVEX at this concentration in New York State. Work done in New Jersey by Younger[2] indicated that 2.0 ppm to 2.5 ppm produced "adequate control" for most species tested. Boschetti[3] reported several successful field tests in Massachusetts of SILVEX at a range of 1.0 ppm to 2.0 ppm. He also indicated that some success had been achieved at lower concentrations.

The purpose of this paper is to further evaluate the over-all effectiveness of SILVEX as an aquatic herbicide. In this study, a re-examination of the critical concentrations and the application techniques required for the control of aquatic vegetation were made.

METHODS:

Concentrations of SILVEX, ranging from 0.2 ppm to 1.0 ppm were administered in whole pond treatments throughout Massachusetts. The only exception was two 15 acre plot treatments in a 140 acre pond.

Applications were made with standard proportioning equipment and sprayed on the surface of the water by means of a 12 foot boom. On one occasion, a high pressure fire hose system was used. Biological surveys of the treated areas were made throughout the tests.

RESULTS:

Ponds, treated at the rates of 0.3 ppm to 1.0 ppm were found to be effectively controlled of the following types of aquatic vegetation: Myriophyllum sp., water millfoil; Nuphar sp., yellow water lily; Nymphaea sp., white water lily; Utricularia sp., bladderwort; Brasenia sp., water shield; Elodea sp., waterweed; Vallisneria sp., tape grass; Sagittaria sp., arrowhead; Pontederia sp., pickerel weed; Cabomba sp., fanwort. Limited control was obtained of Potamogeton sp., pondweed. The results against this latter group of weeds produced only sporadic results. A summary of the species effected at the specific concentrations used is found in Table I.

TABLE I

SPECIES	CONCENTRATIONS OF SILVEX PPM			
EFFECTED	1.0	0.8	0.5	0.3
MYRIOPHYLLUM	x	x	x	x
NYMPHAEA	x	x	x	x
NUPHAR	x	x	x	x
UTRICULARIA	x	x	x	-
SAGITTARIA	x	x	x	x
CERATOPHYLLUM	x	x	-	-
CABOMBA	x	x	x	x
BRASENIA	x	x	x	-
ELODEA	x	x	x	x
PONTEDERIA	x	x	x	x
VALLISNERIA	x	x	x	-
POTAMOGETON	-	-	-	-

A detailed summary of the experimental program is found in Table II.

DISCUSSION:

It was observed, within days after the low-rate applications, that a set pattern of events was taking place within the plants treated. The submergents showed signs of loss of vitality within twenty-four hours. Within 3 days after application, the dense stands of weeds began to sink to the bottom. At all concentrations tested, within 5 to 7 days, browning of the plants was noted. Decomposition of the plants effected was the same at all rates for the submergent forms, generally running from 14 days to 24 days. In one pond, sprayed at 0.8 ppm, the entire process took only 10 days after which no sign of living vegetation could be found.

TABLE II

SUMMARY OF 1959 EXPERIMENTAL PROGRAM WITH SILVEX

SILVEX PPM.	Acres Treated	Date of Treatment	Aquatic Vegetation	Pre-treatment Growth	Degree of Control
0.5	30 A.	7/12/59	MYRIOPHYLLUM	Dense	100%
			NYMPHAEA	Dense	100%
			SAGITTARIA	Moderate	100%
0.5	87 A.	7/13/59	NYMPHAEA	Dense	100%
			MYRIOPHYLLUM	Moderate	100%
			POTAMOGETON	Moderate	50%
			UTRICULARIA	Light	90%
			SAGITTARIA	Light	90%
0.8	85 A.	7/16/59	MYRIOPHYLLUM	Dense	100%
			NYMPHAEA	Moderate	100%
			BRASENIA	Light	100%
0.5	7 A.	9/15/59	BRASENIA	Dense	100%
			NYMPHAEA	Moderate	100%
			NUPHAR	Moderate	100%
			MYRIOPHYLLUM	Light	100%
			SAGITTARIA	Light	90%
0.2	20 A.	9/17/59	ELODEA	Dense	100%
			NYMPHAEA	Light	100%
			POTAMOGETON	Light	0%
0.3	203 A.	9/19/59	MYRIOPHYLLUM	Dense	100%
			NYMPHAEA	Dense	100%
			POTAMOGETON	Moderate	40%
			UTRICULARIA	Light	80%
			VALISNERIA	Light	50%
			SAGITTARIA	Light	100%
			CABOMBA	Light	100%
0.8	9 A.	9/25/59	NYMPHAEA	Dense	100%
			UTRICULARIA	Dense	80%
			CERATOPHYLLUM	Light	80%
			MYRIOPHYLLUM	Light	100%
			SAGITTARIA	Light	100%

Of the emergents tested at 0.5 ppm, Nuphar sp. (yellow pond lily) and Nymphaea sp. (white pond lily) took about 1 month to completely disappear. At low rates, which were tested during the month of September 1959, and at a difference of 10° in water temperature from the previous tests, Nuphar sp., Nymphaea sp., and Brasenia sp. took up to 8 weeks to sink below the surface of the water. The difference in time could be due to a number of factors, some of which may be concentration of chemical, level of physiological activity, and environmental temperature.

Another phenomenon, which lead us to believe that SILVEX was effective in low concentrations, was that in ponds, where only slight currents could be found, large areas adjacent to the location of treatment were effected. It was found that minute quantities of chemical, being carried to other parts of the pond, produced results comparable to areas sprayed at the rate of 1.0 ppm. In one area, a large cove, covering 15 acres was impenetrable because of lack of depth and density of weed growth. By spraying on the outer edge of the cove, the aquatic vegetation, which consisted primarily of Nymphaea sp. and Utricularia sp., was completely controlled throughout the entire 15 acres.

Throughout the study, it was observed that SILVEX acted as a plant stimulant upon aquatic vegetation. This was manifested in a temporary acceleration in growth. Formulations of 2, 4, 5-T, generally classified as systemic herbicides, have been known to produce conditions which result in the death of the plant because of its inability to obtain adequate nutrients necessary for continued metabolism.

Aquatic plants, like their terrestial counterparts, are in constant competition with each other for two very critical and basic elements, i. e. nitrogen and phosphorus. Other inorganic chemicals, occurring in the aquatic environment in trace quantities, can also act as limiting factors on their growth. If the growth rate of the aquatic plant life is increased to the point whereby the required amount of the essential elements is no longer available in sufficient quantities, the physiological activities of the plant cell ceases. This results in a gradual death of the plant. This ecological principal is known as Liebig's Law of the Minimum.[4]

Since concentrations of SILVEX within the range of 0.3 ppm to 1.0 ppm produce results on the same magnitude, in certain plants, as do applications at 2.0 ppm to 2.5 ppm, it appears that the additional chemical may only hasten the process without producing significant differences in the end result.

SUMMARY:

Field studies of over 400 acres treated indicate that SILVEX is an effective low-rate aquatic herbicide. Concentrations ranging from 0.5 ppm to 1.0 ppm effectively controlled most forms of aquatic vegetation treated, with the exception of certain forms of the Family ZOSTERACEAE (POTAMOGETONCEAE).

