

PROCEEDINGS  
OF THE  
SECOND ANNUAL MEETING  
OF THE

NORTHEASTERN WEED CONTROL CONFERENCE

HOTEL COMMODORE

NEW YORK CITY

FEBRUARY 12-13, 1948

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SECOND ANNUAL MEETING OF THE  
NORTHEASTERN WEED CONTROL CONFERENCE

Thursday, February 12

The meeting of the Northeastern Weed Control Conference convened at 11:00 o'clock, a.m., February 12, 1948, in the Grand Ballroom of the Hotel Commodore, New York City, N. Y.; Dr. G. H. Ahlgren, presiding.

CHAIRMAN AHLGREN: Folks, this is the Second Annual Meeting of the Northeastern States Weed Control Conference. The first one was held last year at Cornell University and was primarily an organizational meeting.

I assure you, looking down on you from up here on the rostrum, that I am very glad to see such a splendid turnout today. I suppose the science of weed control is one of the most interesting fields of work that anybody could be in today.

In the past year we have seen some very dramatic developments in this field and I know, too, that from a chemical standpoint weed control can be a pretty lucrative business these days -- we hope -- because we believe there is a very real place for it.

We have first this morning a report by the chairman of our Research Committee, Professor H. B. Musser, of Pennsylvania State College.

PROFESSOR MUSSER: The Research Committee recognizes that our Northeastern Weed Control Conference still is very largely in the formulative stage from the standpoint of organization and program. The committee feels that because of the extremely wide range of problems and interest involved, it is not practicable for a limited group to outline a program which will adequately cover the broad field of weed control in the region.

The following report is submitted therefore with the hope that it may be of use primarily as a guide for Conference discussions, from which may be developed satisfactory programs in the respective fields of interest. The committee suggests that appropriate subcommittees be appointed to study the recommendations herein made, and make such changes as may be required before the report is submitted to the Conference for formal action.

In preparing the report the committee has followed the outline adopted by the Conference for group discussions at the previous meeting at Ithaca last year under the following general headings:

- I. Definition of Problems
- II. Current Status of Research
- III. Suggested Action

The Research Committee has reviewed the statements of problems contained in the group reports at the previous Northeastern Conference meeting. The major problems as developed in these reports may be classified as follows:

A. Effects of herbicides, flaming, cultural practices, and combinations of these, on specific weeds, crop plants, orchard and small fruits, woody plants, shrubs, ornamentals and forest trees. The principal problems in this category include:

- (1) Relation of life histories to methods and effectiveness of treatments, periods of growth, reproductive methods, habits of storage, reactions to environmental factors.
- (2) Relation of climatic and soil conditions and ecological factors to treatment methods and effects.

B. Evaluation of control methods.  
The chief problems are:

- (1) Maximum and minimum rates of herbicide applications and concentrations of solutions.
- (2) Methods of application, dry vs. solution.
- (3) Time of application, pre-emergence and post-emergence.
- (4) Types of equipment.
- (5) Combination treatments.
- (6) Effect of drift, volatilization and creep.
- (7) Residual effects of treatments.

C. Special problems.

- (1) Effects of herbicides on dormant and germinating seeds.
- (2) Effects of herbicides on soil microflora.
- (3) Relationship of herbicidal treatments to palatability.
- (4) Economic losses due to weed infestation.
- (5) Weed control in relation to health, hay fever.
- (6) Development of new herbicidal materials.

Because of the limited and very general nature of the information available in the group reports as contained in the minutes of the first Conference meeting the Research Committee considered it desirable to initiate a more detailed survey of experimental work under way in the Northeastern region.

To accomplish this the Conference chairman was requested to appoint collaborators at each experiment station. A set of forms was sent to each individual for reporting the work currently under way at each institution. This material has been analyzed and summarized on the basis:

- (1) Nature of control treatment or practice: selective herbicide, sterilant herbicide, flaming, cultivation.
- (2) Type of experiment, pre-emergence or post-emergence, solution or dry application, etc.
- (3) Stations reporting work.
- (4) Crops included in experiments.
- (5) Weeds studied.

These summaries are presented in condensed form in the following tabulation. They are listed in the order of the control practice, the type of experiment, the number of institutions reporting, the crops studied and the weeds studied. The first is with selective herbicides:

2,4-D formulations; post-emergence sprays; Maine, Michigan, New Hampshire, New Jersey, New York, Pennsylvania, Virginia, West Virginia, Connecticut; field crops, vegetable crops, potatoes, blueberries, strawberries, pastures, woody plants, lawn grass; large group of annual and perennial weeds and grasses common to crops listed.

2,4-D formulations; pre-emergence sprays; Michigan, New Jersey, New York, Pennsylvania; field crops, vegetable crops, potatoes, blueberries, strawberries, pastures, woody plants, lawn grass; large group of annual and perennial weeds and grasses common to crops listed.

2,4-D formulations; post-emergence dusts; Pennsylvania, Virginia; lawns and pastures; broad-leaf weed, starthistle, devils shoestring.

2,4-D formulations; volatilization; New York; ornamentals and greenhouse crops.

2,4-D formulations; persistence; New York, Pennsylvania, Rhode Island, Camp Detrick; beans, red clover, corn, oats, fescue, bent grass; crab grass.

2,4-D formulations; carriers, absorption, soil microflora, cyto. and hist. changes; Camp Detrick; beans and miscellaneous crops.

2,4-D formulations; pre-emergence (soil moist. and reaction effects); Pennsylvania; corn, oats, red clover, fescue, bent grass; crab grass.

Cyanamid; post-emergence dust; Michigan; asparagus; broad-leaf weeds and grasses.

Cyanamid; pre-emergence dry; Michigan, New Jersey, New York, Pennsylvania, Rhode Island; corn, potatoes, vegetable crops, lawn grasses; annual grasses and weeds.

Dinitro compounds; pre-emergence sprays; Michigan, Maine, New York; corn, potatoes, vegetable crops; weeds and grasses common to crops listed.

Dinitro compounds, post-emergence sprays; Michigan, Maine, New York; vegetable crops, blueberries, orchard and nursery; weeds and grasses common to crops listed.

Dinitro compounds; persistence; New York, Pennsylvania; potatoes, corn, vegetable crops, lawn grasses.

Petroleum products; post-emergence sprays; Michigan, New York, Pennsylvania, Rhode Island; vegetable crops; weeds and annual grasses.

Petroleum products; persistence; New York, Pennsylvania, vegetable crops.

Sulfamate; post-emergence sprays; New Hampshire, New York, Michigan, Pennsylvania; potatoes, vegetable crops, forage and lawn grasses; poison ivy and sumac, cinquefoil, weeds common to vegetable crops.

Sulfamate; pre-emergence sprays; New York, Pennsylvania; potatoes and vegetable crops; weeds common to crops listed,

Sulfamate; persistence; New York; vegetable crops.

Sodium arsenite; post-emergence; Pennsylvania, Rhode Island; lawn grasses; broad-leaf weeds, crab grass, chickweed, white clover.

Sodium chloride; post-emergence spray; Michigan, beets; weeds common to crop.

Sodium chloride; pre-emergence dry; Pennsylvania; asparagus; weeds common to crop.

Sodium nitrate; pre-emergence dry; New York, Pennsylvania; vegetable crops and asparagus; weeds common to crops listed,

Borax; post-emergence; New Hampshire; forage grasses; cinquefoil.

Pentachlorophenol; post-emergence; Michigan; onions; broad-leaf weeds and grasses.

Ferrous sulphate; post-emergence; Massachusetts; cranberry; weeds and woody material.

Ferric sulphate; post-emergence spray; Massachusetts; cranberry; weeds and woody material.

Paradichlorobenzene; post-emergence spray; Massachusetts; cranberry; weeds and woody material.

Cooper sulphate; post-emergence; Massachusetts; cranberry; weeds and woody material.

Naphthalene acetic acid; post-emergence; New York; vegetable crops; weeds common to crops.

Naphthalene acetic acid; pre-emergence spray; New York; vegetable crops; weeds common to crops.

Sulphuric acid; post-emergence spray; Pennsylvania; asparagus; weeds common to crops.

Phenyl mercuric acetate; post-emergence spray; Rhode Island, lawn grasses, crab grass.

Am. arsenate; post-emergence spray; Rhode Island; lawn grasses; crab grass.

I P C; soil treatment; Michigan, Pennsylvania, Rhode Island; quackgrass.

The following are with the use of sterilants as the control practice:

2,4-D formulations; pre-plant or pre-emergence soil mix (dry); Michigan, Pennsylvania, Rhode Island; corn, gladiolus, tobacco seedbeds; quackgrass and seedbed weeds.

2,4-D formulations; pre-emergence soil mix (wet); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbed weeds.

2,4-D formulations; top-killing spray; New Jersey; potatoes.

Cyanamid defol.; gran. and pre-plant or pre-emergence soil mix (dry); Pennsylvania, Rhode Island; radish, tomatoes, tobacco seedbeds; seedbed weeds, quackgrass.

Sodium arsenite; suf. appl. (dry and spray); Connecticut, New Jersey; past and waste land; weeds common to past, poison ivy.

Borax; dry applications; Michigan, New Jersey, Pennsylvania; poison ivy, quackgrass, weedy vegetables.

Ammate; pre-emergence soil mix (dry); Rhode Island, radish, tomatoes, ryegrass, bent grass; seedbed weeds.

Ammate; soil surf.; Pennsylvania; quackgrass.

Am. thiocyanate; pre-emergence soil mix (dry); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Am. thiocyanate; post-emergence spray; New Hampshire, field grasses.

Am. thiocyanate; persistence; Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Sodium chlorate; post-emergence (dry and spray); Connecticut, New Jersey, pastures and waste land, woody material and poison ivy.

Allyl alcohol; pre-plant or pre-emergence soil mix; Michigan, Rhode Island; vegetable crops and grasses (rye and bent); seedbeds.

I P C; soil surf. dry applications, Pennsylvania, Michigan; quackgrass.

Dinitro compounds; post-emergence spray; New Jersey; poison ivy.

Cyanamid plus 2,4-D formula; pre-emergence; Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Cyanamid plus am. thiocyanate; pre-emergence; Rhode Island, radish, tomatoes, ryegrass, bent grass; seedbeds.

Cyanamid plus am. ammate; pre-emergence; Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Uramon; pre-plant or pre-emergence soil mix (dry); Rhode Island, Virginia; radish, tomatoes, ryegrass, bent grass, tobacco seedbeds; seedbeds.

Am. sulphate; pre-plant or pre-emergence soil mix (dry); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Am. sulphate plus; pre-plant or pre-emergence soil mix (dry); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Sodium nitrate; pre-plant or pre-emergence soil mix (dry); Rhode Island; radish, tomatoes; ryegrass, bent grass; seedbeds.

Sodium nitrite; pre-plant or pre-emergence soil mix (dry); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Phenyl mercuric acetate; pre-emergence soil mix (spray); Rhode Island; radish, tomatoes, ryegrass, bent grass; seedbeds.

Cyanamid plus urea; pre-emergence soil mix (dry); Virginia; tobacco seedbeds; seedbeds.

Flaming: This is listed in the order of the equipment used, the type of experiment, the number of institutions reporting, the crops studied, the weeds studied.

Propane garden tractor unit; pre-emergence; Michigan; onions, asparagus; weeds of crops listed.

In New York and New Jersey the equipment used and the type of experiment are not known. The crops studied are woody materials and truck crops, and the weeds studied are weeds of crops listed.

2-row-4-burner propane-butane sizz weeder; post-emergence; Pennsylvania, corn and vegetable crops; weeds of crops listed.

Cultivation:

Two shovel sweeps; repeated cultivations; Pennsylvania, corn, weeds of crops listed.

Combination:

2,4-D plus tillage; pre-emergence herb. app. plus tillage and cultivation; New York, Pennsylvania, corn, vegetables; weeds of crops listed.

Dinitro plus tillage; pre-emergence herb. app. plus tillage and cultivation; New York, Pennsylvania; corn, vegetables; weeds of crops listed.

Nitrogenous fertilizer plus tillage; pre-emergence herb. app. plus tillage and cultivation; New York, Pennsylvania; vegetable crops; weeds of crops listed.

Naphtalene acetic plus tillage; pre-emergence herb. app. plus tillage and cultivation; New York, vegetable crops; weeds of crops listed.

Nitrogenous fertilizer plus mulch; pre-emergence app. with soybean straw; New York; tobacco seedbeds; weeds of crops listed.

H<sub>2</sub>SO<sub>4</sub> plus cultivation; pre-emergence herb. app. plus cultivation; Pennsylvania; corn; weeds of crops listed.

Flame plus cultivation; post-emergence flaming plus cultivation; Pennsylvania; corn; weeds of crops listed.

Am. thiocyanate plus cultivation; pre-emergence herb. app. plus cultivation; Pennsylvania; corn; weeds of crops listed.

The above summary indicates that current work at most of the institutions in the Northeastern region is concerned chiefly with post-emergence selective sprays or dry applications with 2,4-D formulations, dinitro compounds, petroleum products and sulfamate.

In the large majority of cases in these studies, the effect of the herbicides on the various crops apparently has been of primary interest, with records being kept on the response of whatever weeds happened to be present.

About one-third of the institutions in the region have reported studies on pre-emergence selective applications of a wide range of materials, although most of the work has been limited to 2,4-D, cyanamid, dinitro compounds, sulfamate and I P C. Here again effects on the crop have been emphasized.

Only a relatively few stations are investigating the sterilant action of herbicides or their persistence under conditions of heavy sterilant applications. Most of this work has been confined to 2,4-D formulations, cyanamid, borax, sodium chlorate and I P C, although one station has reported on a wide range of materials.

Current work on the effectiveness of cultural practices, flaming and combinations of herbicidal treatments with these operations has been reported by three stations in the region. This work has been limited to corn and a relatively few vegetable crops, with the emphasis again placed on response of the crops to treatments.

In a few instances studies have been directed primarily toward the control of specific weeds. These include poison ivy and sumac, quackgrass, crab grass, cinquefoil, broad-leaf lawn weeds, Northern nut grass, hawkweed, mustard, starthistle, devils shoestring and sorrel. These studies in most cases have been limited to applications of herbicidal materials at various rates under field conditions, with only limited attempts to relate treatments to life histories, soil conditions, ecological factors and similar items.

Basic studies of such factors as volatility of herbicides, persistence, effects of soil moisture and reaction, responses of soil microflora, cytological and histological changes and other physiological relationships have been reported for a very restricted number of crop plants and herbicidal materials by three institutions. This work has been confined entirely to 2,4-D and other growth regulators. The principal plants studied have been corn and beans, with additional work on vegetable crops, oats, red clover, ryegrass and bent grass.

The survey shows a wide range in rates of application of herbicides and in methods of expressing treatment concentrations. Thus, 2,4-D treatments have varied from 1/8 pound to 40 pounds per acre with concentrations of individual formulations as acid equivalents, as formulation quantities, and as parts per million of dilute solutions used at varying gallonage rates per acre.

Similarly, cyanamid treatments range from 25 to 600 pounds per acre and are reported both as quantities of the carrier and in terms of the amounts of nitrogen applied. In other cases rates of application are expressed as gallons of concentrates, gallons of dilute solutions, or pounds of dry and liquid materials, per square yard, 100 square feet, 1000 square feet or acre units of area.

In the case of pre-emergence studies there has been a wide range in time of applications and in depth of mixing; treatments ranging from pre-planting to immediately prior to emergence and varying from surface to plow depth.

Also, there has been wide variability in the degree to which attempts have been made to correlate treatment results with soil environmental factors. In some instances very complete records have been kept on soil moisture, temperature, reaction and similar factors, while in others no effort has been made to evaluate these items.

#### SUGGESTED ACTION:

A. Coordination of research. In reviewing the reports of current research in the Northeastern region the Research Committee has been impressed by the wide variety of problems which are under investigation and the diversity of interest involved. It would seem that if practical progress is to be made in the development of a coordinated research program which will cover so broad a field adequately, a common pattern must be found under which a satisfactory grouping of the many individual experiments may be made.

In this connection the committee suggests that research in the various fields may be coordinated on the basis of major objectives of individual experiments. A tentative classification is proposed for further study as follows:

1. Screening tests of materials and practices for which herbicidal claims are made. Work to be of a pilot nature only and based on standards developed by the Conference.
2. Studies of control methods: Include selective and sterilant concentrations, pre-emergence and post-emergence treatments, sprays, and dry applications, surface and soil mixtures, methods of flaming, cultural treatments and combinations.
3. Control measures for specific weeds: Include life histories, seed dormancy, relation of treatment to stage of growth and physiological condition of the plant and effects of soil conditions, ecological factors and similar items.
4. Crop responses to treatments to be grouped into:
  - a. Corn and small grains.
  - b. Forage, pasture, and lawn grasses and legumes.
  - c. Vegetable crops and potatoes.
  - d. Fruits, ornamentals and forest trees.
  - e. Plants related to public health and welfare.

5. Special problems (fundamental and basic research):
  - a. Volatilization, drift and creep of herbicidal materials.
  - b. Persistence.
  - c. Effects of herbicides on soil microflora and reverse.
  - d. Palatability studies.
  - e. Economic losses.
  - f. Development of new herbicides.
  - g. Physiological and morphological effects.

It is recognized that some overlapping exists in the classification proposed and that in many cases individual experiments may be so designed as to cover several objectives. This is not considered a serious objection, since results relating to each objective may be assigned to the proper group for coordination.

In order to make most effective use of the outline in coordinating research results it is recommended that a greatly enlarged Research Committee be appointed which will be resolved into five subcommittees to assemble results for each of the major coordination groups. The membership of each subcommittee should be large enough so that separate items could be assigned to individual members.

B. Suggested lines of research in 1948:

1. Screening tests of new materials for which no satisfactory information on their possible herbicidal value is available.
2. Intensive studies on control methods for specific hard to kill annual and perennial weeds and grasses. The following list is recommended for special attention:

Quackgrass (*Agropyron repens*), wild garlic (*Allium vivale*), Canada thistle (*Cirsium arvense*), hawkweed (*Hieracium* spp.), cinquefoil (*Potentilla* spp.), chickweed (*Cerastium* and *Stellaria* spp), foxtails grasses (*Setaria* spp); crab grasses (*Digitaria* spp.), mustards (*Brassica* spp.), horse nettle (*Solanum carolinense*), field sorrel (*Rumex acetosella*), nut grass (*Cyperus esculentus*), milkweed (*Asclepias* spp.).

3. Eradication of woody plants.
4. Pre-emergence studies.
5. Combination control methods.

6. Special problems:

- a. Volatility, drift, creep.
- b. Persistence.
- c. Palatability.
- d. Economic losses.

C. Standardization:

The committee has made no attempt to develop recommendations for a program of uniform experiments at this time. It recognizes the possibilities of this method of approach, but believes that such recommendations can best be developed by subcommittees functioning in the various coordinating groups as outlined under Section A, above.

The committee believes, however, that it is practicable to standardize immediately upon methods of expressing rates of application and units of area. The following recommendations are submitted for consideration of the Conference:

These are listed in the order of herbicide, rates and unit of area: 2,4-D formula; pounds of acid equivalent; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

Nitrogenous materials; pounds of material; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

Petroleum products; gallons; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

Dinitro compounds; gallons of concentrate; per square yard for seedbeds, per 1000 square feet for turf; per acre all others.

Chlorates and arsenites; pounds of material; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

Phenyl mercuric acetate, am. arsenate, alcohols; dilution ratio, gallons of dilute solution; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

Ammate; pounds of material; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

I P C; pounds of material; per square yard for seedbeds, per 1000 square feet for turf, per acre all others.

If investigations indicate that various sources of materials may contain different percentages of the active ingredient rates should be expressed on basis of quantity of active ingredient present.

The committee desires to express its appreciation to the individuals at the various institutions who collaborated in supplying information relative to the current status of research work in the Northeastern region. These included: Professor A. E. Prince, Maine Agr. Exp. Station; Professor B. E. Brown, Connecticut Agr. Exp. Station; Professor C. E. Cross, Massachusetts Agr. Exp. Station; Professor B. H. Grigsby, Michigan Agr. Exp. Station; Professor A. R. Hodgdon, New Hampshire Agr. Exp. Station; Professor D. E. Wolf, New Jersey Agr. Exp. Station; Professor R. D. Sweet, New York Agr. Exp. Station; Professor J. A. DeFrance, Rhode Island Agr. Exp. Station; Professor G. M. Shear, Virginia Agr. Exp. Station; Professor Collins Veatch, West Virginia Agr. Exp. Station.

CHAIRMAN AHLGREN: Thank you for your report. We appreciate very much the promptness with which you have delivered it.

CHAIRMAN AHLGREN: Is Professor Grigsby here from the North Central group? Won't you give us a word, please?

PROFESSOR GRIGSBY: Mr. Chairman, gentlemen: I notice that I am listed here as a member of the North Central Conference and I would like to also reiterate the fact that I consider myself a member of this group as well. Michigan, as you know, is a border state and we are very much interested in some of the problems that are perhaps more important in this particular area than in the general area covered by the North Central group.

As for the meeting in Topeka in December of the North Central group, some of you were there, I know, because I see a number of people who were at that meeting, you are perhaps aware of the fact that a good deal of the time at that meeting was given over to a discussion of the uniform plan of experimentation which has been in progress in that group for the past three seasons.

Those experiments all follow more or less in a general pattern but are not designed to limit any investigator but rather to furnish a guide in the undertaking of certain problems. Those plans are largely concerned with the use of 2,4-D and several of the sessions were devoted to a discussion and the results with regard to certain crops such as corn, the cereal grains and flax.

The discussions, of course, pertained to the degree of weed control that is possible in those crops and also some of the effects which may be brought about by the applications of 2,4-D to the growing crops.

The discussions frequently dealt with such things as the difference in response of various varieties of crops, a thing which one cannot lose sight of in attempting to evaluate some of the results obtained by some of the investigators. The possible effects of herbicidal treatments upon the quality of plant products was brought out and, in particular, the case of flax where there was some indication that there may be some effect on the quantity and quality

of the oil -- and that is one of the things that has not had too much attention in the past few years. It is a thing that all of us need to watch in some of our experiments as to the possible effects on the quality of the plant product we are dealing with.

Another thing that seemed to be of considerable importance at that time was the shift in the dosage requirements that were being considered for experimental purposes. The trend in the past few years apparently has been to see how much 2,4-D you could use without killing the crop, and a number of people are coming around to think how little can we use and still control the weeds, which I think is a rather decided shift in thinking and one that may be of considerable importance.

There was some discussion of pre-emergence usage and the results were mostly preliminary. There was not too much known but certainly pre-emergence uses seem to have definite possibilities in crop plants that we have not been able to use 2,4-D in previously.

One of the things that would be of interest to this group was the fact that this year for the first time the North Central group included at least two new sections, one of them being a section on woody vegetation. The responses which can be expected from various types of shrub and brush control measures.

We had a group interested in horticultural crops and we didn't have too much in the way of material to discuss, but plans were formulated for an extended program in horticultural crops including potatoes and sugar beets -- and some of you may object to that inclusion but that was just a temporary arrangement and may be changed afterwards.

There was some discussion of the number of new herbicides, but I am not going to take time to list those. That material will be presented here at this meeting, and some of those are extremely promising and some of them are, well, new materials.

There was also a discussion of a proposed weed publication, possibly a joint venture of this Conference, the North Central and the Western Conferences; and that was left open and no particular action was taken. But it is something that we might all be thinking about, a means whereby we can get a little more rapid transfer of such bits of information as may be useful to our colleagues.

**CHAIRMAN AHLGREN:** We appreciate the report very much, Professor.

I had a telegram from the chairman of the Western group indicating that they were unable to send a representative here but that they wished our meeting every success.

It seems to me that we need to consider a number of committees in addition to what we have in this Conference at the moment. We are essentially a new Conference and we get many ideas from the North Central group. We are capitalizing on their experience at the

moment but we do need to think, for example, of such committees as a Policy Committee and others.

The North Central Policy Committee has done a very good job, as I see it, and I wonder if anybody here in the group has any comments on the supposed introduction of a Policy Committee for this Conference.

(No response.)

CHAIRMAN AHLGREN: If not, I am going to make such a committee immediately and on that committee I would like to place Professor Sweet of Cornell University as the chairman, Mr. Link of the Brooklyn Botanic Gardens, Professor Prince of the University of Maine, and Professor Raleigh of Penn State. I presume that the chairman will get you people together, and if you don't know what to do, I will be glad to spend a little time with you.

The Policy Committee, as I see it, has a number of functions and one of the most important is to attempt to bring together what information we have at this Conference into an orderly fashion, indicating perhaps some of the applications of the materials being discussed.

I think Professor Grigsby mentioned the trend toward a publication of some kind with regard to workers interested in weed work and I think we need a Publication Committee to represent this group. Does anybody have any comments on that?

(No response.)

CHAIRMAN AHLGREN: Is anybody opposed to it?

(No response.)

CHAIRMAN AHLGREN: I presume, however, that everybody is now in agreement and accordingly on the Publication Committee I will ask Mr. Beatty of the American Chemical Paint Company to act as chairman and Professor Musser of Penn State, because he does not have enough work to do, Dr. Wolf of the Seabrook Farms Company, Bridgeton, New Jersey, and in an advisory capacity, Mr. Dale Wolf of the New Jersey Experiment Station.

The weed work in this region has kind of grown up just like Topsy. We are trying now to give it some direction and in general we have very little support for the program. The weed work that is being done at the experiment stations has been taken on by men who essentially have already full-time jobs -- I am not talking about eight-hour jobs either. They are trying to carry this additional work in so far as they can, and it is a very profitable field of investigation agriculturally.

I believe we have to get more support from the government, both federal and state, to carry this work on as efficiently as we can.

Accordingly, we need a committee to look into regional support. Does anybody have any comments on such a committee?

(No response.)

CHAIRMAN AHLGREN: Is anybody against the formation of such a committee?

(No response.)

CHAIRMAN AHLGREN: If not, I want to appoint Professor Albrecht of Penn State, who is not here yet, as acting chairman of this committee and Professor Sweet of Cornell University and myself; and since I am in a strategic position myself at the moment I will see if we can't drum up some interesting weed work throughout the region.

We must think tomorrow afternoon in the continuation of the Northeastern Weed Control Conference and accordingly we need a Nominating Committee. Are there any suggestions from the floor?

(No response.)

CHAIRMAN AHLGREN: This is one of our regular committees and I think it is within the jurisdiction of the chairman to appoint it. We will have Dr. Dickinson of Sherwin-Williams as the chairman of that committee with Professor Prince of Maine and Professor Hodgdon of New Hampshire.

Professor Musser indicated to us the need for an expanded Research Committee. The Research Committee is essentially the core of this organization and we need to give a lot of thought to the problems involved in conducting efficient and effective research, and I am very much in agreement with him on the need to expand this committee into more workable units in order to get more work done.

Again I would be glad to have any comments from the floor.

(No response.)

CHAIRMAN AHLGREN: If there are no comments with regard to Professor Musser's committee, I want to add the following men: Professor Prince, Mr. Lawrence Southwick, Dr. Howard Yowell, Dr. Dell Fink, Dr. C. B. Link of the Brooklyn Botanic Gardens, Dr. O. F. Curtis of Cornell University, Dr. Jacob from the Long Island Vegetable Research Station, Dr. Danielson from the Virginia Truck Experiment Station, Professor Hodgdon, and Dr. Harris of the Shell Oil Company, Professor DeFrance from Rhode Island, Professor Cross from Massachusetts, Professor Veatch from West Virginia, Dr. Dickinson and Professor French of Cornell University.

I wonder, Professor Musser, if you would care to say a word as to when you would like to get this committee together.

PROFESSOR MUSSER: I would like to call a meeting of that committee for this afternoon after the session is over. That is about 5:30, I would suspect, in this room.

CHAIRMAN AHLGREN: We trust that you will all be willing to serve on this important committee. There is a real opportunity here to make some very good contributions to the work.

Tomorrow afternoon we will have reports from the subchairmen of these various groups so that all of you here in attendance will have an opportunity to know what has gone on in the different sections. We hope those reports will be relatively brief and as much as possible in the direction of aid to the Policy Committee here.

As I see these new committees, excluding the Nominating Committee at the moment, we don't expect any report from you here at this meeting. You might have a report next year or at the discretion of the chairman of this organization if we desire to have it earlier; conceivably the policy report, if it could be worked up in a month or two, would be very valuable, but we don't think you can get it done at this particular meeting. We don't want to overburden you since you have come to New York City and we presume that you want to do a few things besides attend this Conference.

Our first speaker this morning is Mr. Kephart who has been with the United States Department of Agriculture for many years. I doubt that he will even tell us how long he has been with the organization.

We look at him as a dean of the specialists concerned with weed control and many of us turn toward him and to him for answers to problems that we are not always able to handle efficiently in the various states.

I know of Mr. Kephart's experiences abroad, and I believe he has been attending the Vienna conferences. I know he has a very worthwhile message this morning.

We are very happy to have you with us, Mr. Kephart.

MR. KEPHART: Dr. Ahlgren and gentlemen: I haven't the slightest hesitancy to tell you how long I have been in the Department of Agriculture. I went into the Department of Agriculture when they were using iron sulphate to spray oats and mustard, and if you don't know how long ago that was, then you know how long I have been in the Department of Agriculture.

I am a little hesitant to read this very short paper, but I received unexpected reinforcement this morning. When I came into the lobby of the hotel I happened to meet a very eminent scientist, a gentleman with one of the big chemical companies, and the first thing he said to me was, "We don't know which way we are going. We

are so confused on this thing, we don't know where we stand." And so I shall expect him at least to applaud when I am through.

The title of these remarks, as you can see from the program, has to do with new weed control developments during this past year and I will touch on those but rather briefly.

It is appropriate that the opening address at this second annual Northeastern Weed Control Conference should have to do with new developments, because weed control is in the happy and exhilarating position at the moment of being in a highly expansive condition. New things are happening on every hand and developments are piling up so rapidly that most of us find much difficulty keeping up with them and are laboring under a sense of some confusion.

It is not news to the members of this Conference that weed control is today's Cinderella in the agricultural headlines. From obscure beginnings ten years ago, this lowly waif among the ashes has blossomed before our eyes into a beauteous creature with resplendent garments to whom all agriculture is now making obeisance and whom even the lordly princes of the advertising pages find it a pleasure to woo. This is heady stuff, and those, like most of us, who are not accustomed to being in the limelight find it a little difficult to adjust ourselves to the hullabaloo that naturally surrounds a reigning queen. Perhaps, therefore, we may be pardoned if a certain degree of confusion seems to exist and if the question is sometimes asked: "Do these weed people really know in what direction they are going?"

Considering the claims and counterclaims that are going the rounds today on such matters as, let us say, pre-emergence weeding of corn, this certainly is a fair question. Do we know where we are going or even where we are? Do all these new discoveries that are tumbling over each other for recognition indicate that something significant is happening in American agriculture or are they merely a part of an ephemeral will-o-the-wisp which will one day vanish and leave us deflated and shaken? Is the "new look" in weed control, in other words, a fact or merely a fad?

Personally, and I am sure that this feeling is shared by many others, I have faith in weed control as an honorable and useful profession and I believe that there is much solid worth in the things that weed people are now accomplishing. I am confident that we really are on the threshold of a new day in agriculture in which the age-old and laborious struggle with weeds that so long has been a millstone around the farmer's neck is at last to be shaken off.

Nevertheless, to the candid eye there is no gainsaying that there are dangers in the present situation which, if not recognized and acted upon in time, may react unfavorably both to us and to the whole weed-control program. In a time of great success it is well to watch your step and not let overconfidence get the better of you.

At the risk, therefore, of being Banquo at this feast, I would like in a few moments to make a few comments on today's developments in weed control with a view that we may keep ourselves in rational balance and not, so to speak, press our luck to far.

Before doing that, I had better review briefly some of the important things that happened this year in order that the bitter pill which follows may seem a little more sweet.

All of the advances that I will mention are in the field of chemical weed killers, which is a point to which I will refer again, and which I wish you would keep in mind. During the past twelve months, more new herbicides have come into use, or more new uses of old herbicides have been discovered than in any previous twelve months that I can recall.

Let us go down the list of some of those, chosen at random and by no means complete. First, there is TCA, which means the sodium and ammonium salts of trichloro acetic acid. Though not as effective as the first trials indicated, it may nevertheless play an important role in controlling grassy weeds.

Then there are two new forms of the old chemical cyanamid, the sodium acid cyanamid and the potassium cyanate or aero cyanate. Several new uses of this dual-purpose chemical really show much promise.

From Hawaii, we are beginning to learn about their remarkable success with pentachlorophenol and sodium pentachlorophenate. I understand that the Western Weed Control Conference last week announced the successful use of a powerful combination of pentachlorophenol, 2,4-D, and aromatic oil. It is claimed that this combination really has synergistic or additive herbicidal properties over and beyond the herbicidal properties of the three ingredients.

Not long ago it was announced that our old friend paradichloro benzene, the peach tree borer insecticide, has been found useful for weed control in cranberries. Last summer, extensive and promising tests were made of new high-aromatic petroleum oils in the high-boiling point range as distinguished from the low-boiling point range of Stoddard solvent and the other older materials.

One of the large corporations has announced sodium isopropyl xanthate and allyl chlorophenyl carbonate, certainly very interesting materials from the standpoint of their composition.

This year recognition was given again to one of the original growth-regulator substances, 2,4,5-trichlorophenoxy acetic acid. It seems to have some properties that 2,4-D does not possess. Work on nutgrass in Mississippi indicates that ethylene dibromide may be a superior soil fumigant that will destroy nutgrass tubers in situ.

A very original development out in Oklahoma was the preparation of a homemade methyl ester of 2,4-D, prepared from a common anti-freeze solution. Last, but perhaps not least, was the announcement some days ago of the discovery of 3-acetyl-6-methoxy-benzaldehyde, or AMB, an exudate from the roots of the California brittle bush which thus produces its own herbicide to protect itself from encroaching neighbors.

These, and doubtless other new developments, will be discussed in detail later in this Conference. I mention them partly to illustrate the rapid pace at which we are travelling and partly to lead into my second group of remarks.

These have to do with our intense preoccupation at the moment with weed-killing chemicals and our seeming neglect of other avenues of approach to scientific weed control.

Recently, I had occasion to go over the list of weed control research projects now in active operation or being planned by the Department of Agriculture and by state agricultural experiment stations. Nearly 90 per cent of the available funds are now concerned directly or indirectly with herbicides.

The research on weed control being conducted by commercial companies is probably even more heavily weighted on the side of chemical weed killers. This situation is further reflected in the program for this Conference. Of the twenty-nine or more papers scheduled, the only one that does not seem to be concerned principally with the use of herbicides is a paper by Dr. Muenscher of Cornell on weed species.

From all this, one might judge that the future of weed control is almost exclusively a matter of using chemicals. Obviously, this is not the case, but it does indicate that our research program is in danger of getting out of balance.

I have thought many times during the past year of a remark made toward the close of last year's session of this Conference by Professor F. B. Wright of the Department of Agricultural Engineering at Cornell. His comment did not catch the attention that it deserved. "Don't forget," he said, "that farmers still have scythes and mowing machines and that it costs nothing to use them."

The point that Professor Wright made is the point that I would like to make here, namely, that the use of chemicals, however spectacular, costs cash money. At the moment, farmers have money to spend on chemicals, but does it not seem likely that when boom days are over, farming will return to a way of life in which money is not spent uselessly? Farmers will revert to the practices which are easy and inexpensive.

Of course, there are some chemical methods so vastly superior to any other system that they will be cheap whatever the cost. For example, if chemical treatment of the weeds in corn proves to be as satisfactory and dependable as now seems possible, the saving in hard labor will be so great that few farmers will want to go back to old-fashioned laborious cultivation.

For many other jobs where a little intelligent use of a mowing machine or a cultivator does practically as well as the use of selective herbicides there will be quite a tendency to use the old methods.

As a second point, may I call attention to the fact that the intelligent way to control weeds is not to have any weeds to control. The reason that weed control is such a vicious problem is due primarily to the fact that virtually all soils that have been under cultivation for any length of time contain uncountable billions of viable weed seeds.

Most of these seeds remain dormant in the soil unless they are brought within half an inch or less of the surface. They form an almost ineradicable reservoir of trouble, for every time the soil is stirred a new crop of weed seedlings appears.

Experiments indicate that it would take not less than ten years during which the soil would need to be stirred once a week throughout every growing season before all of the weed seeds in the usual fertile soil could be worked out by tillage. Obviously this is impossible to accomplish. Hence, our troubles from weed seedlings will not be solved in the course of ordinary farming.

It will take either new kinds of crop rotations or the use of direct action on weed seeds in the soil. A year ago I would have said that the prospect of getting direct action, which means the use of chemical seed killers, was not good. We did not know of any chemical that could be added to the soil that would kill any appreciable percentage of the viable weed seeds therein.

During this past year several different chemicals have shown some promise for this purpose, including ethylene dibromide, allyl alcohol, and perhaps others. The question will remain, however, whether that kind of soil fumigation or sterilization against seeds is economically feasible except on the highest priced land. If it is not feasible, there still remains the good old-fashioned way of getting a weed-free farm through the use of proper cropping methods.

I know that this is not a fashionable idea. I know that it takes time, persistence, a well planned cropping system, and probably more brain power than most people are willing to devote to it, but it is entirely possible.

Let me remind you of the famous case of the Bailey Brothers of Woodleaf, North Carolina. As I remember the story, these boys inherited a poor, badly rundown, and very weedy farm in the clay hills of northwestern North Carolina. Their patrimony consisted of a number of acres of raw, red subsoil and mean weedy grasses.

All the fertilizer that the boys could afford to buy would not produce a paying crop of corn. But the boys could read and they were intelligent. They heard about Korean lespedeza, at that time a new introduction in America.

Somewhere they obtained a little seed. They already had a locally adapted strain of winter vetch. With the help of a very sensible agronomist at North Carolina State College they developed a cropping method, using these two legumes and phosphorus fertilizer, and within ten years converted their raw-red subsoil into one of the most productive and profitable farms in their part of the country; and as an incident to this they practically abolished weed troubles, for no weed can grow in a self-respecting crop of Korean lespedeza, winter vetch or red clover.

Instances like this can be multiplied for practically every agricultural region in the United States. I often wonder whether one of the most profitable ways that we could use public funds in weed research would not be to seek out these successful instances of homemade, weed-free farms, and utilize this ready made knowledge in the development of better overall farm cropping practices.

We should bear in mind that often there really is no sense in spending money to control weeds. Weeds are not like insects and plant diseases. They can be seen, felt, and almost heard.

They are big organisms that any child can understand. There is nothing very mysterious about them, and it does not take a scientist with a microscope to learn the more essential facts about their habits and home life. It does take some intelligence to utilize these self-evident facts in order to turn them against the weeds and to our own advantage.

The confusion, of course, comes about because of the almost endless number of details that are involved in the development of these new chemicals. I am confused, you are confused and everybody is confused. That seems to me to be a healthy sign.

After all, progress only comes when people have imagination and develop new ideas. The faster they develop, the more confusion there is. The difficult thing is not to let the confusion run away with you.

I hope, therefore, that before another meeting of this Conference comes around that we will have on the agenda some thoughtful consideration of the broad philosophy of weed control. I hope that

no one will misunderstand me to say that I advocate the discontinuance or even a slackening of the work on chemicals, on new machinery, or on any of the other direct action approaches to weed control.

I ask merely that we look on these more clearly as part of weed control, not all of it. We must, I am convinced, think of weed control in its relation to the overall picture of profitable agriculture, keyed not to the present highly stimulated and somewhat artificial prosperity on farms, but to farming in which strict cost accounting and old-fashioned thrift are essential ingredients and where the farmer controls his weeds so easily that he is scarcely aware that they are there.

CHAIRMAN AHLGREN: I think we have all enjoyed this very splendid picture of the confusion that is existing in weed work today. Are there any questions that you would like to address to Mr. Kephart?

I am sure the audience is completely confused because there are no questions. Thank you ever so much.

I think Mr. Kephart introduced a man who I would like to ask to come up and say a few words to us. We have Dr. Quisenberry with us who is from the United States Department of Agriculture, and it is in his division that weed work is being conducted at the present time.

Won't you come up and at least say hello to our group, Dr. Quisenberry?

DR. QUISENBERRY: Dr. Ahlgren and gentlemen: It is a pleasure for me to come to this meeting again. I had the privilege of being at Cornell last year and seeing you organized.

I know many of you are very much interested in some of the things that are happening so far as weed research is concerned. As Mr. Kephart has told you, you know of some of the work that has been done in our Bureau of Plant Industry, and the work has been very limited for many years due to the limitation of funds,

Sometimes questions have been raised as to why the work is so restricted to certain weeds. That has been done because the appropriations made by the Congress for that work have specifically stated on what weeds the work should be done.

With the coming of this new research and marketing act, it has made possible the expansion of some of our activities, all of which are cooperative with the state agricultural experiment stations. In this fiscal year we got approval of a new project entitled "To Establish a National Cooperative Weed Research Program." I don't believe that is exactly the correct title, but it gives you the idea.

We got a modest amount of money to start with and some new work has been gotten under way. I think it has been fortunate in some ways that we did not get more money because with the shortage of manpower at the present time it is pretty hard to recruit a force very rapidly. We did not get clearance on that project until about the last part of September but the work is under way.

We have had tentative approval on increased funds with regard to that work for next year and we hope to expand our work -- again, cooperatively. I am sure you will be interested to know that the Bureau of Plant Industry and Soils has decided that if the present plans develop as tentatively approved, that some time during the year beginning July 1st, there will be established in the Bureau a weed research division which will cut right across all crops, all weeds, and include the entire field of weed research.

At the present time the weed work is a project in the division of cereal crops and diseases. The next thing that you may be interested in is that in developing this new program which is cooperative with all of the agricultural experiment stations and with commercial organizations, the Bureau wishes to set up a National Advisory Committee to help plan this work, and all of the various weed conferences over the country will be asked to help set up this committee and to name their representatives.

Now one more point and then I shall close, and that has to do with the possibilities under this research and marketing act. Many of the states -- Dr. Willard is here from the North Central region -- can tell you about what they are doing in drawing up their projects to take advantage of this money for cooperative research. The North Central is well along with their plans.

The Western region is getting started and certainly, as Dr. Ahlgren pointed out in his opening remarks, if you people are interested in weed control the state people can get together with the blessings of your directors and get your projects lined up and be in a position to take advantage of some of this money which apparently is going to be appropriated.

Most certainly the administrators down there are not going to approve projects until they see a nice project laid before them, so the project comes first. Again let me thank you for being able to say a few words to you, and I hope you have a very successful meeting and I am sure you will.

CHAIRMAN AHLGREN: Thank you very much, Dr. Quisenberry. I indicated earlier that Dr. C. J. Willard was in the audience. He is the new chairman of the North Central Weed Control Conference which is a very active organization and doing good work. I wonder if Dr. Willard would come up and say a few words to our group.

I expect part of this will be a rebuttal.

DR. WILLARD: Dr. Ahlgren, members of the Northeastern Weed Control Conference; Dr. Quisenberry and I were trying to figure who attended the most weed control conferences and I think he is going to be one up on me presently but so far we are tied. He and I were both at the Western Conference last week and we were also both at the North Central Conference, so we are sort of getting a considerable dose of weed control.

Now the thing that interests me in attending all these is that weed control is growing up. Notice I didn't say grown up. It is growing up and it has all the growing pains of any gangly youngster that is all legs and arms and changing voice.

So we can expect the confusion that has been emphasized here for some little time to come. But nevertheless it is growing up as is emphasized by the attendance that we had at the North Central Conference, something over 600. I haven't heard the official attendance of the Western Conference, but at one of their meetings where they got out and looked at airplanes and other means of putting herbicides on, a good many estimated the crowd at a thousand; and you certainly have got a considerable start here over what you had a year ago at Ithaca.

Now in all of this confusion -- and this intense hunting for new things -- the research base of what we are doing is getting too small. That has been emphasized each time here and those of us who are somewhat old-timers on the job like Mr. Kephart and some others, are snowed under with being requested to do work that ten men couldn't do -- and one of the essentials is money.

Dr. Quisenberry has just indicated one of the best sources for some of that. The commercial concerns have been quite generous in furnishing money also; and actually the biggest bottleneck at the present time, as Dr. Quisenberry also indicated, is personnel, men to do the job. I would like here to suggest, as I have several other times and places, the fact that we have here a new profession, a profession which I am confident will take its place with the profession of entomology and plant pathology.

Mr. Kephart emphasized how simple weeds were but Mr. Kephart also knows when we came to study weeds that it wasn't quite so simple to find out all about it as we might guess from his remarks; and I look forward to the time when we will learn all about a new weed or an old weed just as the entomologist when he is asked to control a new insect. He sends several men out to get its life history and its reaction to all sorts of chemicals and so on. We should do the same thing with every weed.

Now by the time we have done that for all the weeds in the country -- there are several hundred of them -- we will be approaching maturity as a profession. And by that time I certainly hope that we also don't ship weed seeds over the country in feed and hay and seeds and so on, to reseed them.

