WHAT A UTILITY EXPECTS OF

CHEMICAL BRUSH CONTROL

By
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The investor-owned tax-paying electric utility, like any other business enterprise, must closely scrutinize the value received for each dollar spent. As labor and material costs continue to rise, new methods and improved materials must be developed if we are to continue to supply good service at reasonable rates.

When applied to brush clearing, let us consider the chemical treatment of right of ways since this is probably one of the most extensive fields of brush control.

The application of chemicals for brush control on a large scale was conceived about 20 years ago and developed as a substitute for brush cutting. The development of this method has been steady and successful to the point of being accepted as the standard method of brush control. The old hand-cutting method had many desirable features in that it was selective, results were immediate, desirable ground cover was not disturbed and the general appearance of the right of way was not drastically changed. The undesirable feature was the necessity for subsequent costly cutting after recurring growth.

In order to determine what results could be expected from chemical brush control, it is first necessary to define the conditions that are desirable on a right of way.

First, the right of way should have no brush or trees that would interfere with the operation of the lines.

Second, there must be access for equipment and personnel to perform construction and maintenance work.

Third, there must be patrol accessibility.

Fourth, the right of way must present an appearance acceptable to the public and also to the owner of the land if the right of way is by easement rather than by fee.

Fifth, the use by the owner for grazing, a hay crop, gardening, etc., must not be interfered with.

There is little disagreement among utility people on the first three conditions. The appearance of the right of way has a varying degree of importance to different companies. This is to be expected since no two power systems have precisely the same problems. A system that operates in an essentially rural area with right of ways not generally exposed to the public probably has little reaction from the public. On the other hand, a company that operates in a metropolitan area, with many suburban communities, few rural areas and many road crossings, has a very different public relations problem. In the latter case, many people would be frequently exposed to the appearance of the right of way and it is of utmost importance that the appearance be acceptable. A ground cover that blends with the sideline foliage and the use of whatever natural landscaping is available will contribute to this acceptance. Some companies retain or plant certain species of low-growing roadside trees and shrubs at right of way crossings to provide a screen.

The attainment of these conditions at a savings over former methods is what a utility expects of chemical brush control.

The use of chemicals for right of way brush control involves four distinct parties:

1. The Chemical Manufacturers
2. The Applicators
3. The Public
4. The Utility

In order to derive the maximum benefits from chemical control, a utility should design a program of treatment. It should provide the applicator with detailed instructions of the work to be performed and the manner in which it is to be done. The type and mixture of the chemical to be used should be specified and a common understanding of the methods to be used should be arrived at. Insofar as possible, the applicator should be warned of any critical areas where drift may cause damage to vegetation beyond the limits of the right of way.

The chemical manufacturer's part in this program is to first - continue to develop new and more effective chemicals and secondly - provide the users with complete information not only as to what the chemical will do but also what its limitations are and conditions to avoid. A great deal has been written in late years on the use of herbicides and some of it has not been complimentary. I believe that much of the criticism stems from an improper use of the chemical, either through carelessness, lack of knowledge or need of public education on effects of chemical brush control.

The application of chemicals is a very important part of brush control. If the greatest benefit is to be derived from the chemical used, the application must be made in a thorough manner under capable supervision. It is important to "read the label" and use good judgement. Great care must be exercised to prevent drift which will affect plants off the right of way. Although a contractor may be insured against such accidental damage, the adjustments or litigation results in poor public relations for the utility company.

It is important that an applicator understands that a drenching foliage spray means that sufficient spray be applied so that it drips off the leaves and that the complete bush be sprayed. A spray applied from the middle of a 250 ft. right of way will not produce satisfactory results. Indeed the brush at the sides of the right of way may grow more profusely because of the light application. Similarly a basal spray does not mean a squirt of chemical at the stem as the applicator passes by. A thorough wetting of the stem for a distance of 18 to 24" from the ground all around the stem so that the chemical runs off onto the ground is necessary for complete kill. Poor results with present methods will only result in the development of new or different methods.

I have been asked to comment upon the percentage of kill that may be expected from a brush control treatment. I assume that kill in this instance means root kill and not top kill. To arbitrarily propose any standard percentage would be unreasonable. An examination of the variables involved indicates that not only each section of a right of way must be considered but the geographical location itself may introduce variables.

Some of the variables encountered are as follows:

1. Type and Strength of the Chemical Used
2. Type of Treatment (Foliage or Basal)
3. Efficiency of Application and Coverage
4. Relative Numbers of Different Species of Brush and Weeds
5. Weather Conditions
6. Season of Year
7. Ground Conditions

Experience and good judgement in the light of the known conditions are to my mind the most important factors in determining what the predicted kill should be for any specific location.

This question of expected results leads to the subject of evaluation. Chemical treatments must be clearly evaluated. The easiest to observe of course is top kill. More difficult to observe is root kill which cannot be adequately judged until at least two years after treatment. The economic advantage of root kill over top kill is obvious. Root kill techniques may cost considerably more than treatments that result in top kill, but how many times must a plant be top killed before it is dead? Many different species require several top killings before they are eliminated. Proper treatment will go far toward accomplishing complete root kill.

Although the use of chemicals for brush control appears to be the most successful to date, the ecological approach should not be overlooked. The retaining of desirable ground cover will in many cases retard reforestation. Laurel, hazel, low brush blueberry and fern are desirable ground covers and should not be destroyed by blanket spraying. Some plant communities, including some produced by blanket spraying, advance 20 times as quickly as others. It follows then that selective basal spraying has certain merit over blanket spraying from both a vegatative management aspect and a public relations viewpoint. We not only foster desirable shrubs that inhibit the re-invasion of plants that eventually become trees, but we develop a more stable plant community. In many cases we also preserve wild life cover and food.

There appear to be a number of areas of disagreement or lack of knowledge among the parties involved in chemical brush control. Reasonable agreement based upon scientific knowledge and experience would be a valuable contribution to the art of chemical treatment.

For instance, should oil be used in foliage spray? Should stumps be treated within 24 hours of cutting? What is the effect of rain preceding or following a treatment? What is the basis for a decision to foliage spray or basal spray? Why cannot a dye, aluminum powder or other marker be included in a spray in order that both the applicator and his customer will have knowledge of the efficiency of application?

I believe that the use of chemicals for brush control will receive wider acceptance if properly controlled. The development of chemicals is an important factor, but most important at this time is the coordination of knowledge and experience in such usable form as to provide the utilities and the applicators with reliable information which will promote the judicious use of chemicals for the benefit of all.

I appear before your 17th Annual Conference - not merely as an advocate but also as a victim.

The ragweed segment of your over-all weed control program is not an impersonal academic problem as far as I am personally concerned. I have been and am currently one of the millions of hay fever-ragweed victims. Therefore, any group - professional or otherwise - and any effort, concerted or individual - that has as its objective the control and ultimate eradication of ragweed automatically enlists my enthusiastic support.

There are no reliable statistics relative to this problem of ragweed morbidity. The figures are presented in terms of percentage of entire population - in percentage of units of one hundred thousand of our population - and in terms of millions of man-hours lost in the world of industry and the professions.

Regardless of the total number of people involved we can safely say that the hay fever-ragweed menace definitely constitutes a public health problem of major proportions in the United States.

Now, I need not tell you that the weed problem as a public health menace has been under an almost eclipse of public and governmental apathy as far back as any of us in this room can remember. The reason for this apathy is two-fold:

1. To be frank and practical we must fully admit that among all of the major problems currently facing mankind - weed control currently cannot be given top priority from any logical standpoint. The sheer multiplicity of major problems confronting western man places our problem here today into one of relatively minor significance.

   However, the way modern man seems to be preparing for genocide this might in itself furnish a tragic and final solution to the problem of weed control both in this country as well as on this planet.

   From what I have been able to determine - there is no discernible pollen count in any area saturated by thermonuclear fallouts.

   It is safe to say, however, that your professional solution to this problem of weed control is not predicated upon the use of modern weapons of destruction. No, the solution obviously lies not in the eradication of man - it lies in the eradication of poisonous weeds and plants that have bedeviled man for centuries and which, in the agricultural segment of our economy alone, causes losses in excess of six billion dollars per year.

   Thus, we can say that one reason for public apathy is the priority of major social, political and economical problems - which we are trying to solve either through planned workable solutions or through blind improvisation.

2. The second reason for the prevalent apathy is definitely attributable to a lack of tangible all-out public relations programs on many fronts, both public and governmental.

This problem of weed control has got to be pinpointed in the public mind; its significance must be dramatized; the public must be made more conscious than it is of your programs and objectives.

Now, it is a sad commentary on 20th century living that any cause, no matter how intrinsically worthwhile, can succeed, only if it is related to a program of public relations which has as its objective the control of public attention.

In these days of mass communication and complexities of all types - public relations has finally assumed a status of a pseudo profession.

All organizations of any consequence - public, private and corporate - have public relations departments - each striving to develop a so-called public image - each trying to dramatize its status by fixing public attention upon its many faceted aspects.

Establishing public relations programs is no easy task, for in the last analysis public relations presupposes a working organization with a philosophy and a fixed set of goals or objectives. Public relations basic function is to interpret - not to initiate. It is concerned with methods and techniques as well as with the basic objectives of any group. Public relations is not press relations which is merely a technique for telling the world how you live. Press relations in the 20th century is the sum total of your organizational and professional environment - it is how you live.

Now, transmuting this conception into an effective tangible program relating to your efforts is not easy but it can be done.

Your programs enjoy a universal commendation and reception. Everybody you talk to is in favor of weed control; however, when it comes to voting appropriations into health department budgets - this becomes an entirely different matter.

New Jersey, for example, has a varied program on paper - yet year after year no specific amounts are allocated specifically to a Ragweed Control Program. At the County level programs are practically nonexistent. Only in the larger cities (where, ironically, the problem is less severe) is attention being given to this basic problem.

Obviously, the time has come to descent from "Cloud 9", professional papers, and get down to the hard ground of reality. Professionals talking to themselves on this problem are merely applying intelligence operating in a vacuum. The danger remains as serious as ever.

We have got to begin at the beginning and realize that it will take at least two generations to accomplish something that will really meet this problem head-on.

We must begin with children of school age and orient their thinking on this problem at an early age. Therefore, we must initiate efforts in each State Department of Education to the end that syllabi be devised at the elementary, junior high, and senior high school levels that will contain the basic information that boys and girls can readily assimilate at the various grade levels. Such syllabi can be incorporated in classes in health, in science, and in biology all through the grades from early elementary through senior high. This is the group through which effective appeals must be made. This is the group that will dominate society in the years to come.

By working with the State Departments of Health and coordinating their efforts with State Departments of Education, we can go a long way toward producing the basis of a popular appreciation of the problem.

We must always remember that awareness precedes appreciation.

Aside from the area of public education, the industrial segment of the problem has not been fully explored. We have no way of accurately determining the total number of man-hours lost through hay fever-ragweed victims. We know it must run into millions of hours. Here again the tool of education is in order. Every industry of any size has a training program involving both its hourly and salaried employees. Given the proper information, pamphlets, literature, visual aids, etc., it would be a simple matter to integrate this information into the regular schedule of training classes.

Data furnished by the various Extension Services of our State Universities could well be used as basic content material for such courses.

When we consider the penetration of various civic, professional, fraternal and service clubs groups, the possibilities are limitless.

All State Department of Health personnel should have completely and competently staffed speakers' bureaus together with visual aid material so that the message of weed control can be broadcast throughout the various states. Whether the health services are centralized or decentralized is immaterial. The important point is that key public organizations should be alerted as to the services that are available at the State Department level.

What I am saying is this: The only way you are going to get any public acceptance of your efforts is by building a fire under public opinion to the end that responsible public agencies will react affirmatively to your requests.

This means, among other things, that your programs and objectives should be infiltrated into our political parties. Let's stop kidding ourselves. No political party buys either a concept or a program or even an aspiration upon its intrinsic methods or upon its inherent worth. Agencies of government react only after they are forced to do so by the inexorable pressure of public opinion. What good is any program of weed control at any governmental level, if the program remains sheets of paper locked up in a government file? The vast majority of states fiscally ignore the ragweed control program as it relates to public health. Weed control for agriculture yes; highways yes. These become line items in most state budgets. But when it comes to people - the immediate victims of the problem - weed control appropriations by contract are pathetic.