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2. Younger, R. R. - Proceedings 13th Northeastern Weed Control Conference, "Progress Report on the Use of Kuron, 2, 4-D, and 2, 4, 5-TP Granules as Aquatic Herbicides," pp 322, 328

3. Boschetti, M. M. - Proceedings 13th Northeastern Weed Control Conference, "Field Testing of Kuron as an Aquatic Herbicide in Massachusetts," pp 315-321

4. Clarke, George L. - Elements of Ecology, John Wiley & Sons, Inc., New York, 1954, pp 280-291

A STUDY OF THE EFFECT OF THE WEED KILLER, 2, 4-D GRANULAR ON THREE EXPERIMENTAL PLOTS OF LONG POND, DUTCHESS COUNTY, N. Y.

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The purpose of this study was to compare the results upon three experimental plots, after each had been treated with different concentrations of 2,4-D granular. Observations were made not only of the effects upon the pondweeds, but also upon any changes occurring within the plankton and benthic populations. The dates during which this study was carried out were June 1 - September 24, 1959.

I wish to thank Mr. John Gould of the New York State Department of Conservation for his continuous encouragement as well as his practical help. I could not have obtained my samples without the use of the dock and boat of Mr. Otto Johnson. Under the plan of aiding summer research for college faculty, the Shell Companies Foundation gave me a small grant toward current expenses. As usual, the Zoology Department of Vassar College stretched its budget to supply me with apparatus, with student assistance and film. The Chipman Chemical Company sent the correct amount of 2,4-D granular.

Long pond has been described in detail. (Pierce, 1958, 1959). Therefore a description of only the experimental plots will be given here. These three plots were located within the very shallow littoral zone (1-2 feet) which was choked with a dense growth of submergent and floating plants. All plots were 50 x 50 feet.

Plot CN, unlike most of the lake, had a hard gravel bottom. The common surface plants were Nymphaea odorata and Brasenia sp. The submerged plants included Utricularia purpurea, Chara fragilis, and four species of Potamogeton, namely, P. amplifolius, P. natans, P. Robinsii, and P. crispus.

The two plots J S W and J S E were more typical of the shore line and similar to the control plot. The bottom consisted of a deep soft mud which favored a very dense growth of aquatic plants. The dominant floating plant was Nymphaea

Pierce, 1958. 12 Ann. Meet. Northeast Weed Control Conf. 338-343

1959. 13 Ann. Meet. Northeast Weed Control Conf.

odorata which literally covered the surface of the plots. The submerged plants formed a tangled mass through which it was impossible to row. Although there were several weeds composing this mass, *Utricularia purpurea* was by far the dominant species.

The control plot was selected south of the plots J S W and J S E, at a point far enough removed to be unaffected by diffusion.

Between June 1-4 a preliminary sampling was made. After the application of the pellets on June 11, this routine sampling was repeated at intervals, namely on June 15, July 1, July 23, and September 20. Samples were taken at random from each plot and the control. At each station the bottom temperature was recorded, a water sample from the bottom was obtained, and two hauls for benthic organisms were made with an Eckman dredge. One plankton haul was also made. Since it was almost impossible to drag the net through the dense weeds, no attempt at quantitative data was made. The contents of the dredge were sieved, identified, and counted in the field. The plankton was taken directly to the laboratory where it was identified under a binocular dissecting microscope. The water samples also were carried immediately to the laboratory where determinations of pH and O_2 in ppm were made by the use of the Hellige Testing Apparatus. Duplicate water samples have been sent to the laboratory of the Chipman Chemical Company for further analysis of the 2,4-D content.

The application of the pellets was made by hand on June 11. Plot CN received 2.7 lbs., which is at the rate of 10 lbs./acre, and 1.5 ppm. Plot J S W received 5.7 lbs., which is at the rate of 20 lbs./acre, and 3.1 ppm. Plot J S E received 11.4 lbs., which is at the rate of 40 lbs., and 6.2 ppm.

Upon application, the pellets sink slowly to the bottom or come to rest upon the leaves of the floating or submerged plants. Although most pellets dissolve (or at least disappear) by the fourth day, a few were visible even on the seventh day after application.

Since plot CN was so different from the other two, this will be described separately, and plots J S W and J S E will be commented upon together. In plot CN by the fourth day, the usual changes had become apparent. The stems of *Nymphaea* and *Brasenia* were elongated, coiled, and weakened. The leaves were overturned, and many of them broken off. Observations were made almost daily for a week. By June 23, 12 days after the application, these two plants were cleared away. The *Nymphaea* remained absent for the season; but about a month later, July 21, a few plants of *Brasenia* returned. Unfortunately there were no plants of *Brasenia* in the plots J S W or J S E with which to compare the effects of a stronger concentration. Daily observations for a week, and later at longer intervals, showed no damage to the submerged plants. In fact, by July 6, a month later, the forest of Potamogetons was thriving, producing new blossoms, and many new green leaves. By July 23, the conditions were the same. It is impossible to make a decisive statement about either Utricularia or Chara. They may have been held in check but they certainly were not cleared out. For the Potamogetons, the dose of 1.5 ppm of 2,4-D, far from slowing them, appeared to increase their growth.

The results of the pellets upon the two plots J S W and J S E were similar, with greater devestation occurring in J S E where the stronger concentration, 6.2 ppm, had been used. By the fourth day, the usual reaction had taken place in Nymphaea. The stems were elongated, many were coiled, the leaves were overturned and beginning to break off. This devestation continued for three or four weeks until finally all leaves and stems had decayed, sunk, or been removed by the wind. By July 21, the surface was cleared of lily pads to the extent that a fisherman was observed trying his luck in the area. Needless to remark, the surface remained clear for the season. There is no question that with either concentration, 3.1 or 6.2 ppm, Nymphaea can be controlled. One comment should be added here concerning the action of the pellets. After one week the dividing line between treated and surrounding untreated area was very distinct. So very marked was the margin of the J S E plot, that an uninformed observer could have placed the stakes around it accurately.

The results upon the submerged plants were much more difficult to evaluate. In all fairness it must be admitted that the bladderwort was so dense that even if some of it had been killed, this would scarcely be noticed. During the two weeks after treatment this plant appeared to be held in check. By the middle of August, the great mass appeared to be reduced a little. When comparisons with surrounding untreated areas and the distant control were made, there was less bladderwort in the experimental plots. However, bladderwort was still abundant and far from being eliminated. The moss Drepanocladus uncinatus proved to be a stubborn plant which flourished under treatment.

At all times throughout the study, the control area presented a lush green surface of flat lily pads and abundant blossoms, and the submerged plants were equally luxuriant.

The summer of 1959 was extremely hot as is reflected by the temperatures recorded from bottom waters. From June 1-September 24, the temperatures varied from 66° - 80° F., and during most of July and August the level remained high, 78° - 80° F. The pH reflected somewhat the seasonal changes. In

June it was 7.5 falling in summer to 6.8, and rising again slightly in September to 7.2. The dissolved oxygen content also reflected summer conditions. In early June it was as high as 8.5 ppm, falling to an extreme low of 3.5 ppm in July, and rising in September to 6.5 ppm. Neither the pH nor the oxygen content showed any change which could be interpreted as due to the treatment by 2,4-D pellets. Any variations were apparently seasonal and comparable to the control.