I hope we have progressed in education not to do that. In order to do all of this we have to have the personnel, and I want to suggest that we have here a new and growing and important profession. I suggest to those of you who are here who realize that to pass that word along to some of the young men who are choosing a profession now, as thousands of them are.

Of course, the older professions get first choice and we have twenty or thirty men in our department studying soil and crops and I have had some difficulty in getting one or two to study weed control.

Let's see if we can't change that and build up what I am confident is to be a new and important profession coordinated with the other pest control professions.

CHAIRMAN AHLGREN: Thank you, Dr. Willard. I am sorry that I have to announce that Dr. Walker, our next speaker, is apparently unable to be with us. I did see our dean of weed investigations a little while ago in the hallway and asked him if he wouldn't be willing also to give us a few words on this topic, "Regulatory Developments in the Marketing of Herbicides."

Mr. Kephart, I wonder if you won't come forward again. As I see this field it is developing now in rather a close relationship to the insecticide and fungicide field.

MR. KEPHART: I am strictly a pinch hitter on this thing. Really all I know about this is rather a conversation that I have had with Dr. Walker and his group downtown. I acted in an advisory capacity to them until they could get a better weed man than I am to help them in their own staff.

I understand that they now have a man such as that coming up but at the moment they are even more confused than we are. As you know, Congress revised the old federal act some time ago and included in the act herbicides and rodenticides. For some strange reason they made the new act go into effect with respect to insecticides and fungicides, the old part of the thing, some time next winter, I believe it is, or next summer; but the new part, the herbicides part about which these fellows knew practically nothing, they put into effect last Christmas Day.

This meant that all the manufacturers of herbicides that are going to move in interstate commerce had to register their labels with this group down there, presumably before last Christmas Day. Well, they simply couldn't do that. But they are moving as fast as they can toward that end.

The primary difficulty that they have had is to determine what they shall require on those labels. There are, as many of you know who are in the insecticide and fungicide business, rather stereotyped requirements that have to go on the labels that move in interstate commerce for those materials. They had to indicate the toxic constituent, the percentage and various other things.

They have to indicate whether there are any hazards in connection with the use of any of those things. In administering this herbicide end of the thing they found that there are two difficulties. First, how shall they express the content of the toxic material in herbicides, particularly in 2,4-D herbicides, and second, how shall they word these cautionary statements.

I believe the first part of that has been pretty well ironed out. The difficulties arose chiefly with the forms of 2,4-D. That is with regard to the ester forms. I don't want to discuss that because I am not sufficiently familiar with the pros and cons of that.

This other matter of what kind of cautionary statements shall be required on labels, not those that they can put on if they want to, but those that are the basic cautionary statements, are still being discussed. There was a meeting down in Washington yesterday about this and there were several representatives of the industry down there. Their reason for being there was primarily to decide how they shall put cautionary statements on there with respect to 2,4-D dust.

The one thing that we run into so far with 2,4-D is the dispersion of 2,4-D dust by airplane. Last summer in Texas and Louisiana and Arkansas, a great deal of cotton was very badly damaged because they dusted a rice field with 2,4-D from airplanes. The cotton was damaged for distances of thirty or forty miles.

Naturally, that stirred up a great deal of ill feeling and so much ill will to 2,4-D that there are some chances that the use of 2,4-D may be totally prohibited in some areas. We think that is going much too fast and that it is not necessary; that means can be worked out by which 2,4-D can be used fairly safely, even by means of the airplane.

The group did agree that the dispersion of 2,4-D dust from airplanes is a highly hazardous business and it should be restricted to the rather few areas where it can be put out by airplane where there will not be any appreciable damage to economic plants within a radius of twenty-five to thirty miles.

I am not sure how they are going to word that but anyway it is going to restrict the use of 2,4-D dust. We were not able to decide whether the same thing applies to the dispersion of 2,4-D dust by ground equipment.

A factor in this thing that nobody foresaw -- and I didn't and I don't think anybody did a year ago -- was that it is not entirely the direct drift of this dust or these sprays that causes damage at some distance. In the case of the Texas situation it was caused pretty largely by the air currents.

Now in the summer the air rises in columns and covers a large area; it drops perhaps many miles away. To a plant as sensitive as cotton a mere whiff of that stuff coming from twenty-five or thirty miles away is all that is needed to put that cotton out of business. That is something that nobody foresaw.

It is quite likely that there will be other things that we didn't foresee. I think we have been lucky with regard to this 2,4-D that we haven't run into more difficulties. You all know about BHC. It looks fine and nobody foresees the difficulties; before you know it, the difficulties are with you.

Who, for instance, saw what was going to happen with the potato crop when they used this new insecticide last year. The first I knew of it was when I tasted the potatoes after they were dug. We can't avoid that but we should be in a position through this federal insecticide and fungicide act to at least prepare ourselves for those things.

Those of you who are in the commercial end of this and are going to distribute 2,4-D or other herbicides in interstate commerce I think would be very well advised to try to work as cooperatively as you can with the fellows down there who are to administer this thing. I know they want to be cooperative and they don't want to do anything that is too unduly restrictive.

You are pretty well represented by Mr. Pritchard down there who sees to it that we don't do anything too drastic to you, but they are very anxious that you express to them any objections that you may have to any actions that they may take. They don't want to be dogmatic about this but they do have the primary responsibility of protecting the ultimate consumer.

Their primary responsibility is not to protect you, but they want to protect you as much as they can. So far as I know, that expresses their attitude and that pretty nearly expresses all I know about this.

CHAIRMAN AHLGREN: Thank you ever so much, Mr. Kephart. We just received a telegram from Dr. Walker which reads as follows: "Pressing duties in Washington prevent my appearance on the program this morning."

I am sorry he couldn't be here but we certainly appreciate Mr. Kephart's appearing for him. That concludes our program this morning.

AFTERNOON SESSION

Northeastern Weed Control Conference, 2:30 o'clock, p.m.;  
Dr. G. H. Ahlgren, presiding.

CHAIRMAN AHLGREN: We are very fortunate, indeed, to have Dr. J. W. Mitchell who is connected with the United States Department of Agriculture, Bureau of Plant Industry Station. He is one of the true pioneers in the developmental phases using 2,4-D for the control of weeds.

I believe Dr. Mitchell and some of his co-workers published the original papers on the destruction of broad-leaf weeds and indicated the selectivity of 2,4-D at the same time. The subject of Dr. Mitchell's talk this afternoon is "2,4-D, Its Physiological Effects on Plants and Factors Affecting Its Inactivation in Soil."

I know we are all very much interested in that because of the application that this subject has to much of the work that many of us here are doing. It is with a great deal of pleasure that I present Dr. Mitchell to you.

DR. MITCHELL: Mr. Chairman and gentlemen: Since the discovery that 2,4-D could be used to kill weeds, a lot of valuable data has been accumulated from practical experiments regarding:

- a. Kinds of plants this chemical will kill.
- b. Forms of the chemical that can best be used.
- c. What effects these have on crop plants.

Although the results appear to be a bit confusing at times, these practical experiments have already gone a long way toward a true evaluation of 2,4-D as an herbicide.

Comparatively little effort has been spent, however, in learning how systemic plant poisons such as 2,4-D kill plants or why this chemical will kill some kinds of weeds and scarcely affect the growth of others which are even more serious pests.

Although basic research on 2,4-D has been limited, we have gained some knowledge, however, as to how plants respond to this poison. Results of this research should be made clear to those making practical field tests with this type of herbicide.

Most basic research with 2,4-D has involved three separate fields of study:

- a. The absorption and translocation of 2,4-D by plants.
- b. The effect of 2,4-D on the growth and chemical composition of plants.

c. The behavior of 2,4-D in soil.

Absorption and Translocation:

Knowledge as to how plants absorb and translocate 2,4-D is of importance because the effectiveness of this herbicide in killing perennial plants depends to a large extent on the amount of the chemical that is translocated down into the roots.

2,4-D is apparently absorbed by surface cells of most any part of the plant. It is very readily absorbed by roots, leaves and stems.

To be most effective as an herbicide, however, the chemical must not only be absorbed, but it must be translocated throughout the plant.

The rate at which 2,4-D is translocated depends to a large extent upon where the chemical is applied. For instances, 2,4-D is readily absorbed by the roots of many kinds of plants.

Applied in this way, the chemical is apparently absorbed into the vascular system where it is carried upward in the transpiration stream to the above-ground parts. In this way, the chemical is readily distributed throughout the plant.

It apparently moves most readily from the roots to other parts of the plant when:

- a. The soil is moist.
- b. The air relatively dry.
- c. And the rate of transpiration high.

Applied to the roots, 2,4-D will move to the top of a plant, even though a section of the stem has been killed. This is true because the chemical moves from the roots up through the stem mainly in the non-living cells of the water conducting system.

The application of 2,4-D to the roots of weeds may present some difficulties from the standpoint of large scale practice. On the other hand, this method of application has received relatively little attention in comparison with top sprays.

On the basis of the way plants respond when their roots are treated under controlled conditions, it would appear that soil treatments could well be tested further in an attempt to develop an economical and effective way of applying 2,4-D to the roots of perennial weeds.

We have been using radioactive isotopes in our work in tracing the absorption and translocation of growth regulating substances by plants. The way we do that is to obtain a radioactive element and then synthesize that into a growth regulating compound.

You have heard of dresses with built-in bustles and this is a molecule with built-in radioactivity. We put that on the tip of the bean leaf. The radioactive growth regulating substance, that is, and it will be absorbed by that leaf and translocated to other parts of the plant.

The compound retains its radioactivity regardless as to whether it is in the plant or out of the plant, and after it has been absorbed and translocated we can measure the amount that has been translocated and where it has gone in two different ways.

One is graphically: we cut that plant off three days after we apply the material and lay it on a piece of film. Then we get an impression of the plant due to the radioactivity that is actually in the leaves and stem.

Then the film was developed in the usual manner. You can see this outline of where the radioactive growth regulator has travelled down the petiole and up the stem. It has accumulated in some very small buds and you can see that radioactivity is relatively high in these small buds.

The young leaves have also accumulated quite a large amount of the growth regulating substance. A young leaf which grew rapidly during the period of treatment also accumulated quite a large amount of this compound.

We have ground these leaves up and have taken these leaves off the plant and ground them up, extracted and identified the same compound as we put on over here. So we are quite sure now that these growth regulators are absorbed and translocated through the plant as such, and you can identify them when they accumulate in the buds.

This proves why I think we get such marked effects on the buds of plants and flowers of plants when we apply 2,4-D. The material seems to accumulate in these rapidly growing parts.

Now we can use another method to measure very accurately the amount of material that has been absorbed and been moved by the plant. We have made measurements on a bean plant where we applied a measured amount of a chemical.

Then by dissecting the plant and placing the material in a Geiger counter we can measure very accurately the amount that has accumulated in the various points: 1.53 micrograms of the radioactive growth regulator in the terminal bud of the bean plant and 0.74 in the young, rapidly growing leaves of the grass plant.

This gets into methods which we aren't particularly concerned with here but I did want to show you that you can demonstrate very clearly that these chemicals are absorbed and translocated from leaves to other parts of the plant. But when dealing with the absorption and translocation of 2,4-D by leaves we are confronted with an entirely different situation than when the chemical is applied to the roots.

After the chemical is absorbed by a leaf it is moved from the leaf to other parts of the plant. But instead of translocating the chemical in dead cells of the xylem water conducting system, the plant moves it from the leaves mainly in living cells, apparently in a manner similar to the way in which sugars and other carbohydrates are translocated from leaves.

2,4-D is translocated most readily from the leaves of a plant at a time when carbohydrates are being translocated from the leaf to other parts of the plant. Thus, young, rapidly growing leaves are relatively inefficient as far as the translocation of 2,4-D is concerned.

Leaves growing in deep shade or darkness and depleted of sugars are likewise relatively inefficient in translocating 2,4-D.

If we take test bean plants and apply a measured amount of 2,4-D, then place one plant in the light, place the other plant in deep shade or darkness, we get this type of response within a few hours.

The plant that is in the light apparently is able to absorb the compound and translocate it from the leaf over to the stem where it will bring about a growth response. The plant that is kept in the dark responds very little, the reason being that it does not apparently absorb and translocate the stimulus.

A group of the same plants were treated at the tip of each leaf; then the plants were placed in deep shade, and these bean plants continued to grow quite a bit after treatment.

On plants treated in exactly the same way but placed in bright sunlight soon after the treatment was applied, the stimulus was absorbed and translocated to the terminal bud and as a result the growth was greatly inhibited.

The difference between these two plants was the matter of whether they were exposed to bright light soon after treatment. On the basis of these results leaves absorb and translocate 2,4-D most readily when fairly well expanded and grown in sunlight.

This may explain in part the varied results obtained with 2,4-D in attempting to kill leafy weeds grown under a variety of environmental conditions. 2,4-D must penetrate the roots and other underground parts of perennial weeds to be effective in killing these plants.

When leaves are treated, the movement of 2,4-D parallels to some extent the movement of carbohydrates. The chemical appears to move most readily from the top to the roots when carbohydrate reserves are being actively replenished in the roots.

It might be expected then that 2,4-D would be most effective in killing roots if applied to the above-ground parts after the stems and leaves are well developed. Theoretically, treatment of young, rapidly growing sprouts of perennials would be relatively ineffective in killing the roots.

With respect to old leaves, there is evidence that these may absorb and translocate 2,4-D less readily than do young, fully expanded leaves. 2,4-D was more effective in checking the growth of test plants when applied to young, expanded leaves than when applied to old leaves.

It has often been observed that plants respond most readily to the chemical during an active stage of growth. This might be expected first, because plants apparently absorb and translocate the chemical most readily during an active stage of growth; secondly, because 2,4-D affects physiological processes such as:

- a. Respiration.
- b. Enzyme activity.
- c. Utilization of reserve carbohydrate and nitrogenous compounds.
- d. And other growth processes.

A chemical which kills by stimulating these processes would theoretically be most effective if applied when these growth processes are most active.

Now let us consider the absorption and translocation of 2,4-D when applied to stems. Applied to the upper stem (i.e. that portion bearing leaves) the chemical is apparently translocated both upward and downward.

But when applied to the stem near the ground level, the stimulus is first moved mainly in a downward direction, and finally it may be translocated to the upper part of the plant. The flowers and fruits of plants will also absorb 2,4-D.

As far as weed control is concerned, the application of 2,4-D to the flowers and fruits of plants is mainly of interest in checking the development of pollen or weed seeds. It has been demonstrated that the flowers and young fruits of plants such as morning glory and ragweed are very sensitive to 2,4-D.

On the other hand, relatively mature fruits are not readily injured by even large amounts of 2,4-D. As would be expected, growth regulators are not readily translocated from relatively mature fruit to other parts of the plant, since the flow of carbohydrates and nitrogenous materials is into the fruit rather than out of it.

Now 2,4-D has a very marked affect on enzyme systems of some kinds of plants and in this way it affects the chemical composition of these plants. Morning glory and dandelion plants have been used by different workers to study the effect of 2,4-D on some carbohydrate and nitrogenous fractions of plants.

In these experiments careful growth measurements were also made after the plants were sprayed with different amounts of the chemical. Growth of leaves, stems and buds was completely checked by treatment in the case of both kinds of plants.

There was no evidence that the plants "grew themselves to death" since their overall dry weight failed to increase after the sprays were applied.

Reserve carbohydrates were reduced in the case of morning glory from about 15 per cent at the beginning to almost zero during the three weeks immediately following the treatment. The sugar content of the plants at first increased, but after three or four days began to decrease and reached a low level, so that at the end of three weeks the plants were practically depleted of their supply of readily available carbohydrates.

During the third week they turned brown and finally died. Factors apparently responsible for the death of these morning glory plants include:

- a. The inhibition of new growth.
- b. And the rapid depletion of readily available carbohydrates which these plants contained.

There, of course, may have been other factors which also partially accounted for their death. The depletion of food reserves, however, must have played an important part in the herbicidal action of 2,4-D in this case.

Rasmussen has reported that the reserve carbohydrates in dandelion sprayed with 2,4-D were reduced, but not sufficiently to account for death of the plants. His final measurements were made, however, on those plants that survived treatment, and he states that some roots used in the final sample "appeared normal." He concludes that factors other than the loss of reserve carbohydrates may play an important part in the killing effect of 2,4-D.

Both work by Brown and Rasmussen indicate that the rate of respiration of plants nearly doubled following treatment with 2,4-D and this effect may account in a large part for the rapid loss in reserve carbohydrates noted.

Now let us consider the inactivation of 2,4-D in soil. Since 2,4-D is extremely toxic when applied to the roots of some kinds of plants, there has been considerable interest as to how this chemical is affected when mixed with soil.

It was discovered several years ago that under some conditions 2,4-D becomes inactivated when placed in contact with soil. It is now known that a number of environmental factors can greatly affect this rate of inactivation.

One of the first questions was: how is 2,4-D inactivated by soil? In early work with this chemical, it was noted that dandelions sprayed with the chemical during a rainy season died and quickly rotted away. Some kinds of micro-organisms were apparently able to grow readily on plants to which the chemical was applied.

Later laboratory tests showed that some molds grew vigorously in media that contained sufficient 2,4-D to kill many kinds of common weeds. In other experiments soil microbes were grown in media containing 2,4-D, and they apparently decomposed the chemical thus inactivating it.

Finally it was found that if 2,4-D was added to soil that had been heated so as to kill most of the molds and bacteria in it, then the chemical remained active, while a like amount of the chemical in unheated soil quickly lost its herbicidal activity.

It appears on the basis of these results that some microbes are at least partially responsible for the inactivation of 2,4-D in soil. Other investigators have found that 2,4-D is very readily absorbed by charcoal or other finely divided material.

It is reasonable to assume that 2,4-D may also be absorbed by soil particles in such a way as to partially account for its inactivation.

Effects of temperature on the inactivation of 2,4-D in soil: Soil containing known amounts of 2,4-D has been stored at controlled temperatures ranging from 36 to 70 degrees Fahrenheit, and the rate of inactivation of the chemical determined. 2,4-D retained its herbicidal activity when stored in soil at 36 degrees Fahrenheit, but the rate of inactivation increased with an increase in storage temperature.

It was concluded from this work that the rate of inactivation of 2,4-D in soil would not be seriously retarded unless the soil temperature dropped below about fifty degrees Fahrenheit.

Soil moisture has an effect upon the inactivation of 2,4-D in soil. The chemical retained practically all of its herbicidal activity when stored for eighteen months in soil having a moisture content of about 2.5 per cent. On the other hand, 2,4-D applied at the rate of four pounds per acre lost approximately one-half of its activity during one month's storage in soil having a moisture content of 10 per cent, and all of its herbicidal activity in soil having 30 per cent moisture.

These results indicate that moisture is a critical factor and that 2,4-D is inactivated at a relatively slow rate when the soil moisture falls below about 10 per cent.

When the chemical is applied to soil during the dry season, its effect can be expected to last a relatively long time. The organic matter content of soil may also influence 2,4-D inactivation.

Since soil microbes apparently account in a large part for the inactivation of 2,4-D in soil, it would be expected that the chemical would remain active for a relatively long time when mixed with soil low in organic matter. Applied at the rate of ten pounds per acre to soil low in organic matter, the chemical retained its full activity when tested after one month.

When manure was added to the soil, 2,4-D mixture at the rate of one thousand pounds per acre, the 2,4-D lost more than one-half of its herbicidal activity within three weeks. Thus, 2,4-D was inactivated at a relatively slow rate when mixed with soil low in organic matter and stored under controlled conditions of temperature and moisture.

In summary, a number of facts have resulted so far from basic research on 2,4-D. First, we know that 2,4-D is absorbed and translocated throughout plants very readily when the chemical is applied to their roots.

Translocation of 2,4-D from leaves and other above-ground parts of plants is influenced by environmental conditions, the maximum rate of translocation occurring under conditions most favorable to the translocation of carbohydrates or other products of photosynthesis.

We know that the depletion of reserve food materials in the plant results when 2,4-D is applied, and it is reasonable to suggest that any other chemical or mechanical treatment which would bring about a similar effect should be tried together with a 2,4-D treatment.

We know that the rate of inactivation of 2,4-D in soil is affected by several factors, including moisture, temperature and the presence of soil organisms and organic matter.

I am sure that as we gain more basic information about how 2,4-D and other herbicides kill plants, we will be better able to make more efficient use of these chemicals as weed killers.

MR. HOFFMAN: Is there any evidence of specific enzymes being affected by 2,4-D?

DR. MITCHELL: The only evidence we have is indirect. We do know that reserve carbohydrates are regularly affected. So I suppose the enzymes in that process are affected.

We do have measurements on the increased rate of respiration so I suppose any enzymes concerned in that process might also be affected. So far as I know there are not any direct measurements on the effect of 2,4-D on enzyme systems in plants today.

MR. BUCHA: I was interested in your picture where you applied your radio isotope. I believe you applied 25 micrograms to a leaf and while I didn't total the amounts which you located in your photograph in various sections of the plant, I know that the total would be only a small percentage of what was originally applied.

Can you tell what became of the rest of it? Is it in the roots or what happened to it?

DR. MITCHELL: We found some of it in the root tip. It goes to where the cells are growing most rapidly and, of course, in the root tips you have that situation. About 20 per cent of the amount of radioactive growth regulator applied to the leaves were absorbed and we can account for that much.

I think about 11 per cent of the amount which we put on the grass was accounted for. However, twenty-five-millionths of a gram is a relatively large amount to apply. If you cut that down to three-millionths of a gram then we got up to 40 per cent absorption.

I suppose a good bit of it is not absorbed and we will find it still on the leaf in the position where it was applied. But as you decrease the amount applied the efficiency of the absorption goes up.

It surprised us that by smearing a little lanolin on the leaf we could get as much as 40 per cent of the compound absorbed and account for it in other parts of the plant.

FROM THE FLOOR: Would it be possible that the 2,4-D passing through that dissected portion of the stem would indicate that it would go through a dead layer on the surface of the leaf? For example, if the 2,4-D were applied in oil which caused the killing of the surface cells, would it get into the leaf then?

DR. MITCHELL: I don't have the results on the test that you describe. On the other hand, I think a number of workers have had the idea that we might mix some of the contact type of herbicides together with 2,4-D and increase the effectiveness.

I don't believe that it has worked out that way since 2,4-D apparently is absorbed readily by living cells, and the process that it stimulates certainly has to do with living cells and not with dead cells.

So if you mix 2,4-D with contact poison that is going to kill the cells immediately you couldn't expect plants to respond to the degree that they would if the cells were living and actively growing. So I doubt if you would get very much absorption through a layer of dead cells.

The thing I was trying to bring out in these stems is that 2,4-D travels upward in the water stream which goes through non-living cells of the xylem. In that case I think Dr. Zimmerman has fairly clearly demonstrated that the chemical is actually in the water stream and travels up through these non-living cells.

That doesn't mean that it would be readily absorbed by dead cells on the surface of the plant.

CHAIRMAN AHLGREN: Thank you very much Dr. Mitchell. Our next topic has to deal with machinery for applying herbicides by Professor O. C. French of Cornell University. To me this is a very interesting topic and I know I am going to be very interested in hearing what Professor French has to say.

It is essentially the science of applying herbicides that has changed very, very rapidly during the last year and I presume are still changing. We have gone from high gallonage application to low gallonage. We look forward with a great deal of pleasure to hearing from Dr. French now.

DR. FRENCH: Mr. Chairman and gentlemen: I don't propose to stand before you and give you the answers on machinery for applying herbicides or killing weeds. There is more than one answer, I assure you, and I wish I knew a few more of the answers. But I think that throughout the years that we have been working with chemicals for the control of weeds we have learned some facts that are still applicable today even on a changed program.

The practice of controlling weeds by other than cultivation has been greatly stimulated in recent years by the development of new chemicals and also by flame weeders. Mechanical cultivation of row crops should not, however, be considered as an obsolete practice.

For many crops it is still the most economical and practical way to control weeds. That the frequency may be reduced and perhaps complete elimination of post-planting cultivation may be realized is entirely possible for many row crops.

Ground spraying equipment:

There is considerable confusion on the part of manufacturers as to what is desired in spraying equipment for applying herbicides. They have reason for this confusion because of the varying recommendations from over the country. It is true that recent practices of low volume applications of 2,4-D have thrown additional confusion into the picture but some of the fundamentals remain unchanged.

Let us consider some of the requirements of spraying:

- (1) Distribute the spray over desired area and plant surface.
- (2) Produce a spray which will have momentum to overcome wind resistance; and will not drift materially.
- (3) Accomplish the above with a minimum of material.

Experimental results seem to show that for most application of selective herbicides that pressures of from 30 to 75 psi with proper nozzles is most desirable to prevent drifting of atomized spray droplets. For applying contact herbicides such as fortified oils for killing all vegetation, it is probably desirable to use pressures of from 100 to 150 psi to secure adequate wetting of plants.

To obtain distribution of the spray there are a good many arrangements of booms and nozzles which may be used but from my observation and experience, I prefer the following:

(1) For low volume (5-25 gallons per acre) use flat-fan nozzles with 70 degree angle of spray, spaced 12 to 15 inches apart on boom with boom height set to give double coverage (from 18" to 22" high).

Although the low volume sprayers do not require pipe booms as large as 1-1/4" diameter, in most cases this size is desirable because of its rigidity and also ease of attaching nozzles. I do not like to see a boom made up of short lengths of pipe and pipe tees with bushings. To help eliminate scaling and clogging of nozzles, brass pipe is preferred.

(2) For volumes of less than 5 gallons per acre, cone-spray nozzles work out better than fan-type.

(3) For high volume spraying (25-up) use 80 degree fan nozzles spaced 15 inches.

(4) Use as large a nozzle size as is possible and reduced pressure. Clogging of nozzles will be reduced.

(5) If three-piece hinge type booms are desired, it is more satisfactory to use a commercial double swivel connector rather than hose connection although more expensive originally.

(6) Whenever possible a boom should be mounted ahead of the propelling unit in view of the operator.

(7) Sprayers mounted on tractors or trucks are much more maneuverable than trailer types, but may not be practical in all cases.

Pumps for sprayers: Since high pressures are not required, there is no need to use the more expensive high pressure reciprocating pumps. For most small spraying units eg. up to 12 to 15 feet of boom, bronze gear pumps are probably the most desirable selection. For large volume and longer booms, a centrifugal pump or a regenerative centrifugal (commonly known as a turbine pump) may best be used.

Gear pumps will wear rather quickly if abrasive materials are handled. If clean water or oils are used the wear will not be excessive.

The size of pump will have to be determined from the size and number of nozzles used.

For tractor mounted sprayers, the pump can easily be driven from the power-take-off drive or from the tractor belt pulley.

For sprayers delivering not over 20 GPM the rotary gear pump may be the most economical. Capacities over 20 GPM generally require centrifugal or turbine types. Where centrifugal type pumps are employed they should be mounted so as to have a positive suction head, or engine exhaust primers should be used.

Field speeds for ground sprayers: Some fields may be smooth enough to permit speeds up to 10 miles per hour but in the majority of cases, speeds of 6 miles per hour and less must be figured on. With boom lengths greater than 15 feet, excessive whipping of the boom will occur at speeds greater than 5 miles per hour.

Sprayers for lawn and golf courses: Experimental work this past Fall at Cornell has resulted in practical means of applying 2,4-D on lawns by combining spray equipment directly on the lawn mower thus doing two operations at one time. This also solves another rather important problem; it eliminates the need of a marker thus making it simple for the operator to avoid skips in coverage.

A further interesting point in this development has been the use of bottled CO<sub>2</sub> as a source of pressure for atomizing the concentrated 2,4-D mixture. Low pressures at the nozzles are used, usually 30 to 35 psi. At this pressure, one pound of CO<sub>2</sub> when expanded will displace approximately 25 gallons of spray mixture. At application rates of from 3 to 4-1/2 gallons per acre a seven pound CO<sub>2</sub> bottle will displace enough spray to cover from 35 to 60 acres depending upon the 2,4-D application rate.

This method has the advantage that no pump is required hence a special drive or auxiliary engine is avoided. The only thing required is a pressure tank, pressure reducing valve and the CO<sub>2</sub> bottle plus the usual boom and nozzles.

Precautions for concentrated spray application: Those of you who have had experience in applying concentrated spray applications will realize the necessity for adequate screening or filtering of the spray mixture ahead of the nozzles. To apply spray at less than 5 gallons per acre at ground speeds of under 6 miles per hour requires very small nozzles which will clog very easily.

Another precaution worth taking is to prevent drip from the nozzles and boom after the pressure is shut off. With very concentrated material every bit of material saved is worthwhile. Furthermore, burning or sterilization of the soil may result if considerable concentrated materials are deposited in a small area under a nozzle.

To meet this situation, small spring loaded ball valves may be installed between the boom and the nozzle. These valves are available preloaded to require 5 psi to unseat the ball. Hence, when the nozzles are shut off, drip will be kept at a minimum.

A further word of caution is to point out the necessity of carefully calibrating the sprayer for rate of delivery as well as calibration of ground speed. A small change in ground speed will greatly affect the rate of application.

Spraying by aircraft: There has been a great amount of interest in and use made of aerial application of herbicides during the past two years throughout the country.

I have not had the opportunity to study aircraft spraying here in the East, but have had some experience the past two years in California.

The results there have been generally very satisfactory for application of herbicides, primarily 2,4-D and Sinox on grain fields, rice fields and also on drainage and irrigation ditches. In 1946, most of the application by airplanes was at the rate of 15 gallons per acre whereas in 1947, there was a goodly amount applied at rates of 5 to 10 gallons per acre with excellent results.

Some application of fortified oil contact spray on alfalfa fields for controlling annual grasses, chick weed, etc. in early Spring was not too successful by planes. Adequate wetting was not obtained on the grasses.

The results on rice were unusually successful the past season. Approximately half of the 235,000 acres were sprayed with 2,4-D by planes. Although the 1947 acreage of rice harvested was 18,000 acres less than 1946, due to water shortage the average yield was 76 bushels per acre and the total production was a quarter million bushels larger than the 1946 crop. Very little trouble was experienced in drifting of the 2,4-D spray onto adjoining crops. A few cases were observed where the ester form of 2,4-D was used, however.

The plane operators were careful to adjust their nozzles and pressure to produce as large droplet sizes as possible and still get distribution. No 2,4-D dusts were applied to my knowledge and I doubt that any will be applied except on brush land areas for clearing purposes and that will be very closely regulated.

Most of the airplane sprayers in the West have been equipped with booms and nozzles extending from wing tip to wing tip. Positive valve shut-offs directly in front of each nozzle. Recirculation type of agitation is provided by the centrifugal pump.

Some of the operators employed power-take-off drives for the centrifugal pumps, while others depended on auxiliary propellers. Several planes were using the wire brush type of dispersing devices, four units being mounted on each plane.

Most of the operators used whirl jet type nozzles. If fine atomization was desired, the nozzles were directed downward at 90 degrees to direction of travel. For 2,4-D the nozzles were directed backward with respect to the direction of flight.

Flame cultivation: The use of flame cultivators may offer some advantages over either sprays or mechanical cultivation on certain row crops. For example, it may greatly reduce soil erosion due to non-disturbance of the soil. For field crops unless the flame cultivator can eliminate hand weeding, I fail to see where it can compete with mechanical cultivation.

For home gardens it does offer a great deal of promise in saving labor. Now there are certain applications of that over the country that do not agree with what I have said but I still think that it is quite a long ways from as general an application as herbicidal weeding.

Pre-emergence treatments: It is my observation that pre-emergence treatment by either flaming or chemical sprays offers much promise on many row crops, particularly vegetable crops.

From the result of experiments last year at Davis, California on sugar beets, I offer these following suggestions:

(1) If possible, the seedbed should be prepared and then weeds permitted to emerge and allowed to grow for a time before planting.

I am sure that is the general practice. I would like to see the weeds grow a while. It looks bad and it is against all our principles of good husbandry as practiced, but I think it is the right way to do it.

(2) Seed in the weedy soil then treat immediately following seeding preferably during the seeding operation to save an operation.

(3) If treatment is delayed to a date following planting, weather may not permit proper timing.

(4) The above also reduces likelihood of chemical injury to crop seedlings. This also reduces the possibilities at least of injury to the seedling due to the material that is being applied.

In the case of sugar beets, as I recall, any application that was made -- and that doesn't include all of them, of course, but the ones that were made there -- anything applied six days before emergence of the beet caused no injury to the seedling, whereas, when it was timed down to three days, then we got injury.

For this particular work a sprayer can certainly be devised to be mounted on a tractor and planter unit so that seeding and spraying can be done simultaneously.

This scheme plus precision seeding can virtually eliminate any hand thinning or weeding in some of our vegetable crops.

For crops ordinarily requiring hand weeding in the row at time of thinning, it may prove economical to arrange the spray boom so as to spray only a strip directly in and a little to each side of the seedling row. In other words not to spray the whole seedbed because you can take care of that with mechanical cultivation in many cases cheaper than you can with your chemical sprays.

MR. BARLOWE: Has there been any practical marker developed for large field type sprayers to tell where the past strip has been sprayed?

DR. FRENCH: I don't know of any really practical marker of this type. When they get up to 40 feet, as some of them are using in the Middle West and Far West, I think that the practice has been for the operator to merely gauge from the wheel tracks of his previous trip across plus a liberal overlap.

There has been considerable thought that has been given to various dyes and what not that might be added to the spray, but to my knowledge it has not been designed.

This subject takes me back a good many years to when we were applying sulphuric acid on grain; and there was one nice thing about that material, you didn't have to worry about it if you had a fairly large field because by the time you got around, you had the mark there and also had it on your pants and your neck.

MR. DAY: Is there any practical limit that you have found as to the orifice size of a nozzle which can be used and sent out to the average farm where the farmer doesn't realize the necessity for absolute cleanliness in the entire operation of feeding those nozzles?

DR. FRENCH: I am afraid I haven't the specifications for you. I do know this, that when we get down into the range of nozzle sizes that we are recommending for applications as low as 5 gallons to the acre, we run into lots of trouble. Now we have some considerable appreciation of the problem.

MR. DAY: Along with that, has any thought been given to single coverage rather than double coverage thereby enabling you to use a larger orifice?

DR. FRENCH: That is exactly what is being done but the thing that I don't like to see is where you spread those nozzles out so far that they begin to recommend the higher speeds, ground speeds. You get a whipping of the boom and you are inevitably going to get skips and not the complete coverage which you would like to have.

That is the only advantage of double coverage that I know of; it is to assure yourself that you get complete coverage.

MR. GOODMAN: Is it practical for home owners? Will it be possible to cut and spray together?

DR. FRENCH: Yes, sir.

MR. GOODMAN: What about the leaf coverage when it is covered with 2,4-D in your plant activity?

DR. FRENCH: We have apparently gotten results with it on a perhaps limited scale, and I don't know that we are ready to say that it will control all weeds or foreign objects found everywhere. It has worked fairly successfully, I believe; and Dr. Pridham has carried on most of those experiments for us at Cornell. He might wish to comment on that later.

CHAIRMAN AHLGREN: Dr. Howard Yowell of Standard Oil Development Company is going to discuss both of the topics listed on Petroleum; the first is "Petroleum Chemistry as Related to Herbicides" -- and the second is "The Herbicidal Properties of Certain Pure Hydrocarbons".

DR. YOWELL: Despite the fact that the bulk of the petroleum products used in agricultural pursuits is utilized in providing power and lubrication for farm vehicles and implements, the increasing usage of oils for combating noxious crop pests is placing new significance on the potentialities of hydrocarbons in scientific agriculture.

Since experiment station personnel and other agricultural research workers are finding such a variety of uses for petroleum products in agricultural applications, the Program Committee of the Northeastern States Weed Control Conference concluded that the time was right for a review and discussion of petroleum chemistry as related to herbicides. It is the aim of this paper to summarize briefly the operations and products of a modern refinery to provide a general background information which may prove helpful in weed control problems.

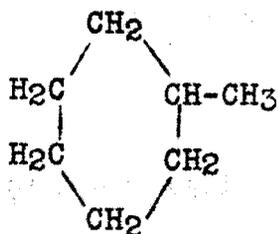
Petroleum chemistry is essentially the chemistry of hydrocarbons since crude oil is primarily an extremely complex mixture of compounds containing only carbon and hydrogen. Naturally occurring crude petroleum contains only three types of hydrocarbons; namely, paraffins, naphthenes and aromatics, although another type, olefins, is formed during thermal refining operations.<sup>(1)</sup>

There are, however, literally tens of thousands of individual compounds present in crude petroleum and, depending on molecular weight and chemical structure, they vary in physical appearance from gases, through liquids, to high melting solids.

Simple examples of the four main classes of petroleum hydrocarbons are as follows:

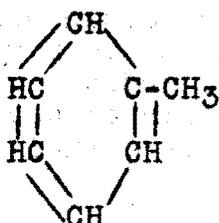
- Paraffin       $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$       normal Heptane
- Olefin       $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2$       normal Heptane-1

Naphthene



Methylcyclohexane

Aromatic



Toluene

Although three of these four compounds can be identified in crude petroleum, their actual concentration is too small to warrant their isolation or the isolation of any one of the multitude of compounds present. For that reason finished petroleum products are for the most part complex mixtures of individual compounds, although by proper choice of crudes and refining techniques, it is possible to manufacture products predominating in any one class of hydrocarbons.

The first step in the refining of crude petroleum consists in separating it into the following fractions by distillation:<sup>(2)</sup> These are in the order of the fraction, the approximate boiling range in degrees Fahrenheit, and the number of carbon atoms per molecule, Gas; -258 to 31 degrees; 1-4. Gasoline; 32 to 400; 4-12. Kerosene; 350 to 530; 12-16. Gas oil; 500 to 700; 16-20. Lubricating oil (distilled under vacuum); 28-32. Residuum (asphalt); 30.

In a modern refinery all of these fractions are subjected to additional distillations and chemical treatments to produce specified finished products. For example, Stoddard Solvent, which is so widely used as a selective weed killer in carrots,<sup>(3)</sup> is a 300-400 degree Fahrenheit narrow fraction obtained from the raw gasoline product.

The normal gasoline fraction in crude oil is too small in volume and also normally too inferior in quality (octane number) to meet present day requirements for motor fuel. Consequently, the yield of gasoline from crude oil is greatly increased by cracking some of the higher boiling fractions, especially the gas oil, into smaller fragments which are in the C<sub>4</sub>-C<sub>12</sub> molecular weight range of motor fuel.

These cracked products are predominately olefins, more highly branched paraffins, and aromatics, all of which are high in octane number. The cracking reaction is obtained by subjecting the crude fractions to high temperatures (99-1200°F.) either alone or in the presence of special catalysts.<sup>(4)</sup>

When the original gasoline fraction is "reformed" to improve its octane rating, milder reaction conditions are used to "temper" the

cracking reaction, since it is already in the desired volatility range, and yet chemically change the original feed into the desired olefins, aromatics, and highly branched structures.

None of these reactions is clean-cut and a considerable amount of material in the gas oil range is produced as a by-product in these cracking operations. These by-products are also higher in aromatic and olefin contents than the original feed. It will be evident from later discussion that the cracking operation in addition to improving the gasoline fraction, also enhances the herbicidal activity of the gas oil.

Highly unsaturated hydrocarbons such as diolefins and polyolefins are also produced as by-products in the cracking reaction. Such compounds are also produced as by products in the cracking reaction. Such compounds are particularly objectionable in refinery products since they polymerize to dark colored gums on standing. Conventional refinery techniques for removing these undesirable impurities involve treating these products with prescribed quantities of sulphuric acid under carefully controlled conditions.

Aromatic hydrocarbons are objectionable in typical refinery products such as kerosene, diesel fuel, and lubricating oils. In cases where these products fail to meet specifications because of a high aromatic content, they are extracted with special solvents such as liquid sulfur dioxide under pressure, or with phenol both of which preferentially remove the aromatic hydrocarbons.

The aromatic hydrocarbons are not chemically altered in the extraction process and can be recovered from the solvents as aromatic concentrates. The separation of naphthenic and paraffinic hydrocarbons is difficult and products predominating in one or the other type of hydrocarbon is manufactured from a crude oil initially containing a high concentration of the desired class of hydrocarbon.

Petroleum refining is quite complex and the foregoing rather oversimplified summary is intended only to present a general picture of the manner in which petroleum products of interest in weed control are produced. Special interest has been placed on types of hydrocarbons since recent publications have shown that the structure of a particular hydrocarbon or petroleum fraction greatly influences its behavior in agricultural applications.

Within the past year, Chapman and Pearce showed that dormant spray oil predominating in paraffins (as indicated by a high viscosity index) was considerably more active insecticidally than a naphthenic oil in the same viscosity and boiling range. These authors also pointed out that the naphthenic oil was more phytotoxic than the paraffinic oil when applied as foliage sprays.

The most fundamental study to date of the effect of type and structure of hydrocarbons on herbicidal activity was reported by J. R. Havis of Cornell at the December, 1947 A.A.A.S. meeting in Chicago. (6) In this investigation, thirty-one pure compounds covering

a wide boiling range and representative of the four classes of hydrocarbons found in petroleum products were applied to the foliage of peas, lettuce, spinach, carrots, onions, and timothy.

A summary of these data in Table I provide many interesting and valuable conclusions. Of the four main classes of hydrocarbons it is quite apparent that the aromatics are by far the more potent herbicidally.

Although the lower boiling hydrocarbons are all low in herbicidal activity, probably because they evaporate before they have time to exert a lethal action, it is interesting that the C<sub>8</sub> olefins, paraffins, and naphthenes were toxic to carrots. Moreover, the C<sub>16</sub> olefins and paraffins were also toxic to carrots.

It is indeed fortunate, therefore, that Stoddard Solvent, which is a special narrow fraction boiling in the C<sub>10</sub>-C<sub>14</sub> range, was tried early in the game as a selective weed killer for weeds in carrots. Stoddard Solvent normally contains from 5 to 15 per cent aromatics and from the data in Table 1, it is probable that not much higher concentrations could be tolerated by carrots.

Although considerable effort is being exerted on studying the herbicidal action of hydrocarbons, a gratifying by-product of this work is a general picture of those hydrocarbons that are not toxic to plant life. Such information may prove helpful in other applications of petroleum products to agriculture, such as non-phytotoxic insecticide solvents and Summer spray oils.

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Table I

HERBICIDAL PROPERTIES OF 31 PURE HYDROCARBONS\*\*

Aromatics	H.R.*	Naphthenes	H.R.*	Olefins	H.R.*	Paraffins	H.R.*
Benzene	1						
Toluene	5	Methylcyclohexene	1	Diisobutylene	3	Iso-Octane	1
Xylenes	7	Ethylcyclohexene	3	n-Octane-1	3	n-Octane	3
Isopropyl Benzene	7			n-Octane-2	3		
Diethylbenzene	7						
Tetrahydronaphthalene	9	Decahydronaphthalene	7	Vinylcyclohexene	5#		
Triethylbenzene	7	Dicyclohexyl	7#	n-Decane-1	7#	n-Decane	5#
Methyl Naphthalene	9			Tri-isobutylene	5#		
Dimethyl Naphthalenes	9						
Diphenylmethane	9			n-Dodecane-1	5#	n-Dodecane	1#
Amyl Diphenyl	1			n-Tetradecane-1	5#	n-Tetradecane	1#
Amyl Naphthalene	7			n-Hexadecane-1	5	n-Hexadecane	3

\*Herbicide Rating 1 = no toxicity 9 = rapid, complete kill.

#Tolerated only by carrots.

\*\* From paper No. 203, by J. R. Havis, Department of Vegetable Crops, Cornell University

THE HERBICIDAL PROPERTIES OF CERTAIN PURE  
PETROLEUM HYDROCARBONS

(Preliminary Report)<sup>1,2</sup>

By J. R. Havis  
Cornell University, Ithaca, New York

The use of petroleum naphas for selective and non-selective weed control is receiving considerable attention by investigators. Furthermore, heavier grades of oils have been found to be valuable as insecticides and as carriers for insecticides. Various investigators have postulated and others have presented evidence to show that herbicidal properties of petroleum oils are dependent on the quantity of unsaturated or sulfonatable hydrocarbons contained therein. However, very little experimental work has been done with pure hydrocarbons.

Herbicidal tests were made of 31 pure hydrocarbons of aromatic, olefin, and paraffin series, ranging in boiling point from 80° to 300° C., representing those hydrocarbons found in petroleum naphthas. The tests were made under greenhouse conditions at 70° to 80° F. on young plants grown in 7½" x 11½" flats. A flat contained one 7-inch row of each of the following: peas, lettuce, spinach, carrot, onion, timothy. The chemicals were applied with hand-operated atomizers, and care was taken to obtain good coverage. At least two tests of two replications each were made for most of the hydrocarbons.