Therefore, through associational efforts and through an aroused public opinion resulting from public relations programs infiltrating into all major segments involving our contemporary society - political parties will be eventually forced to take cognizance of your efforts by the simple process of transmuting your objectives into line item appropriations.

Obviously in the time allotted me today, the scope of this paper cannot penetrate into every aspect of this broad problem. Public relations as a method must of necessity vary with each area and with each state. The problem in Southwich, Massachusetts, could not be handled in the same fashion as in Springfield, Hartford, or Boston. The Northeast Weed Control Conference after seventeen years surely is not deficient in professional experience or know-how. Year after year professional papers have been delivered - each excellent manifestations of trained intelligence applied to a specific specialized area. In that segment of your operations involving horticulture, agriculture, industry, highways and aquatics, tangible accomplishments have really manifested itself. However, in that segment involving public health (people) much more remains to be accomplished before you can realize your basic organizational objectives.

We must consistently remember that operational programs must be staffed by competent people. Top flight sanitarians and public health personnel are in this business primarily because of love, and not because of financial remuneration. Most state staffs in this broad field are both incomplete and inadequate. The burden upon those few who remain impervious to industrial allurement is very heavy indeed. Morale is low - too low - in many key departments involved in this field. It is one thing to envision programs notable for their interest and scope but it is quite another matter to recruit and retain sufficiently capable personnel to transmute these programs into effective action.

The crisis is in the effective transmission of the mass of excellent technical data now extant to the general public through normal channels of education and government. We have the information - but we lack the effective human element to bring that information into areas where it counts.

The accumulation of more technical data in the field of public health is not the answer. Data we have. We suffer from the lamentable lack of adequate personnel capable of translating all of these data into the language of the layman so that he can become the catalytic factor in dramatizing the problem in areas where the professional man has never entered.

In short - to upset the crisis is in the area of communication and until this problem is dispassionately analyzed and workable solutions realized, the public relations aspect of weed control will always be relegated to an innocuous place in the public consciousness.

In conclusion, may I respectfully suggest that the Northeastern Weed Control Conference broaden its Sectional Organization and include a section on Public Relations and Public Communication.

You now have seven basic sections involving every aspect of weed control except the one that involves getting your story to the general public as well as to responsible agencies which alone can give substance to your varied programs.

Since your conference by its very nature enjoys excellent liaison with government at all levels, you are in an excellent position to initiate various types of programs covering the entire spectrum of weed control techniques and methods. The Weed Control Program in all of its many ramifications involves by its very nature close cooperative effort with the chemical industry, the transportation industry, government, education, agriculture, city planning and sanitation - in fact, your program involves practically every area that is concerned with the environment of modern man.

Because of this obvious fact, your efforts deserve a primacy on the agenda of many of our key industrial, agricultural and governmental groups.

For example, according to an expert in the Rutgers University Extension Service, Donald A. Schallock, over one-quarter of a million persons - about 5% of the population of New Jersey suffer allergic reaction to ragweed pollen. Can you imagine what political effects this group would have on New Jersey politicians and the New Jersey Legislature if each ragweed sufferer wrote to the appropriations committee Chairman during January, February and March of 1963 when the Committee is in session? This is but one simple manifestation of what I have been trying to explain and explore with you today.

By establishing a Public Relations Section and then having that Section work with State Departments of Education, industry, etc. in formulating basic informational materials for mass dissemination, you could then be on your way.

Step by step through prepared and supervised visual aids, through Speakers' Bureaus and Handbooks, through official exhibits, through encouragement of research into the biological and physiological aspects of allergic reactions - through political infiltration - through all of these and many more media - this Conference can really perform a monumental service to the American people.

You are quietly performing as real frontiersmen as 20th Century man still fights to retain his ascendancy over his environment.

By realizing the natural affinity between your efforts and the general public, the personnel comprising this Conference have every reason to believe they will continue to enjoy the sustained approbation of a citizenry that will inevitably become increasingly aware of the scope and beneficial aspects of your programs and objectives once they are given a dramatic synthesis of your efforts through the medium of effective public relations.

Presented by George H. Shay
at the General Session of the
Northeastern Weed Control Conference
Hotel New Yorker
January 9, 1963

SPECIFICATIONS AND USE OF CONTROLLED ENVIRONMENT ROOMS IN STUDYING THE EFFECTS OF ROOT PRESSURE MECHANISMS ON THE UPTAKE OF PESTICIDES BY PLANTS

Wm. Harold Minshall [1]

Facilities at the Pesticide Research Institute at London, Ontario include four controlled environment rooms (CER) each with a light section 12' x 14', a dark section 3' x 11', and an entrance corrider 3' x 3' to the dark section. Temperature is controlled and can be programmed from 40° to 99°F. To permit studies in water relations the relative humidity is also controlled from 50% to 90%. With new fluorescent lamps the light intensity is approximately 2500 ft-c at plant level and is composed of a 1:4 wattage ratio of incandescent: slimline fluorescent. After the fluorescent lamps have been in service for 5000 hours the light intensity approaches 1500 ft-c. The large light panel (11' x 8') is in a separately conditioned light loft separated from the room by waterwhite plate glass.

Each CER has a vertical air handling unit including a sprayed refrigerated coil, a dry heating coil, and a fan section. Air from this handling unit is introduced into both the light and dark room through channels in the floor and is returned to the unit through high sidewall registers. From 0 to 20% of the circulated air can be exhausted and replaced with temperature-conditioned fresh air.

Two refrigeration compressors chill a glycol-water mixture line to 34°F and a steam converter heats a second glycol-water mixture line to 150°F. Circulating mains provide chilled or hot glycol solution to the coils in the air handling unit.

Transducers for the sensing of temperature and humidity are in each room. These elements, mediated by strip chart recorder-controllers, control pneumatic throttling valves on the cold and hot glycol lines to the coils in the air handling units. To provide for programming of "day-night" temperatures and humidities the control index of the recorder-controller can be continually reset by a programming unit. This unit provides for rate of rise, rate of fall, and constant hold in adjustable quantities. It has been found possible to set a programme that approximates closely the temperature and humidity of a typical June day at London, Ontario. Further details are available in a separate publication.

I have been asked specifically to deal with problems that may arise with work in controlled environments. One major difficulty is

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associated with heat gain from the lamps. This heat gain acts as reheat to lower the humidity in the room; it establishes a temperature gradient from the ceiling to the floor; and the radiant energy may increase the temperature of the leaves and the soil several degrees above the "controlled" ambient temperature. If one wishes only to grow plants these radiation effects are not of great importance for they occur in Nature but if one wishes to investigate the effects of temperature or of humidity in time and in space under reproducible conditions then they must be taken into consideration. Let us examine two areas wherein the radiation from lamps may cause difficulty. The first area is the effect of radiation on relative humidity, the second its effect on soil temperature.

With the main cold glycol line held at 34°F the range of relative humidity that can be obtained in our CER at different ambient temperatures and under conditions of light and dark is set forth in the following table.

Temperature, °F	Range of Relative Humidity, %			
	Dark		Light	
	Min.	Max.	Min.	Max.
55	62	95	65	75
65	50	90	55	74
75	40	92	42	78
85	32	85	32	80
95	30	70	30	66

It is readily apparent that light approximating one-fifth of sunlight markedly reduces the range of relative humidity, especially at temperatures below 70°F. When necessary we raise the maximum humidity by either injecting water into the room with atomizers or reducing the quantity of radiant energy. Also the minimum humidity can be lowered somewhat by decreasing the temperature of the main cold glycol line. By means such as these we have obtained relative humidities between 40 and 90 percent at 70°F which were adequate for the purposes desired at that time.

Our problem concerning the effect of radiation on soil temperature arose when studying the process called root pressure. If the shoot is removed from a plant, xylem sap usually exudes from the stump because of pressure forces acting in the roots. Thus rate of exudation is a measure of root pressure activity. In the early stages of our work we found that bean plants held in the light room always had a much higher rate of exudation than did plants held in the dark room. The possibility that light might be exerting some direct effect on root pressure was most intriguing because light was not supposed to affect this particular process. Since ventilation in the dark room was provided by a fixed portion of the air from the air handling unit the ambient temperature in the light and dark rooms was approximately the same. However, soil temperature in the light room was found to be 10° higher than the soil temperature in the dark room and this difference in soil temperature, produced by radiant energy, accounted for the higher rate of exudation in the light room.

In connection with root pressure you may be interested in some data that we have shown at recent meetings suggesting that this process may play a part in the uptake of pesticide chemicals.

Table 2. The effect of an application of urea on the content of atrazine in the exudate of tomato. Treatments of urea (100 ml per pot of 1.6 g per l solution) and of atrazine (10 lb per acre) were made Nov. 27. Shoots were removed 9.40 a.m., Nov. 28 and the exudate collected from 10 a.m., Nov. 28 to 10 a.m., Nov. 29.

Material applied Nov. 27		Quantity of exudate in 24 hours,	Quantity of atrazine in the exudate for the 24 hours,
9 a.m.	5 p.m.	ml/plant	µg/plant
Atrazine	Water	17	52
Atrazine	Urea	39	114

Stimulation of the root pressure mechanism by an application of urea increased the quantity of atrazine exuding from the stump.

The root pressure mechanism is affected by such factors as temperature, soil moisture, and the supply of nitrogen in the nutrient medium. Our controlled environment rooms have proved adequate to investigate the effects of these factors.

A check list of items important in the design of controlled environment equipment with comments on certain of the items.

Size may vary from walk-in-rooms to reach-in-cabinets. Generally speaking the larger the space the greater is the latitude in the sizing of the cooling and heating equipment and the greater the adaptability during experimentation.

Temperature: In degree-day calculations the base temperature usually varies from 40° to 45°F. Very little if any growth takes place below this base temperature. Some species need a night temperature lower than the day temperature. Radiant energy from the lights is frequently sufficient to satisfy this requirement in alternating temperatures. Programming of temperature is necessary if one wishes to experiment with the effects of thermoperiodicity.

<u>Degree of temperature control</u> can vary from plus or minus 5° (coarse) to plus or minus $1/2^{\circ}$ or better. Doubling the degree of control will frequently double the cost of the equipment. Under some circumstances there is little point in achieving plus or minus $1/2^{\circ}$ control of the ambient air if leaf temperatures or soil temperatures are allowed to vary from 5 to 10° between light and dark periods. Published values on the degree of control provided need to be checked closely for the value can vary widely depending on the sensitivity of the equipment used in its determination.

<u>Relative humidity</u>: Plants will grow in a wide range of relative humidities indicating that humidity is not too critical for growth. If water relations are being investigated the humidity should be held at a constant level.

<u>Light intensity</u>: Gfeller and Goulden (1954) report that successful crops of wheat, oats, and barley were grown under intensities from 1200 to 1500 ft-c. We secure satisfactory growth of tomatoes, bush bean, carrot, plantains, etc. under intensities from 1500 to 2000 ft-c. Many plants, however, will increase their accumulation of dry matter up to and even above full sunlight. When compared to sunlight all types of fluorescent lighting have serious deficiencies in intensity and quality. New development is continuing, resulting in the production of higher intensities. The higher the light intensity the greater is the cooling load and the greater are the difficulties in maintaining leaf temperature, soil temperature, and certain relative humidities. Unless one wishes to specifically experiment with high light intensities it may be advisable to accept intensities sufficient for healthy plant growth for under these conditions the heat-to-light ratio is usually low enough to make cooling a relatively easy matter. Because of mutual shading that occurs out-of-doors many leaves within a crop grow naturally in light intensities much less than full sunlight. Spacing of the plants in the controlled environmental area influences the intensity of light falling on the lower leaves.

