Techniques and Equipment Used in Evaluating Chemicals for their Herbicidal Value

W. C. Shaw and C. R. Swanson 1/

Abstract 2/

The purpose of this paper is to describe equipment and techniques used in successive stages of evaluating chemicals of unknown phytotoxic characteristics for their herbicidal properties. The initial screening process begins with micro-tests in the greenhouse and the evaluation is continued in field plot experiments.

The construction and function of (1) an apparatus for the application of micro-quantities of chemicals as sprays, (2) a screening table for the application of chemicals when larger quantities are available, and (3) an efficient sprayer for the application of herbicidal chemicals to experimental field plots are described.

The details of a micro, macro, and field screening technique are presented, giving the amounts of chemical required for each technique and the number and kinds of plant species used.

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2/ Abstract of a manuscript to be published in a forthcoming issue of "Weeds", Journal of the Association of Regional Weed Control Conferences.

EXPERIMENTAL MECHANICAL EQUIPMENT FOR APPLICATION OF WEED CONTROL CHEMICALS

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Nozzle Tester[1]

The basic mechanism of the nozzle tester which was built by the Agricultural Engineering Department at Cornell was described at the Northeastern Weed Control Conference two years ago.[2] From our experience last summer, it appears that there is still a definite need for nozzle testing.

In order to obtain a quick record of nozzle performance in the laboratory, additions were made to the original apparatus which allow the taking of a photographic record at any desired nozzle height and pressure.

The name and size of nozzle are printed on a card which is slipped into a metal holder directly above the nozzle. Height is indicated by a pointer and scale on the right and pressure is shown by a gauge on the left. The distribution pattern is shown by the 100 c.c. graduates which catch discharge from each of the troughs under the nozzle and which appear in the lower part of the picture.

Back lighting, two photo floods, illuminates the nozzle discharge and gives some idea of the pattern and drop size. A single front spotlight near the camera brings out the necessary details.

The addition of one part of skim milk to three or four parts of water gives a liquid that shows up very well in the photographs.

With this apparatus data may be recorded rapidly, conveniently, accurately, and permanently.

Sprayer for Small Plot Work[3]

One trouble that was found with previous apparatus for small plot work was the use of special containers that were expensive and required extra handling of chemicals in the field.

This outfit uses obsolete milk bottles. A large quantity of these was available from local dealers who were changing over to new models. The clamping device for the cap was patterned after that used on ordinary fruit jars. It may be removed or attached in a few seconds. Large numbers of different test chemicals may be prepared and carried in the regular bottle crates.

Small (ten ounce) CO_2 bottles with automatic pressure regulators make a very satisfactory source of pressure. When the bottles of spray material are inverted for use, the gas bubbling through the chemical gives agitation. Aluminum tubing was used for the hand boom. The whole apparatus is so light and compact that the operator can use it for long periods without fatigue.

SAFETY PRECAUTIONS - bottles break easily if they have small cracks or checks, or if they are dropped. Always inspect carefully bottles or jars that are to be pressurized. If cracked or chipped discard them.

Use a metal screen or other guard over the bottle to prevent its being hit accidentally and to prevent injury from flying glass in case of accidental bumping of bottle or jar.

The height of the nozzles above the ground is kept constant by attaching a light chain to the boom and moving it along; just touching the ground.

Speed of travel is only as accurate as the operator can walk, but with practice this is quite uniform.

(Inexpensive speedometers are now available for tractors and wheeled vehicles.)

<u>Laboratory Spray Apparatus</u>[1]

Experimental work in ornamental horticulture brought about the need for laboratory apparatus which would accurately control speed of nozzle travel for their experimental greenhouse work. In addition to the above described apparatus, a stand and nozzle carrier were constructed to move the nozzle across pots or flats placed under it.

The nozzle was attached to a small car which was mounted on roller skate wheels. This was moved back and forth by a pin extending downward from a horizontal V-belt. The latter was driven by a fractional horsepower electric motor through suitable V-belts and pulleys.

The necessary control is obtained through a manually operated switch, three microswitches and a solenoid which releases a brake. The nozzle is moved from one end to the other each time the manual switch is thrown. The proper speed is attained quickly and remains uniform as the nozzle moves from one end to the other.

A stroboscopic light was used to determine the actual speed of travel of the belt and car, and it was found to be within one per cent of the designed speed of two miles per hour.

By using this equipment, fast and accurate preparation of experimental laboratory units is possible.

Stem Spray Applicator[4]

A report has been made on the use of the floating shoe type support for nozzles when applying chemicals for weed control in bean rows. This work is so similar to that which has been done in cotton that we have copied quite closely the shoe developed by Meek and Wooten at the Delta Branch Experiment Station, Stoneville, Mississippi. However, the shape of some of the members was altered to simplify construction and to adapt the shoes for our crops. It was necessary to make entirely different shields to lift the bean leaves as they are much lower and more dense than cotton foliage. But on the whole this new design seemed more satisfactory than that used previously.

Literature Cited

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2. Northeastern Weed Control Conference Proceedings. January 1950. pp 88-91.

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Movement and Persistence of Herbicides Following Their Application to the Soil Surface

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Introduction

Herbicides that can be applied to the surface of soil to kill weeds upon germination have met with increasing favor. Quite a few new compounds such as CMU(3-p-chlorophenyl-1,1-dimethylurea), Experimental Herbicide 1 (sodium 2,4-dichlorophenoxy ethyl sulfate), and "chloro" IPC (isopropyl-N (3-chlorophenyl)-carbamate) have been introduced and tried for this purpose. Users are interested or concerned with the movement of these chemicals in soils, in how they should be applied to be most effective, and in how long they remain active. They are equally interested in the effect of other factors such as soil types and rainfall on the weed-killing power of these chemicals. Studies on the movement and persistence of sodium trichloroacetate (1) and 2,4-D (2) applied to the soil have been reported.

Method and Materials

A simple technic was devised to study some of the factors which might influence the herbicidal effectiveness of chemicals applied to the soil. The method was designed for use in either the field or the laboratory. The results discussed herein were obtained in the laboratory. The method consisted of using germinating seeds to detect the presence and movement of herbicides in soil. The herbicides were applied to the surface of the soil, and then layers of soil were removed to determine distribution of the chemical.

To hold a soil mass of known thickness, a straight glass tube 1¼ inches in diameter by 5½ inches in length was used. One end of the tube was tightly stoppered and 75 grams of composted loam having a moisture content of approximately 12 percent was poured into the tube. The soil was compacted by applying pressure of 2000 grams to a plunger-like cork forced against the soil through the open end of the tube. The tightly fitting cork originally placed in the tube was then removed. With the tube in a vertical position, pressure was exerted on the plunger-like cork until the soil was forced upward flush with the open end of the tube. Uniform tubes of soil were made up as described. The herbicide was applied to the exposed soil surfaces as an aqueous spray.

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A sample of soil was collected by pushing the column out through the open end of the cylinder for a distance of 3 millimeters and slicing off the ejected portion with a razor blade. In this way it was possible to collect the surface 3 millimeter layer, or any lower layer 3 millimeters or more in thickness.

To obtain a sufficient volume of soil for testing, comparable samples were collected from several replicate tubes and combined. After being mixed the soil was placed in small, shallow tin cups and seeds of mustard, a plant known to be sensitive to the chemicals used, were then planted in them. Sufficient water was then applied to the soil to bring it to optimum moisture content for germination of these seeds. During germination, the cups containing soil and seeds were stored in the dark at 80°F. and in a nearly saturated atmosphere.

To determine the amount of each chemical to be used, preliminary experiments were carried out with each herbicide to determine the dosage necessary to inhibit shoot elongation following germination. This level was used as a basis for determining rate per acre application of the 3 herbicides being tested.

A series of standards for a known range of dosage levels was made for each herbicide. The growth of mustard plants in soil of the standards was then compared with that of other plants in soil containing unknown amounts of the herbicide. In this way it was possible to study the movement and to estimate roughly the amount of herbicide in the soil on the basis of the growth inhibiting effect.

The three pre-emergence herbicides selected for study were CMU[1/], Experimental Herbicide 1[2/], and "chloro" IPC[3/]. These compounds were used in these experiments as a suspension, a solution, and an emulsion, respectively. The rates of application selected on the basis of relative sensitivity of mustard seedlings were as follows: CMU at 20 lbs. per acre, Experimental Herbicide 1 at 2 lbs. per acre and "chloro" IPC at $2\frac{1}{2}$ lbs. per acre, calculated on the basis of the commercial preparations.

1/ Supplied by E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware.

2/ Supplied by Carbide and Carbon Chemicals Corp., New York, New York.

3/ Supplied by Pittsburgh Plate Glass Company, Columbia Chemical Division, Pittsburgh, Pennsylvania, as a 40 percent formulation containing Atlas emulsifier (G-1255).

Results and Conclusions

Penetration of Herbicide Applied as a Spray:- To study penetration the spray mixtures were applied at the rate of 40 gallons per acre. The herbicides were almost wholly concentrated in the surface 3 millimeter layer of the soil. Sufficient amounts of Experimental Herbicide 1 and "chloro" IPC penetrated into the next 3 millimeter layer to inhibit growth of the test plants. None of the three preparations penetrated significantly below the second millimeter layer.

Effect of Volume of Water Used on Soil Penetration of the Herbicides:- Comparisons were made between 40 and 100 gallons of water per acre, using a constant rate of application of each chemical. Here again approximately all of the herbicide remained in the surface 3 millimeter layer of the soil regardless of the volume of water applied.

Effect of Mixing a Sprayed Surface Layer with the Underlying 3 Millimeter Layer:- A thin concentrated layer of the herbicide on the surface of the soil was most effective in retarding the growth of mustard seedlings. When the sprayed surface 3 millimeter layer was mechanically mixed with the underlying 3 millimeter layer the effectiveness of the herbicides was reduced about 60 percent, indicating that even a slight mechanical disturbance of the surface soil after application of the herbicide might reduce its effectiveness.

Effect of Simulated Rainfall on Penetration:- In another experiment water equivalent to ½ inch of rainfall was added drop by drop to the surface of the soil in the tubes after application of the three herbicides. Before the soil layers were sampled one hour was allowed to elapse so that the water could reach an equilibrium with the soil. Some of each herbicide was washed downward from the concentrated surface layer. Under these controlled conditions ½ inch of simulated rainfall reduced the effectiveness of CMU and "chloro" IPC enough to be easily detectable. A measurable amount of the Experimental Herbicide 1 was washed from the surface 3 millimeter layer to the 3 millimeter layer below the surface.

Effect of a Wetting Agent:- CMU and Experimental Herbicide 1 were used for tests with a wetting agent. Water mixtures of these herbicides to which 0.5 percent or 5.0 percent Tween-20 was added were made. The penetration of these mixtures was compared with that of others without the wetting agent. Where no simulated rainfall followed application, the herbicides remained almostwholly in the surface 3 millimeter layer of soil even with the wetting agent present. The wetting agent did not affect penetration of either herbicide.

Persistence of Herbicides in Surface Layer and Layers Near the Surface:- The herbicidal activity of the three compounds in the surface 3 millimeter layer and the 3 millimeter layer underneath this one was greatly reduced during 1 month's storage of the tubes in a nearly saturated atmosphere. At this time the mustard seed germinated readily in samples of the stored soil and the plants grew about as tall as the control plants (Table 1). More inactivation occurred in the surface 3 millimeter layer treated with "chloro" IPC than in the 3 millimeter layer immediately below this one.

It is obvious that the method might be used to determine inactivation of the herbicide in different layers of soil, but no effort was made to study this problem in the present investigation.

Table 1. Effect of herbicides on mustard planted immediately after spray application to soil surface and after storage of comparable soil for one month at 80°F. in a nearly saturated atmosphere.

Herbicide	Rate per acre	3 mm. layer sampled	Percent reduction in height: Sampled immediately	Percent reduction in height: Sampled 1 month after treatment
CMU	20 lbs.	Top	88	25
		Next to top	50	25
Experimental Herbicide 1	2 lbs.	Top	98	38
		Next to top	85	38
"Chloro" IPC	2½ lbs.	Top	90	25
		Next to top	25	25
Untreated controls			0	0

Movement of Herbicides in Various Types of Soil:- In another series of tests the effectiveness of the three herbicides was compared when they were applied to sand, loam, and sand-loam mixtures. After the herbicides were sprayed on the soil, water equivalent to ½ inch of rain was applied to half of each mixture.

In the soil which received no rain the herbicides remained as a thin concentrated layer near the surface. It was again noted that simulated rain moved the chemical downward only a slight distance, making it less effective than when it was in a thin concentrated layer on the surface of the soil. When sand was added to the soil or sand was used, the three herbicides moved downward into lower levels whether or not simulated rainfall was applied.

This may be due to the fact that the chemical may be more readily adsorbed on the surface of the organic matter present in loam.

Summary

A method was developed for collecting thin layers of soil after surface application of the herbicides, CMU, Experimental Herbicide 1, and "chloro" IPC; and testing these samples for the presence of the herbicide at different soil depths by their inhibiting effect on growth of mustard seedlings.

1. A thin concentrated layer of herbicide near the surface of the soil was found to be most effective in the present tests.

2. Approximately all three of the herbicides remained in the surface 3 millimeter layer of loam regardless of whether 40 or 100 gallons of water was applied.

3. Water applied to simulate ½ inch of rainfall washed some of the herbicide from the concentrated layer near the surface downward into the soil, reducing the concentration in the upper layer of soil and thus making the herbicide somewhat less effective.

4. The addition of a wetting agent (Tween-20) had no effect on the penetration of the soil by the herbicide.

5. Activity of the three herbicides in the surface 6 mm. layer of loam decreased markedly during 1 month of storage under humid conditions.

6. In sand and sand-loam mixtures the herbicide penetrated more deeply than in loam.

Literature Cited

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Livestock Poisoning From Herbicide Treated Vegetation

Stanford N. Fertig

With the development of 2,4-D and other new chemicals for weed and brush control, the question of livestock injury and losses became of primary importance to farmers. Whenever chemicals were mentioned, the question of toxicity to animals automatically arose. Farmers, and logically so, were concerned about the effect of the materials recommended on the operator using them and the possible effect on animals eating the treated vegetation, whether it be forage or weeds.

During the past 4 years, several reports of livestock poisoning have been reported in New York State, primarily from eating the stunted growth of sudan grass or the wilted leaves of choke cherry or wild cherry after they had been treated. Naturally, from the farmers' viewpoint the losses were credited to the chemicals used or a result of their use and due compensation called for through mutual agreement or court action.

During the 1950 spray season, a new menace to chemical weed control was introduced by a report of nitrate poisoning in livestock as a result of grazing treated vegetation. A mixture of 2,4-D + 2,4,5-T was used for weed and brush control along a roadside in Central New York. The loss of three dairy cows was reported from grazing the treated vegetation. Local veterinarians, after a post-mortem examination, reported nitrate poisoning. No further action was taken.

In the spring of 1951, a member of the staff of Cornell Veterinary College reported the loss of a valuable race horse. This animal was grazing in a 2,4-D treated pasture paddock. Again, veterinarians diagnosed the loss due to nitrate poisoning. This did not occur in New York State.

On June 28, 1951 one of our assistant county agents reported the loss of three yearling heifers from eating weeds along a corn field where 2,4-D had been sprayed. Weeds present included ragweed (Ambrosia artemisiifolia), lambs-quarters (Chenopodium album), narrow-leaved plantain (Plantago lanceolata), sheep sorrel (Rumex Acetosella), wild strawberry (Duchesnea indica), black medic (Medicago lupulina), buttercup (Ranunculus acris), pigweed (Amaranthus retroflexus), chicory (Chicorium Intybus), Blue Thistle (Echium vulgare), and smartweed (Polygonum pennsylvanicum).

The amine form of 2,4-D was used at 1/2# per acre. Pressures of 80 to 100 pounds per acre (excessive) were used. The 2,4-D was applied in 5 to 7 gallons of water per acre. A strong breeze was blowing across the corn field into the pasture area.

The corn was sprayed June 18, 1951. One week later, on June 25 the first heifer was found dead. Two others were reported

Tuesday, June 26. Forty-six mature cows and five other heifers grazing in the same pasture area showed no ill effects. The heifers were pastured with the cows but were not taken in at milking time and had not been receiving grain or salt up to the time of the loss. Three local veterinarians examined the animals and reported death due to nitrate poisoning.

Two other cases of similar nature were reported in New York State during the summer of 1951 but could not be confirmed.

In an effort to determine if 2,4-D treated vegetation actually increased in nitrate content, preliminary experiments were undertaken in the Agronomy Department of Cornell University during the summer of 1951.

Objectives

The objectives were (1) to find in what weed species this increase occurred, (2) how rapidly the change took place, (3) whether the change was related to stage of growth and (4) what the magnitude of increase was.

Method

Several methods of nitrate determination were tried, since it was not known which would give the most reliable index of change. The use of phenyl-disulphonic acid gave the least variation between triplicate samples on both treated and untreated vegetation and was used in the one experiment reported.

The best method of handling the samples after collection was also a problem. At first, they were collected in glycine bags and placed immediately in a portable refrigerator box lined with dry ice. This did not prove satisfactory due to (1) inability to freeze the entire sample immediately, (2) the impossibility of grinding these frozen samples without thawing and (3) the difficulty of getting an accurately weighed sample for nitrate determination.

A second method consisted of collecting the samples (approximately 400 grams) and placing them in a drying oven at 170 degrees Farenheit within 30 minutes. Although these may have been some hydrolysis, all samples were treated in a similar manner and the percentage error should have been uniform throughout the experiment. This method allowed for easier grinding and handling of the samples.

The results of the prelimary trials are not given although several growth stages were sampled during this period.

The method employed in sampling the area was as follows: A pair of household scissors was used to clip the sections of the plant and cut them in approximately 2-inch sections. Only that portion of the stem was taken which animals might be considered to normally eat. Approximately 50% of each sample was tops while 50% was lateral branches and stem. No plants were sampled a second time and each time the 600 x 30-foot area was covered to get the sample.

Experiment and Results

The plant material used for the results presented in Tables I, II and III was collected from a section of a corn field where the planter did not function. The area had not been cultivated. Strips 600 feet long and 30 feet wide were treated using 1/2 lb. of amine salt of 2,4-D and 1/2 lb. of MCP (60%) per acre. Both chemicals were applied at 35 pounds pressure and in 10 gallons of water per acre. Approximately 400 gram samples of each weed were taken just before treatment and at 24-hour intervals on the 1st, 2nd and 3rd days. Samples were also taken on the 5th, 7th, 9th and 11th days after treatment. The samples were oven dried for 24 hours at 170 degrees Farenheit, ground and nitrate determinations run.

Weed species present in sufficient quantity to allow for the sampling periods included ragweed (Ambrosia artemisiifolia), pigweed (Amaranthus retroflexus), lambs-quarters (Chenopodium album) and Curled Dock (Rumex crispus).

The stage of growth of the weeds when treated were:

Ragweed - - bud to early bloom

Lambs-quarters - - early bud stage

Pigweed - - early bloom stage

Curled Dock - - vegetative stage; no stem elongation

The results of the nitrate determinations are given in Tables I, II and III. Percentage values are average of three determinations of the same sample and are expressed as percent NO_3^-.

Table I. Change in Nitrate Percentage on 4 Species of Weeds Treated with 2,4-D at 1/2 Pound per Acre

Weed Species	Interval of Sampling in Days after Treatment						
	Untreated	1	2	3	5	7	9
Ragweed	2.61	2.29	3.33	1.39	1.43	1.84	1.63
Lambs-quarters	1.59	2.32	2.13	2.01	2.34	2.40	3.06
Pigweed	1.04	1.29	3.31	1.79	1.34	1.47	0.63
Curled Dock	0.29	0.96	0.86	1.15	0.85	0.63	0.41

The percentage values are an average of three determinations on the same sample. In further checking by the laboratory it is felt that values in table are approximately 20% low.

Table II. Changes in Nitrate Percentage on 4 Species of Weeds Treated with MCP at 1/2 Pound per Acre.

Weed Species	Interval of Sampling in Days after Treatment						
	Untreated	1	2	3	5	7	9
Ragweed	2.61	2.57	1.70	2.27	2.15	1.36	2.00
Lambs-quarters	1.59	1.91	2.82	3.18	2.95	2.00	3.20
Pigweed	1.04	1.05	1.23	0.50	0.98	1.23	0.91
Curled Dock	0.29	0.29	0.29	0.36	0.16	0.36	0.36

Values are an average of 3 determinations on the same sample. In further checking by the laboratory, it is felt that values in table are approximately 20% low.

Table III. Changes in the Nitrate Percentage at 0, 10 and 12 days after Harvest of 4 Untreated Weed Species

Weed Species	Days after sample was taken before determination made			New Check from untreated area after 12 days
	0	10	12	
Ragweed	2.61	3.42	3.23	1.23
Lambs-quarters	1.59	1.73	1.69	1.78
Pigweed	1.04	1.11	- - -	0.49
Curled Dock	0.29	0.31	- - -	0.27

Values are an average of 3 determinations on the same sample.

Discussion

From these data, 2,4-D would appear to cause a more rapid and greater increase in nitrate content than MCP. This would conform to the herbicidal activity of the two compounds.

Information in table III would support nitrate accumulation in untreated cut vegetation and would indicate the importance of proper handling of samples and a well organized laboratory routine for running determinations. Delay in making determinations could result in large experimental error.

Although the values are not consistent, it would appear there is justification for some caution in spraying areas where livestock are grazing and weeds are numerous.

Variation in values from day to day may be due to sampling error.

From these data the peak of accumulation would appear to fall on the 2nd to 3rd day after treatment. The loss of livestock reported has occurred 5 to 7 days after treatment. This point may be significant.

The percentage values obtained for vegetation in earlier stages of growth were not significantly different from those reported.

EFFECTIVENESS OF VARIOUS CHEMICALS IN COUNTERACTING 2,4-D TOXICITY TO SEEDLINGS

R. B. Carroll*

Several hundred chemicals have been tested for effect on primary root elongation of corn seedlings when used singly and in combination with 2,4-D. Included in the tests were: carbohydrates, organic acids, organic phosphates, amino acids, vitamins, antimetabolites, enzymes, enzyme inhibitors, antihistamines, pyrimidines, purines, several fluorescent chemicals and various miscellaneous chemicals and biochemicals.

Several chemicals counteracted, to some degree, the inhibition of root elongation resulting from exposure of germinating corn seedlings to solutions containing 2,4-D combined with the test chemical. These chemicals were: L-methionine, thiosemicarbazide, sodium 2,4-dinitro-o-cresol, chloranilic acid, riboflavin and ascorbic acid. Riboflavin was the most efficient of these chemicals.

It was demonstrated in the course of this research that riboflavin would counteract the effects of 2,4-D on germinating corn seedlings only when the seedlings were exposed to light during the test. Exposure of growing corn seedlings to solutions of riboflavin in the light reduced root elongation slightly. Growth in the dark while exposed to solutions of riboflavin had no effect on root elongation.

Further tests with the above named chemicals have demonstrated that riboflavin will counteract the inhibition of root elongation in cucumber seedlings treated with solutions containing riboflavin and 2,4-D.

When young tomato plants were treated with solutions of riboflavin, ascorbic acid, D-iso-ascorbic acid and sodium dinitro-o-cresol, each in combination with 2,4-D, it was found that riboflavin and sodium dinitro-o-cresol

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generally reduced the degree of the five responses measured while ascorbic acid and D-iso-ascorbic acid generally increased the degree of response of young tomato plants to 2,4-D.

The effects of ethylene on germinating corn and cucumber seedlings and on decapitated tomato plants have been overcome by simultaneous exposure of the plants to solutions of riboflavin in light.

The effect of indole-3-acetic on germinating corn and cucumber seedlings also has been counteracted by simultaneous exposure to solutions of riboflavin in light.

The suggestion is made that riboflavin and ascorbic acid act as hydrogen-carriers and further, that 2,4-D acts to inhibit one or more of such chemicals within plants. A tentative hypothesis is offered to explain the effect on the biochemistry of plants treated with growth substances.

SOIL STERILANTS FOR THE CONTROL OF PERENNIAL WEEDS - PROGRESS REPORT[1]

Robert E. Frans and Richard J. Aldrich[2]

Soil sterilization is that term used to designate a material which renders the soil incapable of supporting plant growth and may be temporary or relatively permanent (1).

Considerable work has been done on soil sterility in the past. Much of this work has been done in the West under environmental conditions quite different from those in the East. The New Jersey Agricultural Experiment Station has a project to investigate the use of sterilants under Eastern conditions. This paper will consider first certain factors affecting the persistence of sterilants alone and in combination. Second, progress on the use of sterilants for the control of perennial quackgrass (*Agropyron repens*) and nutgrass (*Cyperus esculentus*) will be reported.

Persistence of Sterilants

Sodium Arsenite

Methods - Tests were established to measure the persistence of sodium arsenite in a light sandy soil and in a silt loam. Sodium arsenite, on the basis of active AS_2O_3, was applied at 4000, 2000, 1000, 500, 250, 100 and 0 lbs. per acre.[3] The experimental design was a randomized block with four replications.

A one-quart soil sample was taken from each plot one month and six months after treatment and planted with 15 oat seeds in the greenhouse. Approximately 30 days after planting the oat plants were cut at the surface of the soil, allowed to air-dry, and weighed.

Results - Results are shown in Table 1 and Figure 1. The data show that arsenite toxicity disappeared more rapidly from the heavy soil. Since the sandy soil would be more readily leached the reduction in toxicity is apparently due to fixation of the arsenite in the heavy soil. The higher figures for all rates on the heavy soil are probably due to higher fertility since the light soil was undoubtedly low in available mineral elements. Greenhouse conditions were better controlled at the second date for both soils which accounts for the differences

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[1]Cooperative investigations between the New Jersey Agricultural Experiment Station and the Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U.S. Department of Agriculture.

[2]Research Assistant in Farm Crops, NJAES and Agent, Division of Weed Investigations, BPIS&AE, USDA, respectively.

[3]All rates as given in this paper are reported as pounds of active material per acre.

Acknowledgement is made to the American Smelting and Refining Company for their support of this project.

between untreated plots. However, this helps to magnify the fact that above 250 lbs. for the light soil and 500 lbs. for the heavy soil there was no significant differences between rates.

Crafts (2) reported from California that 320 lbs. per acre of sodium arsenite gave 90% control of annuals and 0% control of perennials 3 months after spraying, 95 and 60% after one year and two months, and 90% and 20% after two years and two months. In our studies the toxic effect of 250 pounds was almost completely gone in six months and that of 500 pounds considerably reduced, in the heavy soil.

Mixtures of Soil Sterilants

Many of the newer materials used for sterilization purposes have the disadvantage of being too expensive when used at rates needed for satisfactory weed kill. Consequently, tests were established to study the effectiveness of mixtures containing sodium arsenite since arsenite is a relatively cheap chemical.

Methods - Sodium trichloroacetate hereafter referred to as sodium TCA (90% active), sodium chlorate (99% active) and sodium tetraborate, hereafter referred to as borate (93% active), were mixed at varying rates with sodium arsenite and applied to plots replicated four times in a randomized block design. The plots were sampled in the manner described for the previous tests.

Results - Results are shown in Table 2 and Figure 2. The data show that in general, the sodium chlorate and sodium TCA combinations were more effective than the combinations with borate. The combination with sodium TCA at the first date were significantly better than all others at both dates. Sodium chlorate at the first date was significantly better than borate and all treatments at the second date. At the second date the combination with sodium chlorate seemed to be more persistent than either sodium TCA or borate. The effects of sodium TCA were largely dissipated at six months. There were no significant differences between rates of combinations used.

Use of Sterilants for Controlling Perennial Grasses

Soil sterilants have found wide application in the past not only in agriculture but also in industry where longer periods of control of weeds is desired such as railroad, highway, and public utility rights-of-way. From an agricultural standpoint it may often be more profitable to take land out of cultivation for a short period of time to completely eradicate a perennial weed than to allow the weed problem to go unchecked.

Quackgrass

Methods - Five chemicals, alone and in combination, were applied May 7, August 10, and November 13 in conjunction with disking one week after spraying and no disking. Results from only the first two dates are reported since results from the

Table 1. The effect of various rates of sodium arsenite on oats grown for 30 days in soil samples from treated plots.

Treatments	Light Sandy Soil: Sampled 2 mo. after spray Mg/plant	Light Sandy Soil: LSD .05	Light Sandy Soil: LSD .01	Light Sandy Soil: Sampled 6 mo. after spray Mg/plant	Silt Loam: Sampled 2 mo. after spray Mg/plant	Silt Loam: LSD .05	Silt Loam: LSD .01	Silt Loam: Sampled 6 mo. after spray Mg/plant
100 lbs./A	4.11	3.19	4.37	11.65	21.12	13.11	17.96	45.00
250 "	3.74	"	"	6.21	11.65	"	"	34.17
500 "	3.16	"	"	4.47	12.63	"	"	15.07
1000 "	3.52	"	"	4.25	2.56	"	"	8.50
2000 "	2.01	"	"	4.05	2.13	"	"	6.70
4000 "	1.91	"	"	3.87	0	"	"	4.45
Check	18.51	"	"	30.58	32.31	"	"	102.45
L.S.D. .05	3.26			3.26	14.27			14.27
.01	4.46			4.46	19.54			19.54
Av. all treatments	5.28		1.67	9.29	11.76		6.79	30.76

-4-

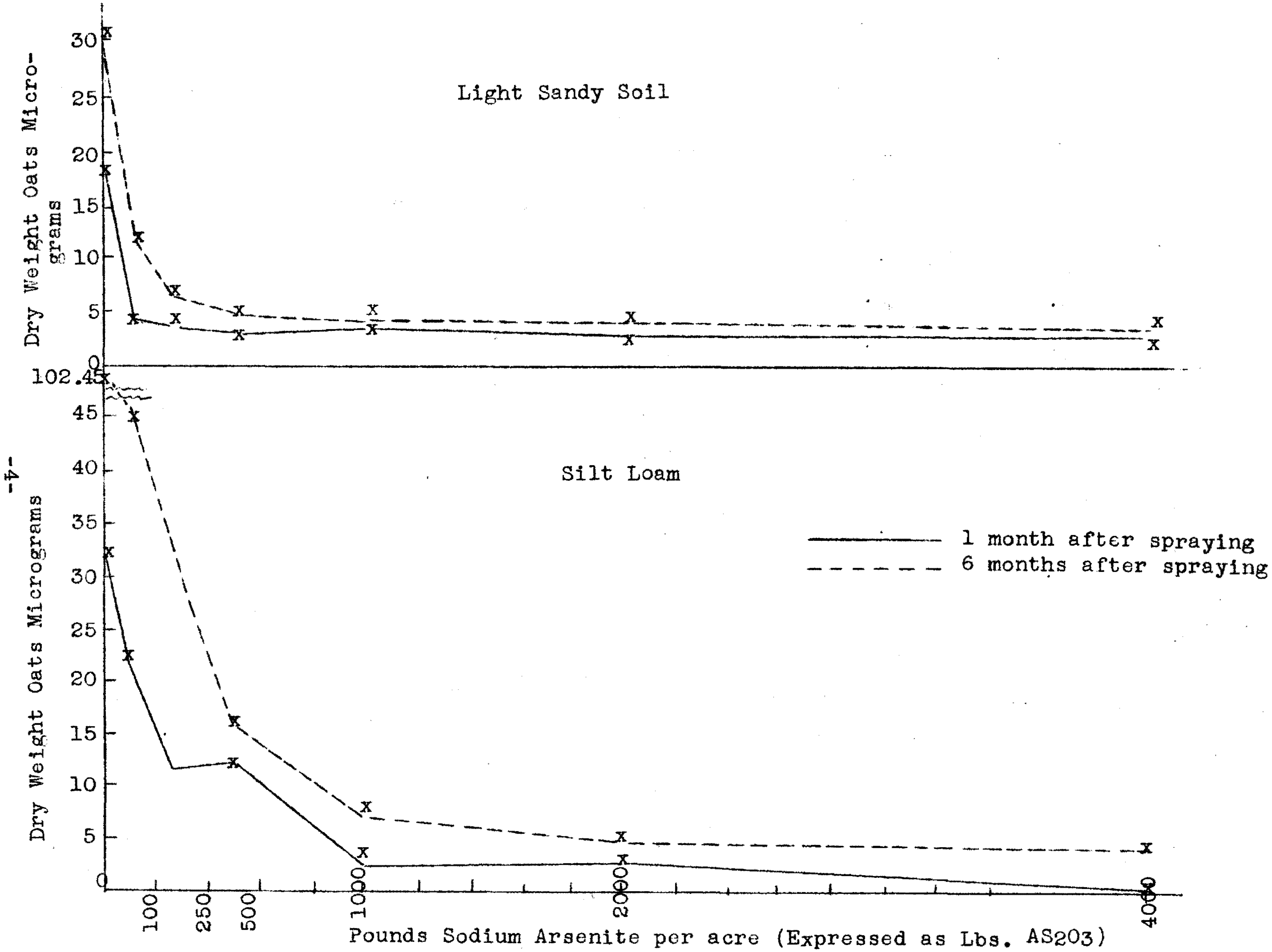
Light Sandy Soil
Dry Weight Oats Micro-grams
Silt Loam
Dry Weight Oats Micrograms
102.45
1 month after spraying
6 months after spraying
100
250
500
1000
2000
4000
Pounds Sodium Arsenite per acre (Expressed as Lbs. AS203)

Table 2. The effect of various combinations of TCA, sodium chlorate and borate with sodium arsenite on oats grown for 30 days in soil samples from treated plots.

Treatments TCA and sodium arsenite lbs./A	Sampled 1 mo. after spray Mg/plant		LSD .01		Sampled 6 mo. after spray Mg/plant	
100 - 0	0				34.96	
90 - 10	0				40.72	
75 - 25	0				40.46	
50 - 50	0				35.19	
25 - 75	0				40.39	
10 - 90	9.29				33.37	
0 - 100	24.54				29.04	
Av. all rates		4.83	5.10	36.30		
Av. all dates and rates						20.57
Sod. Chlorate and sodium arsenite						
400 - 0	4.52				30.42	
360 - 40	2.80				30.72	
300 - 100	3.55				33.90	
200 - 200	4.48				20.98	
100 - 300	10.74				18.19	
40 - 360	11.05				13.22	
0 - 400	18.36				14.14	
Av. all rates		7.93	5.10	23.08		
Av. all dates and rates						15.50
Borate and sodium arsenite						
200 - 0	28.07				43.80	
180 - 20	18.46				38.01	
150 - 50	20.46				34.73	
100 - 100	27.93				29.94	
50 - 150	23.49				22.55	
20 - 180	20.59				28.91	
0 - 200	29.38				17.23	
Av. all rates		24.05	5.10	30.74		
Av. all dates and rates						27.40
L.S.D. .05		2.19		2.19		5.82
.01		5.64		5.64		8.82

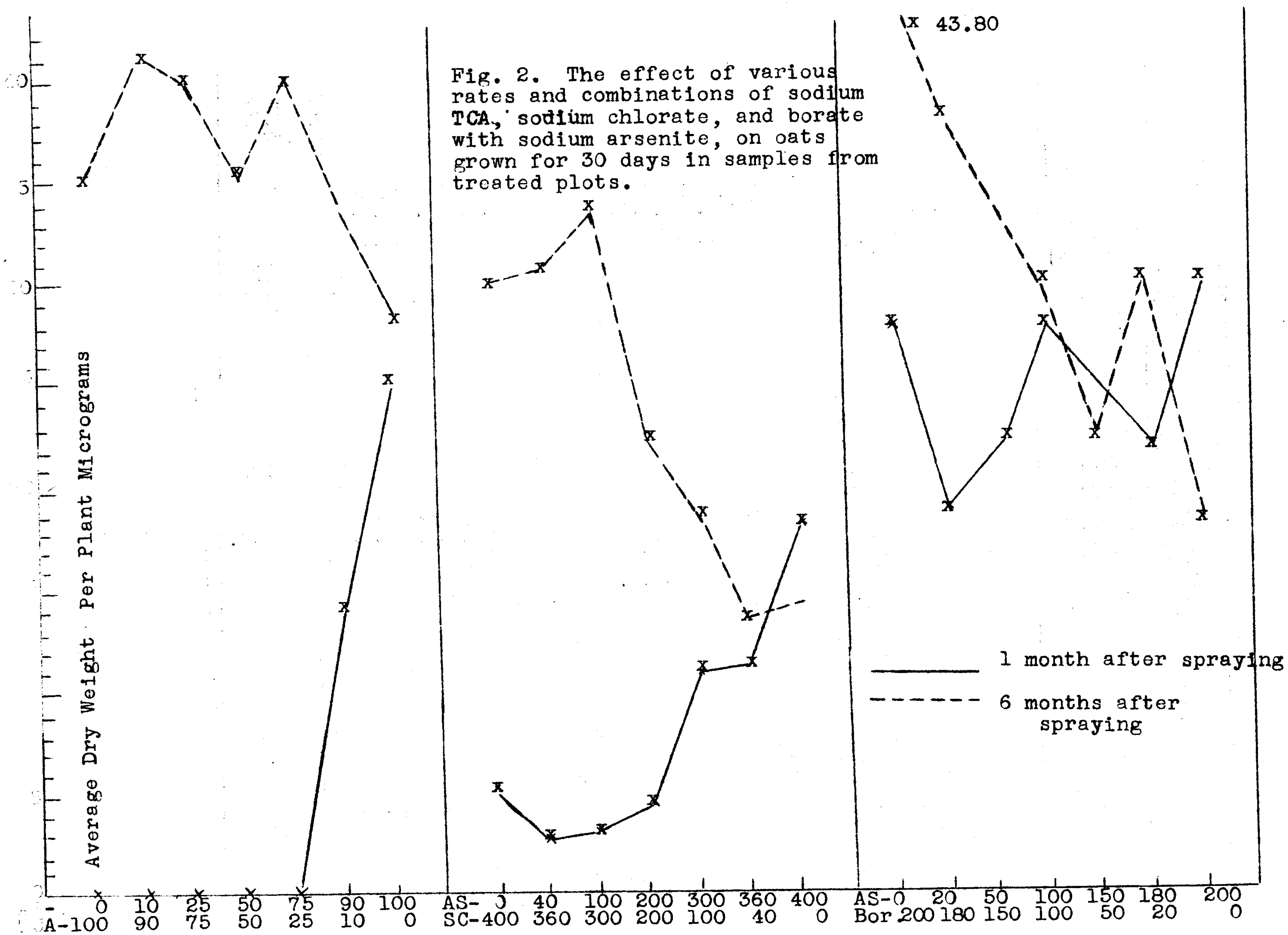

Fig. 2. The effect of various rates and combinations of sodium TCA, sodium chlorate, and borate with sodium arsenite, on oats grown for 30 days in samples from treated plots.

third could not be obtained in time for inclusion. The materials were put on in 100 gallons of water per acre with 5% Nekal NS wetting agent by volume added to each rate. The experimental design was a split-split-plot with three replications.

Results - The results of four estimates of quackgrass control taken in October are presented in Table 3. Sodium TCA and 3-p-chlorophenyl-1, 1-dimethylurea, an experimental DuPont product hereafter designated as CMU (80% active), were by far the most effective treatments, CMU being effective at both dates and sodium TCA at the second date only. This difference is partially explained by the fact that all plots were rated in the fall when the effects of the sodium TCA were somewhat masked by the presence of weeds other than quackgrass. Of the combinations, two proved to be as effective or more so than the primary chemical used alone; they were the combinations of TCA and arsenite at the second date and the combination of CMU and arsenite at the first date. Neither cultivation nor date of spraying was significant. This data presents only the control of the foliage and not of the rhizome system. The plots will be rated again next spring to determine overall control.

Nutgrass

Methods - Four chemicals, alone and in combination, were applied June 9 in conjunction with a disking just before spraying, a disking one week after spraying, and no disking. Chemicals were applied in 100 gallons of water with 5% Nekal NS wetting agent by volume added to each rate. The experimental design was a split-plot with 3 replications.

Results - The results of six estimates of nutgrass control made in October are presented in Table 4. Sodium TCA and CMU were again the most effective treatments at all three cultivations. Nutgrass control was not statistically different between rates of chemicals or combination with arsenite. Again there was no significant differences in control between cultivations. The interaction of treatments and cultivations was significant due mainly to the large differences between the effective control shown by sodium TCA and CMU and the poor control shown by sodium arsenite and 2,4-D. Again this data presents only foliage control and the plots will be rated again in the spring to determine overall control.

Summary

The results of these experiments indicate that sodium arsenite does not persist in the soil as long under Eastern climatic conditions as under Western conditions.

Sodium TCA and CMU have been very effective in controlling one season's growth of quackgrass (Agropyron repens) and nutgrass (Cyperus esculentus). A second year's data will be taken to determine treatments giving complete kill.

Table 3. The effect of various rates and combinations of TCA, Chloro-IPC, sodium arsenite, CMU, and 2,4-D on quackgrass.

Treatments	Average Estimated Per cent Kill Sprayed May 7	Average Estimated Per cent Kill Sprayed Aug. 10	Transformed to Degrees* Sprayed May 7	Transformed to Degrees* Sprayed Aug.10	L.S.D. Between transformed values .05	L.S.D. Between transformed values .01
1. Sodium TCA - 50 lbs./A	59	94	50.7	77.6	22.24	28.65
2. Sodium TCA -100 lbs./A	62	90	52.9	73.0	"	"
3. 50 lbs. TCA + 50 lbs. sod. ars./A	51	95	45.5	78.1	"	"
4. 75 lbs. TCA + 25 lbs. sod. ars./A	50	97	45.1	81.7	"	"
5. Chloro-IPC - 100 lbs./A	87	83	73.9	69.3	"	"
6. Chloro-IPC - 50 lbs./A	58	72	51.4	58.6	"	"
7. 50 lbs. IPC + 50 lbs. sod. ars./A	55	72	48.6	58.5	"	"
8. 10 lbs./A IPC in kerosene	40	44	38.6	41.5	"	"
9. Sodium arsenite - 25 lbs.A	5	13	11.5	15.0	"	"
10. Sodium arsenite - 50 lbs./A	19	15	18.9	18.3	"	"
11. Sodium arsenite - 100 lbs./A	14	53	19.6	48.9	"	"
12. Sodium arsenite - 200 lbs./A	33	43	33.2	41.4	"	"
13. Sodium arsenite - 400 lbs./A	50	95	46.9	78.9	"	"
14. CMU - 80 lbs./A	92	95	80.0	80.8	"	"
15. CMU - 40 lbs./A	100	96	90.0	82.8	"	"
16. CMU - 20 lbs./A	96	91	84.1	74.2	"	"
17. 40 lbs. CMU + 40 lbs. sod. ars./A	96	90	82.5	76.2	"	"
18. 5 lbs. 2,4-D + 25 lbs. sod. ars/A	36	17	32.4	21.8	"	"
19. 10 lbs. 2,4-D + 25 lbs. sod. ars/A	20	32	23.6	34.4	"	"
20. Check	14	51	19.1	43.1	"	"
** L.S.D. .05			19.36	19.36		
.01			24.94	24.94		

* Transformed to degrees according to Fisher's formula $p = \sin^2 \phi$ (3).

** L.S.D.'s reported on transformed data only. The estimated percentage of kill is included for comparison only.

Table 4. The effect of various rates and combinations of TCA, CMU, sodium arsenite, and 2,4-D on nutgrass.

C_1 - Disked one day before spraying
C_2 - Disked nine days after spraying
C_3 - Not disked

Treatments	Average Estimated Kill			Transformed to Degrees			L.S.D.	
	C_1	C_2	C_3	C_1	C_2	C_3	.05	.01
1. Sodium TCA - 100 lbs/A	94	88	97	77.0	70.4	81.1	36.40	46.75
2. Sodium TCA - 50 lbs/A	91	81	83	74.0	65.0	66.0	"	"
3. 50 lbs. TCA + 50 lbs. Sod. ars/A	80	93	87	64.1	76.1	70.4	"	"
4. CMU - 50 lbs/A	100	100	100	89.7	90.0	89.7	"	"
5. CMU - 10 lbs/A	97	99	92	81.5	85.5	75.1	"	"
6. 10 lbs. CMU + 25 lbs. sod. ars./A	95	96	95	78.7	82.1	78.8	"	"
7. Sodium arsenite 400 lbs/A	56	75	41	48.9	60.6	37.3	"	"
8. " " 100 lbs/A	14	48	6	16.7	46.3	9.7	"	"
9. " " 50 lbs/A	24	14	5	25.1	17.5	6.3	"	"
10. 2,4-D 10 lbs/A	31	56	4	12.3	47.9	6.7	"	"
11. 10 lbs. 2,4-D + 25 lbs. Sod. ars/A	25	64	36	26.2	53.7	35.9	"	"
12. Check	19	35	0	17.2	33.1	0.1		
L.S.D. .05				33.16	33.16	33.16		
.01				43.71	43.71	43.71		
Av. all treatments				52.34	60.24	46.41		
L.S.D. .05					24.40			

Summary (continued)

Combinations of herbicides have considerable merit and their use as soil sterilants will bear further study to determine their proper place in weed control practices.

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THE EFFECTS OF CHLORO IPC ON VARIOUS CROPS AND ITS RESIDUAL PROPERTIES IN VARIOUS SOILS

By L. F. Stevens and R. F. Carlson 1.

The compound isopropyl N-(3-chlorophenyl) carbamate has recently been described, by Witman and Newton (2), as having certain properties superior to the herbicide isopropyl N-phenyl carbamate. The latter compound, known commonly as IPC, remains toxic in the soil only a short time, while its derivative chloro IPC remains toxic over a longer period, and has a different range of selectivity. De Rose (1) has shown Chloro IPC to be more effective in the control of crab-grass than IPC. The purpose of this investigation was to determine the residual action of chloro IPC in light, heavy, and organic soils, and to establish the effect of this chemical on certain crops.

In all experiments the chemical was applied as a 40 per cent emulsifiable formulation. The rates used were based on the actual weight of chloro IPC per unit weight of the soil.

GREENHOUSE EXPERIMENTS

The tests in the greenhouse were carried out on three soil mixtures: light soil (½ sand, and ½ garden soil), heavy soil (¼ clay, ¼ sand, and ½ garden soil) and organic soil (¼ peat, ¼ sand, and ½ muck). The reaction of these soils ranged from pH 6 to 6.5. All applications were made by suspending the chloro IPC in water and pouring it over the soil surface. The persistence of toxicity in the surface soil was determined by the fresh weight of the tops of oat seedlings. Oat seeds were planted periodically and allowed to germinate and develop. When the growth in treated soils was equal to or greater than the growth in untreated soils, replanting was discontinued.

The Effect Of Soil Reaction On Residual Action

Procedure: Portions of light, heavy, and organic soils were adjusted to pH 3, 7, and 8.5. The soils were then put into No. 10 tin cans, and treated with chloro IPC at rates of 2 and 24 pounds per acre. A can of each soil mixture and of each reaction was kept as a control. Twenty-five oat seeds were planted in each can at a depth of one half an inch. These seeds were allowed to grow for almost ten days, after which the weights were taken and the soils were replanted. The soils were not allowed to drain and care was taken to keep the soil moisture at field capacity throughout the experiment.

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Results: At the low rate the acid soils became non-toxic before the alkaline soils in every case, with the heavy soil losing its toxicity first, followed by the organic and light soil in that order. (Table 1). The neutral soils varied from this relationship, since the period of persistence did not fall between that of the acid soil and that of the alkaline soil. The residual life of the chemical was shortest in the light soil followed by the heavy soil and organic soil in that order.

A comparison of the results obtained at the high rate of application shows that chloro IPC disappeared from the alkaline soil many days before it was lost from the acid soil, with the neutral soil again varying from this relationship. The heavy soil lost the toxic effect first in every case. Because sodium carbonate was used to raise the reaction to pH 8.5, the alkaline soils eventually developed a "black alkali" condition. This was assumed to have caused an anaerobre condition resulting in a rapid breakdown of the chemical. It was further assumed that such an extremely acid reaction eventually reduced the activity of the soil organisms extending the period of toxicity.

The Effect of Leaching On Residual Action

Procedure: Number 10 tin cans with holes for drainage, were filled with light, heavy, and organic soil. The soil was treated with chloro IPC at 2, 6, 12, and 24 pounds per acre. Each week the soils where leached with 1, 1½, and 2 surface inches of water and every other week the toxicity of the surface soil was determined by the growth of oat seeds. A 5 ml. sample of the leachate from each soil and each rate, was applied to ten cucumber seeds which had been placed in a Petri dish. These seeds were then allowed to germinate at room temperature for four days at which time the length of the primary roots was measured, and the growth was compared to the growth of seedling roots in a 5 ml. sample of the leachate from the control soils. After all toxicity had dissipated in the surface soil from cans treated with the 24 pound rate (104 days in the case of the light and heavy soil and 148 days for the organic soil) the upper, middle, and lower two inch layers of soil were put into four inch pots. The toxicity remaining in these layers was determined by the growth of oat seeds.

Results: The loss of toxicity was independent of the amount of surface water used in leaching. (Table 1). When the amount of water used in leaching was the only variable, the light and heavy soils retained chloro IPC for a similar length of time. The organic soil, however, remained toxic over 40 days longer than the light and heavy soils. The loss of the chemical from all soils was in the order of the rate applied. The cucumber seedling test, used to measure the toxicity of the leachate, showed no statistical difference between treatments. Either the cucumber seeds were not sensitive to such reduced concen-

TABLE I. RESULTS OF GREENHOUSE TESTS TO DETERMINE THE RESIDUAL ACTION OF CHLORO IPC IN VARIOUS SOILS

	Days of Persistance of Chloro IPC in Light, Heavy, and Organic Soil as effected by:								
Pounds/acre	pH of Soil			Surface inches of water			Storage Temperatures		
	3	7	8.5	1	$1\frac{1}{2}$	2	35°	55°	75°
Heavy Soil									
2	9	37	18	44	30	30	84	84	14
6	-	--	--	44	60	60	--	--	--
12	-	--	--	76	76	76	--	--	--
24	108	84	72	104	104	104	84-	84-	70
Light Soil									
2	37	29	47	30	44	30	84-	84-	28
6	--	--	--	60	60	44	--	--	--
12	--	--	--	76	60	90	--	--	--
24	159-	84	94	104	104	104	84-	84-	84-
Organic Soil									
2	18	47	37	60	44	30	42	42	14
6	--	--	--	76	90	60	--	--	--
12	--	--	--	76	103	90	--	--	--
24	159-		94	148	148	148	84-	84-	84-

trations or the chemical did not leach to that depth. Traces of chloro IPC were found in the lower layers of light and heavy soil even after 104 days. Oat seedlings grown in the lower layers were inhibited the least, and the soils treated with 2 and 6 pounds in most cases were free of toxicity. The organic soil appeared to be relatively free of toxic concentration in all layers at all rates.

The Effect of Temperature On Residual Action

Procedure: Four inch clay pots were filled with light, heavy, and organic soil, and the soil was treated with 2 and 24 pounds per acre of chloro IPC. The pots were placed in sand, so that water could be applied from the bottom, and then placed in storage at temperatures of 35°, 55°, and 75°F. Every two weeks for 12 weeks a series of pots containing soil of each mixture, of each treatment and from each storage temperature, were planted with oat seeds to determine toxic effect of the individual treatment.

Results: Temperatures below 75° markedly delayed the disappearance of chloro IPC (Table 1). In this experiment the organic soil at all rates of application appeared to be less effected by temperature differences than the other soils tested. This suggests that factors other than temperature may have a more important influence on the loss of the chemical from organic soils. It is interesting to note that the heavy soil treated with the 24 pound rate became non-toxic before the light and heavy soils.

Toxic Effects On Oat Seedlings

As the toxic concentration of chloro IPC decreased in the soil over a period of time, various degrees of inhibition of oat seedlings were observed. At very high concentrations the seeds did not germinate, while several responses were noticed as the concentration, with time, became progressively lower. At first a swollen and distorted coleoptele appeared but roots failed to develop. Later as the chemical dissipated, roots developed, but these were short with swollen tips. Eventually a primary leaf developed but this was stunted, brittle, cupped at the tip, and dark green in color. When the toxic effects had nearly disappeared the seedlings produced several spiral-shaped leaves. After the toxic effects had disappeared, the growth of the seedlings in treated soils appeared stimulated as compared to growth of seedlings in untreated soils.

FIELD EXPERIMENTS

The soil used in the field experiments was a Hilsdale sandy loam sloping into a Granby sandy loam. The soil reaction ranged from pH6 to 6.5. The chemical was added to sufficient water to insure adequate coverage to the soil or leaf surface as the case demanded. The material was applied by means of a compressed air hand sprayer.

A Comparison Of The Residual Life Of Chloro IPC With IPC

Procedure: Chloro IPC and 50 percent wettable IPC were applied to the soil in plots 4x4 ft., at rates of 2, 6, and 12 pounds per acre. The chemicals were added to one quart of water, and the treatments were applied on July 3, 1951. Oat seeds were planted at two week intervals until a severe frost on September 28, 1951 terminated the experiment. The seeds were sown by hand and the plots were raked after planting to insure contact of the soil with the seeds. The loss of toxicity from these plots was determined by comparing the total fresh weight of oat seedlings grown in the treated plots to that of seedlings grown in control plots.

Results: The temperature over the twelve week period during which these tests were made, was 65.4°F., and the total rain fall was 5.7 inches. The loss of IPC from the soil appeared to be independent of the rate applied, while chloro IPC appeared

TABLE 2. COMPARISON OF THE RESIDUAL ACTION OF CHLORO IPC UNDER FIELD CONDITIONS

	Percent inhibition of oat seedlings planted at two week intervals					
Pounds/acre	2 wks.	4 wks.	6 wks.	8 wks.	10 wks.	12 wks.
Chloro IPC						
2	66	21	58	100	--	--
6	0	0	27	32	57	54
12	0	0	0	0	28	36
IPC						
2	30	100	100	--	--	--
6	0	0	100	--	--	--
12	0	83	100	--	--	--

to be lost in the order of the rate applied. (Table 2). It was observed that the 2 pound rate of chloro IPC outlasted the 12 pound rate of IPC. Since the temperature in the field averaged ten degrees lower than the temperature in the greenhouse, the slow loss of chloro IPC under field conditions is explainable.

The Effect of Chloro IPC On Certain Crops

Procedure: An area 75 x 300 ft. was staked off into 270 plots two feet by twenty feet. The rows ran lengthwise with 15 plots to the row and two rows were allowed for each of the following crops: alfalfa, red clover, Ladino clover, soybeans, rye, wheat, sorghum, and corn. An equal number of plots were chosen at random to receive pre-planting, pre-emergence, and post-emergence applications of chloro IPC at rates of 1, 3, 6 and 12 pounds per acre. Each rate was applied to two plots, and an adequate number of plots were reserved as untreated controls. In each case the chemical was added to 3 quarts of water to insure proper distribution of the spray.

The pre-planting treatments were applied on May 20, 1951, and the crops were planted on May 23, 1951. The seeds were sown by hand and the plots were raked by hand after planting. The corn was planted in hills 1.5 feet apart at a depth of one inch. The pre-emergence treatments were applied on May 26, 1951, and the post-emergence treatments on June 29, 1951, one month after germination.

The data on germination of crop seedlings and weed seedlings in plots treated with pre-planting and pre-emergence applications was taken on June 15, 1951 and June 22, 1951 respectively. Between July 15, 1951 and July 31, 1951, 20 plants were dug from all plots and the fresh weight of the roots and shoots recorded.

TABLE 3. A COMPARISON OF THE SURVIVAL OF CROP PLANTS AND WEED PLANTS IN PLOTS TREATED WITH PRE-EMERGENCE AND PRE-PLANTING APPLICATIONS OF CHLORO IPC.

Pounds/acre	Corn		Sorghum		Wheat		Oats		Rye	
	1	2	1	2	1	2	1	2	1	2
Pre-planting										
1	84	79	85	70	8	100	46	115	16	180
3	74	57	11	60	0	55	4	50	0	140
6	63	34	13	30	0	36	2	35	0	100
12	16	23	10	30	0	41	0	30	0	70
Pre-emergence										
1	105	57	107	90	49	91	66	70	60	90
3	100	59	55	55	48	64	41	75	50	60
6	100	39	40	40	36	23	34	45	42	80
12	63	11	51	30	36	9	14	5	50	20

Pounds/acre	Soybeans		Ladino Clover		Red Clover		Alfalfa	
	1	2	1	2	1	2	1	2
Pre-planting								
1	100	64	65	73	78	78	64	80
3	90	36	21	38	21	33	49	33
6	74	60	14	46	8	39	45	30
12	90	14	2	8	5	8	4	7
Pre-emergence								
1	95	75	88	119	73	81	81	77
3	95	57	87	43	17	42	87	50
6	79	29	79	14	46	78	30	30
12	84	7	5	5	3	11	8	7

1 - Percent of surviving crop seedlings. 1 square foot (based on control) or number of hills per plot in the case of corn.

2 - Percent of surviving weed seedlings 1 square foot (based on control).

<u>Results</u>: In the majority of cases the pre-planting treatments were more harmful to the crop plants than the pre-emergence treatments. (Table 3). Those crops least injured by pre-emergence treatments were alfalfa, Ladino clover, soybeans, and corn. In

TABLE 4. EFFECTS OF CHLORO IPC ON SHOOT-ROOT RATIO AND WEIGHT (EXPRESSED AS PERCENT OF CONTROL) OF CROP PLANTS.

Pounds/acre	Corn		Sorghum		Wheat		Oats		Rye	
	1	2	1	2	1	2	1	2	1	2
Control	100	8.5	100	7.8	100	5.0	100	9.7	100	2.8
Pre-planting										
1	168	8.7	90	6.7	0	0	234	14.0	322	4.2
3	205	4.2	383	5.5	0	0	0	0	0	0
6	377	4.8	478	5.6	0	0	0	0	0	0
12	0	0	535	6.4	0	0	0	0	0	0
Pre-emergence										
1	165	7.2	78	4.9	81	6.3	152	18.4	104	2.9
3	212	7.2	126	7.7	137	6.4	158	15.8	164	4.6
6	222	6.3	243	6.9	161	9.9	339	23.1	164	7.9
12	252	5.5	218	8.4	226	12.6	82	10.7	207	8.3
Post-emergence										
1	158	8.3	81	8.4	85	4.8	100	8.9	87	2.0
3	163	12.7	67	8.3	100	6.7	74	9.4	100	2.5
6	96	10.2	46	6.8	78	6.0	82	6.5	77	2.9
12	83	11.7	42	8.3	67	6.2	77	6.6	118	1.9

Pounds/acre	Soybeans		Ladino Clover		Red Clover		Alfalfa	
	1	2	1	2	1	2	1	2
Control	100	6.0	100	7.2	100	7.0	100	4.4
Pre-planting								
1	118	7.0	185	7.1	85	6.1	131	4.0
3	102	5.4	195	8.6	99	12.5	104	4.4
6	137	5.5	126	10.6	84	7.1	102	4.6
12	159	8.1	200	11.3	88	7.5	129	6.8
Pre-emergence								
1	103	7.4	150	8.3	84	6.9	92	4.1
3	151	7.5	126	10.6	104	6.9	95	4.2
6	162	7.1	337	7.3	103	7.6	110	4.3
12	155	7.4	295	11.8	109	6.6	164	6.8
Post-emergence								
1	80	6.1	155	9.5	87	5.9	94	4.2
3	86	5.6	120	10.1	93	7.8	83	4.4
6	61	5.1	116	7.6	79	5.0	69	3.5
12	58	3.7	108	9.0	65	6.3	67	4.3

1 - Percentage of total weight of control plants
2 - Shoot-root ratio

all cases, but for corn, rates greater than 3 pounds per acre drastically reduced germination. The weeds controlled by these applications were mainly grasses, among which were crab grass (Dogitaria sanguinalis), nut grass (Cyperus escalentus), and old witch grass (Panicum capillare). Broadlevel weeds most seriously reduced were purslane (Portulaca oleracea) and rough cinquefoil (Potentila Norvegica), Lambs quaters (Chenopoduim album) and rough pigweed (Amaranthus retroflexus) were tolerant. Many of the weeds surviving the treatments were dwarfed and flowering was delayed.

Post-emergence applications merely delayed the growth of the crop plants and weeds, with the broadleafed plants the most seriously affected. The chemical when applied to the leaf surface acted as a contact herbicide, which leads to the conclusion that the injury observed was due to the xylene included in the formulation. Those plants having a protected growing point, such as the clover or grains, were quickest to recover.

The pre-planting, and pre-emergence treatments caused an increase in the weight of crop plants. (Table 4) It is probable that this was due to reduced competition, although the possibility of stimulation due to the chemical can not be disregarded. In general, the shoot-root ratio of plants grown in plots treated before germination, were increased over the shoot-root ratio of the controls. Undoubtedly the reduced photosynthetic leaf surface of plants treated with post-emergence applications caused the trend toward reduced weight and reduced shoot-root ratios of the crop plants.

Since this experiment was conducted primarily to determine the injury to crop plants, a brief description of the effect of chloro IPC on the individual crops follows:

1. Alfalfa - Many seedlings growing in plots treated with more than 3 pounds per acre, applied as a pre-planting or pre-emergence spray, dried up and died before true leaves were produced; others remained all summer without developing true leaves; while still others grew to a height of ½ inch and remained stunted with the leaves and axes failing to elongate. Most plants developed more normally, however. In plots treated with 12 pounds per acre many plants developed excessive numbers of branches. Post-emergence sprays caused the young terminal leaves to become chlorotic, and eventually wilt and die. The foliage was reduced severely and the plants were very slow to recover.

2. Red Clover - Stunting, similar to that observed of alfalfa seedlings, occurred even at the 1 pound rate applied as pre-planting and pre-emergence sprays. Red clover was by far the most sensitive of the legumes to Chloro IPC. Plants grown in plots treated with 6 and 12 pound rates were sending out stolens at harvest time. Post-emergence applications caused a necrosis of the leaves and a subsequent delay in growth. Since the growing point is more or less protected in red clover, the plants quickly recovered.

3. Ladino Clover - Due to thick seeding, the pre-planting and pre-emergence applications resulted in a thinning of the seedlings so that growth in the treated plots was increased over the growth in the control plots. Stunted plants were observed in the plots treated with the 6 and 12 pound rate. The 12 pound rate caused the Ladino to produce an abundance of stolens as was observed with red clover. Post-emergence applications caused injury to the crop which was similar to injury of red clover.

4. Soybeans - Although the crop appeared the least sensitive to pre-planting and pre-emergence applications, rates of more than three pounds per acre caused a stunting of seedlings. Most of these stunted plants reached a height of only two inches and remained so until a dry period, at which time the limited root system could not supply sufficient amounts of water and nutrients and death occurred. Plants growing in plots treated with the 6 to 12 pound rates developed a tremendous amount of foliage, and branching was increased over that of control plants. Many plants developed a swelling at the cotyledonary plate, and the tissue often broke at this point so that the shoot developed along the ground until growth proceeded upward at a succeeding node. Plants receiving post-emergence applications were severely injured due to the terminal location of the growing point and the large area of the leaf surface. The injury was characterized by a wilting and necrosis of the leaves.

5. Rye - The pre-planting treatment eventually killed all plants growing in plots treated with 3, 6, or 12 pounds per acre. The plants surviving the one pound rate showed large increase in tillering. The leaves of these plants were a darker green than the leaves of plants grown in control plots. This same type of injury was observed in the plots treated with a pre-emergence application at the 12 pound rate. Plants surviving the 6 pound rate applied after planting but before emergence produced leaves which curled in a tight spiral indicating that possibly chloro IPC was translocated. This latter response was observed only in the seedling stage. Pre-emergence treatments in the 1 to 3 pound range did not injure the surviving plants. Post-emergence applications caused a wilting and slight necrotic condition of the leaves, but recovery was rapid. The rye crop was severely infested with rust so that the results obtained may not be the results one would obtain from a normal crop.

6. Oats - Pre-planting treatments, with the exception of the one pound rate, eventually killed all plants. Plants surviving the one pound rate tillered extensively with low spreading growth. No panicles were produced. Pre-emergence treatments caused injury to seedlings similar to the injury which occurred to oats in the greenhouse experiments. Plots treated with the 6 and 12 pound rate produced plants which tillered abundantly, and lodged severely. A swelling of the nodes and a subsequent change in the direction of growth at these nodes was characteristic of the plants grown in these plots. A dark-green color in the leaves was also noticed. Post-emergence applications killed the tissues exposed to the spray and

and the emergence of flowering spikes was delayed for a week or more. This crop was the most sensitive of the grass crops tested in this respect.

7. Wheat - Pre-planting applications eventually killed all plants. Many seedlings surviving the pre-emergence treatment remained stunted and many of these seedlings eventually dried up and died. Plants growing in the plots treated with 6 and 12 pounds per acre tillered extensively and the leaves were a dark green color. Post-emergence applications delayed growth for a short period by causing a wilting and slight necrosis. This crop was also infested with rust so that the results presented may not be entirely valid.

8. Sorghum - Seedlings surviving the pre-planting and pre-emergence treatments often remained dwarfed and some eventually died. In all cases the young plants produce leaves which took on a purple color at the margins. Plants grown in plots treated with 6 and 12 pounds per acre produced several shoots from the base as contrasted to the controls which produced no shoots. Post-emergence applications severely burned and killed leaves exposed to the spray, however, the plants were quick to produce new leaves and recover.

9. Corn - Pre-planting treatments of more than one pound caused seedlings to develop swollen and distorted roots and coleoptiles. Young seedlings showed a purple color at the margins of the leaves. The 3 and 6 pound rate induced the development of brace roots at the second node and caused a weakening of the tissue at the cotyledonary plate. A severe wind storm on July 27, 1951 blew over many of these plants. Similar injury was observed on plants receiving a pre-emergence application at the rate of 12 pounds. Pre-planting treatments of 12 pounds to the acre eventually killed all plants. The pre-emergence applications in the 1 to 6 pound range were very successful, and the plants in these plots produced flowering structures 1-1½ weeks before plants in the control plots. Post-emergence sprays injured this crop only slightly. This injury was characterized by a chlorotic band across the middle of the young leaves developing at the time the spray was applied. Recovery was rapid.

Weather conditions: The average rainfall received from the beginning of these experiments to harvest was 5.62 inches, while the temperature averaged 66°F. Both the pre-planting and pre-emergence applications were followed by a soaking rain within 12 hours, and the post-emergence applications were followed by a five day period without rain.

DISCUSSION AND SUMMARY

Assuming the breakdown of chloro IPC at ordinary concentrations, to be more rapid in acid soils it is possible that the addition of acid salts applied to the soil as fertilizer may decrease the residual life of the herbicide, and conversely the addition of lime to the soil may extend the period of toxicity. It is possible that the chloro IPC is absorbed by the seeds or seedlings in a dissociated form and that the addition of an excess hydrogen ions to the soil reduces the amount of dissociation. Should this be the case, the determination of toxicity in treated soils by means of plant growth may not be a true indication of the total concentration present, but merely a measure of the dissociated form.

These experiments showed a trend toward more rapid loss of Chloro IPC in heavy soils, and an extremely extended period of toxicity in the organic soils. Evidence indicates that the chemical was leached to a greater depth in light and heavy soils than in the organic soil. Because the organic soil retains a greater concentration at the surface, the chemical may reasonably be toxic for a longer period in this soil. A more extensive distribution of the herbicide below the surface soil, as was observed in the light and heavy soils, would reduce the concentration and increase the possibility of breakdown by soil organism. Since decomposition of chloro IPC was very rapid under anaerobic conditions, the greater the depth of leaching the greater the possibility of anaerobic organisms acting on the compound.

The amount of surface water applied to the various soils tested did not noticeably affect the loss of toxicity or the depth of leaching.

Temperatures of 35° and 55°F. markedly increased the residual life of chloro IPC, and therefore, application of this chemical to the soil in the fall may seriously effect a crop planted in the spring. The 2 pound rate applied in the field in July, however, was non-toxic after 8 weeks at temperatures averaging 65°F.

According to the data presented, chloro IPC persists in the soil for a longer period of time than IPC. It was observed that the loss of IPC was not in the order of the rate applied, while loss of chloro IPC appeared to be greatly influenced by the concentration in the soil.

Chloro IPC was shown to be most toxic to plant growth when applied to the soil before planting or before emergence. The use of chloro IPC on wheat, oats, rye, or red clover to control weeds would be detrimental. Pre-emergence applications in the 1 to 3 pound range showed promise for controlling weeds in alfalfa, Ladino clover, soybeans, and sorghum. Pre-emergence treatments in the 1 to 6 pound range applied to corn resulted in excellent control of weeds with no injury to the crop.

Pre-planting applications of chloro IPC may be less toxic to the crop if planting is delayed. It would be essential, however, that temperatures were high enough to cause at least a partial breakdown of the chemical before the crop was planted. Soybeans were the least affected by pre-planting applications.

Post-emergence applications caused the least injury to grains. The location of the growing point and the area of the leaf surface determined the extent of injury. It seems highly improbable that post-emergence applications would be desirable on any of the crops tested except for sorghum and corn. It would be necessary that the crop be grown in rows, and that the crop plants be beyond the seedling stage. Since chloro IPC is most effective if applied before the emergence of weeds, an application would be most practical after cultivation. It seems likely that the injury induced by post-emergence treatments was caused by the xylene in the formulation, since no response other than chloroses, necrosis, or wilting was observed.

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GENERAL PROGRESS REPORT ON FIELD STUDIES WITH ENDOTHAL*

by
J. Lloyd Poland**

INTRODUCTION

It has been demonstrated that applications of Endothal to different parts of plants, or to soil in which plants are growing, can produce different types and degrees of plant responses. Defoliation, superficial "top-kill" and kill of entire plants have been noted.

These responses are of interest and possible benefit to agriculture and consequently many associated with agricultural research have begun to explore these characteristics of Endothal to determine their possible practical application. Endeavors have embraced both theoretical studies and, in a large measure, practical field-performance evaluation. Early efforts in field research have been highly exploratory and have not always yielded evidence of desirable or suitable responses. Through lack of previous knowledge, the material was experimentally applied in many situations where it did not perform suitably. In other instances it has performed quite well. Some preliminary information is now available which can afford guidance in future investigative work. The intent of this progress report is to briefly summarize some of this information in a manner which it is hoped will present a unified and reasonably complete review of Endothal performance to date.

THEORETICAL ASPECTS

Plant penetration

Preliminary work has indicated that technical grade Endothal does not penetrate different portions of plants with equal facility (33,58). Roots of plants seem to readily absorb water-soluble Endothal and quite low concentrations have produced pronounced responses. When applied as an over-all foliar spray the chemical seems to penetrate terminal twig growth and young foliage much more readily than mature twigs and foliage. This difference in penetrability may be due to the presence or absence of a waxy cuticle on these plant parts as has been suggested as an explanation for differential penetrability of other chemicals (11). Roots are normally non-cuticular, new growth is usually only thinly or incompletely cutinized and mature above-ground tissues tend to have the heaviest cuticular covering. In further support of this idea, there is some evidence that tolerant plant species tend to be ones normally having a relatively heavy cuticle or some cuticular elaboration which might be expected to interfere with wetting or penetration. Perhaps this is a contributing factor to the observations made by Gardner (17), after applying

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* Trade name for disodium 3,6-endoxohexahydrophthalate registered by Sharples Chemicals Inc., Philadelphia, Pennsylvania.

** Niagara Chemical Division, Food Machinery & Chemical Corporation.

Endothal to relatively heavily cutinized coffee plants, "Young seedling coffee trees...were apparently uninjured by drenching applications of both concentrations (10 and 20 pounds of a 38% formulation of Endothal)...There was no injury to the old mature leaves of low-hanging branches in the field where applications were made. Evidently, from the standpoint of the coffee tree, Niagarathal* is truly a selective herbicide".