The benthic organisms identified from the dredges represented the following groups: Annelida, worms and leeches; Gastropoda, several species of small snails; Pelecypoda, mostly the small clam, Sphaerium; Amphipoda, the scud; Isopoda; Insecta, larval forms of mayflies, damsel flies, dragon flies, and midges. Many of these organisms were not strictly bottom dwelling forms but were attached to the living or partly decomposed weeds which came up with the dredge. Careful comparison of these samples indicated that the 2,4-D pellets did not appear to decrease the numbers or eradicate any one group.

No exact counts were kept on the large aquatic vertebrates, such as fish, frogs and turtles. However, all three groups were well represented in the plots throughout the summer. Special attention was given to observation of the fish within the plots. Many young fish as well as adult forms were noticed in all the plots throughout the season.

The plankton identified represent the following groups: Myxophyceae, Chlorophyceae, Flagellata, other Protozoa, Nematoda, Rotifera, Annelida, Crustacea, and Insecta. Within these groups are more than 50 commonly occurring species identifiable by no greater magnification than the low power of the compound microscope, as well as many other minute forms which were not identified. The constancy of the plankton population was monotonous to study. Although no precise quantitative sampling or counting was attempted, largely because of the difficulties of collecting, it is safe to say that there was no indication that the application of 2,4-D reduced the numbers or vigor of the plankters.

SUMMARY

1. Three experimental plots, 50 x 50 ft., were selected along the shore line of Long Pond. These plots were densely populated with floating and submerged aquatic weeds.

2. The study of plots extended from June 1-September 24, 1959.

3. Preliminary study of the following conditions and organisms was made on June 1; temperature, pH, dissolved oxygen content, plankton, benthic forms, aquatic vertebrates, and aquatic plants. This routine study was repeated at intervals, namely, on June 15, July 1, July 23, and September 23.

4. The three experimental plots, CN, J S W, and J S E, were treated with different concentrations of 2,4-D granular. Plot CN received 1.5 ppm, J S W received 3.1 ppm, and plot J S E received 6.2 ppm.

5. *Nymphaea odorata* was successfully eliminated by all three concentrations.

6. *Brasenia sp.* was first cleared away by treatment of 1.5 ppm but made a feeble return later.

7. Concentration of 1.5 ppm did not reduce *Potamogetons* , but rather seemed to accelerate them.

8. Concentrations of 3.1 ppm and 6.2 ppm reduced but did not eliminate *Utricularia purpurea*.

9. The temperature varied from 66° - 80° F. during the season and remained for several weeks in mid-summer at 78° - 80° F.

10. The pH dropped from 7.5 to 6.8 during mid-summer, and returned to 7.2 in the fall.

11. The dissolved oxygen content varied from 8.5 ppm in June to an extreme low of 3.5 ppm in July, but returned to 6.5 in September.

12. The plankton remained constant both in numbers of species represented and in abundance.

13. The benthic forms were continuously represented by the same species, and their numbers remained constant.

14. Fish, both young and adults, were present in all plots throughout the season.

A NEW 2,4-D AMINE PELLET FOR ERADICATION OF WATER CHESTNUT

by

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INTRODUCTION

Water chestnut is an introduced aquatic of annual type which is detrimental to recreational uses of waters, including fishing and water fowl hunting. In a number of local areas it has been successfully eradicated by various methods of suppressing seed formation annually, carried on over a period of several years, a span of time necessary to cover delayed germination of all seeds. Improvements in methods, both in effectiveness and in economy, are being sought for application in a project for eradication of this plant in progress in New York[1].

In areas too large for hand-pulling of plants the use of 2,4-D has been generally used. Spray methods were extensively tested by Smith[2]. Last year at the 13th Annual Meeting of this Conference a report "Comparative Tests of Various Herbicides on Waterchestnut" (Greeley and Steenis) included information on tests of granular formulations of 2,4-D. There were indications that a soluble form of 2,4-D on a granular carrier seemed promising. This conclusion was drawn from plot tests[3] of 2,4-D amine and 2,4,5-T amine on vermiculite. However, from other experience it was expected that use of 2,4-D amine on 8-15 mesh hard atta-clay pellets would be a more economical and desirable formulation.

1/A Federal Aid in Fish and Wildlife Restoration Project FW-3-D.

2/Smith, Ralph H. Experimental Control of Water Chestnut (<u>Trapa natans</u>) in New York State, New York Fish and Game Journal, 2:173-193. 1955.

3/The 1958 plot tests carried on by John H. Steenis of the Patuxent Research Refuge, U.S. Fish and Wildlife Service, gave the initial information for devising an amine pellet. His continued interest in conducting further tests in 1959 is gratefully acknowledged.

Although 2,4-D ester pellets are currently manufactured and amine pellets are not, preliminary inquiry to several manufacturers indicated that amine formulations on attaclay could be manufactured. It was decided to use amine pellets in the New York water chestnut eradication project in 1959 rather than ester pellets for a number of reasons.

The water chestnut plant has certain peculiarities that favor the use of a water-soluble material on pellets. The entire stem of this plant has large numbers of filamentous "root-leaves" which are effective structures for absorbing material in solution. The plant is not dependent upon its roots for effective nourishment and has a small root system in relation to the area of these stem leaves.

This applies to mature or nearly mature plants. In its young stages the water chestnut plant is a relatively simple shoot without leaves. Presumably the primary growth is from stored nutrients in the large seed. After rosettes of floating leaves reach the surface, growth of the submerged leaves is rapid. In May 1958 plots to test methods for early control of water chestnut, including ones with several rates of applications of ester pellets, gave no indications that plants could be successfully killed in early stages, before rosettes appear at the surface of the water.

Considerable experience with 2,4-D on water chestnut has indicated that late in the growth season, after flowering and setting of seed has started, there is a point beyond which application of the herbicide is too late to stop all seed formation. In the time required for the plant to die seeds which are partially mature are likely to grow to maturity.

Since available information indicates that application of 2,4-D is effective only for a short period, neither too early nor too late for effective results, it appeared desirable to hit the plants quickly with a soluble formulation rather than to rely on slow absorption of a less soluble formulation. Although a test plot with ester pellets applied June 17, 1958 gave an effective kill the slow liberation of 2,4-D would probably result in some waste of the material in applications late in the season when quick absorption is likely to be essential.

The water chestnut eradication project being aimed entirely at this plant, it was not desired to prevent growth of other types of aquatic plants. Ester pellets are reported effective for a long period and might prevent desirable plants from growing.

A considerable amount of experience in using the liquid amine on water chestnut, also the previously-mentioned 1958 plot tests indicated that this material diffuses rapidly. In large scale applications this quality is desirable as it makes for greater economy of coverage, also more rapid application as it is not necessary to be as careful to avoid skipping some spots in an area being treated.