<u>Light quality</u> is important in the phasic development of plants and in growth. Growth can be improved by adding a small proportion of light from incandescent lamps to all types of fluorescent lamps now available. Good growth can be obtained from Standard Cool White or White fluorescent lamps plus incandescent. We secure better lamp life from Standard Cool White lamps than from White lamps and suspect the poor lamp life of the White lamps is linked to a greater sensitivity to high temperature. New phosphors with improved quality are being made available in fluorescent lighting but one must decide if the added advantages in quality are worth the additional expense in installation and maintenance.

<u>Carbon dioxide content</u>: The average content of CO_2 in air is .03% by volume or 300 p.p.m. Heinicke and Hoffman (1933) noted that if more than 20% of the available CO_2 was removed the rate of assimilation dropped rapidly. The level of CO_2 is usually maintained by injecting fresh air into the circulation system. Increasing the rate of air circulation will also increase the supply of CO_2 to the leaves.

<u>Direction of air circulation</u>: In many installations the air enters the room through a perforated or slotted floor and is removed just below or through the ceiling. This means the direction of the air movement in the room is counter to the direction of the radiant energy waves. Joffe (1962) has recently given the advantages of injecting the air obliquely from above.

<u>Wind speed or speed of circulation</u>: Air circulation is the only means of counteracting the heating of leaves and soil by radiant energy. This heating effect can not be completely removed, however, it can only be minimized. Some installations have circulation rates as low as 15-20 feet per minute. Joffe (1962) recommends rates of 250-300 f.p.m. Wadsworth (1960) found that air speeds up to 780 f.p.m. did not affect the growth rate of plants in water cultures but in an earlier publication found that the growth rate of plants grown in soil or sand was optimum at a rate of 60 f.p.m. and fell off at rates higher than this. He suggests water supply is the factor responsible for the difference in the results.

In conclusion I suspect that very few answers have been provided for questions you may have. Unfortunately those designing controlled environmental equipment have available very little basic information on the physiological requirements of plants. In many calculations they are forced to use empirical formulae and occasionally even resort to hear-say information. If one wishes to control a specific factor in the environment the selection of the equipment must be approached in the same manner as one approaches all scientific experimentation. Select the best engineering means of manipulating the factor you wish to vary and proceed to develop it.

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PRESENT AND FUTURE STATUS OF PESTICIDE TOLERANCES*

by

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I was very pleased when I arrived in my new office, on my first day on the job last August 1, to find a letter from your good President on my desk, inviting me to come here today and participate in your program. The letter was actually written two days before I took office and I accepted the invitation the second day I was there.

It is a pleasure to be here with you today. I bring you the greetings of the NACA staff and the best wishes of our Association.

I have had a lot of advice given me since assuming this position, and I have heard a lot of descriptions of trade association executives. The other day a new one came around which went something like this:

If he writes a letter, it is too long; if he writes a post card, it is too short. If he attends committee meetings, he's butting in; if he stays away, he is a shirker. If he bills members for their dues, he's insulting; if he doesn't, he's slipping. If he asks for advice, he isn't competent; if he doesn't ask for advice, he is a know-it-all. If he speaks out on a subject, he's trying to run things; if he remains quiet he has completely lost interest.

I feel a little bit like that here today. This is an extremely important conference and I have a most important subject to discuss. On the one hand I am extremely interested in the subject and its implications; however, my total knowledge is too limited for me to speak very authoritatively.

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*Presented at Seventeenth Annual Northeastern Weed Control Conference, Hotel New Yorker, New York, N. Y., January 10, 1963.

It is a pleasure, though, to be here and I am thoroughly enjoying this opportunity to get to know some of you.

This work as President of the National Agricultural Chemicals Association has been a very interesting experience. While I have, as a farmer, county agent and Commissioner of Agriculture, been familiar with the use side of the agricultural chemicals business, I have now been able to see a little more directly the production side of it. Then, too, I have been called upon to examine it a little more closely. Frankly, I have been astounded at many of the things I have learned.

I have known that the chemicalization of agriculture has been one of the principal reasons the American farmer has been able to make such a terrific contribution to our American way of life, but some of the statistics have really amazed me. I think you might be interested in looking at a few of them with me.

In the year 1951, some 464 million pounds of synthetic organic pesticide chemicals were produced in the United States. This tonnage included 109 different basic commercial products. Ten years later, the number of products had increased to 193, or had almost doubled. The tonnage had increased to 700 million pounds, or something better than 40%. In 1951, 69% of the products were insecticides; 21% fungicides; and 10% herbicides. By 1961 the relationship between the products had materially changed. Insecticides were down to 57% of the total; fungicides had increased from 21% to 25%, and herbicides had almost doubled and were representing 18% of the total number.

To many, this indicates that herbicides are in the forefront of progress both in the research and development phase as well as in the total production.

I think there are several reasons for herbicides having made such great strides during the last decade. The first and foremost reason, of course, is economic necessity. People are having to substitute herbicides for labor.

Had it not been for herbicides, I would have been forced out of growing corn on my farm in Eastern Virginia. We have a sandy soil there that is very productive, but it is also one of the weediest soils I know. I had always had to employ hand labor with weeding hoes to cut the weeds out. During the war, when the price of labor jumped so rapidly, herbicides came along just in the nick of time.

Some seven or eight years ago, I addressed a large audience of 4-H Club boys and girls. I had been asked to try to skip over the 15 years that lay immediately ahead and project my thinking into the period when these boys I faced would have become established in farming and tell them what I thought they would be experiencing. One of the things I said to them was that they would have no cultivators or weeding hoes on their farms -- that all crops would be protected from weeds and grass with herbicides. Following the speech I was deluged with questions from these boys who were at that time experiencing aching backs and sore hands from fighting weeds. They thought that farming without having to cultivate or chop would be just about the grandest profession in the world.

Another reason for the great growth in herbicide usage is not just the economics of the matter but also it is encouraged by the farmer's desire to do the job a little easier.

I think you will also be interested to look at some of the figures regarding research and development expenditures by the pesticide producers.

A recent survey by our Association indicates that a little more than 10% of the basic dollar sales volume for pesticide chemicals is now being spent by the Industry for research and development. To many, this is a very interesting figure because the chemical industry as a whole spends only about 5% of their basic dollar sales volume for research and development. Further examination reveals that about 30% of this total expenditure is devoted to herbicides and plant regulators. Since pesticides are only about 2% of the entire chemical industry sales, it is evident that the industry believes wholeheartedly that the chemicalization of agriculture is here to stay, despite what might be said by those who advocate other methods of pest control.

Let's compare briefly research and development expenditures of the pesticide chemical industry with some others. I understand that the pharmaceutical industry spends about the same percentage in research and development as we do. I am also told that the electrical equipment industry and the aircraft industry spend only about half as much as we do, and that we spend some three times as great a percentage of our gross sales in research and development as does the petroleum industry.

The breakdown of our research and development expenditures is about like this: 30% goes for basic or exploratory research, that is the screening and synthesizing of materials; 40% of the total expenditure goes for development research which includes field studies, etc. The remaining 30% goes for research and testing required for studies and the other studies affecting the safety of the product. This latter is a remarkable figure and one which should be remembered. It means that one-third of the expenses in research and development on pesticides must go for the checking and double-checking required by the Federal and State governments designed to protect the consumers of these products and the consumers of the food products produced, processed and preserved with the aid of these products. There are some people today, however, who are endeavoring to lead the American public to believe that little if any regard is being given to the safety of these products or the human health factors involved.

I have given you some of these statistics in order to emphasize research as the lifeblood of our industry.

As a result of all this research, the number of basic pesticide chemicals whose labels have been registered by the USDA since the Federal Insecticide, Fungicide, and Rodenticide Act was passed in 1947 is 494, of which 375 are used on raw agricultural commodities.

The number of tolerances granted by the Food and Drug Administration since the Miller Amendment was enacted in 1954, including tolerances and exemptions from tolerances, is the staggering total of 2,450. All of these tolerances or exemptions were on just about 127 pesticide chemicals.

I am sure that any of you who have had to prepare the voluminous detail necessary to obtain a tolerance for a pesticide will agree that this is a tremendous accomplishment. For those of you who have not had this "pleasure", let me assure you that a mountain of paper is necessary for each tolerance granted. When these are granted at the rate of 300 a year it is terrific.

Now to get a little more specifically to my title which deals with tolerances.

We at NACA feel that the pesticide industry is responsible for having tolerances established covering the use of herbicide chemicals on major crops. However, there have been many occasions recently when the Association has been asked for advice as to the tolerances for crops in the minor categories, that is those grown on only a relatively small acreage as compared to major food crops.

Now it is only reasonable to assume that when a company goes to the expense of preparing all of the necessary data required to obtain a tolerance from FDA they expect the return on the sale of the product to justify the expenditure. However, our Industry recognizes the very real pesticide needs which the many producers of minor crops have. In efforts to meet these needs we are actively cooperating with the Committee on Chemical Residues of the of Experiment Station Directors. At the present time, this group is compiling crop categories of the minor crops, based on similar growth characteristics and utilization. Following ultimate review and approval of these crop groupings by FDA and the USDA, it is our expectation that tolerances for entire groups can be more easily established at that time on the basis of their further relationship to major crops for which toxicological data and a pattern of chemical use have already been established.

In the interim, we at the NAC office will certainly look forward to hearing of and studying any specific problem which the producers of the minor crops are experiencing.

There is no question in my mind that the cost of putting a new pesticide on the market is going to continue to grow. I am told that the minimum cost of putting a pesticide on the market has been about one million dollars, the maximum has been about three million dollars, and the average about one million seven hundred thousand dollars. I am told that now, however, the cost has increased to a point that the average is exceeding two million dollars.

In the past eight years we have learned to live and work with a system of tolerances for pesticide chemicals. We at NACA are very proud of the part we played in this picture. Tolerances are the safety guides upon which we rely and upon which we base our entire operations. There is another thing about tolerances which should be noted. Tolerances are not established on the basis of toxicity considerations alone. In many instances the amount of residue resulting from the proposed use of the pesticide is the determining factor. Tolerances are usually set at the lower of two levels -- that which is indicated as an upper safe level on the basis of toxicological tests and that which is considered adequate to cover the residues to be expected when the product is used in the manner proposed. Thus, in an instance where the toxicity data alone would justify a tolerance of 25 p.p.m. but the residue from the proposed use is in the range of 3 to 5 p.p.m., the tolerance will normally be set around 5 p.p.m. This in itself is a double safety factor which is often overlooked when speaking of pesticides.

Before very long, the zero tolerance concept will, in our view, have to be replaced by the establishment of more realistic finite tolerances or by an official allowance for inconsequential residues. That alone will answer many of the nagging questions that are so irritable to many of us right now. There is an old Chinese adage which says, "He who would ride a tiger should first make provisions for dismounting." FDA has been riding a tiger named "Zero". We must all help them to dismount. Let me hasten to add that I am in no way casting aspersions have encouraged them to stay there for fear their dismounting might in some way bring shame upon us. I believe that we have become more sophisticated now and are ready to move forward.

The recent flare of publicity has created an awareness in the minds of the general public who heretofore hardly knew what a pesticide was or what it was supposed to do. As scientists working in the field of agriculture, all of you should be aware of this. We feel that this awareness can be turned into knowledge, and knowledge is fact and facts are the truth. The Good Book says, "Ye shall know the truth and the truth will make you free."

We can now tell the positive side of the chemicalization of agriculture. The public has heard enough about pesticides in these last few months to know that they are chemicals. This gives us a marvelous opportunity to tell the story. Some of the facts that you relay in your everyday conversations will carry more weight than you realize. Remember, you are experts in this business and people will listen to you.

You can tell the fact that pesticides have saved more lives than all of the wonder drugs combined; that they are wonderful tools in the hands of the Public Health Officials and that with these tools, the Public Health Officials have done much to eliminate diseases. DDT alone is credited with saving 5 million lives and preventing 100 million illnesses due to insect carriers of disease organisms.

You can tell the fact that these chemical tools have helped the farmer provide the American public with the most abundant supply of the most wholesome food, presented in the most attractive manner of any nation on earth; that in addition to this, this food has been made available to the American public at consistently lower prices. An hour's labor in the United States today will buy more food than an hour's labor has bought in this country at any time since Captain John Smith and his little band of stalwart Englishmen arrived on the shores of Virginia in 1607. An hour's labor in the United States today will also buy more food than an hour's labor will buy in any other nation on earth.