A number of investigators (45,50,58) have found that when ammonium sulfate is used as an adjuvant to spray solutions of Endothal, the activity of the chemical in foliar applications (i.e. in applications to cuticular surfaces) is greatly increased and that its selectivity is lowered thereby. It is believed that ammonium sulfate aids in Endothal penetration of the waxy cuticle of plants. It has been theorized (11) that cutinized surfaces of plants are more pervious to non-polar substances than to polar ones and that the reverse is true for non-cuticular surfaces. Also, that "Lowering the polarity of the toxicants (phenolic salts in this case) of such solutions by addition of acid salts (activation) or by using the ammonium salts increases their toxicity. Active absorption of the phenol molecules explains this increased toxicity where complete conversion to undissociated parent molecules is not accomplished". Relatively, the polarity of Endothal is somewhat less when in solution with ammonium sulfate than when in solution alone. The behavior of Endothal, in this respect, seems to conform to this theory quite well.

As is the case with certain other plant response chemicals, it has been found that foliar applications of Endothal are more effective when a surface-active agent is used in the spray combination (58).

Translocation

It has been rather convincingly shown that Endothal is readily absorbed through the roots of plants and translocated upward (33,45). Contrariwise, appreciable downward translocation from foliar applications apparently does not occur (33). This unidirectional translocation of Endothal apparently fits the theory that phytotoxic substances can move through the largely dead, normally-upward-conducting xylem tissues but produces kill of live, normally-downward-conducting phloem tissues, therefore interfering with subsequent movement in that direction (2).

Mode of action

To the writer's knowledge, there is no information available on the details of the manner in which Endothal produces its effect, once it has been translocated or has penetrated to the susceptible or responsive tissues of treated plants.

*Application for registration of the word "Niagarathal" as a trade name for formulations containing Endothal has been made by Niagara Chemical Division, Food Machinery and Chemical Corporation.

PRACTICAL ASPECTS

Experimental Formulations

In accordance with the background information presented above, several different Endothal formulations have been prepared. There has been some confusion with regard to these formulations, issued under code numbers, and for purposes of clarification, their compositions are presented here.

Code No.*	Percent Endothal	Approx. Percent $(NH_4)_2SO_4$	Percent Nonic 218**	Physical Condition
ME-3003 (EC3740)	21.7	0	0	Aqueous solution (2 lbs. technical grade Endothal per gallon).
ME-3000 (EC3504)	96	0	0	Dry, powdered, technical grade Endothal.
ME-3001 (Niagara-thal-DF Spray)	16	84	0	Dry, powdered 1:5 Endothal-ammonium sulfate formulation.
ME-3002	16	82	2	Dry, powdered 1:5 Endothal-ammonium sulfate formulation.
ME-3627 (EC4069)	6.4	33.3	0	Aqueous solution containing 40% ME-3001 (4 lbs. ME-3001 per gallon)
ME-3729 (Niagara-thal-DF Liquid)	6.2	32.8	1.6	Aqueous solution containing 40% ME-3001 (4 lbs. ME-3001 per gallon) plus wetting agent.
ME-3124 (Niagara-thal-W)	38	56.5	3.5	Dry, powdered 1:1½ Endothal-ammonium sulfate formulation.

In addition to these, several dust formulations have been tested, both as herbicides and defoliants, but so far results are quite preliminary. Under conditions of moderately high temperatures and high humidity they have shown activity. Distribution and field research with these formulations to date has been extremely limited and therefore they are not included in this discussion.

After the advantage of ammonium sulfate as an adjuvant for Endothal had been demonstrated, detailed studies indicated that,

* "ME" numbers are Niagara designations; "EC" numbers are Sharples designations.

** A Sharples non-ionic surface-active agent.

on most plants, a 1:5 ratio of Endothal to ammonium sulfate seemed to produce an optimum effect for contact herbicide and, particularly, defoliation purposes. Herbicidally, this tended to reduce the selectivity however and for pre-emergence use ammonium sulfate was found to be of no benefit. A compromised formulation containing a 1:1½ ratio was adopted and issued as ME-3124 in the hope that it might prove adaptable to more varied types of tests.

Three of the seven formulations are dry counterparts of liquid ones and one of them has been prepared in dry form only. They can be compared more easily, perhaps, if listed as follows:

Ingredients	Dry	Liquid
Endothal	ME-3000	ME-3003
Endothal + $(NH_4)_2SO_4$ @ 1:5	ME-3001	ME-3627
Endothal + $(NH_4)_2SO_4$ @ 1:5 + Nonic	ME-3002	ME-3729
Endothal + $(NH_4)_2SO_4$ @ 1:1½ + Nonic	ME-3124	None

Field results

As is the case with many experimental plant response chemicals, Endothal has given both good and poor results in a number of tests conducted under ostensibly similar conditions. In some instances weed control has been excellent whereas in others it has been disappointing. Different reports have indicated none to severe injury to the same crop plants. Defoliation responses have varied. Chemicals applied for purposes of producing a plant response are, of necessity, intimately dependent upon the potential reactivity of treated plants. All the variable factors affecting plant growth and survival (i.e. light, temperature, moisture, humidity, soil type, available food supply, etc.) can therefore directly or indirectly affect the results of treating plants with chemicals intended to produce a response of the plant. This is particularly true in treatments where critical, selective dosages or careful timing of applications are involved.

Despite these expected variations in performance of plant response chemicals in general, and Endothal in particular, a number of potentially useful responses have been rather consistently produced by experimental applications of Endothal. Some of these experimental results are included in other papers presented, or to be presented, at this and similar meetings. After reviewing many reports on much of this work and observing a great deal of it in the field, the following characteristics of the chemical seem established:

Herbicidal Characteristics

Pre-emergence or soil applications to crops

Water-soluble Endothal is apparently rather readily absorbed from the soil by some plants at least, under some conditions, and is translocated upward producing varying degrees of tissue kill. This is assumed to be true although there is some evidence that threshold dosages to the soil have caused the roots of some plants to become stunted and remain underdeveloped; indicating that lethal dosages might cause death of these plants primarily by affecting the roots. Other plants either do not absorb the material or are unaffected by it if absorbed. The critical selective barrier is not yet established to the writer's knowledge. It may be differential penetration, differential translocation or differential tissue susceptibility.

When applied at dosages of 2, and especially 4 to 6 pounds of technical grade Endothal per acre, it will selectively control many susceptible weeds in a number of resistant crops.

Probably the primary objective of field research with a new experimental herbicide is to classify weeds and crops with respect to their susceptibility or resistance to a range of dosage levels under a majority of the varying planned or unplanned conditions likely to be met with in field usage. This is difficult, if not impossible to complete, even with well known herbicides and is entirely impossible for a chemical as new as Endothal.

The sensitivity of a few plants to pre-emergence applications of 4 to 6 pounds per acre of technical grade Endothal on cultivated crop soil can be listed with some definiteness however. From the limited data available, there is fairly consistent agreement, but by no means complete, on the following brief classification:

Susceptible weeds (germinating or young stages)

Many annual grasses
Many clovers, *Trifolium sp.*
Some smartweeds or knotweeds, *Polygonum sp.*
Some species of dock, *Rumex sp.*
Ragweeds, *Ambrosia artemisiifolia* and *A. trifida*
Chickweeds, *Stellaria sp.* and *Cerastium sp.*
Wild mustard, *Brassica sp.*
Pigweed, *Amaranthus sp.*
Purslane, *Portulaca oleracea*

Tolerant crops (germinating or young stages prior to full emergence)

Crops for which considerable evidence of Endothal tolerance has been accumulated

Corn	Red beet
Soybean	Sugar beet
Lima bean (some varieties)	Cauliflower
Spinach	Potato

Crops for which preliminary or inconclusive evidence of Endothal tolerance has been reported

Sunflower	Flax
Gladiolus	Peas (canning)
Sweet clover	Onion
Cabbage	

This classification is admittedly quite brief. There are probably other susceptible weed species and other resistant crops but evidence is either lacking or too scant for their classification as yet. Also, certain weeds are known to be susceptible to foliar applications in later stages of their development but their sensitivity to soil treatments in the germinating or young stages has not been determined.

The residual effectiveness of Endothal in the soil is normally sufficient to prevent or inhibit growth of susceptible plants for a period of 3 to 6 weeks or more. This is naturally subject to considerable variation, depending upon soil and weather conditions.

In the one test reported to date (28), 1, 2, 4 and 8 pounds per acre of Endothal had no significant effect upon the activity of micro-organisms present in the treated soil samples used in the test.

Some observations that have been made indicate that the herbicidal activity (and perhaps effect upon crops) may tend to be greatest during rainy periods or when soil moisture content is high.

Post-emergence or foliar applications

In treatments of this nature Endothal appears to function solely as a contact phytotoxin. Endothal-ammonium sulfate formulations have shown more activity than Endothal used alone. Differential penetration of the epidermal tissues seems to be the basis for selectivity; there is probably less selectivity in these treatments than in soil applications.

Some type of response is usually produced with treatments of formulated Endothal involving more than 1 pound of active ingredient per acre. Defoliation of plant species that normally abscise their foliage may result. Partial to complete kill of above-ground tissues frequently occurs, depending upon degree of plant susceptibility. If plants are shallow-rooted, vegetatively mature and well covered by the spray, then frequently complete plant-kill has been achieved. On the other hand, if they are deep-rooted, vegetatively immature or incompletely covered by the spray, varying degrees of tissue necrosis is produced and subsequent regrowth often takes place. Many young, shallow-rooted, seedling plants do not survive treatment whereas after their root systems and vegetative potentialities are more firmly established they may tolerate Endothal even when well covered by a spray application.

Over-all selective applications to crops

Field tests of post-emergence applications of Endothal to crops have not been as numerous as pre-emergence tests. Except for clover control in turf (40) and general weed mitigation in cafetals (17), no adequate evidence on crop tolerance to over-all sprays is available. Results of some tests have shown that the following crops may be sufficiently tolerant to permit the selective use of formulated Endothal post-emergently:

Turf	Red beet
Coffee	Cranberry
Sorghum	Onion
Sugar beet	Potato

Directional contact applications to crops

Very little investigative work of this nature has been undertaken. Weeds are usually present in various stages of growth and for this reason relatively higher dosages of Endothal are required. Experimentally, Endothal has been applied in mid to late season when annual grasses invaded corn. Results were promising. In one test (62) it did not perform satisfactorily when applied directionally to snap beans.

General contact applications in non-crop areas

Where general kill of mixed herbaceous weed populations has been attempted with foliar sprays of Endothal, results have been largely disappointing. Most weed species have been either "topburned" or defoliated. Too many species have produced regrowth and survived. Drenching applications of 6 to 8 pounds per acre of actual Endothal have substantially reduced or eliminated stands of annual grasses. Five to 10 pound dosages of formulated Endothal per acre, in thoroughly applied sprays, have produced kill of many broad-leaved annuals that were vegetatively mature.

In one rather extensive test (47), localized spot-spraying of dwarf ragweed by the Department of Health of the city of Syracuse, New York, has given adequate kill of that weed species with no evidence of damage to adjacent vegetable and ornamental crops from the drift of the spray. This work was carried out in connection with a ragweed eradication campaign conducted for purposes of locally reducing the pollen count of the air.

There are very preliminary indications that red cedar, Juniperus virginiana, is highly sensitive to formulated Endothal and trial spot-treatments to this species, where it occurs as a "weed" in pastures or in areas of concentrated apple production, will be field-checked next year.

Applications of Endothal-2,4-D combinations have been made and the fortified herbicidal effects afforded by this combination have looked interesting but test work and results are not far enough advanced to be reported.

Crop desiccation characteristics

The desiccation or "defoliation" of such crops as potatoes, corn, rice and forage legumes grown for seed has been experimentally attempted with formulated Endothal. Pre-harvest treatments have been applied in concentrate form to potatoes for vine-killing purposes with considerable success in several tests. In a few very limited tests, applications of Endothal to corn have shown promise of producing a desirable desiccation response on that crop. The moisture content of rice grain has been lowered 15 to 20% one to two weeks after airplane pre-harvest treatment. Adequate desiccation of the vegetative parts of seed legume crops has been achieved with airplane treatments made before combining.

In tests of this type the degree of desiccation achieved is a result of the combination of vegetative plant tissue kill by Endothal plus the subsequent drying effects of sunlight and movements of the air. Endothal functions entirely as a contact phytotoxin; it has no chemical drying action in its own right. In test results reported to date, it has successfully killed the crop plants without injury to the crop itself. Seed from treated ladino clover, alfalfa and rice plots have shown germination percentages equal to those of untreated checks, except that, in one plot on rice, an excessive dosage of Endothal reduced germination 16% below that of the check. Tests on the viability of treated potato tubers have not been completed as yet.

Crop defoliation characteristics

Endothal seems to both induce or initiate the abscission process as well as to accelerate the rate of abscission (1).

It is effective at relatively low per acre rates of application. Ramie, for instance, has been successfully defoliated in the field, under ideal conditions, at per acre rates as low as 0.6 ounce.

It seems to be less dependent upon plant and foliage maturity, or senescence, than some of the other defoliant chemicals (56).

Like other chemical defoliants the optimum temperature range for Endothal performance is 70° - 90° F. Unlike certain other defoliants however, there is preliminary indication that it tends to produce a fair defoliation response at temperatures below this range.

It is effective as a defoliant on a relatively wide range of plant species (44).

The per acre rate of chemical required for defoliation tends to be considerably below that which will produce herbicidal effects. This characteristic is advantageous in that it will permit the use of defoliation dosages with little risk of crop or crop plant injury. However, it is disadvantageous because in some instances, particularly on crops to be combined, it is desirable to defoliate the crop with a dosage of chemical that will also kill the weed growth so often present in such plantings at harvest time. Moreover, since efficient defoliation dosages of Endothal do not kill or injure plants to any substantial degree, refoliation can and often does readily occur after treatment, if favorable growing conditions prevail.

Endothal, applied as a spray, will ordinarily produce its complete initial effect within a few hours, under favorable conditions, so that rains occuring 5 to 6 or more hours after treatment ordinarily will not interfere with the defoliation response.

Reported results of tests indicate that the following crops can be successfully defoliated with formulated Endothal:

Cotton	Red kidney bean
Ramie	Castor bean
Soybean	Nursery stock (many species but not all)

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THE INFLUENCE OF ENVIRONMENTAL FACTORS ON THE ACTIVITY OF CRAG HERBICIDE 1 (SODIUM 2,4 DICHLOROPHENOXYETHYL SULFATE)

A. J. Vlitos*

The unique properties of CRAG Herbicide 1 in soil have stimulated considerable academic interest in the effects of the soil microflora, pH, temperature, and moisture levels on its herbicidal efficiency. As reported by King, Lambrech, and Finn (1) the compound is highly herbicidal when in contact with non-sterile soil, but lacks toxicity in aqueous solutions or when in contact with sterile soil. This suggestion of a microbial factor raises several interesting questions concerning the mechanism of the reaction in soil. A study of this mechanism requires first a critical examination of the conditions under which the conversion of sodium 2,4 dichlorophenoxyethyl sulfate to its active herbicidal form will occur.

Preliminary experiments at this laboratory have been designed to evaluate the effect of factors, other than microbial, which may influence the chemical reaction to the active form of the compound in soil. Particular attention was directed towards soil pH and temperature effects in both sterile and non-sterile soils.

A series of sandy loam soils, the pH of which was adjusted to 3.0, 4.0, 5.5, 6.0, 7.0, and 8.0 after autoclaving, was treated with CRAG Herbicide 1 (100 p.p.m.). Adjustment of soil pH to the same values was carried out with similar soil which was not autoclaved, and which was also treated with CRAG Herbicide 1 (100 p.p.m.). Twenty-five cucumber seed (Var. Davis Perfect) were placed in contact with the above soil-herbicide mixtures in Petri dishes, and incubated at 25° C. for a period of 6 days. At the end of this time, measurements were made of the cucumber root elongation. This method has been found to be a sensitive indicator of CRAG Herbicide 1 efficiency. Table 1 lists the average root lengths of cucumber seeds which were in contact with the soil-herbicide mixture for 6 days.

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(1) King, Lawrence, J., J. A. Lambrech, and Thomas P. Finn. Herbicidal Properties of Sodium 2,4 Dichlorophenoxyethyl Sulfate. Contrib. Boyce Thompson Inst. 16(4): 191-208. 1950.

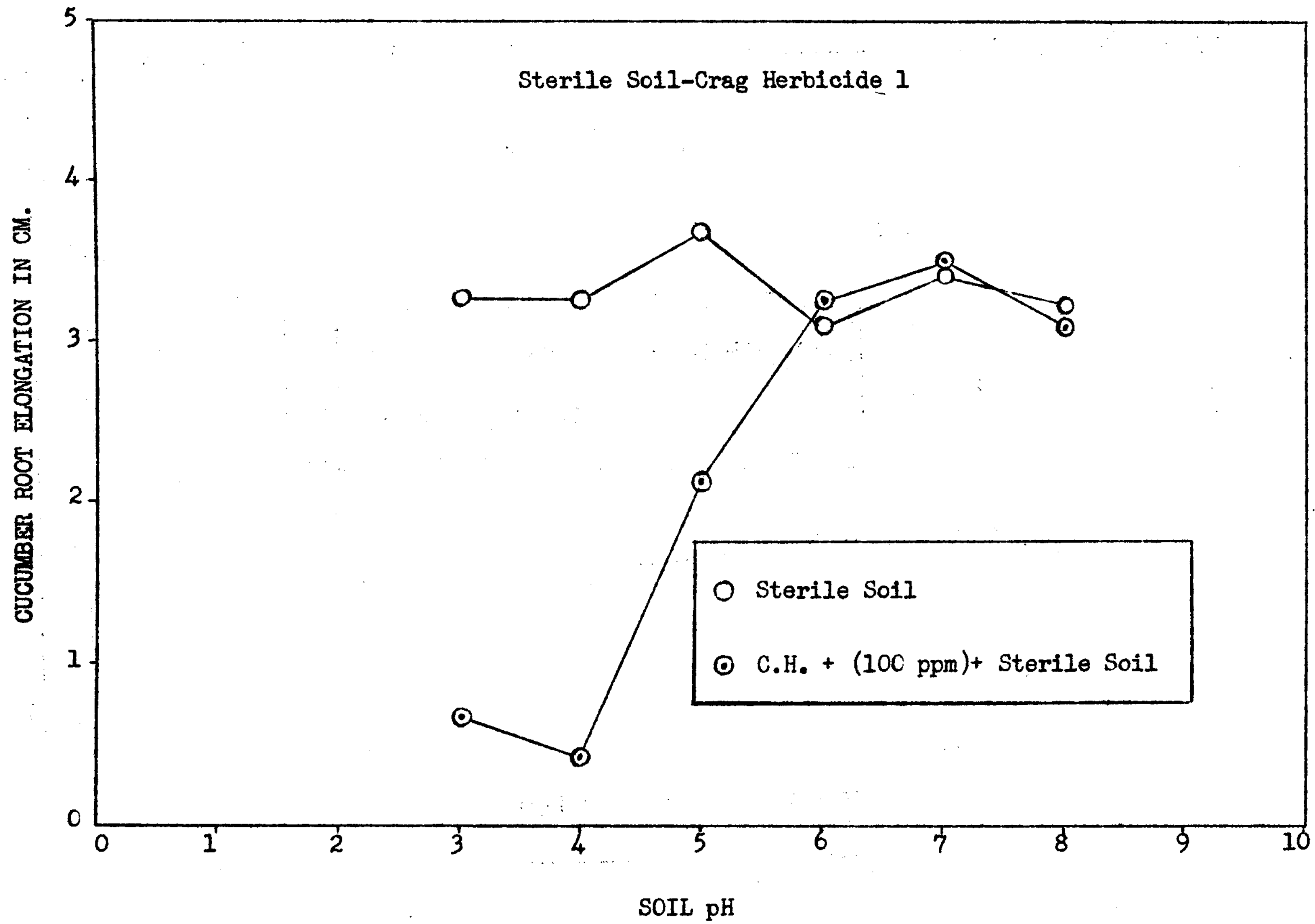
Table 1. Cucumber root suppression in soil - CRAG Herbicide 1 mixtures.

Treatment	Soil pH 3.0	4.0	5.5	6.0	7.0	8.0
	Average root length (cm)[a]					
CRAG Herbicide 1 100 p.p.m. + sterile soil	.54	.49	2.2	3.2	3.5	3.1
Sterile soil	3.4	3.4	3.6	3.3	3.4	3.2
CRAG Herbicide 1 100 p.p.m. (sterile)	-	-	3.5[b]	-	-	-
CRAG Herbicide 1 100 p.p.m. + non-sterile soil	.53	.48	.52	.92	1.1	3.0
Non-sterile soil	3.2	3.4	3.3	3.2	3.1	3.0
CRAG Herbicide 1 (Non-sterile)	-	-	3.0[b]	-	-	-

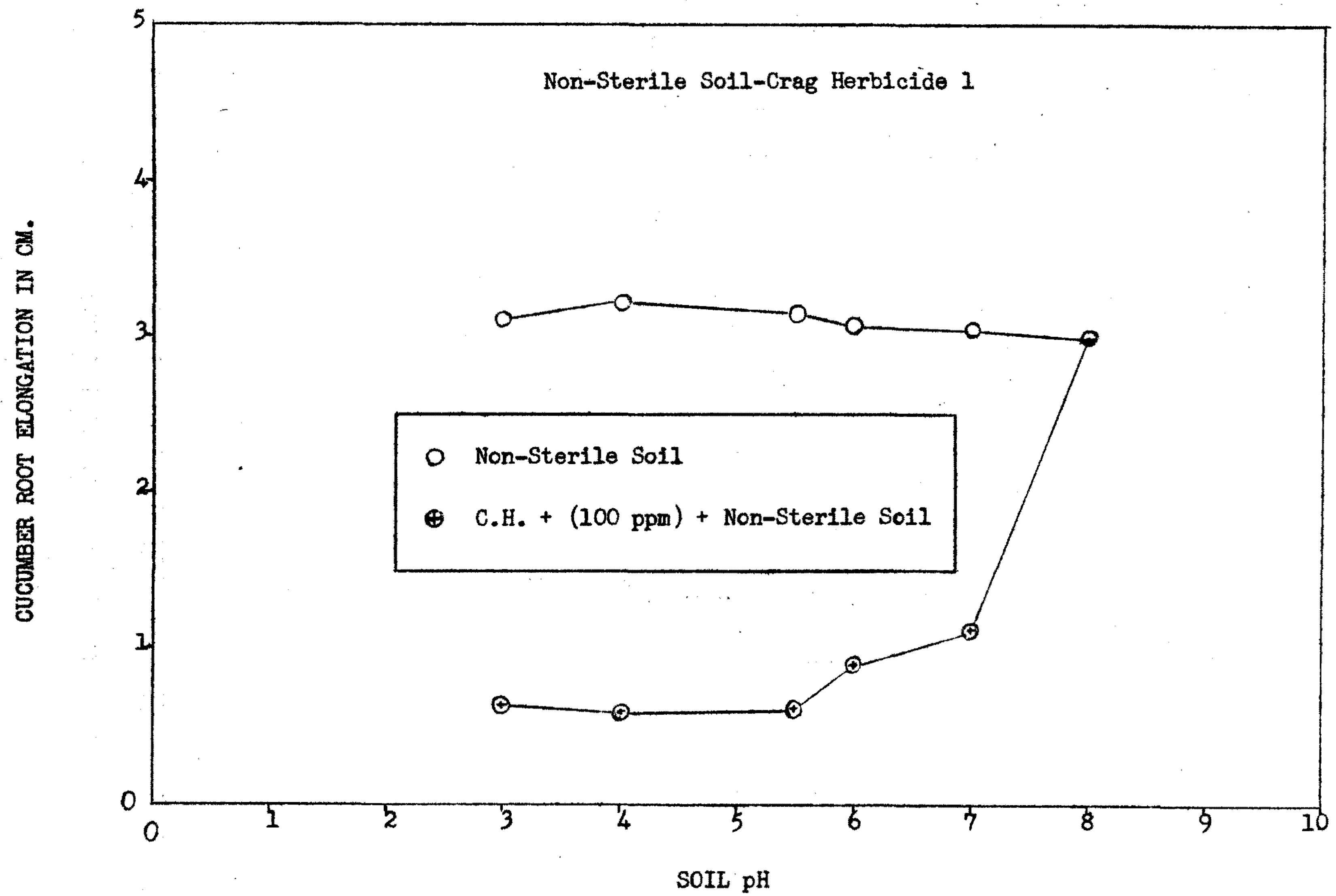
(a) Represents average for 25 cucumber seed.
(b) pH of CRAG Herbicide 1 fluctuated between pH 5.0-6.0.

In sterile soil CRAG Herbicide 1 was converted to its active herbicidal form at pH values of 3.0 and 4.0. Soils which possessed microbial populations resulted in a conversion of the herbicide at pH values of 3.0, 4.0, 5.5, and 7.0. Non-sterile soils with a pH 8.0 did not exhibit breakdown of the compound to its active toxic form. Apparently a microbial factor operates in the chemical conversion of 2,4 dichlorophenoxyethyl sulfate in soils possessing pH values from 7.0 to 5.5. Below pH 5.5 it appears that the breakdown of the herbicide may proceed without microbial action. These results suggest that the possible mode of CRAG Herbicide 1 breakdown by soil microorganisms consists essentially of acidic secretions by bacteria, actinomycetes, or fungi in contact with soil and herbicide particles. Carroll (2) has suggested the enzymatic hydrolysis of the compound by pure cultures of bacteria and fungi

(2) Carroll, R. B. Factors Influencing the Activation of 2,4 Dichlorophenoxyethyl Sulfate. Southern Weed Conf. Proc. 4: 13. 1951.



Sterile Soil-Crag Herbicide 1
CUCUMBER ROOT ELONGATION IN CM.
SOIL pH
0
1
2
3
4
5
6
7
8
9
10
Sterile Soil
C.H. + (100 ppm)+ Sterile Soil


Non-Sterile Soil-Crag Herbicide 1
CUCUMBER ROOT ELONGATION IN CM.
SOIL pH
Non-Sterile Soil
C.H. + (100 ppm) + Non-Sterile Soil
0
1
2
3
4
5
6
7
8
9
10

in buffered, alkaline solutions. Our work has indicated that the chemical conversion of CRAG Herbicide 1 does not occur in non-sterile soils with a pH 8.0. From a practical standpoint of weed control, CRAG Herbicide 1 would be effectively converted to its active form on soils suited for crop production. It should also be emphasized that this work deals with only one soil type of a given microbial population. Variations in microbial numbers and types would be expected in soils of different structure and composition.

Whether the effect of soil pH was directly upon the organism responsible for the chemical conversion was not determined, however, this possibility cannot be precluded. Nevertheless it has been established that in sterile soils the compound is readily converted to an active herbicide under acid conditions. The most probable reaction to account for the breakdown is an acid hydrolysis. In non-sterile soils secretion of bacterial acids in "micro" areas possibly accounts for the hydrolysis of CRAG Herbicide 1, though no evidence for this has been found. In highly alkaline soils either the organisms responsible for the breakdown product are not present, or else the secretion of the bacterial acids are not in high enough concentration to cause hydrolysis. These hypotheses are under investigation. In addition, chemical analyses are being made of soil samples in which CRAG Herbicide 1 has presumably been converted to an active herbicide. Identification of the toxic agent will add greatly to our knowledge concerning the mechanism of the soil CRAG Herbicide 1 reaction.

A few reports have been made from field workers indicating that CRAG Herbicide 1 is more effective at higher temperatures than in cool areas. In view of the above work one would expect the biological-chemical reaction to increase in velocity with increases in temperatures. However, since little is known of the specific microorganisms involved in the reaction, and the possible effect of temperature on these, it was decided to study the overall effects of three temperatures on a soil-CRAG Herbicide 1 mixture. Assay of the herbicidal breakdown product was made using the above mentioned cucumber root suppression test. Fifty grams of sandy loam soil (pH 5.5) were treated with CRAG Herbicide 1 at 100 p.p.m. Replicated samples were stored for 48 hours in incubation chambers in which constant temperatures of 0° C., 24° C., and 30° C. were maintained. At the end of the incubation period soil solutions were prepared of each soil-herbicide mixture from each of the three temperature rooms. The soil solutions were filtered free of soil bacterial or fungal contaminants. Ten milliliters of the bacterial free solutions were poured over 50 cucumber seeds in Petri dishes. Appropriate herbicide and soil controls were included. All plates were incubated at 25° C. for a period of 6 days. Measurements of root elongation were made at the end of the period. Table 2 lists the results obtained.

Table 2. Cucumber root suppression in soil-CRAG Herbicide 1 mixture.

Treatment	Temperature 0° C.	24° C.	30° C.
	Average root length (cm)		
CRAG Herbicide 1+ Soil (100 p.p.m.)	1.4	0.4	0.1
CRAG Herbicide 1	1.5	1.2	1.4
Soil	1.4	2.7	1.7

Filtrates from soil-CRAG Herbicide 1 mixtures were toxic to cucumber seed if the original mixtures were stored at 24° C. or 30° C. Toxicity of soil filtrates from mixtures stored at 0° C. was negligible. These preliminary tests indicate that at freezing temperatures one may not expect the herbicide to be converted to its active form. Analysis of the breakdown of CRAG Herbicide 1 at temperature ranges between 0° C. and 24° C. seems warranted in view of the above work. Quantitative chemical determinations of the toxic principle in soil-CRAG Herbicide 1 mixtures will also furnish a valuable aid for elucidating this problem.

Summary

CRAG Herbicide 1 (Sodium 2,4 dichlorophenoxyethyl sulfate) has been shown to be converted to an active herbicidal compound in sterile soils of low pH. Non-sterile soils of acidic or neutral character also exhibit the conversion of the compound to its active form. In highly alkaline soils, sterile or non-sterile, the chemical conversion does not occur.

The herbicidal form of CRAG Herbicide 1 is found in soil more readily at high temperatures (24° C. and 30° C.). Little or no herbicidal action was noted at low temperatures (0° C.).

It is suggested that the method of microbial activity on sodium 2,4 dichlorophenoxyethyl sulfate is the secretion of bacterial or fungal acids causing hydrolysis of the molecule to its active compound. Elucidation of the steps involved in the microbial hydrolytic action will add greatly to our knowledge of soil microbiology and related fields.

ACTIVATION OF SODIUM 2,4-DICHLOROPHENOXY ETHYL SULFATE

R. B. Carroll*

Sodium 2,4-dichlorophenoxy ethyl sulfate ("Crag" Herbicide-1, C.H.-1) has the unique characteristic among hormonal type herbicides of being very toxic to young seedlings when applied to soil but is relatively non-phytotoxic when applied to foliage. During investigations of its phytotoxicity to various seedlings, L. King and co-workers found that the addition of soil to test plates containing the chemical and germinating seedlings activated the material so that it inhibited elongation of primary root of cucumber seedlings similar to sodium 2,4-dichlorophenoxyacetic acid. Further, it was found that sterilization of the soil prior to additions to the plates reduced the resulting inhibition as compared to that obtained using non-sterilized soil.

Investigation of some of the factors believed responsible for this phenomenon has demonstrated that pH is directly related to activation. Lowering the pH increased the phytotoxicity of the C.H.-1 solutions. Further chemical tests have demonstrated that under acid conditions C.H.-1 is hydrolyzed to yield 2,4-dichlorophenoxy ethanol and sodium bisulphate. Biological tests with 2,4-dichlorophenoxy ethanol have shown that very low percentages of this chemical were highly toxic to germinating seedlings. The ethanol derivative was found to be about one-hundredth as active as 2,4-dichlorophenoxyacetic acid when applied to foliage of tomato plants. However, the ethanol compound cannot be used in the same manner as C.H.-1 since the concentration of the ethanol effective for weed control would result in damage to crop plants.

Presumptive evidence has been gathered to show that the ethanol compound travels freely upward in the xylem of treated tomato plants but its movement downward in the phloem is highly limited.

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Riboflavin has been shown to counteract the inhibitory effect of the ethanol compound on germinating corn and cucumber seedlings.

When some 26 different cultures of micro-organisms were grown in sterile buffered nutrient solutions containing C.H.-1 approximately half of them activated the solution under alkaline conditions. This would seem to indicate enzymatic hydrolysis of C.H.-1 by these organisms.

THE USE OF CERTAIN ESTERS OF TRICHLOROBENZOIC ACID FOR PRE-EMERGENCE WEED CONTROL[1]

Robert H. Hamilton and Richard J. Aldrich[2]

Benzoic acid derivatives have been of considerable interest to plant physiologists in regard to induction of flowering, formative effects, and structural relationships. The work reported here, to the best of our knowledge is the first in which benzoic acid derivatives have been used as selective herbicides.

In the spring of 1949 the Isopropyl ester of trichlorobenzoic acid (Isop. T.C.B.) was included in a field screening test on 61 crop plants. From the results on crop injury and weed control it was concluded that these materials held promise as herbicides. Briefly, the results were: Isop. T.C.B. when applied pre-emergence at 3 pounds per acre gave somewhat less crop injury than the amine salt of 2,4-D applied at $1\frac{1}{2}$ pounds per acre. Pre-emergence weed control was good but when applied post-emergence the material was less effective.

General Methods

In 1950 field tests were conducted on nine field and vegetable crops, while in 1951 the materials were used primarily in field and sweet corn tests.

The trichlorobenzoic acid esters (referred to as T.C.B. esters in the remainder of this manuscript) were applied either as emulsions in water, or in oil in which they were soluble. The materials were applied at 10 gallons per acre under 30 p.s.i. pressure in all tests.

No special precautions were taken against volatility with T.C.B. esters in the field, as laboratory tests using tomato as a test plant showed that vapors were not excessively toxic. Volatility should be of less importance with these materials than with 2,4-D esters as post-emergence applications of 2,4-D esters are much more toxic than comparable post-emergence applications of T.C.B. esters.

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[1]Cooperative investigations between the New Jersey Agricultural Experiment Station and the Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

[2]Research Fellow, Farm Crops Department, NJAES; and Agent, Division of Weed Investigations, BPIS&AE, USDA, respectively.

Acknowledgement is made for the support of this project to the B. F. Goodrich Chemical Company.

METHODS, RESULTS AND DISCUSSION

1950 Tests on Crops

Methods

In 1950 several esters of T.C.B. were used in tests on vegetable and field crops, namely; potatoes, lima beans, sugar beets, carrots, cotton, cucumbers, and corn. The object of these tests was to get an idea of the group of crop plants on which the materials might be used and to secure weed control data. Each of the above tests was set up as a randomized block with three replications. All the above mentioned crops were planted June 8 and 9. However, the corn and sugar beets did not come up and were replanted June 27. The treatments were made June 14 on the first planting and July 1 and 2 on the replanted crops. The plots were two rows (28 inches apart) wide and 20 feet long.

Results

It is apparent from observation of table 1 that cucumbers were extremely sensitive to T.C.B. esters. In many cases there was no emergence.

Sugar beets were also quite sensitive with most plots receiving a severe injury rating. Stand counts were taken on the sugar beets and marked reduction in stand was noted, with most plots running less than 70 per cent of the check.

The next most sensitive crop was lima beans in which the best treatment showed slight to moderate injury. In most treatments the injury was moderate to severe.

In carrots the injury was somewhat variable, but all plots showed at least slight injury, and in every case some reduction in stand was noted.

Cotton was included in the tests in 1950 even though it is of no economic importance in this region. Injury ratings made in the two leaf stage showed none to slight injury in most cases. Later some leaf distortion was noted which appeared to be very similar to that reported for 2,4-D. Perhaps these leaf distortions were caused by volatilization from the post-emergence applications made in adjacent plots. Stand counts showed no reduction in stand. Two treatments and a check plot were hoed, and the dry weight taken at the end of the growing season. At this time the cotton was in the "square" stage. The results were analyzed and there was no significant reduction in dry weight. In 1950 a pre-emergence test was made on cotton but a very poor stand of cotton was secured due to a heavy rain immediately following planting which resulted in crusting of the soil surface. Stand counts showed no reduction in stand by treatment, although some hormonal effects were noted.

Potatoes showed rather severe hormonal effects. Stand counts showed that the stand had been reduced in all cases.

Table 1. Effect of T.C.B. on crop injury and weed control.

Pounds of chemical per acre	Injury Ratings[1]						Stand Counts[2]			
	Lima Beans	Potatoes	Sugar Beets	Carrots	Cotton	Cucumber	Corn	Beets	Carrots	Cotton
Methyl T.C.B.										
4 pounds	M	M	S	M	Sl-M	S-O	N	34	30	136
8 pounds	M-S	M-S	S	M-S	Sl-M	S-O	N-Sl	12	16	117
Methyl T.C.B. (in oil)										
4 pounds	Sl-S	M-S	M-S	M	N	N-O	N	50	16	160
8 pounds	S	M	S	M-S	Sl-N	O	N	8	20	150
Ethyl T.C.B.										
4 pounds	Sl-M	M-S	M-S	Sl-M	Sl-N	O	N	12	15	154
8 pounds	S	M-S	S	M-S	Sl-M	S	N	62	33	177
Ethyl T.C.B. (in oil)										
4 pounds	S	Sl-M	S	Sl-S	Sl-N	S-O	N	20	29	135
8 pounds	Sl-S	M-S	S	Sl-M	S-O	N		8	13	138
Isop. T.C.B.										
10 pounds								107	37	151
Isop. T.C.B. (in oil)										
10 pounds	S	S	S	N-S	M-S	S-O	N	2	23	84

	Per Cent Weed Control						
	Grass	Broad Leaves	Total	Pounds Chemical per acre (in oil)	Grass	Broad Leaves	Total
Methyl T.C.B.				Methyl T.C.B.			
4 pounds	71.3	56.2	64.7	4 pounds	61.7	55.3	58.4
8 pounds	87.7	61.2	80.5	8 pounds	75.1	47.0	68.2
Ethyl T.C.B.				Ethyl T.C.B.			
4 pounds	65.3	49.8	62.8	4 pounds	57.0	59.4	56.6
8 pounds	87.5	51.1	79.6	8 pounds	84.5	48.4	75.3
Isop. T.C.B.				Isop. T.C.B.			
10 pounds	94.5	69.0	87.6	10 pounds	97.1	66.0	89.0

[1]N = No injury Sl = slight injury M = moderate injury S=Severe injury O = no emergence
[2]Sugar beets and carrots three 3 foot counts per plot. Cotton one row per plot.

At Cranbury, New Jersey the Isopropyl ester of T.C.B. with 50 per cent Chlorinated-cyclohexanone was included in a test on potatoes. The mixture was applied at 10 pounds per acre, but since Chlorinated-cyclohexanone has not been effective in our pre-emergence tests the effective rate of herbicide was probably about 5 pounds per acre.

In this test no hormonal symptoms or reduction in stand were noted. The low yield obtained with the Isop. T.C.B. treatment in comparison with 2,4-D probably represents a difference in weed control. It would appear from the table that T.C.B. gave no control of grass, however, when the weed counts were made there were very few weed seedlings per square foot even in the check plots.

Table 2. Effect of T.C.B. (Isop.) and 2,4-D on weed control and yield of potatoes.

Chemical Treatment	Per cent Weed Control		Yield in Bushels per acre
	Grass	Broad leaves	
Uncultivated check	--	----	115
Cultivated check	--	----	457
2,4-D Amine 1 lb./acre	69	100	331
T.C.B. Isop. 5 lbs./acre*	0	92	269

*Plus 5 lbs./acre chlorinated-cyclohexanone

1951 Tests on Crops

In 1951 most of the tests were on field and sweet corn because from the preliminary work in 1950 it appeared that these were the crops on which the materials might be most useful in our region. At the present time 2,4-D is not recommended pre-emergence in sweet corn in New Jersey and not in field corn on the lighter soils in the state.

In 1951 the Methyl and Ethyl esters of T.C.B. were applied as emulsions only, but the Isopropyl ester was again applied both in oil and water. The materials were applied at 10 gallons per acre, except in a test on sweet corn in Burlington County in which they were applied at 5 gallons per acre.

Sweet Corn

Methods -- A sweet corn test in Burlington County was treated on May 2 four days after planting. The soil, a very light sand, was fairly dry when treated. Materials in this test other than T.C.B. esters included the following: 2,4-D Butoxy ethanol ester at 1½ pounds per acre, 2,4-D amine salt at 1½ pounds per acre, and 3-p-chlorophenyl-1, 1-dimethylurea (CMU) at ½ pound and 2 pounds per acre. The methyl, ethyl and isopropyl T.C.B. esters in water and isopropyl T.C.B. ester in oil were all applied at 3 pounds per acre. Yield data were not secured on this test, but the T.C.B. esters provided satisfactory weed control with no injury to the sweet corn.

In the test at New Brunswick the three esters of T.C.B. were applied at 4 and 8 pounds per acre. The Isop. T.C.B. ester was applied in oil and in water. Treatments were made one and seven days after planting. Golden Bantam was the variety used. Soil conditions were adequate for germination when planted. Two days after planting, or one day after the first treatment, there was 1½ inches of rain.

Results -- The data on stand, plant height, and yield are shown in table 3. Stand and plant height were not significantly reduced by any treatment. However, plants from plots treated one day after planting tended to be shorter than those treated seven days after planting. Two harvests were made in the sweet corn to study the effects of chemicals on maturity. The first harvest was made August 20 and the second August 24. Separate analysis for yield on each harvest showed no significant differences at either date. However, when an analysis was run on total yield there were significant differences at the 5 per cent level. Two extra checks were included in this total yield analysis to secure the interactions of dates, chemicals, and rates. The variation between the checks added probably resulted in significant differences between treatments. The interaction between chemicals and dates was significant. Isop. T.C.B. in oil applied at one day was the only treatment which significantly reduced yield. The one day treatment with 1½ inches of rain the next day should be a rather severe test of the toxicity of esters of T.C.B. yet comparatively little injury was noted.

Field Corn

Methods -- A pre-emergence field corn test was conducted at New Brunswick using the T.C.B. esters at 5, 7½ and 10 pounds per acre and the butoxy ethanol ester of 2,4-D at 1½ pounds per acre. This test was put on seven days after planting at which time approximately 10 per cent of the corn had emerged.

Table 3. Effect of T.C.B. esters on plant height, and yield of sweet corn.

Pounds of chemical per acre	Treated One Day After Planting				Treated Seven Days After Planting			
	No. of plants per plot*	Plant height in Cm.*	Yield per plot in pounds	Av. yield of treated plots	No. of plants per plot*	Plant height in Cm.*	Yield per plot in pounds*	Av. yield of treated plots
Methyl T.C.B.								
5 pounds	190	69.6	46.1	41.7	189	70.5	49.6	51.2
8 pounds	176	63.7	37.3		190	67.0	52.8	
Check	200	69.6	51.0					
Ethyl T.C.B.								
5 pounds	186	68.7	42.2	41.2	197	69.1	46.9	40.8
8 pounds	185	65.0	40.3		179	69.4	41.2	
Check	191	70.0	53.8					
Isopropyl T.C.B. (in oil)								
5 pounds	186	66.9	40.9	35.7*	197	69.1	46.9	45.9
8 pounds	185	69.4	30.5		190	66.0	44.8	
Check			43.3					
Isopropyl T.C.B.								
5 pounds	191	69.4	46.3	43.0	186	73.4	48.3	44.4
8 pounds	169	66.1	39.8		166	64.5	40.5	
Check							37.3	
L.S.D. .05			12.0	8.3			12.0	8.3

* Differences not statistically significant

Results -- The butoxy ester of 2,4-D resulted in onion leafing and reduced corn height. None of the T.C.B. esters noticeably injured the corn. It is apparent from table 4 that both the check and the butoxy ester of 2,4-D gave significantly reduced yields. The check plot probably gave a significantly lower yield because of early weed competition, although the checks were kept weed-free after weed counts were secured.

Weed Control

Weed control in 1951 was, in general, better than that in 1950, although adequate in both years. Table 5 shows the weed control as a per cent of the check which was obtained on corn in 1951. Weed counts were made with a one square foot quadrant; three random samples were taken in each plot.

Table 4. Effect of T.C.B. ester and 2,4-D ester on plant height and yield of field corn.

Pounds of chemical per acre	Height in Cm.	Yield in bushels per acre
Methyl T.C.B.		
5 pounds	95.6	82.2
7½ pounds	92.1	92.1
10 pounds	91.9	88.1
Ethyl T.C.B.		
5 pounds	93.6	87.8
7½ pounds	91.6	90.5
10 pounds	94.3	88.5
Isopropyl T.C.B. (in oil)		
5 pounds	92.8	85.2
7½ pounds	93.8	88.9
10 pounds	94.0	90.6
Isopropyl T.C.B.		
5 pounds	93.1	91.4
7½ pounds	94.8	84.9
10 pounds	96.4	88.6
Butoxy Ester, 2,4-D		
1½ pounds	87.9	69.4
Check	89.9	70.6
L.S.D. .05		11.1
.01		15.0

Table 5. Weed control obtained with T.C.B. esters in 1951.

Pounds of chemical per acre	Per cent Control Grass	Broad leaves	Average per cent control
Methyl T.C.B.			
5 pounds	71.3	92.7	83.3
7½ pounds	63.4	95.9	81.5
10 pounds	71.6	97.3	85.9
Ethyl T.C.B.			
5 pounds	74.9	94.4	85.7
7½ pounds	84.7	97.2	91.6
10 pounds	83.7	98.2	91.8
Isopropyl T.C.B.			
5 pounds	59.1	88.6	77.8
7½ pounds	64.1	94.3	82.9
10 pounds	70.4	93.9	81.6
Isopropyl T.C.B. in oil			
5 pounds	72.3	91.0	83.2
7½ pounds	77.2	77.5	82.9
10 pounds	69.5	94.9	87.3

Weed seedlings are not killed as completely with the T.C.B. esters as with 2,4-D, but the development of the few remaining seedlings, where T.C.B. has been applied, are greatly reduced. Field observation of persistence of T.C.B. esters indicates that satisfactory weed control is secured for approximately two months.

Wheat was sown in the fall of 1950 as a cover crop over plots which had been treated in June. The wheat appeared normal indicating that the chemicals were no longer effective.

SUMMARY

Results have shown that T.C.B. esters when applied pre-emergence at rates of at least 4 pounds per acre give effective weed control. T.C.B. esters appear to be somewhat less effective in post-emergence applications than 2,4-D. In field screening tests two years results showed that T.C.B. esters applied pre-emergence injured a fewer number of crops than 2,4-D. Results on sweet corn show it to be very tolerant to T.C.B. esters, even on light sandy soils. Rates of T.C.B. esters up to 10 pounds per acre on field corn resulted in no detectable injury.

It is felt that these materials will find useage in some of the borderline cases where application of 2,4-D involves risk of crop injury.

TWO HERBICIDES OF VALUE IN WEED CONTROL IN VEGETABLES

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B. F. Goodrich Chemical Company
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The two contact herbicides, Good-rite n.i.x. and Good-rite Oktone, discussed in this paper have shown considerable merit in certain weed control applications in vegetable crops. These two products are quite different in nature but, to some extent, complement each other.

The data on which the discussion is based have been obtained from tests conducted in New York, New Jersey, Ohio, Wisconsin and Florida, by the author, other company representatives, experiment station workers, and commercial growers.

Good-rite N.I.X.

Good-rite n.i.x. is a yellow powder that dissolves rapidly and completely in water. Chemically, it is sodium isopropyl xanthate. It has the property of killing, under proper conditions, soft succulent plant tissues. More matured, hardened or woody tissues, and those which have a waxy surface, are more resistant.

In general, when weeding vegetable crops with Good-rite n.i.x., the spray should be directed below the foliage to prevent injury. With proper applications the following crops have been successfully weeded with this herbicide:

Onions (possible, but not desirable to spray over tops of these - should be 3" or more high)
Corn (at least 5" high)
Peas (5" high)
Beans and Lima Beans (before trifoliate leaves unfold)
Cabbage and all of the Brassica oleracea series (preferably 4" or more)
Tomatoes, Peppers and Eggplant (preferably well over 6" high)
Carrots and Parsnips (at least 8" - past carrot oil stage)

In fact, most crops with a stem that holds the foliage off the ground can be weeded with n.i.x.

Onions at the crook stage can be weeded with n.i.x. with no significant damage. Of interest are recent tests in direct applications of n.i.x. over cabbage group vegetables (broccoli, kohl rabi, kale, cauliflower, etc.) at the three-leaf stage. The crop appeared to be injured, but recovered completely. We suggest limited trials on this.

The effectiveness of Good-rite n.i.x. varies with the species of weed and its size. In general, the control of annual grasses, purslane, ragweed, and most crucifers is excellent when the plants are not over one inch in height. The lambsquarters weed is killed below a two-inch height. The several Amaranthus species are controlled at even greater size and chickweed (Stellaria media) is controlled at any size. It is of great importance to apply n.i.x. before weeds become too large.

Wetting agents (Santomerse S or the liquid detergent "Joy" sold in grocery stores, and others) enormously increase the herbicidal action of n.i.x. With wetting agent, the material is especially useful for crop pre-emergent, or pre-setting applications. Some of the Florida growers, for example, have soil that may be bedded a short time before seeding or setting. If the emerged weeds are sprayed with n.i.x. just prior to seedling emergence or plant setting, and no great amount of subsoil is turned up, considerable weed control is possible.

N.i.x. has no residual effect in the soil; it is not corrosive to equipment; it has no hormone action, and it may be removed from spraying equipment completely and rapidly by rinsing with water. It is not harmful to the operator. While gross drift may cause injury to nearby plants, casual drift will not. The product is not volatile.

N.i.x. must be applied at temperatures 70°F. or above. Sunlight helps its action. Depending on degree of temperature and sunlight, it will take from two to four hours for n.i.x. to kill. Therefore, rains or watering prior to that time will reduce or even nullify its action.

N.i.x. is used at a pound in ten gallons of water. Eighty gallons per acre are used to cover. It is generally more economical to spray the rows only, and handle the space between with cultivation. However, the economical aspects must be considered in relation to individual problems. Certain Florida growers find applications low enough in cost to use complete area coverage.

N.i.x. solutions decompose slowly, and fresh preparations should be made each day. The dry powder should be kept covered to prevent decomposition.

I will close the discussion of Good-rite n.i.x. with one actual example of its field use, this on sweet corn. Just prior to the emergence of the corn, n.i.x. plus wetting agent was applied to the rows at a cost per acre, chemical plus application, of $3.00 to $3.50. After the corn had grown to a height of 6", weeds could not be controlled mechanically, and a second application was used, directing the spray at the base of the plants, but this time n.i.x. was used without wetting agent. Such an application eliminated all need for expensive hand weeding.

Good-rite Oktone

Good-rite Oktone is a saturated (40%) solution of octachlorocyclohexenone in petroleum oil. Spray solutions are prepared by dilution of one quart with fifteen gallons of Diesel #2 or Stoddard solvent or with twelve gallons of kerosene. These solutions are stable indefinitely.

Good-rite Oktone is valuable for certain applications which cannot be handled satisfactorily with Good-rite n.i.x. For example, an area to be planted with set plants may be infested with Bermuda grass. On the other hand, the weather prior to setting may be too cold, cloudy or rainy to obtain good results with n.i.x. For such applications, Oktone should be used. Oktone may be used pre-emergence to large-stemmed plants. Under certain weather conditions, small stemmed plants are injured by pre-emergent applications of Oktone as presently formulated. Tests are now under way on a new formulation to avoid this injury.

Oktone is a contact killer only. It has no hormone action. It may be removed from spray equipment with water plus detergent. It is not harmful to operators.

We are doing intensive field work with many commercial growers and are finding increasing numbers of valuable applications for these two herbicides. Several commercial growers are already employing them profitably.

Herbicide Screening with Three Species of Beans

by
R. D. Sweet and S. K. Ries

Beans comprise one of the important cash crop groups produced in New York. Dry or field beans, snap beans, large seeded limas and small seeded limas are the major crops of the group and total approximately 200,000 acres.

Beans are produced not only as a cash crop by general farmers but also by intensive vegetable growers. The weed problem, therefore, varies according to type of farming system. In the farm rotation perennials such as quackgrass, Agropyron repens, nutgrass, Cyperus esculentum, and horsenettle, Solanum carolinense are the most serious. In the latter, mustard, Brassica arvensis, ragweed, Ambrosia artemisiifolia, lambs quarter, Chenopodium album, redroot, Amaranthus retroflexus, foxtail, Setaria lutescens, and crabgrass, Digitaria sanguinalis, are prevalent.

Pre-emergence weeding of beans with either di-nitro compounds or aromatic oils has proved commercially feasible for controlling many of the broadleaved annual weeds. Unfortunately, however, these treatments must be timed rather accurately or failure may result either because of crop damage or poor weed kill. Further drawbacks to the pre-emergence program are that the present herbicides do not control perennial weeds, and that only under favorable circumstances can annual grasses be controlled.

If a truly selective herbicide could be found for beans, the timing problem from the standpoint of crop injury could largely be eliminated. Spraying could then be done primarily on the basis of the best time for controlling the several weed species.

Materials and Methods

Screening tests were conducted on several bean species as follows: Red Kidney variety of dry bean, Phaseolus vulgaris, both pre- and post-emergence tests; Black Valentine green snap bean, Phaseolus vulgaris, post-emergence only; Fordhook 242 lima bean, Phaseolus limensis, both pre- and post-emergence; Henderson baby lima, Phaseolus lunatus, post-emergence only.

All tests were conducted under field conditions in adjacent areas on a silt loam soil, except with Black Valentine. This test was located on a silty clay loam. Plots were six feet wide and 12 feet long. Two crop rows were planted lengthwise of each plot. Each treatment was replicated three times.

The following herbicides were included in the tests: fuel oil, di-nitro, PCP, NIX, Oktone plus fuel oil, monochloroacetic acid, endothal, phthalamic acid, IPC, chloro IPC, CMU, E. H. 1, MCP, 2,4-D, and low volative 2,4-D in oil. Each of the above was applied at two rates and each was used in both the pre-emergence and post-emergence

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[1]Much of this work was made possible by a grant from the Standard Oil Development Company, Linden, New Jersey.

Table 1. Average ratings of bean foliage responses to chemicals.

Chemical and Rate		Post-Emergence				Pre-Emergence	
		Henderson	Fordhook	Black Valentine	Red Kidney	Red Kidney	Fordhook
Check		8.0	8.3	9.0	9.0	9.0	8.7
Fuel oil	50 gal.	2.0	4.3	1.7	6.0	7.0	9.0
DN	3 lbs.	5.3	5.0	1.7	2.3	8.3	9.0
DN	6 lbs.	4.0	3.7	1.3	2.0	7.7	9.0
PCP	3 lbs.	4.7	4.3	3.0	4.0	8.3	8.7
PCP	6 lbs.	3.3	4.0	2.0	3.0	9.0	9.0
NP-128	6 lbs.	2.3	4.7	1.3	2.0	8.7	8.3
NP-128	12 lbs.	4.0	3.0	1.0	2.0	8.0	9.0
NIX	15 lbs.	6.0	6.3	2.7	6.3	8.3	9.0
Oktone	2 qts. + oil	1.7	3.7	1.0	4.7	8.7	9.0
Oktone	5 qts. + oil	2.0	3.3	2.0	4.7	8.0	9.0
MCA	10 lbs.	2.7	5.0	2.3	5.3	7.7	8.7
Endothal	6 lbs.	9.0	7.3	2.3	2.7	7.7	9.0
Endothal	12 lbs.	8.0	4.7	1.7	2.0	6.7	9.0
Phthalamic acid	1 lb.	8.7	7.0	7.3	7.3	7.7	9.0
Phthalamic acid	3 lbs.	8.7	7.7	6.0	6.3	6.0	9.0
IPC	2 lbs.	7.7	8.7	6.3	8.3	9.0	9.0
IPC	8 lbs.	6.3	7.0	3.0	6.0	8.0	9.0
Chloro IPC	2 lbs.	5.3	7.7	4.3	7.7	7.0	8.7
Chloro IPC	4 lbs.	5.0	7.0	3.3	8.7	6.0	8.3
CMU	1/2 lb.	3.3	6.0	2.3	6.7	8.0	8.7
CMU	2 lbs.	2.0	4.0	1.0	3.7	7.3	8.3
E. H. 1	1 lb.	7.7	8.0	8.7	9.0	7.3	8.3
E. H. 1	3 lbs.	6.7	5.0	8.3	8.0	6.3	7.7
MCP	1 lb.	3.7	5.7	5.0	6.3	6.0	8.3
MCP	2 lbs.	4.7	3.3	5.7	4.0	8.0	8.7
2,4-D	1 lb.	3.3	2.0	2.0	3.0	7.7	8.3
2,4-D	2 lbs.	2.7	2.0	1.3	1.7	6.7	8.0
MCP 1 lb. + IPC	2 lbs.	5.0	3.0	4.0	5.3	8.3	9.0
LV-4 in oil	1 lb.	1.3	1.3	1.0	1.7	6.0	8.3
L.S.D. at 5%		1.7	1.8	1.0	1.7	N.S.	N.S.
L.S.D. at 1%		2.3	2.4	1.3	2.2	N.S.	N.S.

tests. All materials were applied at the rate of 50 gallons to the acre at 25 pounds pressure by means of constant-pressure small-plot sprayer described in detail in "Weeds", in press.

In the pre-emergence screening tests, chemicals were sprayed when the bean seed had radicles about one-fourth inch long. Plumules had not yet emerged from the seed coat. The post-emergence tests were applied when the primary leaves were fully developed, but before the trifoliates had unfolded.

Results

A summary of the ratings obtained on crop response to both pre- and post-emergence treatments is given in Table 1. In the pre-emergence tests no chemical caused a statistically significant reduction in growth for either Red Kidney or Fordhook lima beans. In 26 out of the 30 comparisons, Red Kidney growth was rated numerically lower than that for Fordhook, indicating that the former is probably a little more sensitive to chemicals if they are applied to the soil. In the post-emergence tests, however, where chemicals were applied to the primary leaves and immature trifoliates, Fordhook averaged somewhat more sensitive than did Red Kidney. This suggests a differential varietal response depending on stage of growth when treated.

Disregarding the specific response of varieties or species to foliage sprays of various chemicals, and averaging the over-all crop response, one can see from Table 1 that such compounds as 2,4-D, CMU, MCP, MCA, Oktone in fuel oil, PCP and DN were particularly toxic. NIX, Endothal, phthalamic acid, IPC, Chloro IPC, and E. H. 1, on the other hand, were relatively non-toxic.

Of the four varieties tested, Black Valentine was the most sensitive to foliage applications of herbicides. As is shown in Table 1, it ranked numerically lowest in 22 out of 30 possible comparisons. Four chemicals, phthalamic acid, IPC, E. H. 1, and MCP did not seriously reduce vegetative growth of this variety. When yields were taken, however, those plots receiving E. H. 1 were the only ones which yielded as well as the check, Table 2.

Table 2. Yield in ounces per plot of Black Valentine beans which received post-emergence applications of herbicides.

Treatment		Ave. yield per plot
Check		69.7
IPC	2 lbs.	23.3
E. H. 1	1 lb.	68.0
E. H. 1	3 lbs.	83.3
MCP	1 lb.	15.7
MCP	2 lbs.	14.0
L.S.D. at 5%		20.4
L.S.D. at 1%		29.0

Yields were not obtained on the other three varieties. Due to late plantings, July 3 and 9, the later maturing beans were killed by an early frost before reaching maturity.

It is noteworthy that the Henderson baby lima was very tolerant of Endothal whereas Black Valentine and Red Kidney were very susceptible to this chemical. Henderson was damaged somewhat more by E. H. 1 and 1 lb. of MCP than were Black Valentine and Red Kidney. Fordhook was intermediate in its response to Endothal, E. H. 1 and MCP.

Discussion and Summary

Whereas a wide range of commercially available chemicals make satisfactory pre-emergence herbicides for beans, only a very few show any promise when applied as post-emergence foliage sprays. Dinitros, oils, and PCP, three of the very good pre-emergence chemicals, were particularly harmful to the crop.

Bean varieties exhibited a remarkable differential response to Endothal. Henderson was tolerant of 12 pounds and Fordhook tolerant of 6 pounds, whereas Black Valentine and Red Kidney were as sensitive to 6 pounds of Endothal as they were to 1 pound of 2,4-D. On the other hand, the latter two varieties were more tolerant of E. H. 1 and MCP than were the former.

It may be concluded from these studies that none of the herbicides tested, escept possibly E. H. 1, can be safely used as a post-emergence herbicide on all bean species commonly grown in New York.

There was no consistent tendency of beans to react according to species. Examples of inconsistencies were the differential response of Black Valentine and Red Kidney to NIX, IPC, and Chloro IPC, and to those treatments containing fuel oil.

Preliminary Report of Weed Control on Four Different Species of Beans

By A. J. Tafuro[1] and R. H. Beatty[2]

One of the most expensive cost items in bean production is weed control. Chemical weed control is being used in many bean production areas, but extensive work is still being done to further increase the efficiency of chemicals as weedkillers in beans. This paper is a preliminary report on some newer chemicals for pre-emergence weed control on four different species of beans.

In the summer of 1951, applications of various herbicides were made to three replicates of thirteen plots, 20 feet long and 6 feet wide. Each plot had four rows, and each row was planted to a different species of bean. The four different species used were: lima bean (Fordhook), snap bean (Tendergreen), soybean (Hawkeye), and field bean (Red Kidney). Included in each replicate was one unsprayed check. The beans were planted on July 11, 1951, and the materials were applied three days later before any bean plants emerged through the ground. Application was made with a low pressure, low volume hand sprayer. All materials were applied at the rate of 45 gallons per acre.

At the time of application five 18" squares were permanently staked off in each plot and weed counts were taken three and five weeks after the spray was applied. There were no weeds present at the time spray was applied.

(1-2 - American Chemical Paint Co., Agricultural Chemicals Division, Ambler, Pa.)

TABLE I

Total weed counts taken from five 18" squares permanently staked in each plot at three and five weeks after spray was applied.

Material	Rep. I		Rep. II		Rep. III		Av. Total Reps.	
	3 wks.	5 wks.	3 wks.	5 wks.	3 wks.	5 wks.	3 wks.	5 wks.
MCP 60% - ½ lb/a	32	68	31	50	39	58	34	59
MCP 60% - 1 lb/a	11	11	1	6	7	18	6	12
MCP 60% - 1½ lb/a	1	8	7	16	2	6	3	10
MCP 90% - ½ lb/a	7	14	25	42	16	38	16	31
MCP 90% - 1 lb/a	3	7	1	12	1	5	2	8
MCP 90% - 1½ lb/a	0	5	1	4	4	13	2	7
CMU - ½ lb/a	2	7	3	10	11	24	5	14
CMU - 3/4 lb/a	29	50	2	8	6	14	12	24
CMU - 1 lb/a	5	6	1	1	0	4	2	4
CK	106	157	241	284	60	92	136	178
LV-4 - ½ lb/a	20	35	11	15	18	31	16	27
LV-4 - 1 lb/a	2	5	2	11	3	11	2	9
LV-4 - 1½ lb/a	1	1	1	3	5	11	2	5
Premerge - 3 lbs/a	5	7	5	16	2	14	4	12

MCP (both 60% and 90% 2-methyl-4-chlorophenoxyacetic acid) amine gave similar weed control. At the 1 and $1\frac{1}{2}$ lb. per acre rate both MCP's gave very good weed control, but slight epinasty was observed in the $1\frac{1}{2}$ lb. plots on all beans except lima bean. All plants were free of this injury five weeks after spray. MCP at $\frac{1}{2}$ lb. rate gave good initial weed control, but residual effect was depleted two weeks after application.

CMU gave good weed control at all rates used. Weed control at the 1 lb. per acre rate was very good but injury was observed at this rate to all beans except lima beans. Injury was in the form of a marginal burn, but did not seriously affect growth of plant. CMU did not control bindweed (Polygonum convolvulus) at any of the rates used.

Weed control was very good at the 1 and $1\frac{1}{2}$ lb. rates with WEEDONE LV-4, a low volatile 2,4-D ester, but there was injury to all species of beans at all rates used. Premerge at the one rate used (3 lbs/A) gave good weed control; a slight burning of the lower leaves was observed on the field beans. No injury was observed in the three other species of beans sprayed with Premerge.

Yield data was not taken due to crop injury from rabbits.

SUMMARY

1 - Four different chemical weedkillers were used at three concentrations, on four different species of beans as a pre-emergence application.

2 - The 60% and 90% MCP used in this test gave similar results.

3 - MCP (60% and 90%) at 1 and $1\frac{1}{2}$ lb. rate gave good weed control. Slight epinasty was observed at the $1\frac{1}{2}$ lb. rate except on lima beans.

4 - CMU at 1 lb. rate gave very good weed control, but a light marginal leaf burn was noticeable at the 1 lb. rate. CMU did not control bindweed (Polygonum convolvulus).

5 - LV-4 injured all species of beans at all rates used. Weed control at the 1 and $1\frac{1}{2}$ lb. rate was very good.

CONCLUSION

1 - 1 lb. per acre of MCP (60% and 90%) as used in this test appears safe as a pre-emergence spray for the control of weeds in Fordhook, Tendergreen, Hawkeye and Red Kidney beans.

2 - There was no difference between a 60% or 90% MCP in weed control or injury to crop.

3 - LV-4 a low volatile ester is too toxic to beans as a pre-emergence weedkiller.

4 - Premerge at the recommended 3 lb. rate gave good weed control, but gave slight injury to field beans.

PRE-EMERGENCE WEED CONTROL IN BEANS WITH WATER SOLUBLE DINITRO COMPOUNDS

By: L. L. Danielson[1], Ernest R. Marshall[2] and John VanGeluwe[3]

Green beans is an important crop grown along the eastern seaboard, particularly in Virginia and the Delmarva Peninsula. New York State also has large acreages of green and dry field beans. Earlier results of pre-emergence chemical weed control in beans have been presented by Tafuro and VanGeluwe (1950, 1951). In order to follow up these results with additional research, a cooperative project was arranged between the Virginia Truck Experiment Station at Norfolk, Virginia and G.L.F. Soil Building Service at Ithaca, New York.

Objectives of the cooperative program were to test the effectiveness of water soluble dintro compounds as pre-emergence weed control materials for use on green and dry field beans and to find whether or not beans would be injured by relatively high rates of the materials. It was decided that this should be arranged by means of a series of three experiments. The first test was conducted early in the 1951 season at the Virginia Truck Experiment Station farm at Onley, Virginia. This test was then followed by two others, one with green beans in Virginia and the other with dry field beans in New York. These individual experiments will be discussed separately.

EXPERIMENT I

Methods and Procedures

The first test was conducted at the Virginia Truck Experiment Station farm at Onley, Virginia. On April 6, 1951 a field was planted with Bountiful Beans. Pre-emergence weed control applications were made on April 18 and April 20, 1951, three days and one day respectively before bean emergence. When the second series of applications were made on April 20th the beans were just cracking the surface of the soil. All treatments were applied with a jeep sprayer. Forty gallons of water per acre was used in this test. The experimental plots were 46 feet long, four rows wide with the rows 36 inches apart. All plots were replicated four times, using a randomized block design. The weather was clear with no wind on April 18th and clear but with some wind on April 20th.

The pre-emergence materials used in the test were the water-soluble dinitro materials, Sinox PE and Dow Premerge, each containing three pounds of DN per gallon.

[1]Virginia Truck Experiment Station, Norfolk, Virginia

[2,3] G.L.F. Soil Building Service, Ithaca, New York

Results and Discussion

Good weed control was obtained in all plots sprayed with the DN compounds. No visible injury was noted on the beans from any of the treated plots, even plots which were sprayed with $7\frac{1}{2}$ pounds DN per acre. Temperatures during the germination period were very low (50°-60°F.) and germination was very slow. The stand of beans was seriously affected by seed corn maggot injury so that this test was not carried through the complete season. Stand counts were made however, and the results are show in Tables 1 and 2. Counts were taken from 40 feet of the two center rows of each four row plot. Stand counts shown in Table 1 are the means of four plots. Counts were made on May 22, 1951.

Table 1. STAND COUNTS OF BOUNTIFUL BEANS TAKEN ONE MONTH AFTER PRE-EMERGENCE WEED CONTROL TREATMENTS WERE APPLIED.

Treatment	Plants per 80' of row
3 days before emergence	
Sinox PE ½ gal/A. (1½ lbs. DN)	136
Dow Premerge ½ gal/A. (1½ lbs. DN)	111
Sinox PE 1 gal/A. (3 lbs. DN)	102
Sinox PE 1½ gals/A. (4½ lbs. DN)	124
Sinox PE 2 gals/A. (6 lbs. DN)	63
Sinox PE 2½ gals/A. (7½ lbs. DN)	84
Check	105
1 day before emergence	
Sinox PE ½ gal/A. (1½ lbs. DN)	90
Sinox PE 1 gal/A. (3 lbs. DN)	162
Sinox PE 1½ gals/A. (4½ lbs. DN)	174
L.S.D.	N.S.D.

Table 2. EFFECT OF DIFFERENT RATES OF WATER SOLUBLE DN APPLIED PRE-EMERGENCE ON BOUNTIFUL BEANS AT TWO DIFFERENT DATES

Rates Used	Date of herbicide application April 18	April 20	Mean of rates
Sinox PE ½ gal/A(1½ lbs DN)	136	90	113
Sinox PE 1 gal/A(3 lbs DN)	102	162	132
Sinox PE 1½ gal/A (4½ lbs DN)	124	174	149
Mean of dates	121	142	
L.S.D.	Rates N.S.D.	Dates N.S.D.	Dates-rates N.S.D.

Although these data were not statistically different and the stand was seriously reduced by bean maggot injury there were indications which warranted further investigation.

In general this test showed that the beans which emerged were not damaged by as much as 7½ pounds DN per acre applied three days before emergence, or by 4½ pounds DN applied one day before emergence. The stand of beans was not affected by any rate used and perhaps stand was a little better at rates up to 4½ pounds DN per acre. Indications were that best results could be obtained if the materials were applied just prior to, or at come up of the beans.

EXPERIMENT II

Methods and Procedures

The second experiment was conducted at the Virginia Truck Experiment Station, Norfolk, Virginia. Plantings of Black Valentine beans were made on June 24, 1951 and sprayed immediately with herbicides for weed control. Forty gallons of spray was used per acre. This test was designed to test the toxicity of the herbicides to the crop, and to indicate their use in weed control. The plots were two rows wide and 50 feet long. There were four replicates laid out in a randomized block design. Stand counts were made and weight of twelve plants were taken from each plot, 12 and 33 days after planting. Yield data were taken on August 20, 1951. Only one picking was made because of dry weather, however, this one picking represented most of the crop.

Table 3 shows the results of this experiment.

Table 3. EFFECT OF PRE-EMERGENCE WEED CONTROL APPLICATIONS ON STAND, WEIGHT OF PLANTS AND YIELD OF BLACK VALENTINE BEANS

Treatment	Plants 100' row	Weight of 12 plants in gms Days after planting 12 days	33 days	Yield lbs,per acre
Premerge 2 gal/A (6 lbs DN)	749	25.7	250	4719
Crag Herbicide #1 2 lbs/A.	604	25.7	221	2614
Check	754	27.2	258	4225
L.S.D. .05	49	N.S.D.	N.S.D.	1572
L.S.D. .01	69			2204

These results show that Crag Herbicide #1 reduced stand and yield of beans. Premerge did not affect either stand or yield significantly although yields from the Premerge plots were somewhat higher than the check. Weed control was good with both herbicides used. It appears that Premerge can be safely used as a pre-emergence application to green beans at rates up to 2 gallons per acre with no toxic effects to the crop.