The results of the herbicidal tests are summarized in the table. The hydrocarbons are listed in order of increasing boiling points. The conventional 1 to 9 rating system is used to evaluate degree of injury where 1 denotes no injury and 9 indicates complete, rapid kill. Type of injury was either acute "A" or chronic "C", as defined by Crafts and Reiber(1). Chemicals were designated "+" if tolerated only by carrots or by "-" if tolerated by no crop, and by "----" if tolerated by all.

A study of the table suggests that in general the three series might be given the following toxicity rating:

aromatics > olefins > paraffins.

Straight-chain paraffins were the least toxic. The cyclo paraffins, especially the double ring naphthenes, were markedly more toxic than the straight chain paraffins.

Boiling point appeared to influence the toxicity of each of the series of hydrocarbons. In general the hydrocarbons included in the boiling range from about 150° to 275° C. were more toxic than those

<sup>1</sup>Published as Paper No. 293, Department of Vegetable Crops, Cornell University, Ithaca, New York.

<sup>2</sup>The author is indebted to the Standard Oil Development Company, Elizabeth, New Jersey for supplying the pure hydrocarbons and for a grant in aid.

SUMMARY OF THE HERBICIDAL PROPERTIES OF 31  
PURE HYDROCARBONS

Name of Hydrocarbon	Series	B.P. ° C.	Toxicity		Carrot Tolerance***
			Rating*	Type**	
1. Benzene	Aromatic	80	1	----	----
2. Iso-octane	Paraffin	99	1	----	----
3. Methylcyclohexane	Cycloparaffin	101	1	----	----
4. Diisobutylene	Olefin	101-104	3	A	-
5. Toluene	Aromatic	110.5	5	A	-
6. n-Octene-1	Olefin	121.5	3	A	-
7. n-Octene-2	Olefin	125	3	A	-
8. n-Octane	Paraffin	125.5	3	A	-
9. Vinyl-cyclohexene	Olefin	129-130	5	A	†
10. Ethylcyclohexane	Cycloparaffin	130.5	3	A	-
11. Xylenes	Aromatic	138-144	7	A	-
12. Isopropyl-benzene	Aromatic	152.5	7	A	-
13. n-Decene-1	Olefin	172	7	A	†
14. n-Decane	Paraffin	174	5	A	†
15. Tri-isobutylene	Olefin	175-180	5	A	-
16. Diethyl-benzene	Aromatic	180	7	A	-
17. Decahydro-naphthalene	Cycloparaffin	185-195	7	A	-
18. Tetrahydro-naphthalene	Aromatic	207	9	A	-
19. Triethyl-benzene	Aromatic	211	7	A	-
20. n-Dodecene-1	Olefin	213	5	A	†
21. n-Dodecane	Paraffin	216	1	----	----
22. Dicyclohexyl	Cycloparaffin	230	7	A	†
23. Methyl-naphthalene	Naphthalene	240-245	9	A	-
24. n-Tetradecene-1	Olefin	250	5	C	†
25. n-Tetradecane	Paraffin	253.5	1	----	----
26. Diphenyl-methane	Aromatic	262.4	9	A	-
27. Dimethyl-naphthalene	Naphthalene	264	9	A	-
28. n-Hexadecene-1	Olefin	280	5	C	-
29. n-Hexadecane	Paraffin	286.5	3	C	-
30. Amyl-diphenyl	Aromatic	290-300	1	----	----
31. Amyl-naphthalene	Naphthalene	288-292	7	A & C	†
	Aromatic				

\* Rating: 1 - no toxicity, 9 = complete, rapid kill.  
 \*\* Type of toxicity: A = acute or rapid, C = chronic or slow.  
 \*\*\* Tolerance: † = tolerated by carrot, - = tolerated by no crop,  
 ---- = tolerated by all.

hydrocarbons boiling on either side of that range. The low boiling hydrocarbons evaporated from the plant surfaces more quickly than those falling in the boiling range of maximum toxicity. This may at least partially account for the latter's greater toxicity. Factors other than evaporation rate, however, must be responsible for the relatively low toxicity of the hydrocarbons in the boiling range above 275° C.

Of the five hydrocarbons given a toxicity rating of 9, all except diphenyl-methane are characterized by the naphthalenic molecular structure. It seems probable then that the presence of naphthalene aromatics may be responsible for a large share of the herbicidal properties of certain petroleum fractions.

Olefins boiling above 250° C. and paraffins and aromatics boiling above approximately 280° C. produced chronic injury as opposed to acute injury for the lower boiling hydrocarbons.

Laboratory tests were made with 29 of the hydrocarbons to determine their toxicity to dormant and germinating vegetable and weed seed(2). Although none of the hydrocarbons were found to be lethal to dormant seed, their comparative toxicities to germinating seed were similar to their effects on foliage.

Studies with the pure hydrocarbons are being continued.

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CHAIRMAN AHLGREN: We have with us now also Dr. C. E. Minarik from Camp Detrick, Maryland.

Dr. Minarik and his group of workers at Camp Detrick have probably screened more chemicals for their herbicidal properties than any other group in the world.

I can't think of anyone more qualified to present this topic, "Methods of Evaluating Chemicals for Herbicidal Use."

Tests for Evaluating Potential Herbicides  
C. E. Minarik  
Camp Detrick, Frederick, Maryland

The discovery of a compound which is capable of producing a desirable and specific result, whether it be killing bacteria, insects or weeds, stimulates the search for other compounds which may be more

effective or more desirable from some other viewpoint. Such was the case in the antibiotic field. The introduction of penicillin initiated the quest for other antibiotics capable of conquering those bacteria which penicillin does not touch. It has resulted in the isolation of streptomycin, streptothricin, chloromycetin, bacitracin, tomatin and many other bacteriocidal or bacteriostatic substances from other bacteria, fungi or the higher green plants.

In a similar manner the search for an insecticide better than DDT has brought forth several which are in some way superior to DDT.

In the herbicide field the first and in many respects the best new herbicide to appear in recent years is 2,4-D. It is not necessary to enumerate the many advantages this compound has over the old-style weed killers, nor is it necessary to point out its shortcomings and the area in which there is room for improvement. However, the discovery of 2,4-D provided the incentive which set off the search for more effective weed killers.

A program designed for the evaluation of potential weed killers must, of necessity, have a definite type of weed control in mind when the program is established. In other words, some of the specifications of the herbicide must be laid down before the evaluation program is started.

It must be previously decided whether the compound sought should be a contact herbicide or be translocatable; whether it should be effective only on certain broadleaf plants, or only on grasses, or whether it must be able to eliminate certain weeds from plantings of specific crops without injury to the crops.

The test must be designed to demonstrate effectively that the potential weed killers can or cannot be used for the particular purpose intended. The best way to test them is to try them out under the same conditions under which they will ultimately be employed and on the same weeds. Unfortunately such tests are not always practical as primary screening tests since they involve the use of comparatively large quantities of the potential herbicide, and secondly they cannot be conducted at all seasons of the year -- at least not in the northern section of the United States. Consequently, one is forced to establish a greenhouse or laboratory test which has a high degree of correlation with field behaviour.

In selecting the primary screening test for a general purpose contact herbicide, almost any plant which can be produced in numbers in the greenhouse during all seasons of the year would be satisfactory as the test plant. The method would consist of spraying a known volume of a solution of the candidate herbicide over a known area which contained a number of the test plants. The criterion of effectiveness in such a test could be death or, with sublethal dosages, changes in fresh weight of the plants several days after treatment. It would be advisable to use a standard for comparison, and to express the activity of the candidate herbicides as a percentage of the activity of the standard.

Fine mists or aerosols are avoided since drops approximately 0.2 to 2.0 mm. in diameter are the most effective. Finer sprays require greater pressure and result in greater turbulence and poorer interception by the plants. In one laboratory which screens many compounds the plants to be treated are placed in the bottom of a box 4 feet tall and one-half square yard in cross section. The box has a 1/4" hardware cloth bottom and is elevated about 6" off the floor. This spray chamber is kept in a separate room which is equipped with an exhaust fan.

A measured volume of the test substance is placed in the spray gun and applied to the plants from a relatively fixed position at the top of the spray chamber which is kept open. A door in the side of the chamber permits access to the inside.

After the plants have been sprayed they are not removed to the greenhouse for some time. This delay permits vaporization of volatile substances which might affect other plants in the greenhouses. Spray treatments in a greenhouse are unwise and to be avoided.

The selection of a method for evaluating general purpose herbicides of the plant growth-regulator type is more difficult. The test must be so designed that it permits the expression of the typical plant growth-regulator responses, the most readily observed of which are curvature, inhibition of shoot elongation, inhibition of root elongation, production of galls, inhibition of fresh weight production, malformation of leaves or death. One or more of these responses may be used as a criterion of effectiveness.

One of the most sensitive responses to growth-regulators is inhibition of root elongation. A method in which this criterion is used consists of placing 25 cucumber seeds on filter paper in a 6-inch Petri dish, adding 15 milliliters of a 1 p.p.m. solution of the test substance and incubating in the dark at 28° C. for 4 days. At this time the length of the primary root of each seedling is measured and degree of inhibition is compared with the inhibition produced by the standard 2,4-D which is tested concurrently.

This test is rapid and reproducible. After investigating the potentialities of over 50 other species, cucumber was selected as the test plant because it is very sensitive to small amounts of 2,4-D, it can be grown under the conditions of this test without becoming contaminated by molds, it has a distinct primary root which is easy to measure, and it is a fairly large seed which makes it easy to handle.

A glance at the program of this conference clearly indicates the rising interest in pre-emergence or pre-planting weed control. This interest is quite justified.

It is common knowledge that the susceptibility of plants is greatest at the very youngest stages, and that resistance increases with age. Therefore it is logical to make the treatment at the time when the weed is most susceptible, that is, during germination. To

delay weed control until both weed and crop are established, exposes the crop to unnecessary risk of injury by the herbicide. It is our belief that more and more weed control will be conducted against germinating weed seeds and less against established weeds. A weed control program will call for weed prevention and not weed eradication. For this purpose then a herbicide which is effective against seedlings or germinating seeds would appear to be very desirable. The cucumber germination test just described is admirably suited to detect compounds with this characteristic.

Although the cucumber is a broadleaf plant, it is quite sensitive to isopropyl N-phenyl carbamate and related compounds which are effective in inhibiting germination of some grasses and cereals. Consequently it should be possible to screen out by this method compounds which might be specific for inhibiting the germination of both grasses and broadleaf plants. This situation is the converse of the situation in the corn germination screening test reported a few years ago. In the latter test corn seed was used as the test plant and compounds which were good herbicides for broad-leaf plants were detected with considerable accuracy. The corn seedling resembles established broad-leaf plants in its susceptibility to plant growth-regulators. This is not true, however, of the established corn plant.

Another test, which was developed by Mitchell and has been used quite widely, involves placing a drop containing 4 or 5 micrograms of the potential herbicide on a primary leaf of a young bean plant. After 7 to 10 days the fresh weight of all tissue above the primary leaves is weighed. The inhibition in fresh weight production is a measure of the herbicidal activity of the compound. It, too, is compared with the inhibition produced by 2,4-D which again is run concurrently. Another criterion which can be used in this test is inhibition of shoot elongation above the primary leaves. Both Kidney Bean and Black Valentine garden bean plants make admirable test plants since they both produce uniform plants during all season of the year. They are also rapid growers, being ready for treatment 7 days after planting. This test picks up compounds active in affecting growth of broadleaf plants and demonstrates translocatability.

Another test which has been used involves applying 5 milligrams of the test substance in solution to 2 lbs. of soil in which oat seedlings are growing. After 7-10 days the fresh weight of the aerial portions of the plants is measured. Inhibition of tissue production is again the criterion and comparison is made with a standard.

This test is designed to pick up growth-regulators which are active against annual grasses. Since absorption and transport of growth-regulators by the tops of grasses is inefficient, the regulator is applied to the roots. The inefficient top absorption and/or transport of growth-regulators by cereals was well illustrated by some experiments conducted by Ennis at Camp Detrick. Aqueous solutions containing a wetting agent were sprayed upon oat and barley plants with the soil covered in one case and not in the other. The tops of another set of plants were immersed for 30 minutes in solutions of the growth-regulator and care was exercised to prevent the regulator

from contaminating the soil. With a fourth set of plants the growth-regulator was applied directly to the soil. The regulator used was isopropyl N-phenyl carbamate. Grain yields were reduced only when the growth-regulator was allowed to come in contact with the roots, clearly illustrating that the regulator was either not absorbed or not transported when presented only to the tops of cereal plants.

These three primary screening tests are adequate for separating active compounds from inactive. The next step in any program should be secondary screening in which the compounds which appear promising in primary tests are subjected to further evaluation on other species of plants and on more mature weeds. Both spray and soil applications should be used in the secondary tests. The third step in the program should be evaluation in the field. Although hundreds of compounds might be evaluated in the primary tests, relatively only a few would reach the field testing stage. Regardless of the number of type of screening tests employed, it is still possible to overlook some compounds which may be specific for some species of plants which were not used as test plants. Other active compounds may also be overlooked because they do not produce the plant responses which were used as criteria for herbicidal effectiveness.

A characteristic which is very desirable in herbicides is differential killing. If a herbicide can be applied to a planting and eradicate undesirable plants without harming the crop, it can be quite valuable. Unfortunately the primary screening tests described cannot distinguish between a general purpose herbicide and one which may be specific for certain weeds. Consequently it is necessary to conduct tests of a different nature to screen compounds for differential herbicidal activity.

#### Concentration

One of the most important considerations in developing screening tests for the growth-regulator type herbicide is the concentration at which the compounds should be tested. The level of treatment may be such that the standard against which candidates are tested produces 50% inhibition. In this way a compound which is superior to the standard has ample latitude to display its superiority. However, there is some question as to the soundness of this procedure. It is quite possible that a compound which may be inferior to 2,4-D at a low concentration may be superior at a higher concentration or for a specific purpose. The herbicidal effectiveness of most compounds increases with rising concentrations but the rate of increase may not be the same for all compounds. In this manner a compound which may be better than 2,4-D may be overlooked when the tests are run at only one level.

This thesis has also been suggested by Fults and Payne who tested 74 compounds for growth-regulatory and herbicidal activity at 13 different concentrations. The growth-regulatory activity was determined by Went's pea test and herbicidal effectiveness by a spray test on castor beans. Their results confirm the belief that the rate of increase in herbicidal effectiveness with a rise in concentration is not the same for all herbicides.

### Solubility Aids

The low solubility of many compounds which are potentially good herbicides has introduced another serious problem, namely, means for getting such compounds into solution for testing. This can be accomplished by using suitable solubility aids. Among the first to be used successfully were the Carbowaxes, which act not only as solubility aids but also as wetting agents. Many growth-regulators can be dissolved in Carbowax and then diluted with distilled water so that the resultant concentration of Carbowax is less than 2%. It is not safe to exceed this concentration because of injury to plant tissue. There are other solubility aids on the market and many of them are suitable for use in screening tests. However, the solubility aids selected must be non-injurious to plants or they must be used in sufficiently low concentrations so that the effect of the solubility aid does not mask the effects of the growth-regulator. In any case, a check should be run on the solubility aid without the herbicide and the concentration of the solubility aid should be maintained constant within any one screening test.

Two investigators have reported testing compounds at a number of concentrations varying from 27000 p.p.m. to 7 p.p.m. using Carbowax as a solubility aid. The concentration of Carbowax ranged from 27% to 0.007%. It is obvious that such results do not present a true picture of the effect of concentration on herbicidal activity.

Either oil or water can be employed as solvents or carriers in the bean single droplet tests. Comparison of results indicates that some compounds which were inferior or equal to 2,4-D in aqueous solutions were markedly superior when used in oil solutions. This indicates the necessity for using the same solvent and solubility aid at the same concentration throughout in each screening test.

The differences in the results of these tests may have been due to differences in rate of penetration. If a good penetrant had been used in the aqueous solutions, these differences might have been reduced. Furthermore, since the herbicide is not effective unless it enters the plant, it is advisable to use a penetrant in all tests even if the compound being evaluated is soluble and the penetrant is not needed as a solubility aid.

### Hydrogen Ion Concentration

The hydrogen ion concentration of the growth-regulator solutions also influences the activity of the compound. It has been demonstrated that acid solutions of indole acetic acid and other "auxins" are more active in the Avena coleoptile and pea tests than are neutral or alkaline solutions. Similarly the activity of 2,4-D and presumably of many other synthetic plant growth-regulators is also altered by the hydrogen ion concentration. In the bean single droplet test a pH of 3 is the most active and increasing pH values results in decreasing activity for 2,4-D. At pH 7 the activity of 2,4-D in this test is completely lost. This is of importance in screening since frequently a drop of acid or alkali is required to bring a compound into solution.

One effect of low pH is to suppress dissociation of 2,4-D and it is possible that 2,4-D is active only in the undissociated form. Esters which do not dissociate in aqueous solutions are equally effective at high and low pH levels. The pH or the degree of dissociation of the acid appear to be of importance only in altering the rate of entry of the compound into the plant tissue. It is not conceivable that unbuffered solutions of 2,4-D at either high or low pH values would long remain at those values once they came in contact with the highly buffered solutions within the plant.

pH does not appear to affect the cucumber germination or the oats soil tests. Possibly pH does not affect entry of growth-regulators into plant roots as markedly as it does entry into leaf or stem tissue.

To summarize briefly, a herbicide screening program must be tailored to fit the needs. Tests should employ sensitive, rapidly-growing test plants which are uniform and which grow well all year round. The tests should be conducted at more than one concentration if possible and penetrating agents should also be employed. The penetrant or surface active compound should be non-injurious to plants and should not mask the effects of the growth-regulator. The pH should be adjusted to permit maximum activity.

The section of the Northeastern Weed Control Conference on "Vegetables and Potatoes" convened at 9:30 o'clock, a.m., February 13, 1948 in the Hotel Commodore, New York City, N. Y.; B. H. Grisby, presiding.

"Why Control Weeds in Field Peas"  
D. S. Fink - The American Cyanamid Co.

Some time ago I had occasion to list the advantages to be gained from killing weeds in peas. The number of advantages is rather astounding.

More astounding perhaps is the fact that not one of the advantages has been measured in detail. That is, in dollars and cents to be specific. If we are to place modern weed control on a scientific footing and have it put to practice on the farm, it will be necessary for the experimenter of today to do much more than merely kill the weeds in the experimental plots.

I would like to enlarge on that statement just a bit. I haven't had too much experience in this business of killing weeds -- or in the weed-killing business -- I find there is a distinction -- and not too many of us in the Northeast have had too much experience, but I have been on the firing line for the past three seasons and I am aware of a few things.

I am aware of the fact that when we talk about killing weeds in peas we are talking about thousands of acres of weedy peas. If perchance we were talking about weeds in spring sown grains we would be talking about millions of acres of weedy grains here in the Northeast.

What does this mean? It means that if, by and large, we are to do something about these weedy crops, we will need the services of hundreds of thousands of interested people and why? Because any one man and any one machine can cover only so many acres in any one day. Regardless of how many acres that individual and his machine can cover, nevertheless it is a very, very small part of the total job.

Furthermore, if it is desirable to perform the practice only when wind velocities, for example, are less than 10 miles per hour, many work days become very short in the Northeast. Furthermore, an operator can work on the average of only every other day because here in the Northeast during May and the month of June it is raining about half the time. There are, in addition, many other factors which limit the number of work days available.

In my opinion, gentlemen, this brings the actual performance of killing weeds in our region down to almost individual farmer operations. This then calls for a tremendous educational program. This

educational program must be preceded by a very clear evaluation of the advantages of controlling weeds for any given crop -- and we are dreadfully lacking in that kind of information.

In the background of my discussion I would like to mention that I am talking about a weed control practice that I have had experience with that is nearly half a century old. It has not been adopted to any extent in proportion to its effectiveness.

I am just briefly going to list some of these advantages that I feel are pertinent and should be looked into very thoroughly. First for the grower: what do weed-free peas mean?

(a) It means less labor and time per ton of vined peas is required in field loading. I see no reason why we can't get somewhere a field-loading time-cost study attempting to get at some of these economic factors.

(b) It also means less labor and time per ton of vined peas is required in hauling from the field to the viner, and that is an appreciable item today.

(c) Less labor and machinery is tied up at the viner during unavoidable delays when the crop is coming in faster than can be handled by the viners. Here, too, a time-cost study dealing with unavoidable delays at the viner is needed.

Reduction in time, labor and machinery costs during each of the three operations I have just mentioned represents a very immediate cash saving to the grower if hauling is done by hired truck and hired man.

Further advantages for the grower:

(d) The crop brings a higher quality rating. Obviously, when viners are working at capacity, field men will favor weed-free peas when ordering-in fields to the viner.

(e) More peas per ton of green material. A viner operates most efficiently with weed-free material causing less wastage and damage of highest quality peas. A study is needed of the effect of the viner on yield and quality rating per ton of green material, comparing weed infested versus clean peas at the same state of growth.

(f) For the grower weed-free peas mean larger yields per acre. Weed eradication with pre- or post-emergence weed control chemicals allows the grower to plant his crop early. It is an old axiom that early planting means larger yields. There is no longer a need for prolonged disking of the soil to rid it of weed growth, this only delays planting and reduces yield.

Eradicating weeds increases the yield of the crop during dry seasons because moisture which would have been used by the weeds is available for the pea crop. During wet seasons, if the weeds are not killed, they grow faster than the peas and reduce the stand and yield of the crop through crowding.

Finally, the grower is assured of a better seeding catch of any grasses or legumes seeded with the peas when weeds are eliminated by weed control chemicals not affecting the new seeding.

For the processor, weed-free peas mean less labor is required per ton of vined peas in pitching green material into the viner. With peas having an average infestation of mustard, one man in three is essentially pitching only mustard into the viner.

It means for the processor that the viners are operating at maximum capacity. If viners are behind schedule and they are handling peas with an average infestation of mustard, one viner in three is essentially handling only mustard. A vining time-cost study is certainly needed.

The viners are operating at maximum efficiency for the processor with weed-free peas. Weed-free peas go through a viner faster than peas infested with weeds. There, too, a vining time-cost study is needed comparing clean peas versus weed-infested peas. Also for the processor weed-free peas mean that the crop as a whole will be of a higher quality rating.

Obviously when viners are operating at maximum efficiency more of the total crop is being processed at the right time. Further, weed-free peas have better quality because there is no possibility of the juice of weeds which is crushed out of the plants in going through the viner to impart their highly undesirable flavors to the peas.

Also for the processor, less labor per ton of vined peas is required for stacking the refuse.

Less seed is needed for planting. The seeding rate can readily be reduced 1 bushel an acre, (from 5 to 4 bushels) providing adequate weed control measures are followed.

Finally, for the processor, weed-free peas require less labor and time in cleaning and grading after they are shelled. Here, too, a time-cost study is needed.

In conclusion, gentlemen, I wish to again emphasize that, certainly during a less prosperous agricultural period, there will be great need for a clear evaluation of the advantages of chemical weed control for any crop; and that the advantages are truly numerous.

CHAIRMAN GRIGSBY: The next paper listed here is by Mr. D. M. Parmelee of the Seabrook Farms Company of Bridgeton, New Jersey and his topic is "Weed Control Experiments at Seabrook Farms."

MR. PARMELEE: Mr. Chairman and gentlemen: This paper of mine is to tell you what we have done. I haven't attempted to draw conclusions definitely from any of this work. I am leaving the conclusions pretty much up to you.

You are going to notice that I mention a material called aromatic HB quite a lot. I have just recently learned that the material is no longer available. It is an oil fraction but Dr. Sweet from Cornell has done some work with a similar material which I believe he plans to tell you about later in the program so that the experimental work which we have done with HB is not entirely wasted if we can make a direct substitution for this other material.

The weed-control experiments at Seabrook Farms during the 1947 season were conducted in an effort to reduce the cost of hand weeding incident to the raising of vegetable crops. With this in mind the bulk of the experiments were concentrated upon those crops which demanded the largest cost per acre in hand work; namely, beets, spinach, and carrots.

In conducting these tests, emphasis was laid upon those materials that did the best job at the least cost. We are not particularly interested in the academic phase of it because we are strictly a commercial outfit.

Therefore, all the experiments conducted were of a practical nature. In order to establish a starting point, a rough average of \$15.00 per acre was taken as a basic cost of hand weeding beets or spinach. It is, of course, to be recognized that some fields have required more than \$50.00 per acre in hand work; whereas, occasionally one will fall as low as \$6.00.

Some of the materials used in a weed control program vary in degrees of toxicity toward different weeds. For instance, Stoddard Solvents are rather ineffective against milkweed, Queen Anne's lace, or ragweed; and the presence of lamb's quarter precludes the use of salt solutions for the selective spraying of beets.

Most of the weeds at Seabrook are reasonably easy to kill in their early stages of growth. Pigweed, lamb's quarter, purslane, crab grass, goosegrass, and chickweed constitute the bulk of the weed population.

The first large scale operation was the treatment of 200 acres of carrots with Stoddard Solvent. It seems unnecessary to dwell at great length upon a procedure as well established as the selective spraying of carrots.

However, one important practice slightly different from the usual, was established as a result of this work with Stoddard Solvents. It was observed that on hot, slightly windy days, the weed-kill was not as effective as on cool, calm days.

This lack of killing power was attributed to loss of spray material by evaporation. By lowering the level of the nozzles to within six or eight inches of the ground, this loss became negligible. At the same time, of course, it was necessary to increase the number of nozzles on the boom and to decrease the amount of spray per nozzle in order to maintain the same rate of application.

Considerable difficulty was experienced during this operation when the weeds became too large. Because of inexperience in this type of work, more acreage was planted per day than could be handled with the sprayer. Consequently, the weeds on the last planted fields were much larger when sprayed than those on the fields treated first.

The weed-kill on these later fields was not complete, and in several instances repeat applications were necessary. In an effort to forestall such a situation another year, an experiment was set up to spray carrots before emergence with a heavier oil fraction. The results of this experiment were excellent, but the procedure will not be recommended until further tests have been made.

Following the carrot operation, attention was devoted to pre-emergence weed control in beets. This was strictly an experimental test which incorporated the use of three brands of Stoddard Solvents, two types of dinitros, and flaming. It also varied the time of fitting, planting, and application of the herbicide to include a wide range of conditions.

Results of these experiments indicated that excellent weed control could be secured by the pre-emergence application of 80 gallons per acre of Stoddard Solvent. In this particular instance there was an interval of two weeks between fitting and planting, and four more days elapsed before the treatment.

In the light of subsequent experience, however, it is believed that this time could be cut down somewhat without affecting the results. There was no difference in performance of the three different brands of Stoddard's Solvents. The dinitro sprays used under these same conditions showed considerable residual effect and severely hampered the germination of the crop.

The flame treatment gave reasonably good weed control, but it was concluded that pre-emergence flaming was too slow and consequently too costly from the tractor-acres-per-day point of view. Therefore, further experimentation was abandoned.

There have been developments since this experiment last spring which lead me to believe that there may still be some possibilities for it.

In a second series of experiments on beets which substantiated the initial findings, an interesting fact was learned about the behavior of di-nitros. It was observed that di-nitros would kill broad-leaf weeds very effectively at relatively low concentrations; but when the concentration was increased to kill the grass weeds, the residual effect of the spray inhibited the growth of the crop.

In the South the Sizz Weeder has been highly successful in the selective weeding of cotton. The success of this operation lies in the ability of the stem of the cotton plant to withstand the hot blast of flame shot in under the leaves.

It was believed that possibly lima beans with their relatively thick stems might likewise be able to stand this same kind of treatment. An experiment was set up to Sizz Weed limas at various stages of growth.

This experiment was unsuccessful. When the plant had two or four leaves, the leaves hung too close to the ground to permit the flame to go in under them without severe burning. But if the plant were allowed to grow large enough, prior to treatment, to stand the loss of the two lower leaves, the weeds were then too large to be killed.

The selective weeding of asparagus with calcium cyanamid dust was considerably more successful. Applications of 100 to 300 pounds per acre were made during the night, while the plants were wet with dew, by means of a ground duster.

Considering the fact that some of the weeds were 3 feet tall at the time of application, the cyanamid did an exceptional job of weed control. Pigweed which had already set seed was defoliated, although not completely killed outright.

The asparagus suffered slightly as a result of this treatment, particularly on the 300-pound-per-acre application, but it quickly recovered, and within three weeks little evidence of damage was visible. At the time of this application to the asparagus, adjacent fields in limas were in the six-leaf stage of growth.

Small quantities of drifting cyanamid dust resulted in no injury to this crop. This fact had led to the conclusion that cyanamid may safely be applied by airplane next year.

Experimental work in spinach this year received the most attention. A series of one-hundredth-acre plots were set up to be treated with 2,4-D, di-nitros and oil fractions. In the first series the applications of the sodium salts of 2,4-D were the most spectacular.

Applications were made on moist soils two weeks before planting at 1/2, 1, 2 and 5 pounds per acre. The plots were irrigated

the day following planting. When the crop emerged five days later, the weed control in all plots was excellent; but those receiving 2 and 5 pounds per acre showed definite damage to the crop.

Later experiments indicated that although 2,4-D was an effective, low-cost, pre-planting herbicide for vegetable crops, its application would be limited to those fields under irrigation where moisture could be controlled. It was particularly important to make applications of 2,4-D on soils with sufficient moisture to effect the germination of the weeds.

However, if a heavy rain occurred after the application but before the germination of the weeds, the toxicity of the 2,4-D would be removed and few, if any, weeds killed. On the other hand, rain or thorough irrigation was essential within twenty-four hours after the crop had been planted in order to remove the toxicity before the crop germinated. All of these experiments were conducted with the sodium salt of 2,4-D, and the behavior of other forms under similar conditions is not known.

The di-nitro applications on spinach plots verified the initial findings on beets. That is, a light application controlled broad-leaf weeds, but crab grass and goosegrass continued to be troublesome.

Although Stoddard Solvents was shown to be a very effective contact herbicide, experience indicated that its performance might be improved if its toxicity did not disappear so rapidly. Furthermore, Stoddard Solvents are relatively expensive, costing more per acre in a few fields than hand weeding. An attempt was made, therefore, to secure materials of a similar nature with more 'staying power'.

A search yielded three materials from three oil companies. Shell Oil sent Shell Weed Killer #110; Socony Vacuum, PD544C; and Standard Oil, a drum of HB Aromatics. All of these materials looked well in pre-emergence tests at 30 and 60 gallons per acre, but at 60 gallons per acre HB definitely retarded the germination and growth of the spinach.

This led to further tests using smaller quantities of HB. Applications were made using 10 and 20 gallons per acre emulsified in water, also on a pre-emergence basis. The resultant weed control equalled any obtained with Stoddard Solvents at only one-seventh the cost.

In further tests, HB was mixed with Stoddard Solvents and applied at various rates, but no particular advantage was noted. The Shell Oil and Socony Vacuum products were excellent weed killers at 40 gallons or more per acre, but at low concentrations were not as effective as HB and for this reason appeared to be more costly.

Concurrently with the aforementioned tests, a large scale experiment was set up employing plots of one-third of an acre each to determine the optimum amount of Stoddard Solvent to be used where grass was troublesome. Applications of 40, 60, 80, 100 and 150 gallons per acre were made.

It was found that an application of 80 to 100 gallons per acre controlled grass effectively. There was little justification of additional quantities, nor would less do a complete job.

In several instances when the initial application of one material or another had partially failed, it was found that a second application of 40 gallons per acre of Stoddard Solvent often was sufficiently potent to complete the kill.

This was particularly advantageous when the crop had to be treated the same day it was planted because of threatening weather. Frequently the kill of weeds would be only about 85 per cent effective under these conditions due to slight shifting of the soil during the planting operation which partially covered tiny weeds with dust or crumbs of soil. A second light application three or four days later would usually complete the job.

In summing up the year's work in preparation for the 1948 season, it has been decided that of all the materials tested, three are ready for limited commercial application; namely, calcium cyanamid, Stoddard Solvents, and HB. However, HB will be handled with caution until the experimental data are more conclusive.

For selective weeding of asparagus and possibly peas, calcium cyanamid will probably be used. It is believed that although cyanamid may not be as effective as 2,4-D for asparagus, it can be applied safely by airplane and for this reason is less expensive.

Cyanamid is preferred over the di-nitros for selective weeding of peas, since it can be applied with less risk to the crop. An added advantage of cyanamid, apart from its weed control properties, is its value as a nitrogenous fertilizer which, in part at least, will offset its cost as a weed killer.

For pre-emergence work both Stoddard Solvents and HB emulsions will be used. Experimentation has shown that although HB is much cheaper and more potent, its residual effect occasionally limits its use, and Stoddard Solvents may have to be substituted. That is, under normal conditions applications of HB would be made two days after planting, allowing about three days for the material to evaporate before the crop emerges.

If, however, weather or other factors delay the time of application until the day before the crop is expected to emerge, Stoddard Solvents may yet be applied without risk.

As a selective spray for carrots or other members of the umbellifera family, the use of Stoddard Solvents is a well established practice, and no change is anticipated.

MR. LOUGHLIN: Which di-nitros did you use?

MR. PARMELEE: The Dow contact and Dow selective.

MR. LOUGHLIN: What concentration on the contact?

MR. PARMELEE: We varied the contact all the way from 1/2 gallon an acre up to 4 gallons to the acre. We had all the ranges.

MR. REIBER: What crop did you try that with, that experiment?

MR. PARMELEE: That was on spinach. I think the one you are referring to is spinach, although we did do it also with beets.

"Chemical Weed Control in Onions"<sup>1</sup>

W. A. Hedlin, Cornell University

The weed problem with onions starts at seeding time and persists through harvest, causing one of the heavier expense items in the production of this crop. There are three distinct phases of weed control work in onions. The first is dealing with weeds before they emerge from the ground, the second is with weeds in seedling onions when they may be as big or bigger than the onions, and the third is with weeds in well grown onions. Occasionally there is also a problem at harvest time but this may be eliminated if the earlier control is achieved. This paper deals with some pre-emergence weed control and work done with a selective weedicide in onions.

The experiments were conducted on muck soil in the area at Elba, N. Y. The weed population consisted mainly of purslane (*Portulaca oleracea*), crab grass (*Digitaria sanguinalis*), pigweed (*Amaranthus retroflexus*) and lamb's quarter (*Chenopodium alba*).

Work done by Dr. W. E. Chappell\* in the summer of 1946 indicated that Aero Cyanamid (Ca Cn<sub>2</sub>) might give satisfactory results as a pre-emergence weed control with onions. In 1947 experiments were set up to continue his work and also to determine the effect of post-emergence treatments.

<sup>1</sup>Paper No. 291, Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

The author is indebted to the American Cyanamid Company for supplying the materials used.

\*Now at the University of Connecticut, Storrs, Connecticut.

This material was applied as a dust on plots 10 feet by 20 feet with a hand duster, using four replications. The seed was sown on April 28 and on May 5 all plots but the check received 100 or 200 pounds per acre as a pre-emergence treatment. At this time there was no growth on any of the plots. The onions on the checks emerged on May 15 and were from 24 to 48 hours later on the treated plots. On May 22 all plots but one and two received 50 or 100 pounds per acre. Counts of weeds and onions were made on five 3-foot samples for each plot except for harvest data which included the whole plot.

Table I. Early Effects of Cyanamid on Number of Weeds and Onions

<u>Treatments</u>	<u>Weeds</u>	<u>Onions</u>
1 Check	118.75	23.25
2 100	59.00	23.50
3 100+50	10.75	23.75
4 100+100	13.75	22.75
5 100+50	12.25	24.00
6 100+100	14.50	24.75
7 100+50+50	10.50	22.00
8 100+50+50	13.75	23.25
9 200+50	27.75	23.50
L.S.D. .05	14.48	2.40
.01	19.93	3.21

All plots were weeded the following day. It is apparent that a large number of the weeds were killed after emergence by the second application of dust, although there was no effect on the onion count at this stage. On June 6, just before another application of dust, counts were made again.

Table II. Effect of Cyanamid at Final Weed Count and at Harvest

<u>Treatments</u>	<u>Weeds</u>	<u>Onions</u>	:	<u>Onions per Plot</u>	<u>Yield in Pounds per Plot</u>
1 Check	27.0	15.25	:	331	55.6
2 100	21.75	18.25	:	355	59.9
3 100+50	8.75	13.00	:	256	43.25
4 100+100	8.75	14.00	:	206	34.50
5 100+50+50	13.25	16.50	:	242	42.60
6 100+100+100	8.50	12.75	:	219	30.10
7 100+50+50	12.25	12.75	:	249	35.75
8 100+50+50+50	10.25	13.00	:	240	40.00
9 200+50+50	13.25	14.5	:	271	41.40
L.S.D. .05	9.80	3.40	:	69.97	12.50
.01	13.28	4.60	:	94.98	16.94

It can be seen that the residual effect of the 100 pounds per acre as pre-emergence treatment has been largely dissipated as there is no longer a difference between the check and the 100 pounds pre-emergence treatment. A portion of the loss in stand, noticeable also in the check, is due to maggots.

In all cases foliage applications after 100 pounds per acre pre-emergence significantly reduced the yield.

About 150 acres were dusted by airplane in the Elba area in the spring of 1947 at a rate of 50 to 70 pounds per acre. The results of this treatment indicated that 100 pounds is more than is required as pre- or post-emergence treatments. Some striking results were obtained when dust was applied to very weedy seedling onions, provided the foliage was wet with dew at the time of application. The onions suffered very little damage but all small broad-leaved weeds were dead within 48 hours.

In the spring of 1947 some of the herbicidal properties of KOCN were observed and experiments were set up to determine the value of this chemical for weed control in onions and the inter-relationship between weed control and crop injury.

In all cases sprays were applied at approximately 80 gallons per acre with a knapsack sprayer on plots ten feet square. Weed and onion counts were taken over the whole plot, the weeds being those too close to the onions to be taken out by cultivation.

Table III. Mean Values for Number of Weeds per Plot

<u>Concentration</u>	<u>Grass</u>	<u>Purslane</u>	<u>Lamb's Quarter</u>	<u>Pigweed</u>	<u>Totals</u>
Check	44.5	31.5	9.0	18.5	103.5
0.5%	15.5	10.0	3.5	7.5	31.0
1.0%	9.0	4.0	0.0	0.5	13.5
			L.S.D.	.05	10.97
				.01	25.31

The weather at the time of application was hot and dry. In no case was a satisfactory result obtained with KOCN when the plants were wet, though wet ground was no liability. In these plots the stand of onions was not affected but unfortunately yield data could not be obtained as the plot was flooded during heavy July rains.

The susceptibility of the different weeds is indicated in Table III. Crab grass will not normally be killed unless very small at the time of spraying, though one grower who sprayed 5 acres three times asserts that annual grasses were eliminated.

Purslane was readily killed by low concentrations until it had developed its fleshy stems, so it should be sprayed before the plants exceed one inch in diameter. This is particularly important when using low concentrations for seedling onions.

Lamb's quarter and pigweed both were killed very readily when small, the latter becoming much more difficult as it grows larger.

In dealing with weeds in larger onions stronger solutions may be used, especially when the spray is directed downward. The spray in this experiment was high to cover weeds and onions indiscriminately or low so as to hit as small a portion of the onion plant as possible. The field had been weeded about ten days previous to the first spray so there were no large weeds present. The results obtained are indicated in Table IV.

Table IV. The Effect of KOCN on Number of Weeds and Yield of Onions per 100 Square Feet

<u>Treatments</u>	<u>Weed Count July 4 Sprayed</u>	<u>July 29 Before Spraying</u>	<u>August 11 After Spraying</u>	<u>Weeds Pulled</u>	<u>Number of Onions</u>	<u>Yield in Pounds</u>
Check	25.5	52.25	63.50	88.00	211.50	31.00
1% low	5.25	43.50	6.00	11.25	216.75	31.00
1% high	8.00	38.00	6.00	14.00	193.50	26.00
2% low	1.50	48.25	4.25	5.75	213.75	26.75
2% high	2.50	43.75	1.75	4.25	238.75	27.50
3% low	0.25	48.75	4.25	4.50	196.00	25.50
3% high	0.75	55.25	1.75	2.50	236.25	26.50
4% low	0.00	51.50	52.75	52.75	243.25	30.50
L.S.D. .05	4.70	14.60	14.41	17.70	54.36	8.28
.01	6.40	19.87	19.62	24.83	72.73	11.26

When a 3 per cent spray was used high a slight curling was noted on the onions. This disappeared within 48 hours and was the only visible effect on the crop. The weed count on July 29, just before the second spraying, indicates that there was no residual or pre-emergence effect on the weeds from this compound since the treated plots grew as heavy a second crop of weeds as the checks. When the second spray was applied on July 29 it was all sprayed low as the top growth of onions was large enough to protect the weeds from a general spray. As far as the weed kill is concerned, there does not seem to be a valid reason for going above 2 per cent, provided the weeds are not allowed to become too large before the application is made. It is of interest to note that there was no effect on yield or number of onions between the "up" and "down" applications.

Mr. Bernard Berglin of Elba treated 5 acres three times, twice with a 2 per cent solution and once with 3 per cent. By this means he eliminated two hand weedings after the middle of June. Checks were maintained in the field throughout the season and these showed no difference in yield between checks and treated. This field was treated for the first time on June 24.

A comparison was made between KOCN and sulfuric acid on 10 by 15 foot plots with 5 replications.

Table V. Effect of KOCN and H<sub>2</sub>SO<sub>4</sub> on Yield of Onions

	<u>Mean Yields</u>
100 pounds CaCN <sub>2</sub> * plus 3 applications of 3% KOCN	52.6 pounds
3 applications of H <sub>2</sub> SO <sub>4</sub> at 2 1/2%	56.0 "
Check	59.8 "

L.S.D. at .05 = 14.53  
.01 = 20.90

\*The Cyanamid was applied 6 days after sowing, before there was any growth on the field.

Summary

Cyanamid should not be applied at more than 60-70 pounds per acre as pre- or post-emergence treatments. The lower limit may be less than 60 pounds. If it is to be used to kill weeds after they are up the foliage must be wet at the time of application.

These studies indicate that KOCN can be used as a selective weedicide in onions if low concentrations are used while the onions are small and applications made before the weeds have grown too large. The foliage must be dry for this material to be effective when applied as a spray.

MR. BAERMANN: Was Stoddard Solvent used as pre-emergence treatment in onions?

MR. HEDLIN: It has been reported in the proceedings of the Horticultural Society.

MR. PATTERSON: Did you try any work with flame on onions?

MR. HEDLIN: Flame will work with reasonable success, I believe, on set onions but we burned up seed onions with that.

CHAIRMAN GRIGSBY: The next paper is by W. C. Jacob of the Long Island Vegetable Research Farm and the topic, "Pre-emergence Chemical Weeding of Potatoes on Long Island."

MR. JACOB: Mr. Chairman and gentlemen: With many of the major vegetable crops, the control of weeds by chemicals applied to the soil prior to emergence has been quite successful. With seed crops, the methods suggested necessitate some major changes in seedling procedure and extremely careful timing of the chemical treatments.

On Long Island, potatoes are planted in late March or early April and the plants do not emerge until early May. During this period of about a month, most of the weed seeds in the germinating layer have produced seedling plants and are susceptible to herbicidal action of the chemicals. Thus, the normal cultural practices followed by potato growers furnish ideal conditions for pre-emergence chemical weeding of this crop and it seemed desirable to obtain information from which definite practices could be developed.

In 1947, an experiment was conducted at the Long Island Vegetable Research Farm, Riverhead, New York, to determine what concentrations of the materials available were most satisfactory for pre-emergence weeding of potatoes and how much influence the time of application had on their effectiveness as measured by weed control, top growth and subsequent yield of the crop.

Materials and methods: Five materials were selected to be used at two concentrations. The materials and concentrations were:

1. Sodium salt of 2,4-Dichlorophenoxyacetic acid at the rates of 5 and 10 pounds per acre of 2,4-D acid equivalent.
2. Sinox General at 2 pints and 3 pints plus 4 gallons and 6 gallons of kerosene respectively per acre.
3. Dowspray 66 Improved at 2 and 3 gallons per acre.
4. Methyl-ester of naphthalene acetic acid at 4 and 8 pounds per acre.
5. Aero cyanamid, dusting grade, at 50 and 100 pounds per acre.

All the materials except cyanamid were mixed with water and applied as a spray at the rate of 100 gallons per acre. The materials represent two di-nitros, two hormones, and one dust.

Three different dates of application were chosen representing the day after planting, two weeks after planting and four weeks after planting, the last date corresponded to the date of emergence of the earliest plants.

Plots which received normal cultivation and weed plots on which the weeds were allowed to grow were included for comparative data.

The spray treatments were applied with a compressed air hand sprayer and the dust was put on with a hand operated Niagara duster.

Certified Green Mountain seed from Maine was used and 2,000 pounds of 5-10-5 fertilizer was applied in bands at planting time. The soil reaction in April was about pH 5.2. Immediately following planting on April 22, the ridges were leveled with a meeker harrow and except for the normal cultivation plots, no additional cultivation was given.

The potatoes were planted on April 22, 1947 and the treatments were applied on April 23, May 10 and May 23. The normal cultivated plots were cultivated six times between May 24 and June 30.