Just to keep the matter in a little better perspective, you can tell the fact that the number of deaths allegedly caused by the misuse of pesticides has decreased from about 150 annually during the early 1950's to less than 100 at the present time; that at the present time in the neighborhood of 150 deaths annually are caused by the alleged misuse of Aspirin alone.

When marshaled for a purpose, public opinion can change laws and regulations for better or for worse. It is very obvious to me that if we allow the creation of doubt and fear of science, that has been communicated to our general public in these past few months, to go unchecked and unanswered, our Industry will be harassed by such a wave of restricting and throttling legislation that Industry will be forced to curtail research and development activities. This will necessarily result in a lessening of the ability of Industry to provide these tools for the public health officials and for the American farmer.

We have a public relations program that is designed to tell people that pesticides are an important tool for fighting diseases by attacking mosquitoes, flies, lice, rodents and other pests that disseminate diseases; that pesticides are an important tool in the hands of the farmer for producing foods and fibers; that it would be extremely costly in money and in human misery to live without them. To tell people that properly handled these are safe tools for the people to use and that they result in foods that are the most wholesome of any foods in the world.

We try to do this not by telling the masses of the people what we in Industry or in NACA think, but rather by supplying statements from outstanding scientists, who have usually spoken in some article or magazine, to thought leaders such as county agents, vocational-agricultural teachers, metropolitan newspapers, outdoor and garden writers, and numerous other people.

The kind of statement I refer to, for instance, is the statement in the Journal of the American Medical Association (Vol. 178, No. 7, 11:18:61):

> "The Council on Foods and Nutrition recognizes the contributions that chemical substances in food production, processing, and preservation have made to the quality and quantity of the American food supply. While many chemical additives are essential to efficient agricultural production, others are vital to the manufacture of food products. There is no reason to believe that the present use of chemicals in foods is endangering the health of people. Responsible manufacturers have made careful safety tests before the introduction of new chemicals, and the Food and Drug Administration is diligently and effectively protecting consumers from presence of hazardous

and statements such as that made by Dr. William Darby, Chairman of Department of Biochemistry, Vanderbilt University School of Medicine, and past Chairman of the Food Protection Committee, National Academy of Sciences - National Research Council:

> "Despite all of the implications of harm from residues on foods, Miss Carson has not produced one single example of injury resulting to man from these residues."

We need your support and help as does the American public in telling the story, because as I said earlier, the Good Book says, "Ye shall know the truth and the truth will make you free."

Chemical Weed Control in Seeded Cantaloupes 1/

J. D. Riggleman and F. C. Stark 2/

Most of the 1900 acres of cantaloupes in Maryland are planted early with the hope that the fruit will mature in time for an early market. Frequently cool weather results in slow germination of cantaloupes as compared to that of the weed seeds. Weeding is a tedious hand operation, which a herbicide applied in a band over the row at planting could replace. Usually, cantaloupes are seeded thickly, and thinned with a hoe 3-4 weeks later. If a herbicide could be broadcast after thinning, the need for further cultivation would be eliminated. In a weed-free field, it is possible to eliminate competition, to obtain better pest control, and to provide more efficient harvesting, resulting in greater net income to the farmer.

Two experiments were conducted during 1962. The first was replicated, with the herbicides applied at planting and/or at thinning. Because little is known about the use of many new herbicides on cantaloupes, a second trial was established wherein the materials were applied at planting or at thinning to single non-replicated plots with an exponential sprayer.

Materials and Methods

The experiments were conducted on a sandy loam at the University of Maryland Vegetable Research Farm, Salisbury, during the 1962 growing season. Rainfall during each month was only about 1/2 of the norm. Irrigation was necessary July 11 and August 21. Seed (var. Early May) was planted May 22. Herbicides were applied to dry soil in late evening May 22, or to moist soil in late evening June 26. Appropriate insecticides and fungicides were applied weekly.

Replicated trial:

The herbicides were applied in 4 replications to single row plots 30' long with a tractor-mounted broadcast-sprayer at 50 GPA. All plots were cultivated, side dressed and thinned on June 25. The check was cultivated June 5, 25, and July 9. The fruit were harvested 3 times weekly from August 20 to September 5. Each fruit was measured for size and percentage of soluble solids.

1/ Scientific Article No. A1020, Contribution No. 3413 of the Maryland Agricultural Experiment Station, Department of Horticulture.

2/ Research Assistant, University of Maryland Vegetable Research Farm, Salisbury.
Professor of Vegetable Crops, University of Maryland, College Park.

Logarithmic trial:

The materials were applied with an exponential sprayer 3/ to single row plots 75' long and were not replicated. Plots 1-9 were treated May 22 after planting and not disturbed further. Plots 10-15 were treated June 26 after thinning and cultivating. All herbicides were applied as surface sprays, except plot 5 (R 1870) which was incorporated with a rototiller immediately after application. No yield or soluble solids data were taken.

Results and Discussion

Replicated trial:

The data for the replicated trial are presented in table 1.

Alanap 2S 3+3 lbs AI/A. Foliar injury resulted from each application of Alanap. Control was good for about 1 month after each application. Yield was drastically reduced below that of the check.

Dacthal 75W 9+0 lbs AI/A. Dacthal applied at planting caused only slight injury. Although cultivated in June, good control was maintained through the entire season. The marketable yield was less than the check.

Dacthal 75W 18+0 lbs AI/A. Stunting of the vines was slightly greater than at the 9 lb rate. Marketable yield was less than the cultivated check but was no different than the 9 lb rate. Control was excellent for the entire season.

Dacthal 75W 9+9 lbs AI/A. Two applications caused the same slight stunting as the single 18 lb application. Control was excellent for the entire season. The yield was reduced drastically, and the crop was about 10 days later than the check.

N 3291 6S or N 4069 6E 4.5+4.5 lbs AI/A. No difference could be observed between these materials. Pre-emergence applications had no effect on either crop or weeds. Post-emergence applications severely injured the cantaloupes.

Logarithmic trial:

The data are presented in table 2.

When applied at planting, the following materials caused severe injury at rates sufficient to allow acceptable commercial control: Zytron 3E, R 1607 SE7 2E, and R 1607 6E. N 3291 applied at planting gave no control.

3/ Dedolph, R. R., C. W. Basham and F. C. Stark, 1960, An Exponential sprayer for experimental work, Proc. Amer. Soc. Hort. Sci. 75: 785-88.

The following materials gave good control with no injury in the specified ranges: FW 925 2E at 1.8 to 2.6 lbs AI/A for 4 to 6 weeks, Diphenamid 80W 0.7 to 1.4 lbs AI/A for 8-10 weeks, Premerge 3E 1.8 to 2.2 lbs AI/A for 4 weeks, R1870 6E (incorporated) 1.5 to 4.5 lbs AI/A lbs for 8 weeks and Dacthal 75W 7.2 to 16.0 lbs AI/A for 12 weeks.

When applied at thinning, FW 925 2E and N 3291 6S caused severe injury. Shell 7961 50W gave no injury or control in the applied range. Control was good with no injury from Casoron 50W at 2.8 to 8.0 lbs AI/A for 4 weeks and at 5.6 - 8.0 lbs AI/A for 8 weeks. Diphenamid 80W provided good control with no injury for 8 weeks at 2.0 lbs AI/A and Shell 7585 2S gave good control with no injury for 4 weeks at 1.4 to 3.3 lbs AI/A.

Summary

When applied immediately after planting, Dacthal 75W at 9 lbs AI/A gave excellent control but caused some reduction in yield. A serious reduction in yield occurred where Dacthal or Alanap was applied following thinning. From the logarithmic trials the promising materials for application at planting are: FW 925, Diphenamid and R1870. For application at thinning the promising materials are: Casoron, Diphenamid, and Shell 7585.

Table I

The effects of herbicides applied to canteloupes at planting and at thinning on freedom from injury, control of weeds, and on yield[1].

Treatment	Lbs[2] AI/A	Freedom from Injury[3] 6/14	7/5	7/25	Control of Weeds[4] 6/14	7/5	7/25	8/17
1. Cult. Ck.[7]		10.0	10.0	10.0	10.0	10.0	8.5	7.8
2. Alanap 2S	3+3	8.3	8.5	9.5	9.8	10.0	8.8	4.8
3. Dacthal 75W	9+0	10.0	9.3	9.3	10.0	10.0	10.0	8.0
4. Dacthal 75W	18+0	9.8	7.8	9.0	10.0	10.0	10.0	9.5
5. Dacthal 75W	9+9	9.8	8.3	8.5	9.8	10.0	10.0	7.8
6. N 4069 6E	4.5+4.5	10.0	1.0	1.0	9.8	10.0	10.0	2.0
7. N 3291 6S	4.5+4.5	10.0	1.0	1.0	9.0	10.0	10.0	1.0

Treatment	Number of Fruit per Acre >4" dia	>5" dia	> 8%SS[5]	Marketable[6]
1. Cult. Ck.[7]	9801a	2790a	5241a	2586a
2. Alanap 2S	7691 b	272 c	2450 b	204 c
3. Dacthal 75W	9733a	2110ab	4424ab	1702 b
4. Dacthal 75W	7282 b	2518a	3947ab	1565 b
5. Dacthal 75W	6330 b	885 bc	2382 b	544 c
6. N 4069 6E	--[8]	--	--	--
7. N 3291 6S	--[8]	--	--	--

1/ Canteloupes (Var. Early May) were seeded May 22 with herbicides applied late that evening. All plots were hoed and cultivated June 25 with plots 2, 5, 6, and 7 receiving a herbicide late evening June 26.

2/ Lbs AI/A at planting and at thinning respectively.

3/ Rated from 1-10 where 10 = no apparent injury to the foliage.

4/ Rated from 1-10 where 10 = nearly perfect control and 7 = commercially acceptable control.

5/ % soluble solids determined with a hand refractometer.

6/ To be marketable, a single fruit must be greater than 5" dia and also be greater than 8%SS.

7/ Check cultivated June 5, 25, and July 9; hoed 6/25.

8/ These plots were so severely injured by the second application that no yields were taken.

Table II

The effects of herbicides applied with an exponential sprayer to cantaloupes at planting--or at thinning--on injury[1], control[2] and the acceptable range[3].

Materials	Range Lbs AI/A	June 22 Injury Down to	June 22 Control Down to	June 22 Accept. Range	July 25 Injury Down to	July 25 Control Down to	July 25 Accept. Range	August 17 Injury Down to	August 17 Control Down to	August 17 Accept. Range
Applied at planting[4]										
1. FW 925 2E	8-½	2.6	1.8	1.8-2.6	7.0	NC	None	--	NC	None
2. Diphenamid 80W	8-½	1.4	0.7	0.7-1.4	1.4	0.7	0.7-1.4	1.7	1.7	1.7
3. Premerge 3E	8-½	2.2	1.8	1.8-2.2	--	NC	None	--	--	--
4. Zytron 3E	16-1	8.0	14.0	None	8.0	NC	None	--	--	--
5. R 1870 6E[5]	12-3/4	4.5	1.5	1.5-4.5	4.5	1.5	1.5-4.5	--	NC	None
6. N 3291 6S	8-½	6.0	NC[7]	None	8.0	NC	None	--	--	--
7. R 1607 SE7 2E	8-½	0.7	5.0	None	4.0	NC	None	--	NC	--
8. R 1607 6E	8-½	0	4.0	None	0	5.0	None	--	--	--
9. Dacthal 75W	24-1½	15.6	7.2	7.2-15.6	15.0	7.5	7.5-15.0	16.0	14.0	14.0-16
Applied at thinning[6]										
10. Casoron 50W	8-½				None	2.8	2.8-8.0	None	5.6	5.6-8.
11. FW 925 2E	8-½				0	2.0	None	--	NC	None
12. Diphenamid 80W	8-½				2.0	1.4	1.4-2.0	2.0	2.0	2.0
13. N 3291 6S	8-½				0	NC	None	--	NC	None
14. Shell 7585 2S	4-½				3.3	1.4	1.4-3.3	None	NC	None
15. Shell 7961 50W	4-½				3.3	NC	None	--	NC	None

1/ Cantaloupes were injured from maximum lbs AI/A down to the lbs AI/A in injury column.
2/ Control from maximum lbs AI/A down to lbs AI/A in control column.
3/ The range as lbs AI/A where there was acceptable control and no injury.
4/ Planted (var. Early May) May 22 with herbicides applied late that evening.
5/ This material was incorporated 4-6" deep with rototiller immediately after application.
6/ Planted May 22, thinned and cultivated June 25, with the herbicide applied late evening, June 26.
7/ NC = No control

A PROMISING NEW HERBICIDE FOR RED BEETS

Alexander Zaharchuk[1]

A concentrated table beet farming industry is located in Central New York. Growers state that hand-weeding of this crop costs about $30 to $40 per acre. Promising new herbicides are being screened to find a herbicide selective to beets.