Bids were put out in the spring of 1959 for 12,000 pounds of a 10% (acid equivalent) 2,4-D amine on hard grade 8-15 mesh attaclay pellet. Contract award was made to Chemical Insecticide Corporation. The material supplied bore the following information: Isopropanolamine salt of 2,4-D 12.5% (acid equivalent 10.0%), inert ingredients 87.5%.

METHOD AND RATE OF TREATMENT

The pellets were applied by using a Garber Seeder (power take-off tractor model). To use it in a boat a flexible drive shaft and gear reductor were employed, the source of power being a gas operated motor taken from a portable sprayer. By clamping two 12 foot aluminum boats together it was possible to operate an air-propellor outboard motor to propell this rig. Later, in dense water chestnut it was necessary to use two of these motors, one mounted on each boat.

Tests of effective rates of application were conducted in late June on a large rather homogeneous area of water chestnut in an enclosed bay of the Mohawk River. Plots of approximately one acre each were used, each with an untreated buffer zone using various gate settings of the seeder from No. 5 to No. 10.

On the basis of these tests a setting of 7½ was adopted for application of approximately 50 lbs. of pellets (5 lbs. acid equivalent) per acre using boat swaths approximately 15-20 feet apart (center to center). In view of the extensive diffusion of 2,4-D amine observed in the test plots, which resulted in effective control across the untreated buffer zones as well, it was concluded that there was no need to confine swaths to the effective throwing range of the seeder. As mounted on the boat the seeder threw a swath of about 15 feet with the material used.

Under field conditions application rates were subject to many variables including boat speed which was estimated to approximate 3 miles per hour but is affected by wind, load and other factors. It was estimated that pellets could be spread at about 6 acres per hour.

RESULTS

A large number of field checks from late June to early September, usually made weekly, contributed useful information in drawing conclusions. Observations on liquid amine treatment areas were also made both this year and in previous years.

As bearing on the use of pellets there are two types of situations affecting success of control of water chestnut in the Mohawk River: enclosed bays and open water areas. In the Hudson River both types are complicated by tidal flow.

Results of control operations with amine pellet in enclosed bays of the Mohawk were consistently good; results in open water were poor. In many areas there was a gradient in the degree to which the plants were affected. In tidal areas preliminary tests of pellets of both amine and ester types carried on by John H. Steenis (Hudson River 1959) were ineffective. It is evident that dilution factors greatly affect the success of pellet treatments. The good results in enclosed bays not subject to rapid dilution by untreated water is probably attributable to a greater total absorption of 2,4-D by the plants.

In view of the fact that water chestnut beyond the zone of pellet applications was affected, it is clear that diffusion under water is an effective method to reach water chestnut. Pellets sink rapidly and presumably most of the soluble 2,4-D is liberated at or near the bottom. Since the transpiration stream of the plant is upward, any 2,4-D absorbed in the lower parts of the plant would be translocated upward.

Observations on the effect of 2,4-D amine sprays indicated that absorption is by the floating leaves and upper area of stem with its root leaves. However, the lower structures of the plants are not readily reached by sprays and regeneration of healthy lateral rosettes from below the point of injury is a frequent occurrence. There was less tendency to similar regeneration in plants treated with pellets. Very weak terminal rosettes were observed in some plants receiving sublethal treatments of pellets.

In one ponded area in the Vischers Ferry Game Management Area, two attempts were made in 1958 by spraying to control a small patch of water chestnut with considerable recovery of the plants each time. In 1959, one pellet treatment killed these plants.

It is concluded that pellets provide a successful method for putting 2,4-D amine in contact with lower structures of water chestnut where effectiveness is greater. By use of the seeder device, as described, this can be done rapidly and economically. Pellets appear to be a material improvement over sprays where treatment by underwater diffusion is effective at all. As previously mentioned, this is in enclosed bays or other areas where there is not rapid dilution.

TESTS OF AMINE UNDER SUBMERGED CONDITIONS

In areas not subject to rapid dilution, it is possible that a submerged method of using 2,4-D amine solution that would be as effective as the pellet method in treating submerged parts of water chestnut plants might be devised. One trial was made at the Vischers Ferry Game Management Area to test the effect of allowing amine solution to flow into a canal area. This gave a good kill on water chestnut but also killed several willow trees having roots in the water. Further work to control the rate of application would be needed to develop a practical method for using the amine liquid most effectively and safely.

John Steenis has suggested the possibility of adding a high specific gravity liquid to carry the 2,4-D amine solution downward in the water and has conducted several promising tests on water chestnut involving addition of triethanolamine to the spray solution.

Methods other than use of pellets for carrying 2,4-D amine to the bottom show some promise but there is insufficient data at present for comparing these with pellets.

SPRAYING AS A SUPPLEMENTARY METHOD

Since sprays can be effectively used to kill the top structures of water chestnut plants directly, this method is more effective than the pellet method in tidal areas or other locations subject to rapid dilution, even though repeat spraying may be necessary to prevent regrowth from below the surface. It is clear that the surface leaves can be treated at a relatively constant rate under varying types of water conditions.

In view of the reliance on pellets for use on a major fraction of the entire acreage treated in 1959, spraying was used only as a supplementary method. By use of an 18 foot spray boom, 2,4-D amine was applied at an approximate rate of 5 lbs. per acre (acid equivalent). This was in a water solution. To avoid necessity of mixing each tankload applied, the pump was rigged with a screened water intake trailed from boat.

This method proved to be only partially successful and several plot tests to improve it were conducted. These indicated that spraying with undiluted amine is more satisfactory than using water to dilute it. It is anticipated that spraying in many areas subject to tide or other dilution factors will continue to be a useful method.

EFFECT OF PELLETS ON OTHER PLANTS

Since the objective of eradicating water chestnut in the New York project is concerned with improvement of fish and game resources, the maintenance of favorable aquatic vegetation is a consideration of some importance. Although water chestnut tends to crowd out other aquatic plants, there were in many of the areas concerned various other species which afforded opportunity to observe effects of the treatment. Under the operating conditions of the project, using both pellet distribution apparatus and spray boom at relatively low rates of application, there was a high degree of selectivity for water chestnut with little or no effect on other aquatic plants and no damage to bank or shore vegetation.

The effect of 2,4-D applied for water chestnut eradication on shore vegetation is a matter of importance since it is often necessary to treat areas close to shore properties.

Filamentous algae frequently formed dense mats in dying or dead water chestnut after the pellet treatment but this effect appeared to be temporary.

Duckweed was commonly observed under similar conditions.

Coontail (Ceratophyllum) frequently appeared in treated areas. Although some stands of this plant growing at time of treatment seemed to be damaged by the effect of 2,4-D regrowth was vigorous.

Pondweeds (Potomogeton) were not very common in the areas treated. Several patches observed showed some browning of floating leaves following 2,4-D pellet treatment but showed a tendency to recover. In fact several of these patches of pondweed under observation increased materially following kill of water chestnut.