The crop was sprayed eight times during the season with a 4-2-50 Bordeaux plus 1 quart DDT emulsion per 100 gallons for disease and insect control. On September 8, all living vines and weeds were killed with sodium arsenite (5 gal/acre) and the potatoes were ridged on September 12. At this time all the crop was fully matured except the 2,4-D plots which were still green. The crop was harvested on October 22 and 23.

Observations as to weed control and top growth were made on June 4 and June 19, after which the vines filled the rows completely and no further observations were made.

The experiment was a randomized block design with four replications, each plot consisting of four rows 33 inches apart and 21 feet long. The two center rows were used for all data. The weed plots and cultivated plots were four rows wide and 210 feet long because of the shape of the block and the need for open ends to permit commercial equipment to be used for cultivating.

Appropriate precautions were taken in the analysis to provide proper comparisons with cultivated and weed plot data. Only the center 16 feet of the two middle rows of each treated plot were used for harvest records. All data were subjected to analysis of variance techniques to determine significance of differences.

Results and discussion -- weed control observations: Efficiency of weed control on the various plots was observed on June 4 and June 19. Each plot was rated between 0 and 9, 0 being assigned to plots having the same weed cover as the untreated areas and 9 being given when no weeds were present on the plots.

Graduations between these extremes were estimated and appropriate ratings between 0 and 9 were assigned. Smartweed, lamb's quarter and pigweed constituted the major portion of the weed cover present. Crab grass is a problem in potato fields after the vines have matured but this weed germinates on Long Island late in June, so it was not considered in the experiment.

Table 1 is a summary of the average weed control ratings for the four replications of each treatment. From these data it can be seen that only 10 pounds of 2,4-D gave any weed control at the earliest application date.

Table 1. Ratings\* for weed control observed on two dates for two concentrations of five materials applied at three different dates between time of planting and time of emergence of potatoes.

Material	Amount applied per acre	Observed on 6/4/47			Observed on 6/19/47		
		Application date			Application date		
		4/23	5/10	5/23	4/23	5/10	5/23
2,4-D (Sodium Salt)	5 pounds	3.75	6.50	6.75	3.25	6.00	8.50
	10 pounds	6.75	7.75	8.50	6.00	7.50	9.00
Sinox General	2 pints	2.75	4.25	8.25	3.50	3.75	7.00
	3 pints	1.25	4.25	9.00	1.50	4.25	7.75
Dowspray 66 Improved	2 gallons	1.25	3.50	8.00	2.75	3.25	5.25
	3 gallons	1.50	4.75	8.25	1.50	3.50	7.00
Methyl-Ester of Naphthalene Acetic Acid	4 pounds	4.50	4.25	5.50	4.75	4.75	5.00
	8 pounds	5.50	5.75	8.50	3.75	6.75	7.75
Aero Cyanamid (Powdered)	50 pounds	1.50	1.75	5.00	1.75	1.50	4.50
	100 pounds	1.25	.75	8.50	3.00	2.00	7.00
Difference necessary for significance @ P = .05			2.50			2.00	

\* Rating system used: 0 = No control of weeds - same weed cover as untreated plots.  
9 = No weeds growing on plot.

Both of the hormones gave some weed control at the second date with heavier concentrations being more effective. This date was still too early for any effective action by the di-nitros or cyanamid. Most of the materials applied at the time of emergence gave significant weed control.

Both rates of 2,4-D and Sinox General and the higher rates of methyl-ester, Dowspray 66 Improved and cyanamid provided good to excellent control of weeds. The slower action of 2,4-D is illustrated by the increase in weed control on June 19 as compared to June 4 for the last application date. With the other materials, a few weeds were showing on June 19 which were not visible on June 4.

It is evident that except for 10 pounds of 2,4-D and 8 pounds of methyl-ester all the materials were most effective at the final treatment date. The extra two weeks of time for germination between May 10 and May 24 was definitely reflected in the improved control of weeds. Four pounds of methyl-ester and 50 pounds of cyanamid were definitely inferior to the higher rates for the control of weeds. Reduction of 2,4-D below 5 pounds per acre seems possible and increase of cyanamid above 100 pounds is also indicated.

Potato top growth observations: At the same time as weed control observations were made, ratings were given each plot with regard to potato top growth. A rating of 9 was given when the top growth appeared to be as vigorous as the plants on the cultivated plots. A rating of 0 indicated no top growth at all and gradations between these extremes were estimated for all plots.

Table 2 is a summary of the average ratings for each treatment as observed on June 4 and June 19. It can be seen that 2,4-D was the only material which seriously reduced top growth prior to the application on May 23. Methyl-ester at 8 pounds on April 23 showed top growth significantly reduced but the May 10 application was not different from cultivated plots.

Table 2. Ratings\* for potato top growth observed on two dates for two concentrations of five materials applied at three different dates between time of planting and time of emergence of potatoes.

Material	Amount applied per acre	Observed on 6/4/47			Observed on 6/19/47		
		Application date 4/23	5/10	5/23	Application date 4/23	5/10	5/23
2,4-D (Sodium Salt)	5 pounds	8.25	5.75	4.00	8.00	6.25	3.50
	10 pounds	3.25	5.25	3.75	5.25	5.75	2.00
Sinox General	2 pints	9.00	8.75	7.50	8.75	8.25	8.00
	3 pints	9.00	8.50	6.75	8.75	8.00	7.75
Dowspray 66 Improved	2 gallons	9.00	8.75	8.00	8.75	9.00	8.50
	3 gallons	8.75	8.75	7.25	9.00	7.50	8.25
Methyl-Ester of Naphthalene Acetic Acid	4 pounds	8.00	8.50	6.25	8.25	8.25	7.25
	8 pounds	7.50	8.00	4.00	7.50	8.00	6.75
Aero Cyanamid (Powdered)	50 pounds	8.50	9.00	7.75	9.00	9.00	8.25
	100 pounds	9.00	9.00	6.00	8.50	9.00	7.75
Difference necessary for significance @ P = .05			1.25			1.25	

\*Rating system used: 0 = No growth of potato tops.  
9 = Normal tops compared to plots receiving normal cultivation.

The ratings showed some change from June 4 to June 19 for the May 23 date of application. All ratings improved except for 2,4-D which decreased. This is indicative of the type of action of these chemicals on the plants. The di-nitros caused a temporary injury while the 2,4-D injury became worse and it delayed the maturity of the plants at least two weeks.

Stand counts were taken on June 4 and showed no variation in stand caused by treatment.

From these data it is evident that lower concentrations of 2,4-D must be used to prevent injury to the potato plants. The slight reduction in top growth caused by some of the other chemicals was not serious as will be shown by the yield data.

Yields of potatoes: The two middle rows of each plot were harvested for yield records. Table 3 is a summary of the average yield of U. S. No. 1 size taken for each treatment. The estimates of variation were such that the same difference is necessary for significance between treatments and between normal cultivation and weed plots and treatments.

Table 3. Yield of potatoes in bushels per acre of U. S. No. 1 from plots treated with two concentrations of five materials applied at three different dates between time of planting and time of emergence of potatoes.

Material	Amount applied per acre	Application date		
		4/23	5/10	5/23
2,4-D (Sodium Salt)	5 pounds	296		326
	10 pounds	312	340	348
Sinox General	2 pints	344	318	411
	3 pints	314	272	401
Dowspray 66 Improved	2 gallons	326	377	380
	3 gallons	322	310	424
Methyl-Ester of Naphthalene Acetic Acid	4 pounds	318	334	344
	8 pounds	269	352	344
Aero Cyanamid (Powdered)	50 pounds	282	318	347
	100 pounds	294	288	393
Normal cultivation			426	
Weeds uncontrolled			318	
Difference necessary for significance @ P = .05			74	

Seven treatments gave yields not significantly lower than normal cultivation and of these four gave yields significantly higher than the weed plots. Thus, from the yield figures Dowspray 66 Improved at 3 gallons, Sinox General at 2 pints and 3 pints and cyanamid at 100 pounds all applied on May 23 were all satisfactory treatments for weed control purposes.

To determine the accuracy of the rating systems used, the weed control rating was multiplied by the top growth rating and the average product for each treatment plotted against the average yield for the treatment. From Figure 1, the high correlations between the ratings and yield can be seen.

Using treatment averages a correlation coefficient calculated from the error term in the covariance analysis was only .35. This is significantly less than .96, but also significantly greater than zero. This indicates that variations in weed control and top growth accounted for only about 10 per cent of the random variations in yields, while variations in treatment yields were about 92 per cent accounted for by the variation in weed control and top growth caused by treatments.

Five materials at two concentrations applied at three dates between planting and emergence were used for pre-emergence chemical control of weeds in potatoes. Dowspray 66 Improved at 3 gallons, Sinox General at 2 pints and 3 pints, and cyanamid at 100 pounds per acre all applied at time of emergence of potato plants gave satisfactory weed control and did not reduce the yields of the crop below those obtained by normal cultivation.

MR. PASS: How did the naphthalene acetic acid work out?

MR. JACOB: It gave reasonably good weed control but not as good as 2,4-D and not quite as good as some of the di-nitros applied during emergence time, and it had poor yields. Three hundred forty-four bushels was the highest yield for any of the treatments with naphthalene acetic acid which is not significantly better than the weed plots.

MR. ROCKWELL: Did I understand that the plots which were treated were not cultivated at all?

MR. JACOB: That is correct. There were no cultivation methods performed on these plots at all any time during the season with the exception of those plots which had normal cultivation practices followed.

MR. CAMPBELL: Was there any comparison made with cultivated plots?

MR. JACOB: Yes, I had cultivated plots in the experiment. That was the original yield which I gave, 425 bushels for the cultivated plots.

MR. WILLARD: Were any experiments with lower amounts of 2,4-D?

MR. JACOB: I had no experiments on that. Dr. Smith at Cornell did have 2 and 3 pounds, and I understand his injury to potatoes was negligible.

MR. ALBIN: Did you happen to save any of those potatoes?

MR. JACOB: Unfortunately, I was unable to store them.

DR. SWEET: This work at Cornell was being carried through the usual storage test.

CHAIRMAN GRIGSBY: We will now hear from Mr. Cook of the Cornell Station who will speak on "Weed Control in Potatoes by Cultivation, Flame and Various Chemicals."

MR. COOK: This problem was suggested to me by Dr. Craft who is in Extension 4-H at Cornell. He grows potatoes and is quite interested in working with flame. So I rigged up an air-oil type burner and the whole description of the experiment and the results are contained in this little paper that I have written.

The usual method of weed control in potatoes with a weeder and hiller was compared with flame guns mounted on the hydraulically adjustable drawbar of a Ford tractor. The chemicals used in the test included Ammate, Dow contact herbicide and 2,4-D. The treatments were carried out with Chenango, an early, blight resistant variety and were grown on Lackawana stony loam on an upland potato farm near Norwich, New York.

To be sure of a good stand of weeds, a plot was selected where weeds were allowed to grow undisturbed and go to seed the year before. There were four replications of eight randomized treatments. There were three different flame gun treatments at varying speeds (high 7 mph, medium 5 mph, low 3mph); one Ammate, one Dow contact herbicide, one 2,4-D, weeder, hiller and one check with no weed control.

The plots were 32 feet by 12 feet each in size, consisting of four rows. The yield samples were obtained from the two center rows each 20 feet in length. The outside rows and 6 feet on each end of inside rows were not used in sample, but as guard rows. The samples were harvested and graded as U. S. No. 1, size A, tubers over 2 inches in diameter; and size B, tubers 1-1/2 to 2 inches.

The defects were divided into sunburn and all others. The weight and number of potatoes of each grade was recorded. Twenty tuber samples were obtained from each plot to check for any internal injury that might have been caused by quick killing of the vines as they were burned off on September 5 and 6 to destroy weeds and to make easier digging. All treatments were compared with the standard cultivation practice on potatoes, that of using a weeder and hiller alternately.

The chemical treatments were given at pre-emergence. Flaming and weeding were done at pre- and post-emergence repeated three times at five to ten-day intervals when weeds were 1/2 to 1 inch tall.

The rates of application of the various chemicals were: Ammate, 435 pounds per acre; Dow contact herbicide, 3 gallons per acre in 100 gallons; 2,4-D, 4 pounds per acre (active dichlorophenoxy-acetic acid from the ammonium salt).

The weeds present in the plots consisted of about 85 per cent annuals and 15 per cent perennials by populations. The species of annuals were as follows: *Amaranthus retroflexus* (pigweed), *Chenopodium album* (lamb's quarter), *Polygonum convolvulus* (black bindweed), *Stellaria medis* (chickweed), *Malva rotundifolia* (common mallow), *Setaria lutescens* (yellow foxtail), and *Setaria viridis* (green foxtail).

The species of perennials were: *Asclepias syriaca* (milkweed), *Agropyron repens* (quackgrass), *Cerastium vulgatus* (mouse-ear chickweed), *Cirsium arvense* (Canada thistle), *Chrysanthemum leucanthemum* (ox-eye daisy), *Convolvulus arvensis* (common bindweed), *Convolvulus sepium* (wild morning glory), and *Oxalis florida* (yellow wood sorrel).

The flame guns were used and were of the torch type coil burners made by Aeroil Products Company. They burn either kerosene or fuel oil No. 2 at the rate of 3 gallons per burner per hour. The four burners were so placed on a boom to cover two rows, with two burners directed toward each row. Each burner flame covers a strip 18 inches wide.

Effect of treatments on weeds and potatoes: 2,4-D showed its usual form of injury to potatoes -- epinasty -- deformed leaves, fused leaves and petioles. It killed all weeds except grasses (quackgrass and foxtail).

Ammate killed some of the weeds such as common mallow, pigweed, lamb's quarter and bindweed but caused little injury to milkweed and the grasses. Weeds continued to germinate after the spray and these showed no injury, showing that Ammate remains active in soil only a short time.

Dow contact herbicide killed all broad-leaved weeds, but only injured grasses which eventually recovered. A few young potato seedlings were killed that were showing above ground at the time of treatment.

Flame killed or singed all young weed seedlings. Older weeds were injured but soon grew out of it. Milkweed was very hardy, even though severely burned with leaves dropping and stem charred but new buds emerged and continued growth.

Weeder-hiller killed all small, young, shallow-rooted weeds but caused only slight injury to potatoes and deep-rooted weeds as milkweed, quackgrass and Canada thistle.

There was evidence of highly significant differences between treatments. All treatments were significantly better a 1 per cent level than check plot (no weed control). There were significant differences between the different flame treatments.

The low speed flaming was significantly better than high speed (at 1 per cent level). Low speed even though it did more injury to potato leaves did a more thorough job of eliminating weeds. No significant differences were evident in yields between treatments of 2,4-D, Ammate, Dow contact herbicide, low speed flame and weeder-hiller method. These data indicate that any one of these treatments might be used to control weeds in potatoes.

The costs of materials should be considered. Ammate is too expensive, as it costs about 25¢ per pound and the recommended rate is 400 to 500 pounds per acre. 2,4-D and Dow contact are within reason, costing only a few dollars per acre.

The fuel cost in flaming is reasonable. At low speed (3 mph) this machine, covering a strip of two rows or 6 feet wide, will flame 2 acres per hour with 12 to 15 gallons of kerosene or fuel oil No. 2.

This is a preliminary report. More work is planned to determine the best time and method of treatment.

CHAIRMAN GRIGSBY: Mr. C. H. Deaborn of the New York Agricultural Experiment Station will speak on "Weeding Sweet Corn With 2,4-D; Effects of Timing, Rates and Varieties."

MR. DEARBORN: The weeding of sweet corn with 2,4-D sprays reported by Shafer<sup>2</sup> indicates that the crop had a greater tolerance to 2,4-D than did many of the weeds common to corn fields. It also appeared that the crop responded differently to 2,4-D at different stages in its development. The results reported by Anderson and Ahlgren<sup>1</sup> of studies with field corn further suggest that varieties may differ in their tolerance to 2,4-D.

In view of these reports, experiments were conducted to determine the effects of three concentrations of 2,4-D on the growth of sweet corn when applied at different stages of growth of the crop and to determine if varieties of sweet corn differ in their response to 2,4-D.

Response of sweet corn to time and rate of application of 2,4-D:  
These tests were conducted at Geneva, on an area of Ontario silt loam soil 111' x 256' which was drilled with Golden Cross Bantam sweet corn at the rate of 14 pounds to the acre on June 26, 1947. This area was divided in twelve blocks 39' x 64'. Each block constituted an experiment of twelve plots 12' x 16' each. Each plot contained three record rows 3' apart, with a guard row on either side of each plot.

Four treatments were replicated three times on each of the twelve blocks. The treatments for eleven of the blocks were as follows: 0.0, 0.4, 0.6, and 0.8 of a pound of 2,4-D acid to the acre. The treatments for the other blocks were as follows: 0.0, 2.0, 3.0, and 4.0 pounds of 2,4-D acid to the acre. The triethanolamine salt of 2,4-D was used as a spray over the crop and weeds. A boom of three fan nozzles, operating at 75 to 80 pounds pressure was used to deliver the 2,4-D.

On July 1, Block 1 received the fraction-of-a-pound series of treatments and Block 2 received the heavy 2,4-D treatments of 2.0, 3.0, and 4.0 pounds to the acre of 2,4-D acid equivalent. Approximately 30 per cent of the corn stand was showing above ground at this time. The remaining 10 blocks received the fraction-of-a-pound of 2,4-D series of treatments as follows: July 3, Block 3; July 8, Block 4; July 14, Block 5; July 21, Block 6; July 29, Blocks 7 and 8; August 1, Block 9; August 6, Block 10; August 14, Block 11, and August 20, Block 12.

Brace roots were beginning to develop on July 29. It seemed desirable to have a test of exposed versus covered roots in case lodging became serious later in the growth of the plants. Therefore Block 8 was treated before cultivation and Block 9 was treated after cultivation.

Broad-leaved weeds were pulled during the first week in August in the check plots of all blocks. Records were made on the growth and yield of corn and on the weed population. The method of analysis of variance was employed in the interpretation of the data. Each block was analyzed as an experiment. All data are expressed in tons to the acre of ears of corn in the husk.

Mature grain from treated and untreated plots has been planted in the greenhouse to determine if any symptoms of 2,4-D injury appear on the new plants. Corn at the canning stage from treated and check plots is being preserved for flavor studies.

The yield data are presented in Table 1. It will be observed that the productivity of the twelve experiments varied markedly. Although the effect of location and time cannot be separated due to the design of the experiment, it is believed that the variable productivity by dates is largely due to location. Experiments 3, 4, 7, 10 and 12 fell on very poorly drained areas, whereas experiments 8, 9 and 11 had decidedly superior locations.

Experiments 5 and 6 were the only ones in which yield differences between treatments were statistically significant. The 0.4 and 0.6 pound treatments applied on July 14 resulted in an increase over the check plots of approximately one ton to the acre of corn.

All 2,4-D treatments applied July 21 resulted in a similar tonnage per acre increase of ears-in-the-husk over their respective checks. Corn plants receiving 2,4-D treatments on this date showed a marked rolling of the blades at the W3 or late-whorl stage. This condition persisted nearly through the T2 or mid-green tassel stage at which time the tassel forced its whorl. The rolling was most severe on the 0.8 pound treatment and persisted on some of the blades throughout the life of the plants.

The only condition known to be peculiar to this date of application was that it was preceded by cloudy weather, showery weather, for four days and followed by cloudy weather for three days with a .15 inch shower on July 22. Corn seedlings in Experiment 2 showed a similar rolling of the blades but they outgrew the deformity in four to five weeks.

Some lodging occurred throughout the field but the records indicated that it was not associated with treatment. Similarly there were no significant differences in number of plants lodged in connection with the before-cultivation treatment of Block 8 versus application after cultivation in Block 9.

The initial kill of broad-leaved weeds was practically the same for each of the light rates of 2,4-D. Commercial control was affected with all applications against the following susceptible weeds: Lamb's quarter (*Chenopodium album*), ragweed (*Ambrosia elatior*), red root (*Amaranthus riboflexus* L.). Wild lettuce (*Lactuca canadensis* L.) was slow in responding to these light rates and was not generally killed. Alfalfa that was not completely turned under in plowing was damaged but not killed by these treatments.

A few broad-leaved weeds occurred as a secondary infestation in experiment 1 about six weeks after the plots were treated. It should be emphasized that there was an abundance of yellow foxtail (*Setaria glauca*), a scattered stand of smartweed (*Polygonum hydro-piper*), barnyard grass (*Echinochloa* sp), and quackgrass (*Agropyron ripens*).

Table 1. Yields of Sweet Corn Ears in Tons to the Acre

Experiment		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Date		7/1	7/1	7/8	7/8	7/14	7/21	7/29	7/29	8/1	8/6	8/14	8/20
	2,4-D Lbs./Acre												
	0.0	3.17	3.97*	1.57	0.68	2.16	2.33	2.13	4.75	4.25	1.19	4.43	2.36
	0.4	3.46	2.96*	1.60	1.37	3.18	3.36	2.43	4.95	4.52	0.79	3.17	1.53
	0.6	2.90	3.18*	1.87	1.32	3.07	3.39	1.61	3.61	4.91	0.73	3.46	1.09
	0.8	2.86	2.52*	2.41	1.04	2.82	3.47	1.65	5.44	4.26	9.56	4.07	1.92
L.S.D. 5%		N.S.	N.S.	N.S.	N.S.	.56	.63	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

\* Yields for 0.0, 2.0, 3.0 and 4.0 pounds of 2,4-D acid treatments.

With the exception of quackgrass, this later infestation of weeds appeared to be somewhat delayed in come-up as a result of the weedicide applied. The only weeds that withstood the heavy 2,4-D treatment in Block 2 were foxtail, smartweed, quackgrass and wild lettuce.

Tolerance of sweet corn varieties to 2,4-D: Tests were conducted on Dunkirk sandy gravelly loam of good fertility to determine the tolerance of eight important sweet corn varieties to 2,4-D. Two replications of each variety were planted on August 12 in plots consisting of six rows 30 inches apart and 15 feet long. The surface of the soil was dry at planting time.

On August 13 a light shower came. The next day 4 pounds per acre of ammonium salt of 2,4-D was applied as a spray to three of the rows in each plot. On August 15 3-1/4 inches of rain fell in forty minutes.

On August 19 corn in the untreated rows of each variety had emerged, but none was above ground in the treated plots. Two weeks after planting, data were obtained on the number of hills showing and the height of plants. All treated plots were seriously damaged both as to actual emergence and plant height. This may have been due to the heavy rate of 2,4-D or to the cloudburst which came immediately after treating.

To gain some knowledge of varietal response to 2,4-D, when applied to the foliage, the check plots of each variety were split in half cross-wise to the row direction. On August 26, one-half was sprayed with  $\text{NH}_3$  salt of 2,4-D at 1 pound per acre and the remaining half left untreated.

The spray was directed so that it would cover both the weeds and the corn. Purslane and red root seedlings were very prevalent. On September 15, three weeks after spraying the plants, data were taken on the height and the number of plants showing typical 2,4-D malformation. These results are presented in Table 2.

As can be seen in Table 2, the Seneca Dawn and North Star varieties had more malformed plants than the others. Carmelcross and Spancross were less susceptible. Golden Cross and Marcross were only slightly injured and Lincoln and Ioana showed no malformed plants.

It should be pointed out, however, that the malformation even on the most susceptible varieties were not severe. Height measurements showed no significant difference between treated and untreated plants. The malformations gradually disappeared as the season progressed, but no yields were obtained because the planting was destroyed by frost. Excellent weed control was obtained in all treated plots.

Table 2. Varietal response of sweet corn to a foliage spray of 1 lb./acre of 2,4-D.\*

Variety	Percentage of treated plants malformed	Height in inches		
		Check	Treated	Difference
Spancross	35.8	18.0	17.5	-0.5
Seneca Dawn	65.0	19.0	19.5	+0.5
North Star	65.2	23.5	22.5	-1.0
Marcross	15.0	20.5	21.0	+0.5
Carmelcross	43.2	20.0	19.0	-1.0
Lincoln	0.0	21.0	19.0	-2.0
Golden Cross	24.8	21.0	19.5	-1.5
Ioana	0.0	20.5	20.5	0.0
Least significant difference 5%	22.8			N.S.

\*Observations made three weeks after treatment.

Greenhouse tests were conducted to determine if rainfall could influence the toxicity of 2,4-D when applied as a pre-emergence treatment on sweet corn. On October 13, twelve flats were sown to Golden Cross and twelve to North Star sweet corn, and watered.

The following day four flats of each variety were dusted with NH<sub>3</sub> salt of 2,4-D plus talc for a diluent at the rate of 2 pounds per acre, and four more at 4 pounds per acre. Immediately after treating one-half of the flats received a heavy watering, and were again watered heavily two days later. The other flats were sub-irrigated once to maintain a desirable moisture content without danger of washing the 2,4-D into the soil.

On October 17, four days after planting corn, seedlings were visible in all flats. Two weeks after planting, data were taken on percentage emergence, and amount of malformation. The results are given in Table 3.

As indicated in Table 3 heavy watering did not consistently influence percentage emergence but it in all cases increased the degree of malformation resulting from the 2,4-D applications. Although the injury is not as pronounced as that which occurred under field conditions when an extremely heavy rain came soon after treating, the data do indicate that rainfall might greatly influence the performance of 2,4-D.

Table 3. The effect of heavy watering on the toxicity of 2,4-D to sweet corn.

Variety	Treatments		Percentage emergence	Malformation rating*
	Lbs. of 2,4-D	Watering		
Golden Cross	2	Heavy	85	4
"	2	Normal	85	4
"	4	Heavy	65	9
"	4	Normal	70	7
"	0	Heavy	75	1
"	0	Normal	80	1
North Star	2	Heavy	100	7
"	2	Normal	100	4
"	4	Heavy	85	7
"	4	Normal	95	5
"	0	Heavy	90	1
"	0	Normal	80	1

\*1 = No injury  
 9 = Severe injury

The performance of sweet corn treated at ten different stages of growth approximately a week apart indicated that the yield was not adversely affected by 0.4, 0.6, and 0.8 of a pound of 2,4-D acid to the acre. Experimental blocks treated at these rates on July 14 and July 21 produced significantly more corn to the acre in the husk than did uncultivated check plots.

These fractional rates of 2,4-D gave commercial control of lamb's quarter, red root and ragweed although there were a few young seedlings of these weeds at harvest time in the first block treated.

Varietal response to foliage sprays of 1 pound of 2,4-D per acre were studied. Of the eight varieties studied, the growth of Seneca Dawn and North Star showed the most 2,4-D symptoms, whereas Lincoln and Ioana showed the least. Both greenhouse and field tests indicated that rainfall might influence the toxicity of 2,4-D to sweet corn when applied as a pre-emergence treatment.

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"Pre- and Post-Emergence Chemical Weeding of Several Vegetables"  
R. D. Sweet and J. R. Havis, Cornell University

Chemical soil treatments have been advocated by several investigators (1, 2, 3, 4) as a means of weeding vegetables. The questions of materials, rates, and timing, however, have not yet been answered. The purpose of these studies was to determine the relative merit of several petroleum products, two growth regulators, and a dinitro compound when applied to the soil as non-selective herbicides for weeding various vegetables.

Two types of tests were conducted -- "pre-emergence" applications on direct seeded crops, and "post-setting" applications on transplanted vegetables. For the sake of clarity these two types will be presented separately.

Pre-Emergence Tests

In these tests the treatments were applied after the crops were planted but before they had emerged. Weeds had been allowed to germinate before planting.

Experiment No. 1

The following materials were used: dinitro ortho secondary butyl phenol in oil (Dow Contact herbicide), and five petroleum compounds of widely different boiling range and aromatic content, as is indicated in table 1.

Stoddard Solvent is the material widely used in spraying carrots. Heavy aromatic naphtha is similar in boiling range to kerosene. Tar L is an aromatic distillate which when broken into two components produces HB as the lighter and Tar H as the heavier fractions. The latter contains compounds which are essentially non-volatile and which are dissipated from the soil principally by action of micro-organisms.

Table 1. Petroleum products used in the pre-emergence tests.

Type of material	Code Symbol	Approx. Boiling Range° F.	Approx. Aromatic Content %
Stoddard Solvent	Var. 2	300-400	10-15
Heavy aromatic naphtha	HAN	350-550	75+
Aromatic distillate	HB	400-650	75+
" "	Tar L	400+	75+
" "	Tar H	650+	75+

On the basis of previous tests the following rates in gallons per acre were used: 25 and 50 of HAN, HB, and Tar L; 15 and 25 of the Tar H; 50 and 80 of Varsol 2; 1 and 2 of Dow Contact. All materials except Varsol 2 at 80 gallons were emulsified and brought up to 100 gallon volume. A knapsack sprayer was used for all applications.

The soil used in these tests was a Dunkirk sandy gravelly loam of good fertility with a potentially high weed population. Plots were 10' x 10' and replicated three times. On July 12 the area was given a final fitting. About 1" of irrigation was applied July 18. The succeeding two days several showers occurred. On July 26 one-half of each plot was sown to radish and one-half to beets by means of a hand seeder.

Treatments were applied two days after seeding. At this time the radish had radicles  $1/4$ " to  $3/8$ " long but the beets did not yet show evidence of germination. Weed seedlings, especially purslane, were very abundant at the soil surface. A few large grass plants not uprooted in the fitting process were growing vigorously.

No plots received cultivation with conventional equipment, but the check plots were hand weeded 3 weeks after planting. The weeds were so prolific in these plots that yields would have been materially reduced if they had not been weeded. Weed counts were made. The first harvest of radishes was made four weeks after sowing and the final harvest three days later. Beets were harvested at the bunching stage on September 16, seven weeks after sowing.

A summary of the data obtained on weed population and yield of radish and beets is presented in table 2.

Excellent control of weeds was obtained in all treated plots except those receiving the aromatic distillates of a tar nature. Tar L at 50 gallons per acre gave fairly good control of the seedling weeds, but not of the few large grasses which were present at time of treatment. Tar H was not satisfactory as an herbicide. It was difficult to apply except at low concentrations, and under these conditions gave poor weed control. Havis, working with pure hydrocarbons, has shown that those which boil higher than  $575^{\circ}$  to  $600^{\circ}$  F. have relatively poor herbicidal properties. This probably accounts for the unsatisfactory performance of the Tars.

No yield records were taken in the tar plots, except Tar L 50 gallons, because the crops were badly stunted by excessive weed growth. Where data were obtained, there was no significant difference in yield between any of the treated plots and the hand weeded checks, as is indicated in table 2. There was, however, a significant reduction by HB 50 gallons when compared with the highest yielding treated plots. The di-nitro at the 2 gallon rate caused a similar reduction in the radish but not the beet plots.

Table 2. The effect of pre-emergence materials on the weed population and yields of radish and beets.

Material	Rate/A Gals.	Weeds/sq. ft. (3 wks. after treatment)	Yield in oz. per 10 ft. of row	
			Radish Roots	Beets Roots
Var. 2	80	1.1	16.4	27.8
(Stoddard Solvent)	50	2.9	15.3	27.8
H.A.N.	50	0.9	15.3	33.2
(aromatic Naphtha)	25	1.6	18.0	24.2
H.B.	50	0.6	8.9	15.6
(aromatic distillate)	25	1.3	9.4	36.4
Dow Contact	2	1.3	8.9	20.2
(Di-Nitro)	1	1.2	14.2	22.5
Check	-	10.8	14.7	28.9
(Handweeded)				
Tar L	50	1.3	9.4	**
(aromatic distillate)	25	1.3*	**	**
Tar H	25	3.1*	**	**
(aromatic distillate)	12	4.8*	**	**
L.S.D. 5%		2.4	7.5	17.3
1%		3.3	10.3	23.9
*Mostly large weeds				
**Yields extremely low due to weeds				

Experiment No. 2

It was apparent from the above experiment that crops could be successfully weeded by applying any one of several petroleum compounds or a di-nitro as a pre-emergence treatment. Variations in the time of applying these materials, however, could conceivably influence their effectiveness as herbicides and might also affect their toxicity to crops.

To test the effect of timing a subsequent experiment was conducted. The soil was fitted August 22 to destroy a crop of summer grass and purslane. Live sprigs of the latter, however, remained

on top of the ground. A shower came August 25. On August 29 the area was planted to radish and spinach. Numerous purslane and other broadleaved annual weed seedlings were present. Spinach was substituted for beets because of the late sowing date. The same size of plot and number of replications was used in this test as in the preceding one.

Treatments consisted of Dow Contact at 1 and 2 gallons per acre and the aromatic distillate HB at 15 and 25 gallons per acre, applied as follows: treatment "A" immediately after planting, "B" one day later, and "C" two days after planting. About 1" of rain fell between the "A" and "B" treatments. Radish and spinach emerged 4 and 7 days respectively after sowing. Weed counts were made September 23, approximately 3 weeks after the last treatment. Radishes were harvested in three pullings; September 24, October 2 and 9. Spinach was harvested October 9.

The findings of this experiment are presented in tables 3, 4, and 5.

It can be seen in table 3 that all treatments significantly reduced the number of weeds per square foot. The aromatic distillate HB at 25 gallons, however, gave significantly better weed control than did the di-nitro compound at the 1 gallon rate (table 4). On the other hand this rate of HB reduced the stand and the yield of both radish and spinach. The high rate of di-nitro exhibited the same tendency, but it was less pronounced.

Table 3. The effects of pre-emergence sprays on weeds, radish and spinach.

Material	Gallons per acre	Time of treatment	Weeds/sq. ft.	Plants/10 ft. of row		Yield in oz./10 ft. of row	
				Radish	Spinach	Radish Roots	Spinach Tops
H.B. (Aromatic distillate)	25	A	1.8	45.6	8.3	7.8	2.4
		B	2.8	66.1	10.6	12.1	3.4
		C	1.1	80.0	12.2	13.8	3.4
Dow Contact	15	A	4.6	66.7	13.6	10.5	4.7
		B	5.3	91.4	15.6	15.5	7.6
		C	3.7	80.3	18.9	15.9	8.4
Dow Contact	2	A	7.1	25.0	11.9	4.8	4.6
		B	4.0	42.0	16.1	8.3	6.8
		C	7.0	65.6	11.4	11.9	5.2
Dow Contact	1	A	9.9	62.5	13.9	11.1	7.6
		B	5.0	55.6	14.4	11.6	6.2
		C	12.0	74.7	18.3	15.2	9.1
Check	-	-	24.1	91.9	16.7	18.7	7.1
L.S.D. 5%			8.2	34.5	8.7	6.7	3.9

Table 4. Summary of the value of materials as pre-emergence sprays.

Material	:Gallons : :per acre:	:Weeds/ :sq. ft.:	: Plants per 10		: Yield in oz. per	
			: ft. of row	: ft. of row	: 10 ft. of row	
			Radish	Spinach	Radish	Spinach
					Roots	Tops
H.B.	25	1.9	63.9	10.4	11.3	3.1
(Aromatic distillate)	15	4.5	79.4	16.0	14.0	6.9
Dow Contact	2	6.0	44.9	13.2	8.3	5.5
(Di-nitro)	1	8.9	64.3	15.6	12.5	7.6
L.S.D. 5%		4.6	25.5	5.7	4.8	2.4

Table 5. Summary of the influence of time of treatment on the effectiveness of the materials.

Time of Treatment	:Weeds per : sq. ft.:	: Plants per 10		: Yield in oz. per 10	
		: ft. of row	: ft. of row	: ft. of row	
		Radish	Spinach	Radish	Spinach
				Roots	Tops
A At planting time	5.9	49.9	12.0	8.6	4.8
B 1 day after planting	4.3	64.3	14.2	11.9	6.0
C 2 days after planting	5.9	75.1	15.2	14.2	6.5
L.S.D. 5%	N.S.	22.0	N.S.	4.2	N.S.

The effect of timing is summarized in table 5. Since the weeds had already germinated before the first treatment was applied, timing had little influence on weed control. In contrast, however, the stand and yield of radish were significantly affected by the time of treating. Treatments applied immediately after planting were more toxic than those applied only 2 days prior to crop emergence. The reason for this anomalous situation is not clear. Since treatment "A" was applied about 18 hours prior to a 1" rain, perhaps the toxicants were washed far enough into the soil to come into contact with the crop seed. Subsequent preliminary greenhouse tests have

neither corroborated nor disproved this theory. Another possible explanation may be that the emulsions were diluted when applied on wet soils as in treatments "B" and "C". This might render the herbicides less toxic to the crop plants as they emerged. No greenhouse work has been done to check this theory.

Post-Setting Tests

The purpose of these tests was to investigate the possibility of weeding transplanted crops such as cabbage, broccoli, and tomatoes with chemicals to eliminate hand hoeing. Herbicides used were methyl ester of naphthalene acetic acid at 3 pounds per acre; NH<sub>4</sub> salt of 2,4-D at 3 pounds per acre; Dow Contact at 3 gallons per acre; Varsol 2 at 100 gallons per acre; HAN at 50 gallons per acre, and aromatic distillate HB at 50 gallons per acre (see table 1). Applications were made over the entire soil surface on August 12, 3 weeks after the crops had been set in the field. A knapsack sprayer was used, and reasonable care was taken to prevent direct spray from hitting the crop plants. Weeds, which included grasses, purslane and other broadleaved species, were beyond the seeding stage. Weed counts were made September 16.

Although no direct application was made on the crop plants, 2,4-D was injurious to the three crops tested. No other material produced appreciable crop injury. The unsatisfactory weed control for 2,4-D and M E N A, as shown in table 6, was partially due to growth of grasses. Good weed control was obtained in plots treated with Dow Contact and the three petroleum products.

The quantity of material used on an acre basis could have been markedly reduced if spraying had been restricted to the area between plants. The speed of weeding a given length of row was greatly accelerated by using a knapsack sprayer instead of a hoe. This was especially true where stones were a problem.

Table 6. Control of weeds in transplanted crops by means of non-selective herbicidal sprays.

Material	Rate per acre	Ave. number weeds per sq. ft.
HAN	50 gal.	1.8
HB	50 gal.	2.7
Dow Contact	3 gal.	3.0
Varsol 2	100 gal.	3.8
2,4-D	3 lb.	9.3
MENA	3 lb.	10.7
Check	----	13.2
L.S.D. 5%		5.6
1%		8.4

### Summary

The herbicidal value of five petroleum products, two growth regulators and a di-nitro were studied. Treatments consisted of "Pre-emergence" sprays on the direct-seeded crops; radish, beets, and spinach, and "post-setting" sprays on the transplanted crops; tomatoes, cabbage and broccoli.

When weeds had already germinated, excellent control was obtained with several petroleum products having a boiling range below 650° F., but not with heavier fractions. Di-nitro ortho secondary butyl phenol in oil also gave good control. Under these conditions, time of application had little influence on weed kill. On the other hand, timing had a pronounced effect on the toxicity of the herbicides to the crops. Applications made immediately after planting were more toxic to the vegetables than were those made just prior to crop emergence. The reason for this unexpected behavior is not clear. It may be that rains on the early treatments brought the toxicants into contact with the seed, or perhaps the wet soils present at the time of the later treatments resulted in a diluting of the emulsions.

The post-setting treatments show the possibilities of eliminating hand hoeing of widely spaced transplanted crops by the use of contact herbicides. 2,4-D and methyl ester of naphthalene acetic acid were not satisfactory for this purpose.

### Literature Cited

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3. Warren, G. F. Dept. of Hort., Univ. of Wisc. Unpublished data.
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MR. PARMELEE: How did you put on those post-planting applications? Did you shield the plant?

DR. SWEET: We assumed that if a grower was going to do hand hoeing he might give his crew knapsack sprayers and turn them loose in the field. That is the way we did it. We could get by without any shielding even with tomatoes with some of the petroleum products that worked well in pre-emergence, and they also did a good job in that way.

Although there was an occasional gust of wind or something that carried some of the spray on to the tomatoes -- sure, it would burn a few leaves -- in a few days you could hardly tell and certainly not any more damage than a person with a hoe or with a tractor that nips a few of the ends of the vines.

MR. WOLF: Since HB may not be available this coming year, would you consider the heavy naphtha 132 as sufficiently active to replace the HB and use it in place of HB?

DR. SWEET: We would. We feel that you will have to step up the dosage per acre a little bit over what you might use with HB but we actually have more tests with the heavy aromatic naphtha than we do have with the HB.

We were planning it a year in advance and we feel if the cost factor can be met this is potentially an excellent material.

MR. WOLF: Have you tried a number of those materials straight as compared to emulsions to form any conclusions as to the most practical method of application?

DR. SWEET: I don't know just how to answer that. We have used it both ways and both ways give effective weed control. However, when you are trying to cut the cost and get good coverage so far with the equipment we have been using we have had to put on somewhere between 75 and 100 gallons an acre to get coverage. So then it became necessary to emulsify so that we could cut our rates down.

But I see no point in putting on, say, 75 gallons or 80 gallons like we would of Varsol.

MR. WOLF: What sort of luck did you have with snap beans?

DR. SWEET: We had excellent results with snap beans.

FROM THE FLOOR: They gave you the same results as radishes and beets?

DR. SWEET: Better than radishes. They sometimes popped through in three days, and with our heavier boiling materials they weren't dissipated. And with the higher rate of the di-nitro that we were using, the 2 gallon rate, we sometimes got into difficulty with radishes and even with snap beans.

But we had excellent results and we think it has potentially quite a place because many of the snap beans are not planted until the soil is definitely warm. And you do have a chance to work it and get those seed started.

To me one of the big questions in this thing is whether it is really going to work early in the season on those crops that are planted on cold soil. I am not sure.

The meeting of the Northeastern Weed Control Conference on "Field Crops, Pastures and Turf" convened at 9:30 o'clock, a.m., February 13, 1948, in the Hotel Commodore, New York City, N. Y.; E. Van Alstine, presiding.

"The Study of Dry and Spray Treatments of 2,4-D Formulations on Established Turf"

H. B. Musser, Pennsylvania State College

This experiment consisted of tests of the effectiveness of five concentrations each of parent 2,4-D acid and the sodium salt applied as a dry mix with fertilizer in comparison with a standard spray solution of the sodium salt. Rates of treatment varied from 1-1/2 pounds of acid equivalent to 8 pounds acid equivalent per acre as dry applications and 3 pounds acid equivalent for the sodium salt solution.

Dry treatments with fertilizer were applied in two series as follows:

1. With 6-10-4 fertilizer at rate of 1000 pounds per acre in which all nitrogen was derived from sulphate of ammonia.

2. With 6-10-4 fertilizer at rate of 1000 pounds per acre in which one-half of the nitrogen was derived from activated sewerage sludge and one-half from sulphate of ammonia.

All treatments were made in August 1946 on plots 12' x 14' each in four replications on six-year old Kentucky bluegrass-white clover turf. Weed population readings were made prior to treatment and two months later.

Results of the experiment are shown in the accompanying table. Since the data did not show significant differences between the results with the different fertilizers used, this summary table shows averages for both series. Results indicate that:

1. Dry applications of the formulations used were just as effective under the conditions of this experiment as liquid sprays for control of dandelion, buckhorn, broad-leaved plantain and white clover.

2. There has been no evidence to date of injury to the turf from any formulation or concentration used.

Effectiveness of 2,4-D (parent acid and sodium salt) for weed control when applied as dry mix with fertilizer at various rates. Per cent survival -- no treatment equals 100 per cent.

This is in the order of the rate of application for dandelion, buckhorn, broad leaf plantain, and white clover; 1.5 pounds per acre: 18.6, 28.9, 40.3, 23.5. 3 pounds per acre: 8.7, 7.7, 6.9, 13.9. 5 pounds per acre: 6.2, 8.4, 8.9, 11.9. 6 pounds per acre: 5.7, 8.8, 8.2, 13.5. 8 pounds per acre: 4.3, 6.1, 8.6, 12.6.

Standard spray solution (2.5 pounds per acre): 3.4, 7.6, 8.2, 9.0.

- (1) 6-10-4 fertilizer (1/2 N) used at rate of 1000 pounds per acre.
- (2) 2,4-D treatments applied in late August, 1946.
- (3) Survival readings made October, 1946.

CHAIRMAN VAN ALSTINE: Are there any comments or questions on Dr. Musser's speech?

FROM THE FLOOR: How is it applied?

DR. MUSSER: On these small plots the mixture was applied with the type of distributor that is normally used on the golf course for applications for fertilizers on greens. The Root distributor, that is. The Root distributor is a very good tool, providing your fertilizer is in very good condition.

FROM THE FLOOR: For the small home owner which would you prefer to recommend, assuming that you got the right concentration, a dry application or a spray?

DR. MUSSER: I think it is much simpler to apply a dry application. It is the simplest thing in the world.

Some distributors are afraid that somebody will use this fertilizer with 2,4-D in it for his garden, flowers or something of that sort. Of course that is a practical consideration and yet it seems to me that if it is properly labeled it is just as sensible for somebody to take iodine or any other poison that is properly labeled as to apply this material in the wrong way.

We are doing it with other materials right along; why shouldn't we be able to do it with this?