PROCEDURE

Single rows of fifteen crops were planted, one of which was Early Wonder beets. The planted area was repeated twice. Plot size is six feet wide with a one-foot buffer between treatments. Two replications. Spray volume is 60 gallons per acre.

The pre-emergence plots were sprayed one day after seeding. The post emergence crops were sprayed 22 days after planting. The beets were 1.5 inches high and in the cotyledon stage. Weeds were small, in the cotyledon stage to first true leaves. Major weeds present were smartweed, lambsquarter and crabgrass.

RESULTS

Pre-emergence application of BASF HS-119 (1-phenyl-4-amino-5-chlor-pyridazon-6) at 5.0 lbs. were needed for good weed control, At this rate very slight injury was noted to the crop. BASF HS-95 (N-p-Chlorphenyl-N'-methyl-N'-isobutinylurea) gave severe injury to the crop even at the 1.0 lb. rate. BASF HS-92 (1-Phenyl-4-amino-5-chlor-pyridazon-6) + (N-Cyclooctyl-N-dimethylurea) at the 4 lbs. rate, which was needed for grass control, gave slight injury to the crop.

In the post emergence application, HS-119 gave excellent weed control at the 2.5 lbs. rate. No injury was observed, even at the 5.0 lbs. rate. HS-95 gave severe injury, even at the 1.0 lb. rate. HS-92 gave moderate injury at the 4.0 lbs. rate, which was needed for broadleaf and grass control.

CONCLUSION

HS-119 appears very promising as a beet herbicide when applied early post emergence to the weeds. Beets appear more tolerant to HS-119 applied post emergence than pre-emergence.

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1/ Coop. G.L.F. Exchange, Inc. Research & Development
Soil Building Division, Ithaca, New Yrok

CHEMICAL WEED CONTROL IN CUCUMBERS

Charles J. Noll[1]

Alanap has been used for weed control on cucumbers for a number of years. With adequate soil moisture and good growing weather, good weed control has resulted. These desirable conditions are not always present when Alanap is applied and poor weed control may be the result. Therefore, the search for a better weed control chemical for use on this crop was continued during the summer of 1962. This report summarizes the results of this test.

Procedure

The seedbed was prepared, pre-planting treatments applied and incorporated and seeds planted June 4. The pre-planting treatments were applied as a spray and incorporated in the soil with a rototiller set shallow. The variety seeded was Marketer. The pre-emergence treatments were applied 2 days after seeding and the post-emergence treatments were applied 15 days after seeding. Individual plots were 36 feet long and 6 feet wide. Treatments were randomized in each of 6 blocks.

The chemicals were applied with a small sprayer over the row for a width of 2 feet. Cultivation controlled the weeds between the rows. An estimate of weed control was made July 5 on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. The growing season was very dry and no irrigation was applied. Cucumbers were harvested October 17th, all fruits were removed at that time.

Results

The results are presented in Table 1. Most chemicals were used at 2 rates each. The best weed control were at the two rates of R-1856, R-1870, Dacthal, Trifluralin, and Hyvar and the higher rate of treatment of Alanap 3. The stand of cucumber plants was significantly reduced by both rates of treatment of Hyvar, R-1870 and Casoron and by the higher rate of treatment of Trifluralin, N-4069 and DNBP. The number of fruit and weight of fruit were significantly increased as compared to the untreated check by the following treatments: Alanap 3 at 4 and 8 lbs., Dicryl 4556 at 4 and 8 lbs., Dacthal at 8 lbs., Trifluralin at 2 lbs., NP 1475 at 12 lbs., N-4069 at 12 lbs. and DNBP at 6 lbs. per acre.

Conclusions

Under the condition of this experiment considering weed control, stand of plants and yield Alanap 3 applied 2 days after seeding was a good treatment. Other chemicals that look worthy of further investigation are Dacthal and Trifluralin. With these two chemicals the higher rates of treatment reduced the stand and yield of cucumbers.

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[1]Associate Professor of Olericulture, Dept. of Horticulture, College of Agriculture and Experiment Station, Pennsylvania State University, University Park, Penna.

Table 1. Weed control, stand of plants, and number and weight of fruit of cucumber under chemical herbicide treatments.

	Treatment	Active Rate Per Acre lbs.	Application Days from Planting		AVERAGE PER PLOT *Weed Control (1-10)	Stand of Plants	No. of Fruit	Wt. of Fruit lbs.
1	Nothing	---	---		7.6	77.7	17.3	6.6
2	R-1856	4	Soil Inc.	0	2.5	73.8	36.7	14.4
3	"	8	" "	0	2.2	74.7	27.0	10.0
4	R-1870	8	" "	0	2.0	38.5	24.5	13.2
5	"	16	" "	0	1.0	13.3	17.8	11.2
6	Dacthal	8	Pre-emerg.	2	1.5	74.8	34.5	16.9
7	"	16	"	2	1.3	80.5	17.4	6.9
8	Trifluralin	2	"	2	1.2	69.8	41.7	17.5
9	"	4	"	2	1.0	52.2	24.7	11.3
10	NP 1475	12	"	2	5.0	74.7	42.0	17.3
11	TD 282	6	"	2	5.8	70.2	30.2	12.0
12	Hyvar	1	"	2	1.0	0	0	0
13	"	2	"	2	1.0	0	0	0
14	N-4069	6	"	2	6.0	69.2	32.5	13.9
15	"	12	"	2	5.8	25.2	36.3	15.2
16	Dicryl 4556	4	"	2	6.8	80.5	34.8	16.0
17	"	8	"	2	4.0	81.0	48.3	18.8
18	Alanap 3	4	"	2	2.8	72.5	41.0	17.9
19	"	8	"	2	1.8	72.2	41.3	15.5
20	DNBP	3	"	2	5.0	68.0	29.5	11.5
21	"	6	"	2	3.8	57.2	41.0	15.7
22	Casoron	3	Post-emerg.	15	3.5	52.3	30.7	14.5
23	"	6	"	15	1.2	31.7	6.3	2.0
24	Alanap G	4	"	15	5.3	76.7	33.8	12.3
25	"	8	"	15	5.2	75.8	37.2	14.6
26	Diphenamid	4	"	15	3.3	82.3	35.2	15.0
27	"	8	"	15	1.6	82.3	25.5	10.0
Least significant difference 5%					1.5	12.2	16.5	8.2
" " " 1%					2.0	16.1	21.9	10.8

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

PREEMERGENCE WEED CONTROL IN CARROTS

M.F. Trevett and William Gardner[1]

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on the control of annual broadleaf weeds in carrots.

Procedure

Nantes Long carrots were planted in a loam soil June 8, 1962, and later were thinned to two inches in the row. Treatments were replicated 6 times in a randomized block of single-row plots paired with untreated plots. Sprays were applied with one pass of a small plot sprayer at 40 pounds pressure per square inch and 50 gallons per acre volume.

The principle weeds were: Lambs-quarters (*Chenopodium album* L.); Red-root pigweed (*Amaranthus retroflexus* L.); Smartweed (*Polygonum pensylvanicum* L.); Shepherd's-Purse (*Capsella bursa-pastoris* L.).

Results

Plots receiving planting application of 4 or 6 pounds per acre of Trifluralin, 2 pounds of Linuron, or 2 pounds of Prometryne produced significantly higher yields of cut-off carrots than plots receiving 2 pounds per acre of Atrametryne, 2 or 4 pounds of Alipur, 10.5 pounds of Dacthal, or 1 pound of CP-31675. Planting applications of 4 or 6 pounds of Trifluralin, 2 pounds of Linuron, or 2 pounds of Prometryne did not differ significantly in effect on yield from planting applications of 3 pounds of Prometryne, 6 pounds of NIA-2995, preemergence application of 4 pounds of Solan, or from hand hoed plots, Table 3.

Stand of carrots was significantly lower in plots receiving 4 pounds of Alipur per acre, 10.5 pounds of Dacthal, 2 pounds of Atrametryne, or 1 pound of CP-31675 than in plots receiving 4 or 6

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pounds of Trifluralin, 2 pounds of Prometryne, 2 pounds of Linuron, or 6 pounds of NIA-2995, Table 2.

Broadleaf weeds were inadequately controlled by 2 or 4 pounds of Alipur, 10.5 pounds of Daothal, or 1 pound of CP-31675. Trifluralin gave poor control of Shepherd's Purse; Prometryne gave poor control of Smartweed.

Two pounds of Atrametryne and 1 pound of CP-31675 produced foliage injury on carrots. Three pounds of Prometryne stunted carrots for the first three weeks following emergence.

Treatments were not affected by rainfall pattern, Table 3.

Summary

Linuron, Trifluralin, Prometryne, Solan, and NIA-2995 are promising herbicides for the control of broadleaf weeds in carrots.

Table 1. Herbicides Applied to Carrots, 1962.

Designation	Chemical Formula
Alipur	N-cyclo octyl-dimethylurea + butynyl-n-(3 chloro-phenyl) carbamate
Atrametryne	A Geigy product
Dacthal	2,3,5,6-Tetrachloroterephthalic acid
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
NIA-2995	Methyl n-(3,4-dichlorophenyl) carbamate
Prometryne	2,4-Bis (isopropylamino)-6-methylmercapto-s-triazine
Solan	N-(3-chloro-4-methylphenyl)-2-methylpentanamide
Trifluralin	2,6-dinitro-N,N-Di-n-propyl-a,a,a-trifluore-p-toluidine

Table 2. Yield of Carrots and Broadleaf Weed Control.

Treatment (lbs. active ingredient per acre)	Yield, lbs. per 25' of row	% Broadleaf weed control	No. plants per 25' of row
6# Trifluralin, PL[1]	12.4a[2]	82.7	139.5
2# Prometryne, PL	11.6a	85.4	135.1
2# Linuron, PL	11.5a	97.6	127.8
4# Trifluralin, PL	11.3a	82.2	119.8
3# Prometryne, PL	11.2ab	94.2	126.1
Hand hoed	11.0ab	--	122.5
6# NIA-2995, PL	9.2abc	83.7	120.5
4# Solan, Pre-emergence[3]	9.1abc	83.6	113.0
2# Atrametryne, PL	7.3 bcd	95.9	75.6
4# Alipur, PL	6.3 cd	48.2	84.1
10.5# Dacthal, PL	4.3 de	12.7	77.0
2# Alipur, PL	4.1 de	39.2	93.8
1# CP-31675, PL	1.9 e	32.1	47.7
L.S.D. 5%	3.4	15.0	33.9

1/ Planted 8 June, '62. PL applied 11 June, '62.

2/ Means having same letter designation do not differ significantly at the 5% level (Duncan's Multiple Test).

3/ Applied 25 June, '62.

Table 3. Rainfall, Monmouth, Maine, June-July, 1962.

Date	Inches of Rain	Date	Inches of Rain
8 June	--	26 June	.04
9 "	--	27 "	.02
10 "	--	28 "	--
11 "	.27	29 "	--
12 "	.02	30 "	--
13 "	--	1 July	--
14 "	--	2 "	--
15 "	--	3 "	--
16 "	--	4 "	--
17 "	--	5 "	--
18 "	.16	6 "	.07
19 "	.45	7 "	--
20 "	.04	8 "	--
21 "	--	9 "	--
22 "	--	10 "	.23
23 "	.09	11 "	--
24 "	.57	12 "	.19
25 "	--	13 "	1.49

Carrot Herbicides and Some Factors Influencing Their Activity[1]

by R. P. Hargan[2] and R. D. Sweet[3]

Stoddard solvent has long been a standard material for weed control in carrots. There are, however, several gaps in its effectiveness. Herbicides offering residual action, greater efficiency in application, possibility of application over a wider range in time, and better ragweed control will greatly aid the grower.