EXPERIMENT III

Methods and Procedures

The third experiment was conducted in a field of Red Kidney beans at the Paul Draper farm near Geneva, New York. Herbicide applications were made with a jeep sprayer on June 22, 1951 using 30 gallons of spray per acre. Temperatures were 70°F. with little wind. A 6x6 Latin square design was used and plots were four rows wide and 160 feet long. Results are shown in Table 4. Weed and grass counts were for 30 square feet. Pre-emergence applications were made three days after the beans were planted and before any beans emerged.

Results and Discussion

Table 4. EFFECT OF PRE-EMERGENCE APPLICATION OF VARIOUS RATES OF WATER SOLUBLE DINITRO MATERIALS ON WEED CONTROL AND YIELDS OF RED KIDNEY BEANS

Treatment	Counts per 30 sq.ft. Weeds	Grass	Weeds & grass	Yields in lbs/acre
Sinox PE ½ gal/A (1½ lb DN)	27	15	42	2480
Sinox PE 1 gal/A (3 lbs DN)	26	17	43	2438
Sinox PE 1½ gal/A (4½ lbs DN)	21	20	41	2438
Sinox PE 2 gal/A (6 lbs DN)	19	13	32	2402
Experimental DN ½ gal/A. (1½ lbs DN)	24	14	38	2354
Check	123	49	172	2312
L.S.D. .05	33	20	77	N.S.D.
L.S.D. .01	44	26	103	

The results show that all treatments significantly reduced weed counts over check. Good weed and grass control was obtained lasting for four weeks when one gallon of Sinox PE was used. Two gallons of Sinox PE gave good weed and grass control for six weeks. All plots were then cultivated for the remainder of the season according to general practices. Although there was no statistical differences in yields, all dinitro plots yielded more than the check plots. No toxic or injurious effects were noticed from any rate of DN tested.

General Summary

Test conducted in Virginia and New York showed that water soluble dinitro materials could be used successfully for weed control in green and dry field beans.

No toxic or injurious effects on the beans were noticed from any rate of DN up to 7½ pounds per acre.

Good weed and annual grass control was obtained for 4 to 6 weeks with 3 to 6 pounds of DN in the water soluble form.

Bean yields were as high or higher than those of the check when plots were cultivated after the residual weed control effect of the DN's had run out.

Applications of the spray could be made either at planting or just as the beans were cracking the soil.

From these results it appears that water soluble dinitro compounds such as Sinox PE and Premerge can be used safely and effectively for pre-emergence weed control in green and dry field beans.

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THE COMPARISON OF SEVERAL CHEMICALS AS WEED CONTROL AGENTS IN LIMA BEANS

Walter C. Jacob (1)

Although previous work (1), (2)* has shown that Dinitro formulations are satisfactory materials for weed control in lima beans on Long Island, the high cost of materials prompted further search for new materials of possible lower cost. Several of the newer materials were compared with various formulations of Dinitros with respect to degree of weed control and influence on stand of the beans as well as any subsequent injury to the crop.

Materials and Methods

Fordhook lima beans were seeded in a newly prepared seed bed on July 25, 1951. The plots were sprayed on July 27, 1951. The weather was hot and dry and no rain fell until July 28 when .43 inch was recorded. Materials were applied in 30 gals. of solution per acre with a hand aprayer. Each plot was 9' x 12' in size and the 25 treatments were arranged in a 5 x 5 balanced lattice square design. The beans began to emerge on July 30 and all observations were made on August 24.

Table 1. Materials used, rates of application, and source of material.

Material	Rates used	Active Ingredients	Source of Material
NP-128	6, 12 lbs.	O-chlorophenosulfonyl fluoride	Penn. Salt Mfg. Co.
MCP	3/4,1-1/2 lbs.	2 methyl 4 chlorophenoxyacetic acid	Amer. Chem. Paint Co.
ACP-904	3/4,1-1/2 lbs.	2 methyl 4 chlorophenoxyacetic acid	" " "
2,4-D	3/8, 3/4 lbs.	2,4-dichloro phenoxy acetic acid	" " "
Crag #1	1, 2 lbs.	Sodium 2, 4-dichloro phenoxyethyl sulfate	Carbide & Carbon Chem. Co.
Premerge	3, 6 lbs.	DNOSBP alkanolamine salts	Dow Chemical Co.
Sinox PE	3, 6 lbs.	DNOSBP alkanolamine salts	Standard Agr. Chem. Co.
CMU	1/2, 1 lb.	3 (p-chlorophenyl)-1, 1-dimethylurea	Du Pont
N.i.x.	8, 16 lbs.	Sodium isopropyl xanthate	B. F. Goodrich Chem. Co.
Sinox Gen.	2, 4 pts.	DNOSBP, DNOSAP	Standard Agr. Chem. Co., Inc.
H 916	3, 6 lbs.	Pentachlorophenol	Dow Chem. Co.
I.P.C.	3, 6 lbs.	Isoprophy phenyl carbamate	Jack Wilson Chem. Co.

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* Numbers in parenthesis refer to Literature cited at end of paper.

Results and Discussion

In Table 2 are given the weed control ratings and stand counts for the various treatments. Most of the materials used gave adequate weed control with no reduction in stand. Crop injury ratings were not given since only CMU at 1 lb. showed any injury to the crop. This was a typical marginal burning of the lower leaves, a slowing of growth and eventual loss of many leaves. No injury was apparant until 3 weeks after treatment. The combination of 2,4-D and MCP in equal proportions looked very good and no hormone effects could be detected in the plants. Materials with a weed control rating of less than 5 were definitely unsatisfactory, between 5 and 7 could be judged fair and above 7 were excellent. The plots were examined again at six weeks after treatment on September 7 and the ratings given at one month were still good. The weeds present were much larger but no change in relative rates were apparent. After this time the new weed seedlings began to emerge at the lower rates of application.

Table 2. Weed control and stand of lima beans as influenced by various chemical herbicides.
(Applications made 2 days after seeding)

Materials Used	Rate per acre of active ingredients	Ave. age weed control rating *	Stand of plants in 4 yards of row
2,4-D+MCP	1-1/2 lbs.	8.6	28.8
Crag #1	2 lbs.	8.2	23.9
ACP 904	1-1/2 lbs.	8.0	29.8
Premerge	6 lbs.	8.0	32.0
ACP 904	3/4 lb.	7.8	34.1
2,4-D+MCP	3/4 lb.	7.7	30.8
MCP	1-1/2 lb.	7.6	24.7
CMU	1 lb.	7.2	27.4
Crag #1	1 lb.	7.2	28.4
Premerg	3 lbs.	7.2	30.8
MCP	3/4 lb.	6.9	26.8
Sinox Gen.	4 pts.	6.8	30.6
Sinox PE	6 lbs.	6.8	29.1
CMU	1/2 lb.	6.4	33.1
Sinox PE	3 lbs.	6.4	32.0
Sinox Gen.	2 pts.	5.9	24.6
H 916	6 lbs.	5.2	31.6
NP 128	12 lbs.	5.2	32.0
NP 128	6 lbs.	3.9	27.1
N.i.x.	16 lbs.	3.6	26.9
H 916	3 lbs.	3.3	31.4
I.P.C.	6 lbs.	3.0	27.0
I.P.C.	3 lbs.	2.5	27.9
N.i.x.	8 lbs.	2.1	25.1
Check		1.3	27.8
L.S.D. .05		1.7	6.1

* Key to weed control rating
1 - No weed control
9 - Perfect weed control - no weeds

It was interesting to note the excellent weed control with 2 lbs. of Crag #1 with no injury. Previous work (2) has shown that 3 lbs. of Crag #1 will seriously reduce stand of lima beans.

While CMU at 1/2 lb. gave good weed control with no injury to the crop, 1 lb. was too much for lima beans. This material has too narrow tolerance limits for grower use, as presently formulated.

The two materials N.i.x. and I.P.C. were really not supposed to be satisfactory for this type of pre-emergence use. They were included here just as a further check on that point. H 916 and NP 128 must be used in rather heavy applications to be satisfactory.

In general the Dinitros are still satisfactory for pre-emergence use in lima beans. The various formulations of MCP should be field tested because of the small amounts needed to control weeds. If prices are right it is possible that a combination of 2,4-D, MCP and MCP alone at about 1 lb. per acre total acid could be the future preferred materials for lima beans.

Summary

1. Twelve weed control materials at two rates each were applied pre-emergence to lima beans seeded in a newly prepared seed bed.

2. The hormone-like materials MCP, 2, 4-D+MCP, Crag #1, and APC 904 all gave satisfactory weed control with no crop injury at rates of 3/4 to 1-1/2 lbs. per acre.

3. All dinitros performed satisfactory even at rates as low as 3 lbs. per acre.

4. The new du Pont chemical CMU has too narrow a tolerance range to be used on lima beans.

5. If prices are right MCP or Crag #1 may be better materials to use for lima beans than Dinitros. However, there is no other material yet tried which has the tolerance range of dinitros.

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Weeding of Lima Beans with Pre-Emergence Applications of Herbicides

Charles J. Noll and Martin L. Odland[1]

The growing of lima beans for processing is an important source of income to farmers of Pennsylvania. Most of them are grown on general farms and weed control is an important factor in determining the extent of acerage. Weed control between the rows can be done relatively cheaply by using various types of cultivators. Weed control in the row is much more difficult and if dependent upon hand weeding is prohibitive in cost.

Preliminary experiments in weeding lima beans with pre-emergence applications of herbicides were run in 1948 and 1949. The most promising herbicides used in these tests together with some untried herbicides were used on a larger scale in 1950 and 1951. Most of the work reported in this paper will deal with the results in the 1950 crop.

PROCEDURE

In 1950 lima beans were planted on two different dates and pre-emergence treated with eleven chemicals at two rates of application together with the carrier of some of the chemicals, fuel oil, and an untreated control. The treatments were randomised in six replications. Each plot consisted of a single row forty feet long by three feet wide. The herbicides were applied with a hand sprayer over the row for a width of eighteen inches.

The first planting was made on June 7th and the herbicides applied June 9th. The second planting was made June 16th and the herbicides applied June 19th. Weeds between the rows were controlled through cultivation. Harvest was made on Sept. 8th for the first planting and Sept. 26th for the second planting. The 1951 plot layout was similar to the arrangement of the 1950 plots and the herbicide treatments were much alike.

RESULTS AND DISCUSSION

The 1950 results on lima bean stand and yield of beans and weed control is presented in Table 1. Stand of plants in both tests is realtively poor with corresponding poor yield. Weed control was estimated at 1 to 10, 1 being perfect weed control and 10 no weed control. Pre-emergence treatments resulted in both significant increases and significant decreases of stand, yield and weed control. In the first planting all plots with a significant increase of yield had a stand equal to or better than the check and, with one exception, a significantly better weed control. In the second planting all chemicals gave a significantly better weed control than the check and thirteen treatments resulted in a significant increase in yield.

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The 1951 plots had good stand, good yield and practically no weeds. A statistical analysis of the data shows no significant difference in a comparison of the untreated and the chemically treated plots in stand, yield or weed control.

CONCLUSION

Although the results are not consistant from planting to planting or from year to year, certain chemicals offer promise for the weeding of lima beans in a pre-emergence application of herbicides where weeds are a problem. The best of these herbicides are Dowicide G, Sinox and Shell Oil 130. Other chemicals gave increased yields and increased weed control but weren't as consistantly good as the first three herbicides listed. Further investigations should be made on rate and time of application on all chemicals used in these experiment before general recommendations are made.

TABLE 1 THE EFFECT OF PRE-EMERGENCE HERBICIDES ON STAND, YIELD AND WEED CONTROL IN LIMA BEANS IN 1950

Treatment		First Planting			Second Planting		
Herbicide	Rate per acre	Stand	Yield	Weed Control	Stand	Yield	Weed Control
Nothing	--	21.3	4.0	6.7	61.8	15.3	8.2
Fuel Oil	13 lbs.	22.0	4.6	°°8.7	**75.2	*18.0	**6.2
Dowicide G	15 lbs.	23.3	**6.8	**2.5	**78.7	**20.9	**2.0
" "	22½ gal.	20.3	4.6	**2.2	58.5	**18.6	**1.5
Shell Oil 130 penta.	5 gal.	21.5	**5.7	7.5	57.3	**19.2	**3.8
" " 130	7½ gal.	18.2	*5.2	*5.7	62.3	**18.6	**3.3
Premerge	1 gal.	°17.1	3.5	**2.3	*72.3	**18.6	**3.2
"	1½ gal.	°17.7	4.2	**2.8	56.7	17.1	**1.5
Sinox	3 gal.	18.5	*5.2	**3.2	*70.5	**20.3	**3.5
"	4½ gal.	23.5	**5.8	**4.0	59.8	16.3	**2.0
General Weed Killer	½ gal.	°°16.7	3.7	**4.7	59.3	17.3	**2.0
" " "	3/4 gal.	18.5	4.2	**2.0	62.7	**19.1	**1.3
H 916	1 gal.	21.0	4.7	6.0	62.7	**18.5	**3.3
"	1½ gal.	19.8	3.7	6.5	66.5	**19.7	**3.7
ACP 646A	1½ gal.	°°11.5	°°2.0	**4.3	64.5	*18.3	**2.7
" "	2¼ gal.	°° 8.0	°°1.3	**2.7	59.5	°12.2	**1.5
P.S.-NP128	7 lbs.	*25.0	**5.9	°°8.3	61.0	**18.7	**3.0
" "	10½ lbs.	21.5	**5.8	*5.8	54.0	16.6	**3.2
Exp. Herb No. 1	5 lbs.	°° 5.8	°°1.0	**1.8	°°41.5	°°11.5	**2.3
" " "	7½ lbs.	°° 2.2	°°0.6	**1.7	°°28.2	°° 4.4	**1.7
24D Amine	1 lb.	°°15.8	3.3	**4.3	57.5	**18.5	**3.7
" "	1½ lbs.	°°13.7	°2.6	**3.3	°°46.8	°12.4	**2.2
24D Ester	1 lb.	°17.5	4.3	**4.3	60.3	15.5	**4.3
" "	1½ lbs.	°°10.8	°2.6	**2.5	°°47.7	°12.6	**2.8
Significant Diff.	5%	3.38	1.01	.92	7.85	2.32	.79
	1%	4.59	1.37	1.25	10.66	3.15	1.07

Significant increase 5% * 1% **

Sginificant decrease 5% ° 1% °°

Growth of Cabbage and Cauliflower Following Application of TCA on Quackgrass[1]

by

R. D. Sweet and S. K. Ries

Quackgrass (Agropyron repens) is a common weed in the Northeastern United States and Canada. It is only of minor importance where cultivated crops are grown continuously. Where intertilled crops are grown only once in several years, however, quackgrass flourishes and soon becomes a commercial problem.

Many workers have found that TCA (sodium salt of Trichloroacetic acid) is an effective chemical for controlling quackgrass. From an economic standpoint, most farmers can neither afford to lay aside their land for a season nor to change the cash crop grown in their normal rotation, while eradicating quack. The most satisfactory method of control, therefore, would be to apply the TCA while producing a tolerant crop in the rotation.

Cabbage has been reported by Barons (1) to be fairly tolerant of TCA. Unpublished screening work by the authors in 1949 and 1950, coupled with field scale applications, indicated that members of the crucifer family such as cabbage, cauliflower, radish, and wild mustard exhibit tolerance to TCA. In cabbage there appeared to be a differential varietal susceptibility to TCA.

The purpose of the tests reported here was to determine the varietal tolerance of cabbage and cauliflower to TCA. These crops are the leading crucifers produced in general farm rotations in New York. An additional objective was whether dosages needed for quackgrass control were harmful to the crops.

Materials and Methods

The experimental area consisted of a typical legume rotation where quackgrass had become thoroughly established and the field was to be put into an intertilled crop. The soil was a stony silt loam. Plowing was done late in the fall of 1950. On April 25, 1951, when the earliest new growth of quackgrass had reached 5 inches in height, part of the area was treated with TCA at 25, 50, and 100 pounds to the acre. The spray liquid was applied to each plot at the rate of 50 gallons with a knapsack sprayer. The entire area was thoroughly worked May 9 with a spring-tooth harrow. About six weeks after the first treating date, on June 5, an application of TCA at the same rates as above, was made to another series of plots. In addition, TCA treatments of 25 and 50 pounds each were superimposed on some of the plots which had received a corresponding amount at the earlier treating date. The entire area was again thoroughly harrowed June 11. A light harrowing was made June 20. Planting started June 22, when approximately three replications were planted. Due to heavy rains, the remaining plants were not set until June 25.

[1]Much of this work was made possible by a grant from the Standard Oil Development Co., Linden, New Jersey.

Each TCA and check plot was 15 by 20 feet in area. One 13-plant row of each Glory and Danish varieties of cabbage and Erfurt and Supersnowball varieties of cauliflower were planted lengthwise in each plot. At the plot junctions, a guard row was planted to one of the four above items chosen at random. The experiment was a randomized block design with six replications.

A starter fertilizer-solution was used at planting time. The entire area was sidedressed at the first cultivation, July 13, with a 6-12-6 fertilizer at the rate of 500 lbs. per acre. One additional cultivation was given about two weeks later. The crop made excellent growth until mid-August. The rainfall was heavy during June and July and light during August and September (Table 1). After mid-August, the crop frequently wilted during the heat of the day.

Table 1. Inches rainfall for May through September.

May	2.13	July	4.15
June	6.03	August	1.83
September	1.56		

Results

The quackgrass made good growth in April and early May, but the dry weather of May, coupled with the several thorough harrowings, served to keep the quack from becoming serious even in the check plots. The check plots were rated as having commercial control. All rates of TCA, regardless of time of application, gave apparent eradication of quackgrass. Because of the dry conditions which prevailed in the latter part of the growing season, final records on quackgrass response will not be made until the spring of 1952.

As can be seen in Table 2, treatment with TCA, regardless of rate or time of application, had no harmful affects on the average weight of cauliflower. Both the Erfurt and Supersnowball varieties, which are representative of the two important types grown in New York, were equally tolerant of TCA. No foliage symptoms could be detected.

The results with cabbage were different from those with cauliflower. Whereas the Danish variety showed no foliage symptoms, the Glory variety exhibited very striking symptoms, especially on individual plants. There was a marked reduction in leaf bloom over the entire plant. A definite savoy effect developed on the younger leaves that were to eventually make up the heads. Innermost head-forming leaves, instead of systematically overlapping each other in characteristic fashion, grew upwards at the tips. The net effect was to give the head a ragged open appearance at the top center. An additional symptom on these leaves was a tendency for the epidermal layers of adjoining leaves to be fused together. If this occurred on early formed tissues, the condition sometimes existed until almost harvest time. It gave the appearance of the plant having been tied for bleaching, much the same as is normally done with cauliflower.

From the standpoint of cabbage yield (Table 2) there was no statistically significant reduction with the Glory variety, in spite of the marked symptoms, even where high rates of TCA were applied.

Table 2. Effect of TCA on the average weight of cabbage and cauliflower heads.

Time of Treatment (Days before planting)	Rate lbs/acre	Yield in pounds			
		Cauliflower		Cabbage	
		Super	Erfurt	Glory	Danish
Check	---	2.68	2.60	5.14	4.02
60	25	2.60	2.90	4.58	4.28
60	50	2.94	2.84	5.16	4.46
60	100	2.86	3.04	5.06	4.52
17	35	2.90	2.90	4.98	4.82**
17	50	2.60	2.74	4.96	4.66**
17	100	2.76	2.92	4.30	4.48
60 and 17	25 and 25	2.54	2.66	5.04	4.88**
60 and 17	50 and 50	2.66	2.92	4.74	4.40
L.S.D. at 1%		NS	NS	NS	0.64

The yield of Danish cabbage was not lowered by any treatment, and average head weight actually was statistically greater than the check on several of the treated plots.

Discussion and Summary

The 1951 season was excellent for controlling quackgrass. The dryness early, coupled with the heavy rains during planting time and early growth of the crops, followed by a dry fall gave a combination of environmental factors which: (1) favored weakening the quackgrass by the mechanical harrowings, (2) helped leach excess amounts of the TCA, (3) encouraged good plant growth in spite of foliage symptoms, and (4) discouraged regrowth of the quack on the treated areas.

It is quite possible if the rainfall distribution had been reversed, i.e. wet in April, May, and early June, dry in late June, July, and early August, followed by wet in the fall months, the results would have been somewhat different. Under these conditions one might expect the following: (1) decidedly poorer quackgrass control by harrowing; (2) poorer early growth of crop and probably more injury to the Glory variety of cabbage from the heavy TCA rates, especially when applied just prior to planting; (3) more regrowth of quackgrass in the checks and perhaps on the treated plots at the low rates.

In conclusion, it appears that commercial control of quackgrass can be obtained without giving up use of the land for a growing season. A combination of fall plowing, early spring application of TCA at 25 lbs. to the acre and thorough harrowing, followed by planting a late crop of cabbage or cauliflower will give a practical answer to reducing quackgrass on general farms in the northeast where these intertilled crops are grown occasionally in the rotation.

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Chemical Weed Control In Asparagus And Sweet Corn

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The possibilities of chemical weed control in vegetable crops have been demonstrated previously by many investigators. The synthesis of new chemicals with herbicidal properties is progressing at a rapid rate and considerable testing is necessary to determine how they may best be applied, under what conditions they may be used with safety, what plants are susceptible and those that are resistant to the various chemicals. This paper deals with the results of tests conducted during 1951 to determine the value of several chemicals in pre-emergence applications on plots of asparagus and sweet corn.

Materials and Methods

Fourteen treatments were applied to plots of Washington asparagus and these were replicated three times. The plots consisted of three 25-foot rows, each four feet apart. The soil was a Scarborough very fine sandy loam with a rather impervious subsoil and was considered to be low in fertility. The plots were disked on May 2 and treatments excepting Cyanamid were applied on May 3. The Cyanamid treatments were applied on May 23 when the weeds were about one inch tall.

The treatments with their respective per acre rates of application were as follows; 2 pounds of 2,4-D acid equivalent as the sodium salt, 20, 30 and 40 pounds of Sodium Pentachlorophenate, 3, 6 and 9 pounds of DNOSBP in Dow Premerge, 2, 4 and 8 pounds of CMU Weed Killer, 400 pounds of Granular Cyanamid, and 1, 3 and 6 pounds equivalent of Chloro IPC. The Cyanamid applications were concentrated in a band 18 inches wide over the row whereas the other materials were distributed as an over-all application.

Eighteen treatments were also applied to plots of North Star sweet corn and these were replicated four times. The plots consisted of four 24-foot rows each and the seed was planted by hand with the rows spaced 3 feet apart and the seed 9 inches apart in the row. Records were taken from the two middle plot rows only. The soil was a Scarborough very fine sandy loam and was prepared in the usual manner. A 5-10-10 fertilizer was applied broadcast at the rate of 1800 pounds per acre. The corn was planted on May 16 which is two days after the average date for the last spring frost in this locality.

The following chemicals with their respective per acre rates were applied to the corn one day after planting: 10, 15 and 20 pounds of Sodium Pentachlorophenate, 1.5, 3.0 and 4.5 pounds of DNOSBP in Dow Premerge, and, 0.25, 0.50, 1.00 and 2.00 pounds of CMU Weed Killer. Further treatments, applied six days after planting were as follows: 1.5 pounds of 2,4-D acid equivalent as the sodium salt, 3 pounds E.H. No. 1, 400 and 600 pounds of Granular Cyanamid, 8 and 12 pounds of Weednix, and, 1.5 and 3.0 gallons of Sulfasan.

With the exception of the Cyanamid all chemicals were diluted with water and applied at the rate of 100 gallons per acre. The sprays were applied with a Brown Open-Hed No. 4 hand pressure sprayer fitted with a No. 8004 Spraying Systems fan-type nozzle and the rate of application was regulated so that the plots were covered twice to assure as uniform application as possible.

The stand of sweet corn was so badly reduced by an infestation of wireworms that after notes were made on weed counts, etc., the plots were plowed under on June 28, fertilized with 900 pounds of 5-10-10 per acre and immediately planted again with North Star sweet corn. Individual treatments were put on the same plots they had previously been applied except that 750 pounds of Granular Cyanamid was applied to plots that previously had received 8 pounds of Weednix and 4.5 gallons of Sulfasan were applied to the plots that previously had received 12 pounds of Weednix.

The weed population was abundant and consisted of the following sorts: purslane, smartweed, lamb's quarters, chickweed, pigweed, galinsoga, ragweed and wiregrass. A sparse and variable stand of nutgrass was present in the plots and was not included in the weed counts.

Results and Discussion

The results of the tests with asparagus are presented in Table I. It is readily apparent that CMU Weed Killer was very effective in controlling weeds at 2,4 and 8 pounds per acre. In fact this was the most effective material for controlling weeds although it was not significantly better than Granular Cyanamid. Past experience with Cyanamid, however, indicates often this material is not very effective in controlling weeds in asparagus beds during dry weather. 2,4-D did not perform as well as was expected from the results of previous exploratory work with asparagus, especially in regard to preventing the development of weeds that did germinate and live. The higher rates of Premerge and Sodium Pentachlorophenate were satisfactory in regard to weed control especially for the first four weeks after treatment. While better than the control Chloro IPC was unsatisfactory in regard to weed control at the rates used in this test. No damage to the asparagus was apparent as a result of the use of chemicals.

Results with the first planting of sweet corn are presented in Table II. Here again the ability of CMU Weedkiller to prevent weed growth is particularly outstanding. It is doubtful, however, that this material can be used to weed corn because of excessive damage to the crop.

Premerge and Sodium Pentachlorophenate appear to be well adapted to weeding corn particularly in view of the fact that previous tests have given similar results. Granular Cyanamid gives control for about three or four weeks and then its effect seems to be lost. Weednix gave relatively poor response with Sulfasan fairly good and E.H. No. 1 reduced weed population but the weeds that remained grew vigorously.

The results of the second planting of sweet corn are presented in Table III. It is clear that the corn on the Granular Cyanamid treated plots had been damaged. Undoubtedly this was due to excessive salt concentration considering that two fertilizer applications and a previous application of Cyanamid had been made on the 400 and 600 pound plots in the first planting. Here again it is clear that CMU Weed Killer is toxic to corn especially in amounts over 0.5 pound per acre. The outstanding treatments in this planting are Premerge Sodium Pentachlorophenate and 2,4-D in that order.

Conclusions

The results of these tests indicate that CMU Weed Killer and Granular Cyanamid are superior pre-emergence herbicides for asparagus beds and Premerge, Sodium Pentachlorophenate, and 2,4-D are adapted to weeding fields of sweet corn.

Table I - Effect of Chemicals on Weed Control in Asparagus
5 Weeks After Treatment

Treatments Rates per Acre	Number of Weeds per sq. ft.	Weed Size Rated 1-10
2,4-D Sodium Salt		
2.0 pounds acid equiv.	47.3	7.3
Sodium pentachlorophenate		
20 pounds	28.7	6.0
30 "	18.3	3.0
40 "	9.7	2.0
Dow Premerge		
3 pounds DNOSBP	50.7	4.0
6 " "	17.0	2.3
9 " "	11.0	2.0
CMU Weed Killer		
2 pounds	3.0	1.0
4 "	4.0	1.0
8 "	0.0	0.0
Granular Cyanamid		
400 pounds	4.0	1.0
Chloro IPC		
1 pound	140.0	8.7
3 "	62.3	6.7
6 "	44.3	5.0
Control	150.0	10.0
L.S.D. 5 percent	33.5	1.0
1 percent	45.3	1.3

Table II - Effect of Chemicals on the Weed Control and Damage to North Star Sweet Corn Planted May 16, 1951 - Readings Made June 19, 1951

Treatments Rates per Acre	No. Weeds per sq. ft.	Weed Size Rated 1-10	Crop Damage Rated 1-10
Applied 1 day after planting			
Sodium Pentachlorophenate			
10 pounds	8.8	4.0	1.7
15 "	10.2	2.8	2.2
20 "	5.5	2.0	3.7
Dow Premerge			
1.5 lbs. DNOSBP	19.7	7.3	1.2
3.0 " "	4.8	5.3	2.2
4.5 " "	2.3	4.8	2.2
CMU Weed Killer			
0.25 lbs.	10.0	5.3	2.0
0.50 "	3.5	5.8	2.7
1.00 "	1.0	2.8	3.2
2.00 "	.3	.8	7.2
Applied 6 days after planting			
2,4-D Sodium salt 1.5 lbs. acid equiv.	2.5	3.3	4.0
E.H. No. 1 3.0 lbs.	7.3	8.3	3.0
Gran. Cyanamid			
400 lbs.	13.5	5.3	.7
600 "	5.5	3.0	4.5
Weednix			
8 lbs.	27.2	5.8	2.7
12 "	31.5	4.8	3.7
Sulfasan			
1.5 gals.	14.7	4.8	4.0
3.0 "	7.3	3.0	5.5
Control Cultivated	0.0	0.0	0.0
Control Not Cultivated	32.0	10.0	0.0
L.S.D. 5 percent	7.3	1.9	2.0
1 percent	9.7	2.6	2.6

Table III - Effect of Chemicals on Weed Control, Damage, Growth and Yield in the Second Planting of North Star Sweet Corn Planted June 28, 1951 - Readings Made July 30, 1951

Treatments Rates per Acre	No. of Weeds per Sq.Ft.	Weed Size Rated 1-10	Hgt.of corn inches	No. of Mktable Ears	Wgt. of Mktable Ears Lbs.
Applied 1 day after planting					
Sodium pentachlorophenate					
10 pounds	18.2	3.0	24.2	47.0	32.5
15 pounds	14.7	2.3	23.0	42.5	31.2
20 pounds	14.7	1.5	22.0	41.7	31.8
Dow Premerge					
1.5 pounds DNOSBP	24.8	5.8	23.8	44.5	33.2
3.0 " "	15.7	3.3	23.8	46.0	34.8
4.5 " "	7.0	2.3	21.7	48.2	34.8
CMU Weed Killer					
0.25 pounds	11.0	4.0	20.5	39.8	29.2
0.50 "	4.5	2.0	20.2	33.8	24.4
1.00 "	0.5	1.0	19.0	36.2	26.2
2.00 "	0.0	0.0	12.7	19.2	9.0
Applied 4 days after planting					
2,4-D Sodium Salt					
1.5 pounds acid equiv.	25.2	2.5	21.5	45.0	34.5
E.H. No. 1					
3.0 pounds	22.2	4.3	22.0	49.5	35.8
Granular Cyanamid					
400 pounds	13.5	1.8	16.5	35.5	26.2
600 pounds	11.7	1.3	12.7	27.2	17.7
750 pounds	11.2	1.0	13.5	26.0	18.0
Sulfasan					
1.5 gals.	27.0	7.8	23.2	40.7	28.2
3.0 "	25.2	5.8	24.2	45.2	33.0
4.5 "	27.8	3.3	20.0	44.5	34.5
Control					
Not cultivated	45.7	10.0	25.0	35.2	24.8
Control					
Not cultivated	44.0	10.0	24.2	37.8	25.8
L.S.D. 5 percent	20.4	2.0	2.8	8.9	5.7
1 percent	28.5	2.7	3.8	11.8	8.2

Chemical Weeding of Red Beets[1]

by

R. D. Sweet, S. K. Ries, and M. E. Patterson

The most common method of chemically weeding red beets in New York is the post-emergence use of common salt (NaCl) at the rate of 400 pounds per acre in 200 gallons of water. This method is not satisfactory because salt, regardless of rate, does not control lambs quarter (Chenopodium album), purslane (Portulaca oleracea) or annual grasses. Also, salt cannot be applied safely until the beets have from 3 to 5 true leaves.

The purpose of these experiments was to determine if any of the available herbicides would effectively control weeds, particularly lambs quarter, without injury to the beets.

It is reported in the summary of the 1950 North Central Weed Control Conference in the section on weed control in red beets, that encouraging results have been obtained with TCA from 8 to 20 pounds per acre. Single reports are made concerning good results with Varsol (Stoddard Solvent) (1), Endothal (2), NIX (3), and 2 pounds of PCP plus TCA (4).

The Research Coordinating Committee of the Northeastern Weed Control Conference for 1951 concluded that better selective herbicides than salt are needed for red beets, and that present pre-emergence studies are inadequate.

Materials and Methods

The twelve materials tested and their formulations were as follows:

(1) IPC (isopropyl-n-phenyl carbamate)--(emulsion)
(2) Chloro IPC (isopropyl-n-3 chloro phenyl carbamate)--(emulsion)
(3) CMU (3-p-chlorophenyl-1, 1-dimethyl urea)--(wettable powder)
(4) Endothal (sodium salt of 3,6-endoxohexahydro phthallic acid)
(5) TCA (sodium salt of trichloroacetic acid)
(6) DN (alkanolamine salts of 2,4-dinitro-o-sec-butylphenol)
(7) PCP (pentachlorophenol)--(emulsion)
(8) NIX (sodium isopropyl xanthate)
(9) NP-128 (emulsion)
(10) Naphthyl phthalamic acid (wettable powder)
(11) Monochloroacetic acid
(12) Oktone

Four experiments were conducted at three different locations. Factors studied in addition to the direct effects of pre-emergence applications of chemicals at varying rates were (1) time of application (Geneva), and (2) depth of planting (E.Ithaca No. 2). Both of these tests were of split plot design. At the other two locations a randomized block design was employed.

[1]Much of this research was made possible by a grant from The Standard Oil Development Co.

All materials were applied with a small hand sprayer, which used CO_2 as a source of pressure. A regulating device maintained a constant pressure of 25 pounds per square inch. The chemicals were mixed in and sprayed from separate quart milk bottles. A complete description of the apparatus is in press (5).

Pertinent data regarding planting and treating dates, volumes of spray, etc., are given in Table 1.

Table 1. Experimental Methods

	Location			
	E.Ithaca No.1	Geneva	Snyder	E.Ithaca No.2
Planted	June 19	June 25	July 30	Aug. 28
Sprayed	June 28	A-June 27 B-July 2	Aug. 3	Sept. 3
Weed Control & Tolerance Observations made	July 11	July 18	Aug. 20	Oct. 26
Harvest date	Sept. 11	Oct. 16	Oct. 22	-----
Variety	Crosby Egyptian	Detroit Dark Red	Crosby Egyptian	Crosby Egyptian
Soil Type	Dunkirk fine sandy loam	Ovid silt loam	Dunkirk silty clay loam	Dunkirk fine sandy loam
Number of replications	3	3	4	5
Square feet per plot	96	48	84	56
Amount harvested per plot	Beets & leaves of 4 rows 12' long	Beets of 2 rows 12' long	Beets & leaves of 4 rows 10' long	
Gallons of spray per acre	37.8	37.8	32.4	38.9
Stage of beet growth at spraying time	Seed germinated	A-Seed not germinated B-5-10% of plants emerged	Seed germinated	Cotyledons just starting to emerge
Stage of weeds at spraying time	No weeds emerged	A-None visibly germinated B-Some germinated but none above ground	No weeds emerged	No weeds emerged

Results

Beet yields and ratings of weed control for the different locations are given in Table 2. Tolerance ratings and stand counts are present in Table 3. To facilitate presentation, the experiments will be reported by location.

E. Ithaca No. 1:

A heavy stand of purslane (Portulaca oleracea) and groundsel (Senecio vulgaris) developed in the check plots. Four treatments gave weed control and did not cause a significant decrease in yield. These were 1/2 pound of CMU, 2 and 6 pounds of Endothal and 2 pounds of Naphthyl phthalamic acid. However, two of these treatments, 1/2 pound of CMU and 2 pounds of Naphthyl phthalamic, caused visible injury to the beet foliage. IPC did not control groundsel, but at the higher rates did effectively control purslane.

Geneva:

A moderately heavy stand of lambs quarter (Chenopodium album), pigweed (Amaranthus retroflexus), purslane (Portulaca oleracea), and some annual grasses developed in the check plots. Three treatments, 8 pounds of IPC, 1/2 pound of CMU, and 6 pounds of Endothal, controlled weeds, caused no visible injury to the beets, and yielded significantly higher when compared with the check. For these three treatments there was no difference between times of application, i.e. at planting time and at time of come-up. Eight pounds of IPC did not control either lambs quarter or pigweed, but completely controlled purslane and gave commercial control of annual grasses. Six pounds of Endothal and 1/2 pound of CMU effectively controlled all weeds present. Two pounds of Chloro IPC gave weed control similar to 8 pounds of IPC and did not decrease the beet yield.

Snyder:

A very heavy stand of barnyard grass (Echinochloa crusgalli) developed in the checks. There was also some purslane (Portulaca oleracea), lambs quarter (Chenopodium album), and chickweed (Stellaria media). Six pounds of Endothal was the only treatment which controlled weeds and yielded significantly more than the check plots. One pound of Chloro IPC, 1/4 pound of CMU, and 8 pounds of TCA controlled weeds and were not visually injurious to the beets. The yields from these treatments are comparable with those of the check. One-half and one pound of CMU caused a decrease in yield. One-half and one pound of CMU and one pound of DN reduced the beet stand, compared to the check. TCA did the best job of controlling barnyard grass. Neither IPC nor Chloro IPC controlled barnyard grass.

E. Ithaca No. 2:

This experiment was designed to determine if there is a correlation between the depth of planting beet seed and the apparent tolerance of beets to CMU and Endothal. Beet seed was planted with a hand seeder. The depth was controlled by the depth adjustment on the planter. The approximate depths the seed was planted were 1/16, 1/2, 1 and 1-1/2 inches. The results of this experiment are presented in Table 4. The beet stand counts are based on counts of four feet of row in each replication.

Table 3. Chemical Weeding of Red Beets

Treatment	Rate in lbs/acre[2]	Tolerance Rating[1] E.Ithaca No.1	Geneva	Snyder	E.Ithaca No.2	Stand Counts[3] Snyder	E.Ithaca No.2
Check		8.7	8.0	9.0	5.8	11.7	16.0
IPC	2	8.7	8.2	8.3		9.9	
IPC	4		8.3	9.0		11.6	
IPC	8	8.0	8.3	8.5		13.7	
Chloro IPC	1			7.8		11.5	
Chloro IPC	2	7.7	7.7	6.3**		11.7	
Chloro IPC	4			4.5**		10.8	
CMU	1/8			8.3		11.6	
CMU	1/4			7.5	6.8	10.2	15.7
CMU	1/2	5.3**	8.8	3.3**		7.2**	
CMU	1			2.0**	2.2**	4.1**	4.7**
CMU	2	1.7**	3.3**				
Endothal	2	8.7	9.0	9.0	6.4	11.3	15.2
Endothal	4		9.0			10.1	
Endothal	6	7.0	8.8	8.8	5.6	11.3	13.8
TCA	8	7.0	8.2	8.0		9.5	
TCA	16	8.7	7.7				
DN	1			3.3**		6.4**	
DN	2	3.0**	6.8**				
DN	6	1.3**	1.0**				
PCP	2	7.3	8.7				
PCP	6	4.0**	8.2				
NIX	8	8.3	8.3				
NIX	16	9.0	8.2				
NP-128	5		7.7**				
NP-128	10	6.3	8.5				
Naphthyl Phthalamic acid	2	3.3**	2.8**				
Naphthyl Phthalamic acid	6	1.7**	2.0**				
Monochloroacetic acid	5		8.3				
Monochloroacetic acid	15	8.0	8.0				
Oktone	2 qts.	8.3	8.5				
Endothal + CMU	2 + 1/4			7.0			
Endothal + IPC	2 + 2			8.8			
L.S.D. at 5%		2.3	1.0	1.9	1.7	3.0	1.9
L.S.D. at 1%		3.1	1.3	2.5	2.3	4.0	2.5

[1]Tolerance rating scale
1 - No tolerance
5 - Commercial tolerance
9 - Normal growth

[2]lbs. of active ingredient per acre.
[3]Beets per foot of row

**Significantly less tolerant when compared with check at 1% level.

**Significantly fewer beets than in check at 1% level.

Table 2. Chemical Weeding of Red Beets

Treatment	Rate in lbs/acre[1]	Yields in Tons Per Acre: E.Ithaca No.1	Geneva	Snyder	Weed Control Ratings[2]: E.Ithaca No.1	Geneva	Snyder	E.Ithaca No.2
Check		17.70	10.34	10.78	3.3	2.7	2.0	1.6
IPC	2	18.60	10.89	11.33	4.3	3.3	3.5	
IPC	4		10.52	12.52		3.7	4.3	
IPC	8	17.70	14.29**	11.33	6.0	5.8**	4.3	
Chloro IPC	1			11.00			5.3**	
Chloro IPC	2	13.61	11.79	11.16	3.3	5.8**	5.8**	
Chloro IPC	4			9.80			8.0**	
CMU	1/8			11.54			4.8	
CMU	1/4			12.09			6.5**	5.6**
CMU	1/2	14.52	14.83**	7.01	8.0**	7.8	8.3**	
CMU	1			3.27			9.0**	8.4**
CMU	2	2.72	7.71		8.7**	8.8**		
Endothal	2	13.61	13.61		8.0**	4.2	4.5	7.0**
Endothal	4			10.78			5.0	
Endothal	6	18.15	15.34**	14.27**	8.3**	6.8**	7.0**	7.4**
TCA	8	14.52	11.34	11.75	3.3	2.5	6.0**	
TCA	16	13.16	11.03		2.7	2.8		
DN	1			8.71			5.5**	
DN	2	9.08	9.53		6.3**	4.2		
DN	6	3.15	.54		8.0**	7.5**		
PCP	2	18.15	10.80		2.7	2.8		
PCP	6	5.45	12.39		6.3**	4.8		
NIX	8	15.88	12.97		2.3	1.8		
NIX	16	18.15	11.57		2.0	3.2		
NP-128	5		11.80			2.8		
NP-128	10	14.97	10.89		4.3	2.0		
Naphthyl Phthalamic acid	2	12.71	6.49		6.7**	6.0**		
Naphthyl Phthalamic acid	6	1.36	1.72		8.3**	8.0**		
Monochloroacetic acid	5		10.98			1.0		
Monochloroacetic acid	15	4.07	10.12		1.7	2.5		
Oktone	2 qts.	18.15	12.71		2.0	1.8		
Endothal + CMU	2 + 1/4			10.35			6.8**	
Endothal + IPC	2 + 2			11.71			7.5**	
L.S.D. at 5%		6.80	1.82	2.50	2.2	2.5	2.4	2.6
L.S.D. at 1%		9.07	2.40	3.32	3.0	1.8	3.2	3.6

[2]Weed control rating scale
1 - No visible control
5 - Commercial control
9 - Complete control

[1]lbs. of active ingredient per acre.

**Significantly greater than check at 1% level.

Table 4. Stand Counts of Beets[1]
In Depth of Planting Experiment
E. Ithaca No. 2

Depth in Inches	Treatment				
	Check	2 lbs. Endothal	6 lbs. Endothal	¼ lb. CMU	1 lb. CMU
1/16	12.4	10.9	11.8	11.1	3.1
1/2	14.2	16.7	13.7	20.0	4.6
1	17.9	16.0	14.4	15.3	5.0
1-1/2	19.6	17.1	15.3	16.4	6.2

[1]Average stand per one foot of row.

Analysis of the data showed that there was no correlation between depth of planting and crop injury from the two chemicals tested.

A heavy stand of Galinsoga (Galinsoga cilita), purslane (Portulaca oleracea), and lambs quarter (Chenopodium album) developed in the check plots. One-fourth pound of CMU, 2 and 6 pounds of Endothal gave excellent control of most weeds and did not visibly injure the beets. The stand was reduced severely by the 1 pound rate of CMU and slightly by the 6 pound rate of Endothal. One-fourth pound of CMU controlled lambs quarter. Neither 2 nor 6 pounds of Endothal effectively controlled lambs quarter.

Summary and Conclusions

The results of these experiments indicate that CMU and Endothal offer promise as effective herbicides for selective pre-emergence weed control in beets. In the four experiments, 6 pounds of Endothal consistently proved to be the best treatment, although there is some question as to its ability to control lambs quarter.

CMU is a very potent herbicide and must be used with discretion. Rates higher than 1/2 pounds were highly toxic to beets. CMU proved to be the best chemical for control of lambs quarter (Chenopodium album).

Eight pounds of TCA effectively controlled annual grasses. Treatments of TCA caused definite foliage symptoms at E. Ithaca No. 1 and Geneva, but the beet plants later grew normally. therefore the tolerance ratings and yields did not show this response. These symptoms were characterized by an early excess of anthocyanin pigments and later yellowing and development of a mottled appearance.

Those treatments which caused no injury to the beets, but failed to kill weeds were: 2 and 4 pounds of IPC, 2 pounds of PCP, 8 and 16 pounds of NIX, 5 and 10 pounds of NP-128, 5 and 15 pounds of monochloroacetic acid, and 2 quarts of Oktone. Those treatments which gave adequate weed control but injured the beets were: 1, 2, and 6 pounds of DN, 1 and 2 pounds of CMU, and 2 and 6 pounds of phthalamic acid.

With Endothal and CMU, the treatments that looked most promising, there was no difference in either weed control or crop yield between treating before beet germination and treating at time of come-up. (Tested at only one location).

There was no correlation between depth of planting and crop tolerance to CMU or Endothal with the rates used. (Tested at only one location).

On the basis of these tests, it is suggested that trial applications be made of CMU at 1/4 to 1/2 pounds per acre, particularly where lambs quarter is a problem. Endothal at 4 to 6 pounds per acre was effective in all tests on most weeds, but was not consistent in controlling lambs quarter.

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ENDOTHAL, E.H.#1 AND OTHER MATERIALS FOR PRE AND POST-EMERGENCE WEED CONTROL IN MUCK GROWN ONIONS

By: Michael Papai[1], Ernest R.Marshall[2] and John VanGeluwe[3]

In many seasons onion weed control becomes a very serious problem in both seed and set onions. Hand weeding is time consuming, expensive and often serious damage occurs to the crop before weeds can be pulled. Chemical weed control is practiced to some extent at present. Materials now used have several weaknesses such as the necessity for a very careful watch of moisture relationship, careful timing and the relatively high volumes of water needed for control. This makes application difficult with the type of equipment now used on open ditch muck soils. Special grade cyanamid which has been used in the past for weed control in onions has become unavailable.

To meet the problems confronting the onion growers a research project was set up to test various materials for pre and post-emergence weed control in muck grown seed and set onions.

These experiments were conducted in the Orange County, New York muck area. These mucks are generally quite acid, having a pH range of 5.0 to 6. In general open drainage ditches are used and fields are usually quite long and narrow making high gallonage impractical. All sprays were applied at 35 gallons per acre with a small plot compressed air sprayer, mounted on wheels. Four 14 or 15 inch rows were treated at a time. All plots were 50 feet long with guard strips on all sides. The tests will be described in the sequence in which they were conducted.

A detailed test was conducted on the Gus Myruski farm. On April 23, 1951 post-emergence treatments were made on onion sets which were 3 - 4 inches tall. Weed seedlings 1/2 inch or less were in abundance and also present were a number of weed plants of various species which were somewhat over 1/2 inch in height. Treatments were replicated three times. Materials used and data taken one week after treatments were applied are shown in Table 1.

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Table 1. WEED CONTROL AND ONION INJURY ON MUCK GROWN ONIONS ONE WEEK AFTER HERBICIDES WERE APPLIED TO ONIONS 3 - 4" TALL

Treatment	Per cent weed control	Onion injury rating*
E.H.#1 4 lb/A	53	0
E.H.#1 5 lb/A	63	0
E.H.#1 6 lb/A	50	2
E.H.#1 8 lb/A	47	4
Endothal (formulated) 2½ lb/A	83	1
E.H.#3 2½ gal/A	47	3
Sinox PE ½ gal/A (1½ lb DN)	80	5
Sinox PE 1 gal/A (3 lb DN)	87	6
NP 128 5 gal/A	90	8
Check	0	0

* 0 - no injury
10 - very severe injury

The data presented in Table 1 are the average of the three replicates. It was apparent that good weed control could be obtained with endothal, Sinox PE and NP-128. The most promising treatment was 2½ pounds of endothal (formulated) which gave good weed control and only very slight injury to the onions. Observations of E.H.#1 plots at 4 and 5 pounds per acre indicated that this material was non-injurious to set onions at this stage of growth. Since these were post-emergence treatments it was decided that Sinox PE might be suitable as a pre-emergence herbicide. NP-128 showed no selectivity giving very serious injury to onions.

Another test was set up to test various materials as onion pre-emergence herbicides. Test 2 was conducted on the Anna Glebocki farm. Treatments were applied April 24, 1951 to seed onions which had been planted one week previously and had sprouts about a half inch long. All treatments were replicated three times and were as follows: E.H.#3 at 2½, 5 and 7 gallons per acre; E.H.#1 at 5 pounds per acre; Sinox PE at 1 gallon per acre; endothal at 5 pounds per acre; and Stoddard Solvent at 35 gallons per acre and check.

Following these applications the weather was very dry for several weeks and weed growth was negligible. None of the materials injured the emerging onions. Sinox PE and endothal looked the most promising as pre-emergence weed control materials under the above mentioned weather conditions.

Test 3 was conducted on the Joe Nieziolek farm. On May 8, 1951 pre-emergence weed control treatments were applied to plots of seed onions in a replanted area next to a ditch bank. There were two replicates. Weed growth was very heavy with most weeds about 1/2 inch high. Soil was very dry but rain came two days after application. Treatments were: Sinox PE at ½, 1 and 1½ gallons per acre; endothal at 2½ and 5 pounds per acre; CMU at 1, 2 and 3 pounds per acre; Stoddard Solvent at 35 gallons per acre; Niagarathal W at 2½ pounds active per acre and check.

Stand of onions was very poor in this test so no detailed data were taken. Weed control was good with all rates of Sinox PE, endothal, Niagarathal W and the 3 pound rate of CMU. Onions were completely eliminated in the Sinox PE plots, at all rates of application. CMU at 2 and 3 pounds per acre severely reduced the onion stands. Niagarathal W gave some reduction in stand and some injury. Endothal (formulated) gave good weed control and no onion injury. In general it appeared that formulated endothal was the material which could be used most successfully.

Test 4 was conducted in the same area as described above. The onions in Test 4 were up and about 2 inches high, many of them in the "seven" or "flag-up" stage. Weed growth was profuse with many weeds considerably over 1 inch in height. Treatments were as follows: CMU at ½ and 1 pound per acre; endothal at 1, 2 and 3 pounds per acre; and check.

CMU at both rates severely injured the emerged onions. Endothal at 1 and 2 pounds per acre gave no injury, but gave some injury at the 3 pound rate. Weed control was only fair under the above conditions, with all materials used.

Test 5 was applied on the Gus Myruski farm. On May 9, 1951 post-emergence weed control treatments were applied to set onions which were 6 inches high and the largest weeds were 2-3 inches high. Materials were applied early in the morning when the onions were wet. Treatments used were: endothal at 1, 2, 3 and 4 pounds per acre; endothal at ½ pounds plus Sinox PE 1 quart per acre; endothal at 1½ lb plus DN #1 3/4 pound per acre; endothal 2 pounds plus DN #1 3/4 pound per acre; endothal 3 pounds plus DN#1 3/4 pound per acre; E.H.#1 5 pounds plus Sinox PE 1 quart per acre; CMU at 1 pound per acre; and check.

In this test all materials gave injury to the onions. Best weed control was obtained with endothal at 3 and 4 pounds per acre. Least injury was from the E.H.#1 plus Sinox PE. It was evident that onions of this size could not safely be weeded with the above materials when applied to the onions when they were wet.

Test 6, 7 and 8 were a series of three identical tests, applied on the Gross, Slesinski and Brozdowski farms. All tests were on seed onions. Test 6 was applied on May 24th, test 7 and 8 were applied on May 26, 1951.

Onions in test 6 were one week out of "flag" and in the other two tests the onions were just past "flag". In test 6 there were a few weeds present 2 to 4 inches high. Weed growth was very heavy in test 7 with a majority of the weeds 3 to 4 inches high. In test 8 there was only a fair stand of weeds about 1 inch high. Preliminary observations and ratings were made on May 29, 1951. These data are shown in Table 2.

Table 2. WEED CONTROL AND ONION INJURY RATINGS FROM POST-EMERGENCE WEED CONTROL PLOTS IN MUCK GROWN ONIONS ON THREE FARMS IN ORANGE COUNTY, NEW YORK.

Treatment	Test 6		Test 7		Test 8	
	Weeds	Injury	Weeds	Injury	Weeds	Inj.
Endothal 1 lb/A	8	1	6	0	0	0
Endothal 2 lb/A	8	4	8	0	6	2
Endothal 3 lb/A	8	6	8	0	7	3
Endothal 4 lb/A	8	8	8	0	8	4
E.H.#1 4 lb/A	4	0	2	0	0	1
E.H.#1 6 lb/A	6	0	2	0	0	2
E.H.#1 8 lb/A	8	1	3	0	0	4
E.H.#1 10 lb/A	8	2	3	0	3	8
CMU 2 lb/A	4	0	0	0	4	0
CMU 3 lb/A	7	0	0	0	8	0
Endothal 1 lb + Sinox PE ½ pt/A	2	4	4	0	8	3
Endothal 2 lb + Sinox PE ½ pt/A	6	6	5	1	8	4
E.H.#1 4 lb + Sinox PE ½ pt/A	6	2	3	0	4	1
E.H.#1 6 lb + Sinox PE ½ pt/A	6	2	5	1	6	2

0 - no control or no injury
10 - perfect control, or very severe injury

Injury was very light in test 7 probably due to the excessive weed growth which covered the onions, thereby resulting in very little spray mixture hitting the onion leaves.

June 9, 1951 two weeks after application the tests were rated again as to the residual effect of the materials on both weeds and onions. A summary of the ratings at that time are shown in Table 3.

Table 3. SUMMARY OF EFFECT OF DIFFERENT HERBICIDES ON WEED GROWTH AND SEED ONIONS WHEN APPLIED SHORTLY AFTER FLAG STAGE

Treatment	Observations two weeks after application		
	Control of Purslane and annual grasses	Control of large weeds	Onion Injury
Endothal 1 lb/A	poor	slight	none
Endothal 2 lb/A	fair	moderate	none
Endothal 3 lb/A	good	good	none
Endothal 4 lb/A	excellent	excellent	severe
E.H.#1 4 lb/A	fair	poor	none
E.H.#1 6 lb/A	excellent	fair	none
E.H.#1 8 lb/A	excellent	fair	none
E.H.#1 10 lb/A	excellent	fair	slight
CMU 2 lb/A	poor	poor	none
CMU 3 lb/A	poor	poor	moderate
Endothal 1 lb + Sinox PE ½ pt/A	poor	poor	none
Endothal 2 lb + Sinox PE ½ pt/A	slight	good	slight
E.H.#1 4 lb + Sinox PE ½ pt/A	excellent	fair	slight
E.H.#1 6 lb + Sinox PE ½ pt/A	excellent	fair	moderate

The principal weeds in these plots were lambsquarter (Chenopodium album); Redroot pigweed (Amaranthus retroflexus); ragweed (Ambrosia elatior); peppergrass (Lepidium (sp.); smartweed (Polygonum persicaria); purslane (Portulaca oleracae) and annual grasses. These weeds were 10 - 12 inches high in the check plots when the notations shown in table 3 were made. The best treatments appeared to be E.H.#1 at 6 and 8 pounds per acre. These E.H.#1 treatments gave excellent control of small weeds and no damage to the onions. From these results it appeared that E.H.#1 could be used as a post-emergence application on seed onions up to 6 inches tall at rates up to 6 pounds per acre with little or no injury to onions grown in muck.

Test 9 was conducted on the Pierce Brothers farm. On June 8, 1951 post-emergence weed control treatments were sprayed on onions grown from seed which were 5-6 inches tall. There were only a few large weeds present; the field having renently been cultivated. Onion stand was somewhat irregular due to disease and irregular seeding with the planter used. These plots were not cultivated again during the growing season, however, the grower did hand hoe some of the larger weeds which came into some of the plots where weed control was inadequate. Treatments used were those showing most promise in the preceding tests. There were five replicates in a randomized block design. Results of this test were as shown in table 4.

Table 4. INJURY RATINGS AND WEED CONTROL ON ONION PLOTS TREATED WITH POST-EMERGENCE HERBICIDE SPRAYS

Treatment	Injury rating* (mean of 5 plots) June 11	Injury rating* (mean of 5 plots) June 16	Weed Control June 16
E.H.#1 5 lb/A	0	0	few big weeds
E.H.#1 6 lb/A	0	.8	few weeds
CMU 2 lb/A	0	1.2	clean
CMU 3 lb/A	0	1.8	few large weeds
Endothal 2 lb/A	2.4	3.2	clean
Endothal 3 lb/A	3.8	4.0	some weeds
E.H.#1 2½ lb. + Endothal 1 lb/A	3.4	3.2	weeds coming in
E.H.#1 5 lb + Endothal 2 lb/A	5.2	6.4	clean
E.H.#1 2½ lb + CMU 1 lb/A	.8	3.2	clean
E.H.#1 5 lb + CMU 2 lb/A	.4	4.6	few large weeds
CMU 1 lb + Endothal 1 lb/A	1.8	3.2	very clean
CMU 2 lb + Endothal 2 lb/A	3.8	5.4	some weeds
Endothal (formulated) 2 lb/A	3.6	3.6	weeds coming in
Check	0	0	very weedy
L.S.D. .05	1.0	1.2	
L.S.D. .01	1.3	1.6	

* 0 - no injury
10 - onions beyond recovery

In all injury ratings given in test 9 a rating of 4 or more could be considered as being too serious to warrant further testing.

Table 5. WEED CONTROL COUNTS AND RATINGS FROM POST-EMERGENCE WEED CONTROL PLOTS ON MUCK GROWN ONIONS 18 DAYS AFTER APPLICATIONS

Treatment	Weed counts			Weed control rating*			
	Small under 2"	Large over 2"	Large & small	Small under 2"	Large over 2"	Large & small	Onion* Injury
E.H.#1 5 lb/A	47	23	70	8.8	3.8	6.3	0
E.H.#1 6 lb/A	30	30	60	9.4	2.2	5.8	0
CMU 2 lb/A	156	5	161	6.8	9.4	8.1	3.6
CMU 3 lb/A	138	9	147	7.2	9.4	8.3	5.6
Endothal 2 lb/A	55	23	79	7.6	5.8	6.7	2.4
Endothal 3 lb/A	30	30	60	8.6	5.4	7.0	3.6
E.H.#1 2½ lb + Endothal 1 lb/A	34	33	67	8.4	3.6	6.0	1.4
E.H.#1 5 lb + Endothal 2 lb/A	23	25	48	9.0	6.4	7.7	7.0
E.H.#1 2½ lb + CMU 1 lb/A	69	9	78	8.8	9.2	9.0	5.8
E.H.#1 5 lb + CMU 2 lb/A	40	8	48	9.2	9.6	9.5	6.8
CMU 1 lb + Endothal 1 lb/A	56	17	73	9.4	9.0	9.2	3.4
CMU 2 lb + Endothal 2 lb/A	25	8	33	9.4	9.2	9.3	5.2
Endothal (formulated) 2 lb/A	56	30	86	7.2	4.0	5.6	4.4
Check	304	49	353	0.0	1.0	0.5	0.0
L.S.D. .05	56	17	59	0.7	2.3	0.1	0.1
L.S.D. .01	74	23	78	0.9	3.0	0.2	0.2

* 0 - no control or no onion injury
10 - peffect control or very severe onion injury

Counts are from 25 feet of plot two rows wide

Table 6. WEED COUNTS AND YIELD DATA FROM POST-EMERGENCE WEED CONTROL TREATMENTS ON MUCK GROWN ONIONS TWO MONTHS AFTER TREATMENT

Treatment	Counts 38 sq.ft.			Weed control rating*	Yields		50 lb. bags per acre
	Weeds	Grass	Total weeds and grass		No. bulbs	Wt/bulb oz.	
E.H.#1 5 lb/A	37	8	45	5.0	252	1.96	459.3
E.H.#1 6 lb/A	43	10	53	4.2	278	1.79	495.2
CMU 2 lb/A	55	12	67	2.4	247	1.88	434.1
CMU 3 lb/A	42	8	50	4.8	282	1.72	450.2
Endothal 2 lb/A	60	14	74	1.6	235	1.94	423.1
Endothal 3 lb/A	33	18	51	3.4	268	1.73	428.7
E.H.#1 $2\frac{1}{2}$ lb + endothal 1 lb/A	33	9	42	3.4	280	1.83	469.6
E.H.#1 5 lb + endothal 2 lb/A	28	6	34	6.4	259	1.61	385.6
E.H.#1 $2\frac{1}{2}$ lb + CMU 1 lb/A	43	7	50	4.2	284	1.50	390.0
E.H.#1 5 lb + CMU 2 lb/A	39	10	49	5.4	289	1.51	394.9
CMU 1 lb + endothal 1 lb/A	41	13	54	3.6	248	1.89	435.2
CMU 2 lb + endothal 2 lb/A	27	17	44	4.2	278	1.76	452.2
Endothal (formulated) 2 lb/A	58	20	78	1.0	249	1.88	476.0
Check	82	14	96	1.0	283	1.96	548.4
L.S.D. .05	8	9	9	2.2	42	0.25	58.6
L.S.D. .01	10	12	12	3.0	55	0.33	77.5

* 0 - no control
10 - perfect control

The early injury ratings again showed E.H.#1 to be safe at rates up to 6 pounds per acre. Further data were taken on June 26, 1951 and data are given in Table 5.

Examination of data shown in Table 5 shows that of the materials used at the given rates, E.H.#1 gave adequate weed control and no apparent injury to the onions. Further weed counts and yield records were taken on August 6th at time of harvest, shortly after onions had gone down due to mildew and blast. Yields represent topped onions from 25 feet of each of two rows from each plot and are calculated on an acre basis for total yield. Data are presented in Table 6.

Once again it became evident that E.H.#1 gave good commercial weed control if applied before weeds were 1/2 inch tall and at the same time gave as high yields as any materials tested. A combination of E.H.#1 at 2½ pounds and endothal at 1 pound per acre also gave some control of weeds and only slight injury to the onions.

SUMMARY

Weed control on muck grown onions is a serious problem confronting the grower. Several experiments were set up to test a number of materials as possible selective weed control materials for use as pre and post-emergence weed control on muck onions. Of the materials tested endothal specially formulated gave the most promising results as a pre-emergence herbicide. CMU, Sinox PE and Niagarathal W caused serious injury to emerging onions and were not suitable for use as pre-emergence weed control.

E.H.#1 at 5 and 6 pounds per acre gave good control of weeds on emerged onions and did not give injury to the onions if applied to onions after "flag stage" until the onions reach 6 inches in height. To be effective this material must be applied before weeds are 1/2 inch high. Endothal specially formulated gave good weed control but caused some injury to emerged onions. CMU at rates used gave temporary control of weeds and rather severe injury to onions. Combinations of materials worked no better as weed control materials than materials used alone and showed no greater degree of selectivity.

CONCLUSIONS

1) Endothal specially formulated and used at 2½ to 5 pounds per acre gives good weed control and no injury to onions when applied as pre-emergence treatment.

2) Water soluble DN's such as Sinox PE are not satisfactory as pre-emergence or post-emergence materials for use on onions.

3) E.H.#1 at rates of 5 and 6 pounds per acre gives good weed control on muck when applied before weed seedlings are 1/2 inch high.

4) E.H.#1 at rates of 5 and 6 pounds per acre causes little injury to onions when applied when the onions are past the "seven" or "flag stage" up until they are 6 inches in height.

5) Endotnal and E.H.#1 at rates used give good weed control on muck soils in 30-35 gallons of spray per acre.

6) The combinations of materials tested are no more satisfactory as weed control materials than these same materials used separately.

7) In addition to E.H.#1, endothal and CMU warrant further testing as post-emergence treatments for onion weed control.

ADDITIONAL EXPERIMENTS WITH AERO CYANATE FOR WEED CONTROL IN ONIONS

Joe Antognini and D. Y. Perkins

Under controlled environmental conditions in the greenhouse it has been found (1) that the effectiveness of Aero Cyanate in killing purslane is greater the higher the relative humidity, the lower the temperature, and the lower the wind velocity. This effectiveness is believed to be due to a decreased evaporation rate which allows the Aero Cyanate solution to remain on the leaves for a much greater length of time than occurs when the rate of evaporation is high. These findings suggest that for best results with Aero Cyanate as a herbicide against purslane spraying should be done in the early morning hours and in the evening, thereby avoiding spray applications when the temperature and wind movement may be high and the relative humidity low. In order to test this hypothesis under field conditions the following experiment was undertaken.

Methods

Three gallonages of Aero Cyanate, 50, 100 and 200 gallons per acre for the area actually covered, were applied at two different times, 9:00 A. M. and 1:00 P. M. At 9:00 A. M. the temperature was 65°F. and the relative humidity was 85% and at 1:00 P. M. the readings were 81°F. temperature and 46% relative humidity. A 1-1/2 per cent solution of Aero Cyanate was used and the gallonage was changed while the speed of the sprayer and the pressure were kept constant.

The experimental design was a randomized block factorial with each treatment replicated four times. Each replicate consisted of three onion rows 250 feet long. At the time of application purslane was the only weed present and the majority of the plants possessed only the cotyledonary leaves. The purslane plants were so numerous and so small that it was impossible to make an accurate count before spraying. As a result the counts shown in table 1 are weeds per square foot four days after application. The number of weeds per replicate was determined by taking the average of four counts, each of a one square foot area.

Results

The data in table 1 indicate that the 60-gallon treatment applied in the morning resulted in significantly poorer control than the 100 and 200-gallon treatments. The same is true for the afternoon applications. For the afternoon applications it was also found that the 200-gallon treatment was significantly better than the 100-gallon treatment. The poorest control was obtained with the 60-gallon application in the afternoon and the best control with the 200-gallon application in the morning, although this treatment was not statistically better than the 100-gallon application in the morning. For a given rate of application the results were better when applied in the morning as compared to the afternoon. If spraying is to be done in the morning it would not be advantageous to use higher than 100 gallons per acre but, on the other hand, if the spray were applied in the afternoon, significantly better results would be obtained by using 200-gallons rather than 100-gallons per acre. One hundred gallons per acre in the morning gave considerably better results than 200-gallons in the afternoon.

Table 1. The Effect of Gallonage and Time of Application Using a 1-1/2 Per Cent Aero Cyanate Solution

Treatment		Weeds per Square Foot
Gallons per Acre	Time of Application	4 Days After Application
60	9:00 A. M.	4.37
100	" "	0.94
200	" "	0.69
60	1:00 P. M.	15.62
100	" "	8.18
200	" "	2.37

II

Previous experiments on the use of Aero Cyanate for post-emergence weed control in onions have shown that concentrations as low as 1 per cent cannot be safely used on onions in the flag stage, although they can be used during the crook stage. Little work has been done to ascertain the effect of different concentrations of Aero Cyanate on onions at later stages of development. With this problem in mind the following experiments were set up to determine the effect of rate of application of Aero Cyanate on onion stand and yield.

Methods

Identical plots were laid out on two farms (farms A and B). Farm A was a very clean farm, relatively free from weeds, and one on which adequate provisions were provided for dusting with DDT, Parathion and Diathane to control thrips and blast. Farm B was a weedy farm on which little provision was made for thrip or blast control. As a result, farm B was seriously affected by both thrip and blast during the later stages of the season. These conditions are reflected in the lower yields obtained from farm B. The onions on farm A were seeded on April 26, five days later than those on farm B.

Four experiments were set up on each farm. These experiments consisted of the application of three concentrations of Aero Cyanate (1%, 1-1/2% and 2%) to onions in four stages of growth - crook stage, first true leaf 1-1/2 inches long, first true leaf 3-1/2 inches long, and first true leaf 5 inches long respectively. All treatments were applied at the rate of 100 gallons per acre. A randomized block design was used for each experiment with four replications of each treatment. Purslane was the major weed present.

Results

There were no significant differences in stand at any given time or rate of application on either of the farms. Yield results, however, were rather contradictory and these figures have been recorded in table II.

Table II. Effect on Onion Yields of Three Concentrations of Aero Cyanate When Applied to Onions at Different Stages of Growth.

Farm A

Growth Stage	Onion Yield for Each Aero Cyanate Treatment 1%	1-1/2%	2%	Ck
Crook	181.49	209.18	192.37	204.56
First leaf - 1-1/2"	183.01	181.63	178.75	182.00
" " - 3"*	181.57	177.19	179.75	198.14
" " - 5"	181.06	184.44	180.06	179.57
Sum	727.13	752.44	730.93	764.27

* Significant at 5% level.

Farm B

Growth Stage	Onion Yield for Each Aero Cyanate Treatment 1%	1-1/2%	2%	Ck
Crook	89.25	93.88	97.50	97.31
First leaf - 1-1/2"	98.31	85.44	90.06	99.44
" " - 3"	95.94	92.82	96.51	101.87
" " - 5"	98.75	92.44	96.19	105.06
Sum	382.25	364.58	380.26	403.68

* Significant at 5% level.

On farm A none of the yield differences were sifnificant except those for the experiment in which the leaf was three inches long at time of spray application. In this experiment all of the treatments were sifnificantly different from the check, but were not different from each other. On farm B the only differences that were sifnificant were those for the experiment in which the leaf was five inches long at time of spraying. Here again the treatments were all different from the check but were not different from each other. When the four experiments on farm A were combined there were no significant differences among the sums of the results, but when the four experiments on farm B were combined there were significant differences. Here again there were no significant differences between the treatments but all the treatments were different from the check. Further work is needed to ascertain the relationship between stage of growth, spray application and resulting yields.

Literature Cited

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Comparative Effects of Various Weed Killers on Yield, Weed Control. and Tenderometer Values for Peas.[1/]

Max E Pattersen[2/]

Following the successful use of granular calcium cyanamide as a weed control measure on peas in western New York State during the 1950 pea season (5) (2) it seemed desirable to continue experiments with this material during the 1951 season. It has been suggested (5) that the effect of additional nitrogen on peas is favorable in producing peas that are more tender than identical peas of the same age grown without the extra nitrogen. This effect should be most noticeable at tenderometer values above 85.

The report of the Research Coordinating Committee recommended selective weed control in pea fields without damaging the hay seeding (3). Therefore, it was postulated that if a legume was sown at the same time the granular cyanamide was applied, the legume seed would not germinate until after the toxic residue of the granular cyanamide had been dissipated, and therefore, the legume seeding would not be injured.

Reduced gallonages of ammonium dinitro ortho secondary butylphenol (Dow Selective) have been reported as being used for weed control on peas successfully in other areas (4). If these reported reductions in gallonages would result in practical weed control in this area, savings of over one-half the cost of materials would be possible.

In limited greenhouse and field tests, Dearborn (1) noted that peas were quite tolerant to dilute concentrations of 2,4-D at which concentrations mustard was quite susceptible. This work pointed to the desirability of continuing studies with 2,4-D and related compounds.

Unpublished data from this Station show that peas planted in three-foot rows and cultivated will produce as large a yield per acre as peas planted in the usual seven-inch drill widths. The cultivation eliminates weed competition and the wider spacing eliminates competition from other pea plants. Cultivation is not practical for machine harvested peas, since this operation drags stones to the surface which greatly interferes with mowing. However, the possibility remains that the rate of seeding could be reduced if adequate weed control were provided, and then, no cultivation would be necessary.

In addition to treatments which would fit the possibilities or answer the questions suggested above, sufficient checks and an acceptable control (salt) were included as treatments in this experiment.

1/ Acknowledgment is made to the American Cyanamid Company for support of this work.

2/ Research Associate, N. Y. S. Agr. Exp. Sta.