Emergent vegetation including arroweed (<u>Sagittaria</u>) and cat-tail were frequent in many areas where pellets were used. Arroweed was not visibly affected in most areas. Occasional plants showed some distortion from 2,4-D in an area where some pellets were spilled in loading the boat. Cat-tail seemed to be unaffected.

It should be emphasized that the selectivity depends to an important extent upon a low rate of application. Under experimental conditions, as previously mentioned, a heavy treatment with liquid amine allowed to flow into the water killed or damaged several willow trees in the immediate area of heavy concentration. Also, a bed of pondweed <u>Potomogeton</u> was apparently killed (not checked for regrowth).

PELLETS AND SAFETY FACTORS

Ordinary precautions were taken to avoid excessive exposure of personnel to dust from pellet application by placing the distribution apparatus on the stern rather than the bow of boat. However, the amine pellets used were somewhat more dusty than might be desired and methods of manufacture to keep fine dust at a minimum would be desirable. Dust from pellets was somewhat irritating in the opinion of personnel applying these pellets and respirators were used occasionally.

Although wind drift of dust from pellets was recognized as a possible hazard to shore vegetation, no damage of this type materialized even though pellets were applied under a wide range of working conditions as to wind as a factor.

RECOMMENDATIONS

Amine pellets (10% 2,4-D acid equivalent) on 8-15 mesh hard attaclay gave effective control of water chestnut at approximate rate of application of 5 pounds per acre acid equivalent in areas not subject to rapid dilution, such as the enclosed bays along the Mohawk River. Since such areas comprise a large fraction of the entire New York infestation of this plant, the pellet method is a useful management tool. Treatment of water chestnut previous to flowering stage is recommended for best results in suppressing all seed formation. Bays should be treated rapidly to build up an even density of 2,4-D over the entire local area. Small patches in large areas of water will require higher rates due to diffusion into untreated water. Pellets are not recommended in tidal areas, in strong current or other areas where dilution is rapid.

Aquatic Weed Control, Carnegie Lake, Princeton, New Jersey

1953 to 1959

Robert K. Huckins
Chipman Chemical Company, Inc.

Aquatic vegetation has been a nuisance at Carnegie Lake, Princeton, New Jersey, for at least 50 years. Over the last seven years there has been a rapid spread in the size of the infested area and a marked change in the weed species composition. Both chemical and mechanical means have been used to control the aquatic growths and each has been successful for a time. This paper will deal with the changes that have occurred and the attempts made to combat them, and is presented to show the fluid situation encountered when dealing with aquatic weeds.

<u>Carnegie Lake</u> - Carnegie Lake, located in Princeton, New Jersey, and the property of Princeton University, is a 262 acre, very shallow impoundment which receives waters from the Stony Brook and Millstone River drainage basins. It is a long, narrow body of water, some 4 miles in length, and for the most part not over 400 feet wide. It is used primarily as a site for the University rowing activities, although there is a fair amount of recreational boating, sailing and fishing carried out as well.

The lake lies on a southwest-northeast axis, with the drainage towards the northeast. The Stony Brook enters the lake at the southwest end and waters from this drainage make up the first two miles of the lake. At this point the Millstone River enters into the lake and from there to the dam at Kingston there is a practically straight course of approximately two miles.

The nature of the Stony Brook basin is such that the waters of the Stony Brook are heavily silt-laden and have contributed materially to the rapid filling in of the upper end of the lake. As the waters flow down through the first mile of lake, they are, except in the driest of seasons, very muddy and cloudy. The Millstone River system, on the other hand, is generally clear running, except in time of storm and flood, and where these waters enter the lake they push the silt-laden waters aside and over against the northwest bank. Depending on water flow, these two waters eventually intermingle and at the lower end of the lake the water is once again cloudy. The differences in the silt-load and subsequent turbidity of the lake from these two watersheds have a marked bearing on the weed growth conditions within the lake itself, as will be explained shortly.

As mentioned above, the lake is used for rowing activities of the Princeton University crew under the following conditions: The boat house is located at the southwest end of the lake near the entrance to the Stony Brook. The starting line and rowing course is just northeast of the entrance of the Millstone River and runs for approximately two miles to the dam at Kingston, at the northeast end of the lake.

Practice rowing is conducted over the full length of the lake and on occasions a 4-mile race is held covering the entire lake. The majority of the races are, however, held on the mile and three-quarter course which is 200 feet wide and is located as explained above. In order to use the lake for both actual racing and practice, it is necessary to have a relatively weed free situation, not only on the course but in the areas between the course and the boat house so the racing shells and accompanying launches may go back and forth.

Vegetation Progression - In 1952, in the area at the start of the rowing course, which is also the area of clear water caused by the influence of the incoming waters from the Millstone River, there appeared a small patch of weeds of about one acre in extent. In the early spring of 1953, the Coach of Crew at Princeton University consulted with the New Jersey Division of Fish and Game, Aquatic Weed Control Project (Federal Aid to State Fish and Wildlife Restoration, Project D-J, F-1-R-1 to R-5*) and a general survey of the situation was made. Present at that time were submersed aquatic plants of the following species:

Fanwort	(*Cabomba caroliniana*)
Elodea	(*Anacharis canadensis*)
Pondweeds	(*Potamogeton natans* and *P. pusillus*)

The principal emergent species noted were Yellow Water Lily, *Nuphar* spp. The waterlilies were not in the rowing course but were located somewhat above the starting line.

In 1954, the weed growth had enlarged to cover approximately five acres, again in the clear waters influenced by the entrance of the waters of the Millstone River. In 1955, the weed growth had expanded to cover some 5 to 10 acres and, because of its barrier influence, was extending the silt-free area, thereby weeding waters farther and farther down the shore of the lake and outward into the lake proper. By 1957, the upper half of the mile and three-quarter rowing course was badly choked with weeds, and in the fall of that year an inspection and up-to-date survey of the weed growth was made at Carnegie Lake by the coaching staff, members of the Fish and Game Division, and by the author. It was noticed almost immediately a new species of aquatic weed had become dominant in the lake. The new offender was identified as Water Milfoil, *Myriophyllum heterophyllum*.

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*The author was Project Leader of this Project from 1951-1956.

Growths of this weed were very heavy in the lower two miles of the lake and including the entire race course. Spotted infestations were noted in all parts of the lake up to and including the area around the boat house. Also noticed were scattered clumps of Curly Leafed Pondweed, Potamogeton crispus.

Control Efforts - In April of 1953, there was approximately one acre of weeds that were troublesome. This area was treated on April 9, 1953, by hand-broadcasting copper sulfate crystals over the weed bed at a rate of 500 pounds per acre.

By April 21, some 98% of the weeds had gone to the bottom and the area was clear enough for unrestricted rowing. Subsequent observations made on July 1 showed considerable growth of the Cabomba and fair control of the other submersed weeds.