Extensive studies by this department in 1961, partially reported by Sweet et al. (2), indicated several new chemicals had much promise in providing improved weed control in carrots. In order to more completely assay these promising herbicides, the influence of soil type, soil moisture, soil incorporation, and time of application were studied in 1962.

Materials and Methods

The chemicals studied were :1/ Amiben (E.C.), 2/ Dacthal (W.P.), 3/ Linuron (Lorox W.P.), 4/Prometryne (W.P.), 5/ Solan (E.C.), and 6/ Trifluralin (E.C.) as compared with Stoddard Solvent.

Several tests were conducted throughout the season to include differing weather and soil moisture conditions. Soil types well represented those of our carrot producing areas and included muck, sandy loam, and a fine sand. Treatments were sprayed on the soil surface or to emerged foliage with a low pressure sprayer.

As is indicated in the discussion of Test V, the factors of soil incorporation and irrigation were investigated. In all other tests the chemicals were left on the surface of the ground and were not irrigated. A summary of the specific conditions including weed species encountered is included with the discussion of each test.

Amiben, Dacthal, and Trifluralin were applied only at planting or to newly emerged weeds as the crops were emerging. Linuron, Prometryne and Solan were applied both at planting and at various stages after weed emergence. Stoddard solvent was applied only after weed emergence.

Plots included at least two rows of carrots and were 15 feet long. Tests I-III had three replications while Test IV had two and Test V had four.

The plots were evaluated by visual ratings of the crop tolerance and weed control. The ratings are based on a 1-9 scale with 1=no weed control or

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[4] Considerable assistance was also provided by G. H. Bayer and J. C. Cialone, Research Assistants, Cornell University, Ithaca, N. Y.

complete crop kill; 7= commercially acceptible weed control or crop tolerance; 9=complete weed control or normal crop. The ratings were made within one month of application.

Results and Discussion

Each test is separately discussed as the conditions varied greatly from test to test. The data for these tests are summarized and presented in table form with the discussion.

Test I - Muck Soil in Newark, N. Y.

Treatments were made at planting and again when the crop had the first true leaves and weeds were in the 4-8 leaf stage. The soil at planting was moist and in excellent seed bed condition. The weather for the next two months, however, was unusually dry. Weeds present were crabgrass, lambsquarters, mustard sp., purslane, ragweed, redroot, pigweed and smartweed.

Excellent weed control was given by at-planting applications of 1.8 lbs. of Linuron and 3.6 lbs. of Prometryne for the first month as indicated in Table 1. Prometryne at 3.6 lbs. continued to control weed growth through the second month while 3.6 lbs. of Linuron were needed for equivalent control. Excellent post-emergent control was provided by one pound of Linuron and 4 pounds of Solan. The main weed escaping post-emergent application of Solan was purslane. Trifluralin was reported in 1961 (2) as giving good weed control at 4 pounds on muck. These 1962 findings indicate very poor response in dry weather. However, the only weeds escaping Trifluralin at 7.2 pounds and higher were mustard sp.

The single application of Stoddard Solvent gave poor control - possibly due to the fact that the weeds were taller than generally recommended for good weed control. Other treatments were notably poor especially in the second month after application. Carrots were tolerant of all treatments with no injury evident.

Table 1. Summary of weed control ratings on muck soil.

Chemical	Lbs. /A	Timing*	Weed Control	Chemical	Lbs. /A	Timing*	Weed Control
Linuron	1.8	At Pl.	8.0	Trifluralin	1.8	At Pl.	2.7
	3.6	"	8.7		3.6	"	5.3
	0.5	Post	7.0		7.2	"	6.0
	1.0	"	8.3		10.8	"	5.3
Solan	3.6	At Pl.	3.3	Dacthal	14.3	At Pl.	7.0
	7.2	"	6.3				
	2.0	Post	7.3		42.9	"	6.3
	4.0	"	8.3				
Amiben	7.2	At Pl.	4.7	Stoddard Sol.	75 gal.	Post	6.7
Prometryne	3.6	At Pl.	8.7	Check	-	-	2.2
	5.4	"	8.7				

*At Pl.-At Planting, Post - Weeds in 4-8 leaf stage.

Test II - Fine Sand in Webster, N. Y.

Treatments were made at emergence of the carrots with the weeds in the cotyledon stage and again when the crop had its first true leaves and the weeds had 4 - 6 leaves. The soil was very dry and baked hard at emergence. Subsequent weather was very dry. Weeds present included crabgrass, lambsquarter, ragweed and redroot pigweed. The results are summarized in Table 2.

Excellent weed control was given by at-emergence applications of Linuron at 1.8 pounds and Prometryne at 3.6 pounds and by post-emergence applications of Linuron at 1 pound and Solan at 4 pounds. One-half pound of Linuron post-emergence controlled all weeds except crabgrass while ragweed was the only weed escaping 7.2 pounds of Solan and 7.2 and 10.8 pounds of Trifluralin at emergence. Lambsquarter was the only weed escaping Amiben.

The poor weed control associated with Trifluralin applied to newly emerged weeds in the cotyledon stage coincides with previous findings of poor control on emerged weeds. It is, however, at variance with the findings of this department in comprehensive studies at another location, also in 1962, reported by Bayer et al (1).

No injury to the crop was observed in any treatment in this test.

Table 2. Summary of weed control ratings on fine sand. Test II.

Chemical	Lbs. /A	Timing*	Weed Control	Chemical	Lbs. /A	Timing*	Weed Control
Linuron	1.8	At Em.	8.7	Trifluralin	1.8	At Em.	3.0
	3.6	"	9.0		3.6	"	5.0
	0.5	Post	7.3		7.2	"	5.7
	1.0	"	9.0		10.8	"	5.0
Solan	3.6	At Em.	6.3	Prometryne	3.6	At Em.	8.2
	7.2	"	7.0		5.4	"	8.5
	2.0	Post	7.3	Stoddard			
	4.0	"	8.0	Solvent	75 gal.	Post	4.3
Amiben	7.2	At Em.	5.7	Check	-	-	2.3

*At Em = at emergence of crop and with weeds in cotyledon stage.
Post - weeds in 4-6 leaf stage.

Test III - Fine Sand in Webster, N. Y.

Treatments were made at planting and again when the weeds had 4-6 true leaves. The soil was wet at planting while it later turned dry and became very hard. The weed stand was dense and uniform; however, the carrots failed to emerge. Weeds present included crabgrass, lambsquarter, purslane and ragweed. The ratings are summarized in Table 3.

Again, at-planting applications of Linuron and Prometryne gave excellent weed control. Dacthal at 8 pounds gave a higher degree of control than in the other tests indicating a need for adequate moisture at application.

Although ratings reported are low, post-emergent applications of Linuron at 1/2 and 1 pound completely controled the broadleaved weeds and allowed only crabgrass to escape. Similarly at-planting treatments of 4 and 6 pounds of Trifluralin only allowed lambsquarter to escape.

Table 3. Summary of weed control ratings on fine sand, Test III.

Chemical	Lbs. /A	Timing*	Weed Control	Chemical	Lbs. /A	Timing*	Weed Control
Linuron	1	At Pl.	9.0	Trifluralin	1	At Pl.	2.8
	2	"	9.0		2	"	3.5
	0.5	Post	6.7		4	"	6.0
	1.0	"	7.7		6	"	6.4
Solan	2	At Pl.	6.7	Dacthal	8	At Pl.	7.5
	4	"	7.4				
	2	Post	6.7		24	"	7.4
	4	"	7.3				
Amiben	4	At Pl.	4.9	Stoddard Solvent	75 gal.	Post	7.3
Prometryne	2	At Pl.	8.4	Check	-	-	1.6
	3	"	8.5				

*At Pl = At Planting. Post = Weeds in 4-6 leaf stage.

Test IV - Sandy Loam Soil at East Ithaca, N. Y.

Treatments were made at the following three times: 1/ at planting, 2/ at emergence of the crop with weeds in the cotyledon stage, 3/ crop with 2-4 true leaves and weeds in 4 leaf stage. The soil was in excellent seed bed condition at planting with the soil surface drying slightly. The evening following application 0.87 inches of rain fell. Subsequent weather provided normal rainfall. Weeds present in the area were crabgrass, Eragrostis sp., purslane, and redroot pigweed.

Crop tolerance and weed control are summarized in table 4. At planting and at emergence applications of one pound of Linuron and Prometryne gave excellent control of weeds. At the 4 leaf stage broadleaved weeds were controlled by one pound of both materials, however, annual grass control decreased greatly. Two pounds of Linuron and higher rates of Prometryne were needed for annual grass control at this stage. Weed injury took three days to become visible in this late application. A second test also applied at the same location to bone dry soil immediately followed by irrigation again showed a need for 2 pounds of either chemical for adequate grass control.

Post-emergent applications of Linuron and Prometryne both caused considerable crop injury in the early and the late post-emergence applications. The Linuron injury progressed in severity with time after taking 3-4 days to initially appear.

Post-emergent applications of Prometryne granules were also used to avoid foliar injury. Applications made early in the morning to the emerging crop resulted in severe injury, however, applications at the later stage to dry foliage in mid-day caused no injury. Weed control was good in early post-emergence application but was very poor in the later stage. Thus, in clean fields or with very young weed seedlings post-emergent applications may be possible with this formulation.

Table 4. Influence of time of application on crop and weed response on sandy loam. Test IV.

Chemical	Lbs/A	Timing*	Crop Tolerance	Weed Control
Linuron	1	At Pl.	9.0	8.5
	2	"	8.5	8.8
	1	At Em.	7.0	9.0
	2	"	5.0	9.0
	1	4 Leaf	6.0	6.5
	2	"	4.0	8.0
Prometryne	1	At Pl.	8.0	8.0
	2	"	7.5	8.5
	1	At Em.	5.5	9.0
	2	"	6.0	9.0
	1	4 leaf	7.0	4.5
	2	"	7.0	7.0
Stoddard Solvent	75 gal.	At Em.	7.5	7.0
			8.0	8.0
Check	-	-	7.6	1.9

*At Pl. = At planting. At Em. = Crop just emerging-weeds in cotyledon stage. 4 leaf = Crops in 2-4 true leaf stage - weeds in 4 leaf stage.

Test V - Sandy Loam Soil at East Ithaca, N. Y.

The main objective of this test was to study the influence of soil incorporation and irrigation on weed control and crop response on the above herbicides. Treatments were made prior to planting and incorporated with a wheel hoe within five minutes of application. Duplicate treatments were applied after planting and left on the soil surface. The effect of irrigation was determined by irrigating two of the four replications immediately after application of the herbicides with 1/3 inch of water. The entire test was then irrigated 7 days later. The soil was very dry at planting with subsequent weather being dry. The weeds primarily included a heavy stand of crabgrass and redroot, pigweed. Post-emergence applications were made when the crop had 2 true leaves, and the weeds were 2-4 inches tall. The results are summarized in table 5. The outstanding treatments for weed control were at-planting applications of 3 pounds of Linuron, 3 pounds of Trifluralin, 24 pounds of Dacthal, 4 pounds of Amiben and 1 pound of Prometryne. Linuron at 1/2 pound at-planting was insufficient for crabgrass control while even 2 pounds was insufficient in the post-emergence application for adequate crabgrass control.

Solan and Stoddard Solvent gave poor control in the post-emergent applications - possibly due to the weeds being further advanced than generally recommended for post-emergent applications.

Time of irrigation did not greatly affect the weed control with these treatments; however, incorporation generally reduced the weed control.

There was no evident injury to the crop in any at-planting treatment. Post-emergent applications of Linuron, however, produced a slight chlorosis at 1 pound and a severe burning of leaf tips at two pounds. The carrots nearly recovered; however, growth was very slightly depressed. Carrots were tolerant of all other treatments.