FROM THE FLOOR: Dr. Musser, was there any significant difference that you noticed with mixing the acid with fertilizer?

DR. MUSSER: We have those records separately and we ran analytical and statistical studies on them and could get no differences on them between the clear acid mixed with the fertilizer and the sodium salt.

The averages we showed you were the averages of both of them.

"Crab Grass Control in Turf"  
J. A. DeFrance, Rhode Island State College  
(paper read by Dr. T. E. Odland)

Crab grass, the number one enemy weed of lawns, putting greens, and other turf, is a Summer annual that can be recognized in late Spring and early Summer by its short, wide, yellowish-green leaf blades. They are very noticeable during June and July after the lawn has been cut, as they grow faster than the regular lawn grasses.

Soon flat stems spread out from the crown; the plant takes on its characteristic crab-like aspect and later appears as a bronzy, reddish-purple mat of tangled, wiry, finger-like, seed-bearing stems, many of which stand erect or spread out above the lawn grasses.

In closely cut turf, many seed-producing stems lie close to the ground and thus escape the cut of the lawn mower. When crab grass reaches maturity and dies out or is killed by frost, it leaves brown unsightly areas in the turf.

#### Review of Literature

Two species of crab grass (*Digitaria*) abound in New England, *D. sanguinalis*, hairy crab grass; and *D. ischaemum*, smooth crab grass. Hitchcock (18) states that they are common weeds in lawns; they form a fine green growth at first but start late and die in the Fall. He distinguishes the two species primarily on the basis of a smooth sheath for *D. ischaemum* and a hairy sheath for *D. sanguinalis*. *D. ischaemum* was by far the most common species found in turf used in this study.

Tests with chemicals such as sodium arsenite, sodium chlorate, sodium fluoride, Lawn Sinox, and 2,4-D at various rates of application for crab grass and weed control in lawns have been reported by Davis (4), Farnham and Hallowell (12), Mitchell, Davis and Marth (21), Grau (13, 14), Monteith and Bengston (22), Marcovitch (20), Robbins, Craft and Raynor (25), Welton and Carroll (27), and by DeFrance (6), with varying degrees of success.

The prolonged germination period of crabgrass makes control with only one application of any chemical very difficult. If the crop of crab grass germinated all at once, instead of from May to August, the plants could be killed in the seedling stage by one treatment of certain chemicals, as discussed by Robbins, Craft and Raynor (25), DeFrance (6), and Pridham (24), but repeated treatments are necessary if the successive crops are to be eliminated.

Methods for destroying weed seed in soil by use of calcium cyanamid, chloropicrin, arsenate of lead, 2,4-D, ammonium thiocyanate, ammonium sulfamate, allyl alcohol, sodium nitrite, ammonium sulfate, and uramon, have been presented by Abbott (1), Carr (2), DeFrance (7, 10), DeFrance, Bell and Odland (11), Hamner, Moulton and Tukey (16), Henderson, Mathews and Jenkins (17), Howard and Stark (19),

Monteith and Rabbitt (23), and by Welton and Carroll (28). These methods help produce weed-free topsoil, compost, manure and muck prior to seeding, for use as compost and top dressing.

Controlling crab grass by providing shade from dense turf, by adequate fertilization, brushing, raking, mowing and other means have been advocated by Curtis and DeFrance (3), DeFrance (5, 6) and Grau (13, 14, 15).

Observations made during 1946 at the Rhode Island Agricultural Experiment Station and reported by DeFrance (8,9), indicated that certain water-soluble mercurial formulations appeared to be effective crab grass controls. The effectiveness of PMAS (a water solution of a phenyl mercury organic complex) as a crab grass killer was discovered by Charles H. Allen, Jr., Turf Foreman, on new turf plots (two-year-old sod) in a cooperative disease control study with Dr. F. L. Howard and Dr. H. W. Keil.

It was pointed out that a combination selective herbicide-fungicide, applied as a single spray, would save many hours of hand-weeding turf areas. Additional work was needed to study the phytocidal effect of the chemicals on other turf, to ascertain effective dosages and opportune timing of treatments.

Just prior to the use of PMAS for crab grass, DeFrance (11) reported sodium arsenite as the most satisfactory control when employed in a test comparing other chemicals and commercial preparations.

Materials and methods: Chemicals used in the test reported here, and the commercial sources of these chemicals were as follows: 'Aero' Cyanamid, granular, American Cyanamid Co., New York; G-652, Dow Chemical Co., Midland, Michigan; sodium arsenite, Chipman Chemical Co., Bound Brook, N. J.; water solutions of a phenyl mercury organic complex including PMAS, PMAS-B, PMAS-AA, and solutions of phenyl mercury and 2,4-D (MQ 71, MQ 72), the W. A. Cleary Corporation, New Brunswick, N. J.; TAT C-lect (PMAS), O. E. Linck Co., Clifton, N. J.; phenyl mercury preparations (Puraturf and Puratized 641), Gallowhur Chemical Corporation, New York; and Mercan L., John Powell and Co., New York; 2,4-D butyl ester (Weed-No-More), Sherwin-Williams Co., Cleveland, Ohio; 2,4-D sodium salt, J. T. Baker Chemical Co., Phillipsburg, N. J.; ammonium arsenate, Merck and Co., Rahway, N. J.

Several tests were conducted in the greenhouse during the Winter of 1946-1947 and in the field during 1947 to determine, (a) concentrations of the materials that would prevent seed germination, (b) inhibition and control of crab grass without injury to permanent turf, (c) the most effective time of application and (d) the number of treatments necessary for complete kill of crab grass.

Treatments were applied to various crab grass infested areas in the field from June 5 to September 26 on soil fallow of permanent grasses, on poor thin turf, and on good dense turf. The field plots were usually 10 feet square. The sprayers used were open-topped 4-gallon pressure sprayers with cone-type nozzles. Application of

actual toxicant reported in this paper was calculated on the basis of 10 gallons of solution per 1,000 square feet.

The crab grass-infested lawn turf areas were composed of mixtures of Colonial bent, Chewing's fescue, Kentucky and annual bluegrass maintained approximately 1 inch to 1-1/2 inch high. Putting-green turf under a disease control study where observations were made on crab grass control consisted of pure plantings of Congressional strain of creeping bent (c-19), Colonial bent, and Piper velvet bent, all maintained at a height of 1/4 inch.

The athletic field provided an excellent turf area to conduct tests for crab grass control. The field was seeded in 1935 to a mixture of Rhode Island bent, Kentucky bluegrass and Chewing's fescue, but crab grass had invaded the area and was quite uniformly distributed. Three series of tests were conducted at the athletic field and the treatments in each series were replicated three times in blocks called A, B and C.\*

Results and discussion: In the greenhouse during the Winter of 1946-1947, crab grass seeds were immersed for one minute in solutions of phenyl mercury acetate formulations of 1:5,000, 1:10,000 and 1:20,000. Treated seeds germinated as well as those not treated, indicating that at the rates used the toxicant did not penetrate the seed coat sufficiently to inhibit germination.

When soil was sprayed with these formulations at the above rates after planting crab grass seed, there was apparently no inhibition of germination. The chemicals sprayed on the soil controlled the algae and green scum growing on the surface, which indicates that the phenyl mercury acetate formulations would probably help eliminate the green mold that often occurs on turf areas. It was observed that the seed germinated over a period of several months when planted at the same time and given the same care.

Field tests were made on 8 areas:

Area 1. A study to inhibit crab grass and other weeds prior to planting showed that soil contaminated with weed seed and treated May 29, 1947, with ammonium thiocyanate 2 to 4 pounds, granular cyanamid 50 to 75 pounds, ammonium sulfate 75, sodium nitrate 75, sodium nitrite 30 pounds, 2,4-D sodium, and 2,4-D butyl ester at 1/4 pound, PMAS, and Puraturf at 1:100 and 1:200, provided practically weed-free soil. Plantings of ryegrass and Colonial bent made four to six weeks after treatment grew satisfactorily.

Area 2. A test to determine minimum strength of concentration needed to inhibit or kill germinating crab grass and seedlings in the one, two and three-leaf stages was conducted on an area fallow of permanent grasses but quite uniformly covered with an excellent stand of both smooth and hairy crab grass.

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\*The data recorded on the crabgrass control experiments represent joint observation by Charles H. Allen, Jr., Turf Foreman; Mark H. Gordon, Assistant in Agronomy; and the author.

The phenyl mercury formulations alone at 1:1,000, 1:2,000 and 1:4,000, or mixed with the 2,4-D formulations; sodium arsenite; G-652; and cyanamid inhibited the crab grass plants present at the time of treatment June 5. However, as warmer weather came, more crab grass germinated and developed.

This test indicated that the ungerminated seeds were not killed by the chemicals, except where rates of 1:100, 1:200 and 1:400 of PMAS and 2,4-D mixtures were used. At those rates the soil remained sterile all Summer and no growth of plants occurred; the heavier concentrations would be impractical, however, for use on turf areas. On plots where 2,4-D was used, plants that developed after the treatments grew quite vigorously.

Area 3. On the campus, a thin poor lawn composed of a mixture of Kentucky, annual bluegrass and a small amount of Colonial bent and fescue heavily infested with crab grass was treated with various chemicals. First treatments were made June 17 when crab grass was in the two and three-leaf stage. Second treatments were made July 1 to the east half of all plots, two weeks after the first treatments except where they produced severe injury to permanent grasses.

Forty different treatments, replicated, were used in this test, including the phenyl mercury formulations and G-652 at rates of 1:1,000, 1:2,000 and 1:4,000; 2,4-D formulations at 1:500, 1:1,000 and 1:2,000; sodium arsenite, 1 1/2 and 1/2 ounces; and cyanamid at 10, 5 and 2-1/2 pounds per 1,000 square feet.

The phenyl mercury and G-652 preparations at 1:1,000 and 1:2,000 produced too severe injury to permanent turf to warrant their use at these rates. One or two similar treatments early in the season gave only temporary control, killing all crab grass plants present at the time, but more seeds germinated, necessitating additional treatments for complete eradication. The best control of crab grass in Area 3 was obtained with PMAS-B and PMAS-AA at the rate of 1:4,000 and produced only temporary injury.

Area 4. A lawn at the turf plots, composed of a mixture of Colonial bent, Chewing's fescue and Kentucky bluegrass infested with crab grass in the two and three-leaf stages was treated with materials at rates given in Table 1. The first treatments were applied to whole plots July 14.

A second treatment was given July 21, to 1/2 of each plot. Percent of area covered by crab grass was recorded before the first treatment; turf injury notes were taken one week after treatments, and final notes in September when remaining crab grass had practically matured.

Crab grass plants present at time of treatment were killed but more germinated and grew later. One application of any material used did not provide significant continuous reduction in the crab grass population. The solution of PMAS-AA at 1:2,000 appeared to give control of crab grass; however, that rate seemed too strong for practical application.

Two treatments of PMAS and PMAS-AA at rates of 1:3,000 and 1:4,000 were very satisfactory both with regard to control of crabgrass and the lack of injury to the permanent grasses in the turf. Addition of 2,4-D at the rate of 1:1,000 to PMAS at 1:3,000 or 1:4,000 did not increase the effectiveness of the spray solution, and 2,4-D at 1:1000 resulted in turf injury.

On Area 4 the materials giving practically 100 per cent control of crab grass without appreciable injury to the permanent turf were PMAS 1:3,000, 1:4,000 and PMAS-AA 1:3,000 and 1:4,000. The most practical materials and rate were PMAS and PMAS-AA at 1:4,000, with two treatments at weekly intervals in mid-July.

Area 5. The first series of plots at the athletic field consisted of forty treatments replicated three times. Materials were applied July 2 when crab grass was in the three-leaf stage. PMAS-B, PMAS-AA, PMAS, Puraturf, MQ 71, MQ 72, and G-652 were used at rates of 1:1,000, 1:2,000 and 1:4,000; Puraturf 1:1,000, 1:2,000 and 1:4,000 plus 2,4-D butyl ester at 1:2,000; 2,4-D sodium and 2,4-D butyl ester at 1:500, 1:1,000 and 1:2,000; sodium arsenite at 1, 1/2 and 1/4 ounces; Cyanamid at 15, 10 and 5 pounds and Mercan L at 1:100, 1:200 and 1:400.

The following materials at rates of 1:1,000 and 1:2,000 appeared too severe; PMAS-B, PMAS-AA, PMAS, Puraturf, MQ 71 and G-652; Puraturf 1:1,000 and 1:2,000 plus 2,4-D at 1:2,000; sodium arsenite at 1 and 1/2 ounce; and Mercan L at 1:100. The 2,4-D materials alone or mixed with the phenyl mercuric formulations did not appear to increase effectiveness of the solutions. The materials and rates that appeared most satisfactory in this test for crab grass control without objectionable injury to permanent grasses were PMAS-B, PMAS-AA, and PMAS at 1:4,000.

Area 6. On the second series of plots at the athletic field, the material and rates of application were adjusted on the basis of previous tests to provide less turf injury and better control. Treatments were made Saturday mornings beginning August 9, with the thought that the home owner would have one day a week when he could make applications. Since Puratized 641 had inhibited crab grass on plots where it had been used for disease control, it was substituted for Puraturf on Area 6. To put Puratized 641 powder into suspension, Isothan\* DL-1 wetting agent was used at the rate of 1/2 cc per gallon of water.

The treatments and results are presented in Table 2.

The soil in block C was of poorer quality, lower in fertility, more subject to drought, and in general, the turf was less dense and of poorer quality than in blocks A and B. Due to the poorer quality of the turf, there was less competition from the permanent grasses, and the crab grass plants, although fewer in number, were more rugged, tougher, woodier, stemmier, flatter and broader in block C, and not so soft and succulent as in blocks A and B.

Results in blocks A and B show that two treatments, a week apart, of PMAS and PMAS-AA at the rate of 1:3,000 gave 100 per cent control of crab grass. Three treatments of PMAS and PMAS-AA at 1:4,000 and 1:5,000 gave 100 per cent control; four treatments at 1:6,000 and five treatments at 1:9,000 applied at weekly intervals gave practically 100 per cent control of crab grass without any serious injury to permanent turf grasses. Puratized 641 at 1:5,000, 1:6,000 and 1:9,000 gave very good control from five applications at weekly intervals without noticeable injury to permanent grasses.

PMAS at 1:6,000 mixed with 2,4-D butyl ester at 1:4,000, and applied three times at weekly intervals gave 100 per cent control of crab grass and other weeds such as common and Fall dandelion, narrow and broad-leaf plaintain and chickweed.

The phenyl mercury formulations had a marked effect on the broad-leaved weeds, especially where light concentrations were used, such as 1:4,000, 1:5,000, 1:6,000 and 1:9,000 when applied three, four, or five times, thus indicating that if 2,4-D is mixed with the phenyl mercury preparations the standard recommendations of 2,4-D can be reduced at least to 1:4,000. Likewise, the rates of the phenyl mercury formulations can be reduced to 1:6,000 when used in a mixture with 2,4-D to provide weed-free turf without severe injury to permanent turf grasses.

Area 7. On the third series of plots at the athletic field, treatments were applied in September when crab grass was maturing and producing seeds. The phenyl mercury formulations PMAS, PMAS-AA and Puratized 641 were used at rates of 1:3,000, 1:4,000, and 1:5,000 and at rates of 1:4,000 and 1:6,000 mixed with 2,4-D at 1:4,000 sodium arsenite was used at 1-, 2-, 4-, and 6 ounce rates.

Two treatments of 1:3,000, three of 1:4,000 and 1:5,000 of the phenyl mercury formulations alone, and three treatments of the phenyl mercury formulations plus 2,4-D appeared to give excellent kill of the mature crab grass plants with only slight temporary injury to the permanent lawn grasses. Severe temporary injury from the 2-ounce rate of sodium arsenite and permanent turf injury resulted from the 4- and 6-ounce rates. This test indicated that phenyl mercury formulations if applied only in September were beneficial from the standpoint of appearance alone. Definite conclusions on crab grass control on Area 7 will not be drawn until the next crab grass season when observations will be made.

Area 8. A turf fungicide development study where various fungicides were used, including some phenyl mercury formulations, offered an excellent opportunity to observe the result of treatments on crab grass control in the Congressional strain (c-19) of creeping bent, Rhode Island-grown Colonial bent, and Piper velvet bent maintained 1/4 inch high (putting-green height).

Table 3 lists some of the chemicals, rates used, and shows crab grass control results on creeping, Colonial and Velvet bent putting-green turf and also dollar spot control on Toronto (c-15) and Congressional (c-19) strains of creeping bent.

Notes on crab grass and dollar spot in the table were taken the last of September when crab grass was mature, and the last severe attack of dollar spot had passed, show the ability of certain chemicals to serve the dual purpose of controlling disease and crab grass.

PMAS, PMAS-AA and Puratized 641 applied eight times during the season, at rates of 1:8,000, gave excellent control of crab grass and dollar spot. On the control plots only 0.2 per cent crab grass was present on Velvet bent, an average of 3.7 per cent on Congressional creeping bent and 15.4 per cent on Colonial bent. This fact is undoubtedly due to the difference in density of the three grasses which have been maintained under identical conditions and indicates that the denser the turf, the less chance of crab grass invasion. No dollar spot occurred on Colonial or Velvet bent, and Congressional bent appeared to be less susceptible than the Toronto strain to dollar spot.

For further information on the fungicide development studies, refer to the paper "Specificity of Fungicides for Diseases of Bent Turf", Rowell (26).

On field tests in general, treatments applied early in the season killed germinating seed and all young plants in the two and three-leaf stages but as the season progressed more crab grass germinated and necessitated additional treatments. One treatment of any material used did not provide complete control of crab grass.

PMAS and PMAS-AA, applied July 14 and 21, at 1:3,000 and 1:4,000, gave practically 100 per cent control without any permanent turf injury. It was thought that complete continuous control did not occur because a few seeds germinated after July 21.

In August when two treatments of PMAS and PMAS-AA at 1:3,000 were applied at weekly intervals and three treatments at 1:4,000 and 1:5,000, complete continuous control was recorded on plots of dense turf. Four treatments at weekly intervals with PMAS-AA at 1:6,000 gave 100 per cent control also. A mixture of PMAS 1:6,000 plus 2,4-D butyl ester 1:4,000 brought 100 per cent control of crab grass and all other weeds such as common and Fall dandelion, narrow and broad-leaf plantain, producing weed-free turf with three treatments at weekly intervals.

Light concentrations (1:5,000 and 1:6,000) of the phenyl mercury materials when applied three, four and five times gave excellent control with little or no discoloration of the permanent grasses. Heavier concentrations (1:3,000 and 1:4,000) requiring two or three treatments for control produced temporary turf injury. 2,4-D sodium and 2,4-D butyl ester alone appeared ineffective against crab grass except during periods of germination and young stages.

The higher the grass, the stronger the concentration that can be used. For example, turf cut at lawn height (1 inch or more), under favorable soil moisture conditions, can stand a 1:3,000 solution of PMAS, or PMAS-AA at the 10-gallon rate, whereas turf cut at putting-green height (approximately 1/4 inch) appeared to stand a concentration of not more than 1:8,000 without injury.

The kind of grass to be treated is a factor in weed control. Kentucky bluegrass was injured less than fescue or Colonial bent. Velvet bent appeared more susceptible than the other grasses to turf injury; consequently less chemical should be used when treating Velvet bent.

Tests have indicated that good coverage and distribution of the chemicals can be obtained by spraying with at least 10-gallons per 1,000 square feet with the ordinary cone-type spray nozzle. Good crab grass control resulted in a preliminary test with a Rollow-sprayer\* having a flat fan spray nozzle that would uniformly cover 1,000 square feet with only 1 gallon of water.

If a lawn is mostly crab grass, treatment with chemicals will naturally produce a brown discoloration of the crab grass plants, but in a lawn that is mostly good turf, little discoloration will be noticed as the plants wither and soon disappear.

Summary and conclusions: Preliminary tests during 1946 at the Rhode Island Agricultural Experiment Station indicated that water solutions of phenyl mercury organic complexes gave promise of effective crab grass control.

Several hundred plots of lawn and putting-green turf were treated for crab grass during the 1947 season. These experiments definitely proved that certain formulations of phenyl mercury complexes are satisfactory for control of crab grass.

Applications of PMAS or PMAS-AA at the rates of 1:4,000 or 1:5,000 (one part of the chemical to 5,000 parts of water with actual toxicant calculated on the basis of 10 gallons of solution to 1,000 square feet) used three times at weekly intervals gave 100 per cent control of crab grass on lawns composed of Kentucky bluegrass, Chewing's fescue and Colonial bent. Such treatments appeared to be the most practical method of crab grass eradication without injuring the permanent turf grasses.

Complete control of weeds, including common and Fall dandelion, narrow and broad plantain, chickweed and crab grass, with no permanent injury to the turf, was obtained by three treatments at weekly intervals in August with a mixture of PMAS 1:6,000 and 2,4-D butyl ester 1:4,000, applied at the rate of 10 gallons to 1,000 square feet.

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\*A newly developed 7-gallon capacity machine that sprays as it rolls along, designed and produced by Walter S. Lapp, Lansdale, Pa.

Dormant hard seed appeared very difficult to kill and it is doubtful if crab grass seed, except when maturing or germinating, can be killed with solutions that do not harm lawn grasses.

The best time for treatment with a minimum number of applications appeared to be in July or August after seeds had germinated or were in the process of germination.

The studies reported in this paper show that sprays with a water-soluble phenyl mercury acetate complex such as PMAS, PMAS-AA and Puratized 641, when applied under conditions of these tests, give very satisfactory control of crab grass.

The phenyl mercury formulations have also given good control of some turf diseases, especially dollar spot. As a preventive against crab grass and certain diseases, it may be advisable to apply the chemicals at 1:4,000 or even 1:10,000 approximately once a month from June through September. Therefore, in the maintenance of putting greens and other fine turf areas, these chemicals have a dual use, controlling both disease and weeds.

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FROM THE FLOOR: Does this PMAS have a bad effect on the broad-leaf plantain the same as 2,4-D has?

DR. ODLAND: No. It is specifically for crab grass so far as we are concerned.

FROM THE FLOOR: I noticed in your figures on your comparison of creeping bent and Colonial bent and Velvet bent that you had much higher incidence on Colonial bent type plots than you did on the creeping and Velvet bent. Is that because Colonial did not keep the crab grass out as well on those plots to start with?

DR. ODLAND: That is right. Crab grass, if you have a good dense turf, why that is a good step forward toward winning the battle. In the Velvet bent when we fertilized that well, and took good care of it, it made such a heavy mat that the crab grass had a tougher time.

Table I. Crab grass Control - Area 4. Mixtures of Colonial bent, Kentucky bluegrass, and Chewing's fescue infected with crab grass in the 2- and 3-leaf stage at time of treatment. First treatment applied to full plot July 14; second treatment applied to one-half of each plot July 21.

Plot	Material	Toxicant in water	Turf Injury	Per cent crab grass before treatment	Per cent crabgrass 2 months after treatment*	
					1 treatment	2 treatments
1.	PMAS	1:2000	Medium	11	7	Trace**
2.	"	1:3000	Light	10	12	Trace
3.	"	1:4000	Very light	12	17	Trace
4.	"	1:2000				
	/2,4-D	1:1000	Severe	6	14	3
5.	"	1:3000				
	/2,4-D	1:1000	Medium	5	8	2
6.	"	1:4000				
	/2,4-D	1:1000	Medium	15	46	4
7.	"	1:5000				
	/2,4-D	1:1000	Light	10	24	2
8.	PMAS-AA	1:2000	Severe	4	3	Trace
9.	" "	1:3000	Medium	7	6	Trace
10.	" "	1:4000	Light	7	13	Trace
11.	MQ 71	1:2000	Medium	14	21	0.5
12.	"	1:3000	Light	12	18	1.0
13.	"	1:4000	Very light	10	18	3.0
14.	Check	000	None	6	19	32
15.	Sodium Ars.	1-1/2 oz.	Severe	8	37	49
16.	MQ 72	1:2000	Light	9	27	7
17.	"	1:3000	Very light	9	25	17
18.	"	1:4000	None	12	26	21
19.	2,4-D, Sod.	1:500	None	18	41	48
20.	"	1:1000	None	15	38	48
21.	" Butyl	1:500	None	13	35	30
22.	" "	1:1000	None	10	33	27
23.	Ammonium Ars.	1:500	Severe	1	7	9
24.	" "	1:1000	Medium	5	31	33
25.	" "	1:2000	Light	6	26	14

\*Per cent of crab grass in Sept., approx. 2 mos. after treatment - \*\* Trace is less than 0.10%

Table 2. Crab grass Control - Area 6. Treatments were applied at weekly intervals as needed:

Plot	Material	Toxicant in water	No. of treat- ments	BLOCK A			BLOCK B		
				Before treat- ment	After treatment		Before treat- ment	After treatment	
				% Crab- grass	% Crab- grass	% Weeds	% Crab- grass	% Crab- grass	% Weeds
1	PMAS	1:3000	2	8	0	5.0	8	0	3.0
2	PMAS	1:4000	3	7	0	2.0	8	0	0.3
3	PMAS	1:5000	3	14	0	2.5	8	0	0.1
4	PMAS	1:6000	4	5	0.5	0.5	8	0	0.1
5	PMAS	1:9000	5	4	0.5	0.5	7	T	T
6	PMAS-AA	1:3000	2	12	0	5.0	7	0	3.0
7	PMAS-AA	1:4000	3	10	0	2.5	7	0	0.3
8	PMAS-AA	1:5000	3	8	0	2.0	9	0	0.2
9	PMAS-AA	1:6000	4	10	0	2.0	7	0	0.1
10	PMAS-AA	1:9000	5	10	0	1.5	4	0	0.1
11	PMAS	1:6000							
12	PMAS /2,4-D	1:4000	3	10	0	0	6	0	0
	PMAS /2,4-D	1:9000							
	PMAS /2,4-D	1:5000	5	8	0	0	7	T	0
13	Check	000		8	28	7	7	36	5.0
14	PMAS-AA /2,4-D	1:3000							
	PMAS-AA /2,4-D	1:2000	3 <sup>d</sup>	8	0	0	7	T	0
15	PMAS-AA /2,4-D	1:6000							
	PMAS-AA /2,4-D	1:2000	3	15	0	T	7	0	0
16	Puratized 641	1:3000	3 <sup>e</sup>	12	0	0.5	8	0	0.3
17	Puratized 641	1:4000	3 <sup>f</sup>	10	T	0.2	6	T	0.1
18	Puratized 641	1:5000	5	10	0.5	0.5	7	0.1	0.3
19	Puratized 641	1:6000	5	10	T	0.2	6	%	0.2
20	Puratized 641	1:9000	5	8	0	2.0	5	T	0.2

(Table continued on page 111a)

Table 2 (continued)

Plot	Material	Toxicant in water	No. of treat- ments	BLOCK C			Turf Injury		
				Before treatment	After treatment		A	B	C
				% Crab- grass	% crab- grass	% Weeds			
1	PMAS	1:3000	2	10	0	2.0	L <sup>b</sup>	L	L
2	PMAS	1:4000	3	7	0.5	1.5	L	L	L
3	PMAS	1:5000	3	8	0.5	0.2	L	L	L
4	PMAS	1:6000	4	9	0	0.1	VL	L	VL
5	PMAS	1:9000	5	8	0.5	0.1	0	0	VL
6	PMAS-AA	1:3000	2	9	T	2.0	L	L	L <sup>d</sup>
7	PMAS-AA	1:4000	3	4	0.5	1.0	L	L	L
8	PMAS-AA	1:5000	3	9	0.5	1.2	VL	L	VL
9	PMAS-AA	1:6000	4	10	0	0.3	VL	L	VL
10	PMAS-AA	1:9000	5	8	0.5	0.2	0	0	0
11	PMAS /2,4-D	1:6000							
	PMAS	1:4000	3	6	0	0	M-	M	M-
12	PMAS /2,4-D	1:9000							
	PMAS	1:5000	5	4	0.2	0	L	L	L
13	Check	000		7	41	2.0	-	-	-
14	PMAS-AA /2,4-D	1:3000	d						
	PMAS-AA	1:2000	3	7	0.1	0	M	S	S-
15	PMAS-AA /2,4-D	1:6000	e						
	PMAS-AA	1:2000	3 <sup>f</sup>	7	T	0	M	M	M
16	Puratized 641	1:3000	3	7	2.5	1.7	M	M-	M
17	Puratized 641	1:4000	3	6	0.5	0.5	M	M	M
18	Puratized 641	1:5000	5	6	1.5	T	L	L	L
19	Puratized 641	1:6000	5	8	1.0	T	L	VL	VL
20	Puratized 641	1:9000	5	5	3.0	T	L	0	L

- a. Other than crab grass
- b. Turf injury recorded as severe, medium, light and none.
- c. Less than 0.10 per cent.
- d. Third treatment was applied 2 weeks after second because of injury from second treatment.
- e. Third treatment reduced from 1:3000 to 1:4000 because of injury from first and second treatments.
- f. Injured from third treatment.

Table III. Crab Grass Control - Area 8a. Effect of some fungicides on crab grass and dollar spot in putting greens.

Treatment	Toxicant in water	Estimated per cent of Crab grass after 8 treatments <sup>b</sup>			Estimated per cent Dollar Spot	
		Creeping bent (c-19)	Colonial bent	Velvet bent	Creeping bent (c-15)	Creeping bent (c-19)
Puraturf	1:16,000	3.8	15.6	0.4	29.5	Tr <sup>c</sup>
Puraturf	1:8,000	2.8	10.0	2.0	1.2	Tr
Puratized 641	1:8,000	Tr	3.1	Tr	Tr	0
Puratized 177	1:4,000	6.4	11.2	1.0	0	0
Puratized 177 <sup>d</sup>	1:2,000	7.1	10.6	0.5	0	0
PMAS	1:8,000	0.2	2.9	Tr	0	0
PMAS - AA	1:8,000	Tr	2.4	Tr	Tr	T
Control (no treatment)		3.1	10.2	0.2	56.0	23.5
Control (no treatment)		4.3	20.6	0.2	52.0	21.0

a. These results come from a cooperative fungicide development study with Dr. F. L. Howard and John B. Rowell.

b. Figures represent average of 5 replicates treated 8 times (bi-weekly from June-September).

c. Less than 0.10 per cent.

d. Applied once a month (4 times during the season).

Weed Control on Pre-emergence  
Treated Corn

S. M. Raleigh  
R. E. Patterson

Pennsylvania Agricultural Experiment Station, State College

Pre-emergence treatments were applied at State College on May 24, 1947 on Ohio M 15 corn which was planted on May 23 and 24 and at Montrose on June 11 the day Ohio K 24 was planted. At both locations there were 4 replications. The plots were 4 rows wide and 40 feet long.

Where no cultivation was used the applications were applied over the entire area. Where cultivation was used with the pre-emergence treatments the application were made covering about 6 1/2 inches on each side of the row. In the table this is shown by having a quantity shown in both the rate per acre and rate per acre over the row column.

The weed counts were made by counting an area 6 inches wide and 2 feet long over the row in 4 locations in each plot. Weed counts were made before 1st cultivation.

At State College the monocots were primarily green foxtail (Setaria viridis) and the dicots mainly red-root pigweed (Amaranthus retroflexus). Lambs-quarters (Chenopodium album) and ragweed (Ambrosia artemisiifolia.) At Montrose the majority of the weeds were smartweed (Polygonum Pennsylvania.)

The 2,4-D treatments gave excellent control of dicots and good control of grasses in the field at State College. The stand of corn in all 2,4-D treatments were reduced by rodents digging up the plants when 3 inches high. The average number of plants per plot treated with 2,4-D was 42.86 while the average of the adjacent plots were 63.95 plants. At Montrose there was fair control of smartweed, but some reduction in stand on this very wet poorly drained soil.

The heavier rates of calcium cyanamid at State College gave excellent control of the dicots and fair control of the grasses. There was little control of smartweed at Montrose. Early in the season all weeds in the 60#N and 120#N plots were smaller than the weeds in the check plots.

Sinox gave good control of the dicots but little control of the grasses at State College.

Number of weeds in 16 square feet and the percentage reduction of weeds with pre-emergence weed control in corn.

Treatment	Rate per Acre	Rate per acre over the row	State College				Montrose	
			Monocots		Dicots		No. Weeds	% Reduc-tion
			No.	% Reduc-tion	No.	% Reduc-tion		
Check			166		88		227	
2,4-D Acid	1#	3#	42	75	3	97	64	72
	2#	6#	20	88	0	100	46	80
	3#	9#	9	95	0	100	15	93
2,4-D Acid + 20# N	2#+20N	6#+60#N	15	91	1	99	50	76
Iso-propyl ester (Esteron)	1#	3#	35	79	0	100	102	55
	2#	6#	39	77	0	100	58	74
	3#	9#	10	94	0	100	36	75
CaCN <sub>2</sub> No Cult.	30#N 60#N 120#N		166 81 61	0 51 63	15 10 8	63 89 91	198 167 112	13 26 51
CaCN <sub>2</sub> No Cult. Raked in	30#N 60#N 120#N		138 57 113	17 65 32	28 14 4	68 84 95		
Defoliant CaCN <sub>2</sub> No. Cult.	30#N 60#N 120#N						177 183 175	22 19 23
CaCN <sub>2</sub> Omit 1st. Cult.	30#N 60#N 120#N		116 121 29	30 27 83	26 19 2	70 78 98	237 204 177	4* 10 22
CaCN <sub>2</sub>	10#N 20#N 40#N	30#N 60#N 120#N	67 169 93	60 1* 44	25 18 13	72 80 83	183 196 180	19 14 21
Defoliant CaCN <sub>2</sub>	20#N	60#N	139	18	6	93	109	52
Sinox	2/3 gal. 4/3 gal.	2 gal. 4 gal.	121 155	27 7	19 2	78 98	179 159	21 30
H <sub>2</sub> SO <sub>4</sub>	2/3 gal.	2 gal.	282	70*	55	38	225	1
Stoddard Solvent	120 gal. 26.6 gal.	80 gal.	504 486	203* 192*	59 88	33 0		
NH <sub>4</sub> SCN <sub>2</sub>	20#N	60#N	No weeds, No corn					

\* Per cent increase over check plots.

FROM THE FLOOR: When is the best time to put the pre-emergence treatment on corn?

MR. RALEIGH: This pre-emergence is very new. New Jersey tried it out two years ago and we tried it out this past Summer. We take the attitude that the time to put on pre-emergence treatment on corn is the day of planting.

That may be right or it may be wrong, I don't know. Something has to be worked out. It certainly is a lot easier to put it on the day of planting if you can from a practical standpoint.

#### Pre-emergence Control of Weeds in Corn with Cyanamid

Dale E. Wolf  
Rutgers University

It was two years ago that we tried our pre-emergence weed control with 2,4-D in New Jersey and found it worked quite successfully. It was only this last year that we started the pre-emergence weed control with cyanamid in corn.

The possibility of controlling weeds in corn with the use of cyanamid was investigated at the New Jersey Agricultural Experiment Station in 1947.

The following data are pertinent to the experiment:

Corn Hybrid Used - U. S. #13.  
Date of Planting - May 9.  
Cyanamid Applied - May 9.  
Spacing of Checkrowed hills in inches - 42 x 42.  
Soil - Between a sandy loam and loamy sand.  
Soil analysis - Sand 79 per cent  
                  Silt 9 per cent  
                  Clay 10 per cent  
Soil Temperature - 52° F. at time of planting.  
Soil Moisture - 0.25 inch of rainfall fell on May 6.  
                  Soil was moist at time of planting.  
Fertilizer - 850#/A 5-10-10 broadcast and disced  
                  in April 21, 1947.  
Rainfall Record - May 6, 0.24 inch; May 13, 0.04;  
                  May 14, 0.12; May 18, 0.27; May 19,  
                  0.07; May 20, 0.96; May 21, 0.40;  
                  May 22, 0.11; May 23, 0.77; May 24,  
                  0.01; May 26, 0.55; May 30, 0.76;  
                  June 9, 1.75; June 14, 0.72; June 21  
                  0.53.

<u>Plot No.</u>	<u>Material</u>	<u>Rate</u>	<u>Treatment</u>
1	Granular Cyanamid	- 150 lbs./acre	- not raked
2	Granular Cyanamid	- 150 lbs./acre	- raked
3	Granular Cyanamid	- 300 lbs./acre	- not raked
4	Granular Cyanamid	- 300 lbs./acre	- raked
5	Granular Cyanamid	- 600 lbs./acre	- not raked
6	Granular Cyanamid	- 600 lbs./acre	- raked
7	Check - untreated	- weeds kept down by normal cultivation	
8	Pulverized Cyanamid	- 150 lbs./acre	- not raked
9	Pulverized Cyanamid	- 150 lbs./acre	- raked
10	Pulverized Cyanamid	- 300 lbs./acre	- not raked
11	Pulverized Cyanamid	- 300 lbs./acre	- raked
12	Pulverized Cyanamid	- 600 lbs./acre	- not raked
13	Pulverized Cyanamid	- 600 lbs./acre	- raked

Weed counts were made June 9, 1947. The following table gives the weeds/sq. ft. in the plots:

<u>Plot No.</u>	<u>Mean Weed Count</u>	<u>Per cent of Check</u>
1	43	53
2	46	57
3	31	38
4	34	30
5	7	9
6	11	14
7	81	100
8	62	61
9	57	70
10	37	46
11	46	57
12	24	30
13	37	46

There was no difference in type of weeds present in these plots. The only difference was in the height of weeds. The weeds present in the plots which received the higher rates of cyanamid averaged 2 inches tall while the weeds in the control plot averaged 8 inches. Those weeds present were: ragweed, pigweed, Pennsylvania smartweed, lambs-quarter, crab grass, nutgrass.

Plots were cultivated twice on June 10. These completely ridded the plots of all weeds.

The treatment had no noted effects on the plants at the time the weed counts were made. Definite nitrogen stimulation was noted the last of June in the plots which received cyanamid. The plots receiving higher rates had a good dark green color and were taller while the check had a light yellow color due to lack of nitrogen.

The plots were harvested on October 21, 1947. The computed yields are in terms of No. 2 shelled corn at 15.5 per cent moisture. Yields are given in the following table:

<u>Plot No.</u>	<u>Yield in bu/acre</u>
1	48.9
2	62.5
3	67.2
4	77.9
5	82.5
6	77.0
7	37.1
8	49.1
9	43.3
10	56.0
11	54.3
12	78.9
13	71.4

These data were analyzed using R. A. Fisher's analysis of variance. The difference between means required for statistical significance is 19.3 bushels at the 5 per cent level and 26.1 bushels at the 1 per cent level.

The first and possibly the second cultivation were eliminated by the cyanamid treatments in this test. The number of weeds were reduced and also those weeds present in the cyanamid treated plots were smaller than those in the check plot.

Granular cyanamid gave better weed control than the pulverized cyanamid but there was no significant difference in the plots raked and those not raked. Yield records indicate that the 300 lbs./acre granulated cyanamid and the 600 lbs./acre granulated and pulverized cyanamid treatment gave significantly higher yields than the check plot.

The plots treated with granulated cyanamid yielded consistently higher than those treated with pulverized cyanamid.

FROM THE FLOOR: Was there any cultivation in any of the plots except the check plots?

MR. WOLF: All the plots were cultivated about one month after the corn was planted on June 9.

FROM THE FLOOR: This is not a question but I would like to remark that we had practically the same test in Rhode Island and the results are practically the same as you have.

"Pre-emergence Spraying With 2,4-D to Control Weeds in Corn  
at the New Jersey Agricultural Experiment Station"  
J. C. Anderson, Rutgers University

Preliminary work done in 1946 has been reported in the Journal of the American Society of Agronomy.

In 1947, an experiment was set up using four field corn hybrids, U. S. 13, N. J. 4, Ohio C88, and Pioneer 332. On these were imposed three rates of application: 1-1/2, 2-1/2 and 3-1/2 pounds of 2,4-D acid per acre. On half of the plots applications were made at the time of planting and on the other half eight days later.

This application was to have been made on the sixth day but rain interfered. The test, located on a Sassafras loam, was completely randomized and replicated four times. The sodium salt of 2,4-D was applied in about 150 gallons of solution per acre.

Broad-leaved and grass weeds of the annual type were in general well controlled. In this respect, the later treatment was considerably better than that at time of planting. The difference may have been due to the 2-1/2 inches of rain which fell between the fifth and seventh days after planting. The treated plots were given no cultivation during the growing season while on the check plots weeds were well controlled by cultivation and hoeing.

The best treatment in the test was 1-1/2 pounds of 2,4-D applied eight days after planting. All four hybrids receiving this treatment yielded as well as the checks. Average yields from plots treated at the time of planting were significantly less than from those treated eight days later.

Rate of application had little effect on yield. However, since 14,000 kernels were planted per acre, the most depleted stand left adequate plants to produce good yields.

Seedling emergence, which is not necessarily synonymous with germination, demonstrated the most sensitivity to the use of 2,4-D. Emergence ranged from 94 per cent for the check to 77 per cent for the 2-1/2 and 3-1/2 pound rates.

Damage to seedlings was significantly less for the latter treatment. Resistance of the corn seedling to 2,4-D appears to increase markedly up to eight days after planting. A duplicate test placed on a loamy sand failed miserably and was abandoned. The seedling emergence was only about 50 per cent and the weed control unsatisfactory.

The differences between replications on the loam in such things as seedling emergence, seedlings affected and moisture in the grain indicate that soil factors are of major importance. The differential reaction of the hybrids indicate that they should be tested before pre-emergence is used on them on a field scale.

In summary it appears that the more important factors to be considered in pre-emergence weed control with 2,4-D are time of application, soil type, rate of application, choice of hybrids, and amount and time of rainfall. All these need much more study.

FROM THE FLOOR: Dr. Anderson, based on your experience would you suggest a heavier than normal planting rate as a good practice?

DR. ANDERSON: I don't believe so.

FROM THE FLOOR: How long after planting does the corn come up generally?

DR. ANDERSON: About seven days.

CHAIRMAN VAN ALSTINE: You said before that the best treatment was 2,4-D applied eight days after planting. But you also said that it rained in the meantime.

Now if it did not rain in the meantime, would that change your opinion?

DR. ANDERSON: It probably would. It seems to me, just theorizing on it, that the reason we got such good results on the eight days is that the weed seed in this upper half or 3/8-inch layer of soil had reached a most critical period as far as the treatment of 2,4-D was concerned, and then we probably had an immediate killing of these weed seeds, and the corn seedlings were in a relatively high state of tolerance or resistance.

FROM THE FLOOR: I wonder if any of the gentlemen from the stations here have had any experience in controlling weeds and soybeans pre-emergence methods?

DR. WILLARD: I can cite two experiments in which one and two-tenth pounds acid equivalent killed the soybeans, and one in our department in which 6 pounds did not injure the soybeans.

We had beautiful soybeans and beautiful weed control. Now I have no way of reconciling these things. I have talked it over with F. L. Timmons last week and he reported that he had lima beans, soybeans and several others and that if you could plant them, put 2,4-D on at the time of planting and you did not get a rain before they came up they would come through beautifully. But if you could get a rain before, it was goodbye beans. That checks with my observation. Again do not ask me why.

The meeting of the Northeastern Weed Control Conference on Fruit, Nursery and Ornamentals convened at 10 o'clock a.m., February 13, 1948, in the Grand Ballroom of the Hotel Commodore, New York City, N. Y., Dr. A. E. Prince presiding.

"Some Problems on Weed Control in Maine Blueberries"  
A. E. Prince

There are approximately 50,000 acres of land in Maine that produce the commercial blueberry crop. About one-third of this area is in production at a time because of the practice of burning about every three years. The average annual yield is over 200,000 bushels, which are valued at over a million dollars. The commercial growing area is mostly within twenty miles of the coast in the eastern counties.

The blueberry plants are essentially wild because they have grown in naturally, often following fires, as one of the first succession plants along with other indigenous woody and herbaceous species. These other woody and herbaceous plants make up the weeds in blueberries.

Some growers have been able to keep weeds at a minimum by burning, pulling, cutting and stubbornness. Burning every two or three years is a standard practice in blueberry growing, a practice that aids in keeping weeds down, but frequently the weeds survive better than the blueberry plants. Hand cutting and pulling is often done, but the next year there may be two or more sprouts where there was only one the year before.

These weeds compete with the blueberries for space, nutrients, moisture and light and not only reduce the crop in this way, but also pickers do not like to rake blueberries in weedy areas.

Experiments in weed control by Chandler and Mason in the 30's show, among other facts, that alders cut in July and August sprouted less than when they were cut at other times of the year and that sweet fern could be nearly eradicated after three successive years of cutting. It was also shown that certain chemicals had a costly but definite place in the weed control program. When the 2,4-D herbicides were introduced, they offered a new outlook to the weed control problems.

During the summer of 1946 some of the 2,4-D herbicides were tried on a small scale both commercially and experimentally. First results indicated that plants such as alders, birch, sweet fern and some willows could be easily killed, while others like bunch berry, wintergreen and brake fern were little if at all injured. It is plants like bunch berry, wintergreen, choke berry and sugar plum that cause double trouble to growers, because the fruits of these are frequently raked with the blueberries and have to be picked out by hand before the blueberries can be frozen, put into cans, or sold as fresh fruits.