Materials and Methods

The field, two and one-half acres in extent, was located at Geneva, New York, on badly eroded, sloping, Ontario loam. It had formerly been planted to fruit trees with rows running up and down the slope. The immediate previous crop had been sweet clover which was plowed under late in the spring before planting. The field was fertilized the day preceding planting with 1550 lbs. of a 6-12-6 fertilizer, drilled and disked in. Shamrock peas were planted May 10th, 1951. The shape of the field permitted laying out 80 plots 90' x 15'. Since the harvested product was to be used in a processing experiment in which five consecutive harvests were needed, sixteen treatments laid out across the slope were possible, each treatment replicated five times, and each replicate a separate harvest. Chinese mustard (Brassica Juncea) was sown uniformly with the peas on all plots except Check A, at the rate of two and one-half pounds per acre. A John Deere grain drill was used to drill all the seed. Plots were two drill widths wide. The mustard was sown by the grass-seeding attachment of the drill. There were eleven drills, each seven inches apart for the peas. There was only enough pea seed for a uniform sowing of four bushels per acre. However, due to slipperiness of the seed because of the seed treatment, or some other factor, it was discovered by the end of the second block that the drill setting, notch forty, which sowed at the rate of four bushels per acre on other pea seed, was sowing much heavier on this seed. Therefore, the rate of seeding for the last three blocks was reduced to notch twenty-seven, well below the four bushels per acre rate. As a consequence, no yield comparisons between harvests can be made. However, tenderometer values and the percentages of large peas are still valid for each harvest. The soil was relatively dry prior to seeding, so pre-emergence treatments were delayed as long as possible to give the weed seeds time to germinate (2). The rainfall for this period measured .04 of an inch from April 30th to the time of planting. The two days following planting, .89 of an inch fell on this dry soil, and then no more rain fell until the 23rd of May.

The treatments involving the use of granular calcium cyanamide, ammonium sulfate, and medium red clover were broadcast on the now dry soil, by hand, on the 17th and 18th of May. The first block was completed on the 17th, and the second, third, fourth, and fifth on the 18th. Granular calcium cyanamide and ammonium sulfate were applied at the rate of 250 pounds per acre; the medium red clover at 15 pounds per acre. The peas emerged on the 20th of May.

The spray treatments were applied on June 6th when the peas were four to six inches tall. The weeds were up to 2 inches with mustard ranging even larger, but still shadowed by the peas. The tractor, a John Deere MT, was equipped with three separate pumping systems attached to a 3-banked boom which could be raised hydraulically or lowered at will. Two of the pumps were operated from the belt drive and the third from the power take-off shaft. There was no exact speed control at this time. Because of this, although calibrated as closely as possible just prior to spraying, all rates per acre were slightly higher than the desired ones listed. The booms were brush-type, twelve feet long, with nine nozzles spaced eighteen inches apart. Treatments were randomized within blocks so that check plots and broadcast treatments were not in line with the row of plots to be sprayed so that there was no unnecessary tractor injury incurred.

The temperature reached a high of 72° F. and a light breeze was blowing the afternoon the sprays were applied.

Three counts per plot of the monocotyledonous and dicotyledonous weeds were made with a 1' x 2' counting frame on the 8th of June. Starting on the 18th of June, eight counts per plot were made with a 2' x 2' counting frame. Population of the different species were kept separate. The counts were made consecutively, block 1 to 5 respectively, and were completed on the 26th. A total of six ratings were also made from the time following treatment until before harvest. These ratings were relative and based on the following scale: 0 - no control, 2 - poor, 4 - fair, 6 - good, 8 - excellent, 10 - perfect control. The treatments were as follows:

A. (No mustard) Check.

B. (Mustard) Check.

C. " 250# Granular cyanamide broadcast per acre, pre-emergence.

D. " 250# Ammonium sulfate " " " "

E. " 250# Granular cyanamide broadcast " " " plus 15# of medium red clover at the same time.

F. " Check plus 15# of medium red clover broadcast per acre 7 and 8 days after planting.

G. " 2½ pints of Dow Selective in 30 gals. of water per acre.

H. " (2½ pints of Dow Selective in 30 gals of water per acre plus (15# of medium red clover broadcast per acre 7 and 8 days (after planting.

I. " (2½ pints of Dow Selective in 30 gals. of water per acre plus (250# ammonium sulfate broadcast per acre pre-emergence.

J. " Peas thinned to 14-inch rows plus 250# of ammonium sulfate broadcast pre-emergence per acre.

K. " .2# of 2,4-D[1] in 20 gals. water per acre.

L. " .3# of 2,4-D in 20 gals.water per acre.

M. " Peas thinned to 14-inch rows plus 250# of ammonium sulfate broadcast pre-emergence per acre.

N. " .2# of MCP[2] in 20 gals. water per acre.

O. " .3# of MCP in 20 gals. water per acre.

P. " 100# of sodium chloride in 200 gals. of water per acre.

1. 27.0% Triethanolamine salt of 2,4-dichlorophenyacetic acid.
2. 30.5% Diethanolamine salt of 2-methyl-4-chlorophenonyacetic acid.

Each plot had three feet trimmed from each end prior to the first harvest. Starting at the top of the slope, one block was harvested at a time. The plots were mowed with conventional equipment, loaded on trucks, and hauled to a standard vining station for vining. Weights were obtained for each plot, and then the peas were run through a cleaning machine and reweighed. Because of the amount of mustard seed which would shake loose from the iner from a previous mustard plot and contaminate the field weight of a no-mustard or mustard controlled plot, following yield data is based on the weight of cleaned peas. Three tenderometer readings were taken from a composite sample of the cleaned peas. The remaining peas were then run through a sizing machine where the percentages of the various seive sizes were obtained. Size number 5 is the largest seive size. The percent of this size is used to determine the percent of large peas.

The analysis of variance was used to analyze the data.

Results

No visible injury was incurred by the crop from any of the treatments except the 2,4-D and MCP treatments. On these treatments, epinasty and stunting was more severe on the 2,4-D plots than on the MCP plots, and the higher rates were more injurious than the lower rates. Peas treated with the lower rate of MCP had apparently recovered by harvest time. The yield data suggest that ammonium sulfate broadcast just prior to emergence was damaging to the crop under these conditions.

Average Percent Large Peas and Tenderometer Values
For Each Harvest Date.

Harvest	Date	% Large Peas	Ungraded Tenderometer
First harvest	7-14-51	14.8*	84
Second "	7-16-51	28.4	93
Third "	7-17-51	39.6*	104
Fourth "	7-18-51	54.2	115
Fifth "	7-19-51	64.0	130

* 1 plot calculated by missing plot formula.

Granular cyanamide was responsible for a greater reduction in the mustard population than would be expected to occur by chance alone, when measured by actual count. However, when the mustard was in full flower, no visible difference between the mustard check and the granular cyanamide treatments could be

Data Sheet For Weed Counts, Weed Control Ratings, Yield, Percent Largest Size Peas, and Tenderometer Values for 1951 Weed Control in Peas.[1]

Treatments	Weed Counts: Plants/6sq.ft.[2] Monocotyledons	Plants/6sq.ft.[2] Dicotyledons	Plants/32 sq.ft.[3] Mustard	Ragweed	Pigweed	Lambs-quarters	Other weeds	Grasses	Legumes	Weed[4] Control Ratings	Yield Lbs./Acre	% Large Peas	Tenderometer Value
A. Check,no mustard	26	100	2	52	7	85	30	143	83	4.7	1300	44.7	114
B. Check	22	124	154	24	27	55	26	98	69	.3	980	44.4	106
C. Gran.Cyanamide	23	89	94	34	3	33	23	118	61	2.1	1110	43.6	110
D. Ammonium sulfate	18	119	142	31	3	74	34	101	40	.8	610	40.1	104
E. Gran.Cyan.& R.C.	25	73	93	21	1	33	29	144	152	1.6	840	36.6	104
F. Check & R.C.	25	141	120	29	5	75	25	133	255	.6	930	43.0	103
G. Dow Selective	30	83	51	46	8	53	23	138	84	4.3	1220	40.9	106
H. Dow Sel. & R.C.	29	136	58	44	4	53	26	142	239	4.1	1280	44.0	106
I. Dow Sel.& Am.Sul.	24	93	68	26	16	41	30	169	63	4.0	1070	39.9	106
J. 14"rows Am.Sul.	18	112	110	37	10	51	31	154	45	1.3	290	30.1*	102
K. Low 2,4-D	27	123	43	62	10	90	30	149	103	6.6	960	43.2	105
L. High 2,4-D	27	108	28	26	2	34	32	229	22	5.8	720	39.4	100
M. 14" rowsGran.Cyn.	37	119	93	40	24	62	30	159	94	1.3	380	36.4*	104
N. Low MCP	18	103	41	23	4	51	34	144	56	7.3	1340	40.1	103
O. High MCP	38	98	24	40	4	32	29	213	66	6.4	1030	36.8	102
P. Salt	32	74	53	13	21	51	21	209	31	2.8	1090	40.1	108
L.S.D. 19:1	NS	NS	30	22	NS	NS	NS	NS	81	1.2	270	4.6	7
L.S.D. 99:1	NS	NS	40	29	NS	NS	NS	NS	107	1.5	360	6.1	9

(1) Each value an average of 5 replications.
(2) Total of 3 counts per plot from 3 areas each 2 ft. square - June 8th.
(3) Total of 8 counts per plot from areas each 4 ft. square - June 18th to 26th.
(4) 0 - no control, 2 - poor, 4 - fair, 6 - good, 8 - excellent, 10 - perfect control.
* One plot from this treatment calculated by missing plot formula because of inadequate sample.

noted. The yield from granular cyanamide alone (Treatment C) was not significantly larger than that of the mustard check, nor significantly smaller than that of the no-mustard check. Weed control as measured by the rating system was poor. Cyanamide had no effect on either percentage of large peas nor the tenderometer value of ungraded peas when compared with either check treatment. In analyzing the data, there was no indication of greater tenderness from extra nitrogen at the higher tenderometer values on the peas from the fertilization given this field. Any beneficial effects due to the additional nitrogen in the granular cyanamide could not be determined, since comparable amounts of nitrogen applied just prior to pea emergence as ammonium sulfate suggested crop injury.

The dinitro sprays gave fair weed control by the rating system used. Dinitro ratings were comparable to the no-mustard check. Although these treatments gave significant reductions in mustard population, yields were not decreased significantly from those of the no-mustard check and were superior to those of the mustard check. Differences in the percent of large peas and in tenderometer values were not significant for any of the dinitro-sprayed plots.

The 2,4-D and MCP treatments gave much better mustard control than presented in the stand counts. This was because much of the mustard was still green when the counts were made, although the plants did not live to flower. This same delayed action undoubtedly was true for some of the other broadleafed weeds treated with these materials. However, grasses were more predominant on these plots. According to the rating system used, the two rates of 2,4-D and MCP gave the best weed control obtained. All four treatments gave good to excellent control, with ratings significantly better than the no-mustard check on all except the higher rate of 2,4-D. The best yield, larger than that obtained on the check plots that did not have mustard seeded in them and that had not been damaged by tractor traffic was obtained on the lower rate of MCP. The yield from the higher rate of 2,4-D was significantly decreased. There were no significant differences in the percent of large peas when compared with either check. Tenderometer readings for these treatments should only be compared with the no-mustard check. since this group of treatments and the no-mustard check comprised the only plots in which the peas did not receive shading from the mustard. Peas from all four 2,4-D and MCP treatments were significantly more tender than the no-mustard check.

Data from the two treatments in which the peas were thinned to 14" rows show no significant reduction in the stand of mustard from the granular cyanamide. Weed control ratings, both poor, are similar. Yields from this spacing were considerably reduced below those of the mustard check. Little difference between yields of the two wide spacings were noted. The reduced stand of peas in these treatments without adequate weed control favored weed growth to the extent that dwarfing of the peas and failure to develop properly were the consequences. This is evidenced by the significant decrease in the number of large sized peas without being more tender than the mustard checks.

The weed control portion of the data sheet presents a better picture of the effectiveness of the salt treatment than actually existed due to regrowth of burned-back weeds that were apparently dead. The ratings, taken later in the season, are more reliable and show a significant reduction in weeds over the no-mustard check, but a control that is still poor. Even so, yield was not significantly reduced below the no-mustard check nor significantly increased above the mustard check. The percentage of large peas and tenderometer values are similar to both the mustard and the no-mustard check.

The plots having the delayed seeding of medium red clover showed only a very slight decrease in the stand from the dinitro spray, and a significant decrease from the granular cyanamide. The legumes were smaller than the weeds at the time of spraying so that they may have received a large amount of protection from the peas and weeds.

Discussion

Under the dry weather conditions that prevailed at the time prior to and following emergence of these peas, granular cyanamide gave poor practical weed control on Chinese mustard drilled with the peas. Increases in yield due to the extra nitrogen in cyanamide could not be measured because of possible injury from the equivalent ammonium sulfate treatment which was applied just prior to emergence. Under the conditions in 1951, granular cyanamide was herbicidally active during the emergence of a delayed legume seeding. The granular cyanamide had no effect on maturity or tenderness of peas.

Low gallonage applications of Dow Selective gave a fair control of mustard and no practical reduction in yield of peas under that of mustard-free plots that had suffered no wheel damage. Injury to a delayed legume seeding by lower gallonage applications of Dow Selective was negligible. There are no effects from this material on maturity or tenderness.

Wider crop spacing without weed control decreases yields by more than half that obtained from normal spacing without weed control. The possibilities of obtaining normal yields from half as much seed as is presently used, provided good weed control is obtained, remains to be disproved.

2, 4-D, although a very good mustard control was damaging to the peas at the rates used. MCP at low rates holds promise of excellent mustard control without reducing yields. At the same time, maturity may be delayed sufficiently to add another day's crop gain to the yield before harvesting and still harvest near the tenderometer value desired for the most satisfactory price.

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WEED CONTROL EXPERIMENTS WITH SPINACH AND CANNING PEAS*

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Investigations have been underway at the Maryland Station for the past four years, in an attempt to determine an effective, inexpensive method of controlling weeds in spinach and in cannery peas. Although the experiments are not conclusive, certain treatments show definite promise and are reported at this time for the information of other workers in the field.

SPINACH EXPERIMENTS

The control by hand of chickweed and other weeds in spinach is expensive, and mechanical weeding has not proved entirely satisfactory. Numerous experiments at this station have been performed using primarily the phenoxy compounds in conjunction with delayed planting. These methods have usually either not given good weed control or have resulted in reduced stands of spinach. Granular cyanamid has been effectively used for weed control in other crops, and it has been determined that spinach is moderately tolerant to cyanamid. Since the possibility of using cyanamid with delayed planting of spinach has not been previously explored, (4, 5) the experiment described was designed for this purpose.

The test was conducted on a Sassafrass silt loam soil having a reaction of pH 6.5 and an organic matter content of 0.7%. The plots were located near Sparrows Point in Baltimore County, Maryland. Individual plots consisted of 5 rows of spinach on a raised bed, having a width of 64 inches and a length of 60 feet. The soil was prepared for planting one day previous to applying the cyanamid. The material was applied with a Gandy spreader calibrated to deliver 400 pounds per acre. The 800- and 1200-pound rates were applied by going over the plots two and three times, respective.

Virginia Savoy spinach was seeded October 6 and October 9, 1950, four and seven days, respectively, after granular cyanamid was broadcast

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on the plots. The seeding rate was approximately 18 pounds per acre and was accomplished with as little disturbance to the soil as was practical with standard equipment.

Leaf spinach was harvested on April 11, 1951.

Results-----Weed control was excellent in all except the check plots. In the check plots chickweed, purslane, lambs quarter, and henbit were abundant. From the results shown in Table I it may be seen that only the 400 pound per acre rate of granular cyanamid was effective in increasing the yield of spinach, reflecting the low stand reduction at this rate, as well as in addition to the value of the material as a herbicide and as a source of nitrogen and calcium. The application of cyanamid rates of greater than 400 pounds per acre resulted in considerable stand reduction, although the spinach plants in these plots had a greater weight per plant which made up some of the difference in the total yield.

Table I. Yield per acre of Leaf Spinach and Percent Reduction in Stand from Three Rates of Granular Cyanamid Applied at Two Intervals before Seeding.

	Yield		% Stand
Rate of Application	Lbs/Acre	Bu/Acre	Reduction
Check	8220	457	0
400 lbs/A Cyanamid	11866	659	5.0
800 lbs/A Cyanamid	9361	520	20.0
1200 lbs/A Cyanamid	7487	416	72.5
"F" Value	24.58**	24.58**	------
L.S.D. at 5%	1172	65.1	------
Date of Application			
4 days before seeding	10159	564	27.5
7 days before seeding	8361	465	21.3
"F" Value	21.59**	21.59**	___
L.S.D. at 5%	820	45.6	___
Rate x Date Interaction			
4 days before seeding			
check	8712	484	0
400 lbs/A	11979	666	5.0
800 lbs/A	11503	639	25.0
1200 lbs/A	8440	469	80.0
7 days before seeding			
check	7732	430	0
400 lbs/A	11748	653	5.0
800 lbs/A	7419	412	15.0
1200 lbs/A	6534	363	65.0
"F" Value	4.73*	4.73*	----
L.S.D. at 5%	1715	95.4	----

It is observed that the application of cyanamid 4 days before planting resulted in higher yields than those obtained from applying the material 7 days before planting. The significant interaction of date x rate of application shows that the 800-pound rate, as well as the 400-pound rate gave a yield significantly higher than the check when applied only 4 days before planting, whereas only the 400-pound rate was effective when applied 7 days before seeding.

It would appear to be feasible, from the results of this experiment, that the application of 400 pounds per acre of granular cyanamid, 4 to 7 days before seeding, with adequate moisture, may result in increased yields, good control of certain weeds and a minimum of damage to the stand of spinach. The effective use of the material would seem to require careful seed bed preparation, proper timing and adequate moisture.

EXPERIMENTS WITH CANNING PEAS

Peas for processing in Maryland are of both the sweet (wrinkled seeded) type and the Alaska (smooth seeded) type. Weed control is not a problem in plantings of Alaska peas because of early seeding and rapid growth rate, resulting in good top growth before the weeds germinate so that they are usually shaded out. The sweet types, on the other hand, grow more slowly and are planted later than the Alaskas. Coupled with this, the factor of larger seed size normally results in the planting of less seed, by number, of the sweet types, although the rate of seeding by weight by be identical. Weed growth in the sweet types thus presents a problem to the grower in Maryland about one out of every two or three years. Barrons and Grigsby (1), Warren and Buchholz (7) and Dearborn (2) have demonstrated that the ammonium salt of dinitro ortho secondary butyl phenol is effective in controlling weeds in canning peas, although the material has given varying degrees of success.

The experiments described here were originally designed to determine the practicality of aerosol and low gallonage applications of Ammonium DNOSBP (Dow Selective Weed Killer) as measured in yield of shelled peas. A Cyanate application was included in the 1949 and 1950 tests. Broadcast applications of granular cyanamid were added in 1951 after promising results were obtained in tests conducted in New York (3).

In all of the experiments described, Pride peas were drilled at the rate of 5 bushels per acre between the 10th and 20th day of April, in plots 5'4" by 100', in randomized block designs at the University Plant Research Farm. Each plot consisted of 8 drill rows. The plots were harvested with a mower and the peas shelled out in a commercial type viner.

Results----The results of the 1949 tests are shown in Table II. No response to treatment was measured either in yield or maturity, probably as a result of the scarcity of weeds in the field during the 1949 season. The aerosol applications were moderately effective in killing those weeds which did exist and did not cause any marked injury to the peas. The low gallonage applications, on the other hand, caused considerable damage to the foliage of the peas as well as to the weeds. The season in 1949 was such that the peas quickly recovered and produced a normal yield.

Table II. Effect of Spraying with DNOSBP and Cyanate upon the Yield and Maturity of Shelled Peas (1949).

	Yield lbs/A	Mean Tenderometer Value
1. Check	1031	90.25
2. Dow Sel. Aerosol 3 pts/A (Propellant A)	1123	92.75
3. Do (Propellant B)	1205	90.00
4. Dow Sel. 3 pts/A (5 gal. water)	1072	89.25
5. Dow Sel. 4 1/2 pts/A (5 gal. water)	939	90.00
6. Cyanate 5 lbs/A (5gal. water)	1113	89.50
7. Cyanate 10 lbs/A (5 gal. water)	1103	89.25
"F" Value	1.59	1.46

The 1950 tests were designed to test Cyanate and Dow Selective Weed Killer at high gallonage applications in addition to low gallonage and aerosol applications of Dow Selective. Weed growth was abundant in all plots at the time of treatment, and the peas stood about 5 inches high. The weed population included lambs quarter, pig weed and smartweed, largely in the 2- to 6-leaf stage of development. All of the treatments except Dow Selective (2 pts/A in 100 gal. water) and Dow Selective (3 pts/A in 5 gal. water) gave complete eradication of weeds. These two treatments killed the younger weeds but many of the older weeds recovered. Cyanate at both of the rates employed resulted in damage to the foliage of peas, from which the crop did not completely recover. The yield data in Table III show the deleterious effect of the Cyanate at the 10 pound rate, and the effectiveness of Dow Selective applied in 100 gallons of water at the 3- and 4-pint/A rates. No differences were observed in maturity of the shelled peas among any of the treatments.

Table III. Effect of Spraying with DNOSBP and Cyanate upon the Yield and Maturity of Shelled Peas (1950).

	Yield lbs/A	Mean Tenderometer Value
1. Check (water)	1772	94.00
2. Cyanate 5 lbs/A (100 gal. water)	1593	96.00
3. Cyanate 10 lbs/A (100 gal. water)	1327	90.75
4. Dow Selective 2 pts/A (100 gal. water)	1823	93.25
5. Dow Selective 3 pts/A (100 gal. water)	2144	93.75
6. Dow Selective 4 pts/A (100 gal. water)	2124	94.50
7. Dow Selective 3 pts/A (Aerosol)	2001	94.00
8. Dow Selective 3 pts/A (5 gal. water)	1664	95.25
"F" Value	6.62**	0.81
L.S.D. at 5% Level	320	-----

** Significant at 1%

In the 1951 tests there was again very little of a weed problem. Dow Selective at three rates in high gallonage applications and granular cyanamid drilled on the plots 4 days following seeding at two rates were the treatments employed. Because of the late development of weed seedlings, the Dow Selective spray was not applied until May 22 at which time the peas were just beginning to bloom.

The effects of the Dow Selective Weed Killer in high gallonage applications in both 1950 and 1951 are summarized in Table IV. Rates of 2- and 3-pints per acre resulted in higher yields than the check for the two year period. Spraying with 4-pints per acre in 1951 at the beginning of blossoming resulted in considerable damage, which is reflected in the lower yield value for the two years.

The yield and maturity values from the cyanamid treatments at the University Plant Research Farm are combined with data collected at two locations in the Piedmont section of Maryland and at one location on the Eastern Shore. Both treatments reduced weed growth at the outlying locations. The results are given in Table V, and show that both rates of cyanamid increased yields, and delayed maturation of the peas. It is believed that the delay in maturity was a response to the increase in set on those plots to which the cyanamid was applied. Kramer (4) has given the tenderometer values at which the maximum yield may be expected, and since the differences in maturity in this experiment are significant, the individual plots were corrected to a maximum yield on the basis of the tenderometer values. This correction induced a greater variability among plots so that the "F" value was decreased slightly, although still significant. The magnitude of effect of the cyanamid remains unchanged after the correction.

Table IV. Effect of High Gallonage Applications of DNOSBP on Yield and Maturity of Shelled Peas (1950-1951).

	Yield lbs/A	Mean Tenderometer Value
1. Check	1660	94.0
2. Dow Selective (2 pts/A)	1951	93.5
3. Dow Selective (3 pts/A)	2082	95.1
4. Dow Selective (4 pts/A)	1877	93.5
"F" Value	5.07*	1.16
L.S.D. at 5% Level	237.4	----

* Significant at 5%

Table V. Effect of Granular Cyanamid on Yield and Maturity of Shelled Peas at Four Locations in Maryland in 1951.

	Actual Yield lbs/A	Mean Tenderometer Value	Yield Corrected to Maximum
1. Check	1791	108.1	1956
2. Cyanamid 275 lbs/A	2145	104.4	2379
3. Cyanamid 550 lbs/A	2220	101.4	2586
"F" value	7.45*	6.00*	7.11*
L.S.D. at 5%	274	4.46	394

* Significant at 5%

From the experiments described here, there would seem to be two practical methods of weed control in peas. Each method has its limitations and each has its advantages. Dow Selective Weed Killer may be practical under certain weather conditions, and may be applied after the peas have emerged. Until further studies can be made on the efficiency of the material in an aerosol the method of application would seem to be limited to a high gallonage spray using the Dow Selective at the rate of 3 pints per acre.

Granular Cyanamid would seem to be effective on the basis of one year's results in four locations, when applied four days after seeding at the rate of 275 pounds per acre. The application of this amount of cyanamid would add 56 pounds of nitrogen to the soil, which would make possible an adjustment in the fertilizer program. The increase in yield from the additional nitrogen in addition to the weed control possibilities and ease of application are worthy of consideration. Further work with this material is contemplated.

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Chemical Weeding of Spinach[1]

by

S. K. Ries

In the Northern United States there are three crops of spinach; a spring planted crop for spring harvest, a late summer crop for fall harvest, and a fall planted over-wintered crop. Weeds are probably most serious in the over-wintered crop. Chickweed (Stellaria media) in particular may germinate in the fall and over-winter with the spinach.

The objective of this work was to find an economical pre-emergence herbicide which would control weeds, especially chickweed, in spinach without injuring the crop. Other factors which appeared to have a bearing on successful weed control in spinach were also studied.

This paper consists of a summary of work done with weed control in spinach starting in the summer of 1950. It includes work done in both the greenhouse and field. The work in the field consisted of eight experiments at three locations, totaling 785 plots. Additional work was done with selective post-emergence weed control, but it will not be discussed in this paper. Some of the data presented in this paper have already been reported (8).

Lachman (4,5) reported success with both Stoddard Solvent and IPC. Danielson (1) suggested preplanting soil treatments with 2,4-D. Noll and Odlund (6,7) reported success with PCP in oil, F. H. #2, Stoddard Solvent, fuel oil, NP-128, and aero cyanate when applied as a delayed planting treatment.

Materials and Methods

The materials which were screened in the greenhouse and field and their formulations were as follows:

(1) Aero cyanate (Potassium cyanate)
(2) Chloro IPC (Isopropyl N 3-chloro phenyl carbamate)--(emulsion)
(3) CMU (3-p-chlorophenyl-1, 1-dimethyl urea)--(wettable powder)
(4) Calcium cyanamid
(5) Dowcide G (Sodium salt of pentachlorophenol)
(6) Dow selective (Ammonium salt of dinitro-o-sec butyl phenate)
(7) Esso No. 45 (80% aromatic hydrocarbons, boiling range 350-500°F.)
(8) Esso No. 180 (50-60% aromatic hydrocarbons, boiling range 350-500°F.)
(9) E. H. No. 1 (Sodium 2,4-dichlorophenoxyethyl sulphate)
(10) E. H. No. 2 (Dichloral urea)
(11) IPC (Isopropyl N-phenyl carbamate)--(emulsion and wettable powder)
(12) K 1131 (Ammonium salt of a dinitro compound)
(13) LFN 472
(14) Maleic hydrazide (1,2-dihydropyridazine 3,6-dione)
(15) ME 3000 (96% di sodium 3,6-endoxohexahydro phthallic acid) (Endothal)
(16) ME 3001 (84% di sodium 3,6-endoxohexahydro phthallic acid) (Endothal)
(17) ME 3002 (16% di sodium 3,6-endoxohexahydro phthallic acid) (Endothal)
(18) NIX (Sodium isopropyl xanthate)
(19) NP-128 (emulsion)

1/Part of this research was made possible by a grant from the Columbia Southern Chemical Corporation.

(20) Premerge (Alkanol amine salts of 2,4-dinitro-o-sec-butylphenol)
(21) RDA-4 (Pentachlorophenol)--(emulsion)
(22) RDA-108
(23) Shell ACX 337
(24) TCA (Sodium salt of trichloroacetic acid)
(25) 2,4-D (Sodium salt of 2,4-dichlorophenoxyacetic acid)
(26) Varsol No. 1 (19% aromatic hydrocarbons, boiling range 300-400°F.)
(27) Varsol No. 2 (29% aromatic hydrocarbons, boiling range 300-400°F.)
(28) XP-40a (Diethyl xanthogen disulfide)

The weed control materials were applied in the greenhouse with a constant pressure system mounted on a spray table (8). Herbicides were applied in the field with a three-gallon knapsack sprayer or, with one exception, the spraying apparatus described in "Weeds" (9). At Morrisville No. 2, materials were applied with a spraying system mounted on a jeep.

When a treatment is spoken of as being successful, it will mean that statistically, the weed control was better than the check at odds greater than 99:1 and that the yield was not significantly lower than the check.

Greenhouse Screening Tests

All of the chemicals listed under materials and methods were screened during July and August of 1950, with the exception of CMU and RDA-108. Those materials which controlled either chickweed or timothy or both, and did not injure the spinach plants, were IPC, Chloro IPC, NIX, and the endothal series.

Effect of Chemicals on Spinach and Weeds in Field Plots

Field tests were carried on at E. Ithaca and Riverhead, New York and Morrisville, Pennsylvania. Table 1 lists some of the more pertinent data relating to the experiments carried on at these locations.

To facilitate presentation of results, the reaction of the spinach and weeds to each chemical will be reported separately.

IPC

IPC was tested at three locations and in seven of the eight experiments. The rates used were 2, 4, 6, and 8 pounds of the active ingredient per acre. This chemical did not decrease the yield regardless of rate except in one experiment, Riverhead No. 2, where 4 pounds of IPC yielded less than the check at odds greater than 19:1.

An example of how IPC reacted on large field plots is presented in Table 2.

Under favorable environmental conditions (see section on effect of temperature), four pounds of IPC effectively controls chickweed (Stellaria media), purslane (Portulaca oleracea), smartweed (Polygonum persicaria), knotweed (Polygonum aviculare), narrow leafed plantain (Plantago lanceolata), and annual grasses encountered with the exception of barnyard grass (Echinochloa crusgalli). IPC will

Table 1. Summary of experiments with weed control in spinach.

Location	Date of Planting	Date of Treatment	Soil Type	Time of Treatment	Variety
E.Ithaca No. 1	Sept.4,1950	Sept. 4 Sept. 9	Dunkirk Sandy loam	Planting Come-up	Va.Blight Resistant
Riverhead No. 1	Oct.6	Oct. 6	Sassafrass Silt loam	Planting	Va.Blight Resistant
Morrisville No. 1	Oct. 4 Oct. 10	Oct. 4 Oct. 10 Oct. 16	Sassafrass Sandy loam	A,B,&C[1] A,B,&C A,B,&C	High Curl
Riverhead No. 2	March 27	March 27	Sassafrass Silt loam	Planting	Long Standing Bloomsdale
Morrisville No. 2	April 9	April 10	Sassafrass Sandy loam	Planting	Long Standing Bloomsdale
E.Ithaca No. 2	July 21, 1951	July 21 July 24 July 30	Dunkirk Sandy loam	Planting Come-up 2 true leaves	Long Standing Bloomsdale
E.Ithaca No. 3	Aug. 23	Aug. 30	Dunkirk Sandy loam	Come-up	A.Domino B.Va.Blight C.Long Standing D.King of Denmark
E.Ithaca No. 4	Sept. 19	Sept. 27	Dunkirk Sandy loam	Come-up	Va.Blight Resistant

[1]A = Treatment at planting
B = " " emergence
C = " " 2 true leaves

not kill other broad-leafed weeds such as pigweed (Amaranthus retroflexus), lambs quarter (Chenopodium album), yellow rocket (Barbarea vulgaris), henbit (Lamium amplexicaule), groun"sel (Senecio vulgaris), and galinsoga (Galinsoga ciliata).

Chloro IPC

Chloro IPC was tested in seven of the eight experiments at the three locations. The rates used were 1/2, 1, 2, 3, 4, and 6 pounds. Rates higher than two pounds per acre caused serious injury and a reduction in yield, where yields were taken, in six out of the seven tests. A reduction in yield occurred in one experiment, E. Ithaca No. 2, from the one pound rate, but not from the two or four pound rate of Chloro IPC.

Table 2. Results of pre-emergence treatments applied immediately after planting from a 7 x 7 Latin square. 1/

Treatment 2/	Pounds per acre	Yield 3/ Fresh Weight In Ounces	Weed Control Visual Ratings 4/
1) Check		239.0	1.6
2) RDA-4	3	244.5	5.3
3) RDA-4	6	265.4	5.7
4) NP-128	8	235.7	5.4
5) ME 3000	10	111.9	7.4
6) IPC	2	237.4	6.4
7) IPC	4	257.0	7.6
L.S.D. at 5%		35.3	1.3
L.S.D. at 1%		47.6	1.8

1/ Each plot was 6 x 127 feet
2/ All materials applied in 50 gallons of water per acre.
3/ Each plot average of two samples, each sample, two 25 foot rows.
4/ Weed control rating scale:
1 = no visible weed control
5 = commercial weed control
9 = complete eradication of weeds (mostly chickweed, Stellaria media)

Some results with Chloro IPC are presented in Table 3. In general, about two pounds of Chloro IPC controlled the same weeds as did 4 to 8 pounds of IPC. For details see weed control under IPC.

CMU

CMU was used in four of the experiments at two locations. The rates used were 1/4, 1/2, 1, and 2 pounds per acre. Severe injury and a reduction in yield occurred from the one and two pound rates. One-half pound did not cause visible injury in any experiment and did not cause a decrease in yield in the three tests where yields have been obtained. See Table 3 for typical data from CMU test.

One-half pound of CMU does an excellent job of controlling chickweed (Stellaria media), lambs quarter (Chenopodium album), pigweed (Amaranthus retroflexus), purslane (Portulaca oleracea), yellow rocket (**Barbarea sp.**), galinsoga (Galinsoga ciliata), groundsel (Senecio vulgaris), henbit (Lamium amplexicaule), and annual grasses.

On one instance (E. Ithaca No. 3), CMU definitely did not control narrow leafed plantain (Plantago lanceolata). It appeared to be non-toxic to narrow leafed plantain whereas IPC eradicated it.

Endothal (ME 3000)

Endothal was included in three tests at two locations. The rates used were two, four, and ten pounds. The ten pound rate caused a reduction in yield in the one test where it was used, table 2. The two and four pound rates did not cause any injury to the spinach. For results from the four pound rate see Table 3.

Table 3. Results of treatments applied just before come-up from an 8 x 8 multiple plot Latin square, East Ithaca, N. Y.

Treatment 1/	Lbs. per acre	Yield	Weed Control 2/
Check		2.32	1.4
IPC	2	2.52	2.5
IPC	8	2.34	6.6
Chloro	1	2.68	5.8
Chloro	4	1.88	6.8
CMU	1/2	2.29	7.8
CMU	1	.78	8.8
ME 3000	4	2.52	5.0
L.S.D. at 5%		.26	1.2
L.S.D. at 1%		.35	1.7

1/ All materials applied in 42.5 gallons of water/acre
2/ Weed control rating scale:
1 = no visible weed control
5 = commercial weed control
9 = complete eradication of weeds

Four pounds of Endothal effectively controls annual grasses, chickweed (Stellaria media), pigweed (Amaranthus retroflexus), galinsoga (Galinsoga ciliata), yellow rocket (Barbarea sp), groundsel (Senecio vulgaris), and purslane (Portulaca oleracea). It may not control lambs quarter (Chenopodium album), henbit (Lamium amplexicaule), or narrow leafed plantain (Plantago lanceolata).

Contact Herbicides

In tests at all three locations the following herbicides proved effective if environmental conditions were favorable: 1) Varsol No. 1 and No. 2 at 30 to 90 gallons per acre, 2) PCP at three to six pounds per acre, 3) Shell ACX 337 at 40 gallons per acre, 4) RDA-108 at 60 gallons per acre, 5) NP-128 at 8 pounds per acre, 6) NIX at 15 to 30 pounds per acre, 7) Esso No. 45 at 30 gallons per acre, and 8) Esso 180 at 30 gallons per acre.

In order for these materials to give effective weed control without injuring the spinach, the weeds must germinate before the spinach. This may be brought about by fitting the land a few days prior to planting, and treating before planting or treating immediately after planting. Also, the land may be planted the same day it is fitted so that the weeds will germinate before the spinach. In this case a treatment one to three days prior to spinach emergence may prove successful. With chickweed, this program is not always satisfactory because the germination times of this weed and that of spinach are almost identical.

In general, the aforementioned herbicides will kill all weed seedlings with which they come in contact. The one notable exception is NIX, which seems to be ineffective against annual grasses.

Other Chemicals

The following chemicals were included in at least one field test and their worth as herbicides in spinach at the rates used is doubtful: 1) E. H. No. 1 at 1 to 3 pounds, 2) 2,4-D at 1/2 to 1 pound, 3) TCA at 10 to 20 pounds, and 4) the DN's at 2 to 6 pounds.

Factors Affecting Herbicide Application

Time of treatment

Three experiments were designed to compare time of application. At East Ithaca 1 and 2, the F value for treatment time was significant at the one per cent level. Morrisville 1 was not designed so as to permit statistical analysis.

The best time to avoid spinach injury from all of the materials tested, which included herbicides ranging from the contact type to growth regulators, was immediately after planting the crop.

Rates of emulsifiable IPC up to four pounds per acre did not cause a decrease in yield if applied during a period ranging from time of planting to development of the first two true spinach leaves, Fig. 1. The injury resulting from the application of eight pounds of emulsifiable IPC after the development of two true leaves is indicated in Fig. 1. This injury is believed to be due to the organic solvent present in the IPC formulation and not from the IPC, because necrotic areas developed on the foliage soon after treatment.

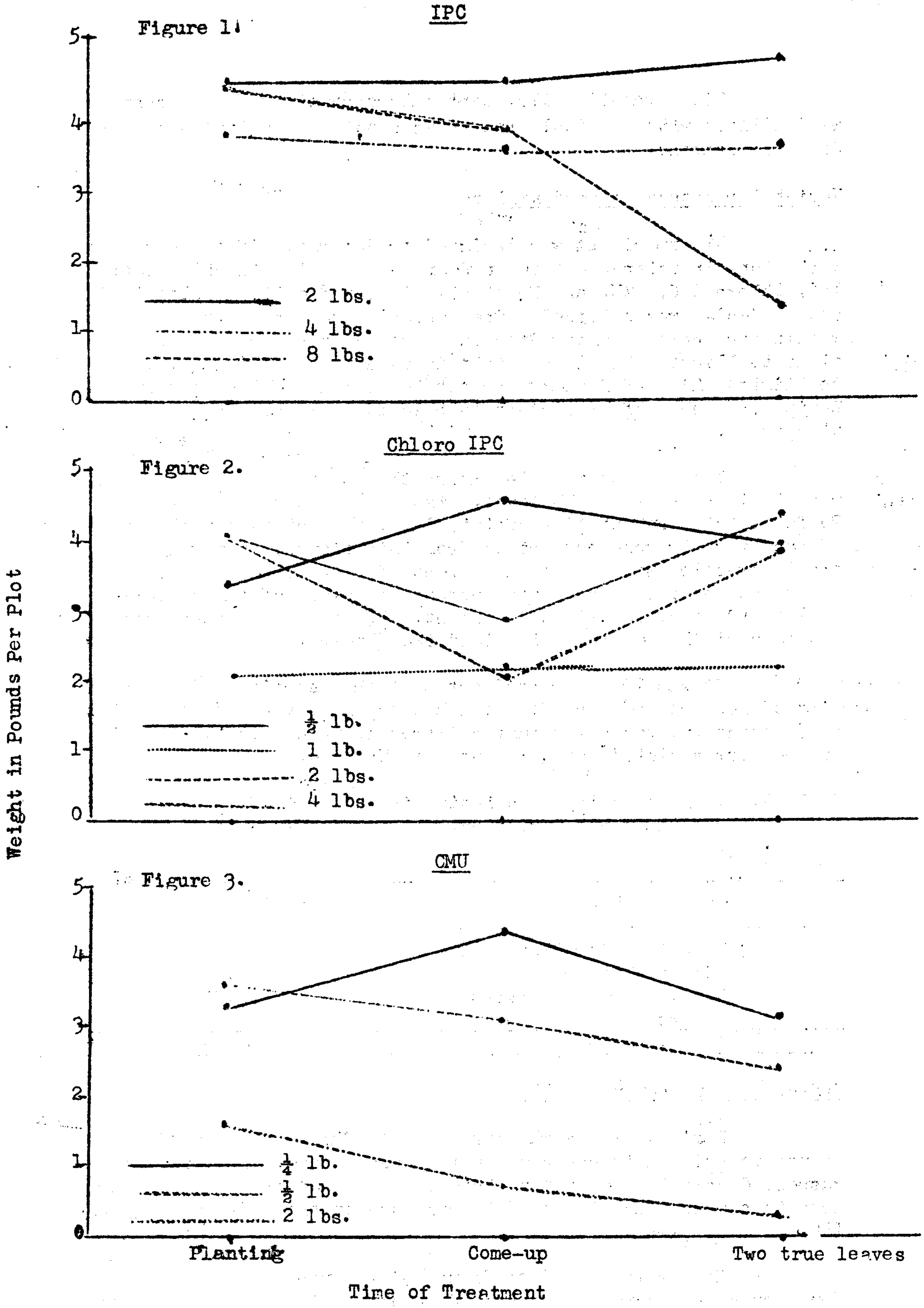
Chloro IPC is much more toxic to the plant when applied just before come-up than when applied at planting time or in the cotyledon stage. Figure 2 illustrates this effect. Similar results occurred at E. Ithaca 1 and in another experiment which is not included in this paper.

Perhaps the most striking apparent inconsistency is the low yield resulting from 1 pound Chloro IPC at E. Ithaca No. 2, Figure 2. In the same experiment the higher rates did not result in this reduced yield. In another experiment the 1 pound rate did not cause reduced yields. It might be concluded from the above that an error had been made in the quantity of chemical or in the method of application. For several reasons, however, these errors are very unlikely: (1) weed control was progressively better as the rates of Chloro IPC increased. (2) In the E. Ithaca No. 2 experiment, treatments were made at planting, at emergence and when the crop had 2 true leaves. In all three instances the 1 pound rate reduced yield. (3) Contamination from another chemical is unlikely because in every case the 1/2 pound rate of Chloro IPC was sprayed immediately before the 1 pound rate.

CMU appears to become somewhat more toxic to spinach as the time of treatment is delayed, Fig. 3.

The Stoddard Solvent type of weed killers may be applied any time prior to one day before emergence without causing spinach injury.

Effect of time of application on spinach yield with three chemicals.



High aromatic oils, pentachlorophenol, NIX, and contact weed killers with residual properties should be applied within two days of planting.

Varietal response to weed killers

An experiment was designed to determine if there are any variations in tolerance between four commercial spinach varieties to IPC, Chloro IPC, CMU, and Endothal. An 8 x 8 multiple plot latin square design was utilized. The varieties were completely randomized within each column. Long Standing Bloomsdale (savoyed leaf, susceptible to blight), Virginia Blight Resistant (savoyed leaf, resistant to blight), King of Denmark (smooth leaf, susceptible to blight), and Domino (smooth leaf, resistant to blight), were chosen as representative types.

The F value for the interaction of treatment times variety was significant at the 1% level. Figure 4 illustrates this interaction. To facilitate presentation of this data, the points for the treatments of each variety were connected. From this figure, it may be seen that the interaction was due to the effect of CMU. The one pound rate of CMU caused a disproportionate decrease in yield of the varieties Domino and Virginia Blight Resistant. The one-half pound rate of CMU caused a similar decrease in yield from Domino.

It should be pointed out that the reactions of the varieties King of Denmark and Long Standing Bloomsdale may not be typical because these two varieties suffered from spinach blight. The yields of the four varieties are presented in Table 4.

Table 4. Yield of spinach varieties in the test of interaction of chemicals and varieties.

Variety	Pounds per plot
Long Standing Bloomsdale	1.11
King of Denmark	1.54
Virginia Blight Resistant	2.87
Domino	3.15
L.S.D. at 1%	.24

Effect of temperature on IPC

Early in the work with spinach, Chloro IPC caused severe injury to spinach in cases where IPC caused none. Temperature was suspected as being related to this response and greenhouse work was done to compare the effect of temperature on the different types of IPC.

It may be seen from Figure 5 that under greenhouse conditions, four pounds per acre of Chloro IPC injured spinach at mean temperatures below 60°F. Four pounds of IPC, however, did not injure spinach at a mean temperature below 50°F. The F value for the interaction of treatment and temperature was significant at the 1% level.

Figure 4. Interaction of Spinach Variety and Chemical Treatment

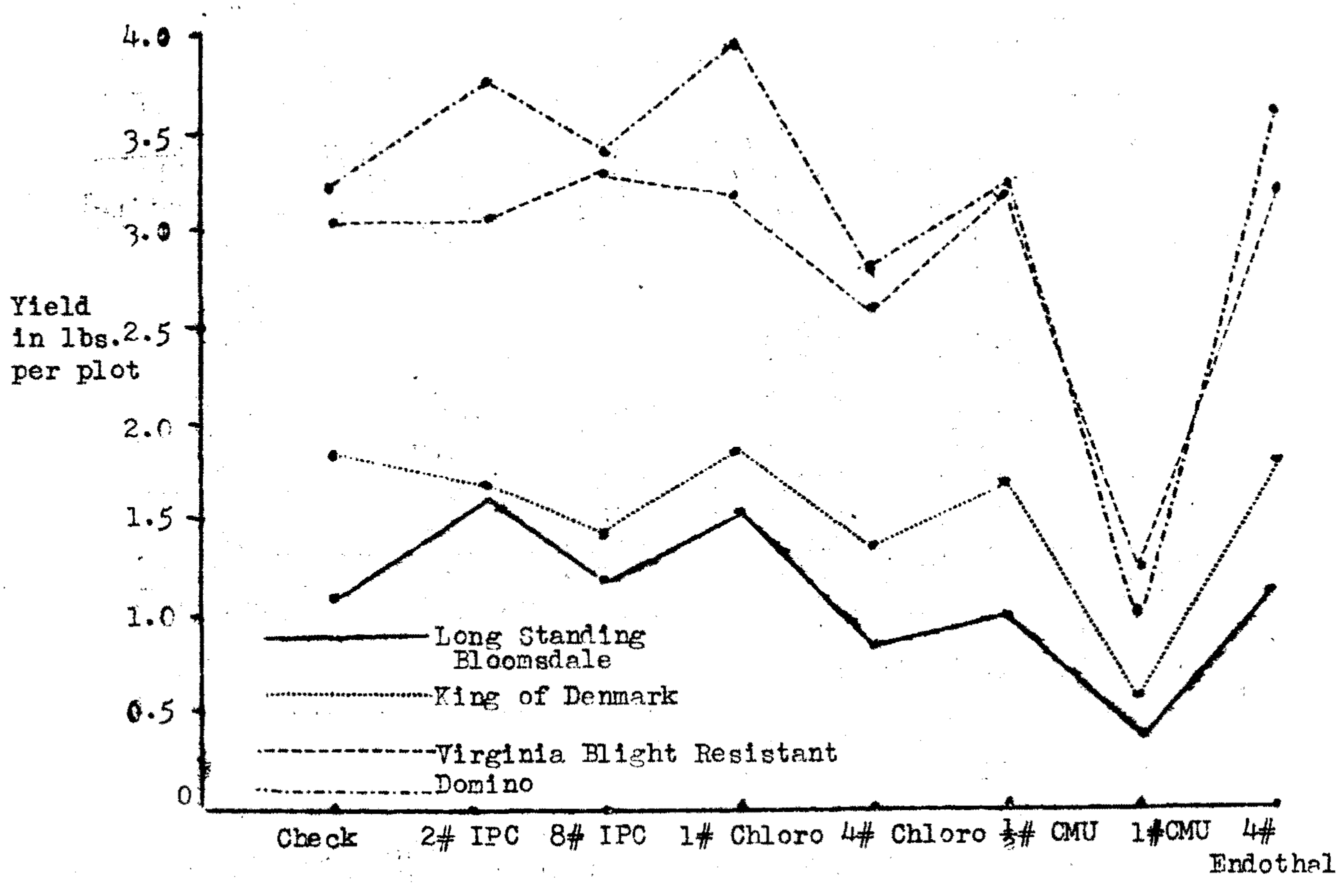
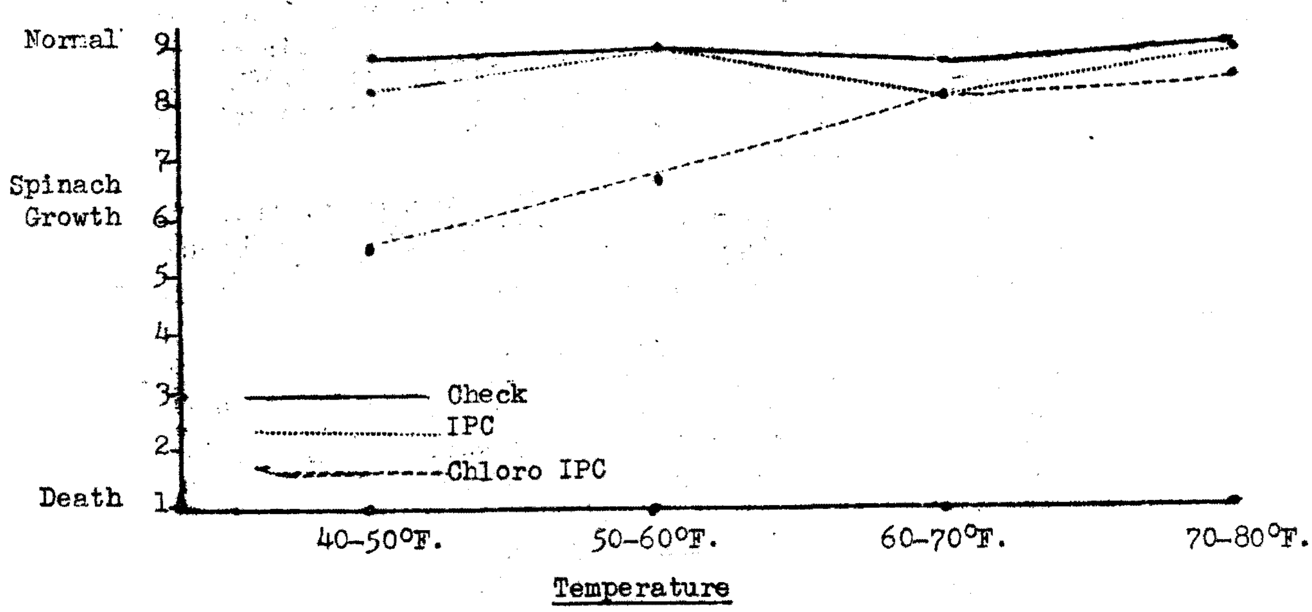


Figure 5. Influence of temperature on the response of spinach treated with IPC and Chloro IPC at time of planting.



Below what temperature in the field does Chloro IPC cause injury? Table 5 shows data taken from three separate experiments yielding information on this subject?

Table 5. Effect of temperature on the toxicity of IPC and Chloro IPC to weeds and spinach when applied at crop emergence.

E. Ithaca Experiments	No. 2		No. 3		No. 4[2]
Chemical and Rate	Yield lbs/plot	Weed Control rating	Yield lbs/plot	Weed Control rating	Yield Growth Rating[1]
Check	3.9	1.3	2.32	1.4	8.7
IPC 2#	4.6	5.0	2.52	2.5	8.0
IPC 4#	3.7	5.3			8.2
IPC 8#	4.0	5.8	2.34	6.6	8.0
Chloro IPC ½#	4.6	4.3			
Chloro IPC 1#	2.2	6.0	2.68	5.8	6.7
Chloro IPC 2#	2.9	7.5			5.6
Chloro IPC 4#	2.1	8.3	1.88	6.7	3.8
L.S.D. at 5%	2.1	1.9	.26	1.2	1.5
L.S.D. at 1%	2.8	2.6	.35	1.7	2.0
Planting date	July 21, 1951		Aug. 23, 1951		Sept. 19, 1951
Treating date	July 24, 1951		Aug. 30, 1951		Sept. 26, 1951
Mean temperature for the 10 days after treatment	70.4°F.		62.6°F.		56.8°F.

[1]Actual harvesting will be done spring 1952.

[2]Weed stand negligible fall 1951.

Treatments were applied at time of come-up in all three experiments and may be compared on this basis. It should be made clear, however, that this time of treatment has resulted in the most injury to the spinach from the Chloro IPC. The main difference between the experiments is the mean temperature following application of the chemicals. The data indicate that IPC did not cause an increase in spinach injury as the average temperature after treatment decreased to 56.8°F. On the other hand, even 1 pound of Chloro IPC caused injury to spinach as the temperature decreased to 56.8°F.

Although the data in Table 5 are not conclusive, they do indicate that much caution should be exercised if Chloro IPC is used on over-wintered or early spring spinach because at this time temperatures are usually low.

In general, weed control with 4 pounds of IPC is not satisfactory at temperatures ranging above 60°F. Chloro IPC gives much better weed control than IPC at the higher temperatures, table 5. This is probably due to a differential rate of breakdown of IPC and Chloro IPC (2, 3, 8).

Summary and Conclusions

Four pounds of IPC is effective in controlling chickweed, purslane, smartweed, and most annual grasses when the mean temperature following application is below 60°F. IPC will not control lambs quarter, pigweed, galinsoga, groundsel and many other broad-leafed plants. Four pounds of IPC may be applied from immediately after planting until the spinach has two true leaves without injury to the spinach.

Two pounds of Chloro IPC is as effective in controlling the same weeds as 4 pounds of IPC without causing injury to the spinach, if applied when the mean temperature following application is above 60°F. Chloro IPC should not be applied when the spinach is emerging.

One-half pound of CMU effectively controlled almost all annual weeds without injury to the spinach in the three tests where it was included. Higher rates of CMU were very injurious to the spinach. With CMU there seemed to be no effect of temperature on weed control. More work should be done with CMU before it is used on spinach in extensive field trials. It is thought that a rate between 1/4 and 1/2 pound of CMU may prove to give adequate weed control and cause little or no injury to the spinach.

Endothal (ME 3000) at a rate of four pounds per acre looked promising, but more work should be done with this material.

Contact herbicides such as the aromatic oils, pentachlorophenols, and NIX may provide excellent weed control without injury to the spinach if the weeds emerge from the ground before the spinach. Care should be taken not to apply these chemicals immediately before spinach come-up.

On the basis of one experiment, the varieties Domino, Long Standing Bloomsdale, King of Denmark and Virginia Blight Resistant have the same relative tolerance to IPC, Chloro IPC, and Endothal. Domino and Virginia Blight Resistant may be slightly more susceptible to injury from CMU than the other varieties.

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Influence of Time of Application of Herbicide on Pre-emergence Weeding of Spinach

Charles J. Noll and Martin L. Odland[1]

Pre-emergence applications of herbicides on drilled vegetables, as a means of weed control, have not been found to be generally successful. Failures with this method of weed control have been due to reduction in stand or injury of crop plants, or unsatisfactory kill of weeds, resulting in reduced yields. However, since satisfactory selective herbicides are not available for many crops, the pre-emergence method of weed control may merit further study. Weed control of a temporary nature or imperfect weed control resulting from the application of a pre-emergence herbicide doesn't eliminate this method of weed control. The species of weed plants and weather conditions are factors that must be taken into consideration. Factors that may be varied or controlled by the grower are the herbicides used, the rate of application, and the time of application.

Preliminary pre-emergence weeding studies at the Pennsylvania Agricultural Experiment Station indicate that pre-fitting land prior to planting was not practical on our heavy soils. Where pre-fitting is impractical, time of application of a pre-emergence herbicide may be extremely important. An experiment designed to study the effect of time of application as well as the kind of herbicide was conducted at State College in 1951.

PROCEDURE

Seven different chemical treatments: Shell Oil 130 at 6 gal. per acre, Dowicide G at 11½ pounds per acre, IPC at 3 pounds per acre, 40% Cloro IPC at 1 gal. per acre, Premerge at 1/3 gal. per acre, CMU at .94 pounds per acre and Stoddard Solvent at 100 gal. per acre were used in the experiment. These treatments were arranged at random, together with a non treatment control, in each of six replicated blocks that measured 40 feet by 84 feet. Each chemical treatment main plot consisted of eight single row sub-plots, forty feet long and eighteen inches wide, which were devoted to the time of application treatments. The herbicides were applied with a hand sprayer over the row for a width of eight inches at a rate of 33 gallons per acre except for Stoddard Solvent which was applied at the rate of 100 gallons per acre.

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The land was prepared and planted on May 21 and the first application treatment was made on that date. Further time of application treatments were made daily for six days, making a total of seven treatments. The eighth sub-plot was left untreated as a control. By the time the last application was made, small spinach plants marked the row.

The weeds which prevailed were red root, annual grasses, and miscellaneous weeds including chickweed. These were not especially abundant and did not cause serious trouble to the crop. The spinach variety grown was Special Summer Savoy which reached the harvest stage on June 29th. The kind and weight of the weeds present in each sub-plot was determined as well as the stand and yield of spinach.

RESULTS AND DISCUSSION

The spinach stand and yield and the weight of weeds in the row for each of the seven chemicals studied is presented in Figures 1 to 7. Per cents expressed are those obtained when comparing the treated plots with the untreated plots. Significant differences are indicated in the per cent at the five per cent level. It may be seen that time of application of the herbicide greatly effects spinach stand, yield and weed control. Spinach yield in some cases was greatly reduced without a corresponding reduction in stand, indicating injury to the surviving spinach plants. With other chemicals, yield and stand of spinach were closely correlated indicating that spinach plants that survived were not materially damaged by the herbicide. Weed control varied greatly with the herbicide used. In some cases, weed control was as good when applied the day the land was prepared as six days later. Other herbicides gave much better weed control if application was delayed.

Shell Oil 130 applications at six gallons per acre (Fig. 1) did not significantly reduce the stand of spinach until the fifth and sixth day after planting. Yield of spinach was significantly reduced at all times of application except the second, third and fourth day after planting. Weed control was significantly reduced at all times of application with the best control at the later dates of application.

Dowicide G applications at 11½ pounds per acre (Fig. 2) significantly reduced the stand of spinach at all times of application. Yield of spinach was equal to that of the untreated plot only when the herbicide was applied the day the spinach was planted. Weed control was not significantly reduced in a comparison of days of application, but was significantly reduced in a comparison of herbicides versus non herbicide treatments.

A.C.P. 644 application at 3 gals. per acre (Fig. 3) did not significantly reduce stand or yield of spinach. The last application, applied the sixth day after planting when the small spinach plants marked the row, did not significantly reduce either stand or yeild of spinach. Weed control was significantly better than no weed control from the first to the sixth day after planting.

Forty per cent Cloro IPC applied at 1 gal. per acre (Fig. 4) significantly reduced the stand and yield of spinach at all days of application except when applied the day the spinach was planted. Weed control was equally as good at all days of application.

Premerge at one third of a gallon per acre (Fig. 5) significantly reduced the stand of spinach at all days of application except when applied the day the spinach was planted. Yield was closely correlated with stand. Weed control was not significantly reduced in a comparison of days of application but was significantly reduced in a comparison of herbicides versus non herbicide treatment.

CMU at 94 hundredth pound per acre (Fig. 6) did not statistically reduce the stand of plants in a comparison of days of application. Yield of spinach and weed control were significantly reduced at all days of application. The best weed control was obtained from the day following planting to the sixth day after planting.

Stoddard Solvent at 100 gal. per acre (Fig. 7) did not significantly reduce the stand or yield of spinach except for the last application made the sixth day after planting. Weed control was significantly better the third, fourth, fifth and sixth days after planting.

CONCLUSION

Under the conditions of this experiment, the following can be concluded as optimum time of application of the most promising herbicide for pre-emergence weeding of spinach taking into consideration stand and yield of spinach and weed control.

1. Shell Oil 130 2nd, 3rd, 4th days after planting
2. ACP 644 First to 6th days after planting
3. 40% Cloro IPC Day spinach was planted
4. Stoddard Solvent 3rd, 4th, or 5th day after planting

FIG. 1. PENTACHLOROPHENOL IN OIL (SHELL OIL 130-6 GAL PER ACRE)

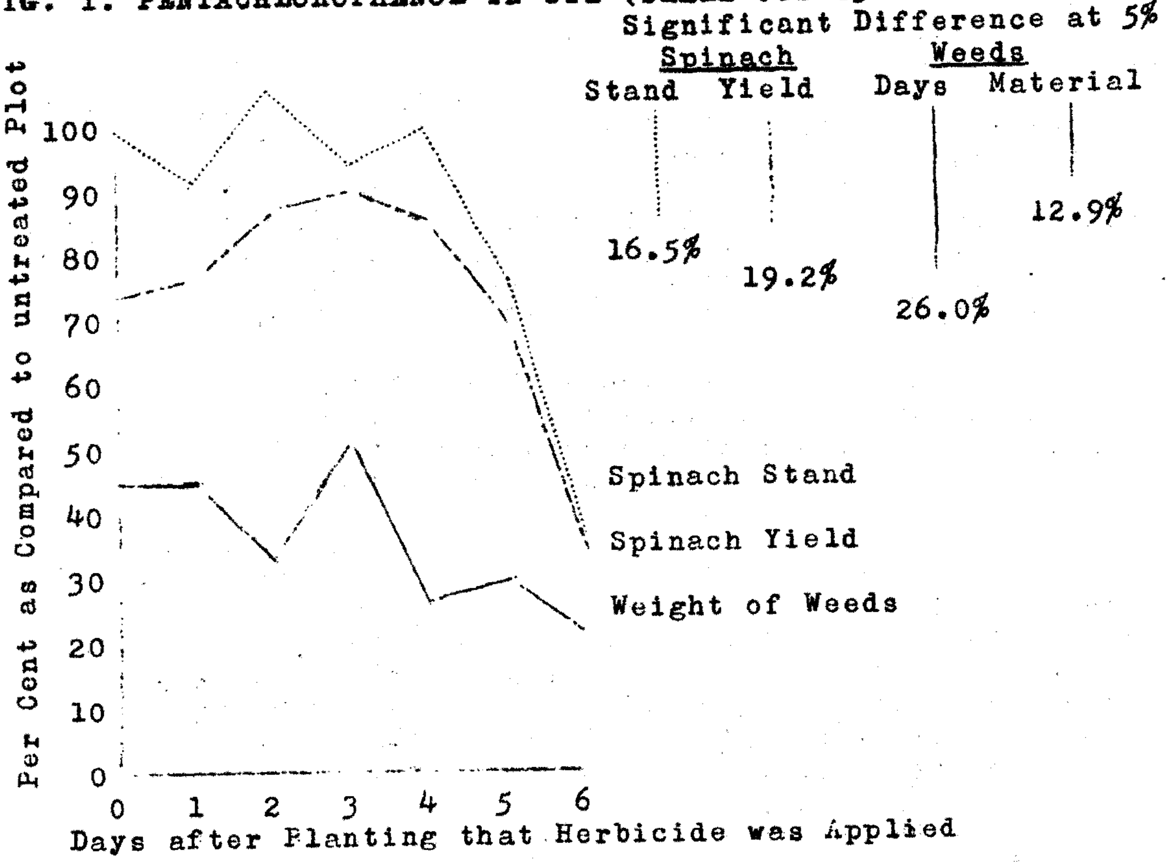

FIG. 2. SODIUM PENTACHLOROPHENATE IN WATER (DOWICIDE G-11½ lbs. PER ACRE)

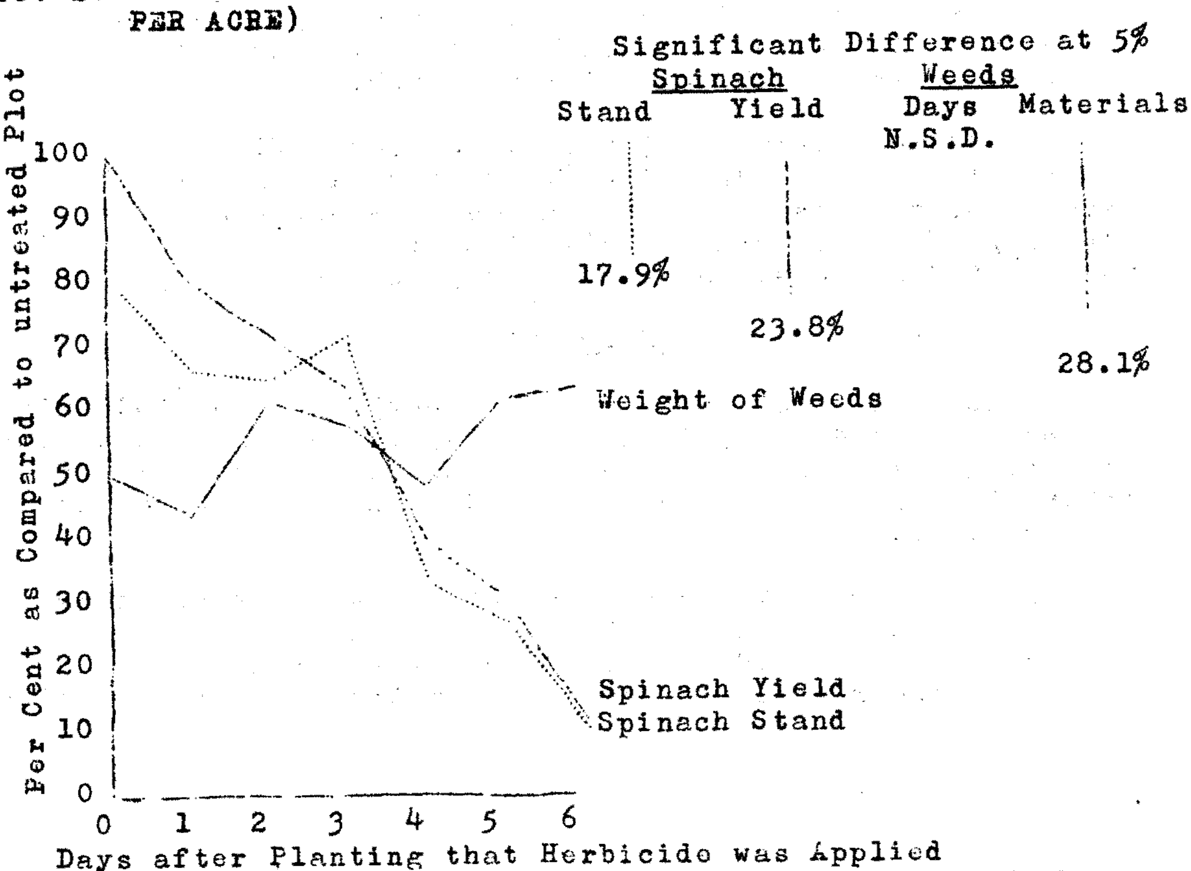

FIG. 1 & 2. STAND AND YIELD OF SPINACH AND WEIGHT OF WEEDS EXPRESSED AS PER CENT OF UNTREATED PLOT

FIG. 3. IPC IN OIL EMULSION, 3 POUNDS PER ACRE (ACP 644-3 GAL PER ACRE)

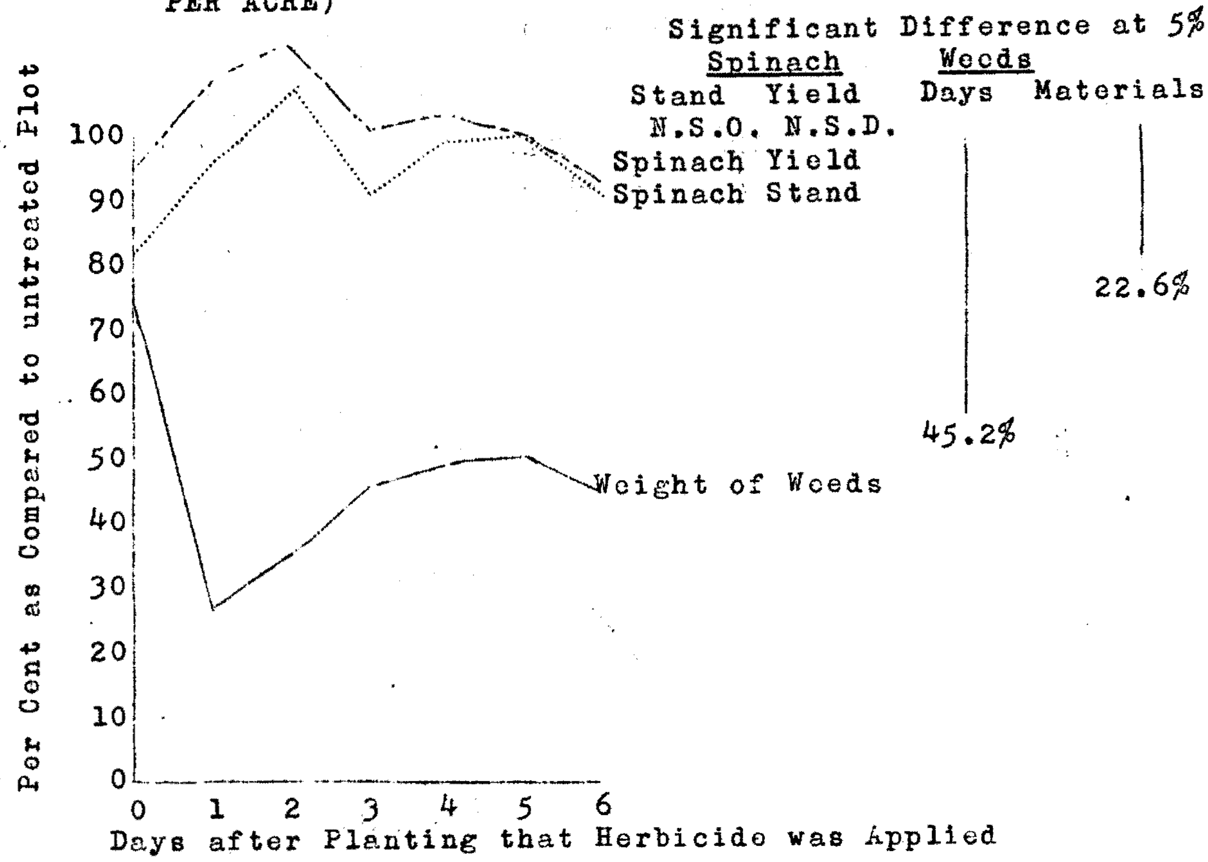

FIG. 4. 40% CLORO IPC IN OIL (130 PROPYL-N-(-CHLOROPHENYL) CARBAMATE 40.6%- 1 GAL. PER ACRE)