Table 5. The influence of soil incorporation and irrigation on weed control on sandy loam. Test V.

	lbs.		Weed Control Rating			
	/A		Irrigated		Non Irrigated	
Chemical		Timing*	Surface	Incorporated	Surface	Incorporated
Amiben	4	At Pl.	8.0	6.5	8.0	8.0
	8	"	9.0	7.5	9.0	8.5
Dacthal	8	"	6.5	5.0	8.0	5.0
	24	"	8.5	6.5	9.0	8.0
Linuron	1/2	"	6.5	5.0	6.0	4.0
	3	"	9.0	7.0	9.0	7.0
Prometryne	1	"	8.0	6.0	-	-
	3	"	9.0	6.0	8.0	-
Trifluralin	1	"	6.5	5.0	4.5	5.5
	3	"	8.5	7.5	8.0	6.5
			Weed Control Rating (Post-emergent applications)			
Solan	2	Post		4.8		
	4	"		5.8		
Linuron	1	"		6.0		
	2	"		6.8		
Stoddard Solvent	75 gal.	Post		6.8		
Check	-	-		1.0		

*At Pl. = at planting.

Summary

1. Linuron appeared safe up to 3 pounds in at-planting applications. Post-emergent applications are erratic in crop tolerance and may cause crop injury. At present there is insufficient information to identify the factors involved. A wide range of weeds are controlled by 1 lb/A at planting. Two pounds were needed for pre or post-emergent control of annual grasses. Soil type and soil moisture do not greatly influence activity of the herbicide. Soil incorporation depressed weed control.

2. Carrots were very tolerant of Trifluralin; however, weed control was erratic. Dry season applications to muck soil, emerged weeds in cotyledon stage on dry soil and wet sandy soil gave poor control. Best weed control occurred when applied to dry soil at 3 lbs/A followed by irrigation. It appears somewhat weak on ragweed and mustard. Soil incorporation generally depressed weed control.

3. Carrots were tolerant of at-planting application of Prometryne. 1-2 pounds controlled most weeds in these applications. Post-emergent foliar sprays injured the crop, however, granular applications may be possible at this stage. Soil moisture and soil type did not appreciably affect control. Soil incorporation depressed weed control.

4. Solan caused no crop injury in pre or post-emergence treatments. Weed control was best in post-emergent applications to weeds in the early seedling state. Four pounds were necessary for adequate control.

5. Dacthal did not injure the crops with rates as high as 42.9 pounds in at-planting treatments. Adequate soil moisture at application or following was essential for good weed control. Incorporation decreased control.

6. Carrots were tolerant of 8 pounds of Amiben at planting. Weed control was poor except where applied to dry soil and irrigated up to 7 days later. Four pounds were sufficient for crabgrass and redroot pigweed control in this test. Incorporation decreased control greatly.

7. Stoddard Solvent gave no injury to the carrots. Weed control was fair when applied in early seedling stage, however, the lack of residual action allowed newly germinating weeds to reinfest the area. Later applications resulted in poorer control.

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POTENTIAL USE OF DIPHENAMID FOR WEED CONTROL IN HORTICULTURAL CROPS OF EASTERN VIRGINIA

H. M. LeBaron[1]

Introduction

Diphenamid is a particularly promising herbicide for the selective control of most annual grasses and broadleaf weeds in various crops under a wide range of soils and conditions(2). At present it is one of the most potentially promising compounds for a number of crop-weed combinations. Some of the crops most tolerant of diphenamid include several horticultural crops which have been susceptible to effective herbicides previously developed and where improved methods of weed control are seriously needed(1). Especially consistent and effective weed control has been obtained from diphenamid in lighter soils.

Procedures

During the past two years, diphenamid has been widely tested on a large number of crop-weed combinations in eastern Virginia. A total of 16 horticultural crops have been studied, often under several conditions, making a grand total of 61 different crop-weed combinations in which diphenamid has been included, as presented in Table 1. This includes some experiments where several different leaf crops were planted in the same plots and treated together.

Several soil types and a variety of climatic conditions and weed populations were represented in these field investigations. The main soil types would include Sassafras sandy loam, Woodstown sandy loam, and Galestown sandy loam. A wide range of temperature, sunlight, and soil moisture conditions at different seasons of the year were studied. These conditions to a great extent determined the weed population in each crop. With few exceptions, soil moisture was adequate, with some rainfall or irrigation usually within the first week after application.

Several methods of application were employed in these studies. For most of the replicated experiments, the 50 W or 80 W was applied with a knapsack sprayer of variable boom width and constant pressure control. Nozzle size was 8002 with 50 mesh screens, and the water applied ranged from 30 to 70 gallons/A. The 5% granular formulation of diphenamid was compared to the wettable powder in most of the replicated trials. This was applied either with a hand-propelled granular herbicide distributor with an auger metering device or with a small hand duster. The logarithmic plots were treated using a Chesterford Logarithmic Spraying Machine operated from the power-take-off of an International 140 tractor. Constant pressure of about 40 psi and ground speed of 3½ mph were maintained to obtain a half-dosage distance of 20 ft. The log plots were from 80 to 120 ft. long with a width of 5 or 15 ft. The 5 ft. plots were treated with 125 gallons/A (arms folded) while the 15 ft. plots received 42 gallons/A (arms out). In most cases, the log treatments were duplicated in a randomized arrangement and usually in different directions.

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Results and Discussion

Effectiveness of weed control:

In all these tests, there was no failure from the standpoint of weed control, except where the weed seedlings were already emerged or where the weed population consisted of resistant species. While diphenamid does have some post-emergent effects, particularly on annual grasses and chickweed when treated in the very early seedling stage, higher rates are required and some of the weeds will likely survive. Weed species resistant to diphenamid are usually not a major component of the weed population in the crops of this area. Henbit, which is moderately tolerant, is one of the main weeds in some fall or winter crops. Strawberries, however, is probably the only one of these crops where diphenamid could be safely used. A number of tolerant broadleaf weeds occur in many of the other crops, but they are seldom a major weed problem. The most common local species include ragweed, annual morning glory, smartweed, Jimsonweed, golden rod, shepherd's purse, and purslane.

Effective pre-emergent control of annual grasses and susceptible broadleaf weeds has virtually always been obtained under the conditions of these investigations from 2 lbs/A of diphenamid. Control of annual grasses and temporary control of some broadleaf weeds have been quite consistent from rates as low as 1 lb/A. Under some conditions favorable results have been obtained down to ½ lb/A or less.

While the optimum rate of diphenamid which should be used commercially will depend on the weed population, crop, length of control desired, soil type and other conditions, it is likely that 2 to 4 lbs/A will be the range suggested for most crop-weed situations of eastern Virginia. It may be that lower rates can be used successfully on cucumbers, broccoli, and other moderately tolerant crops, while somewhat higher rates may be desirable for longer residual control in crops such as strawberries or for control of moderately susceptible broadleaf weeds.

Influence of environment and time of application:

The control of weeds with diphenamid has not been seriously affected by climatic conditions, soil moisture, delay between seedbed preparation and application, or formulation. It has been less subject to variation or failure from these factors than has any other selective experimental compound included in these tests. Treated soil can even be disturbed or cultivated lightly without destroying weed control effectiveness. Irrigation or rain after application will usually improve weed control, and some soil moisture is certainly important. Irrigation immediately following diphenamid application, however, has generally given no significant advantage over precipitation within the first week. Delayed applications because of rain after planting or for other reasons have indicated that diphenamid is just as effective later as when applied at planting time, as long as the weed seedlings have not emerged. Variations in temperature, sunlight, and rainfall, have not resulted in any extreme differences in weed control, although control has usually been better, often to very low rates, in cooler, cloudier and wetter seasons. In experiments where wettable powder and granular formulations have been compared, there were no appreciable or consistent advantage of one over the other.

Crop tolerance and response:

As a result of these experiments, some changes are suggested in the previous classification of crops according to their tolerance to diphenamid[1,2]. At least some revision should be made to cover conditions of relatively light soils and high rainfall.

While most of the crops previously listed as tolerant do have true or natural tolerance, and showed no injury at rates much higher than is needed for weed control, a few should be removed from the tolerant or moderately tolerant lists, at least when applying to conditions similar to eastern Virginia. These susceptible crops include turnip, mustard, kale, collards, and possibly broccoli and cucumbers. It is true that under most conditions, some of these crops will show a degree of selectivity. However, depending on these conditions, species of weeds to control, and duration of control period desired, there is considerable variation in the two critical rates which determine selectivity; i.e., the minimum amount required for weed control and the maximum amount tolerated by the crop. While only 2 to 4 lbs/A of diphenamid are normally the maximum rates needed for effective control of all susceptible weeds under eastern Virginia conditions, all of these crops have shown definite injury to rates as low as 1½ to 2 lbs/A. With the exceptions of broccoli and cucumbers, these crops, previously listed as moderately tolerant to tolerant, have been severely injured from 1 lb/A or less of diphenamid.

There have been notable exceptions where certain of these crops have shown very promising tolerance. The explanation, however, has usually been obvious and apparently tied in with precipitation or movement of the chemical into the seed zone during germination. An example may be given of one log experiment where turnip and Hanover salad showed no injury at 8 lbs/A, while weed control was consistent and good to 2 lbs/A. Soil moisture at the time of seedbed preparation and planting was very good because of a 1 inch rain the day before. Very little rain fell during the next 3 weeks and by that time the crops were well established.

A logical explanation for the apparent tolerance to diphenamid previously ascribed to these crops is that, because of the relatively short period required for germination and establishment, and because of the low leachability of diphenamid in heavy soils[2], they are able to escape injury. This "escape tolerance", of course, does not explain the differences in tolerance between these crops when planted in the same seedbed and at the same depth. However, the degree of true tolerance exhibited by turnip and Hanover salad when they are not injured below 1 lb/A, while spinach, mustard, kale, collards, and cress are damaged down to ½ lb/A, is of more academic interest than of practical importance.

Additional evidence that these crops were lacking in significant true tolerance was obtained from an experiment where pre-plant soil incorporation of diphenamid was compared to surface applications. While weed control was not enhanced, but in some cases slightly poorer or subject to more variation, injury to most of these crops was increased. The crop response from soil incorporation was about comparable to that obtained when diphenamid application was followed soon by irrigation or rainfall. Crops showing true tolerance, on the other hand, were not greatly affected either by soil incorporation or precipitation.

In order for a chemical to be used commercially on a crop, it is not sufficient that the crop will survive a certain percentage of the time. It must be safe on the crop under virtually all conditions, particularly when those conditions are as uncertain as the time of the next rainfall.

Broccoli and cucumbers, based on these results, still warrant further investigation and perhaps should remain on the moderately tolerant list. They are, however, subject to severe injury at relatively low rates under conditions comparable to those in eastern Virginia, where they should not be treated at rates above 2 lbs/A. While other closely related crops previously listed as moderately tolerant[2] were not investigated here, it is reasonable that they may react similarly and should be thoroughly tested under various conditions before the degree of natural tolerance is assumed.

Crops which displayed consistent and true tolerance for diphenamid at weed control rates were tomatoes (direct-seeded and transplanted), peppers (direct-seeded and transplanted), cucumbers (lay-by), snap beans, Irish potatoes, sweet potatoes, and strawberries. All of these crops showed no apparent injury or effects from the highest rate of diphenamid applied, with the exception of direct-seeded peppers. There was no effect from 8 lbs/A on the germination or emergence of peppers. However, after the peppers were established, they failed to grow normally at high rates and remained stunted. There was a tendency for these peppers, even at lower rates, to remain slightly dwarfed but otherwise normal, which was not completely overcome by transplanting these plants into fresh soil. Pre-plant soil incorporation of diphenamid gave slightly greater injury with significant stunting to 6 lbs/A. It is therefore suggested that direct-seeded peppers belong in the list of moderately tolerant crops and further research is needed to determine the possible effects of diphenamid on the yield and quality of this crop.

While results on strawberries and sweetpotatoes have been promising with no apparent injury at weed control rates, both of these crops need further investigation for possible effects of diphenamid on plant growth and yield, particularly in light soils.