One of the more important observations from the 1946 trials indicated that while some 2,4-D formulations caused considerable injury to blueberry plants, other formulations seemed less injurious. Because all materials tried gave some injury to blueberry plants, overall treatments were considered out of the question, but the standard practice of burning blueberry lands every two or three years offered a chance to use these materials effectively.

This can be done by spot spraying susceptible weeds plants the year of the burn when the weeds and blueberry plants are just sprouting. At this time the weeds are small, succulent sprouts which can be easily sprayed with a small amount of material and with minimum damage to blueberry plants.

With these things in mind, plans for 1947 were prepared.

With a full-time assistant to help, an attempt was made to try all of sixteen materials on each of twenty-five woody and herbaceous weeds which could be found on land burned last spring at the new blueberry farm. In most cases at least three individual plants or clumps were treated with each material and marked with wire stakes to which numbered metal tags were attached, all of which will facilitate observations next year. In addition, all the weeds in small, marked areas were treated with some of the materials and in all cases blueberry plants were treated so that the effect of the herbicides on them can be determined.

The materials included fourteen 2,4-D materials, of which seven were dusts, Solvasol and Handy Kill, the latter being an arsenical preparation. Ammonium sulfamate was tried on a few weed species known to be very resistant to the 2,4-D materials.

Since a water supply is not available on many fields the 2,4-D dusts seemed to be what we were looking for, but it was found that even though the weeds were dusted while they were wet, when they dried the dusts drifted, causing some injury as far as fifty feet away from treated plants. It will be next year before the permanence of the injury can be determined.

What we are looking for is a material that will kill all the weeds and will not do serious harm to the blueberry plants. To date none of the materials tried will kill all the weeds, and all materials cause some damage to the blueberries.

From our experience in 1946 we learned that notes taken in the fall, two months after treatment were not final because some plants listed as dead were found sprouting and others listed as uninjured were found dead in July 1947. Because of this, final notes on our 1947 work cannot be taken until next summer.

"Response of Woody Ornamentals to 2,4-D"  
A. M. S. Pridham

The effect of 2,4-D on deciduous types in spring and summer has been discussed in previous papers. The curling of foliage, distortion of twigs and death of growing points is familiar.

The effect of 2,4-D applied to mature deciduous foliage is often negligible while the growth from buds on branches so sprayed is less well understood. It was described in 1946.

The present paper concerns purposeful spraying of a number of individual branches of deciduous trees and shrubs with 2,4-D at the usual volume concentration amounting to 1.6 pounds to the acre in 200 gallons of water. These sprays were applied in one experiment prior to leaf fall and in a second after leaf fall in 1946. Injury to 1947 foliage was, with three exceptions eliminated by spraying after leaf fall. Numerous species and varieties were injured in 1947 by 1946 sprays prior to leaf fall.

In a third experiment the amount of 2,4-D applied was reduced in regular series of five steps each reduced to one-half the preceding and starting with 1.6 pounds at 200 gallons to the acre. Spraying was done before leaf fall in 1946. Injury in 1947 was definite at 1.6 pounds, 0.8 pounds and 0.4 pounds to the acre but not frequent or severe at 0.2 pounds and was not discernible at 1/10 of one pound per acre, 200 gallon volume per unit of leaf surface applied directly. Oaks were the most severely injured and demonstrated the only case of apparent translocation beyond the point of spray application to individual branches.

2,4-D injury to narrowleaf evergreens, especially to *Taxus*, was studied in a series of three experiments.

Amounts ranging from 1.6 pounds of acid equivalent 2,4-D per acre in 200 gallons of water to 320 pounds per acre produced no injury during the year of application, 1946. Annual growth in 1947 ranged from normal growth in plots of 1.6 up to 16 pounds per acre to sharply reduced growth when larger amounts of 2,4-D were applied. A few plants were killed when amounts in excess of 100 pounds of 2,4-D per acre were used.

In a second experiment the same rates of application were followed but the spraying was done in March 1947 while the plants were still dormant. Reduction in growth occurred but no mortality.

In a third series of experiments described in 1946, *Taxus media Hicksii* was planted bare root in July in soil sprayed with up to 100 pounds to the acre of 2,4-D during fitting. In these experiments mortality in 1946 or 1947 did not significantly exceed that in untreated plots. Year old potted cuttings of *Taxus cuspidata* planted in the same plots as *T. m. Hicksii* showed no mortality in 1946 but from 3 to 4 times the mortality in 1947.

### Summary

Injury to woody ornamentals from 2,4-D can be minimized or eliminated by spraying during the dormant period. Weed control in lawn, golf course, park and highway areas during winter is a real possibility. Weed control in the nursery during the winter is another distinct possibility. The treatment of soil to eliminate fleshy rooted perennial weeds is a possibility among woody plants. The amount of 2,4-D to accomplish these objectives appears to be 5 to 10 pounds per acre. Perennials could not be weeded safely with 2,4-D as a herbicide.

#### "Control of Weeds in Strawberries with 2,4-D" Frank Gilbert, Rutgers University

New Jersey strawberry growers are confronted each year with a weed and grass control problem during the first growing season that the plants are in the field. Removal of these weeds by the conventional methods of machine cultivation and hand hoeing is time-consuming, often hindered by spring rains, and is becoming increasingly expensive. The growers have estimated that it costs them from \$40 to \$100 per acre to keep a strawberry field reasonably free from weeds during that first season.

In view of these facts, it is imperative that we should investigate all methods of weed control by the use of selective weed killers.

In the report of the Policy Committee of the North Central Weed Control Conference on Herbicides, December 13, 1946, the wild strawberry, Fragaria americana, was reported as being resistant to 2,4-D. This was a good indication that many of our cultivated varieties would be, at least, tolerant to this weed control chemical.

R. F. Carlson, Michigan State College, East Lansing, Michigan (1) conducted some preliminary experiments with 2,4-D in 1945, and expanded his work to include thirteen strawberry varieties in 1946. The concentrations of 2,4-D which Mr. Carlson used were 400, 800, 1200, 1600, 2000 and 2400 parts per million. His experiments indicated that under certain conditions, 2,4-D might be safely applied at the rate of 1000 parts per million to strawberry plantings to eliminate weeds.

Favorable results have also been reported by C. E. Otis, Dow Chemical Company, with a mixture of Diesel oil fortified with Dow General Weed Killer. (2) However, these were preliminary tests and definite recommendations have not been made.

In order to conduct a preliminary study of the effects of 2,4-D on the Sparkle and Pathfinder varieties, experimental plots were set up in the spring of 1947 by the writer and Mr. Dale Wolf, Farm Crops Department, at the New Jersey Experiment Station. Twenty-four plots 20' x 20' were staked out, and the following sprays applied:

\* 6 plots 2 lb. 2,4-D/A pre-planting - May 1, 1947.

6 plots 1 lb. 2,4-D/A sprayed on both weeds and plants - June 20, 1947.

6 plots 1.5 lb. 2,4-D/A sprayed on both weeds and plants - June 20, 1947.

\*\* 3 plots 1 lb. 2,4-D/A sprayed on both weeds and plants - September 17, 1947.

\* The treatments were triplicated with each of the two varieties, which accounts for the six plots in each treatment.

\*\* The three plots sprayed on September 17, 1947, were the three Sparkle plots previously sprayed just prior to planting.

The plots treated on May 1, 1947 and June 20, 1947 were sprayed at the rate of 150 gallons to the acre using the sodium salt. The plots treated on September 17, 1947, were sprayed at the rate of five gallons to the acre with the triethanolamine salt.

#### Observations:

1. The pre-planting spray of 2 lb./A 2,4-D retarded the growth of grasses and weeds for approximately 6 weeks without any noticeable effect on the plants.

2. The plots which were sprayed on June 20, 1947, had many broadleaved weeds plus a rather abundant growth of grass. Both of the sprays eliminated the broadleaved weeds but had little if any effect on the grasses. The plants in these plots showed no typical 2,4-D injury. However, the growth of the strawberries was retarded by the competition from the grasses.

#### Conclusions:

As previously stated the tests conducted in 1947 were only preliminary tests. Also, there are no yield data as the plants will not fruit until the spring of 1948. Therefore, no definite conclusions can be presented at this time. However, from the reaction of the plants to sprays of 2,4-D, it is the writer's opinion that the Sparkle and Pathfinder varieties will respond favorably to the following sprays:

1. A pre-planting spray applied just prior to setting the strawberry plants in the field.
2. 2,4-D sprays applied during the first year that the plants are in the field, for the control of broadleaved weeds.

The program will be expanded at the New Jersey Experimental Station with the hope that definite recommendations will be possible at the conclusions of the tests in 1949.

#### Literature Cited

- (1) Carlson, R. F. Control of weeds in strawberry plantings by the use of 2,4-dichlorophenoxyacetic acid. Proc. Amer. Soc. Hort. Sci. 49: 221-223 1947.
- (2) Otis, C. C. Strawberry weed-control in the Pacific Northwest. Down to Earth. Vol. 3, No. 3 Winter 1947.

We are just doing some preliminary work and are going to expand our program quite a bit in checking the different chemicals and times of application, so that probably in another year we will have a little more of a picture on the strawberries growing in New Jersey.

I think in some of the other papers we note that there is a difference in strawberry varieties, so I do not think we are going to be too safe in coming out and saying you can spray all your strawberries with such and such a spray at such and such a time. We will have to find out whether those varieties are resistant to 2,4-D.

FROM THE FLOOR: How do you plant them?

MR. GILBERT: Just made small holes and tried to disturb the soil as little as possible.

That is one of our plans for this year. We are going to try to commercialize it.

CHAIRMAN PRINCE: I might inject something in here: I tried weed control on strawberries, too, and had triplicated plots. I made note to begin with the comment that there are some weeds and grasses resistant to 2,4-D. I did not go back for a month, and it was the worst weed patch I have ever seen.

There is no practical weed control where the weeds are resistant to 2,4-D.

"Chemical Weed Control in Massachusetts Cranberry Bogs"  
C. E. Cross, Cranberry Experiment Station,  
East Wareham, Mass.

I am very much impressed in hearing the other papers at this Weed Control Conference. Apparently chemical weed control is largely 2,4-D. 2,4-D is practically specific for cranberry vines. In the report that I am to give you there is no mention made of 2,4-D, and that is the reason why there is not.

There has been a definite weed control project at the Cranberry Station on Cape Cod since 1935.

Before I attempt to tell you something about our weed control measures, you ought to know a little something about this cranberry business in Massachusetts. I am not here to advertise cranberries nor to publicize them, but in order to understand the problems that we face and the need for applications which you would consider very expensive, I think you ought to know a little something about how we raise these things.

For one thing, the cranberry plant itself rarely gets over eight or ten inches high. It is a vine which produces both runners like the strawberry and uprights. It is on the uprights that we get our fruit.

A bog is planted in hills; individual cuttings are placed a foot apart, and it takes four or five years for the cranberry plants to vine in the entire area. No paths are left. If you want to go out into the bog and pull a weed, you trample the plants going out there. Spray hoses dragged into the bog are bound to do a lot of injury, and you have heard that some of us are using helicopters and straight-winged planes for our applications in bogs.

Over half of the crop in Massachusetts was treated with helicopters and straight-winged planes last year.

Some of you may think that these cranberries were present in wild bogs when the Pilgrims came and exist more or less in the same condition today. That is not true. There are wild bogs, and there are many people who gather wild cranberries in every state in New England, and there are a lot of them, but it is nothing compared to the actual crop being cultivated.

There are 15,000 acres of cranberry bogs; in Massachusetts -- today in excess of that. Another thousand acres will be planted next spring.

These bogs represent perhaps the most intensive form of agriculture in the country today. The valuations are very high. The amount of labor necessary to raise cranberries is very high. I heard a thorough-going discussion before cranberry growers not long ago, where it was stated that it cost \$3,500 to set out and bring into bearing condition an acre of cranberry bogs.

Mature bogs are selling for \$3,000 to \$5,000 an acre. That price is not one of these bonzana affairs that sprung up, particularly in 1946. It is based on the actual cost of production.

Hand-pulling of weeds not only causes a lot of mechanical injury to cranberry plants but is excessively expensive, and so we have attempted to find chemical controls, and I think you will understand that all the controls that are of any real help must be selective. Whatever we use for weed control in the way of chemicals has to be tolerated by the cranberry plants to such an extent that they will flower and fruit despite the treatment.

I want to discuss a chemical that is in great use. We buy it in carload quantities even today, despite the fact that Dr. Kephart yesterday told us that it was rather an outmoded treatment, at least for oats.

We use ferrous sulphate. It is inorganic -- as a matter of fact, you will not find many organics in my discussion at all -- but used as a dry sugar of iron, it can be scattered in great quantities on a cranberry bog without causing injury.

As a matter of fact, I notice a definite increase in the amount of chlorophyll in vines treated with it.

Dry ferrous sulphate can be broadcast at the rate of 3,000 to 8,000 pounds per acre in or out of the rapid growing season. Cranberry vines should be dry at the time of application, but rain must fall within ten days to make the treatment effective on weeds. Reliance on rainfall can be avoided either by sprinkling the treated area with water or by mixing a small quantity of common salt with the ferrous sulphate.

3,000 pounds per acre will kill hair-cap moss (*Polytrichum*), sand spurrey (*Spergularia*), arrow-leaved tear-thumb (*Polygonum*), and seedling pitchforks (*Bidens*).

5,000 pounds per acre required to kill sensitive fern (*Onoclea*), marsh fern (*Thelypteris*) and cotton "grass" (*Eriophorum*).

8,000 pounds per acre is required to kill the royal and cinnamon ferns (*Osmunda*), asters, needle grass (*Elyocharis*), and lance-leaved white violets (*Viola lanceolata*).

This last heavy treatment cannot be used safely on bogs re-sanded within two years, but otherwise it appears to be a safe and truly selective method of control.

Ferric sulphate can be broadcast safely on dry, mature cranberry vines at the rate of 2,400 pounds per acre when the relative humidity is less than 50 per cent. It can never be used with safety on newly sanded bogs, or on hill cranberry vines during their first four years of growth. It is apt to occasion less injury to the vines if it is brushed off onto the bog floor as soon as broadcast, and a newly-treated area should not be walked on.

This chemical gives a more satisfactory control of the larger ferns (*Osmunda*) than does its ferrous congener. In addition, it will kill hardhack (*Spiraea*), wool "grass" (*Scirpus cyperinus*), spike rush (*Juncus effusus*), cutgrass (*Leersia*), horsetail (*Equisetum arvense*) and the smaller ferns.

Paradichlorobenzene has now been used successfully for five years in controlling noxious weeds as well as root-eating insects in cranberry bogs. Applications of 1,200 pounds or more cause no injury to cranberry vines except when applied immediately after a summer root grub flooding.

The chemical is broadcast evenly at 1,200 pounds per acre on only a few square rods at a time and is then covered immediately with an inch of sand. The finer the sand, the surer the kill of weeds.

Since mature cranberry bogs in Massachusetts are regularly sanded every three or four years, this particular feature of the paradichlorobenzene treatment brings no great expense to the cranberry grower.

Paradichlorobenzene applied in the above manner, April through August, kills in excess of 75 per cent of the poison ivy present and kills a similar percentage of the woody and very troublesome chokeberry (*Aronia melanocarpa*). The kill of loosestrife (*Lysimachia terrestris*) is also of the same order.

On wild bean (*Apios tuberosa*) and the lance-leaved white violets, however, the kill approaches 100 per cent, never quite attaining that goal because of a failure to kill along the edges of ditches where presumably the heavy vapors escape laterally from under the sand cover.

This treatment appears to be a very expensive one. However, it is the cranberry grower's only known selective control for poison ivy and wild bean, both of which weeds are capable of choking out his cranberry vines.

Occasionally it is possible with paradichlorobenzene to kill root insects and weed pests in this one treatment. It has been estimated that root-eating insects reduce the Massachusetts cranberry crop by 25 per cent annually. The cost of any treatment must be considered in the light of the value derived from it. 200,000 pounds is a conservative estimate of the amount of paradichlorobenzene to be used on Cape Cod cranberry bogs in 1948.

Following paradichlorobenzene treatment, cranberry vines show a marked stimulation. Repeated observations show healthier and more vigorous vine growth, though the reasons for this are at present unknown.

Sodium chloride: Cranberry growers use common salt at 100 pounds in 100 gallons of water to check the growth of certain weeds. It kills relatively few plants but will defoliate a large number of them, and if sprayed lightly at 200 gallons or less per acre, it will not injure cranberry vines or their flowers.

This spray is used to check the growth of wild bean, to kill the arrow-leaved tear thumb, and to prevent the flowering and fruiting of the fireweed (*Erechtites hieracifolia*). At times it gives a satisfactory kill on young stands of ragweed. It will defoliate poison ivy, small ferns and some pitchforks; but regrowth in these cases is so rapid that its value is highly questionable.

Sodium arsenate is now little used for cranberry weeding. Other materials have been found to do more satisfactory work, and growers prefer to avoid arsenicals whenever possible. It is used 1-1/2 pounds in 100 gallons of water as a light spray to control wild bean, goldenrod, and so forth, and as a defoliator like salt.

It will kill the annual partridge pea (*Cassia chamaechrista*) when sprayed in August before the weeds have set seed.

Copper sulphate has many uses in cranberry culture, and it is indeed fortunate that cranberry vines will tolerate large quantities of it. In the winter, four to six pounds of the smaller crystals are scattered on each acre of the ice-covered bogs to discourage the growth of green algae.

In the shallow flooding waters algae are apt to grow with amazing rapidity and when the flood is withdrawn leave a thick, tough covering of whitish "paper" over the cranberry vines.

The copper sulphate should be used before there has been any appreciable development of the algal forms, and repeat applications used if necessary.

Copper sulphate at 20 pounds in 100 gallons of water at 600 gallons per acre in April or May will kill all hair-cap moss. The same concentration at 400 gallons per acre in August kills the tubers and aerial parts of nutgrass (*Cyperus dentatus*). This method, with the possible exception of some oil treatments, is as striking and effective as any used in cranberry weed work.

One caution! Wash the spraying apparatus very carefully. This solution is very corrosive.

Kerosene has been sprayed on Massachusetts cranberry bogs as a more or less standard technique in weed control since 1947. The clear, water-white product is the only oil now in regular use and dosages vary from 200 to 1200 gallons per acre.

It has been found to injure weeds most and damage cranberry vines least when applied just before the start of rapid growth in May. During the active growing season, vine susceptibility and the presence of the fruit prohibit its use. The immature berries are very sensitive to oils.

In the fall, kerosene has an injurious effect on cranberry vines, which does not become apparent until the following spring, when most of their leaves usually fall.

There is a long list of cranberry bog weeds which are readily controlled selectively by kerosene treatments. Many of the grasses, sedges and rushes which grow in the bogs can be killed in this way.

Strangely enough, it is the perennials which are most susceptible, for they begin the season's growth earlier than either annuals or the cranberry vines. Many annual grasses germinate only after the cranberry vines have begun to bloom, and because of this they cannot safely be sprayed with kerosene.

Among these annuals stand *Panicum verrucosum*, *Panicum dichotomiflorum*, *Echinochloa crus-galli* and *Digitaria sanguinea*, all of them costly weeds. There are at least six species of *Junius* easily killed with 400 to 600 gallons per acre, eight species of *Carex*, three species of *Scirpus*, and the monotypic *Dulichium*. Cut-grass (*Leersia oryzoides*) and several species of *Glyceria* can be killed only with 600 to 800 gallons of kerosene per acre.

Among the dicots, loosestrife (*Lysimachia terrestris*) can be killed with 600 gallons per acre in May, and likewise the hoary alder (*Alnus incana*) and the sweet gale and bayberry (*Myrica*). Horsetail (*Equisetum arvense*) can be killed only with heavy kerosene applications approaching 1,000 gallons per acre.

Many other oils and herbicides are being tested. Most promising among these is Stoddard Solvent, which appears to kill a greater variety of cranberry bog weeds but which will still be required in quantities similar to kerosene. Work with this oil must be completed before positive recommendations are made, but it looks now as though it is an excellent herbicide for asters.

FROM THE FLOOR: What is the amount of ferrous sulphate applied?

MR. CROSS: In the red form, 2,600 pounds per acre is the standard application. 2,400 is much safer.

"Chemical Weed Control in Ornamental Plantings"

A.M.S. Pridham, B. B. Robb, Peter Kaufman,  
Alfred Gianfagna, Fred Gordon, P. J. Ketchum  
and John Keller.

Over a period of several years we have conducted a large number of chemical experiments dealing with problems in weed control in ornamental plantings. The results of some phases of this work, at various stages of progress, have already been published. More complete data on these aspects, as well as the results of numerous related lines of inquiry, will appear in various papers in the near future. My purpose today is to summarize the results of some of the newer work.

Weed control in ornamental plantings has many more ramifications than that with vegetables, cereals, and other crop plants. We must observe the reactions to chemicals of many more crop plants of many more kinds of annual, perennial, and woody weeds. The diverse types of cultural conditions require varied approaches and standards of success, equipment for spray applications must be more adaptable to a variety of conditions.

Two general situations exist in nursery and ornamental plantings (1) The nursery or border type of planting with bare soil for all or part of the year, often with the desirable plants or crops in rows; (2) mixed groups of desirable and undesirable plants, not in orderly arrangement, and usually with a natural or artificial ground cover. To be practicable, a chemical treatment should not seriously or permanently injure the soil and should eliminate the weeds without excessive injury to the desirable plants. The amount of injury to the economic value and appearance of the desirable plants varies with the purpose for which the plants are being grown.

For the purposes of organization, weed control methods can be classified as pre-planting treatments, pre-emergence or dormant treatments, and post-emergence treatments.

Pre-planting treatments are based on the premise that soil should be free of parts of woody and herbaceous plants that serve as cuttings in propagation of these plants. It also includes the possibility of eliminating viable weed seed as well.

Present practices include plowing, fitting of the land. They also include several methods of soil sterilization for disease and pest control which also eliminate weeds. The practice of composting soil falls in this category. It is a time-honored practice in all phases of ornamental horticulture.

These practices accomplish the elimination of weeds prior to planting. They do it in varying degrees of efficiency.

The use of 2,4-D for preplanting treatment is based on the experimental fact that when storage organs and seed also are immersed in or in contact with a solution of 2,4-D acid equivalent of  $10^{-3}$  to  $10^{-5}$  (1000 ppm. down to 10 ppm) these growth potentials are likely to be eliminated.

Calculations can be based on the generalization that soil to plow depth weighs 2 million pounds and that under moisture conditions for good growth it will contain 2 million pounds of water. The weight of 2,4-D needed to bring about required results, the elimination of growing points, can easily be determined as a minimum of 20 pounds and maximum of 2000 pounds.

When amounts bracketing the 20 pounds per acre were applied to the soil at the time of plowing so that roots were exposed, good control of quack grass was obtained in 1946. Other weeds of this type controlled under field plot conditions include Artemisia vulgaris and northern nut grass (Cyperus esculentus). Phragmites was eliminated under laboratory conditions. Ammonium thiocyanate and carrot spray (Stoddard's Solvent) were also effective, the latter on nut grass.

The elimination of viable seeds has been less successful but drastic reductions in weed populations have resulted. The 2,4-D applications have been based on the theory that weed seeds that germinate are found in the upper 1/4 inch of soil. To bring this volume of soil to  $10^{-5}$  only 1/28th the poundage of 2,4-D is required. Laboratory and field tests correlate better with  $10^{-4}$  as a basic figure. The larger amount may be due to loss of 2,4-D from the surface layer by leaching, adsorption, evaporation or consumption.

To determine the effects of adequate soil treatments on ornamentals planted immediately in the 2,4-D-treated soil. Taxus was used in rather extensive trials. The results indicate clearly that soil treatments giving good control of such weeds as quack grass had no harmful effect on either T. cuspidata or T. media Hicksii. Injuries were noted only when much heavier applications were made.

Since seeds as well as some ornamental plants that might be placed in treated soil are less tolerant of 2,4-D than is *Taxus*, the possible residual effect is important. Certain plants especially sensitive to 2,4-D injury show progressive structural changes as the 2,4-D concentrations of the soil increases. These correlations can be plotted graphically. Thus the reactions of such test crops as beans, cucumber, and zinnia have served as a reliable index for estimating the concentration of residual herbicide in the soil.

Using beans as a test crop, it was found that 2,4-D disappeared from medium and heavy soils within 60 days and from sandy soils within 90 days. The 2,4-D acid is apparently the most persistent form. 2,4-D on table, tools, glassware, etc. remains a year or more.

Since leaching experiments failed to clear the soil of 2,4-D, its disappearance is apparently due to some other factor.

Satisfactory control of perennial weeds by pre-planting treatments is restricted to applications following plowing. Treatments made in the fall are effective and leave the soil free of toxicant for spring planting.

#### Pre-emergence

The second group of experiments has to do with the control of annual weeds by treatments prior to the emergence of seedlings of ornamental plants or prior to the emergence of foliage from buds in bulbs or twigs. These we call pre-emergence or dormant treatments.

Pre-emergence control applies to nursery crops, park, cemetery, wood land and to highway plantings or to shrub areas on home grounds that are not planted to garden flowers. Pre-emergence spraying may be adapted to crab grass control in cases where turf is not sufficiently dense to shade out seedlings.

When seeds are immersed in solutions containing 10 to 100 ppm. of 2,4-D the establishment of seedlings is eliminated. This appears to be a general property of many growth regulators and applies to all 2,4-D formulations yet tested as well as to idolebutyric and naphthalene acetic acids. Exceptions are triiodobenzoic acid, 2,4-5 trichlorophenoxyacetic acid, and 3,4-dimethylphenoxyacetic acid.

In numerous pre-emergence field trials 2,4-D was applied to the soil surface in amounts calculated to bring the soil solution (at field capacity) in the germination zone to a lethal concentration. The potential stand of weeds from seeds in ornamental plantings has been greatly reduced. Crab grass seeds are affected in the same manner as the seeds of other annuals.

Pre-emergence treatments are most effective in late winter, prior to the period of increased root activity in woody ornamentals. This probably carries a lethal concentration into the growing season for both weed seeds and ornamentals. Seeds absorbing water prior to germination take up enough 2,4-D to prevent the emergence of seedlings. This method of weed control appears to be most effective on sandy soils. In such soils the residual effect of 2,4-D is the longest.

Chemicals other than growth regulators have also been tested. The emergence of seedlings was prevented in laboratory tests by sodium arsenite at 100 to 1000 ppm., by PMAS at 1000 ppm. but not by sodium chlorate at 1000 ppm. Sodium arsenite in these concentrations was effective in the field. PMAS and sodium chlorate have been tested and are less effective under field conditions.

#### Post-emergence

The third type of treatment, post-emergence, relates to the control of seedlings or mature weeds as they occur in mixed populations. The differential action of the herbicide on weeds and desirable plants depends on the amount of herbicide entering into the action at the stage of growth when the application is made. Thus we must choose the chemical that will do the least damage to the desirable plants and to the soil at the time selected for applying the treatment.

Post-emergence control of weeds among herbaceous ornamentals is confined largely to turf areas. Chemical weed control is best known through such use. Tests have been made concerning both the concentration and the volume of the 2,4-D spray required.

It is of practical significance that some very conspicuous weeds like plantain, dandelion and ragweed can be effectively controlled by spray concentrations of 1/4 the strength usually recommended for turf work. The perennials, plantain and dandelion, can be controlled adequately by annual late fall or early spring applications.

The question arises as to what will happen to a lawn that is sprayed repeatedly with 2,4-D at 1.6 pounds per acre or to one sprayed with more than 1.6 pounds per acre. Tests were run in 1946 using 1.6 pounds per acre and 6.4 pounds per acre of 2,4-D acid equivalent in 1, 2, 3 and 5 applications. Repeated applications at 1.6 pounds per acre injured the grass and at 6.4 pounds per acre virtually eliminated it. In 1947 no further treatments were made but all of the 1.6 pound plots are now estimated to contain within 10% as much grass as the controls. Serious injury is still evident on plots that received repeated applications at the rate of 6.4 pounds per acre. Weed populations have come into the bare areas. These plants are largely clover (a hard-coated seed needing scarification), plantain (a seed with mucilaginous seed coat), and crab grass (which seeds late in season). The crab grass was probably introduced from mowing or from seeds coming nearer to the soil surface after sheet erosion.

The volume of spray applied to a given area apparently makes no difference so long as the same amount of 2,4-D per acre is used.

Because of the potential advantages of low-volume sprays, we have made extensive studies of methods of application.

Conventional high volume spray equipment has serious disadvantages. Among these are drift injury, water supply, high cost of equipment, and lack of speed and flexibility. Low volume sprays applied as small droplets at low pressure (20 pounds per square inch) through appropriate nozzles correctly spaced and correctly placed on a boom mounted close to the ground. Under these circumstances drift is minimized and adequate coverage assured for efficient weed control. The problem of water supply is greatly simplified. It appeared that the remaining serious disadvantage of high-volume sprays could be eliminated if the heavy, expensive pump became unnecessary.

The pump required for pressure in conventional spray equipment was eliminated by the use of a carbon dioxide cylinder as a source of pressure. Thus almost any vehicle can be used to transport the necessary apparatus for spray applications - a spray tank of small capacity fitted with a "pop off" safety valve, a CO<sub>2</sub> cylinder of convenient size and a regulator valve.

An obvious application of this light weight equipment is on a reel-type or sickle-bar mower. The cutting action of the blades slightly increases the effectiveness of 2,4-D and the falling clippings suppress drift without decreasing the effectiveness of the spray material. The 2,4-D spray is effective whether applied before, during, or after mowing and the pattern of mowed and unmowed grass provides the operator with a simple guide not otherwise available. The necessary equipment can be mounted on almost any type of mower, from the hand mower to the largest gang mower. Mounting of the spray boom in front of the advancing blades is most convenient.

An ordinary 18 inch hand mower was fitted with a 2 nozzle boom, each nozzle with a 22/1000 aperture. With a pressure of 20 pounds per square inch, and assuming that the operator averages 3 miles per hour, the Cornell spraymower will cover 1/2 acre per hour, will discharge 6 gallons of spray material, and use 1/2 pound of liquid carbon dioxide. With liquid carbon dioxide at 75 cents per pound in a one pound cylinder, the pressure cost would be 75 cents per acre. A hand pumped garden sprayer can be used as a substitute on the same mower. This eliminates the cost of the carbon dioxide, but at a great increase in labor cost and inconvenience.

Under many conditions a gang mower cutting a 10 foot swath can easily average 5 m.p.h. Using Cornell spraymower equipment with a 10 foot boom fitted with 10 nozzles, this equipment in one hour will discharge 30 gallons of spray on 6 acres and will use one pound of carbon dioxide at a cost of 50 cents per pound. Under these conditions, the pressure cost is less than 10 cents per acre. These figures were verified in practice.

The spray boom can be lengthened to fit the largest mowers used on airfields and similar level areas. At the high speeds possible under such conditions, the nozzles are set to discharge the spray parallel with the surface of the ground rather than downward upon it. It can be calculated that under such conditions the spray tank might need to carry an undiluted commercial 40% 2,4-D solution. The pressure cost approaches 5 cents per acre, and thus is insignificant.

Treatment of areas along the roads and paths in the Cornell Plantations was limited to the use of 2,4-D a month after sickle-bar mowing or scything. Thus the weeds treated were resprouts and seedlings. The 2,4-D was applied at the rate of 0.8 pounds in 100 gallons of water per acre. Weeds that were not injured include:

a) Those of guard-rail height or less.

Ajuga reptans  
Duchesnia indica  
Euphorbia maculata  
Fragaria spp.  
Oxalis spp.  
Solanum carolinense  
Viola spp.  
narrow-leaved evergreens

b) Those more than 3 feet in height regrowth.

Asclepias syriaca  
Berberis Thunbergii  
Carya ovata  
Carya cordiformis  
Fraxinus americana  
Solanum Dul camara

Poison ivy was among the plants adequately controlled by the spraying of resprout growth.

The plots, extending over some 10 acres, were judged by H. H. Iurka of the New York State Highway Department in September 1947, a month after treatment. The control plots were considered in need of mowing to meet highway maintenance standards. These standards include good appearance and safe driving conditions based on clear visibility of traffic signs and broad vision over hill crests and around curves. Plots treated with 2,4-D the previous season were judged to meet these standards.

Adaptation of Cornell spray-mower equipment to sickle-bar mowers in the autumn of 1947 gave good weed control and accomplished both weed control and the necessary mowing in one operation.

Because of time limitations my remarks on post-emergence sprays have been confined largely to the complete eradication of weeds in closely-maintained areas. For less exacting circumstances we have made extensive tests on other possibilities. These include (1) dwarfing of weeds to keep them small for easy control by mechanical means or to retain them as a harmless and advantageous groundcover; (2) spraying before the weeds flower to eliminate injurious pollens and, on other types of weeds, to preclude the possibility of seed-set; and (3) the induction of non-viable seeds by spraying before or during the fruit ripening period. Reports on progress in these various lines are being prepared for formal publication. Summaries of the practical aspects have already appeared in Science and New York Nursery Notes.

"Chemical Weed Control in Ornamental Plantings - II"  
A. M. S. Pridham and others, Cornell University

For purposes of discussion, chemical weed control measures may well be classified under three general headings. In the culture of ornamental plants, as with most other plants, these classifications are (1) preplanting treatments, (2) pre-emergence treatments and (3) post-emergence treatments.

By preplanting is meant treatment of the soil with a machine or chemical to eliminate the parts of plants involved in propagation, chiefly vegetative though the ultimate would be elimination of seeds as well. This is accomplished now by such well known methods as steam sterilization of soils.

By pre-emergence treatment is meant the control of the weed population prior to the growth of the crop. This may be done after the planting of annual, perennial or woody species from seed as in general agriculture or it may be done during the dormant period for deciduous and evergreen species in which young, soft growth is especially tender and easily injured by herbicides.

By post-emergence treatment is meant those whose success is based upon differential response of weed and crop to the herbicide or to selection on the part of the operator in applying the mechanical or chemical weed control method under field conditions. The efficiency of post-emergence methods is related to the time in the growth of the crop and the weed when the method is employed.

The present paper, on preplanting measures, is the first of a series of three summarizing our recent investigations in these types of chemical weed control. The work on pre-emergence and post-emergence control measures will be summarized in later papers.

Part I. Preplanting treatments

Our work on preplanting treatments concerns attempts at the control of three especially troublesome nursery weeds, quack grass, Artemisia and nut grass. The data on quack grass are, in part, continued observations on previous work already reported (1). The experiments on the control of Artemisia and nut grass are new.

1. QUACK GRASS

In July 1946 plots 10 x 10 feet were set up in duplicate in a heavy quack grass sod. The soil was plowed and the plot areas treated immediately with various chemicals. A detailed description of the technique and observations on the relative amounts of quack grass present on the plots on December 1, 1946 (about 5 months after treatment) have already appeared (1). Observations made in July 1947, a year after treatment, are of interest.

Observations on the ammonium sulfocyanate plots a year after treatment are shown in Table I, together with a repetition of the report on the condition of the same plots 5 months after treatment.

Table I. Effect of preplanting spray of ammonium sulfocyanate on subsequent stand of quack grass 5 months and 1 year after treatment (averages of duplicate plots).

	Gallons per acre				
	0	26(A*)	107(B*)	430(C*)	645
Relative stand 5 months after treatment	heavy	heavy to medium	0	0	0
Weight of tops in grams 1 year after treatment (from 3' x 3' center of each plot). Average of 2 plots	3710	2124	3225	0	0

Difference of 1184 required for statistical significance at 100:1

\*Letters refer to form of report previously used (1), when column headings indicated amounts in terms other than gallons per acre.

The data indicate that a single application of ammonium sulfocyanate at the rate of 430 gallons per acre has given complete control of a heavy stand of quack grass, with no regrowth within one year. That the soil sterility is only temporary is indicated by the luxuriant growth of annual weeds on all plots in 1947. This confirms the results obtained in February 1947 with test plants grown in soil samples from the same plots.

Observations on the 2,4-D plots a year after treatment are shown in table II, together with a repetition of the report on the condition of the same plots 5 months after treatment.

Table II. Effect of preplanting treatment with 2,4-D formulations on subsequent stand of quack grass 5 months and 1 year after treatment (averages of duplicate plots).

		Pounds of 2,4-D acid equivalent per acre			
		<u>0</u>	<u>20(A*)</u>	<u>40(B*)</u>	<u>100(C*)</u>
Esteron 20%	Relative stand 5 months after treatment	heavy to medium	light	a few plants	0
"	Weight of tops in grams 1 year after treatment (from 3x3' center of each plot)	3719	1008	1728	965
Stantox 20%	Relative stand 5 months after treatment	heavy	light	0	0
"	Weight of tops in grams 1 year after treatment (from 3x3' center of each plot)	4038	1154	1439	580
Methyl ester 20%	Relative stand 5 months after treatment	medium	medium to light	light	very light
"	Weight of tops in grams 1 year after treatment (from 3x3' center of each plot)	2389	1978	2398	1990

\*Letters refer to form of report previously used (1), when column headings indicated amounts in terms other than pounds per acre.

The data indicate that, while increasing amounts of various formulations of 2,4-D in preplanting treatments greatly reduced or eliminated the appearance of quack grass during the remainder of the year, the stand of quack grass increased rapidly during the second season. Of the non-volatile forms of 2,4-D tested, the acid itself

has given relatively the best control of quack grass. In no instance has a 2,4-D formulation approached the degree of control obtained with ammonium sulfocyanate.

During the first season Ammate and Cyanamid were less effective than 2,4-D, and the increase in growth even more rapid during the second growing season. The same was true with Atlas A (sodium arsenite) except when long term sterility was induced by the use of 1000 pounds per acre.

To compare the effectiveness of IPC with that of 2,4-D a series of treatments was set up. Flats of soil were planted with 4 inch stolons of quack grass, 40 stolons per flat, with the stolons 1 inch below the soil surface. Each of the two herbicides at various rates was mixed with sand and the sand spread on the surface of the flats. The flats were kept moist by surface watering and cared for indoors at 70° F. Observations on the number of shoots produced were made 30 days after treatment. Broadleaf weeds, from seeds brought in with the soil, were also counted. These data appear in Table III.

Table III. Growth of quack grass and broadleaf weeds after 30 days in flats planted with 40 stolons each (Averages of 2 flats each).

Rate in lbs./acre	Quack grass Number of shoots		Broadleaf Weeds	
	<u>2,4-D</u>	<u>IPC</u>	<u>2,4-D</u>	<u>IPC</u>
0	54	54	30	30
1	36	72	3	32
5	27	27	1	30
10	9	65	0	12
20	6	38	1	17
40	6	7	1	16
80	3	11	0	4

These data indicate that, under the conditions of the experiment, only partial control of quack grass is possible with either IPC or 2,4-D and that 2,4-D was more effective than IPC. The inhibiting effect of 2,4-D on the emergence of seedlings of broadleaf weeds is also evident.

## 2. Artemisia vulgaris

Attention was called to this weed by Alfred Gianfagna, Suffolk County Agricultural County Agent for florists and nurserymen, at the request of Long Island nurserymen, who have not been able to find satisfactory methods of control in established plantings of nursery stock.

Initial experiments were begun in October 1946 by Powers Taylor with pot cultures in the greenhouse. Four experiments were run. (1) Clumps of actively growing plants were set in pots and the tops sprayed with a range of pC 2,4-D at V = 200 g.a.l.s. (2) Ten 2 inch stolons were set in each pot and the young foliage sprayed as above. (3) Stolons were planted in soil and the surface sprayed with 2,4-D at varied pC 2,4-D at V = 200 g. (4) Stolons were planted in soil mixed with 2,4-D as compared with planting below a 2,4-D zone.

In all of these experiments four 6 inch pots were used in each treatment. Ten stolons were planted in each pot and results recorded after examination of the soil rather than on the absence of plants alone. Where 2,4-D was mixed with the soil it was spread out on a clean level surface sprayed with a fraction of the 2,4-D, then mixed mechanically with a rake, resprayed and remixed till the requisite volume of solution was used up. The soil was immediately used for potting fresh stolons in clean 6 inch pots.

Table IV. Recovery of Artemisia vulgaris 90 days after spray application.

Pounds of 2,4-D 200 gals./acre	Young foliage		Older foliage	
	Per cent plants recovering	Condition of recovered plants	Per cent plants recovering	Condition of recovered plants
0	100	normal	100	normal
$\frac{1}{8}$	100	retarded	100	normal
$1\frac{1}{8}$	70	retarded	100	retarded
$7\frac{1}{8}$	30	abnormal	60	abnormal weak
$12\frac{1}{8}$	50	abnormal	60	abnormal weak

The results of this first experiment indicate that 2,4-D was not effective when applied to the tops. Young foliage is more susceptible but the weed was not eliminated as in the case of dandelion, Taraxacum officinalis.

In greenhouse tests the following was done. 2,4-D was applied to freshly prepared soil by liquid sprays applied directly to the soil surface. In other cases the chemical was mixed with the soil to varying depths. These methods of application were compared with sprays applied to actively growing foliage on young plants.

Table V. The herbicidal value of 2,4-D applied as a spray to freshly prepared soil containing roots of Artemisia vulgaris. (November 9, 1946)

<u>Pounds of 2,4-D in 200 gallons per acre</u>	<u>Percentage roots dead at 90 days</u>	
	<u>1 inch deep</u>	<u>2 inches deep</u>
1 $\frac{1}{4}$	50	0
12 $\frac{1}{2}$	90	50
25	100	95
100	100	100

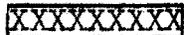
When 2,4-D is applied to the surface layer only complete control of Artemisia was obtained.

Table VI. The herbicidal value of 2,4-D worked into freshly prepared soil containing roots of Artemisia vulgaris February 15, 1947 - May 24, 1947 90 days

<u>Pounds 2,4-D per acre in furrow slice (6")</u>	<u>Per cent roots killed 90 days</u>	<u>Character of growth</u>
0	0	normal
0.02	0	normal
0.2	0	normal
2	0	2,4-D injury
20	80	retarded
200	100	-----
2,000	100	-----

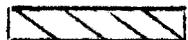
Artemisia can be controlled by mixing 2,4-D with the soil. Control appears to end at an application slightly in excess of 20 pounds of acid equivalent to the acre or a theoretical pC 2,4-D of 5.

Table VII. Control of *Artemisia vulgaris* as indicated by top and root weight March 9, 1947 to December 1, 1947 in greenhouse 6 inch pots, 2 pots per treatment, 20 pounds of 2,4-D per acre.

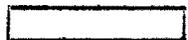
Treatment	Soil with 2,4-D		Control	
	Weight top	Weight root	Weight top	Weight root
 - 2,4-D + stolons	0	0	35	102
 - 2,4-D + stolons	0	0	62	117
 - 2,4-D stolons	23	64	54	118
 - 2,4-D stolons	35	128	52	117



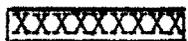
2 inch soil treated with 2,4-D



2 inch soil with Artemisia stolons



2 inch clear soil



2 inch soil treated with 2,4-D, planted with Artemisia stolons.

2,4-D mixed with soil at 20 pounds to the acre gave control of Artemisia except where the stolons were planted below the 2,4-D layer.

Since the plant is shallow rooted forming a sod or mat commercial control might be obtained by disking and spraying or by cultivating and spraying.

Table VIII. Control of Artemisia vulgaris under field conditions as indicated in December 1947 after treatment December 1946.

<u>Soil treatment</u>	<u>Estimated control</u>	
	<u>Hicks Nursery, Wyandanch Soil</u>	<u>Swan River, Patchogue* Soil</u>
Stantox 1.6 lb./acre	20	50
16 lbs./acre	98	100
40 lbs./acre	100	100
160 lbs./acre	100	100
Salt, 2,4-D	Sodium	Ammonium
1.6 lbs./acre	20	90
16 lbs./acre	90	100
40 lbs./acre	100	100
Ammonium thiocyanate		
430 gals./acre Fall 1946	100	
430 gals./acre Spring 1947		100

\*At Patchogue 2,4-D was applied to the foliage without controlling the weeds.

All of the above plots have growth of annual weeds, especially grasses, except where ammonium sulfocyanate was applied in the spring of 1947.

Field Plots.

Two series of field plots (10' x 10') were set up on freshly prepared Long Island nursery soils. The triethanolamine salt was used over a range of 1.6 pounds to 160 pounds of acid equivalent per acre. A duplicate series of plots using the sodium salt of 2,4-D in one case and the ammonium salt in another was included. One plot of ammonium sulfocyanate was included. One series of 2,4-D plots of some size was containing abundant plants of Artemisia still in green leaf were sprayed.

Control was estimated in March, August and finally December 1947 season. (Table VIII).

Commercial tests.