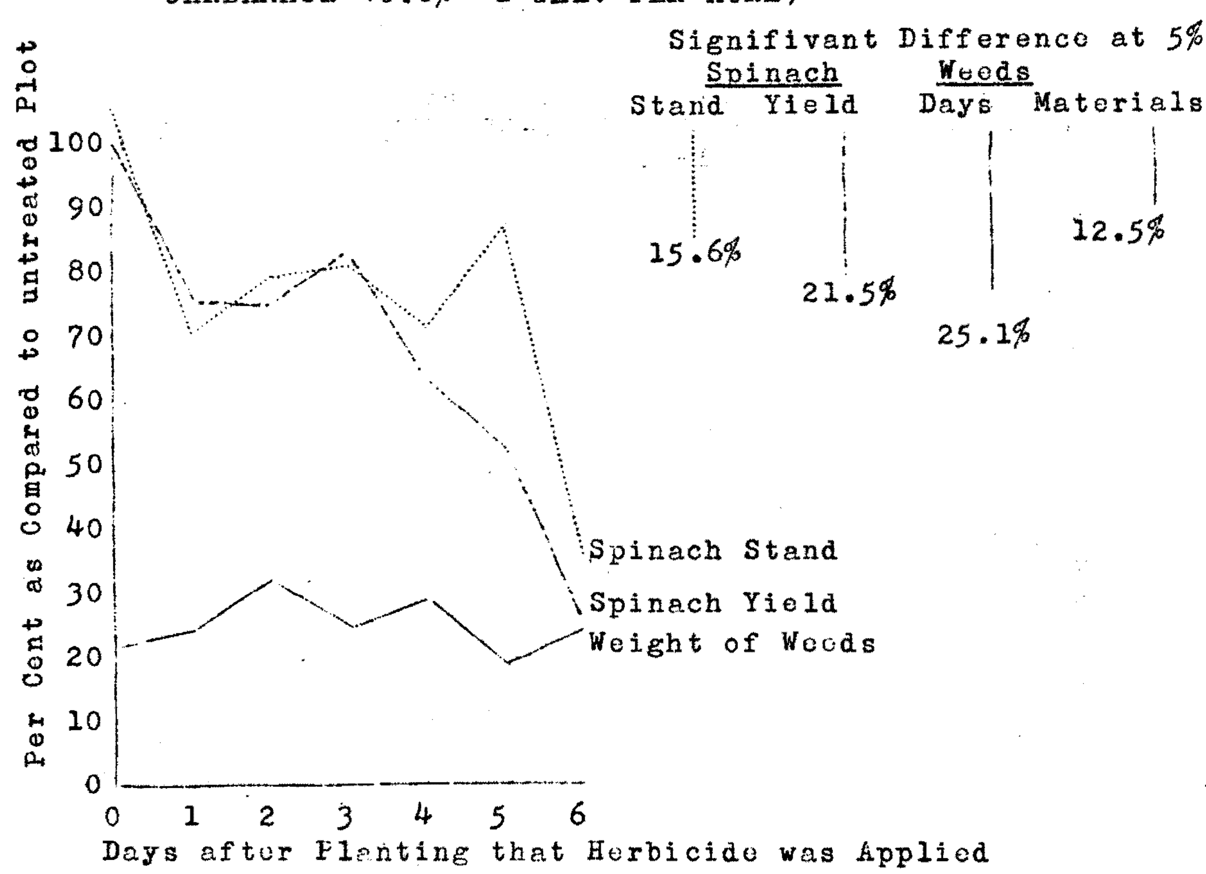

FIG. 3 & 4 STAND AND YIELD OF SPINACH AND WEIGHT OF WEEDS EXPRESSED PER CENT OF UNTREATED PLOT

FIG. 5. DINITRO-O-SEC-BUTYLPHENOL, ALKANOLAMINE SALTS IN WATER (PREMERGE-1/3 GAL PER ACRE)

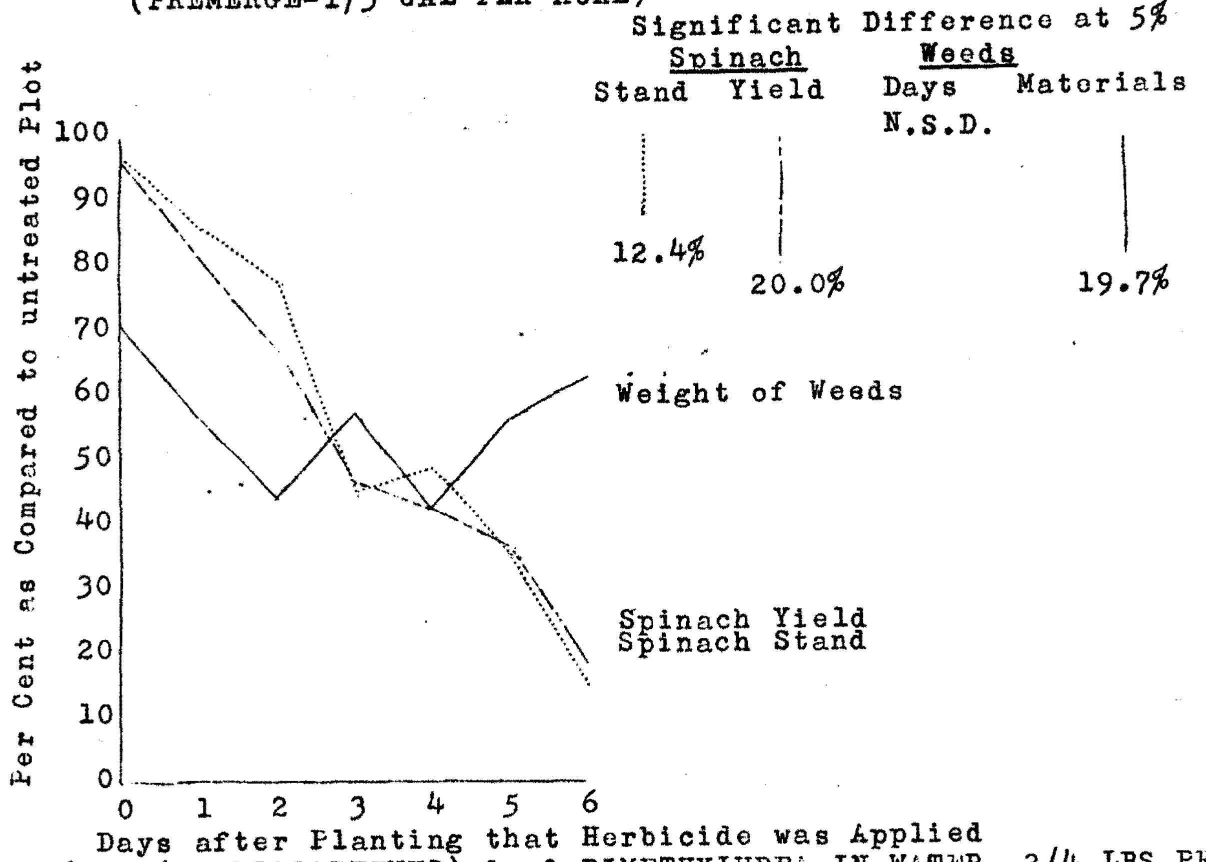

FIG. 6. 3-(P-CHLOROPHENYL)-1, 1-DIMETHYLUREA IN WATER, 3/4 LBS PER ACRE (CMU-.94 LBS. PER ACRE)

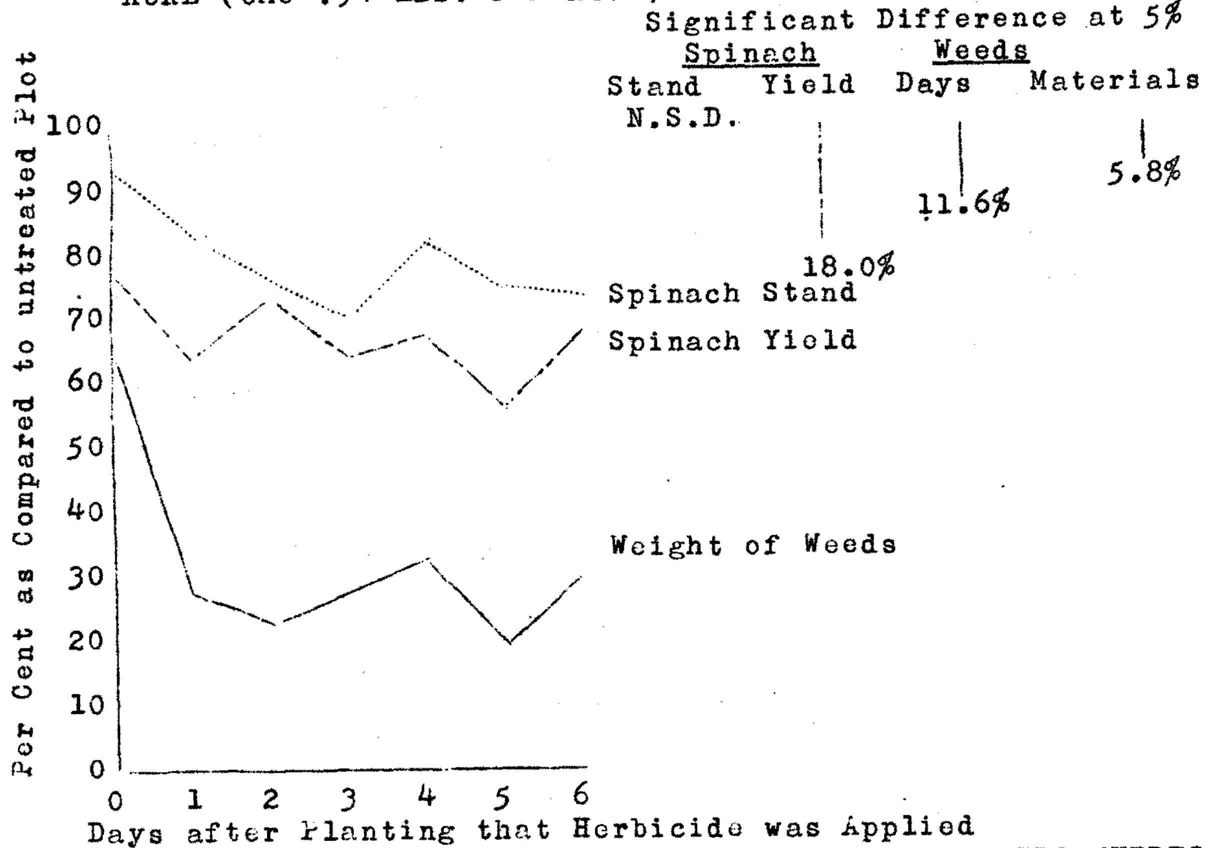

FIG. 5 & 6 STAND AND YIELD OF SPINACH AND WEIGHT OF WEEDS EXPRESSED AS PER CENT OF UNTREATED PLOT

FIG. 7 STODDARD SOLVENT (ESSO WEED KILLER 35-100 GAL PER ACRE)

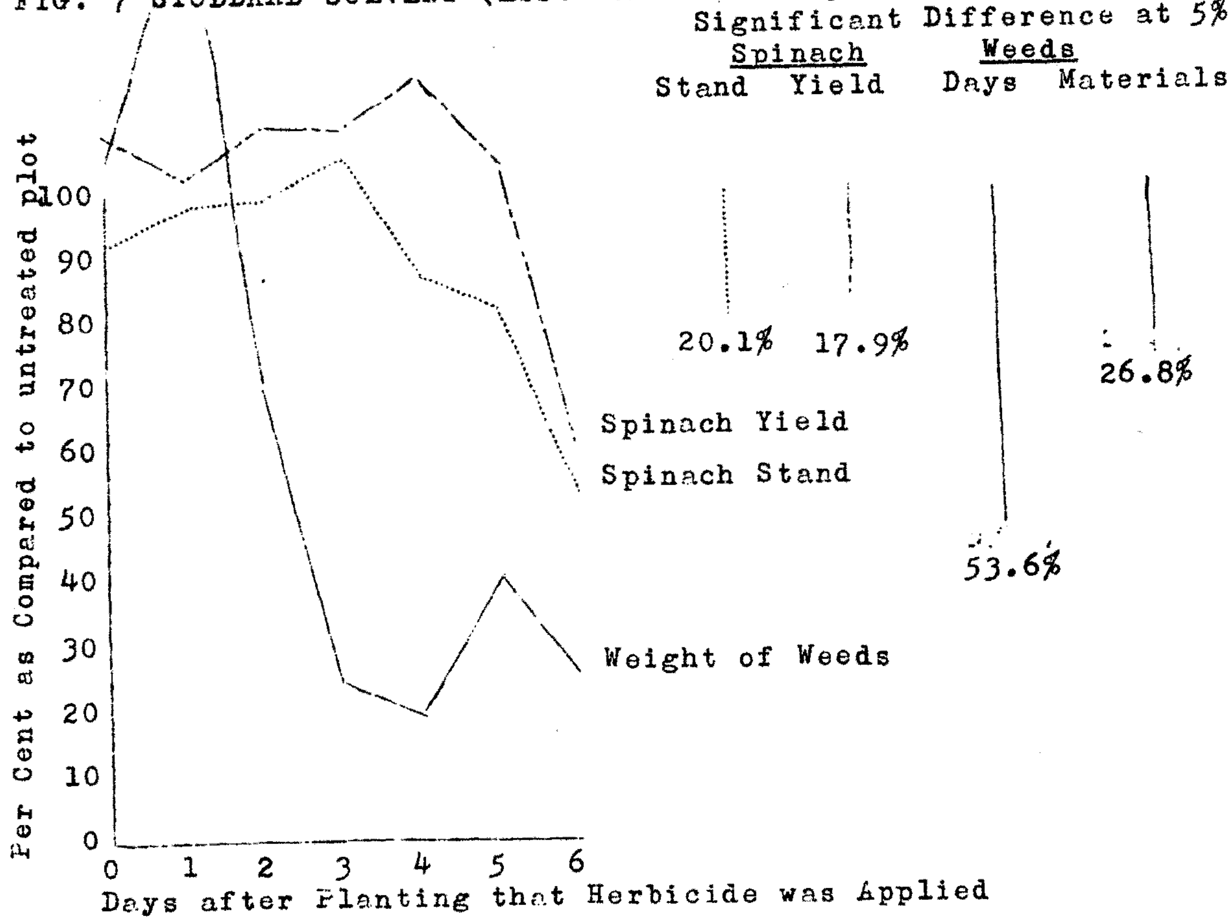

FIG. 7 STAND AND YIELD OF SPINACH AND WEIGHT OF WEEDS EXPRESSED AS PER CENT OF UNTREATED PLOT

EXPERIENCE WITH SOME NEW HERBICIDES ON STRAWBERRIES

By John S. Bailey
Massachusetts Agricultural Experiment Station

A number of chemicals such as 2,4-D, certain of the dinitros, IPC and E.H. #1, have been tried for the control of weeds in strawberries. E.H. #1 or as it is now called, Crag Herbicide #1, seemed to have possibilities for controlling weeds in strawberries without some of the undesirable effects of 2,4-D. It was desired to try this material and to compare with it certain other new materials which seemed to offer desirable possibilities.

This series of trials was set up in May, 1951. Thirty-six plots 12' x 13 1/2', were laid out in four blocks of nine plots each. On May 4, seven plants each of the three varieties, Howard, Sparkle and Catskill, were set in each plot.

The day before the plants were set the plots to receive Dow General were treated at the rate of three pounds active per acre. Crag Herbicide #1 was applied right after the plants were set. The 2,4-D was applied on May 16 just as the weeds were appearing above ground. The Stoddard Solvent was applied May 22 after the weeds had made a little growth. Since strawberry plants are easily injured by this latter material, each plant was covered with a No. 10 can before the plot was sprayed. Each treatment was replicated three times.

Weed counts were made on June 4. The weeds were mostly Lambs' Quarters, *Chenopodium album*, Pigweed, *Amaranthus retroflexus*, and a few grasses.

The results were analyzed by analysis of variance and are given in Table I. The data for broad leaved weeds was transformed to the $\sqrt{n}$ because the numbers are all below 100. Likewise, the data for grasses was transformed to $\sqrt{n+0.5}$ because most of the numbers are below 10. The figures for the least difference necessary for significance apply to the transformed means only.

Considering the control of broad leafed weeds, the difference between the untreated check and each of the CH #1 or Dow General or Stoddard Solvent treatments is highly significant. Likewise, the difference between the 2,4-D treatment and each of the other treatments is highly significant. The differences between CH #1 at 2, 4 and 6 pounds per acre are not significant. The difference between 8 pounds and either 4 or 6 pounds is significant and the difference between 8 and 2 pounds is highly significant.

Table I

Weed Control in Strawberries - 1951

Counts made June 4, 1951

Treatment	Rate	Mean No. weeds/sq. ft. Broad Leaf	Transformed to $\sqrt{n}$	Grasses	Transformed to $\sqrt{n+0.5}$	Days between treatment & count
Untreated	-	76.7	8.29	16.5	4.21	-
Crag Herbicide #1[1]	2#/a.	28.3	5.25	3.3	1.94	31
"	4#/a.	24.0	4.84	1.0	0.93	31
"	6#/a.	20.7	4.54	1.0	0.93	31
"	8#/a.	13.7	3.22	0.7	0.81	31
2,4-D[2]	1/2#/a.	53.3	7.23	9.7	3.07	19
Dow General[2]	3#/a.	19.3	4.36	10.0	3.19	32
Stoddard Solvent	80 gal./a.	22.0	4.69	7.3	2.66	13

	B.L.	Grasses	
LSD @ 5%	1.31	1.12	) - apply to transformed means.
" @ 1%	1.82	1.55	)

[1] Crag Herbicide #1 was supplied by the Union Carbide and Carbon Corp., New York, N.Y.

[2] 2,4-D (Formula 40) and Dow General Herbicide were supplied by the Dow Chemical Co., Midland, Mich.

In regard to the control of grasses, all the treatments except Dow General are significantly better than the check. The difference between CH #1 at 2 pounds per acre and at 4 or 6 pounds per acre is not significant, but between 2 and 8 pounds per acre there is a significant difference.

Since there was not room for replication of all materials tried, some were applied to single plots. These included Weednix, CMU, Sulfasan and 3-chloro IPC. The plots which received Weednix were treated on May 4. CMU was applied May 3 before planting. Weed counts were made June 4, at the same time as the counts on the replicated plots. The data for these two series of treatments is given in Table II.

Sulfasan and 3-chloro IPC (O-isopropyl N-(3-chlorophenyl) carbamate) were applied May 22 and the weed counts were made June 20. The results are given in Table III.

Table II

Weed Control in Strawberries - 1951
Weed counts June 4, 1951

Treatment	Rate	No. weeds per sq. ft.		Days treatment to count
		Broadleaf	Grasses	
Untreated	-	96	13	-
Weednix[1] (Sodium isopropyl xanthate)	6#/a.	114	8	31
"	8#/a.	74	25	31
"	10#/a.	106	5	31
CMU[2]	1/4#/a.	40	21	32
"	1/2#/a.	40	4	32
"	1#/a.	2	1	32
"	2#/a.	3	1	32

[1] Weednix was supplied by Innis Speiden & Co., New York, N.Y.
[2] CMU was supplied by E. I. DuPont de Nemours & Co., Wilmington, Del.

Table III

Weed Control in Strawberries - 1951

Application May 22, 1951.
Counts June 20, 1951.

Treatment	Rate	No. Weeds/sq. ft.	
		Broadleaf	Grasses
Untreated	-	96	13
Sulfasan[1]	1/2 gal./a.	11	12
"	2 gal./a.	18	14
3-Chloro-IPC	2#/a.	9	5
"	3#/a.	2	3
"	4#/a.	3	2

[1] Sulfasan was supplied by the Monsanto Chemical Co., Akron, Ohio.
[2] 3-chloro IPC was supplied by Columbia-Southern Chemical Corp., Pittsburg, Pa.

Discussion and Conclusions

Crag Herbicide #1, 2,4-Dichlorophenoxy ethyl sulfate, did a good job in controlling weeds at all rates of application. The difference between 2, 4 and 6 pounds per acre was not significant for either broad leaved weeds or grasses. It appears that 2 pounds is as good as 6 pounds and to get really better weed control the application must be increased to 8 pounds per acre. Shortly after the counts were taken the weeds came into the plots. It would appear that this material cannot be expected to keep weeds in check for over a month. No injury to the plants was observed from any of the rates of application. Two repeat applications later in the season caused no injury.

Dow General, dinitro-ortho-secondary-butyl phenol, did a good job controlling broad leafed weeds but was not quite so good on grasses. It may have possibilities as a preplanting or late fall treatment but is too toxic to strawberries to be used during the growing season unless some method can be devised for protecting the plants.

Stoddard Solvent seemed to offer possibilities if the plants could be protected. Protecting the plants also protects some of the weeds and leaves some hand pulling or hoeing around the plants. Also, Stoddard Solvent has no residual value. There were about as many weeds in the Stoddard Solvent plots 2 weeks after treatment as in the others 4 weeks after treatment.

The 2,4-D was apparently used at too low a rate to be effective.

Although the Weednix, sodium isopropyl xanthate, was obtained from a representative of the manufacturer only a few days before application, it was quite ineffective in controlling the weeds present.

CMU, para-chlorophenyl-1, 1-dimethylurea, was an extremely effective plant killer as used in these trials. At one pound per acre it killed practically all weeds and all the strawberries. At as little as 1/4 pound per acre there was some evidence of injury to the strawberries. This material is not selective enough for use with strawberries.

Sulfasan, ethyl xanthogen disulfide, looked promising from the standpoint of weed control but caused considerable injury to the strawberry plants from which they never entirely recovered.

3-chloro-IPC (O-isopropyl N-(3-chlorophenyl)carbamate) at 2, 3 or 4 pounds per acre gave very good weed control for a month with no observable injury. When used at 5, 6 or 7 pounds per acre later in the season, there was enough injury to the plants to make use at these rates of doubtful value.

EFFECT OF SODIUM 2,4-DICHLOROPHENOXY ETHYL SULFATE ON THE GROWTH AND YIELD OF STRAWBERRIES[1]

Donald R. Isleib, Richard J. Aldrich and Harry K. Bell[2]

Sodium 2,4-dichlorophenoxyethyl sulfate (designated in the remainder of this paper as EH-1, which is 90% active material) for weed control in strawberries has been studied at the New Jersey Agricultural Experiment Station since 1949. The reports of weed control obtained in first year plantings have been published in previous proceedings (1). The chemical has been extensively tested in strawberries by other investigators (1, 2, 3, 4) and there are numerous references to its use in crops other than strawberries in the literature.

The present paper includes yield data from tests begun in 1950; results from a greenhouse study of the effect of EH-1 on root development of strawberry plants, and; data from a field study of the effect of time of EH-1 application on runner initiation and rooting.

METHODS, RESULTS AND DISCUSSION

Yields from the 1950 Tests

Matawan, New Jersey - The test was made in a commercial planting of the Sparkle variety set in a sandy loam soil. Plots were two rows wide and 30 feet long. The experimental design was a randomized block with three replications. The applications were made in 100 gallons of water per acre.

The yields are summarized in table 1. From the table it is apparent that EH-1 applied in 1950 did not reduce strawberry yields. The differences in yield were not statistically significant. No off-flavor, off-color, or malformation of fruit was noted and the berries were sold with those from the rest of the field.

Test No. 1 at New Brunswick - The treatments shown in table 2 were applied in 100 gallons of water per acre to plants of the Sparkle variety. Plots were two rows wide and 30 feet long. The experimental design was a randomized block with 5 replications. Since part of the planting was lost due to erosion, data were taken on only three replications.

[1]Cooperative investigations between the New Jersey Agricultural Experiment Station and the Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U.S. Department of Agriculture.

[2]Research Fellow, Farm Crops Department, NJAES; Agent, Division of Weed Investigations, BPIS&AE, USDA; and Instructor in Pomology, Horticulture Department, NJAES, respectively.

Acknowledgement is made for the support of this project to the Carbide and Carbon Chemical Corporation.

Table 1. The effect of EH-1 on yield of strawberries, Matawan, 1951

Treatment	Grams per plot*	Quarts per acre
1. 4 lbs. EH-1 per acre applied June 20 and August 10	21,172	5,933
2. 3 lbs. EH-1 per acre applied June 20 and August 10	20,410	5,715
3. Check - given normal field cultivation and hoeing	20,256	5,660

*Average of 3 replications.

The effects of the chemical treatments on strawberry yields are shown in table 2.

Table 2. The effect of EH-1 and 2,4-D on yield of strawberries, New Brunswick, 1951

Treatment	Grams per plot*
1. Check - hand-hoed	5,224
2. 1 lb. EH-1 applied in June	5,228
3. 6 lbs. EH-1 applied in June	8,962
4. 3 lbs. EH-1 applied in June	6,683
5. 3 lbs. EH-1 applied in June and July	7,897
6. 6 lbs. EH-1 applied in June and July	5,917
7. 1 lb. 2,4-D applied in June	6,409

* Average of 3 replications.

The average yield of treated plots was significantly higher at the 5% level than the check yield. This may reflect reduced weed competition in 1950 in the treated plots, although check plots were hand-hoed after weed counts were taken. Possibly competition from weeds which were allowed to grow until being counted accounts for the reduction in check plot yields. This possibility is further substantiated by the fact that plots treated with 1 pound of EH-1, which did not control weeds completely, yielded no more than the check plots.

<u>Test No. 2 at New Brunswick</u> - The treatments shown in table 3 were made July 27, 1950 in 100 gallons of water per acre to plants of the Sparkle variety. The soil is a sandy loam. Plots were two rows wide and 30 feet long. The experimental design was a randomized block with three replications.

There were no statistically significant differences between yields. The comparison of 2,4-D with the total of all other treatments accounted for 40% of the sum of squares due to treatment which suggests that one pound of 2,4-D may have injured the berries.

Table 3. The effect of EH-1 and 2,4-D on yield of strawberries, New Brunswick, 1951

Treatment	Grams per plot*
1. 1 lb. EH-1	13,299
2. 3 lbs. EH-1	16,617
3. 6 lbs. EH-1	14,625
4. 1 lb. 2,4-D	12,685
5. Check - hand-hoed	16,780

* Average of 3 replications.

<u>Variety Test at New Brunswick</u> - The six varieties listed in table 4 were treated with 3 pounds of EH-1 per acre in 1950. Plots were two rows wide and 15 feet long. There were three replications.

Yields are summarized in table 4. EH-1 did not significantly increase or decrease the yield of any variety in the test.

Table 4. The effect of EH-1 on yields of six strawberry varieties, New Brunswick, 1951

Variety	Grams per plot*	
	Check	3 lbs. EH-1 per acre
Dorsett	11,971	12,087
Pathfinder	10,943	12,953
Redwing	7,746	5,833
Redcrop	4,808	7,583
Fairfax	4,748	5,671
Midland	3,013	3,778
Treatment average	7,178	7,954

*Average of 3 replications.

Effect of EH-1 on Root and Top Development

Field observations of the gross morphological responses of strawberry plants to EH-1 have shown that the above ground plant parts are not markedly affected. Since the chemical presumably might be used when runner-plants are rooting, a greenhouse study was made of its effect on root and top development.

Methods - In February, 1951 about 100 Sparkle plants were dug from the nursery at the College of Agriculture. After dead leaves, dead stolons, and soil were removed, root length measurements, leaf counts, and green plant weights were taken. Fifteen groups of four similar plants each were chosen. Each plant in three of the groups (12 plants) was separated into roots and top, ovendried, and the per cent dry weight calculated. The remainder were planted in flats set on the long edge and the erstwhile top of the flat covered by an 11 x 14" glass pane through which roots could be observed. After ten days four of these flats were sprayed with an aqueous solution equivalent to three pounds of EH-1 per acre, four were sprayed with the equivalent of 6 pounds per acre, and four were untreated. To increase root growth, flower buds and runners were removed as they appeared. The plants were harvested May 15. The growth was measured in grams increase in dry weight per gram of original dry weight. The original dry weights of the test plants were calculated from the per cent dry weights obtained on the original three groups which were assumed to be representative of the entire lot.

Results - The effect of EH-1 on growth of roots and tops is shown in table 5. Check plants made more total growth than treated plants; the difference was significant at the .05 level. Roots and tops were inhibited by the treatments, but root development as observed through the glass in the flats appeared to be retarded more by treatment in the early stages of the experiment. The coefficient of correlation between root and top growth was .413, which was non-significant ($p = .19$) and suggests that roots were inhibited more than tops. It is entirely possible that the effect of the treatments had diminished at the time of harvest, and that the treated plants had outgrown an initial retardation.

Table 5. Effect of EH-1 on growth of strawberry roots and tops

Treatment	Grams increase in dry weight per gram original dry weight		Per cent of check	
	Tops	Roots	Tops	Roots
1. Check	7.52	3.82		
2. 3 lbs. EH-1 per acre	6.28	3.03	83.2	79.3
3. 6 lbs. EH-1 per acre	6.30	2.57	83.8	67.3

Effect of EH-1 on Runner Initiation and Rooting

Since the greenhouse study showed that roots were inhibited initially by EH-1 a field test was established to study effects of time of application on runner initiation and rooting.

Methods - The plants were set April 8 in a Sassafras loam soil. Plots were 15 feet long and 2 rows wide. Treatments consisted of a single application of 3 pounds of EH-1 per acre. The experimental design was a randomized block with three replications. The first treatment was made the day after planting, the second ten days later, and thereafter at intervals of about 2 weeks. The entire area was hand-hoed throughout the growing season. Runner counts were made on August 1 and November 1.

Results - Results of the counts are shown in table 6. Differences between counts were statistically significant on August 1, but not on November 1. Nevertheless, when the number of runner plants in the checks on November 1 was compared with the average number of runner plants in the remaining treatments (except the April 9 treatment which may have injured parent plants) it appeared that the treated plants produced a greater number of runner plants than the checks. If EH-1 has an effect on chemical composition similar to that of 2,4-D, this increase in runners may be due to a condition of vegetative growth promoted by a reduction of starches and insoluble sugars and an increase in soluble sugars. The effect of EH-1 on chemical composition is being studied but results are not complete.

Table 6. Effect of date of application of EH-1 on runner plants

Treatment	Total rooted runner plants - 3 plots	
	August 1	November 1
Check	569	1,200
1 day after planting - April 9	603	1,117
2 weeks after planting - April 23	577	1,515
4 weeks after planting - May 9	865	1,515
6 weeks after planting - May 26	750	1,462
8 weeks after planting - June 8	408	1,552
10 weeks after planting - June 25	487	1,342
12 weeks after planting - July 12	637	1,342
15 weeks after planting - August 2	632	1,642
L.S.D. at .05	296	

SUMMARY

Applications of sodium 2,4-dichlorophenoxyethyl sulfate, up to 10.8 pounds per acre in one season, did not reduce the yield of 6 varieties of strawberries. The yield reduction from 1 pound of 2,4-D was quite marked but not statistically significant.

Application of 3 and 6 pounds of EH-1 (90% sodium 2,4-dichlorophenoxyethyl sulfate) per acre ten days after planting significantly reduced growth of plants in the greenhouse. It appeared that the reduction was most pronounced soon after treatment and tended to disappear with time.

A single application of 3 pounds of EH-1 per acre at any time between setting and August 2 did not reduce the number of rooted runner plants produced by parent plants. There was some indication that EH-1 resulted in an increase in the number of rooted runner plants.

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WEEDING SNAP BEANS WITH DINITRO HERBICIDES, 1948 to 1951

M. F. Trevett[1/] and Robert Littlefield[2/]

This paper presents four years' results on the effect of dinitro herbicides on the yield of snap beans, bean seedling emergence, and weed control.

The tests were made on sandy loam and loam soils. Conventional seed bed preparation was practiced with a final fitting made ordinarily 3 to 4 days before planting. Beans were planted at the rate of 60 pounds per acre. Varieties used were either Pencil Pod Wax or Long Tendergreen.

Fifty pounds of nitrogen in a 1-2-2 ratio was banded at planting. All blocks were side-dressed at 50% blossom with 30 to 40 pounds of nitrogen from a straight nitrogen carrier.

Treatments were replicated from 5 to 10 times. Plots generally were three rows wide and 30 feet long, rows two and three in each plot served as record rows, with row one serving as a buffer. Depending on season beans were harvested in two to four pickings at the normal canning stage of maturity.

In 1948 herbicides were applied with a knapsack sprayer and a single nozzle spray wand. From 1949 to 1951 applications were made with a boom of plot width, enabling uniform distribution of a measured amount of spray with a single pass. Spray volume was either 60 or 70 gallons per acre, except for Block B, 1951, in which a 25-gallon per acre volume was used. Applications were made from 48 to 72 hours before bean emergence.

Lambs-quarters (Chenopodium album) and Pigweed (Amaranthus retroflexsus) made up 60 to 70% of the broad-leaf weed population in all blocks in all years. Other broad-leaf weeds present in varying amounts included Spurry (Spergula spp.), Common ragweed (Ambrosia spp.), Shepherds-purse (Capsella spp.), Mustards (Brassica spp.), Horsetail (Equisetum spp.), Smartweed (Polygonum spp.). The principal grass was Barnyard grass (Echinochloa Crus-galli).

Table 1 contains the following data: Variety and tillage practice, date of chemical treatment, rainfall for a three or four-day period subsequent to chemical treatment, bean plant stands, and yields. Statistical significance is given for the 5% level.

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2/ Formerly technical assistant, Department of Agronomy, University of Maine. 1948 tests were supervised by Dr. A.E. Prince.

Table 2 shows the effect of chemical treatment on per cent emergence.

Table 3 shows the effect of dinitros on weed control. Letter designations in Tables 1 and 3 refer to the same block. Weed counts were made in a six-inch strip centered on the crop row. Chemically treated plots were not cultivated until after weed counts had been made. Unless otherwise stated all plots were cultivated at least once, with the checks generally receiving three cultivations. As noted in Tables 1 and 3 certain check treatments were both hand-hoed cultivated.

The dinitros were supplied by the Dow Chemical Company and Standard Agricultural Chemicals, Inc.

1948 Results

In 1948 a selective, water soluble dinitro was used (the ammonium salt of dinitro ortho secondary butyl phenol). Yields of untreated plots (Table 1) were significantly lower than yields from plots receiving 1# DNOSBP (Dinitro ortho secondary butyl phenol) per acre. 1948 was the only year in which significant differences at the 5% level were shown for either selective or residual types (notes 2 and 3, Table 1).

1948 results for bean plant stand are typical for both selective and residual dinitros for all blocks in all years. At the 5% level treatment had no significant effect on stand (Table 1). Table 2 gives per cent emergence from plots in which a known number of seed were planted, constituting essentially field germination and emergence tests. No significant difference in per cent emergence was noted for any of the years in which the tests were run. Since significant differences in per cent of baldheads were not found, data for baldheads are not given.

In 1948, as for the following years, the moderate amounts of rain that fell in the three or four-day period subsequent to chemical treatment apparently did not leach a sufficient amount of the chemical to affect germination (Table 1).

In 1948, as in other years, occasional marginal burn of the first trifoliate leaves was observed, but this had no perceptibly lasting effect on plant development.

The effect of selectives on weed control in 1948 (Table 3) is typical for all years in which selectives were used. Selectives gave good broad-leaf weed control for a three to five-week period. Annual grass control was generally poor.

1949 Results

1949 results were in general similar to those of 1948.

1950 Results

In 1950 residual dinitros were used at 3 and 6-pound DNOSBP acre rates. When properly timed the residuals gave better annual grass control than had hitherto been obtained with selectives. In adjacent corn plots residual dinitros at the 3# acre rate reduced the annual grass population by 54%, and grass height by 30%, 40 days after application.

Timing of residuals is important, for example, in Block A, 1950 (Table 3) 3# of DNOSBP applied late were considerably more effective than 6# applied early. Similarly in Block C, 1950, deferring application 4 days improved weed control.

1951 Results

In 1951 3# of DNOSBP from residual dinitros reduced the annual grass population by approximately 45% and grass height by approximately 36%.

In Block B, 1951 the residuals were applied in 25 gallons of water per acre. Observations made in this and in other blocks indicate that if the seed bed has been well prepared low volume application of dinitros will give a degree of weed control equivalent to that obtained with higher volumes of water. However, if a soil has been left in a cloddy condition, low volume applications have been somewhat inferior.

Summary

Selective and residual dinitro herbicides, under conditions of moderate rainfall following application on sandy loam soils or heavier, apparently can be used safely for pre-emergence weed control in snap beans.

Where broad-leaf weeds predominate, 1# of DNOSBP per acre from either a selective or a residual will apparently be the most economical practice. If annual grasses comprise a substantial portion of the weed population, probably a minimum of 3# of DNOSBP per acre will be required for approximately a 50% control of the grasses.

Deferring treatment to within 48-72 hours of bean emergence will result in better control than if the dinitros are applied at planting.

TABLE 1. BEAN YIELDS IN DINITRO BLOCKS, 1948-1951

Year and Block	Date Dinitros Applied	Rainfall Subsequent to Chemical Treatment	Treatment: Rate/Acre DNOSBP	Stand of Bean Plants Check = 100	Yield: Tons Snap Beans Per Acre
1948[4] A.	17 June	18 June-.06"	Check	100	0.48
		19 June-.38"	1.3# DNOSBP[1]	98	1.29
		20 June-.28"		N.S. at 5%	Check sign. lower 5%
1949[5] A.	27 June	28 June-.08"	Check	100	1.99
		29 June	1# DNOSBP[1]	97	2.57
		30 June		N.S. at 5%	N.S. at 5%
		1 July-.52"			
1950[6] A.	6# DNOSBP applied 19 June, others the 24 June	25 June-.63"	Check	Severe seed corn maggot injury	3.46
		26 June	6# DNOSBP[2]		2.54
		27 June	3# DNOSBP[2]		2.75
		28 June-.28"	1# DNOSBP[1]		2.75
					N.S. at 5%
1951[7] A.	22 June	23 June-.02"	Check	100	4.46
		24 June-.28"	3# DNOSBP[3]	103	4.72
		25 June-.01"	6# DNOSBP[3]	107	4.83
				N.S. at 5%	N.S. at 5%
B.[8]	12 June	13 June	Check	100	3.41
		14 June	3# DNOSBP[3]	98	3.55
		15 June-.29"	6# DNOSBP[3]	100	3.63
		16 June-.32"		N.S. at 5%	N.S. at 5%

1/ Ammonium Dinitro Ortho Secondary Butyl Phenol - Standard Agr. Chem., Inc.
2/ Alkanolamine Salts (of the Ethanol and Isopropanol Series) of Dinitro-O-Sec-Butyl Phenol - Dow Chemical Co.
3/ Triethanolamine and Isopropanolamine Salts of Dinitro Ortho Secondary Butyl Phenol - Standard Agr. Chem., Inc.
4/ Variety - Long Tendergreen. All plots cultivated.
5/ Variety - Pencil Pod Wax. All plots cultivated.
6/ Variety - Pencil Pod Wax. Check plots cultivated and hand hoed. Chemically treated plots cultivated only.
7/ Variety - Long Tendergreen. All plots cultivated.
8/ Variety - Long Tendergreen. All plots cultivated.

TABLE 2. EFFECT OF DINITROS ON BEAN EMERGENCE, 1949-1951

Year	Treatment	Per Cent Emergence Normal Seedlings
1949	Check	84
	1.3# DNOSBP1/ /Acre	81
		N.S. at 5%
1950	Check	81.2
	3# DNOSBP2/ /Acre	81.4
	6# DNOSBP2/ /Acre	82.4
		N.S. at 5%
	Check	84.1
	6# DNOSBP2/ /Acre	81.6
	9# DNOSBP2/ /Acre	86.4
		N.S. at 5%
1951	Check	85.3
	3# DNOSBP3/ /Acre	89.8
		N.S. at 5%

1/ Ammonium Dinitro Ortho Secondary Butyl Phenol - Standard Agr. Chem., Inc.

2/ Alkanolamine Salts (of the Ethanol and Isopropanol Series) of Dinitro-O-Sec-Butyl Phenol - Dow Chemical Co.

3/ Triethanolamine and Isopropanolamine Salts of Dinitro Ortho Secondary Butyl Phenol - Standard Agr. Chem., Inc.

TABLE 3. EFFECT OF DINITROS ON WEED CONTROL[7], 1948-1951

Year and Block	Treatment[6]	No. Broad Leaf Weeds Per Sq. Ft.[4]	No. Annual Grass Weeds[5] Per Sq. Ft.
1948 A.	Check - Cultivated	33.3	3.4
	1.3# DNOSBP[1]/Acre	7.9	4.5
1949 A.	Check - Cultivated	13.2	1.9
	1.0# DNOSBP[1]/Acre	4.1	2.3
		Counts made 30 days after treatment	
B.	Check - Cultivated	12.8	1.7
	2# DNOSBP[1]/Acre	8.0	1.0
		Counts made 30 days after treatment	
C.	Check - Cultivated	21.3	2.3
	1.75# DNOSBP[1]/Acre	4.9	1.8
		Counts made 30 days after treatment	
1950	Not cultivated, or hand hoed	29.9	19.2
A.	Check - Cultivated and hand hoed	2.1	2.8
	6# DNOSBP[2]/Acre, 19 June	2.4	16.5
	3# DNOSBP[2]/Acre, 24 June	2.9	7.5
	1# DNOSBP[1]/Acre, 24 June	7.4	13.2
		Counts made 42 days after treatment	
B.	Not cultivated, or hand hoed	26.8	25.8
	Check - Cultivated and hand hoed	4.5	2.5
	3# DNOSBP[2]/Acre	1.5	13.7
		Counts made 50 days after treatment	
C.	Not hand hoed or cultivated	28.9	24.4
	Hand hoed and cultivated	2.0	1.3
	3# DNOSBP[2]/Acre, 16 June	2.2	20.3
	3# DNOSBP[2]/Acre, 20 June	0.9	7.0
D.	Check - Not cultivated or hand hoed	33.9	41.5
	3# DNOSBP[2]/Acre, not cultivated	7.5	2.3
	6# DNOSBP[2]/Acre, not cultivated	2.6	1.0
		Counts made 41 days after treatment	

TABLE 3. EFFECT OF DINITROS ON WEED CONTROL[7], 1948-1951 (Cont.)

Year and Block	Treatment[6]	No. Broad Leaf Weeds Per Sq. Ft.[4]	No. Annual Grass Weeds[5] Per Sq. Ft.
1951 A.	Not cultivated	6.5	17.3
	Check - Cultivated	6.5	11.1
	3# DNOSBP[3]/Acre	2.8	10.0
	6# DNOSBP[3]/Acre	0.8	5.3
		Counts made 35 days after treatment	
B.	Check - Cultivated	10.2	4.1
	3# DNOSBP[3]/Acre	5.6	2.1
	6# DNOSBP[3]/Acre	5.5	0.8
		Counts made 42 days after treatment	
C.	Check - Not cultivated	20.2	9.9
	1# DNOSBP[1]/Acre, not cultivated	1.4	8.8
		Counts made 20 days after treatment	

1/ Ammonium Dinitro Ortho Secondary Butyl Phenol.

2/ Alkanolamine Salts (of the Ethanol and Isopropanol Series) of Dinitro-O-Sec-Butyl Phenol - Dow Chemical Co.

3/ Triethanolamine and Isopropanolamine Salts of Dinitro Ortho Secondary Butyl Phenol - Standard Agr. Chem., Inc.

4/ Principally Lambs-Quarters (*Chenopodium album*) and Red Root Pigweed (*Amaranthus retroflexsus*).

5/ Principally Barnyard Grass (*Echinochloa Crus-galli*).

6/ Unless otherwise stated all chemically treated plots were cultivated following weed counts.

7/ Blocks 1948A, 1949A, 1950A, 1951A were planted to beans, others were adjacent corn blocks.

Chemical Weeding of Cucurbits[1]

by

R. D. Sweet and S. K. Ries

Vine crops such as cucumbers, muskmelons, and squash are a minor group of crops in the northeast from the standpoint of acreage. The problem of controlling weeds, however, is acute due to the growth habit of these crops.

Warren (2) reported that N-1-naphthyl phthalamic acid (PA) was most promising for control of crabgrass in muskmelons. Other than this work, little or no herbicide research has been reported for weed control in vine crops.

The purpose of these studies was to carry further the work of Warren, and to compare N-1-naphthyl phthalamic acid (PA) with a few standard herbicides in regard to vine crop and weed species responses.

Materials and Methods

The eight materials tested and their formulations were as follows:

(1) CMU (3-p-chlorophenyl-1, 1-dimethyl urea) (wettable powder)
(2) DN (alkanolamine salts of dinitro-o-sec-butyl phenol)
(3) E. H. No. 1 (Sodium 2,4-dichlorophenoxyethyl sulphate)
(4) Esso 180 (50-60% aromatic hydrocarbons, boiling range 350-500°F.)
(5) IPC (isopropyl-n-phenyl carbamate) (emulsion)
(6) MCP (2,methyl 4 chloro phenoxyacetic acid)
(7) PA (N-1-naphthyl phthalamic acid) (wettable powder)
(8) TCA (Sodium salt of trichloroacetic acid)

Materials were applied in all tests with the small-plot constant-pressure apparatus described in "Weeds" (1). Details on experimental conditions are set forth in table 1.

Results

A preliminary small-plot field-screening test of June 1951 indicated that, when applied before crop emergence, several herbicides in addition to N-1-naphthyl phthalamic acid showed promise. Using this screening test as a basis, an experiment was designed in which CMU, DN, E. H. 1, PA, and Esso 180 were applied just prior to emergence of Hubbard squash, *Cucurbita maxima* and Table Queen squash, *Cucurbita pepo*. Niagara cucumber, *Cucumis sativus* had just emerged from the ground.

The response of these crops to the chemicals is presented in table 2. The relatively low ratings for cucumbers treated with CMU, DN, and Esso 180 were due to the fact that this crop had emerged at the time of treatment. The data also show that germinating vine crops are sensitive to E. H. 1 but relatively tolerant of high rates of PA.

[1]Much of this work was made possible by a grant from the Standard Oil Development Company, Linden, New Jersey.

Table 1. Summary of Experimental Conditions

Location	Date of Planting	Date of Treatment	Soil Type	Stage of Crop When Treated	Genera and Species of Crop
Snyder No. 1 (Pre-emerg)	June 8	June 12	Dunkirk silty clay loam	Sprouted Not sprouted	*Cucumis sativus* *Cucumis melo*
Snyder No. 2 (Post-emerg)	June 8	July 10	Dunkirk silty clay loam	Pre-vining " "	*Cucumis sativus* *Cucumis melo*
Snyder No. 3	July 10	July 16	Dunkirk silty clay loam	Emerged Sprouted Sprouted	*Cucumis sativus* *Cucurbita maxima* *Cucurbita pepo*
E. Ithaca No. 1 (Pre-emerg)	Aug. 1	Aug. 4	Dunkirk fine sandy loam	Sprouted " " " "	*Cucumis sativus* *Cucumis melo* *Cucurbita maxima* *Cucurbita pepo* *Citrullis vulgaris*
E. Ithaca No. 2 (Post-emerg)	Aug. 1	Aug. 27	Dunkirk fine sandy loam	Pre-vining " " " " " " " "	*Cucumis sativus* *Cucumis melo* *Cucurbita maxima* *Cucurbita pepo* *Citrullis vulgaris*

Table 2. Growth ratings[1] of three vine crops receiving pre-emergence applications of herbicides, Snyder No. 3. (Averages of 6 replications).

Treatment	lbs. per acre	Hubbard	Table Queen	Cucumber	Treatment Mean
CMU	1/4	6.5	5.2	1.7	4.4
CMU	3/4	6.0	2.8	1.0	3.3
DN	2	8.7	8.0	2.0	6.2
E. H. 1	2	4.8	4.0	4.0	4.3
E. H. 1	4	2.7	1.3	1.3	1.8
PA	1/2	8.5	6.8	7.7	7.7
PA	1	5.8	6.8	8.2	6.9
PA	2	6.8	6.8	7.8	7.2
PA	6	8.0	6.5	7.2	7.2
Esso 180	30 gal.	7.5	6.8	3.5	5.9
Check		8.7	8.0	8.7	8.4
Crop mean		6.7	5.7	4.8	

L.S.D. for treatment at 1% level = 3.5
L.S.D. for crop at 1% level = .8

[1]Crop growth rating scale:

9 = comparable to check
5 = severe injury
1 = complete kill

To further explore the response of vine crops to PA three additional experiments were conducted. In one experiment, Niagara cucumbers and Delicious muskmelons were treated with post-emergence sprays of E. H. 1 and PA just prior to vining. Due to an early frost, yield records were obtained for only cucumbers. The results are presented in table 3.

Table 3. Yield of cucumbers receiving post-emergence sprays of E. H. 1 and PA, Snyder No. 2. (Average of 3 replications).

Treatment	Lbs. per acre	oz./plant
Check		42.8
E. H. 1	2	40.8
E. H. 1	4	34.1
PA	2	31.4
PA	4	53.4
L.S.D. at 5%		N.S.

These data give further evidence that PA is not toxic to vine crops. In contrast to the severe crop injury resulting from the soil application of E. H. 1, the foliage spray was not harmful. E. H. 1 did, however, cause typical growth regulator symptoms on both cucumbers and muskmelons.

The other two experiments were designed to determine whether five important species of vine crops, <u>Cucurbita pepo</u>, <u>Cucurbita maxima</u>, <u>Cucumis melo</u>, <u>Cucumis sativus</u>, and <u>Citrullis vulgaris</u> were equally tolerant of both pre- and post-emergence sprays of different herbicides. The responses of these species to the several chemicals applied before emergence are presented in table 4. The herbicides Esso 180, DN, and PA, up to two pounds per acre, were not toxic to any apecie. At the four pound rate, however, PA was somewhat toxic to both squashes.

Table 4. Growth ratings[1] of five vine crops receiving pre-emergence sprays of Esso 180, DN, and PA, East Ithaca No. 1. (Average of four replications).

Treatment	lbs. per acre	Cucumber	Muskmelon	Watermelon	Hubbard	Table Queen	Treatment Mean
PA	1	9.0	9.0	9.0	9.0	8.5	8.9
PA	2	9.0	9.0	8.8	8.8	8.5	8.8
PA	4	8.8	9.0	8.0	6.8	6.5	7.8
DN	2	8.8	9.0	9.0	9.0	8.5	8.8
Esso 180	30 gal.	9.0	9.0	9.0	9.0	9.0	9.0
Check		9.0	9.0	9.0	9.0	9.0	9.0
Crop mean		8.9	9.0	8.8	8.6	8.3	

L.S.D. for treatment at 1% level = .9
L.S.D. for crop at 1% level = .3

[1]Crop growth rating scale:
9 = comparable to check
5 = severe injury
1 = complete kill

The post-emergence application included IPC, TCA, and PA. The results of this test are presented in table 5. It is interesting

Table 5. Growth ratings[1] of vine crop species receiving post-emergence sprays of PA, TCA, and IPC, East Ithaca No. 2. (Average of four replications).

Treatment	lbs. per acre	Cucumber	Muskmelon	Watermelon	Hubbard	Table Queen	Treatment Mean
Check		9.0	9.0	9.0	9.0	9.0	9.0
PA	1	9.0	8.8	8.8	8.5	9.0	8.8
PA	2	8.5	8.5	9.0	7.8	7.5	8.2
PA	4	9.0	9.0	9.0	7.5	7.0	8.3
PA	8	8.2	8.2	8.5	6.8	6.2	7.6
TCA	8	6.8	5.0	6.0	6.2	5.8	6.0
TCA	16	5.0	3.8	5.2	5.5	5.0	4.9
IPC	4	7.8	7.8	8.0	9.0	8.8	8.2
Crop mean		7.9	7.5	7.9	7.5	7.3	

L.S.D. for treatment at 1% level = 3.3
L.S.D. for crop at 1% level = .6

[1]Crop growth rating scale:
9 = comparable to check
5 = severe injury
1 = complete kill

to note that the two somewhat sensitive squash species were almost as tolerant of foliage applications of PA as they were of soil applications. Injury was noticeable at the two pound rate of PA. The other three species, however, tolerated six pounds of PA on the foliage, but showed injury from eight pounds.

TCA was toxic to all five crops. IPC, on the other hand, was somewhat toxic to the three species tolerant of PA but was not harmful to either squash specie.

Weed control ratings for the pre- and post-emergence tests which included the five vine crops are recorded in table 6. The weeds were mostly annual grasses, but also included lambs quarters, Chenopodium album, red root, Amaranthus retroflexus, purslane, Portulaca oleracea, and galinsoga, Galinsoga ciliata. From the table it can be seen that the 2 and 4 pound rates of PA gave excellent commercial control. The relatively low ratings of the aromatic oil and DN were probably due to the fact that weeds had not germinated at the time of treating.

Acceptable control of weeds was obtained from the post-emergence application of all rates of PA and TCA. IPC was ineffective. The latter probably would have given better control if the weeds had not been several inches tall at the time of treating.

Summary and Conclusions

Although contact herbicides such as Esso 180 and DN are good pre-emergence herbicides for vine crops, they are not adaptable to post-emergence application.

Table 6. Weed control ratings[1] for pre- and post-emergence applications of chemicals, East Ithaca 1 and 2. (Average of four replications).

Treatment	Lbs. per acre	Pre-emergence	Post-emergence
Check		1.2	1.5
PA	1	5.8	4.8
PA	2	7.2	5.2
PA	4	8.0	5.0
PA	8	---	6.0
DN	2	4.0	---
Esso 180	30 gal.	2.4	---
TCA	8	---	5.2
TCA	16	---	5.2
IPC	4	---	2.0
L.S.D. at 1%		1.6	2.0

[1]Weed control rating scale:
9 = complete eradication
5 = commercial control
1 = no control

TCA was effective in controlling grasses, but was toxic to the crop species in the experiment. IPC was not particularly toxic to the crops but since only certain weed species are easily controlled by this chemical it is likely to have limited application.

E. H. 1 was not toxic to the vine crops when applied as a foliage spray. When used as a pre-emergence treatment, however, it severely injured all species. This material shows promise providing it can be applied on the foliage before the weeds have become established.

PA (N-1-naphthyl phthalamic acid) at two pounds was effective in controlling weeds whether used as a pre- or post-emergence application. Crop injury from pre-emergence sprays at this rate was negligible on the following species: Hubbard squash, Cucurbita maxima, Table Queen squash, Cucurbita pepo, muskmelon, Cucumis melo, cucumber, Cucumis sativus, and watermelon, Citrullis vulgaris. The squashes were injured by higher rates, but the others tolerated as high as six pounds whether applied as a pre- or a post-emergence spray. From both the weed control and crop tolerance standpoint, PA is a promising herbicide for vine crops.

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PREEMERGENCE WEED CONTROL TREATMENTS ON POTATOES

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All materials were applied in one foot wide bands across the row two days before the tops broke through the ground. Weather and ground was medium moist.

Treatment Number	Material	Amount
1.	Cyanamid	1200 lbs./A.
2.	Cyanamid	800 lbs./A.
3.	CMU,-3-p-chlorophenyl,-1, 1-dimethylurea	1 lb./A.
4.	CMU,-3-p-chlorophenyl-1, 1-dimethylurea	2 lbs./A.
5.	Sodium 2,4-dichlorophenoxy ethyl sulfate water soluble powder, 100% active	5 lbs./A.
6.	Dichloral urea wettable powder, 73% active	5 lbs./A.
7.	Sinox General	2 qts. plus 1 pt./A.
8.	Na trichlor acetate in water	25 lbs./A.
9.	Premerge, 3 lbs. DNOSBP per gal.	2 gal./A.
10.	Check, no treatment	

All plots were cultivated between the rows after the tops were four inches high. Each plot consisted of two, 50 foot rows. Each treatment replicated four times.

Treatment	Bu. per Acre	No. weeds per 4 square feet	
		Dicot.	Mono.
1	206.5	3	2
2	222.5	3	6
3	175.5	4	10
4	251.0	4	5
5	178.0	18	13
6	157.5	13	9
7	220.0	1	3
8	216.0	2	2
9	217.5	0	5
10	156.5	17	31

FURTHER STUDIES CONCERNING CHEMICAL WEED CONTROL AND CULTIVATION WITH POTATOES ON LONG ISLAND

J.Howard Ellison (1)

This paper is a continuation of the report on cultivation and chemical weed control in potatoes, which was given at the 1951 Northeastern Weed Control Conference (Proc. N.E.W.C.C., January, 1951 pp 139-142). The work reported here was carried out much the same as in the previous season, except that some herbicides were changed and irrigation was used differently.

MATERIAL AND METHODS

Katahdin potatoes were planted April 20, 1951 in 34 inch rows and banded with a commercial 7-7-7 fertilizer at the rate of one ton per acre. An experiment was designed in which Crag Herbicide 1 (sodium 2, 4-dichlorophenoxy ethyl sulphate) was applied at the rate of three pounds per acre on May 11, 1951. One third of these plots received no more sprays, whereas one third of them were sprayed again on May 21, and the remaining plots received a third application June 4. The last two sprays were applied post-emergence at the same rate as the first pre-emergence spray. Thus various plots received 3, 6 and 9 pounds of Crag Herbicide 1 per acre. The following chemicals were applied at emergence time (May 14, 1951): Premerge, Sinox General and NP 128 Emulsifiable, each used at the rates of 6, 9 and 12 pounds per acre of active ingredient. All sprays were applied at 33 gallons per acre. One plot per replication was weeded throughout the season by hand hoeing.

On May 11, when Crag Herbicide 1 was first applied, weed and grass seedlings were emerging, and the largest were approximately one-fourth of an inch in height. May 11 was a bright day and the maximum temperature was 67°F. May 14 also was a sunny day, with the same maximum temperature of 67°F.

As in the 1950 setup, there were two similar experiments conducted in 1951. One inch of irrigation was applied to one experiment on May 15, less than 24 hours after the application of Premerge, Sinox General and NP 128, whereas the other experiment was not irrigated at that time. There was no rain within four days after herbicidal treatment. Irrigation was applied equally to both experiments later in the season, namely, one inch of water on July 11, July 19 and August 6, 1951.

In each experiment the herbicidal treatments were used in duplicate series within each replication, so that late cultivation could be used on one series, leaving the other sprayed plots undisturbed. Late cultivation was started June 18 and was handled the same as normal cultivation thereafter. Each experiment consisted of three replications, the plots being four rows 21 feet in length, with the inner two rows used for records. Four normally cultivated rows were grown on either side of each experiment for comparative purposes. Student's "t" test was used to compare normal cultivation with late cultivation and hand hoeing. The crop was harvested and graded September 12 and 13, 1951.

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RESULTS AND DISCUSSION

The two experiments reported here differed only in that one received one inch of simulated "rain" (irrigation) within 24 hours after herbicidal treatment, whereas the other experiment received no irrigation and no rain for four days. Then only 0.06 inches of rain fell on the fifth day. Results from the two experiments will be presented simultaneously, and the various treatments will be evaluated according to their effects on yield of U. S. No. 1 potatoes.

Table 1. Influence of herbicides on the yield of U. S. 1 Katahdin potatoes.

		Irrigated less than 24 hrs. after treatment Bu. per A.	No irrigation nor rain within 4 days. Bu. per A.
Sinox General		253	264
Premerge		218	303
NP 128		201	255
Crag Herbicide 1		186	210
LSD	.05	35	31
	.01	46	42

In the case in which one inch of water was applied soon after treatment, Sinox General was significantly better than Premerge, although the reverse is true where no irrigation or rain fell for four days after treatment (table 1). Both NP 128 and Crag Herbicide 1 were inferior to Sinox General when irrigated within one day of treatment, and NP 128 and Crag Herbicide 1 were inferior to Premerge when no irrigation followed treatment. Potato plants showed slight formative effects when sprayed post-emergence with Crag Herbicide 1. Neither NP 128 nor Crag Herbicide 1 gave as good weed control as Premerge or Sinox General, and the control offered by the latter two herbicides lasted only three to four weeks.

There was no significant difference in yield in either experiment associated with rates of herbicides, nor was the interaction of herbicides and rates significant.

Table 2. Effect of different levels of cultivation and herbicidal treatment on the yield of U. S. 1 Katahdin potatoes.

	Irrigated less than 24 hrs. after treatment Bu. per A.	No irrigation nor rain within 4 days. Bu. per A.
Pre-emergence	170	224
Pre-emergence plus late cultivation	260 *	309 *
Normal cultivation	331 **	359 **
Hand hoeing	282 ***	337 ***

* Greater than pre-emergence at odds of 999:1
** Greater than late cultivation at odds of 999:1
*** Not significantly different from normal cultivation at odds of 19:1

The influence of various levels of cultivation on the yield of potatoes was the same in both experiments (table 2). Pre-emergence plots (mean of all herbicides and rates), which received no cultivation, yielded significantly less than similar plots which received late cultivation. Plots which received normal cultivation throughout the season yielded more than those pre-emergence plots which received late cultivation. No significant difference was found between normal cultivation and hand hoeing. As in the 1950 experiments, the treatments which gave the longest period of weed control also produced the largest yield of potatoes. Weed competition was the limiting factor for crop production in those treatments which failed to control weeds.

SUMMARY

Sinox General, Premerge, NP128 and Crag Herbicide 1 were applied at three rates each as pre-emergence weed control treatments for Katahdin potatoes. Crag Herbicide 1 was used also post-emergence. All treatments were evaluated according to their effect on the yield of U. S. 1 potatoes. When one inch of irrigation was applied within 24 hours of treatment, Premerge reduced yield compared to Sinox General, but where no irrigation nor rain occured for four days, Premerge plots yielded more than those treated with Sinox General. Crag Herbicide 1 and NP 128 were generally inferior to Sinox General and Premerge.

Late cultivation of herbicide treated plots greatly increased the yield, and normal cultivation throughout the season produced larger yields than late cultivation. Hand hoeing was not significantly different from normal cultivation. Treatments affording the longest period of weed control produced the largest yields of potatoes.

EFFECT OF WEEDS, CULTIVATIONS, AND PRE-EMERGENCE HERBICIDES ON POTATO AND CORN YIELDS[1]

Richard J. Aldrich and John C. Campbell[2]

Weimar and Harland in 1924 (8) reviewed the literature on previous research and presented their work conducted in Illinois to support the hypothesis that the primary need of cultivation was to control weeds. Research on the values of cultivation lapsed following this study. With the increased interest in weed control research following the discovery of 2,4-D, the value of cultivation again came under consideration. It would appear that techniques used in the early investigations did not provide a valid test of the benefits of cultivation since the effects of hand-hoeing or scraping used to control weeds in the so-called non-cultivated plots may have been equivalent to a cultivation.

Results from recent investigations have varied from highest crop yields under no cultivation to a straight line increase in yields with increased cultivation. A major difficulty with cultivation experiments has been the problem of isolating the direct effects of cultivation from the indirect effects of weed control obtained with cultivation. Swanson (7) attempted to get around this problem by using 2,4-D pre- and post-emergence to control weeds. Swanson compared corn yields and measurements of soil physical properties from plots: (1) treated with 2,4-D and not cultivated, (2) flamed and cultivated once, and (3) ordinary clean cultivated. Highest yields were obtained on cultivated plots, but the yield data are open to some criticism since it was assumed that 2,4-D had no detrimental effects on corn, but no attempt was made to measure the validity of this assumption. Swanson also observed that grasses were not effectively controlled in the 2,4-D treated plots. Nevertheless, it is indicative that the per cent pore space tended to be higher in cultivated than in 2,4-D plots. Swanson postulates that better aeration in cultivated plots accounted for the higher yield.

In the present investigation the individual effects of cultivations, weeds, and pre-emergence herbicides on potato and corn yields and certain soil properties were studied.

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[1] Cooperative investigations between the Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, and the New Jersey Agricultural Experiment Station.

[2] Agent, Division of Weed Investigations, BPIS&AE, USDA, and Assistant Research Specialist in Plant Pathology, NJAES, respectively.

Materials and Methods

Corn -- In 1950 the following treatments were made in N.J. #7 hybrid corn:

1. Untreated
2. Hand-hoed
3. Cultivated twice
4. 1½ lbs. 2,4-D pre-emergence
5. 1½ lbs. 2,4-D pre-emergence plus hand-hoed
6. 1½ lbs. 2,4-D pre-emergence plus one cultivation (2nd)
7. 1½ lbs. 2,4-D pre-emergence plus two cultivations (1st and 2nd).

The experimental design was a randomized block with four replications. Yields were taken on 2 x 10 hills in each plot. This test was conducted on a Nixon silt loam. Soil moisture tensiometers were placed in plots 1, 5, 6 and 7 of the second replication and soil moisture measured for periods in July and August.

In 1951 the experimental procedure was changed slightly. Weeds were controlled initially in treatments 2 and 5 by covering the small corn plants with paper bags and treating over-all with DNOSBP; weeds were controlled later by applying disodium-3, 6-endoxohexahydropthalate beneath the corn leaves. Treatment 3 was cultivated three times, and treatment 8 was added which consisted of 1½ pounds 2,4-D pre-emergence plus three cultivations. Two tensiometers per plot were placed in plots 1, 5, and 8 in all replications, and one tensiometer per plot was placed in plots 6 and 7 in all replications. Per cent air space and volume weights of samples from 3-6" depth were measured in plots 5, 6, and 8. Leaf samples for chemical analysis were collected September 6.

Potatoes -- The following treatments were made in potatoes of the Green Mountain variety in conjunction with zero, one and five cultivations:

1. Check
2. Chemically weeded by covering with paper bags and treating over-all with DNOSBP
3. Three pounds of sodium 2,4-dichlorophenoxyethyl sulfate per acre pre-emergence
4. Four and one-half pounds DNOSBP per acre pre-emergence.

Plots were four rows wide and 30 feet long; one row 20 feet long was harvested for yield measurements. The experimental design was a randomized split-plot with three replications. This test was conducted on a Nixon silt loam. Per cent air space and volume weights were measured on samples from the 3-6" depth in treatment 2 of each cultivation in all replications.

Results

Corn -- The effects of the various treatments on corn yields, potassium content of leaves, and some soil physical properties are shown in table 1. Soil moisture tensions are presented graphically in figure 1. In comparing yields for the two years it appears that there was a greater necessity for cultivation to obtain maximum yields in 1951 than in 1950. In 1950 the plots treated pre-emergence and hand-hoed yielded as well as plots treated pre-emergence and cultivated twice; in 1951 there was a difference of 31 bushels per acre in favor of the plots cultivated three times. The difference in yields between seasons are probably due to the following: (1) a more serious weed problem in 1951 which was effectively controlled only by pre-emergence 2,4-D and three cultivations; and (2) the elimination of hand-hoeing in 1951, since the effects of the disturbance of the surface layer of soil with hand-hoeing was probably equivalent to that of cultivation. In 1951 the degree of weed control increased with the number of cultivations, but a comparison of yields from chemically weeded, non-cultivated plots and yields from cultivated plots indicate that cultivation had an effect in addition to controlling weeds.

Table 1. The effect of cultivations and pre-emergence 2,4-D on corn yields, potassium content of leaves, and soil air space and volume weight.

Treatment	Bushels of corn per acre 1950	1951	Per cent potassium in leaves 1951*	Per cent soil air space 1951	Soil volume weight 1951
1. Check	28.9	5.7	.36		
2 a. Hand-hoed, 1950	67.9				
b. Chemically weeded, 1951		55.9			
3. Three cultivations	88.8*	67.0			
4. $1\frac{1}{2}$ lbs. 2,4-D	70.6	18.1			
5. $1\frac{1}{2}$ lbs. 2,4-D plus:					
a. Hand-hoed, 1950	89.3				
b. Chemically weeded, 1951		56.8	.79	26.9	1.41
6. $1\frac{1}{2}$ lbs. 2,4-D; one cultivation	87.2	60.6	.59	26.0	1.45
7. $1\frac{1}{2}$ lbs. 2,4-D; two cultivations	90.0	78.2	.82		
8. $1\frac{1}{2}$ lbs. 2,4-D; 3 cultivations, 1951		87.6	.98	26.5	1.45
L.S.D. .05	10.2	20.6			
L.S.D. .01	13.9	28.0			

*Correlation with yields showed $r = .926$; $P = > .05$.

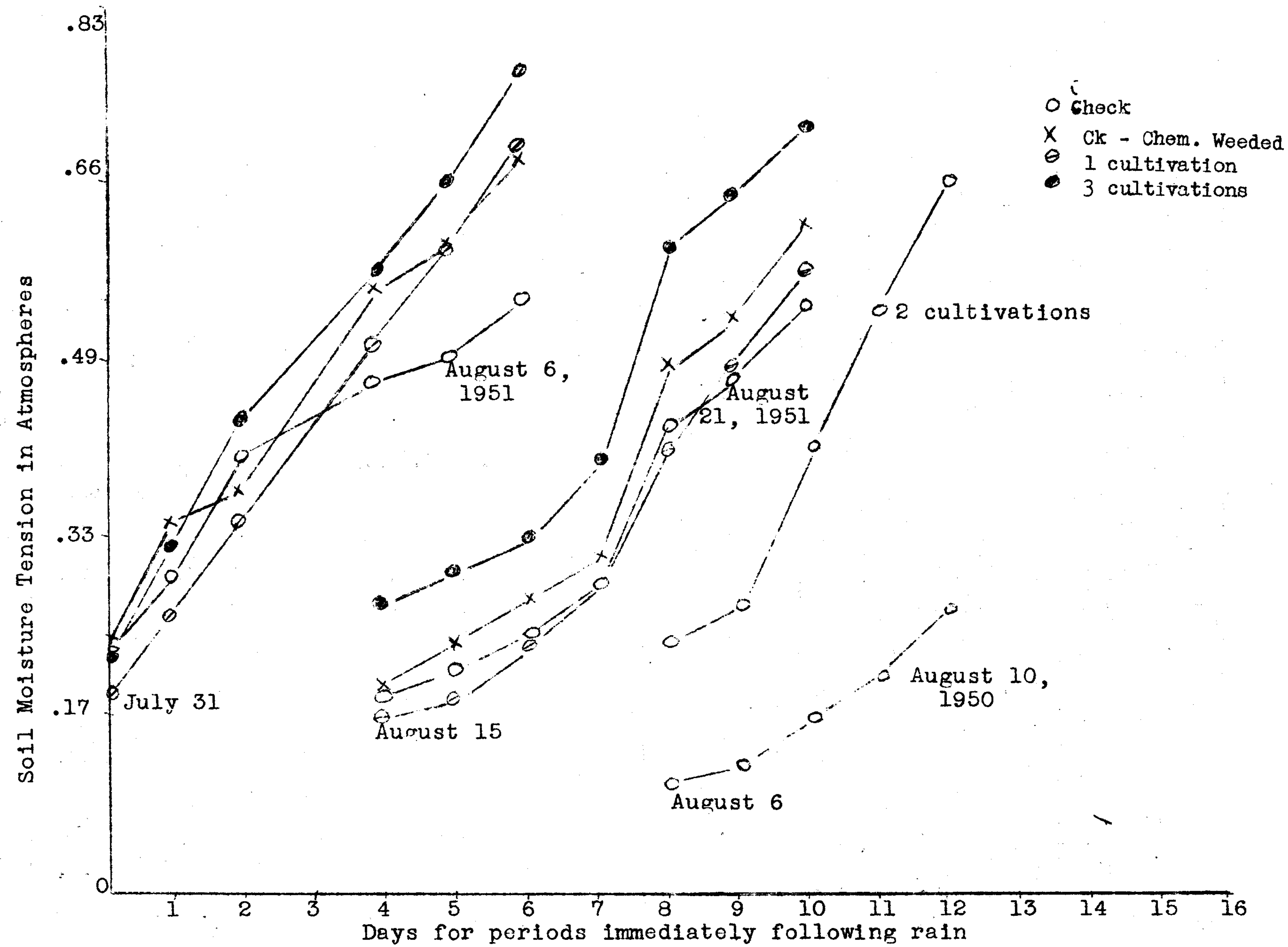

Figure 1. The effects of weeds and cultivations on soil moisture tensions in corn, 1950 and 1951

Examination of the graphs of tensiometer measurements shows that the rate of water loss tended to increase as the number of cultivations increased. For the periods studied in 1950 and 1951 the untreated plots, which were extremely weedy, lost water least rapidly as indicated by soil moisture tensions and presumably had more water available for corn growth. Evaporation would be less from the weedy plots, but it hardly seems possible that a difference in the rate of evaporation could account for the pronounced slower rate of water loss. Although air space was not measured in the non-cultivated check plot, examination of air space measurements, which were highest in the non-cultivated weed-free plot, suggests that air space may have been greater in the non-cultivated check plots than in the other plots. In addition, the abundance of weed roots in the surface soil layer would tend to keep the soil porous. Since water holding capacity is directly related to pore space this may be the reason for more water in the check plots. Regardless of the explanation higher yields from cultivated plots cannot be accounted for on the basis of moisture differences.