In 1954, the weed growth had enlarged to cover approximately five acres. This area was treated again with copper sulfate as in 1953. Work done elsewhere in New Jersey indicated at this high rate of 500 pounds per acre copper sulfate was effective as a control agent for the Anacharis and the Potamogetons, but not for the Cabomba; however, Cabomba was not prevalent nor did it generally reach the surface of the water until late June and thus did not interfere with the rowing in April and May.*

In 1955, the weed growth area had expanded to cover some 5 to 10 acres, and it was decided to switch treatment procedures from chemical to mechanical. While mowing of aquatic vegetation is not generally considered to be very effective, the situation at that time in Carnegie Lake was such that it was far more economical and feasible to mow than to apply further copper sulfate treatments. The weeds would be mowed in the spring at which time there would be sufficient flow of water to remove the cut weeds from the rowing course.

A mowing machine was purchased by Princeton University and, with the cooperation of the Fish and Game Division, mowing of submersed and emergent weeds was undertaken. Reasonable control was obtained, at least in the early and late spring seasons.

The extent of the weed infestation continued to expand and by 1958 it was necessary to operate the mower in the spring and fall and to cover extensive areas. The machine was not capable of handling such large areas and a new approach was sought.

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*Huckins, Robert K. - "Aquatic Weed Control Studies in New Jersey, A Progress Report", Trans. 9th Annual Meeting, Northeastern Weed Control Conference, New York, January 1954.

As a result of the survey of the situation in the fall of 1958, several chemicals were considered for the control of the growths present and each were discarded for various reasons. In the spring of the year, with the high rate of flow entering the lake from both the Stony Brook and the Millstone River systems, it would be impractical to use liquid formulations that require 2 or 3 days of contact time with the vegetation. The only possible carrier for the chemical would have to be a granule which would sink to the bottom and not be overly affected by water movement. It was decided to use a 2,4-D granule formulation as a means of control. Field-testing of granular 2,4-D has demonstrated the effectiveness of this chemical for the control of Water Milfoil, the major weed species now present.

<u>Application of 2,4-D Granular</u> - A 2,4-D granular formulation containing 20% acid equivalent 2,4-D iso-octyl ester impregnated on attaclay granules was used in this work. 2,4-D granules, when broadcast over the surface of the water, sink to the bottom. It is believed, based on my personal observations, the 2,4-D is released into or near the bottom muds, enters the plant through the root system and lower stem areas, and is translocated upward into the plant, causing its death.

Previous experimental work with 2,4-D in the granular form shows that when applied at the acid equivalent of 20 pounds per acre it was effective for the control of Water Milfoil. It was also believed that even at this high rate of application, it would not be effective on the <u>Potamogeton</u> species. As the Water Milfoil represented 95% or more of the weed growth present, it was decided to go ahead with treatment in the spring of 1959 using granular 2,4-D.

A catamaran type of pontoon barge was constructed and a Tarco Scotchman Rotary Seeder* machine was purchased by the University for the application of the chemical.

On April 10, 1959, application began and by April 11, 1959, the entire rowing course had been treated, i.e. some 50 acres. At that time weed growth was just starting, but it was felt, due to the long time required for the chemical to be effective in cool waters, that an early application was a 'must'.

From April 11 up through May, an additional 50 acres were treated adjacent to the course, below the finishing line, and above the starting line. Weed growth was active during this period.

<u>Results</u> - On May 26, 1959, an inspection was made of the aquatic growths present in Carnegie Lake. At the same time, an

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*Tarrant Manufacturing Company, Sarasota Springs, New York.

evaluation was made of the effectiveness of the application of the 2,4-D granular material for the control of individual weed species present in the lake.

Those areas which had been treated for at least a month or more showed a high degree of Water Milfoil control, conservatively estimated at 95%. Some 'holidays' were present, undoubtedly because of skips in the application. No subsequent regrowth was noted in the treated areas throughout the rest of the 1959 season.

In the area around the staring line of the rowing course, referred to in the earlier history of the lake, there was evidence of a considerable growth of Potamogeton natans and P. pusillus, Cabomba and Coontail, Ceratophyllum demersum. Observed throughout the entire lake were clumps of Curly Leafed Pondweed, Potamogeton crispus. In the area above the starting line up to and beyond the boat house there were observed scattered growths of Water Milfoil, which, while not present in heavy mass, were dense enough to cause concern. A narrow strip of this area had been treated about this time with the granular 2,4-D and it was expected this treatment would be effective. The presence of weed growths outside this treated area indicated, however, that the entire area would become weed choked, possibly by lake summer and certainly by the spring of 1960 if additional treatments were not undertaken during the 1959 growing season.

Subsequent Treatments - In the area adjacent to the starting line, some 3 to 4 acres, were heavy concentrations of the 2,4-D-resistant Potamogetons, Cabomba and Ceratophyllum. A spray application of sodium arsenite was made on an experimental basis at approximately 20 ppm.* By this time, water flow had been reduced to a minimum by summer drought conditions. By using an excessive rate in a limited area it was expected some satisfactory weed control would result.

Additional areas of the lake populated with Water Milfoil were treated with granular 2,4-D during the month of August. Some areas of Potamogeton and Cabomba were treated at excessively heavy rates, ranging from 40 to 60 pounds acid equivalent per acre, in an attempt to kill these weeds with this chemical if at all possible.

Results of Late Season Treatment - In mid-August the area treated with the liquid sodium arsenite was inspected; at least 75% of the vegetation had been controlled. The few scattered clumps left would not interfere with rowing and the lake appeared to be in fine shape.

The results of the late-season treatment of 2,4-D granular are not too clear. Where the weeds were not too dense at the time of application it appeared the treatment had been effective. Conversely, where the weeds were so dense as to make it almost

*Chipman Atlas "A", sodium arsenite solution.

prohibitive to get the boat through to treat them, the results were very poor. It is theorized that the dense vegetation kept the granules from reaching the bottom muds and thus nullified the effectiveness of the chemical. Further observations in the spring of 1960 may throw some light on these opinions.

Because of the difficulty in reaching the weeded areas at anything approaching a uniform rate of speed or in a uniform pattern, it is not feasible to state the exact poundage of granular 2,4-D applied in the August treatments. It is estimated that in the more open areas the material was applied somewhere between 40 and 60 pounds per acre acid equivalent and this high rate was successful in controlling the Potamogetons and the Cabomba.

Future Plans - Those areas heavily infested with Potamogetons, Cabomba, etc. in the fall of 1959 have been mapped out and will be treated in the spring of 1960, using heavy rates of granular 2,4-D before the weed growth becomes too abundant. This application will attempt to secure the control of these plants for the entire season. The use of sodium arsenite has shown sufficient promise, even under some flow conditions, to make it worth trying again next year.

Regular inspections will be made of the entire lake starting in the early spring, and chemical will be available to spot treat as needed those areas showing reinfestation.

Conclusions - In reviewing the changes that have occurred in the weed populations over the last seven years, and in consideration of the variety of treatment procedures that have been used to attain at least some degree of control, it is obvious the authorities at Princeton University have a most fluid problem on their hands. It is conceivable that species resistant to 2,4-D will become established in the lake, and certainly reinfestation of many species will occur from the untreated waters of the two contributing watersheds.