In the summer of 1947 tests were set up in the Rosedale Nurseries by Powers Taylor. The sodium salt of 2,4-D was worked into the soil among Taxus cuspidata plantings during normal cultivation procedures. It was used at the rate of 10 pounds per acre and gave control without injury in 1947 to the Taxus.

3. Nut grass (Cyperus esculentus)

This weed has caused abandonment of certain good agricultural land, including nursery land, on Long Island.

A serious infestation of northern nut grass was called to the writer's attention in Suffolk County by Alfred Gianfagna and a month later in Wyoming County, Western New York State, by J. B. Ketchum, County Agricultural Agent.

The Wyoming County owner stated that he was willing to spend up to \$100 for elimination of the weed. This brought both 2,4-D and ammonium sulfocyanate into consideration. Tests were set up in both counties but carried through only in Wyoming. The following is the record of these plots.

On July 6, 12 plots a rod square, 17' x 17', were laid out in the middle of a heavily infested field. Four types of 2,4-D were used:

Trietholamine salt	40 per cent
Isopropyl ester A	
Isopropyl ester B	40 per cent
Sodium Salt	60 per cent
Commercial 2,4-D acid	

These were applied in three rates each, 5 pounds/acre, 15 pounds/acre and 45 pounds/acre. Solutions were applied with a bucket pump, the acid by mixing with sand to bushel volume.

The applications were made to freshly plowed soil and dragged in.

The owner used the sodium salt as a spray from a commercial rig at 5 pounds/acre in 200 gallons of water. This plot covered an acre and lay 40 feet to the north of the rod square plots.

A second series of new plots on freshly prepared soil was set up October 17. Plots 17' x 17' were used in duplicate and dragged after application. The treatments were:

Ammonium sulfocyanate	120 gallons/acre
"	360 gallons/acre
1 pC	100 pounds/acre
Stoddard Solvent	400 gallons/acre

A third group was also applied on October 17th and included:

Ammonium sulfocyanate	120 gallons/acre
Stoddard Solvent	400 gallons/acre

These two chemicals were applied to the plants growing in unplowed land.

On December 1 soil samples were taken from all plots. Four subsamples were placed in clay flower pots, watered and placed at 90° F with 12 hours of 200 foot candle, fluorescent white light.

The following plots show no evidence of nut grass. All samples permit normal growth of such test crops as beans and mustard except 2,4-D acid applied at the rate of 45 pounds/acre.

Plots clear of northern nut grass

Chemical	Rate per acre		
2,4-D			
triethanolamine salt	15 lbs.	45 lbs.	
isopropyl Ester A	15 lbs.	45 lbs.	
isopropyl Ester B	15 lbs.	45 lbs.	
sodium salt	-----	45 lbs.	
2,4-D acid	5 lbs.	15 lbs.	45 lbs.
Stoddard Solvent			400 gallons

Elimination of northern nut grass would appear to be possible on a gravelly clay loam by using 2,4-D in any form at 15 or 45 pounds to the acre and with the acid at 5 pounds. The price on these forms is within the limit of \$100/acre.

Stoddard Solvent also appears to be a promising possibility. Its cost likewise lies within the figure set.

#### Greenhouse Test

Soil heavily infested with northern nut grass was set up in 4 inch pots, 4 to each treatment. The pots were plunged in sand in a No. 10 tin can. Beans were planted in the sand. Ammonium sulfocyanate was applied to the soil in acre rates of 400 to 8,000 gallons and watered in.

After 3 months growth not a single spear of nut grass has appeared though controls show abundant growth. Beans are growing only in the 400, and 800 gallons/acre treatments, indicating that in larger amounts enough is leached from the pots into the sand to eliminate the test crop. This leaching may account for the failure of the Wyoming County ammonium sulfocyanate plots to show elimination of nut grass and to permit adequate growth of beans and other test crops after two month's time.

#### 4. Temporary Soil Sterility

The employment of large amounts of herbicide on or in the soil at once opens the question of the period over which crop plants as well as weeds are: (1) eliminated, and (2) seriously injured.

In order to answer this question test crops including (1) red kidney beans, (2) zinnia, giant strain seed, (3) the commercial cucumber variety Early Fortune, (4) Cornelian oats were used extensively. Red kidney beans were used in all cases. This species and variety was chosen because of the well known response to 2,4-D and to other growth regulators.

The matter of calibrating the response of test crops is difficult in terms of other than pC units. Since for practical purposes acceptance of normal morphological growth at normal rates as compared with controls seems adequate. We have used such response as conclusive when it is repeatable.

A series of test was undertaken to establish the general nature of plant response to pC 2,4-D ranges. These tests are of two types (1) in pure quartz sand, (2) in pots of soil using non-volatile sodium salt of 2,4-D to spray on the surface after planting. The first tests were run by using petri dishes once only. Later we used heat sealing cellophane bags as containers. In either case 100 grams of fresh quartz sand is used as a substrata. This is brought to field capacity by 45 cc. of the test solution (non-colloidal). Seeds are counted and handled on clean paper without touching them by hand. Distilled water is kept in separate containers for mixing solutions and watering controls. Heat sealing the cellophane is done to eliminate transfer of 2,4-D in the air. Within the limits of present knowledge of 2,4-D response the controls appear normal.

The second group of tests is based on the use of pots of soil in which fresh soil is used and seeds are planted in standard horticultural procedure and the soil sprayed with the requisite area (3' x 3') for convenient spraying with a Sure-Shot Sprayer coarse spray. Here pC 2,4-D is used with V 200.

Response of test crops to a wide pC 2,4-D range is given in the following tables (IX, X and XI) for elimination of plant growth and for definite morphological response in red kidney bean and Early Fortune cucumber.

Table IX. Minimum value pC 2,4-D to eliminate emergence of seedling.

<u>Crop</u>	<u>Sand</u>	<u>Soil solution Germinating zone</u>	<u>Mixed in soil lbs./acre outdoors</u>
Alfalfa	6		
Barley		3	66 lbs.
Cucumber	4		
Fescue	3	3	
Kentucky blue grass	6	3	
Ladino clover	4		
Larkspur	4		
Marigold	4		
Mustard	5		
Oats	3	3	66 lbs.
Red Clover	4	4	
Red kidney bean	3	3	66 lbs.
Rhode Island bent	3	3	
Tomato		3	
Wheat	3	3	66 lbs.
Wild white clover	4	3	
Zinnia	4	3	

Table X. Morphological response in red kidney beans in sand cultures.

<u>Chemical</u>	<u>pC definite response</u>	<u>pC normal growth</u>
Sodium salt	4 to 6	10
Acid	4 to 6	
Triethanolamine	4 to 6	10
Methyl ester	4 to 6	10
I.P.C.	?	4
3-5 di methyl phenoxyacetic acid	?	4
2,4-5 trichloro phenoxyacetic acid	?	4
Acenaphthene	?	4
Alpha-naphthaleneacetic acid	4	6
Methyl ester naphthaleneacetic acid	4	10
Indolebutyric acid	4	6

Table XI. Morphological response of germinating cucumber in quartz sand and bathing solution.

<u>Chemical of 2,4-D</u>	<u>pC Definite Response</u>	<u>pC Normal Growth</u>
Sodium salt - light	4 to 6	10
- dark	4 to 5	7
Iso propyl ester	4 to 6	7
Triethanolamine	4 to 6	8
Indolebutyric acid	4 to 5	6
Spray 2,4-D sodium salt	4 to 5	6

From these tables it would appear (1) that when the soil solution or bathing solution is at a value of pC 4 or less growth is eliminated; (2) that definite morphological response is present between pC 4 and some higher pC value associated with the growth regulator used. In the case of 2,4-D pC 5 to pC 6 is the range. Normal growth occurred at all stages from germination to maturity at pC 10 and higher. For cucumber normal growth is evident at pC 2,4-D 6.

Relying on response in beans as indicative of the presence of 2,4-D it was found that normal growth was obtained.

Table XII. Evidence of residual 2,4-D

1. Bench and floor without soil Remains 365 days +
2. Floor with soil Gone in 365 days
3. Field experiments reported above

<u>Plant</u>	<u>2,4-D lbs./acre</u>	<u>Soil type</u>	<u>Response doubtful</u>	<u>Growth normal</u>
Agropyron repens	20	Silty loam, Ithaca		60
	40			60
	100		60	90
Artemisia vulgaris	1.6	Sandy Wyandanch		120
	16.0			120
	40.0			120
	160.0			---
	1.6	Sandy Patchogue		120
	16.0			120
	40.0			120
	160.0		90	365
Cyperus esculentus	5	Wyoming Co. gravel loam		60
	15		60	120
	45		60	120
	45 (acid)		--	---
Field Experiments	Ammonium sulfocyanate gals./acre			
Agropyron repens	200	Silty loam, Ithaca		90
	400			90
Artemisia vulgaris	400 spring	Wyandanch Sand		120
	400 fall	Patchogue Sand		120
Cyperus esculentus	120	Wyoming Co. Gravel loam		90
	360	Wyoming Co. Gravel loam		90
Field Experiment	Stoddard Solvent gals./acre			
Cyperus esculentus	400	Wyoming Co. Gravel loam		90

### Summary

For preplanting treatment 2,4-D, ammonium sulfocyanate and Stoddard Solvent offer possibilities. When used in appropriate amounts both 2,4-D and ammonium sulfocyanate have eliminated three troublesome weeds in uncropped land. The residual effect of these chemicals in clay loams is approximately 90 days and on sandy soils 120.

These figures indicate the possibility of early fall treatments followed by spring planting without a period of a year or more following. Ammonium sulfocyanate has distinct possibilities as a combined herbicide and fertilizer. At present prices all three chemicals are in the same price range. This range is too high for more than local treatment on productive land.

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Due credit in conducting the experiments and preparing this manuscript go to Dr. J. F. Cornman, P. B. Kaufman, A. J. Gianfagna, J. B. Ketchum and to Edward Watkins.

FROM THE FLOOR: I am still trying to find out the effect on the bent grasses of 2,4-D.

MR. PRIDHAM: See Mr. Musser from Penn State. He can tell you that story completely. Where we used 2,4-D on bent grasses, we got no injury or discoloration on the bent grasses. We have not dealt with golf course situations where people who are using them are particularly critical.

Looking at this chart, we see that the growth of grass starts in March or April, and it comes up to a very vigorous growth in June. There are a lot of people playing golf in June, and they are pretty critical. If you burn the grass in June, you are in for trouble. Why not avoid that. You get the same proportion of kill, 90 per cent or better, through the summer and into the fall. Why

not wait until after fall frost when the plants are more nearly mature? Grasses are more mature, and the annuals and perennials around the club house are gone, and you don't get the drift injury. Then come in with your 2,4-D. Very few people are playing golf. The men have more time, and can do a better job. But if you do it in the summer and water the golf green, you are guaranteeing yourself a headache.

FROM THE FLOOR: What is the best time during the fall for mature grass treatment with .2 per cent 2,4-D?

MR. PRIDHAM: The work was done during the early part of September and seeds were gathered two weeks to a month later and brought up to Ithaca.

The controls on untreated crab grass germinated 68 per cent, and the treated plot less than one per cent germination.

FROM THE FLOOR: How long a period do you have? About the first or the middle of September?

MR. PRIDHAM: I am sorry. I can just give you that as a case. We have not gone into enough detail to calibrate that. While the seed is still green and before the plant actually dies would be my idea of the time to put it on.

The reason is based on the chart we had here. What you are interested in is influencing the growth of these seeds while they are forming. Theoretically, from what we heard yesterday from Dr. Mitchell of Beltsville and Professor Minarik from Camp Detrick, the 2,4-D goes up through the plant, up through the vascular system up to the actively growing buds, and at that time the chances are good that you can influence the growth of that seed.

From a practical point of view, it turns out that you essentially eliminate the germination of the seed.

FROM THE FLOOR: I would like to ask if you have studied the possibility of lowering pressures even lower than 25 pounds with the use of carbon dioxide. The quantity used would be much less at that lower pressure, would it not?

MR. PRIDHAM: The question is, How long can you go? That depends on the type of nozzle. I doubt if you can drop it below 25 pounds and get good results.

FROM THE FLOOR: Did the Taxus sprayed with kerosene drop their leaves?

MR. PRIDHAM: No. The spraying was done prior to the opening of the new leaves on the evergreens. If you spray after that time, you will injure certainly the young foliage, and very often the older foliage as well.

So you can use kerosene when the time is particularly advantageous, particularly during colder weather, when the fall weeds are in active growth.

FROM THE FLOOR: Did you spray any sedges?

MR. PRIDHAM: No rosalias. We sprayed rhododendrons, Taxus and juniper vines.

FROM THE FLOOR: What is the effect of the 2,4-D on the established bents?

PROFESSOR MUSSER: It depends in the first place on the formulation, I would say, to some extent, and in the second place on the type of bent that you have.

FROM THE FLOOR: Washington creeping bent is what I was asking about.

PROFESSOR MUSSER: There are some figures from Indiana on the difference in response of individual bent strains to 2,4-D. As I recall, Washington was intermediate in tolerance. Some of them were very susceptible to injury; some of them were intermediate, and some of them were highly resistant. One of the newer types, the Arlington, is highly resistant to 2,4-D treatment. I think on top of them, one of the various types we have is dependent not on the 2,4-D itself, but the type of carrier that is used. We have very much different results as far as injury is concerned with the water soluble salts as against some of the materials that are dissolved in oils.

Oils as a class are highly injurious to the bents, and if you happen to get hold of a carrier that is high in aromatics, you will have a lot more injury on your bents than you do when you use water soluble salts. They seem to absorb a lot more quickly.

But I think it is more the carrier than it is the 2,4-D, because I have applied 2,4-D many times in water soluble salts under good conditions, with fairly dry soil down at root level, without getting any injury to the bents.

Most of our ideas about injury to bents from the 2,4-D have come from the original work that was done on the Carbo-Lax mixture, and we know that that is one of the more damaging compounds on the grasses than a lot of our other materials that we used for solvents.

FROM THE FLOOR: I have read in some of our leaflets that they do not recommend it for bent grasses, and I would like to ask this: Let us go to the beginning. On most golf courses, we will say that the Chairman of the Greens Committee is desirous of getting rid of plantains and chickweeds and clover. If you are going to spray during the spring or the fall, is it going to have any effect on your grasses, which in Long Island contain a certain amount of several varieties of bents?

PROFESSOR MUSSER: I would not be afraid of 2,4-D at rates of not over one pound, applied close to the weed you are trying to get over there if it is applied during the fall period.

I would not go too much over a pound.

FROM THE FLOOR: That would be the acid salts?

PROFESSOR MUSSER: Water soluble salts. I cannot answer that, because I have applied it both on bents at regular height and bents cut to a half inch, and I got more serious effects from the solvent than the 2,4-D on the clipped.

The meeting of the Northeastern Weed Control Conference on Public Health and Welfare convened at 10 o'clock, a.m., February 13, 1948, in the Grand Ballroom of the Hotel Commodore, New York City, N. Y., Mr. C. B. Link, presiding.

"Some Selected Introduced Noxious Weeds that Should  
Receive Special Attention for Control"  
W. C. Muenscher, Cornell University

Much of what we talk about here in this Weed Conference, should be modified somewhat, perhaps, by considering the kind of weeds we are talking about. One could make a blanket statement about weeds and cover quite a few of those, certainly, from certain aspects. But these general statements would not apply to all weeds. Much depends on the kind of weed.

I have selected several examples of weeds, where a knowledge of some of the characteristics is considered rather useful in determining the type of procedure that one would use, with a view toward exterminating such weeds; and these would also serve as examples where this knowledge would make it possible to obtain much greater returns for the expenditure of time, labor and money expended upon these weeds.

I have selected these as illustrations and into each group there might be a number of others that might be selected for the same purpose.

The first kind of weed that I want to mention is the so-called Nut Grass, or perhaps Nut Grasses, Cyperus esculentus and Cyperus rotundus. We must consider both of them.

Yesterday a gentlemen spoke to me about the Nut Grass being very common in the Tropics and how it has spread and is spreading northward; how it is even found now in such states as New York and Maine. I want to point out that those are two different kinds of Nut Grasses, rotundus being most prevalent in the warmer parts of the world, and Cyperus esculentus, the so-called Yellow Grass, being more abundant farther north; and that is the only one that we need to consider for New York and from there, northward.

This last year, Nut Grass has been very abundant in New York State and many people have the idea that it has recently arrived. Nut Grass has been abundant in New York State for at least fifty years. Last Spring we had rather unusual weather conditions, which made it possible for this plant to grow more profusely and show up in a more striking manner in many places, where ordinarily it is seldom noticed.

Nut Grass is a weed that causes trouble under special conditions and chiefly among potatoes. In one week, at Ithaca, New York, I had calls from four housewives, complaining that they had bought potatoes that had nuts inside of them, chestnuts. "How did those get in there?"

They were referring to the Nut Grass.

Last week, I had a letter from a person in western New York, stating that he had an area on the back part of his farm, where suddenly last summer there appeared large quantities of the "peanut grass". Well, he was talking about the same thing.

These Nut Grasses reproduced commonly by means of underground stems, which enlarge at their tips to form tubers, which are quite resistant and durable; they will live even after they have been dried for a considerable time. They are quite resistant to drying out, and they will live in the soil for at least one whole year and probably even longer. There are certain seed dealers who sell these dry tubers in paper packets, under the name of Tuber.

Many people have the idea that that is the only way by which the Nut Grasses reproduce. However, in New York State and even farther north, these plants, will produce viable seeds in large quantities, seeds capable of germinating; and under certain conditions, they germinate rather well and tend to perpetuate the species.

Undoubtedly, in other sections at this Conference, you will hear various aspects of controlling weeds, probably even Nut Grass, by the use of chemicals. As far as I know, most of those methods have aimed at the destruction of the plants after they are up above-ground. There has been some work done on pre-emergence sprays, intended to destroy underground parts, but let us not forget that these plants produce large numbers of seeds, and that these seeds will germinate rather irregularly. Granting that you could find a material which would be suitable for killing the plants that are already in the soil; or granting that it is possible to find a chemical that will destroy the seeds as they germinate, still we must remember that not all of the seeds will germinate at the same time. So that whatever the method that is used, it will have to be repeated at least as many times and as many years as the seeds will remain viable.

Now, there is a fact that we do not know definitely. We hope to have some information on how long these seeds will retain their viability. I might say that work done in various other parts of the world has indicated, has shown, that the seeds of the southern Nut Grass, under certain conditions, will remain viable for at least seven years. Not always do most of them germinate in the first or second year. Sometimes you get an increase in germination with age.

MR. TULLIS: In connection with the germination of the Nut Grass; there has been some impression throughout the South that the nuts remain viable for a considerable period, and only the terminal ones on the string, would germinate when the others have been killed. Is that correct?

DR. MUENSCHER: It is true of the northern one, that not all of them will germinate at the same time. Some of them may germinate the first year and some of them may remain dormant, especially the smaller ones. I am not sure on that point, but the smaller ones may lie over in a dormant condition for more than one year.

MR. TULLIS: Is there a possibility that the seed might even remain viable longer than the nuts?

DR. MUENSCHER: It is not only possible, but it is highly probable that the seed will live for several years.

DR. MUENSCHER: Another plant that I wish to mention now is the so-called Cypress Spurge, or Graveyard Weed - Euphorbia cyparissias, a plant very closely related to the leafy spurge.

The plant has a milky sap, which is highly caustic. The plant is poisonous to livestock and there is one area in Herkimer County where a number of farms had to give up raising dairy cattle because - well, they just couldn't get them, because the plant was so abundant, and they did not dare to feed animals unless they imported the hay. So the plant has considerable interest.

Euphorbia cyparissias has been known in the northern part of this country for at least seventy-five years; and for fifty years or more it was never known to produce seed. Some thirty or so years ago, it was found producing seed in one or two localities.

Some twenty-five years ago, I started to do a little work on trying to locate the reason why this plant produces seed so seldom. I will not go into detail, except to point out that the result was that Euphorbia cyparissias is self-sterile; and whenever you start a plant from one seed or a single plant, or if you start it from a root, the plant propagates by creeping roots very readily; you get a whole colony or a whole patch of it, sometimes acres.

In western New York, you can usually surmise the approach to a cemetery by this Graveyard Weed, growing in the general vicinity. But never does it produce seed. We found that in a place down here, in Orange County, New York, another one in Pittsfield, Massachusetts, and in three or four other places in New York State, there were whole sections of the countryside where this plant was growing, flowering and producing seed.

It was found that in those areas where this plant produces seed, the introduction was from seeds, originally, so that you had a number of plants and there was ample provision for cross pollination, and therefore you have seed setting as in any other Euphorbia.

I mention this because there is some interest in eradicating this plant in a number of places; and one must take into consideration the fact that even though, under many conditions, this plant never produces seed, in those areas where it is most troublesome it

does produce seed; and that in these areas whatever method you use, whether it is mechanical or chemical, to destroy those plants that are already there, remember that the plants produce seeds and the seeds are in the soil. So unless something is done to follow up the work later to kill the seedlings, or to do something to kill the seeds that are in the soil, the performance must be repeated.

Now, that is a rather important point to mention, because, the actual grower or the farmer, who wants to eradicate these plants, is interested in the economics of the whole thing; and I have had farmers tell me, when I point out certain procedures which might cost a hundred dollars, "That is all right, if I know that I can once and for all get rid of it. I don't care whether it is going to cost a hundred dollars."

But there you are up against this cold, practical problem: he will spend his hundred dollars and he gets rid of those plants that are in the soil at the time. But it does not take care of the succeeding crop that he is going to get. He can't afford to repeat this, even though he only has to put out fifty dollars the next time. He should know about that before he starts to decide to spend his hundred dollars and not come back afterwards.

Within the last five years, much interest has developed in a number of the larger centers of population, to do something to destroy ragweed, because it is the plant which causes most cases of Autumnal Hay Fever in the Northeast.

Within the last few years, there has been a considerable hope that ragweed may be eliminated at much less expense or in a practical manner; and it seems that we are about on the verge of having something done about the ragweed problem.

I was interested to see last week in the daily press, a rating of some of the so-called ragweed or pollen-free areas in New York State. There are some that have been declared relatively free.

For a long time people went to the Adirondacks, thinking that the area was free from ragweed pollen. Be that as it may, I want to mention one area, pretty well in the central Adirondacks, where we not only have the common ragweed, A. Artemisiaefolia, and the giant ragweed, A. trifida, but, in fact, a third one -- A. psilostachya, the western ragweed, a perennial. It is, in fact, the only area where we have had ragweeds in abundance, enough to cause some consideration, as far as the pollen that is produced is concerned. It is near Clear Lake Junction. Apparently, in years gone by, they slipped in there in some western hay. I mention this, because the plant also occurs near Buffalo, near Rochester, and I picked it up in Ithaca, New York. Whatever methods are designed for controlling the common ragweeds, I think it is something worth recalling, that we have this plant, the western ragweed which is not going to respond, because of its different life cycle, to the same treatment that can be used for the common annual ragweed.

Likewise, let us mention that the seeds of the common ragweed are known to live for at least eight to ten years, when buried in the soil, under some conditions. So we cannot eradicate the ragweed by simply making one application, which will kill or destroy all of the plants that are present at a given time, because there will have to be some provision made for taking care of the new ragweed plants that are going to come up from the seeds that are in the soil; and they don't always all germinate at the same time.

There is a close correlation between the abundance of ragweeds that you get and the soil disturbance. If the soil is left undisturbed and if it is in solid sod, or there is a lot of competition with other plants, very few of them can get a start, even though the seeds should germinate.

One other plant that might be mentioned in this connection is the so-called Water Nut, or Water Chestnut, Trapa natans. That plant was first noted and reported in 1886, from Sanders Lake, at Scotia, New York, when it was reputedly introduced to improve conditions for fishing. It remained in that lake for quite a while, until they rebuilt the Erie Canal into part of the present Barge Canal system; and they let the water from Sanders Lake into the canalized portion of the Mohawk River, between Locks 6 and 7, an area often referred to as Crescent Lake, a distance of about ten miles; and the water chestnut got out in there.

In 1934, when I was asked to make a survey, there were approximately eleven hundred acres of water chestnut. At that time, the plants had been known from the Sudbury River in Massachusetts, and the Potomac River, below Washington, D. C. to Tidewater. Those were the only three areas known.

I remember in 1935, this water chestnut proposition came up for a hearing in Schenectady; and at that time I was asked whether it wouldn't be a good plan to get public support and just go in there and remove the material by mechanical means. Well, I asked at that time whether there was anybody there who would be willing to accept an offer of one thousand dollars an acre, and, of course, guarantee that they would remove the water chestnut; and no one would take up the offer; and we had eleven hundred acres of it.

I predicted, in 1934, this weed would probably spread to a number of the shallower waters with muddy bottoms, in other parts in the Northeast.

Now, this plant has gotten out of the Mohawk River into the Hudson; and it has gotten into several other localities. Within this last year, we have found it growing in some of the waters surrounding Seneca Lake, in the Finger Lakes region in New York. It has been reported from Lake George and several other places in New York State.

Attempts were made to control or perhaps eradicate this plant. But most of those, as far as I am aware, have been unsuccessful. Perhaps some work that has been done this last year might offer some hope.

This weed is an annual. It starts from a seed or nut, which has four large barbs or prongs, with recrossly arranged barbs. These prongs are very sharp and hard and will go through an ordinary tennis shoe or bathing shoe. The plant starts on the bottom, usually in May, when the seeds germinate, and it grows rapidly, sometimes several inches a day. Towards the end of May, it reaches the surface of the water and forms a large rosette of leaves on a long cord-like stem, the stem being from six to twelve feet in length. The rosettes of leaves cover the surface of the water so that it practically ruins a body of water for boating and fishing and things of that type. Thus the area is spoiled for recreational purposes. That is why a number of people are interested.

Attempts have been made to eradicate this weed without paying any attention to its life cycle. I want to mention a few points: first of all, the plant is an annual. It completes its growth in one season. The only method of reproduction, in increasing the number of plants, is by these seeds. These seeds live only one year and they never will germinate if they are allowed to dry. Once dried, they are dead. That is why we don't have water chestnut more commonly in the Hudson River, because the locks there are provided with contraptions to prevent a lot of the material going through unless it floats over the top at high water. As these nuts are heavy, they sink to the bottom, and the only way in which they can be transported is in blocks of ice, where they may be carried considerable distances. Only dead seeds come to the surface and float. But those are dead, and dead seeds, of course, do not concern us, from the standpoint of spreading the plant.

However, they have caused considerable amount of inconvenience along beaches in the Hudson River, and I have found them drifted up in windrows even down here in Croton Point and around Catskill and near Peekskill; and within the last few years, the plant has appeared several places in the Hudson River.

So a consideration of the life cycle here will give us some points, in connection with the control and eradication of this plant, the water chestnut. I might say that this plant or at least the nuts have been collected and perhaps some of you have seen them at fairs, horticultural exhibits, all sorts of places like that, where people congregate and often are willing to part with some money.

You can see these nuts in a bowl of water, with a plant. Sometimes it is a rosette, a rose or a tulip or poppy, or something stuck in there; and the nut is down in the water. But I have never heard of anybody being able to grow the plant while the seeds are carefully dried first. Then they are dead and they will not germinate. That is a good thing; otherwise we might have the plant disseminated much more widely than it is.

Another plant is the Austrian Field Cress - Roripa austriaca, which back in 1922 was reported near New Milford, Orange County, New York and adjacent New Jersey. There were perhaps ten acres involved at that time, and that was the only North American record of the plant.

Efforts were taken to confine the plant at that time, and if possible, to eradicate it, absolutely.

The plant is a perennial, which spreads by creeping roots and underground stems, any piece of which will develop into a new plant. It was feared that that plant might get away into other parts.

There is a stream that runs through the main field, where this plant grows; and there is adequate provision for transporting the plant from New York to New Jersey. In fact, the plant was in two states at that time. That is why we ran into difficulty.

I arranged with people in New York to do something about this, it was an interstate problem -- so we arranged with New Jersey to do something about it. We went so far as to call a joint meeting of a representative from the Department of Agriculture, in Washington, and the Director of the Experiment Station for New York State, and the Director for the Experiment Station in New Jersey; and it was decided to do some cooperative work.

After the individuals concerned went back to their respective states, they found that there was no set-up or provision for that type of work, the experiment stations maintaining that it was a regulatory matter, and the people who had charge of the regulatory matters maintained that this was not a state of New York problem or a state of New Jersey problem, but an interstate one; and that it should be handled as a Federal project.

Well, I went down to Washington again, and after considerable deliberation with several agencies, it was pointed out that there was no provision for such interstate work, or a Federal matter; and there were no funds anywhere; that we could go ahead, but there were no funds; and I was finally reminded that the only way funds could be appropriated for that purpose was by a special act of Congress - introduce a bill that would take care of this matter; and at that time, Congress was not as lenient in providing funds, as at some other times. In fact, I was informed that there was practically no chance for a bill of that type to pass.

Well, we still have this weed. I don't think it is fifty miles from here. We have it in the two states; and instead of spending ten thousand dollars to get rid of it at that time, now we have the weed in Minnesota, Wisconsin, California and Saskatchewan; and probably in the future, each of those states will spend that much, not in eradicating the weed, but to interfere with it just enough so that they can raise crops in spite of its presence.

MR. MEDOFF: I read an account where the chestnut weed was controlled by the use of a saw, in the form of chain lengths, dragged at the end of a boat. I was very much interested in that, but I was never able to find any more account of it. Would you know the success of such operations?

DR. MUENSCHER: Well, that has been attempted in several places. Most of that work has been done on Sanders Lake, and they have had various contraptions, submarine saws attached to barge-like affairs; and they have had others, large loop chains or cable, with weights on it. Then they have some source of power, on the shore; you can get rid of many of them. But unless you get the last one, they are going to come back.

I have been asked to endorse a program to put a C.C.C. company along the Mohawk River, with a view toward removing these water chestnuts from Crescent Lake, where there are some nice beaches and fishing facilities, and so on.

I said, "All right, first clean out Sanders Lake, because unless you clean that first, you are going to have a continued repetition of these plants in Crescent Lake. Secondly, about one-half, or a third of the infested area is in sections of the old abandoned Erie Canal. If you will go in there and first clean out the old abandoned Erie Canal, so that whenever you have a high water these nuts are not carried back into Crescent Lake, you might get somewhere. But unless you clean out all of the them and the very last one, why, you are going to have them back. It is a continuous proposition."

CHAIRMAN LINK: Our next speaker on the program is Mr. F. S. Spon, of the Pacific Coast Borax Company, who will discuss the "Use of Borate Material in Weed Control." Mr. Spon.

MR. SPON: Mr. Chairman and gentlemen: In talking to such a small group, it is usually more desirable, both from the standpoint of the speaker and listeners, to make it more or less extemporaneous. But with the time limit involved on this program, I felt it better to prepare it, so that I would have enough time left to show you some slides.

The association of Boron with plant growth and nutrition is certainly a subject which requires very little explaining to such a group as I am privileged to address today. Many of you have given much thought to the Boron question and some of your regular activities have resulted in recommendations of Borax additions to fertilizers which have greatly benefitted agriculture as a whole. Your work with Borax has of course included the very important consideration of the tolerance of the individual plant to this element. Such experimental work was, we believe, one of the events leading up to the conclusion that a borate material, used in proper concentrations, would kill plant life and therefore could be considered a herbicide. Although much of the actual weed control work done with a borate

material, used in proper concentrations, would kill plant life and therefore could be considered a herbicide. Although much of the actual weed control work done with a borate material over a period of more than ten years has been a practical rather than a scientific procedure, we turn to a scientific fundamental when we say in the first paragraph of our Weed Control Bulletin:

"All growing plants draw nutrients from the soil and one of the so-called minor or secondary elements necessary for growth is boron. Whereas small quantities of boron are quite essential, large quantities can result in death to the plant. Borascu contains the element boron and it is, therefore, only necessary to determine how much Borascu is required to kill the undesired growths and a simple and effective weed killing chemical is available."

For quite a period of years, refined Granular Borax was used for this work, but the interest has now turned to Borascu as it is less expensive and has the advantage of dissolving a little more slowly, hence is less subject to rapid leaching. As a producer of commercial borax, we are fortunate in that we start with a sodium borate ore. Borascu is a concentrated form of this ore and is a coarser screening of Fertilizer Borate which has been so widely accepted by the Fertilizer Industry this year. The Anhydrous Borax content of Borascu is slightly lower than refined Borax, but experience has shown that it can be used at the same concentrations as has been recommended for Borax.

We recognize the fact that in weed control work, we are dealing with what might be termed an agricultural problem and as such, consideration must be given to the variables which are ever present. The first of these perhaps is weed type. In the Midwest and Far West specific weeds such as bindweed and klamath are classed as noxious and receive special attention. The problem in the Northeastern states, however, seemed to center more in general weed growths and those primarily interested in weed control were industrial organizations. These two conditions necessitated an approach to the problem quite different from that encountered by our representatives in the West in earlier years and it might truthfully be said that it placed our approach on a practical rather than a scientific level. In other words, an official of an oil company, a railroad, or a lumber yard, for example, was not concerned (and did not know for that matter) what weed varieties were creating either a fire hazard or an unsightly appearance on his property but was merely interested in their elimination. Such industrial prospects were evidently acquainted with one definition of a weed which says "A weed is any misplaced plant." Previous experiences with available weed control chemicals had not proven too satisfactory as complete, rather than selective, control was desired and what they considered a weed could run anywhere from a blade of blue grass to a deep-rooted woody shrub.

The initial work which we started here in the East concerned therefore, first a determination of an average figure of material concentration that would be in excess of the tolerance to Boron of most varieties of Northeastern plant life. Test plots set out at 6, 8, 10, 12, and 20 pounds of Borax per 100 square feet soon gave indications that 10 lbs. per 100 square feet was a very workable average. Initial results at higher concentrations were no better and it became evident that the quantity above 10 lbs. could be better used for a later retreatment.

As Borascu must dissolve and become a part of the soil solution before we can look for results, rainfall becomes our second most important consideration. This factor is also coupled to soil type as this affects the speed of leaching.

Since our problem concerned the control of mixed weeds instead of having to consider individual types, we found we must consider rather the two distinct classes which could generally be defined as annual and perennial as most annuals are shallow rooted and most perennials are deep rooted.

Light rains following an application of Borascu means slow leaching and leaves the excess boron in the top layer of soil long enough to effect a poisoning of the shallow rooted growths. Excessive rainfall results in rapid leaching and run off and is therefore sometimes responsible for poor control of the shallow rooted types. It is quite understandable that our more certain control results involve the deeper rooted growths which are generally the perennials. Our experiences have shown that the customer can look for good control of perennial growths without having to give consideration to whether there have been light or heavy rains. This, I might say, applies to both woody and non-woody types. Since a later retreatment may be necessary and is generally recommended anyway, the possibility of excess rainfall does not rule out the chances of eventual satisfactory control of the entire group of unwanted growths.

Early spring is the best time of year for a Borascu application as dead standing growths can easily be removed, the new growth is young and tender and light rains are generally expected. The perennials resuming growth and the early germinating annuals are subject to satisfactory control at that time and the land should make a good appearance for several months. Late germinating annuals then become the problem hence the recommendations of a retreatment at the right time to effect their control and to give the sometimes needed "second shot" to the growths which may for one reason or another have failed to fully respond to the first application.

Equally as important as the recommended quantity of Borascu and the variables of rainfall and soil type is the actual application of the material. Equalling or exceeding the prescribed quantity is highly essential as too small a quantity could prove to be the needed boron addition to promote even lusher growth. Even distribution of the Borascu is also essential for an even control. We

recommend the use of a fertilizer spreader whenever possible as unequal hand distribution often results in spotty control.

Although there are now many regular users of Borascu there have naturally been cases where the control ranged all the way down to "very poor". It has been our good fortune to have had the opportunity to analyze many of the results and certain definite reasons for lack of control have been evident. There were times when heavy rains falling on sloping land have caused a run off of the Borascu. Other cases which showed control of perennials and no control of annuals proved the rapid leaching theory as it applies to deep and shallow rooted varieties. While the natural hazards of too much or too little rain play their part, we have found that the human element is more the major problem. The public in general do not understand that they are fighting nature and must follow instructions as to quantity and as to method of application. It is evident that we all have an educational campaign to wage as in too many cases the weed inflicted individual thinks that long standing growths can be fully controlled forever with one application of some magic chemical. In analyzing successful results, we find the land has been properly prepared, the correct quantity of Borascu has been intelligently spread and follow up applications have been made when required.

A variety of types of industrial problems and weed conditions have responded to Borascu. One of the principal users of course have been the oil companies who seek the most complete control possible to obtain and must avoid herbicides which have a fire or corrosion danger. The railroads have found it useful particularly in yard or other restricted areas where it is not practical to operate their spray cars. Electric power companies, lumber yards and other general types of business organizations have fitted Borascu into their weed control program. As little as four pounds of Borascu per hundred square feet has proved highly effective on poison ivy and The Palisade Interstate Park Commission found it useful in park areas as a selective herbicide.

We might generally summarize by saying that although it has not been our policy to make any positive claims regarding the effectiveness of Borascu, it has been well received and in many cases used extensively. Since it can be freely handled, is not an inflammable material, is not considered poisonous and does not corrode or rust ferrous metals, Borascu has been favored by the public and has been used to good advantage. We believe it has a place in the weed control picture and welcome the opportunity of working with anyone who has a problem that involves general elimination of unwanted growth.

FROM THE FLOOR: How much Borascu do you usually draw?

MR. SPON: The original work was done on a rod basis, but we broke it down to a hundred square feet of measurement. Most of this work was done ten pounds to a hundred square feet. That seems to be the general use, except for the select control of poison ivy, you get down to four pounds without hurting the surrounding vegetation.

FROM THE FLOOR: What experience have you had along places like a sandy coastline, as in New Jersey?

MR. SPON: Sometimes poor; sometimes good. It depends entirely upon how much rain follows the application. We have done work -- well, this work down at Alexandria; and then again down in Richmond, which was in a fairly sandy soil condition, apparently we got the control before too rapid bleaching had taken place. In other words, we do better on heavy soils than on light soils. The light soil is perfectly all right, providing there isn't too much rain afterwards.

FROM THE FLOOR: Immediately thereafter, or do you wait for a good rainfall down the shore?

MR. SPON: I would say this: you don't get good results in washing material into the land. If you have one of these spring deluges, day after day of hard rain, and the area is such that the rapid bleaching will take place; your excess boron will go down; you get the deep-rooted plants, but some of the very shallow-rooted grass types might not be similarly affected. That is where the retreatment action is necessary.

FROM THE FLOOR: What is the cost per hundred pounds?

MR. SPON: It would vary from section to section. The per ton price today, f.o.b. New York, in most distributors' warehouses in the East, would be \$66.00 per ton.

FROM THE FLOOR: Have you had any experience with this on wild rose?

MR. SPON: No, sir; I am sorry to say -- well, I couldn't answer that directly, because as I said before, our work has been more general in the industrial field rather than specific. We probably killed roses and a lot of other things, but we may not have done it. I am not a botanist.

"The Planning and Organizing of a Ragweed Control Program"  
Philip Gorlin, Department of Health, Bureau of  
Sanitary Engineering, New York City

It is the air borne pollen of many trees, grasses and weeds which causes the seasonal discomfort and misery to more than 7,000,000 allergic individuals in this country. This malady has increased steadily in prevalence since 1890, until now it stands first among the non-fatal chronic diseases. About 65 per cent of the total hayfever sufferers in the eastern part of the country are victims of late summer and fall hayfever, and nine out of ten of these are affected by the pollen of the common and giant ragweeds. In New York City alone, there are probably more than 230,000 persons allergic to ragweed pollen. It is obvious, therefore, that the ragweed menace assumes the aspect of a public health problem.

Not many individuals can afford the luxury of escape to hayfever resorts for the duration of the pollen season, or the series of allergen injection treatments offered by the medical specialists. The anti-histamine drugs such as banadryl and pyribenzamine give only temporary relief and are not effective in all cases. The key to the solution of this problem has been pointed out several years ago by Dr. R. P. Wodehouse, world famous botanist and pollen allergist, who remarked that the most practical way hayfever can be controlled is by treating the environment instead of the patient.

The ragweeds are prolific pollen producers. As much as fifty pounds may be the annual pollen crop from one acre of the giant variety. Most of this pollen pollutes the air in the immediate vicinity of the infested area, but some is picked up by air currents and is carried to high altitudes and for great distances. Fortunately, however, the concentration of atmospheric pollen is reduced rapidly as the distance from the source is increased. In order to bring relief to the great majority of hayfever sufferers it is not necessary to eliminate all pollen from the air, but to reduce its concentration sufficiently, since concentrations below twenty-five pollen grains per cubic yard of air in twenty-four hours usually do not bring about allergic reactions.

It was not until 1946 that economic control of ragweed on a municipal scale was first demonstrated. Using the newly developed plant growth regulator 2,4-Dichlorophenoxyacetic acid, now commonly called "2,4-D", New York City eliminated 3,000 acres of an estimated 10,000 acres of ragweed scattered over an area of 320 square miles during a six weeks' period, employing a variety of converted power spraying equipment. An additional 4,800 acres were treated in 1947. Although other factors may have contributed, the ragweed pollen counts in the city were unusually low during the past two seasons. More than one hundred municipal officials, public health officers, civic leaders and members of community organizations attended a course on the control of plants detrimental to health, which was conducted at New York University in the spring of 1947. Interest has been growing in surrounding municipalities and many of them are already participating in the metropolitan anti-ragweed campaign.

#### Steps in the Program

As soon as the municipal and health authorities in a community decide to develop a hayfever prevention and ragweed control program, a committee of capable persons, including several thoroughly familiar with the various technical aspects of the problem and with a knowledge of the community, should be selected to draw up plans and coordinate the activities of the program. Such a planning and coordinating committee might consist of a health officer, an agricultural specialist and a public health engineer. It is essential that the work be carried on or directed and coordinated by the municipality and that all ragweed areas, whether public or private be treated alike.

A desirable ordinance should provide for the elimination of weeds causing hayfever before the period of flowering and pollination. It should place the authority for weed control on public and private land in the hands of a central agency, and it should not be too cumbersome to be enforced. Only such areas as fenced-in vacant lots, railroad rights-of-way, fence rows, and cultivated fields will present special problems. Notices should be sent to such property owners urging them to cooperate with the authorities in compliance with the anti-weed ordinance. Proceedings may be initiated to collect the cost of eliminating noxious weeds from owners of private properties who are negligent in cooperating, but this should not interfere with, or impede the progress of control operations. If pollination is to be prevented, all the ragweed should be sprayed with 2,4-D before the flowers begin to appear.

A survey of the ragweed infested public and private properties should be made and the data charted on maps. These maps and data will facilitate the planning of the field operations. A detailed technical plan of operations can then be drawn up.

#### Suggested Activities

A desirable ragweed control program for a large municipality might consist of the following suggested activities (smaller municipalities, of course, should do what they can within the limits of their resources):

1. Study of hayfever and ragweed problems.
2. Survey of ragweed infested areas in the community (in New York City, this was done with the assistance of the Police Department).
3. Evaluation of ragweed control methods and their adaptation to local conditions.
4. Compilation of data from ragweed survey maps and reports.
5. Preparation of a detailed plan of operations.
6. Preparation of specifications for procurement of equipment and supplies.
7. Preparation of a cost estimate and budget providing for necessary funds to carry on the activities of the program.
8. Procurement of supplies and equipment and conversion of suitable available equipment for weed spraying work.
9. Preparation and distribution of educational material on ragweed control and hayfever prevention such as exhibits, posters, pamphlets, leaflets, etc., enlisting the aid of educational institutions and civic groups.

10. Planning and conducting adequate training programs for the field and supervisory personnel in the methods and practices of modern weed control.
11. Providing educational courses to the public on such subjects as "Identification and Control of Plants Detrimental to Health."
12. Promotion of the program and enlisting cooperation of communities within an area of fifty miles of the municipality.
13. Supervising the spraying of all the areas included in the ragweed survey, and supplying technical assistance.
14. Providing progress information to the public through the local press during the campaign.
15. Making periodical field inspections to observe progress and efficiency of work, prepare reports and recommend necessary corrections.
16. Providing for investigation of serious complaints and for conducting correspondence with the public.
17. Conducting an ecological study of ragweed in the community.
18. Recording observations of the effect of various concentrations of 2,4-D on the growth, habits, pollen and seed production of ragweed.
19. Setting up several atmospheric pollen sampling stations in strategic locations and conducting a pollen survey during the season, in cooperation with the Pollen Survey Committee of the American Academy of Allergy.
20. Correlating pollen survey data with meteorological and ecological data, using standard methods of measurement.
21. Selecting a suitable substitute soil cover plant and planting it in areas from which ragweed has been eliminated.
22. Directing and coordinating the activities of all the cooperating departments, agencies and field personnel participating in the ragweed control program.
23. Conducting an appropriate public relations program, enlisting the cooperation of public and civic officials.