Numerous investigators (1, 2, 4, 6) have shown that adequate soil aeration is essential for maximum crop yields. In some instances (7), yields have been positively correlated with air space measurements which are a relative indication of aeration. In the present investigation, however, yields do not appear to be related directly to air space and volume weight. The difference in air space between the non-cultivated plots (#5) and the plots cultivated three times (#8) was not statistically significant. The plots cultivated three times had a higher volume weight than the non-cultivated plots, which suggests a compaction by three cultivations, but the difference was not statistically significant. Nevertheless, yields were highest on the cultivated plots even though the higher volume weight suggests compaction.

A weakness in the use of air space and volume weight measurements as indices of aeration is that neither takes the effect of a "crust" on the soil surface into consideration. A soil might possibly have adequate air space but still be poorly aerated as a result of a crust which restricts the exchange of CO_2 and O_2.

It has been shown (1, 2, 4, 6) that poor aeration tends to inhibit mineral accumulation in plants. Of the elements studied, Lawton (4) found potassium uptake to be restricted most by poor soil aeration.

From table 1 the low potassium content in the leaves from plants in the check plots indicates that weeds markedly reduced potassium content. Since plots receiving treatments number 5 and 8 were both weed-free the increase in potassium content with three cultivations is due entirely to cultivations. The increase in potassium content with cultivation in the order of $3 > 2 > 1$ is probably due partly to weed control and partly to aeration differences. The positive correlation of .926 between corn yields and potassium content of leaves was statistically significant at the 5% level. If in the present investigation potassium content of the corn leaves is an index of soil aeration it would appear that cultivation improved aeration.

Potatoes -- The effects of the various treatments on potato yields, soil air space and volume weight are shown in table 2. The yields from plots chemically weeded indicate clearly the beneficial effects of one cultivation over none and five cultivations. When weeds were completely eliminated by chemicals, one cultivation increased the yield 74 bushels per acre over the uncultivated treatment; five cultivations decreased yields 43 bushels per acre below uncultivated. The higher yields from plots cultivated once cannot be explained by differences in air space or volume weight. As mentioned earlier, air space and volume weight measurements may be inadequate measures of aeration where surface crusting is common. Consequently, yields from non-cultivated plots may have been restricted by poor aeration resulting from crusting, and yields from plots cultivated five times may have been reduced by compaction and pruning of roots. Additional studies are needed on these points. The trend toward decreased air space and increased volume weight with increased cultivations was not statistically significant but the linear relationship between these soil measurements and cultivations accounted for most of the sum of squares in the analysis of variance. There were insufficient replications to provide a strong test of these variables.

The effective weed control obtained with DNOSBP is reflected in the significant yield increase over untreated plots. Considering the average of all cultivations the increase of 12 bushels per acre from plots chemically weeded over plots treated preemergence with DNOSBP was not statistically significant.

Discussion

Economical use of herbicides in row crops requires a reduction in the number of cultivations to as few as are needed for maximum yields. Recent investigations (3, 5, 9) have shown that the number of cultivations can generally be reduced if weeds are controlled with chemicals. On the basis of contemporary investigations, however, it is not possible to make specific recommendations concerning the number of cultivations needed in conjunction with herbicides.

The need for cultivations is associated with soil structure. Generally speaking soils having a good structure require fewer cultivations for maximum production than soils with a poor structure (10). Soil aeration, which is dependent on soil structure, is particularly important in crop production. Poor aeration inhibits water and mineral uptake by roots and may cause the accumulation of CO_2 in amounts toxic to roots.

In the present studies, some cultivation was needed to obtain maximum yields of corn and potatoes. The highest corn yield, obtained with three cultivations, was apparently due to adequate aeration (as suggested by potassium content of leaves) and by weed control since it was found that potassium in the

Table 2. The effects of cultivations and pre-emergence herbicides on potato yields, soil air space and soil volume weight, New Brunswick, N. J. 1951

Treatment	Bushels U.S. No. 1 per acre				Per Cent Soil Air Space*			Soil Volume Weight*		
	No Cult.	One Cult.	Five Cult.	Av. all Cult.	No Cult.	One Cult.	Five Cult.	No Cult.	One Cult.	Five Cult.
1. Check	170.6	177.1	157.7	168.0						
2. Check (chemically weeded)	279.5	353.3	236.8	289.8	22.1	20.6	18.1	1.44	1.45	1.48
3. 3 lbs. EH-1/A Pre-emergence	193.6	265.4	247.2	235.4						
4. 4½ lbs. DNOSBP per acre pre-emergence	237.1	328.7	267.8	277.9						
L.S.D. .05				35.1						
L.S.D. .01				48.1						
Av. all treatments	220.2	281.1	227.4							
L.S.D. between cultivation means at .05 level = 45.8 bushels										

*Differences between cultivations not statistically significant.

leaves was reduced by weeds and also by the lack of cultivation. Maximum corn and potato yields were not associated with the higher soil air space and lower volume weights. It is suggested that poor aeration in the non-cultivated plots more than offset the effect of more total air space in the non-cultivated plots.

Water disappeared least rapidly from weedy check plots in corn and most rapidly from plots cultivated two or three times. Possibly the more porous soil conditions in the weedy plots was more conducive to water penetration. Also, the vigorous, healthy corn in cultivated plots may have removed water faster than the non-vigorous corn and weeds on weedy plots.

Fundamental studies of the effects of cultivations under diverse soil, climatic, and management conditions are needed. Intelligent recommendations concerning cultivations cannot be made without fundamental knowledge of the effects of cultivation. Weed researchers can now control weeds with chemicals making such studies possible.

Summary

The effects of varying numbers of cultivations, pre-emergence herbicides, and weeds on corn and potato yields and on soil properties were studied. One and one-half pounds of 2,4-D per acre effectively controlled weeds in corn when used in conjunction with cultivation. Four and one-half pounds of DNOSBP per acre effectively controlled weeds in potatoes when used in conjunction with one cultivation.

Using potassium content of the corn leaves as a measure of soil aeration, it was found that cultivation improved soil aeration. Yields were positively correlated with potassium content in the leaves. Cultivations did not improve soil air space and volume weights; rather, the reverse trend was observed.

The presence of heavy weed infestations in corn plots reduced the rate of water removal from the soil. Water disappeared most rapidly from plots cultivated three times.

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WEED CONTROL IN CORN USING VARIOUS COMBINATIONS OF CULTIVATION, 2,4-D AND CALCIUM CYANAMID[1]

C. H. Liden[2]

The commonly accepted cultivations for weed control in corn have been supplemented by use of cyanamid and 2,4-D as pre- and post-emergence treatments. Cyanamid has been used for successful pre-emergence treatment of corn (1,3,4,5) for weed control. Other work at this station (2) has indicated value in the use of 2,4-D as a pre-and post-emergence treatment on corn.

The purpose of this study was to determine the relative value of various combination treatments involving the use of chemicals and cultivation for weed control in corn.

Methods and Materials

The experiments were conducted during 1951 at three locations: (1) Agronomy Tobacco Research Farm, Marlboro, on Adelphia sandy loam of low fertility, (2) Clinton, Maryland on Beltsville sandy loam of low fertility, and (3) Gaithersburg, Maryland on Penn silt loam of medium fertility. The latter two experiments were on farms of cooperating farmers. A randomized complete block design with three replications was used with treatment plot size of 14' X 35' (4 rows of 10 hills, $3\frac{1}{2}$' X $3\frac{1}{2}$' spacing and 3 plants per hill). A basic planter application of 250 pounds 3-12-6 fertilizer was made at all locations. All experimental areas were plowed and prepared for planting 1 week to 10 days before actual planting.

Granular cyanamid was applied with a Gandy spreader at rates of 200, 400, and 600 pounds per acre broadcast plus band applications at the 400-pound rate. A 2,4-D formulation of the diethanolamine salt was used at 1 pound per acre pre-emergence and one-half pound per acre post-emergence. The 2,4-D applications were made by means of a special push-type wheel mounted sprayer using compressed air as a source of pressure and fitted with 4 T-jet nozzles. This sprayer was operated at 15 pounds pressure and calibrated to apply 8 gallons of solution per acre. Cyanamid and 2,4-D pre-emergence treatments were made 3-4 days after the corn was planted. All post-emergence treatments were made

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at time intervals based on when the farmer did or could make a first, second and third cultivation. Cultivations were made with a one-half row garden tractor equipped with standard cultivator shovels.

Combination treatments of cyanamid, 2,4-D and cultivations were as follows:

Treatment No.	Treatment
1.	Cyanamid pre-emerg. 3-4 days after planting. 400 lb. broadcast rate/acre - treat 14" band over row plus all cultivations.
2.	Cyanamid pre-emerg. 3-4 days after planting. 200 lb. broadcast 2nd cultivation.
3.	Cyanamid pre-emerg. 3-4 days after planting. 400 lb. broadcast no cultivation.
4.	Cyanamid pre-emerg. 3-4 days after planting. 400 lb. broadcast 2nd cultivation only.
5.	Cyanamid pre-emerg. 3-4 days after planting. 400 lb. broadcast 3 cultivations.
6.	Cyanamid pre-emerg. 3-4 days after planting. 600 lb. broadcast 2nd cultivations.
7.	2,4-D pre-emerg. + 400 lbs/acre cyanamid in bands at 18" growth of corn plus 3 cultivations.
8.	2,4-D pre-emerg. + 2nd. and 3rd. cultivations.
9.	2,4-D pre-emerg. + 2nd cultivation and band application of 2,4-D.
10.	2,4-D pre-emerg. + post-emerg. treatment when corn is 8" tall no cultivation.
11.	Normal cultivation plus 2,4-D treatment at last cultivation--cover 20" band over row.
12.	Normal cultivation - no chemicals.
13.	No cultivation or chemical treatment - check.

Results

Pre-emergence Cyanamid and Cultivation

Initial control of weeds by the various pre-emergence treatments were noted. Cyanamid at the 400-pound rate, both broadcast and band applications, and the 600-pound broadcast rate, gave good initial weed control except for bindweed. The 200-pound rate was ineffective as an acceptable pre-emergence application. In all cyanamid pre-emergence treatment plots, weed seedlings, both grass and broad leaf species, became well established before normal time for a second cultivation. Even though many of these seedlings persisted through cultivation, in only one instance was the yield significantly lower than on plots that received 3 normal cultivations. There appeared to be an interaction between rate of cyanamid applied as pre-emergence and growth of corn and weeds. Weeds were stimulated by all rates of cyanamid; at the 200-pound broadcast rate with one cultivation weeds competed strongly with the corn while at heavier rates with one cultivation weed competition was not so apparent.

At two locations 400 pounds broadcast plus three cultivations resulted in yields significantly higher than for 400-pounds broadcast plus one cultivation. There was no significant difference between 400-pound rate broadcast plus three cultivations and a 400-pound rate applied to an 18-inch band over the row plus three cultivations.

Even though initial weed control was good, where 400 pounds broadcast was not followed by a cultivation (treatment 3) yields were significantly lower than in the normal cultivation treatment (treatment 12) at two locations. On Adelphia silt loam 400 pounds of cyanamid with no cultivation the yield was slightly higher than with normal cultivation. At all locations the final weed populations of treatment 3 were significantly higher than for treatment 12. On lighter soils, 600 pounds of cyanamid produced noticeable injury for the first 3 weeks, thereafter the corn grew normally.

2,4-D and Cultivation

All 2,4-D pre-emergence treatments using 1 pound acid equivalent per acre of a diethanolamine salt gave good weed control except for bindweed. 2,4-D retarded the appearance of weed seedlings for a longer period than did cyanamid treatments. Although weed populations were generally lower for treatment 10, (2,4-D pre-emergence plus 2,4-D post-emergence with no cultivation) it resulted in lower yields than where normal cultivation was practiced. Three cultivations plus a 2,4-D application immediately following the last cultivation (treatment 11) gave higher yields than three cultivations alone. Pre-emergence 2,4-D plus one cultivation immediately followed by a 2,4-D application, (treatment 9) yielded significantly higher than treatment 10 at two locations. Pre-emergence plus two cultivations (treatment 8) produced higher yields than any other 2,4-D plus cultivation treatment as well as higher than treatment 12, three normal cultivations.

2,4-D, Cyanamid, and Cultivation

Pre-emergence 2,4-D with three cultivations plus 400-pound rate of cyanamid per acre on an 18-inch band when the corn was 18 inches tall (treatment 7) resulted in not only good weed control but in higher yields than three cultivations alone. Neither weed control nor yields of treatment 7 were significantly different from treatment 1 which received 400-pound rate of cyanamid pre-emergence over 18 inches of the row plus three cultivations. Yields of treatment 7 were higher than of normal cultivation, at one location there was a significant difference.

From the data it may be shown that only two treatments were significantly poorer than normal cultivation in affecting final weed population. These were pre-emergence 400 pounds of cyanamid with no cultivation (treatment 3) and with one cultivation (treatment 4).

While there was little difference in weed counts for other treatments, size and kind of weeds appeared to be important. Those treatments that received pre-emergence applications with one or no cultivations allowed weeds to become larger than when additional cultivations were made. The dominating species at Clinton was goosegrass while at Marlboro and Gaithersburg ragweed was most abundant. It appeared that grass was more strongly competitive than ragweed during the last half of the growth period of corn and reduced yields to a greater extent.

Table 1. Weed Populations And Yields Per Acre For 13 Treatments At Three Locations

Treatment No.	Pre-emergence	Post-emergence	Gaithersburg Weeds 6sq ft.	Gaithersburg Yld. Bu/A	Clinton Weeds 6sq ft.	Clinton Yld. Bu/A	Marlboro Weeds 6sq ft.	Marlboro Yld. Bu/A	Av. of all locations Weeds	Av. of all locations Yld. Bu/A
12		3C	15	44.5	5	40.8	30	28.0	17	37.7
5	PE 400	3C	18	58.3	6	49.7	21	66.5	15	58.1
8	PE 2,4-D	2C	18	55.0	5	42.8	15	45.3	13	47.7
2	PE 200	1c	24	40.5	27	22.7	40	35.1	30	32.7
4	PE 400	1C	26	52.4	25	33.1	118	50.8	57	45.4
6	PE 600	1C	22	53.8	17	28.0	82	67.2	40	49.6
9	PE 2,4-D	1C 2,4-D Band	22	50.1	18	30.3	87	37.7	42	39.3
1	PE 400 Band	3C	20	52.5	9	53.2	18	63.3	16	56.3
7	PE 2,4-D	3C 400 Band	11	53.8	6	47.5	15	62.5	11	54.6
13			53	6.0	88	1.6	85	5.8	75	4.4
3	PE 400	0C	44	19.1	22	15.8	143	30.1	70	21.6
10	PE 2,4D	P_oE 2,4-D	45	30.9	7	27.7	30	25.3	27	27.9
11		3C 2,4-D	18	51.5	8	35.2	11	34.1	12	40.2
12		3C	15	44.5	6	40.8	30	28.0	17	37.7
13			53	6.0	88	1.6	85	5.8	75	4.4
	$LSD_{.05}$		18	9.8	17	14.4	60	15.8	38	13.6

Discussion

Results at all locations indicate that at least one cultivation was necessary, whether cyanamid or 2,4-D was used as a pre-emergence treatment. On heavy soils or poorly drained soils, additional cultivation seemed to be more important than on lighter well aerated soils. Applications of 200 pounds of cyanamid per acre were not sufficient to give good weed control while the 600-pound rate gives good weed control, but was accompanied by injury to the corn plants on sandy soils. Where cyanamid applications were not followed by one cultivation, weeds soon grow at such a fast rate that they competed very strongly with the corn. In most cases yields were lower than where weeds were controlled with 2,4-D and had no additional nitrogen to stimulate weed growth.

Table 2. Probable Return From Each Treatment With Reference To Return From Three Cultivations.

Treat No.	Av. Yld/A Bu.	Value Corn/A Dollars	Value Over Check	Treat. Cost/A Dollars	Treat. Cost/A Over Check Dollars	Return/A Over Check Dollars
5	58.1	98.77	34.68	22.30	18.40	18.28
8	47.7	81.09	17.00	4.00	.10	16.90
2	32.7	55.59	-8.50	10.65	6.75	-15.25
4	45.4	77.18	13.99	19.65	15.75	-1.76
6	49.6	84.32	20.23	28.45	24.55	-4.32
9	39.3	66.81	2.72	3.30	-.60	3.32
1	56.3	95.71	31.62	11.81	7.91	23.71
7	54.6	92.82	28.73	13.31	9.41	19.32
3	21.6	36.72	-27.37	18.30	14.40	-41.77
10	27.9	47.43	-16.66	2.65	-1.25	-15.41
13	4.4	7.48	-61.61		-3.90	-57.71
11	40.2	68.34	4.25	4.45	.55	3.70
12	37.7	64.09		3.90		
13	4.4	7.48	-61.61		-3.90	-57.71

Comparisons made using Treatment 12, three cultivations as the check.

2,4-D pre-emergence plus two cultivations seemed to be the most efficient treatment involving 2,4-D and cultivation. When cyanamid was used in combination with these as a source of nitrogen and for weed control, yields were increased.

When the value of the crop and cost of each treatment are considered, it is noted that only four treatments returned a cash benefit substantially greater than the return from normal cultivations. These were treatments 1, 5, 7, and 8. Treatments 1 and 5 were 400-pound cyanamid band and broadcast respectively plus three cultivations. 2,4-D pre-emergence plus three cultivations with a 400 pound band application of cyanamid when the corn was 18 inches tall (treatment 7), 2,4-D pre-emergence plus 2 cultivations (treatment 8) gave equal weed control; however, the addition of cyanamid in treatment 7 tended to increase the yield. The return from all other treatments was either equal to or lower than the return per acre of corn receiving normal cultivation only. While weed control is important in the production of the crop, making a profit is equally important to the producer. It is of interest to note that all treatments having good weed control did not yield more return than normal cultivation, due either to lower yield or high cost of the treatment or in some cases both.

Summary and Conclusions

1. Cultivation, cyanamid and 2,4-D were applied singly and in combination to corn at three locations.

2. Yields of No. 2 yellow corn 15.5% moisture were taken and weed counts made on all treatments.

3. The 400-pound rate of cyanamid for pre-emergence with three cultivations seemed to be a sound treatment.

4. Pre-emergence 2,4-D at 1 pound per acre with two cultivations gave good results both in yield of corn and value return for treatment.

5. With pre-emergence treatment studies, cultivation was necessary for good corn yields.

6. In most cases nitrogen from the cyanamid tended to increase yields, but cost of materila may lower the actual return per acre over normal cultivation.

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FOUR YEARS OF WEED CONTROL IN CORN IN WEST VIRGINIA

Collins Veatch[1]

INTRODUCTION

The ideal in weed control in corn, from the standpoint of labor requirements, would be a pre-emergence application at the time of planting which would control most of the weeds for the season without damaging the crop.

Preliminary trials were started in 1949 to study the possibilities of using 2,4-D compounds to control weeds in corn in West Virginia. These trials have later been expanded to include other chemicals for pre-emergence application.

DISCUSSION

1948 (1)

The first year's work was primarily concerned with a comparison of the sodium salt and the isopropyl and butyl esters of 2,4-D when used for pre-emergence or post-emergence application. These trials were conducted at Wardensville on Monongahela fine sandy loam and at Point Pleasant on Wheeling sandy loam soil.

The pre-emergence trials at Point Pleasant were quite satisfactory at rates of 2 pounds of acid equivalent per acre or higher. Good weed control was secured and the corn yields were comparable to the cultivated check plots. However, at Wardensville the plots receiving 3 or 4 pounds of 2,4-D per acre were reduced in stand and weed control was poor. This failure at Wardensville is largely attributed to a rainfall of 1.87 inches in the 12 day period following the 2,4-D application.

Pre-emergence sprays gave better weed control and corn yields in 1948 at Point Pleasant than post-emergence while at Wardensville post-emergence sprays gave better results than pre-emergence.

In all cases where the plots were cultivated after either a pre- or post-emergence spray, the corn production was increased. The different compounds of 2,4-D did not give any significant differences when applied at equivalent rates.

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[1]Associate professor of Agronomy, West Virginia University. Acknowledgement is made to the following for their kindness in supplying the materials used in these trials: American Chemical Paint Co., Dow Chemical Co., Carbide and Carbon Chemicals Co., Shell Oil Co., American Cyanamid Co., and E. I. du Pont de Nemours & Co., Inc.

1949 (2)

The 1949 weed control trials on corn at Point Pleasant and Wardensville again emphasized the relationship between weed control and weather. Pre-emergence sprays were quite successful at Point Pleasant, but at Wardensville post-emergence sprays still gave the best results in weed control and corn yield. Cultivation followed by a late post-emergence spray gave satisfactory results at both locations.

Annual grasses were controlled at both locations by the pre-emergence sprays or by cultivation in the post-emergence sprayed plots.

NITROGEN TOP DRESSING

The advisability of making a nitrogen top dressing on sprayed plots instead of cultivating was suggested by the 1948 results. A top dressing of ammonium sulphate, at the rate of 250 pounds per acre, was made on two complete tiers of plots at Point Pleasant and on two spray treatments at Wardensville. This top dressing of nitrogen was applied during the last week in June at Point Pleasant and on July 8 at Wardensville. As shown in Table 1, this nitrogen top dressing did increase yields, but the greatest increase was shown on the cultivated or post-emergence sprayed plots and not on the pre-emergence plots.

TABLE 1. EFFECT OF NITROGEN TOP DRESSING ON YIELD*

Treatment	Top Dressed	Not Top Dressed	Increase
Wardensville (average of 8 plots)			
	Bu. per Acre	Bu. per Acre	Bu. per Acre
No Cultivation or Spray	-----	51.08	-----
Hoed	-----	71.31	-----
Late Pre-emergence 3 lb.	50.85	44.04	6.81
Post-emergence 1/2 lb.	69.86	56.78	13.08
Significant Difference	-----	13.00	-----
Point Pleasant (average of 4 plots)			
No Cultivation or Spray	29.90	21.45	8.45
Hoed	96.42	90.50	5.92
Late Pre-emergence 3 lb.	86.94	84.89	2.05
Post-emergence 1/2 lb.	47.49	30.54	16.95
3 Cultivations	100.61	83.84	16.77
Significant Difference	17.44	12.30	-----

*Nitrogen applied at rate of 250 lbs. ammonium sulphate per acre.

1950

In 1950 several other compounds were included in the pre-emergence tests. Some of them proved quite satisfactory under the favorable weather conditions at Point Pleasant and Reedsville. None of the treatments gave satisfactory weed control at Wardensville. There were a good many weeds even in the hoed and cultivated plots at harvest time. This can be attributed primarily to the abnormally heavy rainfall in that area in 1950. At Point Pleasant and Reedsville the plot areas were relatively free from weeds as indicated by the high yields secured on the control plots which were not touched after planting.

TABLE 2

1950
Summary of
Weed Control in Corn

Treatment	Rate/A.	Height of corn when applied	Location of Trial: Point Pleasant Yield*	Reedsville Yield*	Wardensville* Yield*
Pre-emergence					
2,4-D amine	1 lb.		97.1	83.0	38.1
2,4-D amine	2 lbs.		98.4	90.0	51.7
Dow Premerge	1.5 lbs.		86.6	87.2	32.7
Dow Premerge	3 lbs.		88.8	87.0	32.0
Aero Cyanamide	400 lbs.		90.5	62.7	58.3
Aero Cyanamide	600 lbs.		81.2	75.8	41.5
Aero Cyanate	16 lbs.		82.1	74.4	25.8
Shell #130	6 - 8 gals.		100.4	89.4	44.5
Crag Herbicide #1	2.5 lbs.		96.7	67.3	38.8
Check or Control Plots					
No weed control			82.8	79.0	22.2
Hoed			105.0	95.0	93.4
Cultivated			103.6	83.3	100.1
Post-emergence					
2,4-D amine	¼ lb.	(3"-6")	93.3	97.6	15.9
2,4-D amine	½ lb.	(3"-6")	91.7	85.5	10.5
2,4-D amine	¼ lb.	(12"-18")	83.8	88.8	17.1
2,4-D amine	½ lb.	(12"-18")	74.5	87.4	17.4
Harrow 2,4-D	¼ lb.	(12"-18")	104.7	83.3	39.2
Harrow 2,4-D	½ lb.	(12"-18")	104.5	82.0	60.3
L.S.D. (.05)			20.3	19.6	28.5

* Yields in bu. per acre of shelled corn at 15.5% moisture. Each yield is an average of 8 plots.

* At Wardensville the whole area was sprayed on June 27, with 2,4-D at the rate of 1 lb. acid equivalent per acre.

As indicated by the corn yields in Table 2, 2,4-D and Shell #130 gave the best results as pre-emergence treatments. In the post-emergence treatments 2,4-D gave the best results when applied to corn when about 18 inches high which had been harrowed or cultivated with a weeder while under 6 inches in height.

1951

Weed control plots in corn were again established in 1951 at Point Pleasant, Reedsville, and Wardensville. However, due to excessive rains and a spotty but persistent infestation of nut grass on the area at Wardensville these plots were never harvested.

Several modifications were made in this year's trials. The hoed and untreated controls were eliminated; the only check being the cultivated plots. Some new chemicals were included in the pre-emergence treatments. Most of the plots were given some cultivations, as indicated in Table 3, in combination with the chemical spray.

Many of the pre-emergence treatments gave good weed control and were as high in yield as the cultivated plots at both locations. It is interesting to note that 2 pounds of C. M. U. reduced the stand of the corn at Point Pleasant but did not do so at Reedsville. In several cases better results were secured with pre-emergence treatments at Reedsville, when comparative corn yields are considered, than at Point Pleasant. This can be attributed at least partly to the heavier type soil (Monongahela silt loam) at Reedsville.

The post-emergence treatments in combination with cultivation all gave better corn yields than the cultivated check plots.

TABLE 3

1951
Summary of
Control of Weeds in Corn

Treatment	Rate/A.	Cultivation	Location of Trial: Point Pleasant Yield Bu./A.	Reedsville Yield Bu./A.
Pre-emergence				
2,4-D amine	1.5 lbs.	None	70.45	62.58
2,4-D amine	3 lbs.	None		70.85
2,4-D amine	1.5 lbs.	*P.E. .5 lb.	81.84	75.26
2,4-D amine	1.5 lbs.	Cultivated	73.98	85.70
C. M. U.	1 lb.	Cultivated	73.00	
C. M. U.	2 lbs.	Cultivated	37.70	74.20
Aero Cyanamide	600 lbs.	Cultivated	74.30	92.60
Aero Cyanate	16 lbs.	Cultivated	61.12	87.58
Weedone L.V.-4	1.5 lbs.	Cultivated	80.10	90.70

TABLE 3, continued.

Treatment	Rate/A.	Cultivation	Point Pleasant Yield Bu./A.	Reedsville Yield Bu./A.
Pre-emergence				
Crag Herbicide #1	1 lb.	Cultivated	79.43	
Crag Herbicide #1	2 lbs.	Cultivated	74.21	86.90
Exper. Herbicide #2-73	1 lb.	Cultivated	83.09	
Exper. Herbicide #2-73	2 lbs.	Cultivated		84.31
Premerge	1.5 lbs.	Cultivated	71.70	93.56
Premerge	1.5 lbs.	*P.E. .5 lb.	74.06	60.10
Check or Control		3 Cultivations	75.46	75.26
Post-emergence				
2,4-D amine	.5 lb.	Cultivated	87.52	91.80
2,4-D amine	.5 lb.	1 cult.-.5 lb. late spray	87.53	89.20
2,4-D amine	1 lb.	Cultivated		85.10
Weedone L.V.-4	.5 lb.	Cultivated	79.26	88.40
Harrow or Weeder	.5 lb.(2,4-D)	Cultivated	84.11	93.05
L.S.D. (.05)			11.36	16.94

* Post-emergence application; no cultivation.

SUMMARY

Pre-emergence

Pre-emergence sprays with 2,4-D have been quite successful in controlling weeds and contributing to satisfactory yields at Point Pleasant and Reedsville. At Wardensville heavy rains shortly after pre-emergence applications have interfered and prevented successful trials.

Other compounds that look encouraging for pre-emergence application on corn to control weeds are Shell #130, Crag Herbicide #1, Premerge, and possibly C. M. U., although these will all require further testing.

Post-emergence

Post-emergence applications of 2,4-D to corn will control most broad leaved weeds but should be combined with cultivation.

Under favorable conditions annual grasses can be controlled by a pre-emergence spray of 2,4-D or by cultivation.

Cultivation

Cultivation has generally proven beneficial in combination with chemical weed control even though it may not be necessary for weed control.

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WEED CONTROL IN SOYBEANS AND CORN

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Pennsylvania State College

The two center rows of a commercial field of Hawkeye soybeans which had been planted with a four row planter on May 24 were treated with a 4 nozzle experimental sprayer on May 24 and 25. The experiment was set up with 3 replications using split block design.

Monocots, dicot and soybean counts were made on treated and adjacent untreated rows three weeks after planting. The weed population was very scattered but the results on the soybean counts given in Table 1 are very interesting.

The MCP and weedar 64 was very hard on the soybean stand. Weedone 48 did not injure the stand as bad as LV4. Craig injured the stand somewhat. The Di-Nitros, CMU, Chloro IPC and IPC did not injure the stand. The calcium TCA plants continued to die for about 6 weeks, and the plants that did not die were badly stunted all year.

Corn planted and treated on May 26, with 3 treat- of 2, 4-D, Craig, Cyanamid, Di-Mitro and CMU were not injured by any treatment.

Seventeen varieties of sweet corn and two field corns planted in early June, and treated with 1 and 2 pounds of an ester of 2, 4-D the day of planting, were stunted by the pre-emergence treatment.

Post emergence treatments of 1/4 and 1/2 pound of 2 4-D ester applied when the corn was about 6-8 inches and when 12-16 inches caused no apparent injury to any variety of sweet corn or field corn.

Several tests of contact herbicides, IPC and Chloro IPC were applied to annual grasses in corn while cultivating with the spray being applied behind the cultivator. The results were rather poor.

Late in the season when the corn was tall it was decided to try spraying before the cultivator rather than after the cultivator. The results were much better and look encouraging. By spraying before throwing soil on the grass there is a much better chance of good coverage of the grass weeds.

Table 1.--Number of Soybean Plants per 24 Feet of Row (2 Row Plots--3 Replications).

Material	Rate per Acre	Number of Plants Treated	Number of Plants Not Treated
Weedone 48	1 pounds	53	52
	2	54	48
	3	41	58
LV4	1 pounds	39	51
	2	23	58
	3	19	45
ACP 648	1 pounds	46	49
	2	32	51
	3	26	54
ACP L162	1 pounds	49	57
	2	50	56
	3	33	56
Weedar 64	1 pounds	43	51
	2	28	47
	3	22	44
MCP	1 pounds	41	60
	2	14	48
	3	39	47
Craig	2 pounds	42	52
	4	23	60
	6	19	55
Cyanamid	80 pounds N	48	49
	120	49	37
	160	37	49
Sinox PE	1 gallons	54	52
	2	56	56
	3	42	42
Premerge	1 gallons	57	55
	2	45	52
	3	43	49
Calcium TCA	5 pounds	40	41
	10	55	63
	15	47	56
CMU	.5 pounds	49	55
	1	37	39
	2	53	59
IPC	2 pounds	49	51
	4	56	52
	6	55	51
Chloro IPC	2 pounds	66	58
	4	51	49
	6	59	48
Check	1 Series	56	45
	2	51	51
	3	59	59

PRELIMINARY RESULTS WITH HERBICIDES OTHER THAN 2,4-D FOR WEED AND GRASS CONTROL IN FIELD CORN

By: Ernest R. Marshall [1]

As 2,4-D becomes more widely and intensively used for pre and post-emergence weed control in corn, grass control becomes a more important problem. Another ever present problem is that of 2,4-D injury to the corn. This injury may be the result of environmental conditions, misuse of 2,4-D, susceptible corn varieties or other causes. In any case, a safer pre and post emergence material for use on corn would be welcomed, particularly if it would help to control grasses. During the 1951 season several experiments were conducted which were designed to test new materials and combinations of materials as pre and post-emergence herbicides for field corn. Grass control and reduction of injury to the corn were the two principal objects of these tests.

The first test compared the effectiveness of the water soluble dinitro material Sinox PE (containing 3 pounds DN/ gallon), both alone and in combination with 2,4-D with 2,4-D alone. A triethanolamine salt formulation of 2,4-D was used.

The first test was conducted at Ithaca, New York. All treatments containing Sinox PE were applied with a jeep sprayer in 30 gallons of water per acre. 2,4-D treatments were applied in 12 gallons of water per acre. The plots were four rows wide and 50 feet long. All plots receiving Sinox PE treatments were sprayed on June 2, 1951 when the corn had just started to emerge. The straight 2,4-D treatments were applied on June 4, 1951 when the corn was in a tight roll. There were five replicates. Weed counts were taken on June 28, 1951. Counts are from four one foot square areas randomized in each plot. A randomized block design was used. Data and treatments are shown in Table 1.

An examination of the data in Table 1 shows that at the rates used, straight 2,4-D gave better weed control than Sinox PE alone or in combination with 2,4-D. No injury was noticed to the corn from any of the treatments. Principal weeds present were: ragweed, redroot, smartweed, wild lettuce, thistle, plantain, mustard and purslane.

A second experiment was set up to compare the effectiveness of several newer herbicides as pre-emergence and emergence weed control materials for field corn.

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Table 1. WEED COUNTS IN FIELD CORN FOUR WEEKS AFTER EMERGENCE APPLICATIONS OF HERBICIDES WERE MADE

Material	Weeds and grass 4 sq. ft.
Sinox PE 1 pt/A (3/8 lb DN)	21
Sinox PE 1 qt/A (1/4 lb DN)	22
Sinox PE 3 pt/A (1-1/8 lb DN)	17
Sinox PE 2 qt/A (1½ lb DN)	9
2,4-D 3/4 lb/A	3
2,4-D 1 lb/A	4
2,4-D 1½ lb/A	2
2,4-D 2 lb/A	1
Sinox PE ½ pt (3/16 lb DN) + ½ lb 2,4-D/A	19
Sinox PE ½ pt (3/16 lb DN) + 3/4 lb 2,4-D/A	11
Sinox PE 1 pt (3/8 lb DN) + ½ lb,2,4-D/A	11
Sinox PE 1 pt (3/8 lb DN) + 3/4 lb. 2,4-D/A	7
Check	48
L.S.D. .05	18
L.S.D. .01	24

The second test was on the Charles Rooke farm at Alloway, New York. The materials were applied with a jeep sprayer using 35 gallons of spray per acre. Plots were four rows wide and 50 feet long. The plots were sprayed on June 3, 1951. There were three replicates. The corn was just emerging and weeds were about 1/4 inch tall. Principal weeds were mustard, ragweed, lambsquarter and annual grasses. Data were taken on June 21, July 26 and August 9, 1951.

Treatment and data are shown in Table 2. Weed counts were for 4 one square foot areas in different sections of the plot. Injury observations taken on August 9th were designated as injury due to either weed competition or true chemical injury.

-3-

Table 2. RESULTS OF EMERGENCE WEED CONTROL APPLICATIONS OF SEVERAL NEW HERBICIDES TO FUNK HYBRID CORN

Treatment	Weed control rating* June 21	Corn Injury June 21	Weed counts 4 sq.ft. July 2	Weed counts 4 sq.ft. July 26	Weed control observation Aug. 9	Corn Injury Aug. 9
CMU ½ lb/A	6	0	26	92	poor	normal
CMU 1 lb/A	9	1	9	21	good	normal
CMU 2 lb/A	9	2	4	11	good	normal
CMU 3 lb/A	10	4	15	13	excellent	stunted (injury)
E.H.#1 1 lb/A	4	0	69	100	poor	stunted (weeds)
E.H.#1 2 lb/A	5	0	62	123	poor	stunted (weeds)
E.H.#1 3 lb/A	9	1	13	32	fair	normal
E.H.#1 4 lb/A	10	2	9	36	good	stunted (injury)
Endothal 2½ lb/A	5	0	95	126	poor	stunted (weeds)
Endothal 5 lb/A	4	0	93	126	poor	stunted (weeds)
Endothal 7½ lb/A	9	0	15	41	fair	normal
Niagarathal W 2½ lb/A	6	0	61	144	poor	stunted (weeds)
Niagarathal W 5 lt/A	8	0	24	53	fair	normal
Niagarathal W 7½ lb/A	8	0	16	38	fair	normal
Niagarathal W 10 lb/A	9	1	6	22	good	stunted (injury)
Check	0	0	170	179	poor	stunted (weeds)
L.S.D. .05	2		58	69		
L.S.D. .01	3		77	92		

*Rating 0 - no control, no corn injury
10 - perfect control, very severe injury

Para-chlorophenyl-1, 1 dimethylurea (CMU) proved to be the most promising new herbicide of those tested. CMU gave very good control at rates above 1/2 pound per acre. Eighteen days after application a slight injury was noticed on the corn at the 1, 2 and 3 pound rates, but at later dates this injury appeared only on the plots receiving 3 pounds CMU per acre. By August 9th the 1 and 2 pound CMU plots were the best appearing plots in the test. There were few weeds in the plots, the corn was dark green and appeared to be in better condition than the corn in plots which received any other treatment.

2,4-dichlorophenoxyethyl sulfate (E.H.#1) did not give adequate weed control at rates which did not produce injury. The 3 pound per acre rate looked good on August 9th. Injury persisted in the 4 pound rate throughout the entire season.

3,6-endoxohexahydrophthalate (endothal) did not give adequate weed control at rates up to 10 pounds per acre. Injury to the corn was noticed in the plots which received 10 pounds per acre.

Slightly better weed control was obtained with Niagarathal W (38% endothal) than with the straight material.

Quackgrass is a serious problem in New York State. A test was conducted to determine the effect of several herbicides and combinations of herbicides on quackgrass growing in corn. These herbicides were applied to single row plots 100 feet long when the corn was between knee and hip high. The quackgrass was 8 to 10 inches high. This test was conducted on the Charles Updike farm at Waterburg, New York. Quackgrass was the principal problem although broadleaves such as ragweed, smartweed, lambsquarter and thistle were also present. The treatments were applied on July 9th with a knapsack sprayer. All treatments were applied at the rate of 35 gallons of spray per acre. There were four replicates. Treatments and data taken on August 9th are shown in Table 3.

Table 3. QUACKGRASS CONTROL IN FIELD CORN WITH SEVERAL HERBICIDES ONE MONTH AFTER TREATMENTS WERE APPLIED

Treatment	Per cent control Broadleaves	Per cent control Grass	Corn Injury*
Phthalamic acid 5 lb/A	56	14	0
Phthalamic acid 10 lb/A	41	25	0
Endothal 5 lb/A	74	56	.5
Endothal 10 lb/A	94	55	1.5
Endothal (formulated) 5 lb/A	100	91	.5
Endothal (formulated) 10 lb/A	100	95	2.0
IPC 5 lb/A	8	18	.5
IPC 10 lb/A	38	45	1.5
Phthalamic acid 5 lb + 2,4-D ½ lb/A	85	20	0
Endothal 5 lb. + 2,4-D ½ lb/A	95	51	2.0
IPC 5 lb + 2,4-D ½ lb/A	88	18	0
2,4-D ½ lb/A	52	20	0
Chloro IPC 5 lb/A	40	40	4.0
Check	0	0	0
L.S.D. .05	26	23	1.5
L.S.D. .01	35	31	2.0

* 0 - no injury
10 - very severe injury

Phthalamic acid gave poor control of both broadleaves and quackgrass when used alone or in combination with 2,4-D.

Endothal was the most promising material tested. Endothal which had been specially formulated gave very good broadleaf and quackgrass control with very little injury to the corn at 5 pounds per acre. This same formulation at 10 pounds per acre gave almost perfect weed and quackgrass control but there was some corn injury. This injury was a burning of the lower leaves of the plant. The formulated material was definitely better than the straight technical endothal or endothal plus 2,4-D when used at the same rates of endothal per acre.

Emulsifiable IPC did not give weed or quackgrass control at 5 and 10 pounds per acre alone or when combined with 2,4-D.

Chloro IPC at 5 pounds per acre was very injurious to the corn and gave little control of weeds and quackgrass.

SUMMARY

A water soluble dinitro (Sinox PE) did not give as good weed control either alone or in combination with an amine salt of 2,4-D as did the 2,4-D alone.

No injury was noticed on corn when 2 pounds per acre of the triethanolamine salt of 2,4-D was applied at emergence. 2 quarts of Sinox PE (1½ pound DN) did not injure emerging corn.

CMU at 1 and 2 pounds per acre was the most promising material for emergence applications to field corn. Higher rates gave injury.

Endothal and E.H.#1 applied at emergence did not give adequate weed control at rates which would not injure corn.

Endothal at 5 pounds per acre gave very good control of weeds and quackgrass when applied post-emergence to corn 2 - 3 feet high. Endothal at 10 pounds per acre gave excellent control of weeds and quackgrass but injured the corn slightly.

Emulsifiable IPC and chloro IPC did not give good weed or quackgrass control and at the rates used injured the corn.

CONCLUSION

CMU should be tested more thoroughly as a pre-emergence or at emergence herbicide on corn.

Good control of quackgrass and broadleaved weeds in corn can be obtained by a post-emergence application of 5 - 10 pounds of endothal (formulated) if applied when the corn is 2 to 3 feet in height.

PRELIMINARY TRIALS WITH SOME NEW MATERIALS AS SELECTIVE HERBICIDES IN FIELD BEANS

By: Ernest R. Marshall[1]

A large acreage of dry field beans in some years as many as 150,000 acres, is grown in New York State. Excessive weed growth often hinders and may prevent harvesting of this crop. Chemical weed control is gaining favor with bean growers in the northeast. At the present time the water-soluble dinitros are being used quite extensively. A large scale test was set up to screen some of the newer herbicides for selective weed control in field beans.

Pre-emergence herbicide sprays were applied to a field of Red Kidney beans on June 21, 1951, two days after the beans had been planted. Treatments were made with a jeep sprayer which sprayed four rows at a time. All materials were applied in 30 gallons of water per acre. The plots were 50 feet long and 12 feet wide with three replicates in a randomized block design.

Data were taken one month after the materials were applied. These data are shown in Table 1. Weed counts were made from a 10 foot strip 32 inches wide of the center row of beans in each plot.

Para-chlorophenyl-1, 1-dimethylureau (CMU) gave very good weed and annual grass control at 1 pound and 2 pounds per acre. There was early injury on the plants in the plots which received 2 pounds of CMU per acre. This injury appeared as a yellowing of the leaves with some marginal necrosis. This injury later disappeared and two months after application no injurious effects could be noticed.

3,6-endoxohexahydrophthalate (endothal) gave rather poor weed control at all rates used. This was true with both the formulated technical material and the Niagarathal W containing 38% technical endothal with ammonium sulphate as an activator. The 7½ and 10 pound rates of endothal gave moderate to severe injury to the beans. This injury persisted throughout the season. It appeared as a yellowing and stunting of the bean foliage.

Sodium isopropyl xanthate (NIX) gave no weed control at 5 and 10 pounds per acre. There was no bean injury observed from the use of this material.

Emulsifiable isopropyl phenyl carbamate (IPC) gave poor weed control at 4 pounds per acre but when 2 pounds of emulsifiable IPC was combined with 1 pound of MCP very good weed control was obtained. Injury was noted from the IPC at 4 pounds per acre. This injury was principally a stunting effect. Injury occurred with the combination

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Table 1. WEED STAND IN RED KIDNEY BEANS ONE MONTH AFTER PRE-EMERGENCE HERBICIDES WERE APPLIED

Treatment	Counts per 27 sq.ft. Weeds	Grass	Weeds and grass	Bean injury
CMU 1 lb/A	8	1	9	none
CMU 2 lb/A	3	0	3	moderate
Tech.endothal (formulated) 5 lb/A	32	1	33	none
Tech.endothal (formulated) 7½ lb/A	55	1	56	slight
Tech.endothal (formulated) 10 lb/A	28	1	29	moderate
Niagarathal W 5 lb/A (active)	31	2	33	slight
Niagarathal W 7½ lb/A (active)	76	3	79	moderate
Niagarathal W 10 lb/A (active)	34	2	36	severe
NIX 5 lb/A	71	6	77	none
NIX 10 lb/A	119	3	122	none
Oktone 2 qts + 1 gal aromatic 180/A + emulsifier	80	4	84	none
Oktone 4 qts + 1 gal aromatic 180/A + emulsifier	42	1	43	none
IPC 4 lb/A	45	14	59	moderate
IPC 2 lb/A + MCP 1 lb/A	5	0	5	severe
LV-4 1/2 lb/A	14	1	15	slight
LV-4 1 lb/A	35	1	36	moderate
MCP 60% 1 lb/A	13	0	13	none
MCP 60% 1½ lb/A	7	0	7	slight
MCP 90% 1½ lb/A	21	1	22	slight
Agroxone 1½ lb/A	8	3	11	moderate
ACP 904 1½ lb/A	9	2	11	moderate
Check	99	5	104	
L.S.D. .05	42	6	41	
L.S.D. .01	55	8	54	

of IPC and MCP. This injury was a stunting of the bean plants accompanied by some leaf epinasty. This injury did not persist and later in the season was not evident.

Oktone in aromatic 180 gave poor weed control at 2 and 4 quart rates. There was no visible bean injury.

The butoxy ethanol ester of 2,4-D (LV-4) gave fair weed control at 1/2 and 1 pound per acre but also gave typical 2,4-D injury to the bean plants. This injury did not persist throughout the season but was evident on the first two sets of trifoliate leaves produced.

2, methyl 4-chlorophenoxyacetic acid (MCP) gave good weed control at both 1 and 1½ pounds per acre. Some injury was noticed from the 1½ pound rate of MCP. This was more noticeable with the 90% MCP, ACP-904 and Agroxone (90% MCP) than with the 60% MCP material. The 1 pound rate of MCP (60%) gave very good weed control with no injury to the bean seedlings.

Summary

Pre-emergence weed control chemicals were applied to Red Kidney beans two days after planting. Weed counts were taken one month later.

Endothal at 5, 7½, and 10 pounds per acre; NIX at 5 and 10 pounds per acre; Oktone at 2 and 4 quarts per acre and IPC at 4 pounds per acre gave poor weed control.

CMU at 1 and 2 pounds per acre; IPC at 2 pounds per acre plus MCP at 1 pound per acre and MCP at 1 and 1½ pounds per acre gave good weed control.

CMU at 2 pounds per acre; endothal at 7½ and 10 pounds per acre; IPC at 4 pounds per acre; IPC at 2 pounds plus MCP at 1 pound per acre; and MCP at 1½ pounds per acre (60%, 90%, Agroxone, ACP-904) all gave some injury to the bean plants.

No injury was noticed with CMU at 1 pound per acre; endothal at 5 pounds per acre, NIX at 5 and 10 pounds per acre; Oktone at 2 and 4 quarts per acre and MCP at 1 pound per acre.

Conclusions

Further tests should be conducted with CMU at rates up to 2 pounds per acre for pre-emergence weed control in beans. MCP should also be tested at rates up to 1½ pounds per acre. Both of these materials gave good weed control at 1 pound per acre with no visible injury to the bean seedlings or plants.

PRELIMINARY REPORT ON WEED CONTROL IN SMALL GRAINS WHERE LEGUMES ARE SEEDED USING MCP AND DINITROS

Stanford N. Fertig[1]

During the past 4 - 5 years, 2,4-D has been used for weed control in small grains both where legumes were and were not seeded, even though legumes were highly susceptible to injury. Since a high proportion of the spring planted small grain acreage in New York State is seeded to legume-grass mixtures, 2,4-D has been recommended with caution. Treatment applied when weeds were most susceptible hit the legume when small and also most susceptible.

The use of 2,4-D has been less dangerous when treatment was delayed until sufficient growth of weeds and small grain had taken place to act as a canopy and prevent the spray from coming in contact with the legume. Even then results have not been consistent due to variation in amount of canopy present.

Other chemicals, including MCP and dinitro formulations have resulted in less injury on legumes seeded in small grain than 2,4-D and at the same time giving satisfactory weed control.

Purpose of Experiment

To compare the effectiveness of 2,4-D, MCP and dinitro formulations for weed control in small grains where legumes were seeded. To study the most effective concentration of chemical and volume of water to use and their effect on weed growth, small grain and legume when applied at different growth stages.

The experiment will be discussed under 2 headings: I. Use of Selective Dinitros, and II. Use of MCP and 2,4-D.

I. Use of Dinitros

Materials and Method

Two separate experiments were undertaken using different dinitro formulations. These will be referred to as A and B. In experiment A, plots 12 feet wide and 50 feet long were used. A 10-foot alleyway was left between plots and an 8-foot alleyway between replicates. The components of the forage seeding were alfalfa, red clover, ladino and timothy with oats as the companion crop.

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The experiment was a randomized block with 5 replications of each treatment. Two dates of applications were made, with respect to the growth of the small grain (1) when the oat plants were 3-5 inches tall, and (2) when the oat plants were 7-10 inches tall. The dates of treatment were May 26 and June 18. Treatments were applied with a jeep mounted low pressure sprayer.

Chemicals, concentration and volume of water per acre were: Sinox P.E. and Dow Premerge at 1, 1½ and 2 quarts per acre applied in 33 gallons of water. Dow Selective and Sinox-W at 5, 6, and 7 pints per acre in 33 and 66 gallons of water.

Predominate weeds included ragweed (Ambrosia artemisiifolia), mustard (Brassica spp.), lamb's-quarters (Chenopodium album), smartweed (Polygonum spp.), nut grass (Cyperus esculentus) and yellow rocket (Barbarea vulgaris).

Results were based on (a) stand counts of weeds before and after treatment in each plot and (b) discoloration ratinga on the small grain at 2, 7 and 16 days after treatment. Five stand counts were made in each plot before and 24 days after treatment using an 18-inch square quadrat.

Results of Dinitro Treatments

No difference was obtained from injury ratings or by stand counts (Tables I and II) between equal amounts of the different formulations. Six pints of Sinox-W was just as effective as 6-pints of Dow Selective. Differences were obtained, however, between Sinox P. E. and Sinox-W or between Dow Premerge and Dow Selective applied at the same concentration of active material per acre. The material containing the higher concentration of active ingredient per gallon (i.e. Dow Premerge or Sinox P.E.) gave better weed control with less injury to the small grain than Sinox-W or Dow Selective, (Table II).

The volume of water per acre was extremely important using either Sinox-W or Dow Selective. As the amount was reduced from 66 to 33 gallons, there was a marked increase in the degree of leaf burning on the oat plants and legume. The increased injury to the legume was not as marked as on the small grain. Where Dow Premerge or Sinox P. E. was used, there was no difference between the different gallonages either on per cent weed control as determined by stand counts or the degree of injury to the legume or small grain based on injury ratings.

One quart per acre of Dow Premerge or Sinox P.E. gave satisfactory control of ragweed, mustard, lamb's-quarters and yellow rocket. One and one-half and 2 wuarts did not cause excessive burning of the small grain nor did they result in any injury to the legume. One and one-half quarts produced less burning than 7 pints of Sinox-W or Dow Selective when both were

Table I. Discoloration Ratings* 2, 7 and 16 days after treatment with dinitro formulations applied in 33 gallons of water

	2 days	7 days	16 days
Sinox-W			
5 pints	4	2	0
6 pints	5	2+	1-
7 pints	8	5	2
Dow Selective			
5 pints	4	2	1-
6 pints	6	3	1
7 pints	7	4	2+
Dow Premerge			
1 quart	2+	1	0
1½ quarts	5+	3	1
2 quarts	7+	4	2
Sinox P. E.			
1 quart	2	1+	0
1½ quarts	4+	3	1+
2 quarts	7++	4+	2

* The injury rating scale was arbitrarily chosen from 0 - 8. Zero indicating no injury while 8 was most severe. The most severe injury in the field was taken and all other plots compared to it. The plus and minus signs were added or subtracted as fractions of .2.

applied in 33 gallons of water per acre, Table I. This difference was much less when the Sinox-W and Dow Selective were applied in 66 gallons of water per acre.

Table II. Stand Counts of Predominate Weed Species before and 18 days after treatment using dinitro formulations in 33 gallons of water per acre

Chemical	Conc./Acre	Predominate Weeds Present when Treated						
		Ragweed		Lamb's-quarters		Mustard		Average per cent control
		Before treatment	18 days after	Before treatment	18 days after	Before treatment	18 days after	
Dow Selective	5 pints	864	378	432	216	1134	432	57%
	6 pints	756	270	378	108	1242	270	72%
	7 pints	540	108	594	216	1350	216	76
Sinox-W	5 pints	1134	540	756	324	864	270	60%
	6 pints	864	270	594	216	1296	378	67
	7 pints	324	108	540	162	1620	162	74
Sinox P.E.	1 quart	702	162	162	54	1404	270	72
	$1\frac{1}{2}$ quarts	756	108	378	108	1134	54	84
	2 quarts	432	54	864	216	756	54	83
Dow Premerge	1 quart	594	162	540	162	1080	162	76
	$1\frac{1}{2}$ quarts	378	108	702	108	1026	108	78
	2 quarts	756	108	432	108	1350	54	87

B. Field Trials

In addition to the experiments above these formulations were used on a field basis. Four separate fields were treated, totaling 63 acres. Treatments were made as follows:

Field I - 15 acres. One-third treated with Sinox P.E. at 1 quart, one-third with Sinox P.E. at $1\frac{1}{2}$ quarts and one-third with Dow Selective at 6 pints. All were in 33 gallons of water per acre.

Field II - 20 acres. One-fourth treated with Dow Premerge at 1 quart, one-fourth with Dow Premerge at $1\frac{1}{2}$ quarts, one-fourth with Sinox P.E. at 1 quart. All treatments applied in 66 gallons of water.

Field III - 12 acres. One-half treated with Sinox P.E. at 1 quart per acre and one-half treated with Dow Selective at 6 pints, both in 66 gallons of water.

Field IV - 16 acres. One-third treated with Dow Premerge at $1\frac{1}{2}$ quarts per acre, one-third with Sinox P.E. at $1\frac{1}{2}$ quarts per acre, one-third with Sinox-W at 7 pints per acre. All treatments in 33 gallons of water per acre.

Weed species present included ragweed (Ambrosia artemisiifolia), lamb's-quarters (Chenopodium album), pigweed (Amaranthus retroflexus), Smartweed (Polygonum spp.). In addition, field I had a good stand of volunteer buckwheat (Fagopyrum esculentum) 3 - 8 inches tall.

All fields were seeded to a mixture of alfalfa, red clover, ladino and timothy, except field II which was seeded to strips of 5 different strains of English red clover and 2 strains of birdsfoot trefoil.

Results

The results agreed favorably with the plot work. Satisfactory weed control was obtained on all fields, with Sinox P.E. and Dow Premerge being superior to Sinox-W or Dow Selective. There was no observable injury to the legumes in any treatments.

Volunteer buckwheat was controlled more satisfactorily using the materials having the higher concentration of active ingredients per gallon.

II. MCP and 2,4-D Experiments

Procedure and Materials

Plots 12 feet wide and 50 feet long were staked out in spring-seeded oats. A 10-foot alleyway was left between plots and an 8-foot alleyway between replicates. The components of the forage seeding were alfalfa, red clover, ladino and timothy.

The experiment was a randomized block with 5 replications. Two dates of treatment were made, based on the growth stage of mustard (Brassica sp.) (1) when mustard was in the early bud stage, and (2) when mustard was in the early to full bloom stage.

Three materials were used in the experiments: MCP 60 per cent, MCP 90 per cent, and 2,4-D amine at 1/16, 1/8, 1/4, 1/2 and 3/4 pound acid equivalent per acre. All treatments were applied in 7 gallons of water per acre.

Predominate weed species included ragweed (Ambrosia artemisiifolia), lamb's-quarters (Chenopodium album), smartweed (Polygonum spp.), mustard (Brassica sp.) wild buckwheat (Polygonum Convolvulus) seedling yellow rocket plants (Barbarea vulgaris) and sow thistle (Sonchus oleraceus).

Effectiveness of the materials was based on (1) stand counts of weeds taken before and 24 days after treatment in each plot, and (2) visual injury to legumes. Five stand counts were made at random in each plot before treatment. This area was marked and counts made 24 days after treatment.

Results

Results from stand counts and observations of plots showed MCP to be slower acting than 2,4-D amine.

The two lowest concentrations (1/16 and 1/8) pound per acre of all 3 materials was not effective in preventing total seed formation of any weeds present. However, the 1/8 pound per acre of 2,4-D and MCP prevented normal development of mustard and lamb's-quarters plants and markedly reduced the amount of seed pods formed.

Concentrations of 1/4 pound per acre or higher gave satisfactory control of mustard, lamb's-quarters and seedling yellow rocket plants, Table III. 2,4-D, amine at 1/4 pound of higher gave good control of ragweed. Ragweed appeared much more resistant to MCP than 2,4-D. Smartweed, wild buckwheat and sow thistle were not satisfactorily controlled by concentrations tolerant to the legume present.

A higher percentage of weed control was obtained if treatments were applied when the mustard was in the bud stage. The full bloom stage of treatment using up to 1/2 pound of any of the materials did not prevent mustard seed formation, although it was reduced.

Observations on the legume showed red clover and ladino to be most tolerant to treatment, with alfalfa being extremely susceptible, 2,4-D produced the greatest amount of injury, with 1/4 pound per acre killing seedling plants of all legumes. The MCP materials exhibited a lower degree of phytotoxic activity particularly on red clover and ladino. Epinastic responses of the legume were also much less where MCP was used.

The percentage control values in Table III for MCP 60 per cent at 1/8, 1/4 and 1/2 pound per acre were; mustard 52, 88 and 92; lamb's-quarters 22, 66, and 80 and ragweed 13, 20 and 46. The corresponding values using 2,4-D amine were mustard 59, 91, 95; lamb's-quarters 36, 83, 92 and ragweed 54, 78 and 86. MCP 90 per cent showed mustard 46, 81, and 88; lamb's-quarters 21, 63 and 77 and ragweed 10, 18 and 43.

Conclusions

Sinox P.E. or Dow Premerge can be satisfactorily used in place of Sinox-W or Dow Selective at equivalent concentrations for weed control in small grains where legumes are seeded.

Dow Premerge or Sinox P.E. applied in 30-35 gallons of water per acre will result in less burning of the small grain than Dow Selective or Sinox-W in 33 or 66 gallons, when applied at equivalent or even higher concentrations. Legumes are not injured.

Although, the dinitro materials are not as easy to handle, require more liquid per acre, may result in varying degrees of burning to the small grain and do not give as effective weed control on any species as 2,4-D or even MCP they are definitely less injurious to legumes. If applied when weeds are small and in sufficient liquid to give good coverage, satisfactory control of the most serious weeds in small grains, that can be controlled using 2,4-D or MCP, will be obtained.

Using sufficient liquid to give uniform coverage of weeds present is one of the most important consideration in treatment.

From epinastic and phytotoxic responses exhibited by the weeds and legume, MCP was slower in action and definitely less injurious to legumes than 2,4-D. 2,4-D resulted in a higher percentage weed control than MCP but also injured the legume more severely.

Although MCP was not effective in preventing all seed formation of mustard at the stages treated and there was some injury to legumes, it would appear that MCP could be used where red clover or ladino is seeded without permanent injury or reduction in stand.

Where 2,4-D or MCP is used for weed control in small grains where legumes are seeded, a canopy of weeds and crop plants to protect the seeding appears desirable. However, the stage of growth at time of treatment appeared to influence the degree of injury. Red clover and ladino plants 3 - 5 inches tall recovered on those plots where 3/4 pound per acre was used. Smaller plants up to 3 inches tall were killed by 1/4 pound.

In these experiments, MCP 60 per cent (based on 2 methyl 4 chloro) gave better weed control with less injury to the legume than the 90 per cent product.

Table III. Stand Counts[1] of Predominate Weed Species before and 24 days after treatment with MCP 60 per cent material. Mustard plants in bud stage

Common Name	Average # plants per plot before treatment[1]	Concentration of MCP used in pounds active ingredient per acre of 2 methyl 4 chloro					
		1/8		1/4		1/2	
		# plants per plot[1]	% control	# plants per plot[1]	% control	# plants per plot[1]	% control
Mustard	1342	648	52	162	88	108	92
Lamb's-quarters	486	378	22	162	66	108	80
Ragweed	810	702	12	648	20	32	46

[1] Number of plants shown is the average number of weeds per plot projected from 5 - 18 inch square quadrat counts in each of 5 replications.

FURTHER COMPARISON OF MCP AND 2,4-D AS SELECTIVE HERBICIDES FOR USE ON SMALL GRAINS SEEDED WITH MIXED LEGUMES

By: John VanGeluwe[1] and Ernest R. Marshall[2]

The work reported in this paper follows work originated by Tafuro, Flagg and VanGeluwe (1951.) Their work indicated that mixed legumes seeded in small grains were more tolerant to MCP (2 methyl 4 chlorophenoxyacetic acid) than they were to 2,4-D (2,4 dichlorophenoxyacetic acid.) They also showed that low gallonage application (5 - 6 gallons per acre) was desirable when spraying seeded grains.

In order to compare these materials further two tests were conducted in New York State. One test was on the Harold Cowles farm in Chautauqua County, New York, and the other on the Fred Riley farm in Cortland County, New York. Treatments were applied with a jeep sprayer in six gallons of water per acre and 40 pounds pressure. Plots were so laid out that the three replicates were in strips with a guard strip between each strip replicate.

Materials used were a triethanolamine salt formulation of 2,4-D; an amine salt formulation of MCP containing 60% 2 methyl 4 chlorophenoxyacetic acid and and MCP formulation containing 90% 2 methyl 4 chlorophenoxyacetic acid.

The first test at the Harold Cowles farm was applied on June 14, 1951. The treated plots were 40 feet long and 16 feet wide. The test had three replicates in strips so that a 10 foot guard strip could be left between the strip replicates to avoid drift. Treatments were applied when the mustard was in full bloom, at this time the legumes were 2 - 3 inches tall and the grain was 10 - 12 inches tall. The legumes present were Ladino and Red clover.

When the treatments were applied on June 14th, counts were taken of the number of legume seedings in two areas four square feet in size in two different locations in each plot. These same areas were recounted on July 24th, or 40 days later.

Treatments and results from the test at the Cowles' farm are shown in Tables 1 and 2.

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Table 1. EFFECT OF MCP AND 2,4-D SPRAYS ON STAND OF RED AND LADINO SEEDLINGS IN GRAIN

Treatment	Clover plants/8 sq.ft.		Per cent change
	June 14	July 24	June 14-July 24
MCP (60%) 1/4 lb/A	124	52	-58
MCP (60%) 1/8 lb/A	116	79	-32
MCP (60%) 1/16 lb/A	103	90	-13
2,4-D 1/4 lb/A	135	44	-67
2,4-D 1/8 lb/A	143	77	-46
2,4-D 1/16 lb/A	127	90	-29
MCP (90%) 1/8 lb/A	132	76	-42
Check	119	61	-49
L.S.D. .05			17
.01			24

Table 2. PER CENT REDUCTION IN CLOVER STAND FROM THREE RATES OF MCP AND 2,4-D

Rate	Per cent reduction in stand 6/14 to 7/24		Mean of rate
	MCP	2,4-D	
1/4 pound	-58	-67	-63
1/8 pound	-32	-46	-39
1/16 pound	-13	-29	-21
Mean of material	-34	-48	
L.S.D.	.05	.01	
Rate	11	15	
Material	9	12	
Material X Rate	15	21	

Table 1 shows that there were significant differences between treatments. The check plots had a considerable reduction in clover stand. This was probably due in part to competition from mustard and other weeds. Observations showed that mustard control was good with the 1/4 and 1/8 pound rate of both materials but not too good with the 1/16 pound rates. Table 1 also shows the 60% MCP to be somewhat easier on the legume stand than the 90% MCP.

Table 2 shows that MCP is definitely easier on Red and Ladino clover than is 2,4-D. The rate is an important factor in reducing stand. The relationship is almost linear with little difference directly attributable to the treatment X rate interaction.

The plot at the Fred Riley farm in Cortland County, New York was applied on June 19, 1951. The plots were 100 feet long and replicated in strips with 20 foot guard strips between each replicate. The alfalfa was 2 - 3 inches high when the Red and Ladino clovers were 5 - 6 inches tall, and the grain was 10 - 12 inches tall. Mustard was in full bloom. Legumes present were Red and Ladino clover and alfalfa. Counts were made of mustard, clover and alfalfa stands on June 19th and again on July 20th in the same marked areas. These data are shown in Tables 3 to 6.

Table 3. CHANGE IN MUSTARD, CLOVER AND ALFALFA STANDS AFTER MCP AND 2,4-D SPRAYS

Treatment	Stand Counts* June 19th			Stand Counts* July 20th			Per cent change June 19-July 20		
	M	C	A	M	C	A	M	C	A
MCP 60% 1/4 lb/A	52	96	50	8	115	29	-86	+19	-42
MCP 60% 1/8 lb/A	45	84	42	8	127	32	-83	+51	-24
MCP 60% 1/16 lb/A	53	94	46	8	105	34	-85	+12	-19
2,4-D 1/4 lb/A	43	94	46	3	97	25	-94	+3	-46
2,4-D 1/8 lb/A	34	109	54	7	111	39	-76	+ 3	-28
2,4-D 1/16 lb/A	59	92	53	20	115	43	-65	+25	-19
MCP 90% 1/8 lb/A	68	109	55	14	100	33	-80	-8	-39
Check	50	104	46	16	122	32	-67	+17	-31
L.S.D. .05							14	47	27
L.S.D. .01							20	64	37

* M - mustard C - clover A - alfalfa

It can be seen by examining Table 3 that most treatments gave good mustard control. The 1/8 and 1/16 pound rates of 2,4-D however, were no better than the check treatment. MCP at 1/8 and 1/16 pound per acre gave better mustard control than 2,4-D at the same rates. Only one treatment, the 1/8 pound MCP (90%) reduced the stand of clover (-8%). Clover stand increased 51% in the 1/8 pound MCP (60%) plot. This difference is indeed rather striking. The cause of this difference is not known but it may be due to differences in the MCP formulations. Alfalfa stands were reduced by all treatments but the 1/8 pound MCP (60%) and the 1/8 pound 2,4-D were both less injurious to the alfalfa than was the 1/8 pound MCP (90%). The 1/8 and 1/16 pound rates of MCP (60%) and 2,4-D did not reduce alfalfa stands below that which occurred normally in the check plot.

Table 4. REDUCTION IN MUSTARD PLANTS BY APPLICATIONS OF MCP AND 2,4-D AT THREE RATES

Rates	Per cent reduction in mustard 6/19 - 7/20		Mean of rate
	MCP (60%)	2,4-D	
1/4 pound	-86	-94	-90
1/8 pound	-83	-76	-80
1/16 pound	-85	-65	-75
Mean of material	-85	-78	
L.S.D.	.05	.01	
Rate	10	14	
Material	9	12	
Material X Rate	15	20	

MCP gave an overall higher per cent reduction of mustard than 2,4-D. The per cent reduction was directly proportional to the rate, as the rate was decreased the reduction of mustard decreased. There was no difference in mustard control between the three rates of MCP.

Table 5. EFFECT OF THREE RATES OF MCP AND 2,4-D ON CLOVER STAND

Rate per acre	Per cent increase in clover stand June 19 - July 20th		Mean of rate
	MCP (60%)	2,4-D	
1/4 pound	+19	+3	+11
1/8 pound	+51	+3	+27
1/16 pound	+12	+25	+19
Mean of material	+27	+10	
L.S.D.	.05	.01	
Rate	38	52	
Material	32	44	
Material x rate	54	73	

There was no significant differences in the effect of material or rate on the stand of clover. Plots treated with 2,4-D did, however, show less of an increase in clover stand.

Table 6. EFFECT OF THREE RATES OF MCP AND 2,4-D ON STAND OF ALFALFA

Rate	Per cent decrease in alfalfa stand June 19 - July 20th		Mean of rate
	MCP (60%)	2,4-D	
1/4 pound	-42	-46	-44
1/8 pound	-24	-28	-26
1/16 pound	-19	-19	-19
Mean of material	-28	-31	
L.S.D.	.05	.01	
Rate	16	22	
Material	13	17	
Material x rate	22	30	

There were no significant differences in alfalfa stand between materials and the material x rate interation. There was no significant overall difference between the two materials on alfalfa although the 2,4-D was slightly more injurious.

SUMMARY

1) Replicated plots of legumes growing in a grain nurse crop were sprayed with an amine salt of 2,4-D and MCP at 1/4, 1/8 and 1/16 pound per acre when the legume seedlings were 2-3 inches in height and the grains were 10-12 inches high.
2) Red and Ladino clover were shown to be injured less by MCP than by 2,4-D.
3) Injury to legumes increased as the rate per acre applied increased.
4) MCP containing 60% 2 methyl 4 chlorophenoxyacetic acid appeared to be safer to use than MCP containing 90% 2 methyl 4 chlorophenoxyacetic acid.
5) Good mustard control was obtained by rates down to 1/8 pound active ingredient per acre.
6) Alfalfa was injured more by MCP and 2,4-D than was clover, although 1/8 pound MCP or 2,4-D did not reduce the alfalfa stand below that which occurred in the check plots.
7) 2,4-D appeared to be slightly more injurious to alfalfa seedlings than was MCP.

Literature Cited

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HERBICIDES FOR THE CONTROL OF WILD GARLIC IN BARLEY

Richard S. Lindsey[1]

Much of the small grain acreage in Delaware and elsewhere is infested with wild garlic, Allium vineale. The aerial bulblets produced by the garlic are harvested with the grain and considerably reduce the value of the grain for feed or seed. The bulblets, being nearly the same shape and size as the seed of the small grain, are difficult to remove in the cleaning process. When garlic infested grain is ground and fed to dairy animals a garlic flavor is imparted to the milk. The flour from wheat containing garlic bulblets has a distasteful flavor and odor.

The recent use of herbicides in controlling wild garlic, particularly the use of 2, 4-D ester formulations, have opened the possibility of eradicating this noxious weed in small grain crops, or at least it might prevent the production of the aerial bulblets by the wild garlic.

This study was conducted to determine the action of several ester formulations of 2, 4-D, as well as the action of other herbicides, on wild garlic present in a small grain planting (barley).

Materials and Methods

The experiment was conducted near Newark, Delaware, in a field of Wong winter barley heavily infested with wild garlic. The soil was Elkton silt loam. Most of the treatments were applied when the barley was 6 to 8 inches high. Two early treatments of ethyl ester were applied when the barley was 3 to 4 inches high.

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Twenty-three different treatments were used which included three rates of application of five formulations of 2, 4-D, two rates of application of CMU, Dow Selective, Dow Selective plus the ethyl ester of 2, 4-D (all applied on March 28, 1951) and two rates of application of the ethyl ester of 2, 4-D applied earlier, on March 8, 1951. A no-treatment plot was included for comparison. Each treatment was replicated four times. The plots were 12 feet square.

A small tank-type sprayer with a two-foot boom equipped with two Spraying Systems, No. 8001 nozzles, located at each end was used in applying the treatments. The pressure used in spraying was 40 pounds per square inch.