It is obvious that treatment procedures and chemicals will have to be selected to meet the individual situations as they occur. New chemicals will in time be developed which, no doubt, will prove far more efficient than those which have been used over the past seven years.

The methods used at Carnegie Lake to combat and control the heavy aquatic vegetation serve as an example to lake owners in general of what they can expect in their aquatic weed control efforts. In any situation, as long as the upstream watershed remains well populated with weed species, one can look for continued trouble in the ponds and lakes within the watershed, and those concerned with aquatic weed control activities should be expected to develop plans of aquatic weed control which are fluid and not static.

A Review of Simazine for Aquatic Weed Control

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Since the introduction of Simazine as an herbicide, several workers have tested it against aquatic weeds and algae. These trials were more or less of an introductory nature. The results of the trials ranged from poor to mostly fair, and a few showing excellent control. However, all of these tests have served to point out where and how Simazine would fit into the aquatic weed control picture.

In the 1958 season, a total of twenty reports were received and can be summarized as follows:

1.	Lab screening (on weeds)	2 reports
2.	Lab screening on fish	3 reports
3.	Ponds or portions of ponds	7 reports
4.	Irrigation	
	(a) Drained lake or Pond bottoms	2 reports
	(b) Laterals and ditches	5 reports
5.	Algae Control	1 report

Laboratory screening on weeds indicate Simazine is effective against Duck weeds, Hornworts, Najas, some Potamogetons, Elodea, and water star grass at concentration of 5 to 10 ppm. One worker used 2,-10, 25,50,100 on the above species, and reported a browning of the foliage at 96 hours at all concentrations.

Three reports on fish toxicity indicate Simazine is safe on a variety of minnows, bluegills, large-mouth bass, and catfish at a concentration of 10 to 37 ppm. Walker, Missouri, reports safe level up to 50 ppm.

Seven reports were received where Simazine was used in ponds or portions of ponds. Rates used range from 2 to 40 pounds active per acre on a surface basis, and from 1.2 to 9 ppm on a weight volume basis. It is interesting to note that fair results were obtained with rates as low as 1.25 ppm and excellent results with 2.5 ppm to 3 ppm (active). In one case, pond enclosures were treated with 1 to 5 ppm using a 50% wettable powder formulation and rates of 8 to 20 pounds per acre active surface basis using an 8% granular formulation. In both cases, excellent control of four algae species, including Chara, and five species of Potamogeton was obtained with rates of 5 ppm volume basis and rates over 10 pounds active in granular form surface basis. Also significant is the fact that rates of 20 pounds active in granular form gave comparable results with extended periods of control.

In most cases, Simazine has been more effective on submerged weeds rather than on emerged or marginal growth. One worker reports initial kill of top growth of cattails and Phragmites, but recovery within two months. Two workers reported no control of Alligator weed.

A total of seven reports were received where Simazine was used on irrigation systems. In one case, Simazine was sprayed directly to the soil of a drained lake bottom at 10 - 15 - 20 - 26 pounds per acre active. Good control was obtained from May to late July. After this period, Mysophyllum and Potamogeton pictinatus made rapid growth. In another case where Simazine was applied at a rate of 12 pounds per acre (active) to the soil of a drained irrigation stream, Sago pondweed was controlled for three weeks after water was turned into the stream. In another case, at rates of 20 to 40 pounds, active, in granular form were applied to a drained canal bottom. No control was obtained by this treatment.

Algae Control

Grigsby, in the Proceedings of the North Central Weed Control Conference 1958, reported on a laboratory screening trial that three triazine herbicides, including Simazine, possessed algaecide properties. He reported that Simazine at 5 ppm was lethal to green algae and that toxicity persisted in the tank for six months. Walker reported in the July 1959 issue of WEEDS that granular Simazine at 10 pounds per acre (active) controlled Chara, Chladophora and Spirogyra in a pond enclosure. Other workers have reported control of the filamentous algae Pithophora and Cladophora using rates of 1.5 to 3 ppm as wettable powders and 10 to 20 pounds per acre (active) in granular form. Still another worker reported inhibited growth of Chlorella, Oscillatoria and Phormidium for several weeks at a rate of 6 ppm.

Up to the writing of this paper, four reports have been received where Simazine was used during the 1959 season. In Illinois a test on three small enclosed ponds at 6, 3 and 1.25 ppm (active) using a 50% wettable powder yielded the following results:

(1) At 6 ppm excellent control of filamentous algae and pond weed (<u>Potamogeton spp</u>.) was obtained. Water was crystal clear for about a month. Partial fish kill - especially of larger shiners - was noted.

(2) At 3 ppm excellent weed control of Potamogeton was obtained. No fish injury noted.

(3) At 1.25 ppm excellent control of algae and fair control of submerged Potamogeton species. No fish injury was noted.

In Ohio a half acre lake was treated during the first week of May with a 10 lb. actual per acre rate of Simazine. By July 24 good control of pondweed was obtained. Algae control lasted 3 weeks.

Another lake in Ohio treated on August 12, 1958 with 10 lbs. active per acre, required retreatment in July of 1959. This lake was spring fed and had a steady rate of run-off water.

In still another 1.5 acre lake, a rate of 20 lbs. of Simazine 50W and 20 lbs. of Phygon per acre was applied in May 1958 to an area 0.25 acres in size at one end of the lake. Good control was noted during the 1958 season. In July 1959 Potamogeton spp. infested 10% of the area originally treated. Good control of algae was noted during 1958 and no control in 1959.

In interpreting these results, some consideration should be given to the chemical and physical properties of the compounds involved.

Simazine is reported to have a water solubility of 5 ppm. It is stable at ordinary temperatures to acids and bases. Therefore, we can assume that this solubility will not vary significantly with the conditions encountered in ponds or streams. However, little is known at present about the rate of solution. This factor becomes important when we compare the action of Simazine with the present chemicals used for aquatic weed and algae control. Experiences with Simazine on established perennial terrestial weeds have shown the effects of the chemical are relatively slow even under optimum rainfall conditions. The same situation appears to be true when it is used against aquatic weeds. In cases where good control was eventually obtained, a period of three to four weeks elapsed before noticeable symptoms appeared. The rate of decay after this period seems to be much more rapid. A combination of these factors indicate two possibilities.

1. That applications should be made during a period when the weeds are most receptive for the absorption of Simazine. On terrestial weeds, Simazine has little or no effect on foliage. The same is probably true on aquatic foliage since these species have more protective cuticles. Therefore, the rate of reaction on these aquatic species is the result of slow absorption by the roots. If this is true, then it is desirable to maintain the highest possible concentration in the root area. This brings up the question of what formulation to use on submerged species.

2. No one can deny the advantages of using a granular material on a surface rate basis versus the pretreatment work involved in making a ppm application. If we convert some of the rates used with granulars to ppm, we find in most cases that good control was obtained with rates less than 1 ppm, which is not in accordance with laboratory findings. If this is true, granular material seems the logical formulation for submerged species. However, it also implies that applications should be confined to small enclosed ponds with a minimum or no run-off after application is made.

In closing, the following conclusions appear to be valid concerning the use of Simazine for aquatic weed work.