### Spraying With 2,4-D

Ragweeds can be effectively and economically killed by spraying them with a solution containing 0.1 per cent 2,4-D acid equivalent by weight, from the time they are several inches tall until the flowers begin to develop. In the vicinity of New York City, this period would be from the last week in May until the first week in August. Growth and pollen production can be effectively inhibited without bringing about the rapid death of these weeds by spraying them with a reduced concentration of five hundred parts 2,4-D per million.

Any type of power spraying equipment capable of producing a pressure of fifty to one hundred pounds per square inch at the spray gun nozzle can be effectively employed. Spray guns with nozzles designed to produce a coarse, penetrating, fan-type spray, are recommended for application of this herbicide in towns and cities and areas close to desirable vegetation. Finer atomization of the selective spray in applications to weeds in certain cultivated agricultural areas, such as grain fields, requires the use of specially designed equipment. When applying 2,4-D, care should be exercised to keep the spray and mist away from vegetables, shrubs, trees, flowers and other sensitive cultivated plants.

Various formulations of 2,4-D acid, salts and esters are available in powder, tablet or liquid form under many different trade names. They can be purchased at agricultural and garden supply stores. The cost per pound of 2,4-D content may vary from about \$1.50 to more than \$27.00 depending on the packaging and the formulation, which may contain as little as two per cent or more than eighty-five per cent of the acid equivalent, with or without wetting agents, spreaders, stickers or emulsifiers. The rate of application per acre ranges from one and a quarter to two and one half pounds of 2,4-D acid or from one to two gallons of diluted spray per square rod. The amount of herbicide required will depend on the acreage to be covered, the height and density of the weeds and the 2,4-D content of the formulation used. The recommendations of the manufacturers should be followed carefully.

It is recommended that the equipment used for 2,4-D spraying should not be used for the application of insecticides or fungicides to fruit trees, vegetables or ornamentals, since it is very difficult to remove all residue of 2,4-D from the tank and hose. Recent experiments have indicated, however, that rinsing the equipment several times with a one per cent suspension of activated charcoal after thorough scrubbing with hot water and a good detergent may render the sprayer safe for use on vegetation.

For treating weeds on vacant lots and on other neglected uncultivated areas in towns and cities, each municipal weed spraying unit may consist of the following equipment and personnel:

1. A skid or trailer mounted three hundred to six hundred gallons tank capacity power sprayer, equipped with a fifteen to thirty-five gallons per minute pump.
2. Two one-hundred foot lengths of one-half inch or three-quarter inch heavy duty rubber hose, in fifty inch sections, with couplings and hose reels.
3. Two single or multiple nozzle weed guns, scythe or sickle, assorted spare parts and accessories.
4. A three or five gallon knapsack sprayer, either the compressed air type or a lever-operated continuous action type.
5. A truck or a suitable traction vehicle such as a command car, weapons carrier, jeep or tractor.
6. One chauffeur or auto-engine-man who should act as crew chief and keep records.
7. Two spray gun operators, one of whom should operate the auxiliary knapsack sprayer whenever necessary.
8. One general assistant or laborer to help with the hose and use the scythe or sickle in such areas where spraying with 2,4-D should be avoided.

The number of power spraying units required will depend on the amount of work a crew can do in one day, the size and distribution of ragweed areas and the duration of the field control operations. It was found that a spraying crew can treat from one acre of small scattered areas to about six acres of large open areas in one day. About three acres per day was the average performance in New York City during the two years of ragweed control operations.

The control of ragweed in cultivated agricultural areas is not as hopeless a task as many people believe. With the help of the county agricultural agent and by following the recommendations of the local experiment station, ragweed in rural areas can be brought under control. By adhering to accepted agronomical principles such as crop rotation, cover cropping, clean cultivation and soil conservation practices, supplemented by judicious use of 2,4-D or dinitro herbicides, the farmer can keep these weeds under control and at the same time reap economic dividends.

In order to prevent erosion and guard against the return of the ragweeds in unimproved urban areas, it is desirable to introduce a suitable ground cover plant in the treated areas. Such a plant should be preferably a short-growing, hardy, spreading perennial plant which can be kept under control and which would not cause hayfever. The selection and method of introduction of such plants will require further study and experimentation. The ragweeds are pioneer, non-competitive plants which usually take possession of eroded or disturbed soil. Gradually they are replaced by grasses

and more aggressive perennial plants, followed by shrubs and trees. The use of 2,4-D helps to hasten this ecological process. By its selective action, 2,4-D kills these weeds, but allows the common grasses and other resistant plants to live and increase, thus helping to establish a natural soil cover.

Since very little ragweed grows back in the treated areas, the cost of operation is reduced annually. Several years of intensive cooperative effort will bring this menace to health under control. A program of preventive maintenance, thereafter, will guard against the return of the ragweeds and safeguard the health of hayfever victims.

CHAIRMAN LINK: I wonder, Mr. Gorlin, if you would be willing to tell briefly just what area here in the city you attempted to cover in ragweed control this past year. I was surprised, personally, to find out how much empty land there is in the city of New York. We don't think of the city as having empty spots, where there is a surprising amount of wasteland, and also unbuild land, which is rarely covered with plants here; and it is surprising the amount of the land the city attempted to survey this past year.

MR. GORLIN: We have about three-hundred and twenty square miles of territory that we have been trying to treat, and there are about twenty-one city lots to an acre. You can estimate how many vacant lots we had treated during the past two years. There are about five thousand seven hundred miles of streets through which we had to go to cover this area.

We had about thirty units of equipment operating. We borrowed most of it from all city departments, such as the Park Department, Borough Presidents' Offices, highway departments. We used street flushers, chloride distributors, anything with a pump. We bought about six power sprayers from the United States Forest Service. Those are the only units we have. But they had no traction, so we had to borrow trucks from other city departments to mount. We still haven't got all the trucks.

FROM THE FLOOR: Does that include Staten Island, too?

MR. GORLIN: Yes, Staten Island is one of them.

FROM THE FLOOR: What is the cost per acre?

MR. GORLIN: The cost of the acre is about ten dollars, including the cost of materials and labor; and the cost could be reduced tremendously if we had proper equipment and a permanent organization for control.

FROM THE FLOOR: How much would it have been if you had your own equipment? You did a lot of borrowing here.

MR. GORLIN: If you bought equipment, you could use it, use the same equipment for other uses, after you get through with weeds, because at the end of a five-year period, you wouldn't need very many pieces of equipment for maintenance work. It only requires three to five years where most of the equipment will be used. The cost per gallon of spray amounted to about seven-tenths of a cent.

FROM THE FLOOR: Can you be more specific about the amount of 2,4-D that you put on?

MR. GORLIN: We used mostly the soluble salts, ammonium and sodium salts, because they are very easy to work with. But you can use any of the liquid concentrations; they are just as effective. We used the salts because we decided it would cause the least amount of injury to adjoining vegetation, from evaporation or fumes, such as has been found with some of the esters. We did not want to take any chances.

We applied them at the average rate of about two hundred to two hundred and fifty gallons per acre. The first year, we used one-tenth per cent concentration; the second year, we felt, since our personnel was very inexperienced and they used too much of the liquid, we cut the concentration in half and we applied the right amount of 2,4-D per acre of about one and a quarter to one and a half pounds, average of the 2,4-D equivalent.

"Studies on Control of Littoral Plants with 2,4-D"  
T. F. Hall, Tennessee Valley Authority, on leave,  
Botany Department, Cornell University

Studies have been conducted with 2,4-D in relation to the control of littoral plants of importance in malaria control. In these studies attention has been given to formulations, methods of application, growth aspect at time of application, and where the material should be applied to the plant. There follows a summary of results using lotus as the test plant.

Lotus (Nelumbo pentapetala) was treated at rates of approximately one and three pounds of 2,4-D per acre with various formulations during the 1946 growing season. Duplicate plots were sprayed by hand with a compressed air sprayer and evaluated the same season of treatment and during the following growing season after treatment. The results are given in the following table.

The data indicate that, in general, for the control of lotus the esters are more effective than the triethanolamine salt which, in turn, is more effective than the sodium salt. It should be pointed out that lotus plots which showed the greater resprouting one-year after treatment were those rooted closer to top summer pool level. This suggest that the differences in degrees of control noted with different formulations may not be due to the formulations alone but may be due also, to differences in phenological stages at

Formulation	1 Lb. 2,4-D/A		3 Lb. 2,4-D/A	
	Per Cent	Change*	Per Cent	Change*
	<u>2 months</u>	<u>1 year</u>	<u>2 months</u>	<u>1 year</u>
1/2% sodium salt <sup>1</sup>	-80	+ 8	-78	-13
1/2% triethanolamine salt <sup>2</sup>	-80	- 7	-96	-29
1/2% Methyl ester <sup>3</sup>	-74	-22	-89	-13
5% methyl ester <sup>3</sup>	-89	-41	-92	-54
4% butyl ester <sup>4</sup>	-99	-95	-99	-83
Untreated check	-95	-100	-100	-100
	-97	-100	-100	-16
	-89	+5	-100	-96
	-95	-87	-100	-94
	-86	-89	-100	-100
	+3	-5	+3	-5

\*Average change of cover and density from 10 permanent quadrats per plot.

<sup>1</sup> Dow Chemical Co. and Linck Co.

<sup>2</sup> U. S. Rubber Co.

<sup>3</sup> Dow Chemical Co.

<sup>4</sup> Sherwin Williams Co., Butyl ester applied at 0.8 and 2.4 lbs. 2,4-D/A.

the time of treatment and growth stages thereafter. Plants in shallower water in early summer at the time of treatment, commonly, were in more advanced phenological stages than those in deeper water. The methyl ester is known to be highly effective for the control of lotus in both low and high concentrations (1/10% to 20%). The results, in the table, for paired plots treated at 2 1/2 gallons/A of 5% methyl ester (1 lb. 2,4-D per acre), show that after one year the plot in slightly deeper water showed 100% control whereas the plot in shallower water showed no control. The sodium salt and tri-ethanolamine salt plots were in shallower water, and the heavier resprouting noted might be attributed to differences in growth stages at the time of and following treatment. Additional limited tests with the sodium salt have been followed by heavy resprouting, but other tests with the triethenolamine salt applied in deeper water have yielded excellent control one year after treatment. On the basis of all tests with 2,4-D formulations on lotus, the esters are considered to be more toxic than the triethenolamine salt, and the sodium salt is considered to be the least effective.

During the 1946 season, 10% 2,4-D dusts were applied to lotus plots by means of a hand rotary duster at 2.5, 5.0, and 10.0 lbs. 2,4-D per acre. The results are given in the following table.

<u>Lbs. 2,4-D/A**</u>	<u>Per Cent Change 30 days *</u>	<u>Per cent Change 1 year*</u>
2.5	-76	-100
5.0	-98	-100
10.0	-98	-100

\* Average change of cover and density from 10 permanent quadrats per plot.

\*\* Dow 650, Dow Chemical Co.

The data in the above table show that the 10% 2,4-D dust is very effective for the control of lotus applied by a hand rotary duster at discharge rates at least as low as 2.5 lbs. of 2,4-D per acre. These results also emphasize the importance of the time factor in evaluating results i.e., 76% control at 30 days but 100% control after one year.

Experimental airplane test flights with 2,4-D formulations were made during the 1946 season and were appraised during the 1947 growing season. The appraisal of these test plots one year after treatment follows. Colonies treated with the butyl ester 72% 2,4-D at discharge rates of about one pint and two pints per acre per 100 foot swath showed heavy resprouting even in deep water. The plot treated with butyl ester 40% 2,4-D in kerosene at a discharge rate of about three pints per acre per 100 foot swath showed 100% control in deeper water but resprouted heavily in shallower water. The colony treated with the methyl ester 20% 2,4-D at a discharge rate of about 1 gallon per acre per 100 foot swath showed essentially 100% control in deeper water over a swath width of some 300 feet, or an average dosage less than one-half pound 2,4-D per acre. The triethanolamine salt 27% 2,4-D applied at a discharge rate of about three quarts per acre per 100 foot swath gave excellent control of lotus over a swath width approximately 100 feet in deep water. The triethanolamine salt 27% 2,4-D applied at 3 lbs. of 2,4-D per acre gave essentially 100% control of lotus over the 35 acre treatment area.

The effectiveness of 2,4-D in controlling littoral plants have been studied by the quadrat analysis method on some 25 species, and in addition, general observations have been made of its effect on some sixty species. The following plants have been controlled readily with 2,4-D at least under certain conditions: lotus, cocklebur, giant ragweed, sycamore, black willow, black alder, water primrose, parrot's feather, square-stem spike-rush, dianthera, beaked rush, tupeol gum, and soft rush and others. The following species were not readily controlled with 2,4-D: giant cut-grass, lizard-tail, green ash, buttonball, cat-tail, perennial smartweeds,

rice cut-grass, bladderwort, milfoil and others. Susceptible woody species, such as willow, were controlled more readily in the full leaf stage with foliage sprays than in the freshly sprouting stage. Herbaceous plants varied considerably in their response to 2,4-D sprays applied at different seasons depending upon the species involved. The growth stage of the plant at the time of application often appears to be important in relation to the degree of control obtained.

"Effect of 2,4-D Airplane Spray on Cotton"  
T. F. Hall

Previously, airplane applications of 2,4-D sprays, including the butyl ester, methyl ester, and triethanolamine salt, have been made successfully to certain littoral plants in reservoirs without evidence of excessive "drift". In all of these instances the maximum drift observed was well within a few hundred feet of the treatment area as reflected by the subsequent development of formative effects in highly sensitive plants such as cocklebur and trumpet vine. In the early summer of 1947, formagenic effects were found in seedling cotton up to one and one-half miles distant from the block treatment area where the full butyl ester concentrate was applied at a rate of approximately 3 pints to the acre (about 3 lbs. of 2,4-D per acre) with a Vultee BT-13A spray plane. Cotton which was not above the soil surface at the time of application showed no visible response to 2,4-D. On the other hand, seedlings above the soil surface at the time of exposure to 2,4-D responded by (1) a suppression of growth of the apical bud, (2) an increase in emergence of axillary shoots, (3) abnormally dissected leaves, and (4) pebbling of the leaf blades. The degree of the response appeared to decrease directly with the increase in distance from the treatment area. The formative effects were produced only in new growth emerging a short period following the exposure of the plants to 2,4-D. The plants subsequently produced normal foliage, flowered freely, and apparently produced a normal crop.

Because of the experience of formative effects appearing in seedling cotton up to one and one-half miles from the block treatment area, the airplane applications of 2,4-D concentrates in routine areas for the control of plants important in malaria control where cotton is prevalent has been temporarily abandoned in the Tennessee Valley. Temporary abandonment of such airplane treatment has been made during the active cotton growing season pending the accumulation of additional information on the operation. It is not known whether or not the formative effects observed were due to drift of particles, fumes, possible dribble from check valves, or material carried in the wake of the ship maneuvering in the area. Regardless of the factor or combination of factors involved, this experience shows that extreme caution should be exercised if one contemplates applying 2,4-D sprays by airplane in a region where cotton is prevalent. Although the light dosage of

2,4-D on cotton seedlings did not prevent fruiting, it should be pointed out that drift from a ground spray unit on cotton while in flower bud and in flower decreased the yield markedly with unmistakable 2,4-D injury to the crop.

"Weed Control as Related to Mosquito Control on New Jersey Salt Marshes"

Elton J. Hansens, New Jersey Agricultural Experiment Station

Mosquito control on the New Jersey salt marsh has long been hampered by dense vegetation growing along ditches or over the entire marsh. This is particularly true in the northeastern part of the state where the tall foxtail grass, Phragmites communis, grows to a height of 10 to 15 feet. Another troublesome plant which is more abundant farther south in the state is the salt marsh elder, Iva oraria. When this plant invades a salt marsh it is first found along ditches and from there may spread over the entire marsh.

The usual method of mosquito control on the salt marsh is by cutting ditches so that tide water will circulate through the marsh and so that salt water minnows will have access to all parts of the marsh when it is flooded by high tides. The combination of circulation and fish prevents the development of mosquito larvae to maturity when marshes are flooded. Construction and maintenance of ditches is made much more difficult on some 30,000 acres of marsh in northeastern New Jersey by the dense growth of foxtail. Within a year or two after ditches are constructed, foxtail starts to invade the ditches and necessitates more frequent cleaning of ditches than would otherwise be necessary.

It is also necessary to inspect and spray ditches for breeding at weekly intervals in many areas, especially where there is pollution which deters fish. In such areas it is necessary to remove foxtail from the ditch banks so that personnel and equipment can get through. The cheapest method so far developed to curtail foxtail has been to roll the ditch banks with reed-crushers -- caterpillar tractors fitted with wide treads and angle irons to chop the crushed grass. This is a costly operation, costing as much as \$5,000 per year in one county.

Obviously foxtail interferes with ditch construction and maintenance and with larviciding operations. However, even more important, the dense growth of foxtail on many marshes has made it impossible to control adult mosquitoes. In the past few years numerous attempts to kill adult mosquitoes in the marshes before

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they moved out into populated areas have met with failure, whether the applications were made from the air or from the ground. DDT applied at the rate of four pounds per acre did not control adult mosquitoes. When applied from the air the downdraft from the plane was sufficient to flatten the leaves of the plant into an effective thatch roof eight to ten feet above the ground. The DDT was deposited on the leaves but since the mosquitoes spend most of the daylight hours in the grass close to the ground they were unaffected. Results with ground sprays were similar. Fogs also did not penetrate to the ground as evidenced by cage tests where mosquitoes were placed in screen cages on the ground, 3 feet and 6 feet above ground and were all killed only at the higher level.

A weed killer which would control foxtail, it is evident, would be of considerable value in mosquito control work. Consequently applications of 2,4-D (2,4-dichlorophenoxyacetic acid) and other weed killers were made on foxtail starting in 1945 in a search for a cheaper and easier way to dispose of this plant.

In the southern part of the state the salt marsh elder (Iva oraria) hinders ditching operations. It is not as serious a problem as foxtail but is a pest over larger acreages. Usually it first invades a marsh along the ditch banks and later may cover the entire marsh. This low growing shrub makes a marsh useless for growing salt hay and where there is a dense stand may clog caterpillar treads and otherwise interfere with ditch-cleaning and recutting operations. Tests of weed killers against this plant were also undertaken in 1945.

The initial tests in 1945 of 2,4-D against these two plants were promising. 2,4-D and "Ammate" (ammonium sulfamate) severely injured foxtail while ammonium sulfate and a material containing dinitro orthocyclohexylphenol were non-injurious. Salt marsh elder was killed very easily with low dilutions of 2,4-D.

The success of these tests led to more extensive experiments in 1946 in cooperation with several of the County Mosquito Extermination Commissions.

#### Treatments of Salt Marsh Elder

Tests of 2,4-D were made against the salt marsh elder on the Cheesequake Meadow in Middlesex County. Materials used included (1) the sodium salt containing 70% 2,4-D; (2) the alkanol amine salt containing 20% 2,4-D; and (3) a miscible oil preparation containing 12% of the methyl ester of 2,4-D. These materials were applied to the plants with a knapsack sprayer at concentrations of 500, 1000, and 2000 ppm of 2,4-D on May 20. A second set of plots were sprayed at concentrations of 250 and 500 ppm on June 28. The leaves were wetted thoroughly with a fine mist. In both cases the day was warm and rain did not occur for more than four hours after treatment. All treatments on both dates killed the salt marsh elder except in a few places where single plants were apparently poorly sprayed.

Death of the plants occurred one to three weeks after treatment, preceded by the characteristic curling and twisting of leaves and twigs. Examinations in August and in the spring of 1947 showed that the stand of salt marsh elder was eliminated, even at the low dosages of 250 ppm of 2,4-D. Tests in Atlantic County produced similar results.

#### Treatments of Foxtail Grass

Tests of 2,4-D on foxtail grass were made at Seidler's Beach in Middlesex County. Materials used were the same as those applied on salt marsh elder. One-quarter acre plots were sprayed on May 23 with the three materials at 500, 1000, and 2000 ppm. A power sprayer developing 200 pounds pressure was used in making applications, and spray was applied at the rate of 100 gallons per acre. At the time of spraying the grass had already reached a height of 4 to 6 feet.

No appreciable damage resulted from the application of either the sodium or alkanol amine salts of 2,4-D. However, the miscible oil preparation containing 12% of the methyl ester of 2,4-D had marked effects on the plants. At 500 ppm this material stopped growth of the grass by killing the growing tips. A month after spraying, the plants were shorter than when they were sprayed, the reduction in height being due to the dying of the tips of the plants. Severe injury to the whole plant resulted when 1000 and 2000 ppm were used. Leaves turned brown, stems were weakened, and lodging of the grass resulted. Injury appeared more quickly and was more severe when the 2000 ppm concentration was used.

On June 27 half of each plot sprayed with the miscible oil preparation was resprayed and an additional series of plots was sprayed with this material. On the areas which were sprayed a second time new injury was evident in all plots. However, there was no sharp line of demarkation between the halves of the plots which had received one and two spray applications. The new plots showed injury the same as obtained with the original plots.

Ammate was applied on June 27 using 1 pound and 1/2 pound of the material per gallon of spray. Applications were made at the rate of 100 gallons per acre. Immediate burning of foliage resulted but plants were not killed.

In 1947 these six plots were again sprayed with the same concentrations used previously. The foxtail has not all been killed in any of the plots but the stand of grass has been thinned markedly. On the 1000 and 2000 ppm plots it would now be possible to do mosquito control without difficulty. It seems possible that one spray a year of the miscible oil preparation at the rate of 1000 ppm would give satisfactory control of foxtail as far as mosquito control is concerned. However, more research is needed with the aim to kill foxtail with a single application of a weed killer.

### Summary

Studies were made of the effect of 2,4-D (2,4-dichlorophenoxyacetic acid) on the salt marsh elder (Iva oraria) and foxtail grass (Phragmites communis). Materials used were as follows: (1) the sodium salt containing 70% 2,4-D; (2) the alkanol amine salt containing 20% 2,4-D; and (3) a miscible oil preparation containing 12% of the methyl ester of 2,4-D. The materials were sprayed on foliage as a fine mist at the rate of about 100 gallons per acre. Salt marsh elder was killed by all of these materials when used at 250, 500, 1000, or 2000 ppm. The miscible oil preparation severely injured foxtail grass. Growing tips of the grass were killed by 500 ppm of the material, and more severe injury resulted from 1000 to 2000 ppm.

It is desirable to destroy such plants as foxtail and salt marsh elder for improved mosquito control operations but the destruction of all vegetation on the marsh would only increase the mosquito control problem. The preservation of the shorter salt marsh grasses is necessary since their roots serve to bind the soil on the ditch banks and prevent their rapid erosion. Also the grasses other than foxtails are an economically valuable pay crop.

"Present Status of 2,4-D as a Brush Killer"  
Ralph Kaufman, Astlundh Tree Expert Co.  
Jenkintown, Pa.

Our original report on the experimental work of last year was on 2,4-D applied in varying dosages, with water carrier and a hydraulic sprayer. We can pull down the curtain on that phase of the work in favor of something better. Two main factors prove it unsound. First, the difficulty in moving heavy equipment over at least 50% of all overland right-of-way and incidentally keeping the rig supplied with water on rough or arid terrain. Second, waterborne 2,4-D did not produce the brush kill we, or our clients are looking for. Some of it looked good at the start but did not follow through as well as early signs indicated. Too many species of brush show a high resistance and re-developed into healthy sources of trouble. It did produce a stunting and some topkill, but the best results varied from 50 to 60% efficient kill on a good cross section of the different locations sprayed.

The skepticism generated from this experience came very close to halting the work in favor of the proven methods; hand cutting, discing, blading, or mowing.

We tried various rigs that might possibly be adapted to our use and continued testing available forms of 2,4-D.

In spite of skeptics and unfavorable results, some of us felt that 2,4-D would kill anything on the right-of-way if properly applied in effective concentrations. Persistence in that belief and

experiments constantly applied have borne results to a point where we now have a 2,4-D application that shows at least a 50% better kill than anything we have previously tried.

We have not had a complete year to evaluate the material or equipment and will not make any further claims until we do. It looks good and points conclusively to positive economic and efficient success.

Early in the year we made a contact with the American Chemical Paint Company, manufacturers of 2,4-D, who believed as we do, that killing brush on right-of-way is a far different problem than selective weed killing. They have cooperated wholeheartedly with us to perfect carriers and concentrations of 2,4-D and we have put them on right-of-ways in various parts of the country. Thereby getting not only our own reaction, but that of the utility men it will be applied for.

The product is not on the market and will not be until we are sure the formula is as good as we can make it. Even then we will continue to experiment to improve and take advantage of experience gained in actual application.

Our application equipment consists of a tank carried on each man's back, it contains the basic 2,4-D solution under air pressure. This is connected by hose to a wand the operator carries, fitted with nozzles to spray a six foot swath at his side. Instead of figuring in quantities of 150 to 300 gallons of water we can now cover an acre of brush with from 6 to 8 gallons of our brush killer. The coverage is even and goes to work much more rapidly than water-borne 2,4-D.

Each man so equipped is a self-sufficient unit and can spray anywhere he can walk.

We can apply our material on wet brush, immediately before or after rain. We have applied it in showers with no loss of material or cut-back in results.

The work we have done proves that ideal brush for spraying is from 12 to 36 inches tall and not over 48 inches. Taller brush can be sprayed, but it requires more material and labor and the dead brush does not decompose as rapidly over four feet as it does below that height.

We can kill briars and brambles. The two most resistant species of brush are ash and maple. We have also killed them to ground level by varying concentrations and carriers. Digging roots after all foliage on surrounding living trees has fallen will tell the story on root kill.

We believe that a right-of-way should be conditioned, that is, cut cleanly with stumps as low as possible, then sprayed the following year as soon as growth has attained 12 to 36 inches of growth for best results. Old stumps with large root areas and relatively few suckers require more and a stronger application than brush having a root and top that is normal or balanced.

Some of the test plots sprayed show a good 95% kill on brush, with weeds and brambles taking over. The bramble having been covered by the taller brush are not thoroughly sprayed, and continue to grow. To insure a complete kill and a clean right of way, it appears that such conditions indicate a follow-up treatment.

The accumulative kill will leave your right of way in far better condition than one which has been cut over forcing three or four suckers where only one was cut.

2,4-D or any other chemical will not work miracles. Seedlings from parent trees will germinate on cleared right of way. Some undergrowth that was completely covered by taller vegetation will perhaps be missed in spraying. The human element to err can account for some regrowth. Present indications are that we can do a real job with 2,4-D, thereby taking advantage of its characteristic of being harmless to animal and human life, and the cost will be far less than cutting or treating with heavy equipment.

With our form of application we can definitely control drift. That eliminates another hazard which caused concern.

We are now ready to offer utility men a 2,4-D spray that will produce the results we and they are looking for. Fantastic claims at this stage of the game have no part in our program. Our desire is to offer you an efficient job at the most economical figure.

"Controlling Woody Plant Growth by Chemical Means"  
Lawrence Southwick, Dow Chemical Company

You have already heard a lot of discussion on controlling woody plant growth by chemical means. A good many chemicals can be used, e.g., borax, chlorates and oil. Probably the most talked of chemical to control woody plants is, as you know, 2,4-D. Now, 2,4-D is a growth regulating compound; it is a growth substance material and does not control primarily by a contact action.

In controlling woody species, there are several places where a spray program can be used to advantage. For instance, on public utility rights-of-way, 2,4-D is being used successfully in a commercial way, on roadways, particularly for such species as poison ivy and poison oak, and on ditches, making them less of a nuisance as mosquito breeding places, and so on.

You can use these growthregulating materials in sylvan culture, to relieve stands from undesirable species.

Susceptibility of species to 2,4-D varies. We can make no generalizations regarding it. For instance, American Elm, we found out to be more susceptible than Winding Elm. Some oaks are more susceptible than other oaks, and so on. Red Maple is a little bit more susceptible, perhaps, than Sugar Maple or Hard Maple. There are various differences within generic groups, and you cannot make an overall statement regarding susceptibility of species to 2,4-D.

We have found in our testing work and in commercial application, at least fifty common species of brush, which are a menace at times on rights-of-way and these other areas that I have talked about, to be well controlled with 2,4-D.

I want you to notice that I say "controlled"; I don't say "eradicated." Nor do I say "killed". I say "controlled." Because you can often times control a plant by using a growth substance material that is stopping the growth, keeping it down; perhaps kill it down to the ground level; and it may recover to a certain extent. Any of you who have worked with brush, with woody species of plants, know that recovery is more often the rule than complete kill.

That doesn't necessarily mean that 2,4-D wouldn't kill that plant or eradicate it, if it is applied often enough. But I will come to that a little later.

Some species, we found quite resistant to 2,4-D. Those include such species as White Ash, some of the oaks; hickory, Osage Orange and brambles.

In our right-of-way work, we found that we got fairly good control of a good many woody species, only to find that the brambles took over; and linemen do not like to walk a right-of-way which is covered with brambles.

We did find out this past year that another chemical, kin to 2,4-D, controls brambles very well. That is 245T. Instead of 2,4-D, I will refer to that as 245T.

245, in limited tests, has shown excellent control of brambles, including raspberry, blackberry, and excellent control of Osage Orange, which is called Hedgerow Plant in some areas of the South; guava, certain hawthornes. There are possibilities on mesquite, which is more or less of a Texas plant and is in other Southern areas.

Not only is 245T effective on these 2,4-D resistant species, it seems to be more effective as a stump treatment than does 2,4-D, that is, when you use oil for stump and stump treatment.

The possibilities of 245T have not been fully evaluated, and I would like to just repeat one statement that Dr. E. J. Krause, of Chicago, the University of Chicago, made at the Chicago meetings: he said, "245T, I can add, will probably do everything that 2,4-D will do and a lot more." That was his summation of the possibilities of 245T.

Now, as far as formulations are concerned, whether you are using 2,4-D or 245T, or perhaps some other growth substance chemical that may prove effective, we have found on woody species that the ester formulations in oil, applied either in oil, in low volume applications, or applied in higher volume applications, as water-oil emulsions, have given much better results -- or I would say, more consistent results, than the salts, either the amine salts or the inorganic salts; so that, in general, we would not recommend the use of salts for an overall brush control program.

Salts will control some species very nicely, such as sumac and willows. But the species more difficult to control are much more resistant to salts than they are to the esters. We feel that tests have shown that it is due to one thing in particular, and that is that the esters are soluble in the leaf wax - the salts are not; it may crystallize outside of the leaf and may not even get into the plant unless they have a long interval of moisture contact.

The general recommendations that are being made for the use of 2,4-D and 245T, the esters on woody species, are to cut the brush and to treat either the stumps with a one to five per cent solution of the material in oil, or with approximately a three-thousand parts per million spray. After the regrowth has reached the height of two to three feet, a three thousand parts per million spray, about a hundred gallons to the acre, has given excellent results in our tests; better results than using low volume applications in oil. The reason for that, we feel is that we don't get adequate coverage, adequate and uniform coverage of the plant, with a low volume application, particularly where the brush is thick.

We have received some excellent kills, if the brush isn't too thick and with some certain species, with oil in volumes as low as ten gallons to the acre. But, in general, we would recommend the use of water emulsions, at a hundred to one hundred and fifty gallons to the acre; and that program is being carried out commercially today in several states.

This year there will be available in a limited way 245 in ester formulation of trichlorophenoxyacetic acid, and there will be some use of this material in combination with an ester of 2,4-D formulation. In other words, we will have fifteen hundred parts per million of 245T and fifteen hundred parts per million of 2,4-D, which will give us a better overall program, control program, than 2,4-D alone. We are not certain whether 245T will do everything that Dr. Krause said it will. We would rather have the mixture, and, of course, there is not a sufficient supply of 245 tri available this year for extensive use.

There is another way of using growth substance materials, which looks pretty promising, and that is bark treatment during the dormant season. As you will recall, yesterday one of the speakers suggested or stated that 2,4-D, or growth substance, can be taken up through the leaves, through the roots and through the bark. Well, we have found that very true. In some of our tests on elm, for instance, was treated in February and March, when they were about three feet high from the ground; and those elms, with no cut at all on them died.

The older the bark gets, the older the tree gets and the less chance you will have of getting that 2,4-D into the live tissues.

There has been one other development in the use of another chemical for controlling brush through bark treatment, and that is using Di nitro ortho cresols, or DN contact weed killer, at about five-hundredths of a pound of toxicant per gallon, and applying that during the growing season on the bark of, for instance, aspen. Michigan State College reported quite good results with that material. An interesting part of it is, they did not get the amount of regrowth that they sometimes get in using 2,4-D and other chemicals.

To sum up this presentation very briefly, there is a place for other types of weed killers, but I think these growth substance weed killers have the following distinct advantages: in the first place, they are not dangerous to use. They are not dangerous to personnel using them. There is no poisonous hazard to livestock or to animals in the treated areas. There is no fire hazard. These materials, these formulations are not corrosive to equipment, which is rather important.

2,4-D and 245 tri and some of these other growth substance materials, are not harmful to grass cover.

That is very important. Following the use of soil sterilants you may get soil erosion, and on power line rights-of-way and on roadsides you don't want to destroy the grass; you want the grass there. You can use these hormone materials and kill the broad-leaved weeds and the woody species, and let the grass remain.

With repeated treatments, you can kill entire plants. Some species of woody plants you can kill with one application but some species will require more than one application.

The material is concentrated. It is not bulky to carry. It is easy to handle and use; and, in general, it is inexpensive.

We have found that 2,4-D and 245 tri can be applied any time in the spring, from the time of full leaf development to the first frost, and get good control of brush when it sprouts or the regrowth are sprayed.

If you spray tall trees, you don't get the results that you get from vigorous sprouts. Those vigorous sprouts are in a rapidly growing condition, and you can apply the materials any time, anytime they are growing vigorously, which is usually entirely through the summer, except on very dry soils.

MR. HALL: I'd like to ask Mr. Southwick a question: have you run into any woody species, wherein you spray after actual bud emergence, up to the time they are in full leaf, which is controlled readily in that stage?

MR. SOUTHWICK: We have just had a little work on that. That is mostly bark -- we'd call it a "bark treatment" or a stump treatment.

But work is limited in that. Our general recommendations are to wait until we get full leaf expansion.

MR. HALL: That checks very nicely with everything that we are running into, once you get full leaf expansion.

FROM THE FLOOR: Have you had occasion to use it on thorn apple?

MR. SOUTHWICK: Yes, it has been used on thorn apple, with variable results. It probably takes some pretty high concentration, and we think that 245 tri holds much greater possibilities for thorn apple control, speaking of the hawthorn type.

MR. HALL: Is 245 more active on ash than 2,4-D?

MR. SOUTHWICK: The initial work is very preliminary; has shown no advantage on white ash.

FROM THE FLOOR: What woody species, other than rubus, are readily susceptible to 245 that 2,4-D does not affect?

MR. SOUTHWICK: Osage orange, brambles; some of the hawthornes, guava and mesquite. That is about it. We don't know all the species.

FROM THE FLOOR: Will you describe the bark treatment in a little more detailed fashion, that is, as to how it is done?

MR. SOUTHWICK: Well, it can be done either by painting it on or by spraying it. That is all there is to it.

FROM THE FLOOR: No cuts?

MR. SOUTHWICK: No cuts.

CHAIRMAN LINK: Is that used in oil, or --

MR. SOUTHWICK: In oil.

FROM THE FLOOR: Should the spray encompass the tree, if you are going to do it by spraying, or will one side application do it?

MR. SOUTHWICK: Spray all of the bark on all sides. That method is just in the initial stages of development. I don't want to intimate that that is proven for commercial use.

FROM THE FLOOR: What concentrations are used in bark spraying?

MR. SOUTHWICK: Anywhere from one to five per cent; one to five gallons in a hundred gallons of oil.

The business meeting of the Northeastern Weed Control Conference was convened at 2:30 P.M., February 13, 1948, in the Grand Ballroom of the Hotel Commodore, New York City, N. Y., G. H. Ahlgren, presiding.

CHAIRMAN AHLGREN: Will the session please come to order.

We will begin with the report of the Secretary-Treasurer, Dr. Sweet.

DR. SWEET: In 1947 we had a modest beginning at Ithaca and took in the grand total of \$68 in registration fees. We had a printing bill for this program of \$28 and a postage bill for sending you the minutes of the last meeting and sending out some of the programs in advance, amounting to \$28.

Since the Program Committee was scattered, it meant that we had to telephone and telegraph, running up a bill of \$10.

With the service charge involved in the checking account, we have just about one dollar left from last year.

We had some anxious moments this year until, about ten o'clock this morning, we knew what the registration would be. We had a commitment of 125 luncheons at \$3.51 each to which we were committed for two days, and we had just 79 who had indicated that they were coming to the convention. However, business picked up.

Our total income was \$2,016.50. I haven't the exact count of the folks who attended the luncheons, but using an average figure, we come out with a bill to the Hotel Commodore, at \$3.51 each per plate, of just under \$1,300.

We do not have all the bills for running this convention, and we do not know what the Publications Committee is going to run into in the way of expense in getting out the proceedings, but it looks as though we may have more than one dollar left in our treasury, because we should have about \$700 to go towards getting out those proceedings.

Before the conference is over, I hope to have a little more formal report, so that perhaps some auditors could look at it.

CHAIRMAN AHLGREN; You have heard the report of the Secretary-Treasurer. What is your pleasure?

(Several members moved and seconded that the report be accepted. Upon a vote, it was carried unanimously.)

CHAIRMAN AHLGREN: So ordered.

At this time, we might well proceed with the report of the Nominating Committee regarding the officers of this organization for next year.

DR. DICKINSON: Mr. Chairman, gentlemen: The Nominating Committee has met and wishes to submit the following nominations to the conference.

Chairman - G. H. Ahlgren  
Vice Chairman - B. H. Grigsby  
Secretary-Treasurer - Robert Sweet

In nominating the same slate of officers, the Committee wants to emphasize that they do not wish to set a precedent for the future, but for this next year, since the Northeastern Weed Control Conference is still in its infancy and since the present officers have done such excellent work starting the organization on the right path they are now in a position to give even better guidance for the coming year.

CHAIRMAN AHLGREN: I am not quite sure how to interpret that report. I know there is a lot to one of these jobs.

You have heard the report of the Nominating Committee. Are there any nominations from the floor?

MR. SPICER (Stamford, Conn.): I move that the nominations be closed and that the Secretary be instructed to cast a ballot for the slate as presented by the Nominating Committee.

(The motion was seconded by several members and, upon a vote, was carried unanimously.)

CHAIRMAN AHLGREN: I appreciate your confidence in me, and I assure you that I was not looking for this job. I also want to assure you that I have a great deal of interest in this weed work and that I shall do what I can to see that this work develops in a vigorous manner and on as sound a basis as possible for the Northeast Region here.

Is there any old business?

I take it we are all prepared to start the new year out without any skeletons from the past, then.

Is there any new business?

Concerning the publication, those of you who gave papers and who did not have your information taken down or who need to have your papers cleared, I would like to remind you that they should be sent to Dr. Ben Wolf at Seabrook Farms at your very early convenience.

As far as I can see, if there is no new business, this will conclude the business part of the afternoon's program. I would like to explore the Committee reports for a moment with you.

We have only a skeleton group here, so I will be glad to have you decide whether or not to present the reports.

DR. PRINCE: I move that those reports be omitted.

DR. DICKINSON: I second the motion.

(Upon a vote, the motion was carried unanimously.)

CHAIRMAN AHLGREN: You can read these reports in the publication. So ordered.

It seems to me, then, that this concludes the second meeting of the Northeastern Weed Control Conference.

Personally, I would like to express to you my appreciation for all the cooperation given this group, and I would like especially to express to Dr. Harris and Dr. Ben Wolf how much I appreciate their help -- they did most of my work; I did little except appear here before you yesterday and today.

I would also like to thank Dr. Musser of Penn State for all the extra effort that he and his group put in to make this program a success. I assure you it could not have been a success without their help and without the help of each and every one of you here.

A motion to adjourn is in order.

DR. WALKER (Hempstead, L. I.): I so move, Mr. Chairman.

MR. CROSS: I second the motion.

(Upon a vote, the motion was carried unanimously. The Conference adjourned at 3:15 p.m.)

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John Bean Mfg. Co.

Smart, John L.  
Collingwood, Ontario, Canada

Smart Bros., Ltd.

Smith, Allen Elston  
31 Main Street  
Beacon Falls, Conn.

Naug. Chemicals

Smith, George E.  
R. D. #4  
Bethlehem, Pa.

Producer

Snyder, George Russell  
Box 10  
Montreal, Canada

Canadian Industries, Ltd.

\*  
Southwick, Lawrence  
Midland, Michigan

Dow Chemical Company

Spicer, Orville M.  
Stamford, Conn.

The F. A. Bartlett Tree  
Expert Co.

Spon, Francis S.  
51 Madison Avenue  
New York, N. Y.

Pacific Coast Borax Co.

Stark, Frank L.  
Stamford, Conn.

American Cyanamid Co.

Stegall, Goodwin F.  
142 W. Chestnut St.  
Brockton, Mass.

American Cyanamid Co.

Steiner, Harold M.  
Flora Dale, Pa.

M. E. Knouse Farms

Stoddard, John Russell  
1 Park Avenue  
New York, N. Y.

John Powell & Co., Inc.

Stoltzfus, Chris.  
Coatsville, Pa.

Airplane Dusting & Spraying Corp.

Strain, Franklin  
Barberton, Ohio

Pittsburgh Plate Glass Co.-  
Columbia Chem. Div.

<u>Name and Address</u>	<u>Representing</u>
Strasun, Alexandre S. 135 Hoboken Avenue Jersey City 2, N. J.	Reade Mfg. Co.
Straube, Harold L. 1 Park Avenue New York, N. Y.	John Powell & Co.
Sweet, Harold A. 435 Hudson Street New York, N. Y.	General Dyestuff Co.
Sweet, Robert D. Cornell University Ithaca, N. Y.	Vegetable Crops Department
Switzer, Maurice F. 138 Ford Street Newark, N. J.	Jackson & Perkins Co.
Tafuro, Anthony J. G.L.F. Soil Bldg., Ithaca, N. Y.	G.L.F.
Tidwell, Charles H. 341 - 68th Street Brooklyn 20, N. Y.	Chipman Chemical Co., Inc.
Tischler, Nathaniel 317 Leconey Avenue Palmyra, N. J.	Sharples Chemicals, Inc.
Tullis, Edgar C. P. O. Box 2967 Beaumont, Texas	United States Department of Agriculture
Turner, James A. 409 Ocean Avenue Lakewood, N. J.	Esso Standard Oil Co.
Van Alstine, Ernest Agronomy Department Ithaca, N. Y.	Cornell University
Van Geluwe, John D. G.L.F. Soil Bldg., Ithaca, N. Y.	G.L.F.
Van Kesteren, John Jr. Onancock, Va.	Self
Vermeulen, John Box 441 Westbury, N. Y.	John Vermeulen & Son Nurseries

<u>Name and Address</u>	<u>Representing</u>
Viggars, Richard M. Greenhill and Second Wilmington, Del.	F. A. Bartlett Tree Expert Co.
Walworth, Bryant Lenark Road Stamford, Conn.	American Cyanamid Co.
Walker, Charles 5 Maple Street Westbury, N. Y.	Harder Exterminating Service
Walker, Harry G. P. O. Box 4388 Chestnut Hill Philadelphia 18, Pa.	Pa. Salt Mfg. Co.
Weeks, R. W. Box 54 Quinton, N. J.	Esso Standard Oil Co.
Weirich, Clarence L. Westport, Conn.	C. B. Dolge Co.
Welborn, Russell W. 500 S. Main Street Akron 18, Ohio	B. F. Goodrich Research Dept. 2235
Whitten, M. H. Presque Isle, Maine	Maine Potato Growers, Inc.
Wilcoxon, Frank 142 Hollow Tree Ridge Road Noroton Heights, Conn.	American Cyanamid Co.
Willard, Charles J. Ohio State University Columbus 10, Ohio	Ohio Agric. Expt. Station
Wilson, Charles G. Room 307, South Bldg., Bureau of Plant Industry Beltsville, Md.	U. S. Golf Association Green Section
Wolf, Benjamin Bridgeton, N. J.	Seabrook Farms
Wolf, Dale E. Rutgers University New Brunswick, N. J.	New Jersey Agricultural Experiment Station

Name and Address

Representing

Yoder, Rufus Wayne  
Lancaster Hall  
R. D. #7  
Lancaster, Pa.

American Cyanamid Co.

Yowell, Howard L.  
Esso Laboratories  
Chemical Division  
P. O. Box 243  
Elizabeth, N. J.

Standard Oil Development Co.

Zabriskie, John Earl  
86 North Road  
Nutley, N. J.

Gulf Oil Corporation

Zeppenfeld, William W.  
445 Park Avenue  
New York, N. Y.

Monsanto Chemical Co.

Zink, Frank J.  
141 W. Jackson Blvd.  
Chicago 4, Illinois

National Sprayer & Duster Assoc.

\*Snyder, William E.  
Dept. of Floriculture  
Cornell Univ.  
Ithaca, N. Y.