The treatments were as follows:

2, 4-D[1]

1. Butoxy ethanol ester -- 1/2, 3/4 and 1 pound per acre in 10 gallons of water
2. Pentasyl ester -- 1/2, 3/4 and 1 pound per acre in 10 gallons of water
3. Ethyl ester -- 1/2, 3/4 and 1 pound per acre in 10 gallons of water
4. Ethyl ester (early) -- 3/4 and 1 pound per acre in 10 gallons of water
5. Emulsifiable 2, 4-D acid -- 1/2, 3/4 and 1 pound per acre in 10 gallons of water
6. Acetanalide -- 1/2, 3/4 and 1 pound per acre in 10 gallons of No. 2 fuel oil

Other

7. CMU -- 1 and 2 pounds per acre in 10 gallons of water
8. Dow Selective -- 1 and 2 pounds DNOBP per acre in 40 gallons of water
9. 1 pound DNOBP (Dow Selective) plus 1/2 pound of ethyl ester of 2, 4-D per acre in 10 gallons of water
10. 1 pound DNOBP (Dow Selective) plus 1/2 pound of ethyl ester of 2, 4-D per acre in 40 gallons of water

[1]All 2, 4-D materials were furnished by the American Chemical Paint Company.

The rate of aoplication of 2, 4-D is given in terms of 2, 4-D acid equivalent. Those plots receiving 10 gallons of water or oil were covered once. Those receiving 40 gallons of water were covered four times.

Readings of garlic kill were taken at two and four weeks after the application of treatments in three 2-foot square subolots taken at random in each main plot. Counts were taken of killed garlic olants and of living garlic olants. The treatments were rated as oercent killed garlic olants of total number of garlic olants. The damage to the barley was based upon the estimation of degree of epinasty, necrosis and stunting of the barley plants. Head counts of garlic were taken from each whole main olot on May 30, 1951, just prior to harvesting the barley.

Exoerimental Results

In Table I are reoorted the kill of garlic, garlic head counts, and injury to the barley.

All treatments were instrumental in reducing the garlic population and the oroduction of the garlic aerial bulblets over the no treatment blocks.

The damage to the barley by the later treatments (March 28) was similar for all the 2, 4-D materials. The acetanalide was more injurious, apparently because of the effect of its diluent, fuel oil. CMU and Dow Selective were very damaging to the barley and were very poor in their control of the garlic compared to the 2, 4-D.

Least damaging to the barley and very effective in controlling garlic were the 1 oound application of the Ethyl ester aoplied early and the 1/2 and 3/4 pound aoplications of the Pentasyl and Ethyl esters (later treatments). The most effective control with little injury to the barley was obtained from the use of the 3/4 oound application of Pentasyl ester.

Summary

Twenty-three treatments of wild garlic were made in a winter barley planting in the spring of 1951. The treatments involved five formulations of 2, 4-D at three different rates, two rates of application of CMU, Dow Selective and a combination of Dow Selective and the Ethyl ester of 2, 4-D. These treatments were applied on March 28. Also included were two applications of different rates of Ethyl ester applied while the barley was yet dormant on March 8.

The Pentasyl ester of 2, 4-D applied at the rate of 3/4 pound of 2, 4-D acid equivalent gave the most effective control of the garlic and exhibited the least damage to the barley.

Also very effective in controlling the formation of the garlic aerial bulblets and in effecting only slight damage in the barley plants were the 1/2 pound application of the Pentasyl ester, the 1/2 and 3/4 pound applications of Ethyl ester, applied on March 28, and the early application of 1 pound of Ethyl ester.

CMU and Dow Selective were most injurious to the barley and exhibited little control over the garlic.

Acknowledgment

The author is indebted to Professor C. E. Phillips, Head of the Agronomy Department, University of Delaware, for his assistance in planning and analyzing this experiment.

Table 1. Kill of garlic plants, counts of garlic heads, and damage to barley as a result of applying various herbicides to a garlic-infested field of barley.

Treatment	Lbs. per acre	Diluent, gallons per acre	Garlic Kill, %	Garlic Heads/ plot	Barley % Damage
2, 4-D[1]					
1. Butoxy ethanol ester	1/2	10 H_2O	75.6	3.00	3.8
2. " "	3/4	"	84.6	2.25	6.3
3. " "	1	"	94.2	1.00	6.3
4. Pentasyl ester	1/2	10 H_2O	80.1	1.25	3.8
5. " "	3/4	"	94.2	0.75	0.0
6. " "	1	"	100.0	0.00	8.3
7. Ethyl ester	1/2	10 H_2O	92.2	1.50	2.5
8. " "	3/4	"	93.3	1.25	3.8
9. " "	1	"	99.0	0.25	10.0
10. Ethyl ester (applied early)	3/4	10 H_2O	66.4	3.00	5.0
11. " "	1	"	77.7	1.50	1.3
12. Emulsifiable acid	1/2	10 H_2O	88.0	1.75	3.8
13. " "	3/4	"	93.2	1.00	8.8
14. " "	1	"	97.7	0.50	15.0
15. Acetanalide	1/2	10 #2 oil	75.8	2.00	7.5
16. "	3/4	"	97.3	0.50	10.0
17. "	1	"	97.3	0.75	11.3
Other					
18. CMU[2]	1	10 H_2O	53.3	7.00	18.8
19. "	2	"	53.3	8.00	36.3
20. Dow Selective[3]	1	40 H_2O	48.6	7.25	13.8
21. " "	2	"	68.9	4.50	17.5
22. Dow Selective[3] + Ethyl ester	1 + 1/2	10 H_2O	95.7	1.75	26.3
23. " "	1 + 1/2	40 H_2O	97.7	2.00	25.0
24. No Treatment	---	---	---	16.50	---
L.S.D. .05			13.94	4.21	10.38
.01			18.48	5.44	15.08

[1]Pounds of Acid Equivalent
[2]Pounds of Actual Material
[3]Pounds of DNOBP

Reference Material

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CONTROL OF CHICKWEED IN ALFALFA

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An alfalfa stand heavily infested with Chickweed (Stellaria Media) was treated on February 28, 1951 with 10, 20 and 30 pounds of sodium chlorate 1, 2, and 3 gallons of Sinox PE, 4, 8 and 12 pounds of IPC, 2, 4 and 6 pounds of Chloro IPC and 5, 10 and 15 pounds of sodium TCA per acre.

The applications were made in water using a four nozzle fan boom with 35 pounds pressure. One pint of solution was applied to each plot which was 6 x 20 feet. A two foot border was left between each randomized plot. The Chickweed was very uniform with a mat about 3½ to 4 inches thick.

On March 27 IPC and Sinox were applied at the same rates, the heavy rate of sodium chlorate was changed to 5 pounds per acre and Chloro IPC was doubled because the first application did not look like it was going to kill the Chickweed. The sodium TCA was not used because it had shown no control of the Chickweed and had injured the alfalfa. On April 18 the two lower rates of the above treatment were applied. At this time the alfalfa and Chickweed had started its spring growth.

The Chloro IPC at the lower rates was outstanding apparently it did not injure the alfalfa and did an excellent job of killing the Chickweed. It reacted very slowly requiring about six weeks to kill the Chickweed.

The sodium chlorate at the lower rates looks promising. The 20 and 30 pound rates injured the alfalfa severely.

The Sinox quickly killed the top 1 to 3 inches of the mat of Chickweed, but the under-portion continued to grow. This indicates di-nitro would be effective on thin mats of Chickweed or would require a second application.

IPC at twice the quantity was not as effective as Chloro IPC. The Sodium TCA at 15 pounds per acre showed no evidence of Chickweed control but injured the alfalfa.

In February when the chemical treatments were applied, the author observed that Chickweed had been killed in foot steps where a man had walked across the alfalfa field earlier in the winter, so a series of rolling treatments were tested. Chickweed can be killed by rolling on cold mornings after warm periods. Plants can "harden off" by gradual cooling, so rolling will not injure them. The alfalfa may also be injured by the rolling.

Table 1.--Percentage Kill of Chickweed (<u>Stellaria Media</u>) and Height of Alfalfa on May 9, 1951, Average of 3 Replications, Lancaster County, Pennsylvania.

Material	Rate per Acre	Percentage Kill	Height in Inches
	Treated February 28, 1951		
Sodium chlorate	10 pounds	80.0	15.6
	20	96.7	11.3
	30	99.7	7.3
Sinox PE	1 gallons	0.7	16.6
	2	3.4	17.0
	3	3.4	16.3
IPC	4 pounds	36.7	14.6
	8	64.0	14.0
	12	60.0	14.3
Chloro IPC	2 pounds	100.0	18.0
	4	100.0	14.6
	6	100.0	10.6
Sodium TCA	5 pounds	0	16.6
	10	0	16.0
	15	0	13.3
	Treated March 27, 1951		
Sodium chlorate	5 pounds	21.7	16.3
	10	90.7	17.0
	20	100.0	11.6
Sinox PE	1 gallons	0.7	16.3
	2	1.7	16.6
	3	20.0	16.3
IPC	4 pounds	53.4	16.3
	8	46.7	15.3
	12	46.7	14.0
Chloro IPC	4 pounds	100.0	16.3
	8	100.0	12.6
	12	100.0	9.6
	Treated April 18, 1951		
Sodium chlorate	5 pounds	53.4	16.3
	10	73.4	14.0
Sinox PE	1 gallons	20.0	15.6
	2	60.0	15.6
IPC	4 pounds	3.4	15.3
	8	3.4	14.6
Chloro IPC	2 pounds	36.7	16.0
	4	30.0	16.3

*

EFFECT OF DIFFERENT APPLICATIONS OF VARYING RATES OF MCP TO IRRIGATED AND NON IRRIGATED ALFALFA SEEDLINGS AT DIFFERENT STAGES OF GROWTH

By: A. J. Tafuro[1] and Ernest Marshall[2]

The alfalfa plant is one of the most susceptible plants to injury from 2,4-D sprays when these sprays are applied directly to the alfalfa plants. During the past two years the authors have made preliminary tests with the triethanolamine salt of 2,4-D and MCP (60% 2-methyl-4-chlorophenoxyacetic acid) for weed control in seeded grains and have also made close observations on grower sprayed trials.

In a paper presented to the Northeastern Weed Control Conference in January 1950 (1) MCP appeared to be safer to use on mixed legume seedlings (alfalfa and clovers) which were underseeded to grains than was 2,4-D. During the past two years observations of grower sprayed trials have indicated that the stages of growth of the alfalfa plant are very important in relation to the amount of injury occurring to the alfalfa when grains underseeded with alfalfa were sprayed with MCP.

In order to study further this stage of growth-injury relationship, an alfalfa field was seeded on August 13, 1951 at the rate of 15 lbs. of alfalfa seeds per acre. MCP (60% 2-methyl-4-chlorophenoxyacetic acid) amine was used at four different concentrations and an MCP amine formulation containing 90% 2-methyl-4-chlorophenoxyacetic acid was used at two concentrations. These treatments were sprayed on alfalfa seedlings at four different stages of growth. Sprays were applied to both irrigated and non-irrigated plots. This test was conducted on the Westtown School Farm in Westtown, Pa. The rates of MCP (60%) used were 1/6, 1/4, 1/3, 1/2 pound of acid equivalent per acre and the rates of MCP (90%) were 1/6, 1/3 pound of acid equivalent per acre. The first application (I) made was when the majority of alfalfa plants were in the first trifoliate leaf stage; the second application (II) was made when the alfalfa was producing its second trifoliate leaf; the third application (III) was made when the alfalfa was showing the third trifoliate leaf; and the fourth application (IV) was made when the alfalfa had four trifoliate leaves. The plots were 10 feet long and 4½ feet wide. The irrigated plots were replicated four times and the unirrigated plots were replicated two times. Application was made with a low,

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pressure, low volume hand sprayer using 20 pounds pressure from compressed air. All sprays were applied directly to the alfalfa at the rate of 30 gallons per acre. This rate seems high since work by Tafuro and Flagg (1) showed that when rates were increased from 6 to 12 gallons per acre on seeded legumes injury was significantly increased. The rate of 30 gallons per acre was used to get good coverage with the small plot equipment available. Irrigated plots received ½ inch of water whenever needed. This totaled 6 inches of water including normal rainfall during the course of the experiment. Unirrigated plots received only 3½ inches of water from seeding until the end of this test; 1½ inches of this came from periodical showers after the first spray. Unirrigated plots were usually rather dry.

Two 18 inch squares were permanently staked in each 4½ x 10 foot plot for stand counts. One count of alfalfa plants was made at the time of spraying and the second count was made two weeks after sprays were applied.

At each spray application, there was no cover for the alfalfa plants and all sprays were applied directly to the alfalfa plants. Data taken 2 weeks after treatments were applied are shown in Tables 1 to 3.

TABLE 1

% REDUCTION IN STAND OF ALFALFA TWO WEEKS AFTER MCP SPRAY WAS APPLIED DIRECTLY TO THE FOLIAGE

STAGES OF GROWTH	I			II			III			IV		
Treatment	Irrig.	Un-Irrig.	Irrig. & Un-Irrig.	Irrig.	Un-Irrig.	Irrig. & Un-Irrig.	Irrig.	Un-Irrig.	Irrig. & Un-Irrig.	Irrig.	Un-Irrig.	Irrig. & Un-Irrig.
60%-1/6	20.7	17.5	19.6	27.2	19.7	24.7	39.2	35.6	38.0	49.4	31.1	43.3
1/4	39.3	42.6	40.4	44.0	27.8	38.6	35.6	40.4	37.1	45.7	34.0	41.8
1/3	61.1	42.5	54.8	50.4	31.6	44.1	48.9	49.4	49.1	59.6	40.5	53.2
1/2	70.7	72.0	71.1	80.7	43.6	68.3	54.9	34.6	48.1	92.4	100.0	94.9
90% 1/6	30.5	24.9	28.6	21.2	41.4	27.9	32.3	26.0	30.2	43.6	25.8	37.7
1/3	60.6	69.4	63.5	33.9	25.9	31.2	44.5	32.6	40.5	68.8	81.0	72.9
CK	18.7	13.7	17.0	18.6	13.7	17.0	18.6	13.7	17.0	18.6	13.7	17.0
L.S.D. .05	15.65	21.4	15.88									
.01	20.72	28.4	20.97									

In reviewing Table 1 MCP (60%) and 1/6 and 1/3 pound per acre rate applied in the early growth stage was less injurious to alfalfa than the 90% MCP. In the later applications this injury difference diminished. MCP (60%) at the 1/6 lb. rate in the first two applications did not significantly decrease stand over check whereas in the last two dates of application injury is significantly more than check at this rate.

Table 2. PERCENT REDUCTION IN STAND OF ALFALFA TWO WEEKS AFTER MCP (60%) SPRAYS WERE APPLIED DIRECTLY TO THE FOLIAGE AT FOUR DIFFERENT RATES.

Rate		Irrigated	Unirrigated	Irrigated and Unirrigated
1/6 lb/A		34.2	26.0	31.4
1/4 lb/A		41.2	36.2	39.5
1/3 lb/A		55.0	41.0	50.3
1/2 lb/A		74.7	62.5	70.6
L.S.D.	.05	7.9	10.7	7.9
	.01	10.4	14.2	10.8

Data in Table 2 indicates that when sprays at all four dates of application are combined and observed according to rates, the 1/6 pound per acre rate gives less reduction in alfalfa stand than 1/4 pound rate, but not significantly so. At rates used above the 1/4 pound per acre stand reduction greatly increased.

Table 3. PER CENT REDUCTION OF ALFALFA TWO WEEKS AFTER MCP (60%) SPRAYS WERE APPLIED DIRECTLY ON THE ALFALFA FOLIAGE AT FOUR DIFFERENT STAGES OF GROWTH.

Stage of Growth Application Made		Irrigated	Unirrigated	Irrigated and Unirrigated
I		43.1	40.4	42.2
II		39.5	29.1	36.0
III		39.2	33.2	37.2
IV		54.1	46.6	51.6
L.S.D.	.05	5.9	8.1	6.0
	.01	7.8	10.8	7.9

Table 3 gives the effect of MCP application on alfalfa stand when MCP was applied at the various stages of growth. The second and third stages gave less stand reduction than the first and fourth applications. In all cases the II and III applications were highly significant over the IV and in some cases were significantly better at the 5% level than I.

Although both the II and III applications show less reduction in stand than the I, injury to alfalfa plants was more severe in III stage of growth than in the I and II stages. In all cases 1/3 and 1/2 pound per acre rates gave severe injury, enough to seriously decrease stand. At the 1/6 and 1/4 pound per acre rate, the II application gave slight epinasty and some stunting but in almost all cases the plant grew out of it. In the III application alfalfa plants at the two lower rates showed serious epinasty and stunting was more pronounced; in almost all cases the alfalfa plants grew out of this epinasty but they were all smaller plants and never completely outgrew the stunting injury. The 1/4 pound per acre rate was more severe than the 1/6 pound per acre rate. Although the stand was reduced more in the I application than the II or III application, there was little epinasty or stunting at the 1/6 and 1/4 pound per acre rate; the alfalfa plant outgrew these effects and plants looked good. Application made at the IV stage of growth gave severe epinasty even at the lowest rate of MCP used.

SUMMARY

1) Direct applications of 1/6, 1/4, 1/3 and 1/2 pound per acre MCP (60%) and 1/6 and 1/3 pound per acre of MCP (90%) in 30 gallons of water were made to alfalfa seedlings at four stages of growth in both irrigated and non-irrigated plots.

2) Stand counts of alfalfa were made in marked areas at the time of spray application and in the same areas two weeks after applications. Data are presented as the per cent change in alfalfa stand from time of application until two weeks later.

3) MCP (60%) at 1/6 and 1/3 pound per acre rate applied in the early growth stage was less injurious to alfalfa than the 90% MCP.

4) MCP (60%) at the 1/6 pound rate in the first two applications did not significantly decrease stand over check.

5) There was no significant difference of reduction of alfalfa stand between 1/6 and 1/4 pound rates when data taken from plots treated at the four different stages of growth were combined according to rate per acre. The rates used above 1/4 pound significantly decreased alfalfa stand more than the 1/6 pound per acre rate.

6) Application of MCP (60%) at the II and III growth stages gave less alfalfa stand reduction than the I and IV stages.

7) Although data from the II and III applications showed no significant difference in reduction to stand, observations showed that there was more severe injury to the alfalfa in the III plot.

8) Unirrigated plots in almost all cases showed less injury to alfalfa plants sprayed with MCP than the irrigated plots.

CONCLUSIONS

1) MCP (60%) in this test is safer to use on alfalfa than the MCP (90%) used in this test when applied to small alfalfa with only one trifoliate leaf.

2) Irrigation increases injury from MCP application to alfalfa seedlings.

3) 1/6 lb. per acre rate of MCP (60%) is safer to use for weed control in alfalfa if application is made after the first trifoliate but before the third trifoliate leaf occurs on alfalfa.

4) Margin of safety for direct application at 30 gallons of spray per acre is between 1/6 and 1/4 pound of MCP per acre.

LITERATURE CITED

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EFFECTIVENESS OF CHEMICAL COMBINATIONS FOR CRABGRASS CONTROL[1]

Ralph E. Engel and Richard J. Aldrich[2]

Combining different herbicides to obtain increased effectiveness on a given weed is a relatively unexplored field. Combinations of 2,4-D with potassium cyanate and other crabgrass herbicides was tried at the New Jersey Agricultural Experiment Station in 1948. At the New Jersey Experiment Station of Rutgers University in 1951, 2,4-D was combined with several types of chemicals to study the value of the combination for crabgrass control.

Materials and Procedure

Sodium arsenite, sodium benzyl arsonate (PMAS-140), a triethanolamine arsenite, and potassium cyanate were each used with and without 2,4-D (triethanolamine formulation). The test was made on a crabgrass infested fairway of the Rutgers Golf Course. The turf was composed of a mixture of Kentucky bluegrass, *Poa annua*, bentgrass, and fescue. Growth conditions were fair to good. Temperatures were quite favorable, but the soil moisture was below optimum. Each plot was treated on the following dates: August 15, 22, and 29. The test had 3 replications and the plots were 4 x 15 feet.

Injury ratings were made on September 11, 1951. The scale of ratings were as follows: 0 = none, 1 = slight, 2 = moderate, 3 = severe, 4 = very severe. Crabgrass plant counts were made for three random samples of one square foot each per plot. In addition, seven individual estimates of percent crabgrass control were made on September 18 and 24.

Discussion of Results

Both the arsenicals and potassium cyanate performed comparatively well. There was a trend for the turf injury ratings to be higher for the plots receiving both 2,4-D and an additional herbicide. However, in no case was injury severe. Crabgrass control ratings based on plant counts or percentage estimates showed the combination of 2,4-D with an arsenical or potassium cyanate to be more effective than similar treatments without 2,4-D. The F value for chemical treatment plus 2,4-D *vs.* chemical treatment without 2,4-D was highly significant for the percentage estimates. With regard to crabgrass plant counts, in

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all but one comparison (8 pints of PMAS-140 and 2,4-D vs. 8 pints of PMAS-140), chemical treatment plus 2,4-D ranked better than the chemical treatment without 2,4-D. The use of 2,4-D alone gave no control. Combining 2,4-D with another herbicide appeared to make the latter more effective. One-half pound of sodium arsenite with 2,4-D was as effective as one pound of sodium arsenite without 2,4-D.

Table 1. The effect of 2,4-D in combination with several crabgrass herbicides. New Brunswick, New Jersey, 1951.

Treatment	Rate of crabgr. herbicide per acre	Rate of 2,4-D per acre	Turf injury *	Av. No. crabgrass plants/ sq. ft.	Esti. Crabgrass Control**
Check	----	--	0	63.9	---
2,4-D only	----	1/4	0.2	74.4	---
Sod. benzyl arsonate[±]	5.5 pts.	--	0	28.9	26.0
" " "	5.5 pts.	1/4	0.3	24.3	51.2
" " "	8.0 pts.	--	0.3	16.0	56.4
" " "	8.0 pts.	1/4	0.3	40.0	63.8
Tri-ethanolamine Ars.	1/2 lb.	--	0.5	26.9	40.0
" " "	1/2 lb.	1/4	0	18.3	67.4
Sodium arsenite	1/2 lb.	--	0.3	21.3	46.4
" "	1/2 lb.	1/4	0.3	13.4	65.3
Sodium arsenite	1 lb.	--	0.7	14.8	61.1
" "	1 lb.	1/4	1.5	10.3	73.4
Potassium cyanate + WA	8 lbs.	--	0.2	8.2	83.7
" " "	8 lbs.	1/4	0.8	1.1	92.1

*Turf injury values estimated as follows: 0 = none, 1 = slight, 2 = moderate, 3 = severe, and 4 = very severe.

**The F value for herbicide treatments with 2,4-D combination vs. herbicide treatments without 2,4-D was highly significant.

± A 20% solution of sodium benzyl arsonate was used (prepared by the W. A. Cleary Corporation, New Brunswick, N. J.).

Conclusion

The addition of 2,4-D to the contact crabgrass herbicides studied increased the crabgrass kill.

EFFECTIVENESS OF POTASSIUM CYANATE DUSTS FOR CRABGRASS CONTROL[1]

Lee W. Bannerman, Ralph E. Engel and Richard J. Aldrich[2]

Dry applications of certain herbicides for the control of crabgrass in turf areas have become of increasing interest in recent years. Effective crabgrass control has been obtained with potassium cyanate applied to turf areas as a solution. The objective of the present investigation was to study the effectiveness of potassium cyanate dust for crabgrass control.

Methods and Materials

A 25% potassium cyanate dust was tested at 8 and 16 pounds per acre with the wetting agents Sorapon SB, Igepon T, and Nekal BX. Sorapon SB, Igepon T and Nekal BX were applied alone and with the potassium cyanate dust at the rate of 10 pounds per acre. The treatments were made August 14, August 24, and September 3. The experimental design was a randomized block with three replications. Plots were 5 x 15 feet, and 4 x 15 feet were treated leaving a one foot strip in each plot as a point of reference to evaluate both turf injury and crabgrass control. The dust was applied with a small insecticide duster early in the morning to take advantage of the dew on the turf. Turf injury ratings were made on the basis of the following: 0 = no injury; 1 = slight injury; 2 = moderate injury; 3 = severe injury; 4 = kill of turf grasses. Crabgrass control was measured by counting the number of plants per square foot with a quadrant placed at random in three locations in each plot.

Results

The results in table 1 show that the 8 pound treatment of potassium cyanate dust plus a wetting agent gave as good control as the 16 pound treatment of potassium cyanate dust. Eight pounds of potassium cyanate dust plus a wetting agent gave significantly better control than 8 pounds of potassium cyanate alone. Wetting agents applied alone resulted in slight injury to turf but severe injury was evident when potassium cyanate was applied as a dust both with and without the wetting agents.

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[1]Cooperative investigations between the New Jersey Agricultural Experiment Station and the Division of Weed Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

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Acknowledgement is made for the support of this project to the General Dyestuff Corporation.

Table 1. Crabgrass control and turf injury obtained with potassium cyanate dust applied with different wetting agents.

Pounds of potassium cyanate per acre	Pounds of wetting agent per acre	Crabgrass plants per square foot	Turf injury
Check	None	31.9	0.0
8	None	35.7	2.0
16	None	23.6	2.4
8	Sorapon SB	26.9	2.8
8	Igepon T	19.4	1.9
8	Nekal BX	18.4	2.9
16	Sorapon SB	11.1	2.8
16	Igepon T	13.8	2.8
16	Nekal BX	13.2	3.0
None	Sorapon SB	50.9	.7
None	Igepon X	29.1	.4
None	Nekal BX	56.1	.1
L.S.D. .05		12.8	
.01		17.6	

A 10% potassium cyanate dust was included in a general crabgrass test conducted at Rutgers University this summer. The dust was distributed over the turf by hand and no wetting agent was included. The results of this test (table 2) show that the 10% potassium cyanate dust, although not as effective as the potassium cyanate solution, did give considerable crabgrass control. It is also interesting to note that the 10% potassium cyanate dust in this test did not inflict any appreciable amount of permanent injury to the turf.

Table 2. The effectiveness of potassium cyanate dust and spray for crabgrass control.

Pounds of potassium cyanate per acre	Estimated per cent control	Turf injury
10% dust 12 pounds	70	.4
10% dust 24 pounds	76	1.1
Spray 10 pounds plus a wetting agent	92	1.0

Summary

When potassium cyanate was applied as a 25% dust (with a duster) to turf for crabgrass control there was extreme burning of the turf in contrast to the 10% dust (applied by hand) which gave slight injury. The efficiency of the 25% potassium dust was greatly increased with the addition of a wetting agent. The 10% potassium cyanate dust gave considerable crabgrass control; more satisfactory control would probably have been obtained with the addition of a wetting agent. In view of the results obtained from these two tests it appears that with proper formulations and methods of application, potassium cyanate dust may prove useful for controlling crabgrass in turf.

RESULTS OF THE NATIONAL COORDINATED STUDIES ON THE CHEMICAL CONTROL OF CRABGRASS 1951

By
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For the past several years, there have been several conflicting reports published by research workers with reference to chemical control of crabgrass. As a result, it was felt that a coordinated crabgrass control project, with uniform rates of herbicidal application and similar technique used by all cooperators, would perhaps bring to light some factors which would get at the source of conflict and result in a better understanding of our fight against crabgrass.

The coordinated trials were set up as follows: There were three separate trials - early, early-late, and late designed to test the affect of herbicides on seedling and mature crabgrass. Three herbicides were used at one rate of application - sodium arsenite at the rate of one pound per acre; a 10% PMA formulation at 5 pints per acre; and potassium cyanate at 8 pounds per acre. All herbicides were used with wetting agent in 100 gallons of water per acre.

There were nine cooperators who participated in the trials at the following locations - Los Angeles, California; Lafayette, Indiana; Ames, Iowa; Manhattan, Kansas; Beltsville, Maryland; St. Paul, Minnesota; Wooster, Ohio; Kingston, Rhode Island; and College Station, Texas. Results of these cooperators shall be analyzed and presented individually and also as composite summary of all stations together. We shall attempt to tie-in significance of temperature, time of application, and soil moisture as each affects herbicidal treatment.

A Report on the Use of Several Contact Herbicides on Chickweed (Stellaria media L.) and the Effect of These Treatments on Strawberries 1951

by
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Common chickweed (Stellaria media L.) is a serious weed in many strawberry plantings in Ontario. In some areas strawberries are planted between the rows in young orchards and in all parts of the province some strawberries are grown near plants which are susceptible to 2,4-D drift or vapour. During the past season an investigation was made of the effect of several of the contact type herbicides when applied to common chickweed and the effect of these treatments on strawberry plants.

A series of plots was laid out where common chickweed made up from 80 to 95 percent of the ground cover. The materials were applied using a small garden sprayer. In all treatments enough of the material was applied to wet the foliage. Two treatments were made on the 3rd and the 9th of May. Growing conditions through the period over which observations were made were very good.

The materials used for the treatments were:- (a) Potassium cyanate at 0.4, 0.8 and 1.6 percent in water (Aero Cyanate 91%), (b) Sodium chlorate at 0.4 and 0.8% in water (Atlacide), and (c) Varsol, a light petroleum oil used for weed control in carrot plantings.

Four replicates were used for both the potassium cyanate and oil treatments while three were used for the sodium chlorate treatments. The results have been summarized in Table 1.

Table 1. Effect of several contact chemicals on chickweed control

Treatment	%	Control topgrowth 9 May[x] (%) Rep. 1	2	3	4	Regrowth 15 May (%) 1	2	3	4
Potassium cyanate	0.4	40	10[+]	50	50	50	20	20	50
	0.8	60	70	70	90	15	5	15	5
	1.6	90	100	100	90	5	0	tr	5
Varsol	-	50	60	90	40	50	30	30	50
Sodium chlorate	0.4	50	80	90	-	70	5	10	-
	0.8	90	90	80	-	tr	tr	5	-
Checks	-	0	0	0		0	0	0	

[+]Estimates made before second treatment
[x]Poor coverage because of a faulty nozzle

At the lowest rate potassium cyanate did not give satisfactory control. At 0.8 percent fair control was obtained while regrowth was not excessive. At 1.6 percent control of the chickweed was good with only slight regrowth two weeks after the first treatment. At the rate used Varsol did not give satisfactory control. Sodium chlorate at 0.4 percent was not satisfactory while control at 0.8 percent was good.

In order to test the effect of these treatments on strawberries duplicate plots were laid out and treated on the 11th of May. The following treatments were applied:- potassium cyanate at 0.4 and 0.8 percent, sodium chlorate at 0.4 and 0.8 percent, and Varsol. The same method and rate of application was used as in the tests on chickweed.

On the 22nd of May the cyanate at 0.4 percent had no effect on the strawberry plants. The 0.8 percent cyanate treatments had some brown leaves but all regrowth was normal. In the sodium chlorate plots at both rates most of the leaves were brown or dead while all regrowth had a pale green colour. The plants in the Varsol plots were mostly brown while there was very little regrowth when compared with the check plots.

Under the conditions of the test the treatments at 0.4 percent potassium cyanate were not satisfactory. Treatments at 0.8 percent potassium cyanate gave satisfactory control of chickweed and did not have any serious adverse effect on the strawberry plants. The sodium chlorate at 0.8 percent controlled chickweed but had an injurious effect on the strawberry plants. Varsol injured the strawberries and at the rate used was not satisfactory for control of common chickweed.

Defoliation of Nursery Stock by Chemical Means *

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Field performance of defoliated plants

A tractor drawn power sprayer was used at Cornell in mid-October 1950 to apply Niagarathal (ME-3001) and other defoliants. Following defoliation the plants were dug and heeled in for a week in a lath house. The plants were then replanted in the field. This procedure was intended to simulate normal handling of fall dug stock. Defoliation and survival were recorded.

From Tables 1 and 2 it will be noted that Niagarathal and Nacconol N R defoliate plants more readily and with less mortality than the highly concentrated nitrogen carriers, Cyanamid Dust, Ammonium Thiocyanate and Potassium Cyanate.

In order to further compare the growth of nursery stock defoliated by chemical means with that of similar stock defoliated by hand, all 1951 top growth was removed during the last week of June from the Niagarathal, Nacconol NR and the hand defoliated controls. The 1951 twigs and leaves were dried to a constant weight at 185°F. The average dry weight of 1951 growth per plant is presented in Table 3. Analysis of variance indicates that the varieties differ significantly from one another but that defoliants did not significantly decrease the growth of the plants as measured in this experiment.

Table 3. The average dry weight per plant of 1951 growth to July 7. Plants defoliated and transplanted in Oct 1950.

Species of Nursery Stock	Method of defoliation prior to transplanting		
	Hand Defoliated	Niagarathal Spray 0.3%	Naccanol N R 4% spray
Berberis Thunbergii purpurea	4.3	4.9	4.7
Calycanthus floridus	9.8	11.4	11.2
Hibiscus syriacus	3.1	1.4	1.7
Hydrangea arborescens grandiflora	19.3	14.9	23.8
Rose Summer Snow	26.2	42.7	45.3
Symphoricarpos Chenaultii	21.1	24.4	33.8
Syringa vulgaris	13.6	16.2	22.3
Weigela floribunda	27.9	31.4	27.2

* The author wishes to acknowledge the cooperation and assistance of the C W Stuart Company, Newark, New York in the initiation and development of this project. The author also wishes to acknowledge the assistance of the Niagara Chemical Division of the Food Machinery and Chemical Corporation of Middleport, New York during 1950-51. The actual carrying out of experiments reported was done by Mr Wilbur Frommuller.

Table 1. Defoliation in eight nursery crops resulting from a single application of one of five chemicals as compared to hand defoliated plots.

Nursery Stock	Hand	Niagarathal 0.3%	Naeconol N R 4%	Cyanamid Dust	Ammonium Thiocyanate 3%	Potassium Cyanate 2%	Mean % Defoliant per species
Berberis Thunbergii purpurea	10	4	8	4	4	4	48
Calycanthus floridus	3	1	2	2	2	2	60
Hibisucs syriacus	5	5	4	4	3	4	80
Hydrangea arborescens grandiflora	4	4	3	4	4	3	90
Rose Summer Snow	2	1	1	1	2	1	75
Symphoricarpos Chenaultii	1	1	1	0	1	1	80
Syringa vulgaris	2	2	2	2	2	2	100
Weigela floribunda	5	4	3	2	3	1	52
Mean Defoliation (Hand = 100)	100	70	80	60	60	59	

Table 2. Mortality (%) in chemically defoliated plants following fall transplanting as compared to % mortality in hand defoliated plants.

Nursery Stock	Hand Defoliated	Niagarathal 0.3%	Nacconol N R 4%	Cyanamid Dust	Ammonium Thiocyanate 3%	Potassium Cyanate 2%	Mean % mortality per species
Berberis Thunbergii purpurea	18	20	24	50	0	30	24
Calycanthus floridus	0	10	15	0	25	11	10
Hibiscus syriacus	48	63	62	70	100	100	74
Hydrangea arborescens grandiflora	7	3	10	30	16	8	12
Rose Summer Snow	0	0	0	25	16	0	7
Symphoricarpos Chenaultii	0	0	0	-	0	0	0
Syringa vulgaris	5	5	0	10	0	7	5
Weigela floribunda	8	2	13	7	5	0	6
Average mortality %	10.8	12.6	15.5	21.5	20.2	19.5	

Summary

Defoliation of several kinds of nursery stock was accomplished by chemical means.

Niagarathal and Nacconol N R as used in these tests gave as good results as Aerocyanamid Dust, Aerocyanate or ammonium thiocyanate.

Plants that were defoliated and then transplanted ranged in mortality according to species from 48% mortality in Hibiscus to less than 5% in Calycanthus floridus, Rose Summer Snow and Symphoricarpos Chenaultii.

Chemical defoliation resulted in mortality of similar magnitude to hand defoliation where Niagarathal 0.3% or Nacconol N R 4% were used.

Growth of defoliated plants, whether by Niagarathal 0.3%, Nacconol N R 4% or hand defoliated, did not differ significantly during the early part of the growing season (to late June) following fall treatment and transplanting.

No explanation is offered for the failure of certain species and varieties to defoliate readily nor for others to react readily to chemical defoliants.

Effect of Temperature on Defoliation

During the course of studies* on defoliation, the effect of temperature has been evident, especially in the use of apple gas or of ethylene chlorohydrin. Both actively growing plants and also cut branches or twigs have responded to defoliation treatments.

In the present studies procedure was standardized by selecting plant material of comparable age and grown under uniform conditions. Twigs of Ligustrum ovalifolium were selected. The actively growing tip was removed and the remaining foliage reduced to five pairs of mature size leaves of recent origin. This excluded both immature and old foliage. Four twigs constituted an experimental sample. The twigs were sprayed using an air brush with 25 p.s.i. pressure and discharging 105 cc per minute. The twigs were rotated as they were sprayed. The operation was continued till the foliage was dripping wet. Excess moisture was removed by tapping gently. The sprayed twigs were then placed in sterilized pint milk bottles containing 35 grams of pure quartz sand moistened with 10 cc of tap water. The bottle cap was put in place and closed with a paraffin seal. The bottles were appropriately labelled and then placed in dark storage for a period of 96 hours.

* Preliminary Report on Defoliation of Nursery Stock by Chemical Means by A M S Pridham, published in Supplement to Proceedings Northeastern Weed Control Conference, January 1951.

Defoliation was noted as the number of leaves dropping when the twigs were shaken vigorously by hand. Note was made of discoloration to leaves and twigs where such injury occurred. Temperature treatments ranged from 35° to 100°F in controlled temperature chambers.

Data from three experiments are presented. Ligustrum ovalifolium twigs were used in the first experiment. Single rose leaves of the variety Better Times were used in the second experiment and small potted plants of Better Times Roses were used in the third experiment.

Data presented in Table 4 indicated on analysis significant variance due to chemical defoliant and to temperature. The data indicate that at temperatures below 50° and over 90°F that defoliation is less than at 80° or 90°F where activity reaches a maximum. Both ME-3001 Niagarathal and the parent material ME-3000 Endothal were more active defoliants than Nacconol N R or than Potassium Cyanate under the conditions of this experiment. The activities of Niagarathal were outstanding at temperatures too low for maximum activity of other defoliants. Since nursery stock is dug in early autumn till late fall, activity of the defoliant at low temperatures is important.

Data in Table 5 show similar trend to that in Table 4 with a maximum amount of defoliation at 80° and reduction at 40°F. Nacconol N R on the basis of the data obtained is equal in effectiveness as a defoliant to Niagarathal or Endothal. Potassium Cyanate is again the least effective of the defoliants. Applications of defoliants to Rose Better Times at low temperatures are much less effective than applications made at higher temperatures.

Applications of Niagarathal were made to small rose plants of Better Times. The plants were rooted cuttings carrying 3 leaves of mature size and good green color. The plants, one per treatment, were illuminated and stored at constant temperature for 5 days. Defoliation was first noted and first completed at 80°F occurring in 3 days. At the end of 5 days plants were defoliated at 60°, 70°, 80°, 90°, and 100°F. No defoliation took place at 40° or 50°F.

Summary

Temperatures below 60°F reduce the amount of defoliation taking place following the application of a defoliant under conditions of high humidity. Temperatures of 40°F or less seriously interfered with defoliation of the nursery stock tested. Temperatures of 90°F and 100°F tend to reduce the effectiveness of defoliant treatment. The effect of the plant to be defoliated, Ligustrum ovalifolium, or Rose Better Times is an important factor in the amount of defoliation accomplished under specific conditions with chemical defoliants. Defoliated plants produced normal foliage and normal amounts of new growth in present tests.

Table 4. Defoliation (%) in <u>Ligustrum ovalifolium</u> twigs August 17-22, 1951 following application of one of four chemical defoliants. Twigs held at constant humidity at one of eight constant temperatures for a period of 4 days. Injury to the foliage is rated 0 to 10, increasing in severity from none to severe injury 10.

4 day defoliation temperature with high humidity	ME-3001 0.5%		ME-3000 0.5%		Nacconol N R 4 %		Potassium cyanate 2 %		Control		Mean % def. per temperature treatment 4 days
	% def.	inj.	% def.	inj.	% def.	inj.	% def.	inj.	% def.	inj.	
35°F	0	0	0	1	0	1	0	0	0	0	0
40°	18	1	0	1	0	1	0	0	0	0	4
50°	60	0	100	0	0	1	0	0	5	0	33
60°	55	0	100	0	0	1	0	0	3	0	32
70°	40	0	100	3	20	1	0	0	0	0	32
80°	50	2	100	3	35	1	0	0	13	0	40
90°	68	0	100	10	65	5	0	0	10	0	49
100°	45	0	100	10	28	0	0	0	0	0	35
Mean % def. per defoliant	42		75		19		0		4		28

Table 5. Defoliation (%) in Rose Better Times. Mean for 3 tests based on defoliation of leaflets from individual leaves sprayed with one of four chemical defoliants. Leaves held four days at constant high humidity and one of 6 constant temperatures.

4 day defoliation temperature with high humidity	ME-3001 0.5% % def.	ME-3000 0.5% % def.	Nacconol N R 4 % % def.	Potassium cyanate 2% % def.	Control % def.	Mean % def. per temperature treatment 4 days
40°F	12	8	35	5	0	12
50°	45	45	64	5	15	35
60°	85	70	83	10	8	51
70°	93	63	95	47	33	66
80°	100	100	100	25	35	72
90°	60	100	95	15	15	57
Mean % defoliation per defoliant	66	64	78	18	18	49

Weeds of Nurseries and Landscape Plantings

A. M. S. Pridham and others, Cornell University

Alnus incana (speckled alder) control

Several stands of alder are located in meadow areas flanking a highway through Fair Haven State Park, Fair Haven, New York. The meadow is maintained by cutting the grass and brush once or twice each season. Standard sicklebar equipment is used. The alder now present represents regrowth from previous years and in places forms an almost complete and uniform ground cover which is difficult to mow.

Tests were run in April and others in July to obtain information on the relative effectiveness of 2,4-D and of 2,4,5-T as herbicides for the elimination of existing stands of alder. Formulations used were approximately 40% acid equivalent 2,4-D or 2,4,5-T. Brushkiller mixtures were not tested. Single plots of 1500 square feet, each containing in excess of 100 alder, were laid out in selected areas to assure fairly comparable stands of alder. Spray applications were made with a short 6 foot boom attached to a 3 gallon garden sprayer and carried by two men. Two gallons of spray mixture were applied to 1500 square feet or approximately 60 gallons of spray mixture per acre. Applications made in April were diluted with oil. The plants had not leaved out. June treatments were diluted with water. The plants were in full leaf. Heavy rainfall (½") followed both applications. Ten samples were dug at random from each plot on October 15. The condition of the root and top was estimated by cutting the tissue to observe the presence of live cambium tissue and pliable wood.

Table 1. Mortality (%) in Alnus incana sucker growth as observed in October following dormant (April) and foliage (June) applications of 2,4-D or 2,4,5-T. Mortality data include only plants with dead top and root. Number of live plants as indicated by foliage is for complete plot area.

Spray mix concentrate/ diluent	% alder killed top & root, 2,4-D	No. of live plants	% alder killed top & root, 2,4,5-T	No. of live plants
Unsprayed	0	450	0	99
*Diluent(Diesel oil/2	0	275	0	74
1:3	10	75	90	0
1:7	30	24	100	0
1:15	20	157	90	8
1:33	30	314	80	10
1:63	10	300	0	49
**Diluent water 1:15	80	5	80	3

* Sprayed in April before bud break applied to bark
** Sprayed in June on foliage

The data presented in Table 1 indicate that effective control was obtained from summer application of either herbicide. Treatments made during the dormant season are equally effective when equal amounts were used of herbicide 2,4,5-T, here Stantox 2,4,5-T, manufactured by the Standard Agricultural Chemicals Company. Dormant season treatment with 2,4-D was not satisfactory under the conditions of the experiment.

Summer treatment using water as a diluent would likely be less expensive and would be practical when danger of drift and volatility are not limiting factors.

Caution should be given not to apply the results stated here to willows or to red dogwood, <u>Cornus alba</u>. Plots contained a number of live but very few injured or dead plants.

Caution should be used in applying the results to large plants of <u>Alnus incana</u>. Tests were set up to include 2" diameter stems and clump types. Results are not conclusive though basal spraying during the dormant season may prove valuable. Summer sprays applied to 6' plants were effective in better than 50% of the alder treated, killing both top and root.

The present results indicate the probability of eliminating stands of sucker growth alder by applying 2,4,5-T herbicide either before bud break or after leafing out takes place.

<u>Agropyron repens</u> (quackgrass) Control.

The relatively permanent nature of nursery and landscape plantings tends to make control of such perennial weeds as quack grass tedious and often difficult. The long periods of fall and early spring permit continued encroachment of scattered specimens to rather formidable stands. The effect of the herbicide on the crop, in this case trees, shrubs, perennial flowers, etc., is rather more critical than under agricultural conditions.

An attempt was made to control quack grass by foliar applications of a number of herbicides. A single treatment was made in June 20-23, 1950 to regrowth after mowing June 1. The fresh growth was approximately 6" high at that time. Herbicides were used in three amounts and replicated three times to form blocks of 16 plots in a latin square. Many treatments resulted in the death of the tops and delayed regrowth for a month to six weeks time. excavated in October 1950. The roots of quackgrass Random samples of 2 square feet/were collected, cleaned and the dry weights obtained. Samples were again taken in 1951. No herbicides were applied or mowing done in 1951.

The results presented in Table 2 indicate that growth of <u>Agropyron repens</u> (quackgrass) was reduced following applications of sodium tri chloro acetate at the rates employed. No reductions of statistical or practical significance were noted following any of the applications of other herbicides. The amount of reduction following application of sodium tri chloro acetate was not adequate to be considered control. In 1951 the reduction was so small that it is negligible. Top growth of quackgrass was reduced in 1950 by several herbicides.

Table 2. Effectiveness of herbicides used as a single application foliage spray in June for control of Agropyron repens (quack-grass) as indicated by mean dry weight in grams from three replicates for live roots remaining in October 1950 and October 1951 from a 2 square foot random sample per plot. Significant data underlined.

Herbicide	Amount of herbicide per acre				L.S.D. at 1% level
Acetate sod TCA	0	100 lbs.	150 lbs.	200 lbs.	
1950	29.2	<u>15.0</u>	<u>16.3</u>	<u>15.9</u>	11.2
1951	41.8	<u>20.3</u>	26.9	<u>22.9</u>	17.7
Acetate 2,4,5-T	0	10 lbs.	15 lbs.	20 lbs.	
1950	20.8	25.2	24.3	14.6	10.9
1951	42.9	58.6	46.6	46.6	25.0
Aromatic oil	0	100 gals.	200 gals.	400 gals	
1950	37.2	39.4	30.6	31.0	15.0
1951	55.5	62.9	55.8	57.7	31.5
Calcium Cyanamid	0	1500 lbs.	3000 lbs.	6000 lbs.	
1950	13.9	21.8	31.9	23.3	12.0
1951	12.4	32.6	40.8	47.9	23.0
Endothal ME-3000	0	15 lbs.	30 lbs.	60 lbs.	
1950	29.6	37.3	30.7	37.2	18.5
1951	28.5	31.8	38.9	37.8	11.4
Maleic hydrazide	0	7.5 lbs.	15 lbs.	30 lbs.	
1950	45.8	37.1	39.2	43.9	23.0
1951	99.6	60.8	66.6	59.4	41.7

Control of quack grass by applications of sodium trichloroacetate (TCA) has been reported by numerous investigators. Treatments have either been applied after plowing or have been repeated at several intervals as foliage reappears.

The present experiment indicates that control of quackgrass is not likely to follow single applications of herbicides to the foliage in active stands of this weed.

Artemisia vulgaris (chrysanthemum weed) Control. Thomas Eastwood and A. M. S. Pridham.

Artemisia vulgaris (or chrysanthemum weed as it is known to nurserymen in the Northeastern USA) has become a serious weed in many nurseries in plantings of evergreens, shade trees and other plants that are not handled as annual crops. The experiments reported here were undertaken primarily to examine the effectiveness of a group of selected herbicides applied as a spray to either the foliage (top spray) or to the stolons exposed in plowing (root spray). Results are based primarily on sampling of the soil in treated areas to determine the amount of live stolons remaining in late June 1951 following application of herbicides made in November 1950.

Table 3. Effectiveness of herbicides applied during the dormant season (November 1950) to *Artemisia vulgaris* roots following rototilling as compared to applications made to the foliage and undisturbed soil surface. Density of original stand of Artemisia is stated as shoots per square foot. Final stand is stated as dry weight in grams of live stolons gathered in June 1951. Figures are the average of two random samples of 0.2 sq. ft.

Herbicide	lbs/acre in 400 gallons	Original Count of shoots per sq. ft. Root Spray	Top Spray	Final stand Mean DW gr. live stolons in 0.2 sq. ft. sample Root Spray	Top Spray
Control	Unsprayed	37	36	10.5	20.5
Ammate	175	23	43	0.05	0.8
Calcium Cyanamid	3000 Dry	45	51	0.0	16.8
Dowcide F	100	45.5	53	23.6	14.1
IPC 40.6% sol.	100	40	29	9.1	10.5
Santobrite	100	45	40.5	1.8	13.1
Sulfasan	20 gals. 80 lbs.	40	40	0.6	21.2
TCA	150	58	25.5	6.7	16.0
2,4-D Amine	80	39.5	50.5	0.15	0.2
2,4-D Ester	80	82.5	49.5	0.03	20.5
2,4-D-2,4,5-T Ester	40 + 40	36	35	0.0	15.0
2,4,5-T	80	34	31	0.05	12.1
Control		37	50	11.1	14.4
Total		562	534	63.9	175.1
Mean of Control		37	43	10.8	17.5
Mean of Herbicide		44.3	40.7	3.85	12.75

The data presented in Table 3 indicate that the Artemisia population of the original plots was relatively uniform and that the average population of the treated plots was at least equal to that of the control plots. The mean dry weight (gr.) of stolons present in June 1951 following treatment is based on two random samples of 0.2 sq. ft. from a single 10 x 10' plot for each. The data indicate that rototilling reduced the stand by 32% as an average for the control plots only. This reduction is of doubtful statistical significance. Herbicides were consistently more effective when applied in conjunction with rototilling. The average reduction was 78% but with effective herbicides exceeding 90%. The effective herbicides included Ammate, Calcium Cyanamid, Sulfasan (xnthogene sulfide formulation), 2,4-D and 2,4,5-T, both alone and in combination. The results with 2,4-D confirm those obtained in earlier tests.

Soil samples taken in June were freed of Artemisia stolons and then planted with bean and cotton seed to estimate residual effects of the herbicide. All soil samples but one permitted normal growth of test crops as indicated by growth through to maturity of the first mature leaf. The exception was found in one of eight samples taken from two plots receiving foliage application of ester formulations of 2,4-D and 2,4,5-T. The surface 2" of soil was free of residual effect but soil from the 2-4" zone in one case was associated with typical 2,4-D response in the seedling leaves of test crops. No lethal effects from residual herbicides were noted in these tests.

A second test was conducted on uniform established greenhouse cultures of Artemisia vulgaris. The test was set up in mid-June. Herbicides were applied in three ways: 1) to the foliage, 2) to the soil at a rate equivalent to 400 gallons of spray mixture per acre, and 3) by a small volume of concentrate to the soil surface and watered in. Equal amounts of herbicide were used. In September the stolons and roots were harvested, dried and weighed. The soil was replaced in the original container. Planting of bean and rye seed was made to test for residual herbicide effects.

Results presented in Table 4, based on the mean dry weight of live stolons from four cultures, indicate a measure of control from two herbicides, mono chloro acetic acid and sodium trichloro acetate. Applications made directly to exposed roots were more effective than foliage sprays.

After harvesting the Artemisia stolons, the soil was replanted with beans and red top. Growth of test crops failed to occur in cultures treated with TCA 50 lbs./acre equivalent on the soil and in all cultures sprayed or soil treated with TCA at 400 lbs./acre. At the rates of application used cultures from the remainder of the treatments grew well during the four week test period.

Control of Artemisia would appear most likely from application of herbicides to roots and stolons exposed during plowing. Top growth is usually killed by a single treatment of herbicide but regrowth has followed quickly and abundantly. In addition to 2,4-D and 2,4,5-T reduced growth was obtained following field applications of Calcium Cyanamid and Sulfasan. Greenhouse tests indicate reduced growth following applications of mono chloro acetic acid.

Table 4. Effectiveness of herbicide in control of Artemisia vulgaris as indicated by the mean dry weight of stolons from four cultures per treatment made in June and harvested in September.

Herbicide	Per cent concentration	Top sprayed	Root sprayed	Soil treated	Mean weight per treatment
3459	15.0	8.0	2.4	13.5	8.0
	30.0	10.3	1.1	1.3	4.2
TCA	1.6	7.1	2.9	4.3	4.8
	12.0	1.4	1.0	2.6	1.7
ACP 644	2.5	18.3	10.0	15.1	14.4
	25.0	8.9	6.3	3.4	6.2
M.H.	0.36	11.5	13.0	17.2	13.9
	3.6	10.8	11.1	15.1	12.3
Weednix	2.0	13.2	12.8	15.1	13.7
	20.0	16.5	8.7	12.2	12.3
Control					14.2
Mean dry weight per method		10.6	6.9	10.0	

Stellaria media (Annual chickweed) - Thomas Eastwood

Annual chickweed germinates in September with the first cool 40°-60°F weather. Growth continues through the fall, winter, and early spring often overgrowing small plants of a foot or more in height. Chickweed continues active growth till late spring or early summer. Standard tractor cultivation equipment or a Howard Rotary Hoe can handle the weed where such equipment can be used. Hand weeding is often necessary within the plant row and among lining out or seedling stock. Preliminary tests during cool weather before bud break and early growth of nursery stock indicate that several herbicides may have value in controlling annual chickweed. These include early fall applications and late winter applications of DNOC formulations, aromatic oils, potassium cyanate and sodium pentachlorphenate.

The present tests include only pentachlorophenates as they affect the growth of Taxus cuspidata, Ilex opaca and garden peony. Sodium pentachlorophenate, copper pentachlorophenate and zinc pentachlorophenate were formulated with Dye Nacconol NR and water to include preparations containing 1.3 grams, 2.6 grams and 5.2 grams of phenate per 1300 cc of water. These were used in amounts of 150 gallons per acre and correspond to application rates of 12.5 lbs./acre, 25 lbs./acre and 50 lbs./acre. Treatments were made in February 1950 and observations continued through September 30, 1950. No injury was noted in Taxus cuspidata nor in Ilex opaca.

Treatments applied to peony plantings were made March 17, 1950. Sodium pentachlorophenate only was used. The amounts applied were as noted above except that each amount was applied in 200 gallons of spray mixture per acre and also in 100 gallons and in 50 gallons per acre. Plots were 50 square feet in size.

Results were evident by March 24, one week after application, and before peony buds had commenced growth. On April 8 maximum injury to chickweed had occurred but was evident only in the plots receiving 50 pounds per acre. In this case the foliage was killed but flowering proceeded, indicating that the stems were not killed. Observations on May 6 indicated that growth of chickweed had been resumed.

Peonies flowered normally and were uninjured by the herbicides. Temperatures were below 40°F for at least 5 days after application of Santobrite and under these conditions control of chickweed was poor.

TWO HERBICIDES FOR USE IN GREENHOUSES

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Good-rite Oktone and Good-rite n.i.x. have been tested rather widely for certain weed control in greenhouses. When properly used, they can save these growers much labor and expense. The nature and use of the two materials is quite different, but to a large extent, they supplement each other. The following discussion will attempt to explain the role each material plays in greenhouse operation.

Good-rite Oktone

Good-rite Oktone is a general contact herbicide supplied as a forty percent solution of octachlorocyclohexenone in petroleum solvent. This herbicide has been tested rather widely for certain weed control applications in and around greenhouses, and has proved to be particularly useful in these locations because it is not volatile and has no hormone action.

Oktone kills all plant tissues it hits. However, it has very little residual action in the soil. Thus, it may be used under benches and around cold frames where plants later may be placed. Because of the absence of residual action, additional applications are required at about four-week intervals until seed in the soil or the underground food storage of perennials is exhausted.

Oktone should be diluted at the rate of one quart of solution to fifteen gallons of Diesel #2 fuel or Stoddard solvent, or twelve gallons of kerosene. Recommended rates vary with the size of weeds -- very small weeds will be killed by as little as twenty gallons per acre of diluted spray. For larger weeds, usually thirty to forty gallons will be necessary. Where vegetation is very heavy, it is best to make only reasonably heavy applications of the spray, rake out the dead material a couple of days later and then respray. These procedures should be repeated until complete kill is obtained. Solutions stronger than recommended are unnecessary and uneconomical.

Because gross drift from Oktone spray can damage plants it wets, it is advisable to work at lowpressures (10 to 20 pounds) and use a non-fogging nozzle, such as Teejet 8001T.

To clean the sprayer after use, it is necessary only to rinse it well with water containing a detergent.

It may be said conservatively on the basis of much work in greenhouses in the Cleveland area and elsewhere, that a man with a knapsack sprayer and Oktone can do more rough weeding of areas under benches, between greenhouses and cold frames, in one day, than he could with a hoe in two weeks.

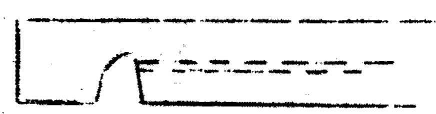
Good-rite N.I.X.

Good-rite n.i.x. (chemically sodium isopropyl xanthate) is a much milder herbicide than Oktone. It decomposes to form harmless products rapidly after it has been applied, and it has no hormone effects. It is toxic to soft succulent tissues, but not to more mature stems. Properly applied, it has been successfully to weed a large number of crops grown in and around greenhouses, including roses, azaleas, hydrangeas, carnations, caladiums, gladioli, peonies, iris (both Dutch and Japanese types), shrubs of all kinds, and with some care and experience, even chrysanthemums and snapdragons.

Good-rite n.i.x. is diluted with water at the rate of one pound to ten gallons. Sunlight accelerates its action and temperatures should be 70°F. or higher during spraying. It is advisable to spray before 4:00 P.M. in the summer and 3:00 P.M. in midwinter. Good-rite n.i.x. should not be applied if rain or watering will remove it before two to four hours have elapsed.

The technique of applying n.i.x. in weeding greenhouse crops follows:

Spray before grasses exceed one inch, or the two-leaf stage. The stem of the crop should be as mature as possible. The spray should be directed below the foliage. In some applications, the Teejet 8001T previously mentioned may be used, but for crops with foliage close to the soil level, a flooding nozzle (for example a 1/8K nozzle) is preferable:



Flooding Nozzle

With the mouth of this nozzle held downward, it may be passed under the foliage even of small carnations. If a few of the lower leaves of such plants are hit, the damage is negligible.

Experienced workers with this spray have weeded a greenhouse bench in less than twenty percent of the time required to do the job by hand, and done a better job. Chickweed and oxalis were especially susceptible.

N.i.x. plus wetting agent is a powerful killer, and may be used in place of Oktone below benches, and for such applications, where chickweed, oxalis, and annual weeds are to be controlled. It is safer than Oktone, as it decomposes rapidly.

Because solutions of n.i.x. decompose on standing, fresh solutions should be prepared for each day's application. The dry powder should be stored in closed containers. N.i.x. is not corrosive to sprayers and may be rinsed out easily with water. It is not toxic to operators.

I have some color photo slides of work with these two material, which I'd like to show you.

COMPARISON OF VARIOUS HERBICIDES FOR THORN APPLE CONTROL IN PASTURES

Stanford N. Fertig[1], John VanGeluwe[2], C. V. Flagg[3], Robert Beatty[4] and E. Lacko[5].

Evidence of the effectiveness of herbicides for thorn apple ctonrol in permanent pastures was reported in the 1950 Northeastern Weed Control Conference Proceedings (1). This paper is a further progress report on the results of those experiments. Results are also presented from more closely controlled experiments laid out in September 1950 and designed to give information on the most effective chemicals, concentrations, method of treatment (basal or foliage) and time of application for Crataegus control.

Further Observations on Work in 1950 Report

Section I:

Located in area cut over in 1947 and treated in 1949. Resprouts from stumps and roots 6 to 8 inches tall.

The high oil-water combinations showed less than 10 per cent recovery with no observable difference between 2,4-D - 2,4,5-T mixtures and 2,4,5-T alone.

Recovery on those plots where low oil-water or water was used as the carrier was very high. The variation in recovery was from 40 percent for the low oil plus 2,4,5-T plots up to 70 percent for 2,4-D in water alone. The percent recovery was in proportion to the amount of oil and the percent 2,4,5-T in the material applied.

Section II:

Located in area cut over 10 to 12 years ago with regrowth from stumps and roots 3 to 6 feet tall.

Plots receiving 2,4-D + 2,4,5-T combinations or 2,4,5-T alone in the high oil-water (10-90) foliage-basal treatment, which showed only slight foliage development in 1950, recovered during the 1951 season and leafed out approximately 50 percent. The basal and foliage treated plots which showed little leaf development and a marked epinasty in 1950 made

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1. New York State College of Agr., Cornell University, Ithaca, N. Y.
2, 3. G.L.F. Soil Building Service, a division of Coop. G.L.F. Exchange, Ithaca, N. Y.
4, 5. American Chemical Paint Co., Ambler, Pa.

greater recovery in total leaf surface and with much reduced epinasty in the 1951 season, compared to foliage-basal treatments.

There was still no observable differences between 2,4,5-T compared to the mixtures.

It would appear that concentrations used in the 1949 plots were too low for effective control.

It was stated in last year's report that the best carrier in the foliage-basal treatments was water alone, with the 2,4,5-T treatments looking better than the 2,4-D + 2,4,5-T combinations. From observations during 1951, the difference in materials held and the water only treatments showed less recovery than where low or high (1 to 10-90) oil was used. However, some recovery was apparent as was true with all foliage applications, regardless of materials used. Also, marked development in buds over last season was noted.

Where basal applications were made in oil only as the carrier (plots 17, 18, 19 and 20) they continued to show the least evidence of recovery of any treatments made. the 2,4,5-T was superior to the 2,4-D + 2,4,5-T combinations.

<u>Section III</u>:

Located in area of virgin growth with specimens up to 18 feet tall and up to 10 inches in diameter. Specimens cut and treated immediately.

There is no evidence of recovery or sprouting in any plots since treatment. Root examination, however, shows little evidence of translocation or injury.

1950 Experiments

<u>Purpose</u>

From information of the previous experiments comparing basal, foliage-basal and stump treatments, the basal applications in oil were most successful even though the concentrations used appeared too low for effective control. Also, it appeared that the time required to cut and treat stumps was not necessary or desirable. Basal applications in oil appeared to give better control than water or oil-water mixtures and were more economical than stump treatment both in materials and labor.

<u>Location</u>

A hillside permanent pasture was selected having a population of thorn apples considered representative of the areas where control measures would be practical. Pasture renovation measures could be incorporated or the area plowed and reseeded if desired. The stand of thorn apples was scattered but uniform. There was a variation in sizes from 1-1/2 inches or less up to 9 inches in diameter and from 1 to 20 feet tall. The experimental layout and plot size is shown in diagram I.

Materials and Method

Eight different materials were used in the tests with four different concentrations, two methods of application and two carriers (oil-water and oil). Table I summarizes these materials.

Table I. Summary Information of Materials Used in Thorn Apple Tests.

Plot #	Formulation	Acid	Acid Equiv./ Gal.	Conc. # Used	Carrier	Method of Treatment
1	Weedone LV-4	2,4-D	4	2	water & oil	F & B
2	Weedone LV-4	2,4-D	4	4	water & oil	"
3	Weedone 2,4,5-T	2,4,5-T	4	2	water & oil	"
4	Weedone 2,4,5-T	2,4,5-T	4	4	water & oil	"
5	ACP-749A	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	2	water & oil	"
6	ACP-749A	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	4	water & oil	"
7	ACP-977	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	2	water & oil	"
8	ACP-977	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	4	water & oil	"
9	Weedone LV-4	2,4-D	4	2	oil	B
10	" LV-4	"	"	3	"	"
11	" LV-4	"	"	4	"	"
12	" 2,4,5-T	2,4,5-T	"	2	"	"
13	" "	"	"	3	"	"
14	" "	"	"	4	"	"
15	ACP-749A	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	2	"	"
16	" "	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	3	"	"
17	" "	2,4-D + 2,4,5-T	1-1/3 lbs. 2/3 lbs.	4	"	"
18	" -911	2,4-D + 2,4,5-T	1.2 lbs. 1.2 lbs.	2	"	"
19	" "	2,4-D + 2,4,5-T	1.2 lbs. 1.2 lbs.	3	"	"
20	" "	2,4-D + 2,4,5-T	1.2 lbs. 1.2 lbs.	4	"	"
21	" -926	2,4-D + 2,4,5-T	1.34 lbs. .66 lbs.	2	"	"

Table I. (Continued)

Plot #	Formulation	Acid	Acid Equiv./ Gal.	Conc. # Used	Carrier	Method of Treatment
22	ACP-926	2,4-D + 2,4,5-T	1.34 lbs. .66 lbs.	3	oil	B
23	" "	2,4-D + 2,4,5-T	1.34 lbs. .66 lbs.	4	"	"
24	" -904	2 methyl- 4 chloro	2 lbs.	2	"	"
25	" "	2 methyl- 4 chloro	2 lbs.	3	"	"
26	" "	2 methyl- 4 chloro	2 lbs.	4	"	"
27	LV-4 + TCA	2,4-D TCA	4 90%	2 10	water	F & B
28	Weedone 2,4,5-T + TCA	2,4,5-T TCA	4 90%	2 10	"	"
29	ACP-977 + TCA	2,4-D + 2,4,5-T TCA	1-1/3 + 2/3 90%	2 10	"	"
30	ACP-571	2,4-D	1/3 lb.	Used as formulated		B

Method of Treatment

Since it was desired to know the volume of solution applied to each plant, calibration of the nozzles was necessary. A plant in each of the size categories in Table II was selected and the time in seconds required to treat this plant was recorded.

Table II. Class (Size Measurement) General Classification of Thorn Apples Treated

Size (Class)	Tree Height (ft.)	Tree Width (Ft.)	Stem Diameter (Inches)
1	1 to 5 ft.	1 to 3 ft.	Below $1\frac{1}{2}$ in.
2	5 to 7 ft.	3 to 5 ft.	$1\frac{1}{2}$ - $2\frac{1}{2}$ in.
3	7 to 9 ft.	5 to 7 ft.	$2\frac{1}{4}$ - $3\frac{1}{2}$ in.
4	9 ft. over	7 ft. over	$3\frac{1}{2}$ - up

For the basal treatments, the trunk was treated from the ground line up 12 to 18 inches. Any lateral branches on this section of the stem was necessarily sprayed. Sufficient liquid was applied for an excess to run down the stem to the crown. Care was taken to uniformily treat the entire diameter of the stem to the height indicated. For the basal treatments a 2-nozzle boom 12 inches wide was used.

For the foliage-basal applications, the time required to completely wet the foliage was again recorded. Since a wider 3-nozzle boom was used for the foliage treatment, it was difficult to get good coverage of the basal stem in the foliage-basal applications without wasting some solution.

After 3 determinations on length of time required to treat a plant in each of the size categories, the volume of solution discharged in this length of time was measured. Three measurements were made and the average of these was used to compute the discharge rate per second.

Throughout the experiment the size of the tree was estimated and length of time required to spray each plant was recorded. From this the amount of solution applied was calculated. Each tree was tagged for future identification.

Treatments were applied using a #59 Monarch nozzle at pressures of 90 lbs. per square inch. Temperature was 73 degrees, weather clean and no rainfall for 7 to 10 days after treatment.

Results

The results will be discussed under 2 headings (a) foliage observations taken 2 weeks after treatments were applied and again June 19, 1951 and (b) stem, foliage and root observations made on November 13, 1951.

Within 24 hours after treatment, the leaves on those plots receiving foliage applications of formulation 742A turned black and wilted. Two weeks after treatment, the leaves on all foliage-basal treated plots were brown and dried.

The foliage of all basal treated plots remained normal throughout the fall There was no evidence of wilting or dying until frost.

The results taken June 19, 1951 was a degree control rating based on foliage and stem characteristics. The rating scale was from 0 to 5 as follows:

1 - No effect.
2 - Main stem and scaffold branches green; foliage present with evidence of epinasty.
3 - Moderate to complete defoliation. Where foliage present, epinasty quite evident. Main stem and scaffold branches green to slight discoloration.
4 - Complete defoliation. Moderate to pronounced discoloration of main stem and scaffold branches.
5 - Complete top kill; no regrowth.

Table III shows the number of plants per plot and the average control rating as made by two of the authors on June 19, 1951.

Table III. Number of Plants per Plot, Method of Treatment and Average Control Rating Based on Rating Scale Above.

Plot #	# Plants per plot	Method of Treatment	Ave. Control Rating for plot
1	20	F & B	3
2	15	"	3
3	16	"	2
4	15	"	3
5	14	"	4
6	22	"	1.7
7	22	"	3
8	14	"	3
9	19	B	2.5
10	10	"	3.0
11	12	"	4
12	12	"	4
13	20	"	3
14	22	"	3
15	20	"	3
16	18	"	3.5
17	17	"	3
18	23	"	3.3
19	26	"	3.2
20	23	"	3.0
21	24	"	2.5
22	19	"	2.7
23	23	"	2.4
24	28	"	3.0
25	15	"	2.7
26	19	"	4.0
27	3*	F & B	3.0
28	8*	"	2.4
29	2*	"	3.0
30	11	B	3.0

*The smaller number of plants due to loss of temporary tags and could not be identified later for permanent tagging.

In plots which rated 3 or lower and where the plants leafed out in the spring, defoliation started to occur about mid-July. This would indicate that the herbicide or its effect was still active 10 to 11 months after treatment and that there was a disruption, blocking, or reduction in translocation between the roots and the stem.

On November 13, 1951 several plants in each plot were pulled and the stems, crown and roots examined for any evidence of movement of materials in stems and roots and the effect on root, stem and branch tissue. When root and crown was compared with the injury ratings to top growth Table II, there was a marked difference. Apparent top kill was not necessarily associated with root kill or even root injury except with those materials containing 2,4,5-T.

Those materials containing 2,4,5-T were the only ones which showed any consistent root injury or kill. The extent of movement into the roots appeared to be proportional to the amount of 2,4,5-T applied. Whereas 2,4-D or LV-4 materials moved a maximum of 6 to 8 inches in lateral and vertical roots, 2,4,5-T showed definite injury and apparent translocation up to as much as 4 feet in lateral roots.

Materials which showed none or only slight injury and movement to the roots included ACP-904, LV-4 and ACP-571.

ACP-904 showed no evidence of any movement from the point of basal application either up or down in the stem tissue between the area treated in the basal applications and that not treated, even though the June 19, 1951 observations showed ACP-904 resulted in complete defoliation of the plants. On November 13, 1951 the stem and branch above the point of treatment appeared perfectly normal, as did the roots.

2,4,5-T as a basal treatment in oil at 2, 3 and 4 pounds of acid equivalent, showed the most extensive root injury of any treatments. At rates of 3 and 4 pounds there was evidence of apparent translocation as much as 4 feet in lateral roots. The roots were darker in color, the outer srufacewas spongy and porous and the region of the cortex appeared water-soaked and spongy.

TCA w·hen used as an addative to foliage sprays, showed no increased effectiveness over the same concentration of 2,4-D or 2 ,4,5-T alone.

Discussion

Observations from the 1950-51 experiments support evidence presented in the 1950 paper, that 2,4,5-T is more effective in thorn apple control than 2,4-D or 2,4-D + 2,4,5-T combinations.

The 1950 work was further confirmed in that basal applications of 2,4-D + 2,4,5-T combinations and 2,4,5-T alone resulted in more root injury and better control than the same concentrations of material applied as foliage applications in water or oil-water (1 to 10-90) combinations.

Increasing the amount of 2,4,5-T in a combination or larger amounts of 2,4,5-T alone, increased the overall effectiveness of basal treatment.