1. Simazine is effective against submerged aquatic weeds.
2. Granular rates in excess of 10 pounds per acre (active) have shown promise on the major aquatic pest.
3. Early applications appear most effective.
4. Simazine is effective on aquatic algae. However, further test work is needed to determine whether wettable powder or granular material is the best method of application.
5. Results on emerged and marginal growth is inconclusive.

THE AQUALIN HERBICIDE PROCESS FOR AQUATIC WEED CONTROL

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The need for an aquatic herbicide, more economical than chaining and more versatile than aromatic solvents, has been apparent in the Western states for some time.

After several years of laboratory and field testing in the irrigated areas of the West, the Aqualin* Herbicide Process was developed for the control of aquatic weeds. All typical submersed and floating aquatic weeds and algae appear to be susceptible. (Emergent species such as cattails and tules are not affected.)

The chemical used in the process (formerly designated as F-98) is a special stabilized formulation of 2-propenal which kills through its sulfhydryl reactivity destroying important enzyme systems in the plant cell. The chemical, though quite volatile, is completely water soluble and through the use of special application techniques can be handled with ease. Once the chemical is applied, correctly, in water it will (1) control submersed weeds for relatively great distances in moving streams and (2) control weeds at rather low concentrations in lakes and static ponds (3) cause weeds to disintegrate eliminating necessity for mechanical removal.

The chemical is toxic to fish but when applied by the Aqualin Herbicide Process method, fish kill may be kept to a minimum. By proper dosage and placement of the chemical, fish can be herded for selectively eliminating rough species from game species.

Aqualin herbicide, currently, is being marketed commercially in the West and in Florida for use in flowing canals, ditches and drains.

During this past summer over two dozen experimental trials were conducted in lakes and ponds of the Northeast, Midwest and South to evaluate the compound in static water. Results ranged from good to excellent depending upon method of application and weed species.

From samples of bottom fauna organism taken prior to and after treatment, with dosages up to 12 ppm in an Iowa lake, it was found that Aqualin herbicide had no effect on the organisms present (CHIRONOMID, CERATOPGONID, TUBERFICID, CHAOBORUS AND TANYPUS).

Toxicity tests on laboratory animals show that Aqualin herbicide is relatively toxic to mammals. However, it is not an insidious chemical nor is it hazardous to use. In feeding tests with laboratory animals and lactating animals, no adverse effects were observed and no milk contamination occurred when it was added to the drinking water at levels far in excess of those that would be encountered under any conditions of use.

*Trademark - Shell Chemical Corporation

The Aqualin Herbicide Process after two seasons of experimental demonstrations and one season of commercial applications, is rapidly becoming an accepted method of aquatic weed control in the irrigated West.

For lakes and ponds, additional tests have been outlined for next season involving new chemical formulations and application techniques.

Survival of *Uca pugnax* in Sand, Water and Vegetation Contaminated with 2,4-Dichlorophenoxyacetic Acid.

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The toxicity of the herbicide 2,4-dichlorophenoxyacetic acid has been studied in a wide variety of animals. Extensive research has been carried out on the lethal effects of this compound on vertebrates, particularly domestic, farm and laboratory animals (1-5). These investigators found that the oral toxic doses of this compound varied from 300 mg/kg to 1,000 mg/kg depending on the species used in the investigation. Generally, 2,4-dichlorophenoxyacetic acid was found to be a relatively non-toxic compound to birds and mammals.

The affect of 2,4-dichlorophenoxyacetic acid on the survival of animals which inhabit vegetation upon which this weed killer is used has been investigated less thoroughly. Putnam (6) found that spray concentrations of this compound did not affect the growth of grasshopper nymphs as long as the weeds remained succulent. Also, fish which lived in lakes into which this compound was placed were not affected directly (7). However, 2,4-dichlorophenoxyacetic acid did affect the embryonic development of frogs (*Rana temporia*) under laboratory conditions (8). Fertilized eggs kept in a concentration of 2,4-dichlorophenoxyacetic acid greater than 0.05% were slow to develop and a concentration of 0.5% stopped development completely. Eggs kept a week in a 0.1% solution (recommended spray concentration) and then transferred to fresh water hatched, but the larvae were smaller than normal. Because of the dilution that spray applications would undergo when applied to ponds, lakes, and streams, it would appear that these animals would probably not be affected in field studies.

The present investigation was undertaken to investigate the affect of 2,4-dichlorophenoxyacetic acid on an amphibian which inhabits an environment in which the water content does not remain constant. Littoral animals, i.e., those which inhabit the tidal zone along the sea coast, are subjected to wide variations in climatic extremes. During the summer months particularly, water evaporation from tide pools occurs very rapidly and consequently a weed-killer sprayed during low tide would concentrate in a matter of a few hours. Therefore, animals which inhabit these areas would be exposed to high concentrations of a herbicide although for a short period of time between the tides.

Uca pugnax, commonly known as the fiddler crab, was selected as the experimental animals to be used in this investigation. This animal inhabits the eastern seacoast to as far north as Cape Cod. It is found in numerous quantities in the marsh grass occupying mud or sand burrows near the high water line. Consequently, this animal is subjected to varying degrees of moisture.

All crabs used in this study were obtained from the Marine Biological Laboratory Supply Department at Woods Hole, Massachusetts during the summer of 1958. 2,4-dichlorophenoxyacetic acid (Eastman Organic) was made up in fresh water solutions of 1,000, 2,500, 5,000 and 10,000 parts per million. Fiddler crabs were exposed to these concentrations for various lengths of time and survival counts recorded.

Forty five (average) fiddler crabs were placed in large confinement basins containing sea water, sand and marsh grass. The various concentrations of the herbicide were then applied as a fine sprinkle. In a series of experiments in which the animals were exposed continuously, 2,4-dichlorophenoxyacetic acid was 100% lethal after 108 hours exposure to 10,000 p.p.m. (50% of the crabs were dead in 72 hours) and 5,000 p.p.m. (50% of the crabs dead in 96 hours), after 10 days in a concentration of 2,500 p.p.m. and after 17 days in a concentration of 1,000 p.p.m.

A second series of experiments was performed in which the confinement basins were prepared as above. However, the animals were exposed to the herbicide for only a twelve hour period. They were then removed, rinsed in fresh sea water and placed in uncontaminated confinement basins. Fifty per cent of the animals exposed to a concentration of 10,000 p.p.m. were dead within 72 hours after they were removed from the contaminated basins. Eighty per cent were dead after two weeks. A single 12-hour exposure to recommended spray concentrations (1,000 p.p.m.) was lethal to 10-20% of the animals within two weeks.

Another group of animals were injected (into the hemocoelom at the base of a walking appendage) with a solution of the sodium salt of 2,4-dichlorophenoxyacetic acid. The toxicity of this compound was found to be greater than 0.4 mg/gram body weight. Larger doses of this substance were not possible because of the large volume which would have to be injected.

It was concluded from this study that 2,4-dichlorophenoxyacetic acid may be toxic to animals which live in the tidal zone if the herbicide is used during low tide in hot weather.

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