The roots of thorn apple plants may remain alive for at least 2 years, even though defoliation has been complete during that time.

The incorporation of materials having high phytotoxic activity in 2,4-D and 2,4,5-T materials tends to limit absorption by causing rapid injury to leaf tissue.

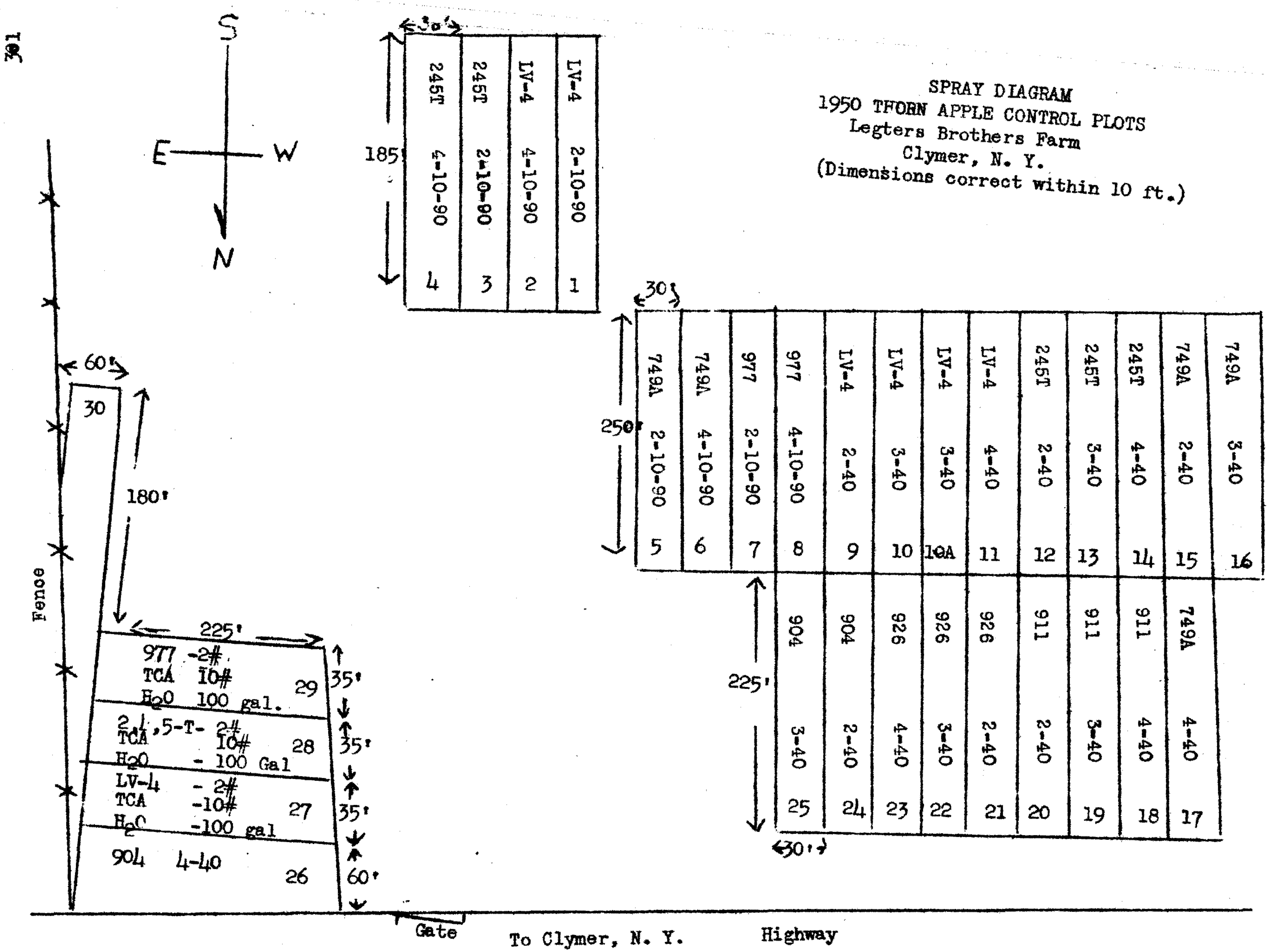
From the examination of the entire plant, including roots, it is evident that basal treatments were more effective than foliage-basal treatments. Plot 6 where plant defoliation was rapid, would indicate that some time is required for absorption of the chemicals from the leaves into the plant and any material which kills or burns the leaf tissue rapidly is not desirable. This confirms work of the previous years where better top kill was obtained using water alone compared to oil-water combinations.

Further work comparing early spring and fall treatments is now in progress.

Literature Cited

1. VanGeluwe, John, Flagg, C. V., Beatty, R. H. and Lacko, E. Progress report on the use of 2,4-D and 2,4,5-T for thorn apple control in pastures. Northeastern Weed Control Conference Proceedings, 5: 235-242. 1950.

SPRAY DIAGRAM
1950 THORN APPLE CONTROL PLOTS
Legters Brothers Farm
Clymer, N. Y.
(Dimensions correct within 10 ft.)



CONTROL OF SCRUB OAK (Quercus ilicifolia) AND ASSOCIATED WOODY SPECIES WITH FOLIAGE AND BASAL SPRAYS

W. C. Bramble, D. P. Worley, and H. H. Chisman*

INTRODUCTION

The problem of controlling bear oak and associated species which occupy thousands of acres of scrub oak barrens in Pennsylvania has confronted foresters for many years in connection with reforestation of such sites with better species (1). Organizations charged with powerline right-of-way maintenance and roadside maintenance through these areas face a difficult problem. Recent efforts to control scrub oak vegetation as a means of preparing planting sites for coniferous trees have met with little success (2). Power line companies through repeated foliage sprays, however, have obtained a certain amount of temporary control and a reduction in height of brush.

The tests described in this report were made with several specific purposes in mind, but are here assembled and described as an attempt to control a definate plant community in its several developmental stages. It is also particularly concerned with the effectiveness basal dormant applications of certain well known weed control chemicals.

DESCRIPTION OF TESTS CONDUCTED

Test #1

Effect of dormant basal sprays on aspen and associated species:

Aspens (Populus tremuloides and Populus grandidentata) are commonly associated with scrub oak in central Pennsylvania where they often invade scrub oak to develop pure stands which overtop and dominate a lower shrub layer composed of bear oak and its other associates. These species also invade areas or fields on scrub oak sites where they become problem weeds when attempts are made to establish coniferous plantations.

In the case here reported, aspen had invaded an old field, along with bear oak and its associates, and trees 1 to 2 inches in diameter and 10 ft. tall overtopped planted white and red pine which were about 3 to 4 ft. in height. The tests of chemical spraying were set up primarily to kill aspen without injuring the pine; the other weed species were also sprayed to relieve competition with the pine.

Treatments consisted of spraying or painting the basal 2 - 3 feet of stem in the winter season with Weedone 245T in a 10 per cent by volume concentration (10 gal. of Weedone 245T in 100 gal. of carrier); Weedone 245T being a 2,4,5-T ester, 3lb. of 2,4,5-T acid per gallon of material. Where oil is indicated as the carrier, kerosene was used. Thus a 10 per cent by volume solution contained 0.3 lb. of acid per gallon of spray. Duplicate 1/10 acre plots were treated in 2 randomized blocks.

Results of the first treatments on aspen applied in March, 1950 are shown in Table 1. In this first treatment, 2,4,5-T in oil (10% Weedone 245T by volume)

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Table 1. Effect of dormant basal sprays of 2,4,5-T (Esteron 245) in 1/10 acre plots on number of living stems per acre of aspen.

Treatment	Mar. 1950 Before Treatment			July 1950 After 1st. Treatment		
Block A	No Stems	Original Stems	Per Cent Kill	New Sprouts	Total Live Stems	Per Cent Reduction
2,4,5-T* in oil (10%)	3930	40	99	1550	1590	60
2,4,5-T** in oil (4%)	4040	100	98	2610	2710	33
2,4,5-T* in water (10%)	5030	4100	18	60	4160	17
2,4,5-T* undiluted	11040	50	99	3020	3070	72
Block B				After 1st. Treatment		
2,4,5-T* in oil (10%)	7830	80	99	2230	2310	70
2,4,5-T* in water (10%)	6800	5670	17	720	6390	6
2,4,5-T* undiluted	3120	160	95	1390	1550	50

Treatment	August 1951 After 2nd. Treatment			
Block A	Stems over 4.5' ht.	Stems under 4.5' ht.	Total Live Stems	Per Cent Reduction
2,4,5-T* in oil (10%)	30***	1300	1330	66
2,4,5-T* in water (10%)	4090	220	4310	14
2,4,5-T* undiluted	300	4280	4580	58
Block B	Without 2nd. Treatment			
2,4,5-T* in oil (10%)	1590	3080	4670	40
2,4,5-T* in water (10%)	5530	450	5980	12
2,4,5-T* undiluted	1040	940	1980	37

*Weedone 245T (3 lb. per gal. of 2,4,5-T acid).
**Esteron 245 (4 lb. per gal. of 2,4,5-T acid).
***All original stems dead.

killed 99 per cent of the original aspen stems; new suckers arose to make the reduction in total stems only 60 to 70 per cent. A lower concentration of 2,4,5-T in oil (4% Esteron 245 by volume) killed 98 per cent; but new suckers were more numberous making the reduction in total number of stems only 33 per cent. A higher concentration (Weedone 245T, undiluted) brushed on the stems, also gave a 99 per cent kill of original stems, and new sprouts arose to make a total stem reduction 50 to 72 per cent. Sprays of 2,4,5-T in water were ineffective and resulted in a 17 to 18 per cent kill of original stems.

The treatments were repeated the following winter on one block of plots (Block A in Table 1) and the second block was left untouched. Water sprays were again ineffective, while 2,4,5-T in oil killed the remainder of the original stems and kept the height of the woody plants at or below 4.5 feet in height. While the aspens continued to sucker even after this second application, the number of stems were again reduced and the planted pine were relieved of overtopping competition. In the plot not given a second treatment, the number of aspen stems doubled and nearly 1/3 were over 4.5 feet in height.

Bear oak and other associated trees and shrubs reacted similarly to the aspen. The effective spray, 2,4,5-T in oil, reduced the number and vigor of nearly all species (Table 2); but the vigorous sprouting species produced new stems after the second treatment. Only red maple was entirely eliminated. However, all the original stems of bear oak were killed and the new sprouts that arose were all under 4.5 feet in height at the end of the growing season, most were under 2 feet in height. Only 19 per cent of the bear oak plants were totally dead without resprouting.

Table 2. Effect of basal dormant spray of 2,4,5-T in oil (10 per cent by volume conc. of Weedone 245T) on trees and shrubs of an Aspen Community.

	Mar.1950 Before Spraying		Aug.1951 After 2 Sprays	
	No. Live Stems Per Acre	Abundance Per Cent	No. Live Stems Per Acre	Abundance Per Cent
Trees:				
Aspen	7550	91	1330	84
Wild Cherry	360	5	80	5
Hawthorn	180	2	100	6
Red Maple	110	1	0	0
Hickory	80	1	80	5
Total	8280	100	1590	100
Shrubs:				
Prairie Willow	9640	71	2600	43
Sumac	2470	18	2610*	44
Bear Oak	1190	9	730	12
Panicled Dogwood	240	2	30	1
Total	13540	100	5970	100

*Numerous new suckers.

The entire effect was a release of the white pine through a reduction in the number and height of the competing brush without markedly altering the species composition of the plant community. Death and serious injury to the planted white pine amounted to but 1 tree in 25, since by the basal spray technique it was possible to avoid spraying pines directly in nearly all cases.

Test # 2

Dormant spraying of woody brush to release planted pine:

In this case an oak-hickory stand with scrub oak in its shrub layer had been clearcut in 1949 to salvage timber following a fire. White pine was planted in openings among the resulting thick brush in the fall. The following winter (Feb. 1950) an effort was made to compare killing back competing brush by means of chemical spray applications with cutting. In 1951 the treatments were repeated.

The method used was to spray the bases of woody stems to 1 - 2 feet above the ground so as to wet them thoroughly on all sides. Duplicate 1/10 acre plots were treated with each of the following sprays:

2,4,5-T in oil	- 2% and 6%, by volume, in kerosene, of Esteron 245 containing 4 lb. of 2,4,5-T acid per gallon
2,4,5-T in water	- 2% and 6%, by volume, of Esteron 245
2,4-D+2,4,5-T in oil	- 2% and 6%, by volume, in kerosene, of Esteron B K containing 1.67 lb. of each acid per gallon
2,4-D+2,4,5-T in water	- 2% and 6%, by volume, respectively, of Esteron B K

The effects of the chemicals in water were not satifactory as they did not kill the tree sprouts which by November 1951, had attained a height of 16 to 18 feet, nor did they reduce the total number of stems per acre (Table 3).

Table 3. Effect of chemical sprays and cutting on all woody stems in a clearcut oak-hickory area.

Treatment	Total no. woody stems per acre Jan. 1950 Before spraying	Aug. 1951 After 2nd spraying	Per cent reduction In No. of stems	Av. ht. Woody Stems (ft.) Aug. 1951
2,4,5-T in oil	125,200	73,550	41	3
2,4,5-T in water	63,150	80,400	none	16
2,4-D+2,4,5-T in oil	135,100	97,450	28	4
2,4-D+2,4,5-T in water	66,700	84,300	none	18
Cutting	90,100	131,000	none	3

The most effective spray proved to be 2,4,5-T in oil which reduced tree sprouts from 2725 per acre to 260 per acre (Table 4), and held their height to 3 feet. This spray reduced the total number of stems 41 per cent. Combined, 2,4-D and 2,4,5-T in oil was less effective, reducing the total number of stems only 28 per cent.

Table 4. Effect of 2,4,5-T in oil on tree stems arising as sprouts in clear-cut oak-hickory area.

Species	No. stems per acre Jan. 1950 Before spraying	No. stems per acre Aug. 1951 After 2nd. spraying	Per cent Reduction
Red Maple	1750	10	99
White Oak	370	25	93
Sassafras	205	30	[illegible]
Cherry	190	160	16
Hickory	120	0	100
Scarlet Oak	90	35	61
Total	2725	260	90

Unfortunately, the oil sprays killed 77 per cent to 80 per cent of the planted white pine as it was impossible to miss spraying the small trees among the brush, (Table 5). On water spray plots, 32 per cent of the pines died, while on cutting plots mortality was 26 per cent.

Table 5. Effect of chemical sprays on planted white pine seedlings.

Treatment	No. trees per acre Jan. 1950 Before spraying	No. trees per acre Aug. 1951 After 2nd.spraying	Per cent Survival
2,4,5-T in oil	465	95	20
2,4,5-T in water	550	380	69
2,4-D+2,4,5-T in oil	475	110	23
2,4-D+2,4,5-T in water	515	350	68
Cutting	420	310	74

Test # 3

<u>Effect on a roadside scrub oak community of chemical sprays compared with cutting:</u>

In this case the vegetation consisted of a dense scrub oak community on a roadside curve where brush clearance was desired to improve vision.

Treatment was given to two randomized blocks of plots, each 2 milacres in area, using the following chemicals and concentrations:

2,4,5-T in oil - 5% by vol. in kerosene of Esteron 245 containing 4 lbs. of acid per gal.

2,4-D ester in oil - 5% by vol. in kerosene of Esteron 44 containing 3.34 lbs. of acid per gal.

2,4-D+2,4,5-T in oil - 5% by vol. in kerosene of Esteron B K containing 1.67 lb. of each acid per gal.

The first spray on freshly cut stubs in March, 1949, reduced the number of stems considerably; but did not give promise of freeing the roadside of brush, or of giving adequate control (Table 6).

Table 6. Effect of chemical treatments compared to cutting on woody stems of a roadside community.

Chemicals used	Total no. stems per 2 - milacre plot: Mar.1949 Before Spraying	June 1949 After dormant Stub spray	July 1950 After foliage Spray	August 1951 After dormant Basal spray	Per cent Reduction
2,4,5-T	287	64	168	7	98
2,4-D ester	374	99	143	83	78
2,4-D+2,4,5-T	346	80	135	85	75
Cutting	280	326	110	144	48

The most effective spray, 245-T in oil reduced the number of stems per acre from 143,500 to 32,000, a reduction of 78%.

A second spray was therefore applied to the plots in June 1949, as a foliage spray using water as a carrier. This treatment did not prove effective in reducing the number of stems (Table 6).

The plots were then allowed to grow for 2 growing seasons (1949 and 1950). In the winter of 1950, a basal spray was given to all plots using the same chemicals and concentrations in oil as in the first sprayings. The results tabulated in August 1951, showed a near elimination of stems on the 2,4,5-T in oil plots (287 stems to 7 stems) and those left were all small shoots from sprouts formed in 1951.

The height of brush was greatly reduced by the 2,4,5-T in oil, dormant basal spray which was more effective than cutting in this respect (Table 7). A very sparse and low shrub cover resulted from this spray, and for a time at least, even the herb cover was greatly reduced leaving bare soil exposed (Table 7). Fortunately, erosion was not evident, or serious, owing to the mat of litter on the ground and the short slope exposed. On longer slopes erosion might be serious.

Table 7. Comparison of height of woody brush after treatments with chemicals and cutting.

Treatment	Nov. 1951: Average ht. of brush (ft.)	Herb cover in percent
2,4,5-T in oil	1.25	8
2,4-D ester in oil	2.55	97
2,4-D+2,4,5-T in oil	3.55	38
Cutting	2.40	100
Uncut Brush	5.00	100

The effect of the series of three treatments with 2,4,5-T on species composition of the scrub oak community is shown in (Table 8). These plots were first cut in March 1949 and the stubs sprayed with a 5 per cent by volume oil solution of Esteron 245. In the early summer of 1949, they were given a foliage spray of 5 per cent by volume Esteron 245 in water. And finally, were given a basal spray of Esteron 245 in oil, 5 per cent by volume, in March 1951. All woody species except hawthorn, sumac, and greenbrier were eliminated by August 1951. The species left were represented by small 1951 sprouts or suckers.

Table 8. Effect of 2,4,5-T sprays on species composition of a scrub oak community.

Species	Mar. 1951 Before cutting and spraying		Aug. 1951 After 3rd spray		Per cent change
	No. stems	% Abundance	No. stems	% Abundance	
Scrub Oaks	53	19	0	0	-100
Dewberry	65	21	0	0	-100
Hazelnut	40	14	0	0	-100
New Jersey Tea	33	12	0	0	-100
Hawthorn	29	10	3	43	- 90
Panicled Dogwood	28	10	0	0	-100
Prairie Willow	14	5	0	0	-100
Choke Cherry	9	3	0	0	-100
Wild Rose	6	2	0	0	-100
Trembling Aspen	5	2	0	0	-100
Smooth Sumac	2	1	3	43	+ 50
Allegheny Plum	2	1	0	0	-100
Raspberry	1	0.5	0	0	-100
Greenbrier	0	0	1	14	+100
Total	287		7		- 98

Test # 4

Effect of foliage sprays on a scrub oak community:

In this case a typical scrub oak thicket was treated with various foliage sprays after cutting in an attempt to reduce, or eliminate, the vigorous sprouts that usually arise, and thus to open the area for planting with coniferous tree seedlings. The treatments were applied in August 1949 to sprouts that had arisen following clearcutting of all stems in August 1948. Duplicate plots, each 300 sq. ft. in area, arranged in randomized blocks were sprayed with the following chemicals in 5 per cent by volume solutions at a 72 gal. per acre rate of application.

1. Esteron 245 - 4 lb. of 2,4,5-T acid per gal., used in water.
2. Esteron 44 - 3.34 lb. of 2,4-D acid per gal., used in water.
3. Esteron BK - 1.67 lb. of 2,4-D acid plus 1.67 lb. of 2,4,5-T acid per gal., used in both water and kerosene.
4. Ammate - Used in a 2.35 lb. per gal. of water solution.

The effect of foliage sprays of the various chemicals named above fell far short of the desired goal, namely, to reduce the scrub oak and associated species to a point where planting the area with conifers was possible without severe competition from hardwood brush. Similar results have been reported with chemical foliage sprays in the Pocono scrub oak area (2). The second year after spraying, September 1951, scrub oak brush cover was hardly affected and the height of brush on the chemically treated plots was put slightly less than that of the cut plots. Owing to the expense involved in the preparing a planting site by this method treatments were not repeated. Chemical costs per acre amounted to as much as 50 dollars.

Summary

The more important effects that chemical sprays appeared to have on scrub oak and associated species may be summarized as follows:

1. Single foliage sprays as applied in these tests did not give effecteve control.

2. Basal dormant sprays of 2,4,5-T in oil eliminated woody plants under conditions where thorough coverage could be given to each plant; in dense low brush reduction in number of stems and height, only, was achieved by repeated sprays.

3. Where large stems were treated by directive spraying, planted pine were safely released with dormant oil sprays; but general spraying of brush with oil sprays killed most of the planted white pine.

4. Species such as aspen and sumac, which sucker from roots, were killed back by dormant basal sprays of 2,4,5-T in oil; while water sprays were ineffective. However, such species suckered vigorously and required at least a second treatment for effective control.

5. Bear oak was effectively killed back by dormant basal sprays of 2,4,5-T in oil; and two sprayings reduced sprouting to a point of temporary control and released planted pine.

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EXPERIMENTS ON THE CHEMICAL CONTROL OF HARDWOODS IN NORTHEASTERN FORESTS[1]

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In the course of many silvicultural operations it is necessary to eliminate or control the growth of undesirable trees. The weeding out of certain hardwoods, usually to favor the growth of pine or some other conifer, has been widely practised in northeastern forests. In the past, foresters have relied almost exclusively on mechanical means of eliminating trees and brush. Not only are such measures time-consuming and costly, but they may only temporarily restrain the undesirable competition, since most hardwoods sprout vigorously when cut down. Early in the search for more effective and economical methods of control, the possibility of using various chemicals was investigated. However, only recently, with the advent of new chemicals, has this become a really fruitful approach to the problem.

In the last few years, an enormous amount of research has been done on chemical methods of controlling woody plants. This burst of activity is due in large part to the development and application of the hormone-related chemicals. These compounds, which are structural analogues of a natural plant growth substance, are toxic to plants in low concentrations and non-toxic to animals and man. Already in extensive agricultural use as herbicides, they are now widely used to control brush on utility rights-of-way, roadsides, pastures, and range lands.

More recently, a beginning has been made in the investigation of possible uses of these substances in silvicultural operations. It was for this general purpose that some experiments have been carried out at the Harvard Forest in Petersham, Massachusetts. Before actually making extensive applications of these chemicals, it was first necessary to test the physical possibilities, with a view to determining the most effective types of treatment for solving the particular problems arising under the local conditions. The experiments reported here were designed to test the effectiveness of the hormone-like chemicals in controlling the growth of some species which have constituted a major problem in the management of this forest. Mention will also be made of some preliminary silvicultural applications of the new methods.

Materials and Methods

In addition to testing various chemicals, it seemed important to investigate the following points: the influence of the carrier, the amount and concentration of chemical required, and the method of application. From the

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literature, it seemed clear that the chemical formulations most likely to be best suited to our needs were the mixture of the esters of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) and the 2,4,5-T ester alone, both of which are effective on a wide range of woody plants. Mixtures of the two esters were obtained in the commercial preparations, "Esteron brush killer", containing an equal mixture of the propylene glycol butyl ether esters, and "Weedone brush killer 64", containing a 2:1 (D:T) mixture of the butoxy ethanol esters; 2,4,5-T alone was obtained as "Esteron 245" or as "Weedone 2,4,5-T".[2] The carriers tested were water and kerosene.

Concentrations of the chemical in the final solution may be expressed in several different ways. In this report, they will be calculated making the approximation the "per cent total acid equivalent" (TAE) listed for commercial preparations is a per cent by volume. (The error arises from the fact that the specific gravity of the preparation is greater than one.) Thus, a 10-fold dilution by volume of a "43% TAE" (by weight) solution gives a 4.3% solution. Regardless of the carrier employed, a 1% solution contains 1.1 grams of chemical (AE) per 100 cc. of solution. Since the effect of any treatment is likely to be a function of the amount of chemical applied per plant, the volume used to treat a given number of trees (of various species) was recorded, and an average volume per tree then calculated. (Of course such an average does not take into account species differences, such as the thickness of the bark, which might introduce a systematic error, as might result from regularly applying more solution to thick-barked oaks than to thin-barked red maples.) From the concentration and volume the average amount (in grams) applied can be calculated.

The method used to apply the chemical will depend entirely on the purpose of the treatment. Since we are interested in developing selective methods of treating individual trees in silvicultural operations, relatively little was done with such non-selective methods as foliage spraying. Further, the size of the trees to be treated affects the type of application. Since we are most concerned with trees ranging from 5 to 20 feet in height, cut stump and basal-bark treatments were chosen for investigation. Economical and effective methods of permanently preventing sprouting from hardwood stumps and of killing standing trees without preliminary mechanical treatment, as by basal spraying, could be of great value to the forester. In most cases, the solutions were sprayed on stumps or on the base of the stem with an ordinary 3-gallon garden sprayer, which can be slung over one shoulder. Several types of nozzles were used, although most of the work was done with a "Teejet 8001" nozzle. In some cases, applications were made with a coarse paint brush. Trees were cut to stump (average about 6 inches in height) with a machete or small hand saw, and solutions applied, usually within an hour, to the sides as well as to the cut surface of the stump. When spraying basally, the stem was treated all around from the ground up about 6 inches.

Most of the applications were made during the summer of 1950. Recent

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[2] The author wishes to thank the American Chemical Paint Company and the Dow Chemical Company for supplying the chemicals used in these experiments.

studies have demonstrated the feasibility of dormant-season applications, and since this might be of real practical advantage to the forester, some tests were made in the winter of 1950. No systematic test was made of the effect on the treatments of either the weather conditions or the time of day. At the time of the winter applications, there were several inches of snow on the ground, and in some cases, light snow was falling.

The area on which most of the tests were carried out had previously supported an old-field pine stand. This was almost completely destroyed by the 1938 hurricane, and the area was subsequently cut over in a salvage operation. It is now completely occupied by the succeeding hardwoods. Experimental plots of varying size were laid out. In most cases, individual trees within each plot were tagged and numbered, at which time the species and size were recorded. The results of the treatments were observed during the summer of 1951. In the case of treated stumps, the presence or absence of sprouts was noted. For basal applications, the principal criterion of effectiveness was the appearance of the foliage. Accordingly, trees were classified as "apparently dead", with no green leaves, "seriously injured", "slightly injured", or "apparently unaffected." In addition, the condition of the cambium both at the base and at breast level was observed.

Results and Discussion

In these experiments, the following species were treated: red maple (Acer rubrum), red oak (Quercus rubra), black oak (Quercus velutina), gray birch (Betula populifolia), paper birch (Betula papyrifera), yellow birch (Betula lutea), black birch (Betula lenta), black cherry (Prunus serotina), and pin cherry (Prunus pennsylvanica). In presenting the results, the various oaks, birches, and cherries have been grouped together, since there were no striking differences in reaction within a genus. To simplify the data, the various size classes have also been grouped together. In general, the basally treated trees were between 5 and 20 feet in height, averaging around 10 feet; the stumps were between 1/2 and 4 inches in diameter, averaging between 1 and 2 inches. Stems of both seedling and sprout origin were used; each member of a clump was counted as an individual stem. In some cases all the members of a sprout clump were treated, and in others only selected stems were used. The results of the 1950 experiments were observed early in June and late in August of 1951. The data given are based on the later reading.

The results of the experiments are shown in Tables 1-2 for basal treatment and 3-4 for stump treatment. It is clear that either the 2,4-D--2,4,5-T mixture or 2,4,5-T alone in the appropriate carrier and in adequate amounts can kill standing trees by basal application or prevent sprouting from cut stumps. A most striking result is the almost complete ineffectiveness of basal sprays when the carrier is water, even with relatively high concentrations of the chemicals. Although some stems treated in this way show signs of serious injury, very few can be classed as "apparently killed".

Table 1. Effects of basal applications of a mixture (1:1) of the esters of 2,4-D and 2,4,5-T (Esteron brush killer) during the summer (S, June 30-August 12), and in the winter (W, Dec. 30), of 1950. In all cases the carrier was kerosene, since little effect was obtained with the chemicals in water.

Per cent apparently killed

Concentration	10%	5%	4.3%	3%				2%	1%
Average amount (grams) per stem	6.6	3.1	1.9	2.0	1.2	0.4	2.6	1.3	0.6
Season of application	S	S	S	S	S	S	W	S	S
Red maple	100+	100	100	100	87	55	100	96	100
Oak (black, red)	100	100	91	100	100	82	87	100	100
Birch (gray, paper, yellow, black)	100	100	100	89	100	(50)++	84	100	88
Cherry (black, pin)			100	100	100	(33)		100	(100)

\+ In this and subsequent tables, underlined figures are based on 20 or more stems.

++ In this and subsequent tables, figures in parentheses are based on less than 5 stems.

Table 2. Effects of basal applications of 2,4,5-T ester (Esteron 245) in late summer (S, September 8) and winter (W, December 30) of 1950. In all cases the carrier was kerosene, since little effect was obtained with the chemicals in water.

Per cent apparently killed

Concentration	5%	3%		1%		0.5%	
Average amounts (grams per stem)	4.8	1.0	2.1	0.4	0.8	0.2	0.4
Season of application	W	S	W	S	W	S	W
Red maple	100	100	100	100	90	86	100
Oak (black, red)	39	100	80	(100)	83	100	33
Birch (gray, paper, yellow, black)	100	100	89	50	(100)	50	50
Cherry (black, pin)	(0)	100	(66)	(75)		(33)	

Table 3. Effects of stump applications of a mixture of 2,4-D and 2,4,5-T esters (Esteron brush killer) during the summer (S, July 13-August 12) and winter (W, December 31) of 1950.

Per cent of stumps showing no sprouting

Carrier	Kerosene					Water				
Concentration	5%	3%		1%		3%			1%	
Average amount (grams) per stem	3.3	2.0	1.4	0.7	0.4	2.2	0.9	3.0	0.9	0.3
Season of application	S	S	W	S	S	S	S	W	S	S
Red maple	100	100	100	100	66	88	75	87	60	82
Oak (black, red)	100	100	100	33	(100)	92	(50)	100	86	38
Birch (gray, paper, yellow, black)	100	100	100	100	100	86	100		50	(100)
Cherry (black, pin)	100	100		100	(50)	100	(100)		80	(67)

Table 4. Effects of stump applications of 2,4,5-T ester (Esterone 245) in late summer (S, Sept. 16-18) and winter (W, December 28-December 31) of 1950.

Per cent of stumps showing no sprouting

Carrier	Kerosene					Water		
Concentration	3%	1%		0.5%		3%	1%	0.5%
Average amount (grams) per stem	1.0	0.2	0.5	0.1	0.3	1.8	0.3	0.1
Season of applications	W	S	W	S	W	W	S	S
Red Maple	100	100	100	100	100	92	100	0
Oak (black, red)	100	(100)	86	(100)	75	(33)	(0)	(0)
Birch (gray, paper, yellow, black)	100	100	89	100	90	36	0	0
Cherry (black, pin)	80			100		60		

For example, of a total of 247 red maple stems treated with various concentrations of the two formulations in water, only 8 were apparently killed. This general pattern applies to all species tested. It appears that when these chemicals are suspended in water they do not readily penetrate through the bark.

On the basis of the data given in these tables we can compare the two chemical preparations. For red maple, 2,4,5-T alone is more effective than the D-T mixture, regardless of the method of application. For example, a 1% solution of T in kerosene applied in the summer completely prevented sprouting from cut stumps, whereas a similar treatment with D-T stopped sprouting in only 66% of the cases, in spite of the fact that the average amount of chemical per stump was twice as great in the latter case. Similarly with the oaks, both basal and stump applications of T in kerosene are more effective than comparable treatments with D-T; however, it is possible that the reverse is true for stump applications when the carrier is water. With basal sprays on birch and cherry, there are no clear-cut differences between the two preparations.

It is of interest to compare the effectiveness of a given concentration or amount of chemical when applied by the two different methods. Whereas aqueous solutions were almost completely ineffective when applied basally, they were able to prevent much of the sprouting from cut stumps of all species tested. A 1% solution of D-T in water applied at the rate of 0.3 g. per red maple stem caused 0% kill of standing trees but prevented sprouting from 84% of the stumps. This difference must be correlated with the presence of a cut surface, through which the chemicals can enter the stem more readily. Although aqueous solutions can prevent sprouting, much greater amounts of the substances are required than when kerosene is used as the carrier. For example, we see in Table 4 that the application of an average of 0.1 gram of T per red maple stump with a 0.5% solution in kerosene completely prevented sprouting, whereas all the stumps sprouted when the same amount was applied in water. The greater ability of the oily solution to penetrate the bark seems to be an important factor for stump, as well as basal, applications. When the chemicals are mixed with kerosene, there is a general similarity in the effectiveness of the two methods, although in most cases the stump treatments are somewhat more effective. Thus, a concentration of T which completely prevented sprouting from stumps resulted in less than 100% kill when applied basally, in spite of the fact that the average amount applied per stem was twice as great; such a case can be found for each of the species groups. Since the total volume of tree through which the chemical must be distributed is so much greater in the case of basal applications, this finding is not at all surprising.

Although both summer and winter applications have proved successful, where comparisons are possible it appears that treatments made during the dormant season are less effective. Whereas this difference is relatively small for red maple, it seems to be very real in the case of the oaks and birches. As can be seen in Table 2, with three concentrations of T applied basally to oaks there was less effect during the winter, in spite of the fact that twice the amount of chemical was used. Similarly, in Table 4 we see that the summer application of 0.1 g. of T per birch stump with a 0.5% solution in kerosene was more effective than 3 times this amount applied in the winter.

A point of some interest is whether or not the effect of a given amount of chemical is independent of the volume in which it is applied. Although it was originally hoped that these experiments would shed some light on this question, the above data do not justify any conclusions. In general, one is left with the impression that this is not a critical point and that the amount of material applied per tree is the most significant factor. There are some exceptions to this. For example, 0.6 g. of D-T applied basally in a 1% solution on red maples caused a greater % kill than 1.2 g. put on in a 3% solution. On the other hand, 0.9 g. of D-T in water was more effective on red maple stumps when applied as a 3% solution than as a 1% solution. It may be that a large volume of a less concentrated solution is preferable only in the case of basal applications.

From the above tables we can get an approximate estimate of the amount of chemical required to give complete control by any given method of treatment. Values of the smallest amounts of chemical which gave such control in some of these experiments are given in Table 5. These do not represent critical minimum values, but they do indicate the general order of magnitude of the amount required for effective treatments. In this table, we can see the general superiority of T over D-T and of stump over basal treatments. The responses of the various species are quite similar, although the birches seem somewhat less sensitive to basal sprays. Quantitative comparisons between species may be confused by morphological differences, such as the thickness of the bark. If large enough volumes are used, a 1% solution of these chemicals in kerosene should be adequate for basal spraying and a 0.5% mixture could be used for stump applications of 2,4,5-T.

Table 5. Smallest amounts of chemical which caused 100% apparent kill of standing trees or completely prevented sprouting from stumps. Applications made during the summer, and kerosene was the carrier in all cases.

Chemical	D-T		T	
Method	Basal	Stump	Basal	Stump
Red maple	0.6	0.7	0.4	0.1
Oak	0.6	0.4*	0.2	0.1
Birch	1.2	0.4	1.0	0.1
Cherry	0.6	0.7	1.0	0.1

* This value is based on less than 5 stems, and 0.7 grams did not completely prevent sprouting.

From the data of Table 5 we can get an estimate of costs per tree of various treatments. If we assume that a gallon of a commercial preparation, containing 1816 grams (43% TAE), costs roughly $10.00, the chemical itself costs 0.55 cent per gram. Kerosene was purchased locally at roughly 15 cents per gallon. One gallon of a 1% solution of chemical (41.6 grams) in kerosene would thus cost 22 plus 15 or 37 cents. If this solution is applied at the rate of 0.5 g. per tree, it could be used for 83 trees and the cost would be roughly one-half cent per tree; for 0.1 g. per tree it would be one-tenth cent. To this figure the cost of labor, which would be very much greater, would have to be added.

In addition to the work with D-T and T preparations described above, several other experimental formulations were tested as basal sprays. Preparations of 2,4-D acid and of an amine of 2,4-D (obtained from the American Chemical Paint Company) emulsified in water were quite ineffective. Likewise, an amine of 2,4-D in kerosene killed only a few stems.

We were also interested in knowing how effective basal sprays would be on somewhat larger trees. To test this point, a large plot was laid out in an area that had been clear-cut in 1928. The trees in this area are up to 30 feet in height and have a breast-high diameter of 2 to 8 inches. Solutions were sprayed on the bark from the ground up to 6 to 12 inches so as to wet it thoroughly. Of these larger trees, the red maples (2 to 4 inches d.b.h.) were the most susceptible to this type of treatment. Five per cent solutions of D-T and T in kerosene gave almost complete kill, while over 50% of the trees treated with 3 and 1% solutions were classed as "apparently killed", the remainder being "seriously injured". Five per cent solutions apparently killed over half the oaks, most of which had a d.b.h. of 4 to 6 inches; lower concentrations however caused only serious injury. The large birches, particularly yellow birch, were quite resistant even to the more concentrated solutions. Because of the size of these trees, rather large volumes of solution are required to completely wet the base. It is clear that if this is done, large red maples and red oaks can be killed by basal spraying. The considerable variation among the species is probably due to differences in the structure and thickness of the bark. For trees with a d.b.h. of over 5 inches it may well be that it is more economical to apply the chemical to cuts, such as frills or notches, in the trunk.

In the course of these experiments a considerable number of observations, most of which have been previously reported, were made on the response of the trees to these treatments. Among these are the following: the effects, such as the curling of leaves and changes in foliage coloration, of basal sprays in kerosene may be seen within a week; these effects characteristically develop downward and inward from the top and outermost regions of the tree; trees treated basally in the winter or fall form small leaves in the spring and these subsequently die back; evidences of persistence of the growth substances in the tree for over a year can be seen; these chemicals frequently cause a splitting of the bark and the proliferation of callus-like tissue on the stem; sprouts frequently originate from previously treated stumps in the transition zone between root and stem; the leaves of these sprouts may subsequently show modifications characteristic of hormone treatment.

Silvicultural Applications

In addition to the above experiments, some attempts were made to use these new methods of controlling hardwood growth in trial silvicultural operations. The first case was designed to test a chemical weeding, by basal spraying, of a young spruce plantation. On this area there was formerly a stand of scrubby old-field white pine. Clear-cut in 1934, the area was planted in 1938 with white spruce; at this time there were a few hardwood sprouts present. By 1944, the spruce stand was badly suppressed by a variety of poor-quality hardwoods. In that year the stand was mechanically weeded (with machetes) in such a way as to release every spruce from overhead competition. In spite of this treatment, by 1950 the hardwoods were again competing seriously with the spruce. Under the circumstances, another weeding seemed desirable. Instead of carrying out a second mechanical weeding, part of the plantation was treated chemically. This was done by spraying the basal portion of the stems of all the hardwoods in the area with 3% solutions of either T (Weedone 2,4,5-T) or D-T (Weedone Brush Killer 64) in kerosene. The trees were largely red maples, oaks and birches, averaging between 10 and 15 feet in height. The spraying was done on September 6-7, 1950, and the area was observed periodically during the following summer. Practically all of the hardwoods in the area were "apparently killed" (i.e. without any green leaves) one year after treatment. The spruce definitely appears to have been released, probably permanently, from the competition with overtopping hardwoods. No obvious injury to the spruce in the area could be detected, and they seem to have grown vigorously during the 1951 season.

Having shown that basal spraying of these chemicals is an effective and probably permanent way of weeding out hardwoods from a young coniferous plantation, it remains to demonstrate the economic feasibility of this practice. In terms of labor, it would seem that such an operation would cost less than a comparable mechanical weeding, during which all the hardwoods would be individually cut down. On the other hand, there would be the additional cost of the chemical and carrier. However, it must be remembered that the expense of a single, permanent chemical weeding must be compared with the cost of repeated mechanical operations, the exact number varying widely under different conditions. The necessary data on this point can only be acquired by careful time-cost studies of actual operations, preferably on a fairly large scale. As yet, we do not have such data.

The second silvicultural application was carried out by the Forest woods-crew, in the course of a cutting operation. The object of the treatments was to prevent sprouting from the cut stumps in order to favor the growth of trees of seedling or seedling-sprout origin. To accomplish this, all stumps over 2 inches in diameter were sprayed with a 2% solution of D-T (Esteron Brush Killer) in kerosene shortly after cutting. Fifteen gallons of solution were used to spray 666 stumps, varying in size from 2 to 12 inches, on a total area of 2.6 acres. This was done in August, 1951, and it is not yet possible to assess the value of the treatment. It seems from preliminary data that the labor constitutes the major fraction of the cost of such a treatment, suggesting that experiments should be carried out to devise techniques for reducing the time involved in applying the chemical.

Some Aspects of Dormancy and Germination of Crabgrass Seed, Digitaria sanguinalis Scop.

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Hairy Crabgrass, Digitaria sanguinalis, is a major weed in many areas of the United States. Present day crabgrass herbicides are primarily useful for contact killing of existing plants. Repeated applications are required, resulting in costly and often unsatisfactory control. Gianfagna has obtained data (Table 4) under Long Island conditions which indicate that crabgrass seeds germinate over a long period of time. Heavy summer rains are characteristic of the annual rainfall pattern for New York State and erosion is serious at such times. Heavy rains may disturb the soil sufficiently to bring more seed to the soil surface and to break or scratch the seed coats. The data (Table 4) are from clean cultivated gladiolus fields where heavy rains would likely disturb the soil surface. In general the soil surface is not disturbed in lawn areas by cultivation equipment. Worms, moles, et cetera might bring seed to the soil surface but it is doubtful whether they are responsible for the continued supply of viable seed at the soil surface.

Present knowledge of the nature of dormancy in crabgrass seed is inadequate to explain its prolonged germination. The present studies were undertaken to explore this phase more completely.

Review of Literature

Pladeck (1) found that at constant temperature freshly matured crabgrass seed germinated from 2 to 5% but if allowed to after-ripen for several months its germination ranged from 40 to 75%. Toole and Toole (2) in using daily temperature alternations of 20° and 40°, 20° and 35°, 20° and 30°, and 15° and 25°C, found that it required 196 days for complete germination of fresh crabgrass seed. But one year old seed germinated in 14 days or less at the foregoing temperatures. Prechilling and abrasion also induced germination, suggesting that certain changes in the seed coat or the embryo must take place before germination starts. Watson (3) observed that the germination of crabgrass seeds increased with increasing soil moisture content but decreased as the degree of soil compaction increased.

Materials and Methods

In this paper dormant seed refers to those crabgrass seeds which fail to germinate within a reasonable length of time when given optimum temperature and moisture. Non-dormant crabgrass seeds are those seeds which normally germinate within 5 to 7 days when given optimum temperature and moisture. Seed designated non-dormant had been collected in September 1948 at Farmingdale, Long Island, New York from field plants by hand-picking the brown, fully mature inflorescences. The inflorescences were lightly rubbed to remove only mature seeds which were then stored in cardboard containers at room temperature. After 2 years of dry storage, non-dormant seed tested 95 to 98% germination, indicating that it was thoroughly after-ripened and viable.

Dormant seeds were obtained from greenhouse-grown plants in the summer of 1950. Both types of seeds were cleaned with the "Clipper Grain and Bean Cleaner" to remove stamens, stigmas, chaff and undeveloped fruits. This method of cleaning afforded seed of uniform size.

Germination tests were made in the laboratory only and followed "Rules and Recommendations for Testing Seeds" (4). Although the seeds were not sterilized, molds rarely appeared. To establish the percentage germination, 50 or 100 seeds were counted at random from the experimental sample and sown on moistened filter paper in 90 mm Petri dishes. Germination tests were usually conducted at a constant temperature of 30°C in light of 100 to 200 foot candles for 14 days.

Seeds were placed to germinate in various oxygen pressures maintained in 6000 ml desiccators. The gas mixtures were prepared by flushing the desiccators with nitrogen. The resulting gas mixture was analyzed at the beginning and at the end of the experiment with the Hays Improved "Orsat" Gas analyzer.

Experimental Results

Gianfagna and Pridham (5) have reported that dormancy of crabgrass seed could be overcome by 1) puncturing the seed coat, 2) scarifying the seed coat, 3) removing the glumes, 4) soaking in ethylene chlorohydrin, or 5) aging the seeds in dry storage. Tests for water absorption showed that the seed coat of dormant seed is permeable to water. Subjecting dormant seed to increased oxygen pressures failed to cause the seed to germinate while low oxygen pressures inhibited the germination of non-dormant seed. The possibility of a germination inhibitor as a cause of seed dormancy was also reported.

Effect of puncturing dormant seed on germination. Seed of various ages, as indicated by browning and shrivelling of the stigmas, was punctured with a fine sewing needle in the middle portion of the endosperm. Preliminary observations indicated that the stigmas turn from light green to brown within a relatively short period of 2 to 3 days. The date of the browning of the stigmas in the middle portion of the inflorescence was noted and the age of the seed determined from such date.

Table 1. Effect of Puncturing Dormant Intact Seed on % Germination When Placed in Light of 100 Foot Candles at 30°C for 14 days.

Days after Browning of the Stigmas	Treatments	No. of Seeds Germinated** Rep. 1	Rep. 2	Average % Germination
7	Punctured	47	45	92
	Control*	0	0	0
14	Punctured	34	46	86
	Control	1	1	2
60	Punctured	44	42	80
	Control	0	0	0

* Unpunctured

** Seeds per Replicate

The data which appear in Table 1 suggest that the embryo of freshly matured seed is fully developed and ready to germinate when the stigmas turn brown. Therefore, to prevent the production of new seeds the inflorescence should never be permitted to develop or should be destroyed before the flowers mature. Germination was practically the same for all punctured seeds, indicating that the dormancy does not become more pronounced as the seed ages. Increase in germination does take place gradually in untreated seed.

Effect of soaking dormant seed in ethylene chlorohydrin on germination. Ethylene chlorohydrin has been used as a dormancy breaking agent by Denny (6) and others. Three gram samples of dormant seed were soaked in ethylene chlorohydrin solutions of varying strength at atmospheric pressure and 30°C for 48 hours. The solution was decanted and the seeds placed to germinate on filter paper moistened with water.

Table 2. Effect of Soaking Dormant Crabgrass Seeds 60 Days Old in Ethylene Chlorohydrin* on Per Cent Germination.

P P M E C*	Water Control	25	50	125	250	500	1000
% Germination	0.5	2	7	26	80	96	75

Optimum germination was obtained by soaking dormant crabgrass seeds in 500 ppm of ethylene chlorohydrin. Germination within the ethylene chlorohydrin treatments was completed within 3 to 5 days after the seeds were placed to germinate.

Reduced oxygen supply retards germination in non-dormant seed. Both dormant and non-dormant seeds were exposed to varying partial pressures of oxygen. Dormant seed failed to germinate in oxygen pressures ranging from 21% to 98% oxygen by volume, indicating that the seed coat of fresh seed may be impermeable to oxygen. It is evident from the data in Table 3 that the oxygen supply must be reduced drastically to prevent germination of non-dormant seeds. At 1% oxygen the seeds may have been killed or forced into a condition of secondary dormancy.

Table 3. Effect of Varying Partial Pressures of Oxygen on Per Cent Germination of Non-Dormant Crabgrass Seeds (2 years old).

% Oxygen	1	2	5.5	12.5	15	21	40	67	86	98
% germ. during O_2 exposures for 14 days	0	42	65	98	92	97	100	100	98	96
Subsequent % germ. after exposures to normal air for 14 days	65	95	98	99	98	98	--	--	0	0

Periodicity of Germination. Plots 32 square feet in size, 4 replicates each, were planted to gladiolus. The first weeding for all plots consisted of hand cultivation, while the second and third weedings were by hand cultivation or soil sprays of contact herbicides. Each plot was weeded three times during the growing season. The contact soil sprays had no residual effects and substituted for a hand cultivation.

The results which appear in Table 4 show that on Long Island crabgrass seeds begin to germinate as early as May 25 and continue through September 15 with new seedlings appearing about three or four weeks after each weeding. Cultivated plots on the average had slightly more crabgrass than plots chemically treated. This is undoubtedly due to the fact that in cultivated plots seeds are continually brought to the surface where they have optimum germination conditions whereas in the chemically treated plots the soil is not greatly disturbed. The reduction in number of crabgrass plants in the uncultivated plots as the season progressed was due to a severe drought during the latter part of June and early July.

Summary

Crabgrass seed (Digitaria sanguinalis) was grown under controlled conditions and harvested at specific periods after the stigmas turned brown and withered.

Failure of seed to germinate when placed under suitable environmental conditions indicated that freshly harvested seed is dormant. Germination was induced in otherwise dormant seed by puncturing the seed coat or soaking the seed in ethylene chlorohydrin 500 ppm, while untreated seed failed to germinate.

Reducing the oxygen supply to 1% prevented complete germination of non-dormant seed. Upon exposure to normal air, germination took place but was less than that at higher oxygen concentrations, indicating that the seeds may have been killed or forced into a condition of secondary dormancy.

Continued germination, May 25 to September 15, may be due to the continued renewal of the seed supply in the germination zone by the erosion and abrasive action of heavy rains or cultivation equipment. Under the conditions of this experiment, however, it is unlikely that current season's seed is a major source of reseeding for September or late summer infestation of crabgrass since seed of known age up to 60 days failed to germinate promptly unless subjected to special treatment.

Interrupted germination or induced dormancy from localized water deficit, accumulation of carbon dioxide or liberation of growth inhibitors by companion plants might prolong the period over which germination may take place. Abrasive action may play a part in breaking secondary dormancy.

Table 4. The Periodicity of Germination of Digitaria sanguinalis in Gladiolus Cultivated and Chemically Weeded from May 27 to September 17, 1949.

Soil Treatment (May 27)	Average Number Plants/sq. ft. (June 16)	Soil Treatment (June 17)	Average Number Plants/sq. ft. (July 27)	Soil Treatment (Aug. 1)	Average Number Plants/sq. ft. (Sept. 17)	Average Number Plants/sq. ft.
Uncultivated	10.6	Uncultivated	7.4	Uncultivated	3.9	21.9
Cultivated	11.7	Cultivated	7.7	Cultivated	1.0	20.4
Cultivated	10.1	*PMAS	2.3	PMAS	3.3	15.7
Cultivated	13.3	*KOCN	3.0	KOCN	2.2	18.5
Cultivated	13.4	*Dow Selective	4.5	Dow Selective	2.4	20.3

* PMAS, phenyl mercuric acetate 1 lb./acre
KOCN, potassium cyanate 15 lbs./acre
Dow Selective, ammonium salt of dinitro secondary butyl phenol, 1½ lbs./acre

Literature Cited

1. Pladeck, M. A study of the effect of certain factors on the germination of some weed seeds. Master's Thesis. Cornell University. 1930.

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Some Effects of Herbicidal Sprays on the Hydrocyanic Acid Content of Leaves of Wild Black Cherry (*Prunus serotina* Ehrh.)[1]

B. H. Grigsby[2] and C. D. Ball[3]

The fact has long been known that leaves of certain species of the genus *Prunus* contain appreciable amounts of compounds which, upon chemical rearrangement, may liberate hydrocyanic acid. Various investigators have shown that the amount of hydrocyanic acid which can be recovered from the leaves often is affected by changes in temperature, soil moisture, and other factors which may cause physiological changes within cherry leaves. Under some conditions, the acid content may become great enough to cause the death of livestock which may browse upon the cherry brush. Wild cherries occur frequently enough in fence rows, on roadsides and along utility right-of-way strips to present a recognized hazard to livestock in much of the eastern part of the United States. Pasture improvement suggestions in this region generally include the cutting and immediate removal of cherry brush. In recent years, the use of herbicidal sprays for the destruction of brush has led to a great reduction in brush cutting and has raised some questions in respect to the toxicity of sprayed vegetation.

When certain herbicides are applied as a foliage spray on wild cherry the leaves often wilt, become yellow and eventually dry while still attached to the twig. These effects are indicative of some profound metabolic changes within the leaves. Since these changes are somewhat similar to those produced by frost or by dry weather, conditions which may cause a release of hydrocyanic acid, it seems that herbicidal sprays could have some effect upon the hydrocyanic acid

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(1) This work was supported by a grant from the Dow Chemical Company.

(2) Department of Botany and Plant Pathology, Michigan State College and in Cooperation with the Division of Weed Investigations B.P.I.S. & A.E., U.S.D.A.

(3) Department of Chemistry, Michigan State College.
Contribution No. 52-1 from the Department of Botany and Plant Pathology, Michigan State College.

content of the sprayed leaves. A search of the published reports on brush control experiments did not reveal any data which would enable one to formulate an answer to this question of toxicity, therefore an experiment was made to determine whether sprayed cherry leaves did show any changes in hydrocyanic acid.

Materials and Methods

Separate clumps of small black cherry brush, 15 to 25 individual plants, 3 to 10 feet in height, were located on the border of a cultivated muck farm. On July 31, suspensions of an ester of 2,4-D, an ester of 2,4,5-T, and a 1:1 mixture of these two compounds, equivalent to some commercial brush killers, were made at a concentration of 2000 PPM. A solution containing 1 lb. of ammonium sulfamate per gallon of water was also made and a small quantity of a commercial sticker-spreader was added to each spray mixture.

Composite samples of twigs from each of the clumps were taken for chemical analyses and then the various spray mixtures were applied, at 250 pounds pressure, in volume sufficient to wet all the foliage in the clump. Twigs, with leaves attached, were cut from the same individual plant at each of the subsequent sampling periods.

Samples for chemical analyses were taken from each treatment, as well as from an unsprayed clump at 8, 20 and 72 hours after spraying. Other samples were taken at 8 and 15 days after the initial treatment. All analyses were started within 15 minutes after samples were cut.

The hydrocyanic acid content of the leaves from all samples was determined by the acid titration method, (Official Methods of Analysis of the A.O.A.C.). The results obtained are shown in Table 1.[4]

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(4) All chemical analyses were made by Dr. Stephen Djanig and the authors wish to express their appreciation for his assistance.

Results

Table 1. Amounts of hydrocyanic acid present in wild cherry leaves after application of herbicidal sprays. Values in mg. per 100 gm. of leaves.

	Time after spraying						Percent reduc-
Treatment	0 hrs.	8hrs.	20 hrs.	72 hrs.	8 da.	15 da.	tion
2.4-D	56.7	58.3	55.6	54.0	50.2	11.3	80
2.4.5-T	70.7	43.7	36.7	36.2	28.6	10.8	85
2.4-D 2.4.5-T	76.7	80.0	73.6	56.1	50.7	5.4	93
Ammonium Sulfamate	98.0	42.1	82.6	58.3	13.5	0	100
No treatment	96.6	87.5	99.3	98.0	87.5	91.9	6

Herbicidal effects of the sprays were observed within 48 hours and became more pronounced throughout the 15-day period. The 2,4-D treated plants became slightly wilted, developed a noticeably epinasty and eventually numerous chlorotic areas were observed. Plants which received 2,4-5-T were similar in appearance but by the 15th day considerably more chlorosis was evident. The mixture of 2,4-D and 2,4,5-T caused earlier yellowing of leaves than did either separate compound; sprayed leaves developed numerous necrotic areas before they fell from the twigs.

The effects of ammonium sulfamate became visible within 24 hours as a pronounced wilting, and at 72 hours the leaves were brown and beginning to appear dry. On the 8th day all leaves in the clump were dried to the point where they crumbled when handled. Because of this drying, samples from this treatment after 72 hours consisted of a larger number of leaves than were used in the earlier samples.

Discussion

Examination of the data in Table 1 shows that there was considerable variation in the hydrocyanic acid content of the clumps of brush sprayed, and that there was some fluctuation in the untreated plants during the course of the experiment. The reasons for these variations are not known. Soil moisture was abundant at all times and no unseasonal temperature changes occurred during the test period.

In plants sprayed with 2,4-D there were no effects on the acid content at the 8-hour sampling period and only a minor decrease at the end of 8 days. At the 15th day, however, there had been a decrease of approximately 80 percent.

The 2,4,5-T treatment caused a sharp decrease within 8 hours and a steady, but lesser, decrease through the 8th day. At the end of the experiment a decrease of 85 percent was found.

The effects of the brush killer mixture were not shown by significant changes in the HCN content during the first 20 hours. A steady decline was found thereafter and a final decrease of 93 percent was effected.

The data on ammonium sulfamate are difficult to interpret because of the decline of more than 50 percent in the first 8 hours. At the end of 20 hours the level was only 8 percent less than the initial value. After that period, however, there was a continuous decline and at the end of the experiment no HCN was found in the dead, dry leaves.

The results obtained in this experiment indicate that the application of these commonly used herbicides probably does not lead to any significant increase in hydrocyanic acid content of cherry leaves. The data show clearly that, under the conditions of the experiment, there is a consistent decrease in the amount of HCN which can be recovered from the sprayed foliage. It is not possible, however, to draw any conclusions in regard to the relative toxicity of any of the leaves used in this experiment because there are no data which indicate the amount of cherry leaves required to cause the death of a cattle or other livestock. The conclusion can be drawn that spraying with 2,4-D, 2,4,5-T, mixtures of the two compounds, and ammonium sulfamate probably does not increase the potential danger already present in wild cherry to grazing livestock.

THE HYDROCYANIC ACID (HCN) CONTENT OF WILD CHERRY LEAVES SPRAYED WITH A BRUSH KILLER CONTAINING LOW VOLATILE ESTERS OF 2,4-D and 2,4,5-T*.

G. E. Lynn and K. C. Barrons
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Couch (1) indicates that when wild cherry trees or shrubs are cut that the wilted leaves develop hydrocyanic acid (HCN), and are poisonous if eaten by livestock. There have been allegations that when wild cherry is sprayed with herbicides containing chlorophenoxyacetic acid esters that these plants become more toxic to livestock, especially cattle. It has been further suggested that this toxicity is due to increased amounts of HCN occurring in the leaves after spraying with the herbicide.

In order to obtain some facts concerning the occurrence of HCN in wild cherry leaves the HCN was determined in sprayed, wilted, and fresh leaves.

Analytical Procedure:

The method used was a slight modification of that given in the Official Methods of Analysis of the AOAC (2). 10 to 20 grams of leaves were macerated in water using a Waring blendor. The HCN was immediately steam distilled off and titrated with $AgNO_3$ using KI indicator. Added amounts of HCN gave an average recovery of 83%. Results have been corrected for this recovery factor.

Experimental and Results:

Couch (1) states that hydrocyanic acid develops in plants when normal growth has been retarded or stopped. The hydrocyanic acid is formed by enzymatic action on a cyanoglucoside. In the present experiments we were not able to analyze the leaves directly from the plant but had to rely upon cutting branches, placing in water, and transporting to the analytical laboratory. Thus, for even the fresh samples, the sampling procedure permitted an elapse of time between severing and analysis of 1 to 4 hours. It is recognized that some autolysis of the glucoside may have occurred in this time.

The first attempts at correlating results from treatments in one plot against those from another plot were unsuccessful due to wide variation between replicate trees. In order to determine plot techniques required, an experiment was designed to find out the variation between species and between single

* 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid.

trees of the same species. It was found that wild black cherry (Prunus seratina) leaves contained more HCN than did leaves from wild pin cherry (Prunus pennsylvanica). It was also determined that the HCN content of the leaves of a single species varied considerably from tree to tree. In the case of pin cherry the range between samples taken from 3 trees was from 26 to 297 parts per million HCN by weight of green leaves. Analyses of leaves from trees growing in the sun and in the shade strongly indicated that there was more HCN in leaves of those trees growing in the shade.

These preliminary experiments indicated that the experiments should be conducted and sampled in such a manner as to permit following the HCN trend on each single tree replicate, and that the experiment should be confined to a single species. Scarcity of black cherry in the area made it necessary to carry out the balance of the experiments on pin cherry.

Pin cherry trees (8 to 10 feet tall) growing on one location in Midland County, Michigan were sampled and then some of the trees were thoroughly wetted with a spray containing 1-1/2 pounds each of 2,4-D and 2,4,5-T (acid equivalent) as the polypropylene glycol butyl ether esters per 100 gallons of water. The sprayed and untreated trees were sampled four and eight days later for HCN analysis. Samples were taken by compositing branches cut at random around and from top to bottom of each tree. The results of the analyses are given in table 1.

TABLE 1 - HYDROCYANIC ACID (HCN) CONTENT OF PIN CHERRY LEAVES FROM TREES SPRAYED WITH A BRUSH KILLER CONTAINING LOW-VOLATILE ESTERS OF 2,4-D AND 2,4,5-T(*)

Parts per million HCN in leaves.	Calculated on:	Date Analyzed 8-9-51 (before spraying)	8-13-51	8-17-51	p.p.m. HCN change in 8 days
Sprayed Trees**	green wt. basis	275	233	93	-179
	dry wt. basis	650	540	215	-435
Untreated Tree***	green wt. basis	209	161	128	-81
	dry wt. basis	437	350	290	-147

(*) Dow Esteron Brush Killer (2,4-D, polypropyleneglycol butyl ether ester 34.8%, 2,4,5-T, polypropylene glycol butyl ether ester 33%; 2 lbs. acid equivalent of each per gallon) applied at rate of 3 qts. per 100 gallons of water as a thorough wetting spray.

(**) HCN results are averages of 2 replicates from each of three trees sprayed (see *) 8-9-51 after sampling.

(***) HCN results are averages of 2 replicates from 1 tree.

The early orientation experiments indicated that wilted cherry leaves had less HCN than fresh leaves. This caused some concern about sampling and analytical techniques since the literature (1) suggest increased quantities of HCN in wilted leaves.

It was possible as a part of one of the spraying experiments to check again on the HCN in wilted leaves. At the time leaves were sampled for "fresh analysis" a portion of the cut branches were allowed to remain out of doors and out of water for 4 days at which time the leaves were analyzed. See table 2.

TABLE 2 - HYDROCYANIC ACID (HCN) CONTENT OF WILTED AND FRESH PIN CHERRY LEAVES.

Parts per million HCN in leaves. Calculated on:		Date Analyzed 8-9-51 (before cutting)	8-13-51	p.p.m. HCN change in 4 days
Wilted plot	green wt. basis	275	106	-171
	dry wt. basis	650	132	-518
Control plot	green wt. basis	209	161	-148
	dry wt. basis	437	350	- 87

These data would seem to indicate that from the standpoint of HCN concentration cut pin cherry is no more hazardous to stock than standing pin cherry.

Summary and Conclusions:

1. Analysis of wild pin cherry leaves that were sprayed with Esteron Brush Killer showed less hydrocyanic acid content than did unsprayed leaves.

2. Analysis of wilted pin cherry leaves from cut trees showed a loss of hydrocyanic acid when compared to fresh leaves.

3. It is concluded that spraying of wild pin cherry with a brush killer formulation of low-volatile esters of 2,4-D and 2,4,5-T does not make brush of this species more hazardous to cattle from the standpoint of hydrocyanic acid content.

Literature References:

(1) Poisoning of Livestock By Plants That Produce Hydrocyanic Acid, U.S.D.A. Leaflet 88, James F. Couch, Sept. 1940.

(2) Official Methods of Analysis of A.O.A.C. 7th Ed. 1950, p. 354.

Brush Control Work in New Hampshire Particularly With Relation To Public Utility Lines

by

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A. R. Hodgdon Agricultural Experiment Station, U.N.H.

I. HISTORICAL BACKGROUND

Brush Control work in New Hampshire probably had its beginning in 1942 when Yeager and Callahan published some of the earliest work on ammonium sulfamate proving it's effectiveness in the control of poison ivy[1]. Since that time, there has been a continued interest at the University of New Hampshire in the treatment of poison ivy and other woody plants. Shortly after the appearance of 2,4-D, first the acid and then a variety of it's salts and esters were tried out on ivy and associated vegetation as well as on sweet fern, huckleberry sheep-laurel, hardhack and other weeds and on blueberries themselves in blueberry pastures[2].

In 1947, the Public Service Company of New Hampshire became interested in the work initiated in Western Pennsylvania by the Dow Chemical Company and the West Penn. Power Company to control woody species along power line rights of way. The senior author next made a visit to the scene of the Western Pennsylvania brush control operations. There he was encouraged by Ashbaugh to initiate similar work in New Hampshire. Director Bevan of the Extension Service at the University of New Hampshire and Halstead N. Colby, Extension and Agricultural Engineer soon became interested and the junior author of this paper, by virtue of his previous experience with herbicides, was called in as a consultant. The direct result of the valuable cooperation was an Extension Service publication[3]. which has had wide circulation and in general has been accorded favorable recognition.

II. MODE OF APPROACH TO OUR BRUSH CONTROL WORK

The work in Brush Control in New Hampshire has been essentially of a practical kind. Experiments with new herbicides, new modes of applications and such types of research for example as highly selective spraying to eliminate certain species without injuring others have been left largely to those who have time, funds and personnel to specialize in them.

In New Hampshire where there are limits to all three, the emphasis quite naturally has been directed toward the primary objective, the killing of weeds. To accomplish this objective, the materials and techniques which have been found effective elsewhere have been adapted to New Hampshire conditions.

III. TYPES OF SPRAYING

With the experience of five years behind us, it is apparent that several positive statements can be made about Brush Control with 2,4-D, 2,4,5-T on public utility lines in New Hampshire. The first two concern the type of spraying:

1. The initial application of spray should be of a foliar type, high gallonage and low pressure using power equipment to thoroughly cover virtually all the vegetation on rights-of-way through forested country. Most of the lines thus far treated had been cut through previously forested country. The vegetational composition of these lines varies widely with terrain, with successional maturity and with previous handling. In general, however, both tree-species and shrubs abound and are often thoroughly intermixed and most of the bulk of vegetation encountered needs to be eliminated.

2. It seems likely that a more selective second application might profitably be made much of the time after the initial foliar treatment. This <u>could</u> take the form of a basal treatment.

IV. EFFECTS OF SPRAYING ON DESIRABLE VEGETATION

The next three statements deal with observations regarding the desirable relatively stable cover which we hope eventually will replace the weed species:

1. Even in heavily wooded sections, carpets of sedges, grasses and rushed may occur which seem to profit from the removal of shading canopies of trees and shrubs and to spread quite rapidly following treatment.

2. Even with high gallonage power operations, it is often possible with trained crews and some exercise of care to protect any sizeable colonies of blueberry or sweet fern and other low shrubs which may be considered desirable and which would be seriously injured or killed by the spray.

3. Some very desirable cover-plants such as mountain laurel sheep-laurel, leather leaf, checkerberry and probably other members of the Heath family which occur so abundantly on much of the acid-soil terrain in New Hampshire seem to be quite resistant to the effect of 2,4-D and 2,4,5-T.

V. EFFECTS OF 2,4-D AND 2,4,5-T FORMULATIONS ON SPECIFIC KINDS OF VEGETATION IN NEW HAMPSHIRE

1. Shrubs and trees ordinarilly killed by 2,4-D 2,4,5-T formulations at recommended dosages and under conditions of proper application:

Alder	Blackberries	Bayberry
Sweetfern	Raspberries	Bird Cherry
Black birch	Arrowwood	Poison Ivy
Yellow birch	Gray Dogwood	Hazelnut
Gray birch	Silky Dogwood	Witch-hazel
Paper birch	Common Elm	
Elderberry	Quaking Aspen	
Sumacs	Pussy Willow	
Chokeberry	Beaked Willow	

Honeysuckles (Loniceras)
Hardhack
Wild Rose
Bush Honeysuckle

2. Species which are sometimes killed and sometimes survive treatment:

Red Oak (usually killed)	<u>Sometimes killed, sometimes not</u>
White Oak (usually killed)	White Pine
Red Maple (frequently killed)	Red Cedar
Nannyberry (sometimes killed)	Junipers
Maple-leaved-Viburnum (")	
Rock Maple (hard to kill)	
Hickory (hard to kill)	
Apple (sometimes killed)	
Black locust (frequently sprouts again)	
Trailing briers (sometimes killed) (sometimes not killed)	

3. Species which are seemingly unaffected permanently by the spray:

(Con't No. 3) Species which are seemingly unaffected permanently by the spray:

Mountain laurel
Sheep laurel
Ferns (killed down but quickly recover)
Grasses
Sedges
Rushes
Clubmosses
True Mosses
White Ash
Leather-leaf
Checkerberry

VI. SPECIFICATIONS FOR SPRAYING

From a detailed and carefully phrased body of specifications which serve to guide and regulate the spraying operations only the high points can be summarized here. These regulations have effectively served to protect all interests involved as well as to enhance the efficiences of operations.

1. The crew supervisor will be the "working foreman". He will be familiar with all agricultural crops near the rights-of way as well as with the principal plants on the treated lines.

2. The normal equipment for spraying will be a crawler type tractor pulling a 400 gallon tank with a hydraulic pump with 18 gallons per minute capacity. A water supply vehicle will accompany the tank and pump. The minimum size of crew shall be four men plus the crew supervisor. When a 4-wheel drive vehicle is accepted for use, the tank will hold a minimum of 200 gallons and the hydraulic pump, have a capacity of at least 12 gallons per minute, in which case the crew shall be two men plus the supervisor as a minimum. The nozzle used is specified as an orchard-type nozzle with an operating capacity of 200 to 300 pounds per square inch.

3. The normal working season will extend from June 15 to September 1 and spraying will be done only when the temperature is above 70°F and only after external moisture following a rain has dried off.

4. A daily report must be made out by the supervisor covering certain details of operations.

(Con't VI. No. 5)

5. The spray will consist of one (1) gallon of concentrated brush control material containing 2 pounds acid equivalent of 2,4-D and 2 pounds acid equivalent of 2,4,5-T mixed with 100 gallons of water and should be applied to cover foliage of all plants on rights-of-way except desirable species.

Literature Cited

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2. Weed Control in Blueberry Pastures. W. W. Smith, A. R. Hodgdon and Russell Eggert, Proc. Am. Soc. Hort. Sci. Vol. 50, 1947.

3. Chemical Control of Woody Plants Using 2,4-D, 2,4,5-T and Their Formulations. A. R. Hodgdon, R. B. Littlefield, F. N. Colby and W. A. Bodwell, May, 1949.

INDEX

CHEMICALS LISTED IN INDEX

Names used in Index	Active ingredient name if different
Monochloracetic acid	
Ammate	Ammonium sulfamate
Ammonium sulfate	
Ammoniumthiocyanate	
C M U	3- (p-chlorophenyl) 1, 1 dimethylurea
Crag Herbicide 1	sodium 2, 4-dichlorophenoxyethyl sulfate
Cyanamid	Calcium cyanamid
Cynate	Potassium cyanate
2,4-D	2,4-dichlorophenoxyacetic acid
Dinitros	dinitro-ortho-secondary-butyl phenol
Endothal	disodium 3, 6-endoxohexahydrophthalato
Fuel oil	
I P C	isopropyl N-phenyl carbamate
IPC, chloro	isopropyl n-(3 chlorophenyl) carbamate
Maleic hydrazide	
M C P	2 methyl 4 chloro phenoxyacetic acid
N I X	sodium isopropyl xanthate
NP-128	o-chlorophenolsulfonyl fluoride
Oils	
Oktone	octachlorocyclohexenone
Phthalamic acid	
P C P	Pentachlorophenol
P M A	Phenyl mercuric acetate
Sodium arsenite	
Sodium benzylarsonate	
Sulfasan	ethyl xanthogen disulfide
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
T C A	Trichloroacetic acid salts
Trichlorobenzoic acid	
Triethanolamine arsenite	

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