Diphenamid has shown no tendency to decrease yield or quality of tomatoes when applied at transplanting or various time intervals thereafter. Yield data and grass control ratings from one experiment are presented in Table 2. Similar data for an experiment on Irish potatoes treated after drag-off (pre-emergence) are given in Table 3. Both tables show that plots treated with diphenamid are almost always slightly higher in yield, though not significantly different at the 1% level, compared to the cultivated check plots.

Residue problem:

One factor which will play an important part in decisions relative to the recommendation and commercial use of diphenamid will be its tendency to remain active in the soil for extended periods[3]. This characteristic of diphenamid, which is so desirable from the standpoint of weed control in many crops in that the soil often remains practically weed-free throughout the growing and harvest season, will quite possibly prove to be one of its greatest limitations and handicaps.

When plots were treated with diphenamid in the spring of 1962, thoroughly disked after the crop was off, and planted with rye in the fall, each area which received 4 or 6 lbs/A could be easily located because of severe stand reduction and stunting of the grain. Very slight stunting could be noted even in some plots receiving 2 lbs/A when the seedbed was prepared by disking. When the seedbed was prepared by plowing, injury to the winter rye from diphenamid residue was decreased. Even here, however, injury could be observed in some of the areas treated with 4 or 6 lbs/A. No evidence has been reported(2) or was found in these tests to indicate that diphenamid residues remain in the soil from the previous year. Much more work needs to be done to determine how long diphenamid is likely to remain in various types of soil under different conditions, the processes by which it is dissipated, and which crops can safely be seeded following its use.

Summary and Conclusions

1. Diphenamid has given remarkably consistent pre-emergent control of annual grasses and most prevalent broadleaf weeds in horticultural crops of eastern Virginia.

2. Rates of 2 to 4 lbs/A of the wettable powder or granular formulations gave effective control in all crop-weed combinations and under all climatic conditions encountered in several sandy loam soils.

3. Effective weed control has not been lost during the growing season from light cultivations, excessive rainfall, or delay in application following planting as long as the weed seedlings had not emerged.

4. Although soil moisture or precipitation is necessary for optimum results, irrigation immediately following planting and application has not shown significant advantage over rainfall within the first week.

5. Several crops previously listed as tolerant or moderately tolerant; i.e., various leaf crops, broccoli, and cucumbers, were found to be very susceptible to injury at the rates of 2 lbs/A and often less.

6. Preliminary evidence indicated that direct-seeded green peppers may also be lacking in natural tolerance to diphenamid, and should be investigated further particularly under conditions of light soils and high rainfall.

7. No injury or decreased yield was observed at weed control rates of diphenamid on tomatoes (direct-seeded and transplanted), peppers (transplanted), cucumbers (lay-by), snap beans, Irish potatoes, sweetpotatoes, and strawberries.

8. Serious injury to fall-seeded rye resulted from applications of 4 or 6 lbs/A of diphenamid to previous crops the same year. The damage from these residues was particularly severe and consistent when the seedbed had been prepared by disking.

9. More work is needed to elucidate the problems relative to the longevity of diphenamid in various soils.

TABLE 1. DIPHENAMID TESTS AND SUMMARY OF RESULTS FROM 1961 AND 1962, NORFOLK, VIRGINIA

Crop	Time of Treatment	Type and Number of Tests Made: Replicated Experiment	Duplicated Log Plots	Field Trial	Total	Maximum Tolerated	Minimum Needed for Annual Grasses	Contr[illegible] Broad[illegible]
Snap beans	pre	1	2		3	8*	1 to 2	2 to
Snap beans	p.p.i.		1		1	8*	2	2
Lima beans	pre			1	1	4*	2**	2*
Broccoli	pre		2		2	1½ to 3	½ to 1	1 to
Broccoli	p.p.i.		1		1	2	2	2
Cucumbers	pre	1	2		3	1 to 3	1	2
Cucumbers	p.p.i.		1		1	2	2	2
Cucumbers	l.b.	1	1		2	8*	2	2 to
Leaf Crops:								
Spinach	pre	3	3	1	7	<½ to 1	½ to 1	2 to
Spinach	p.p.i.		1		1	<½	2	2
Spinach	l.b.			1	1	2		2
Turnips	pre	1	4		5	<1 to 8*	1	1 to
Turnips	p.p.i.		1		1	2	2	2
Mustard	pre		1		1	½	1	1 to
Kale	pre	1	2		3	<½	1	1 to
Collards	pre	1	2		3	<½	1	1 to
Hanover salad	pre	1	2		3	1 to 8*	1	1 to
Upland Cress	pre	1	2		3	<½	1	1 to
Green peppers	pre		1		1	7	1	2
Green peppers	p.p.i.		1		1	6	2	2
Green peppers	a.t.	1			1	6*	2**	2*
Green peppers	l.b.	1			1	4*	2	
Irish Potatoes	pre	2			2	8*	2 to 4	4
Sweetpotatoes	a.t.	1			1	4*	2**	2*
Tomatoes	pre.		1		1	8*	1	2
Tomatoes	p.p.i.		1		1	8*	2	2
Tomatoes	a.t.		1		1	16*	1	2
Tomatoes	l.b.	2	3		5	32*	1 to 2	
Strawberries (yr. of establishment)		1			1	8*	8**	8*
Strawberries (established beds)		2	1		3	8*	2 to 4	2 to
					61			

*highest rate applied
** lowest rate applied

pre = pre-emergence
p.p.i. = pre-plant incorporation

l.b. = lay-by
a.t. = at transplanting

Table 2. Tomato Yields and Grass Control from Diphenamid, 1962, Norfolk, Va.

Treatment	Form.*	Rate (Lbs/A)	Timing**	Yield (Tons/A)	Significant Difference at 1%	Average Grass Control Rating at Harvest***
Diphenamid	S	2	2	11.7		9½
Diphenamid	S	2	4	11.3		8½
Diphenamid	G	4	4	10.7		8 3/4
Diphenamid	S	6	2	10.7		9½
Diphenamid	S	6	4	10.0		10
Diphenamid	G	2	4	9.9		7 3/4
Diphenamid	S	4	2	9.6		9½
Cultivated Check				9.6		7½
Diphenamid	S	4	4	9.1		8½
Check				7.7		0

* S = spray; G = granular.
** Number of weeks that application followed transplanting.
*** 0 = complete infestation
7 = commercial control
10 = complete control

Table 3. Irish Potato Yield and Grass Control from Diphenamid, 1962, Norfolk, Va.

Treatment	Form.*	Rate (Lbs./A.)	Yield (Tons/A)	Significant Difference at 1%	Average Grass Control Rating at Harvest**
Diphenamid	G	4	15.9		9
Diphenamid	G	2	15.1		8 1/3
Diphenamid	S	2	14.7		7 2/3
Diphenamid	S	4	14.2		9
Cultivated Check			13.6		5
Check			8.2		3 2/3

* S = spray; G = granular.
** 0 = complete infestation
7 = commercial control
10 = complete control

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WEED CONTROL IN TRANSPLANTED COLE CROPS

J. F. Ellis and R. D. Ilnicki [1]

Approximately 8,000 acres in New Jersey are devoted to the production of broccoli, cabbage and cauliflower, valued at four million dollars (3). No extensive weed control research has been conducted on these crops in New Jersey. Notwithstanding that they make up a small percentage of the total value of vegetable crops in New Jersey, they warrant more attention with regard to weed control research in this state.

Previous reports have indicated that dacthal and zytron performed well on transplanted broccoli, cabbage and cauliflower (1, 2). Very little research has been done with some of the newer experimental herbicides to show their effects on the cole crops in the Northeast. This study was initiated to evaluate the effects of a number of herbicidal treatments on three transplanted cole crops.

Materials and Methods

The experiment was conducted at the Agronomy Research Center in Adelphia, New Jersey on a Freehold sandy loam soil.

The herbicides used were as follows:

(a) 2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine (trifluralin) -- applied as an emulsifiable concentrate and in granular form (5G) at rates of 1, 2 and 3 pounds per acre incorporated and at rates of 2, 3 and 6 pounds per acre unincorporated.

(b) N,N-dimethyl-2,2-diphenylacetamide (diphenamid) -- applied as a wettable powder (80W) and granular (5G) at rates of 4, 6 and 8 pounds per acre.

(c) O-(2,4-dichlorophenyl)-O-methylisopropylphosphoroamidothioate (zytron) -- applied as an emulsifiable concentrate and the granular (25G) at rates of 10 and 20 pounds per acre.

(d) Dimethyl 2,3,5,6-tetrachloroterephthalate (dacthal) -- applied as the wettable powder (75W) at rates of 6, 8 and 24 pounds per acre.

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(e) 2,4-(dichlorophenyl)-4-nitrophenyl ether (FW925) -- applied at rates of 2, 4 and 6 pounds per acre.

Liquid formulations were applied with a knapsack sprayer connected to a boom equipped with two nozzles spaced 20 inches apart. The applications were made in water dilutions of 40 gallons per acre.

Marion Market cabbage was transplanted June 15, 1962 and treated July 5. Waltham #29 broccoli, Imperial Snowball cauliflower were transplanted on July 3, 1962 and treated on July 25.

Each experiment was designed as a randomized complete block with four replications. The plots consisted of one row of plants and were 3½ feet wide by 35 feet in length.

Results and Discussion

In Tables 1, 2 and 3 are presented summaries of the weed control and crop injury data and the yields of broccoli, cabbage and cauliflower, respectively.

Broccoli

The best treatment on broccoli was the granular form of zytron at 10 and 20 pounds per acre. The emulsifiable concentrate gave lower yields but was slightly better at controlling weeds.

There was little difference between the emulsifiable concentrate and granular form of trifluralin. The emulsifiable concentrate showed lower yields and more injury to the crop than the granular. No benefit from incorporating trifluralin was observed.

On the other hand, the diphenamid granular generally did not produce higher yields than the wettable powder. The 4 pound rate of granular produced the highest yield, but at 6 and 8 pounds yields decreased. The production changed very slightly with different rates of the wettable powder, the general overall yield being higher than that of the granular form. The granular showed slightly better weed control.

Similar to the trend produced by granular diphenamid was the decline in yield with increasing rate of FW925, the 6 pound rate producing the lowest yield.

Cabbage

When comparing the trifluralin emulsifiable concentrate with its granular form at the one pound incorporated rate, it may be concluded that the granular was the better form. Plants per plot and the numbers of heads harvested did not influence these two treatments. The six pound, unincorporated rate of trifluralin had the lowest yield of all treatments. There was no real benefit from

Table 1. The effects of a number of herbicidal treatments on the weed control, injury and the yield of broccoli*. Transplanted on July 3, 1962 and treated on Jyly 25, 1962.

Treatment	Rate, lbs/A	Weed Control** Broadleaves Stand[1]	Weed Control** Broadleaves Vigor[2]	Weed Control** Grasses Stand[1]	Weed Control** Grasses Vigor[2]	Crop Injury** Stand[1]	Crop Injury** Vigor[2]	Plants per plot[3]	Crop Yields** Crates /A[4]
2,6-dinitro-N,N-di-n-propyl-a,a-trifluoro-p-toluidine(trifluralin).									
E.C.	1 inc.	9.0	4.5	9.5	6.6	0.6	0.3	17	148
	2 inc.	9.7	7.0	9.6	6.0	1.0	1.0	16	149
	3 inc.	9.6	7.8	9.8	7.9	0.7	0.7	17	180
	2 uninc.	9.5	6.1	8.8	1.7	0.5	0.2	17	164
	3 uninc.	8.9	4.2	8.7	3.9	0.8	0.8	16	112
	6 uninc.	9.8	7.5	9.3	4.8	0.9	0.6	18	155
5G	1 inc.	9.3	6.8	9.0	4.2	0.3	0.1	17	173
	2 inc.	9.2	5.3	8.9	4.6	0.5	0.1	16	160
	3 inc.	9.2	5.1	9.4	4.7	0.3	0.1	17	160
	2 uninc.	9.0	5.5	8.8	3.9	0.3	0.2	17	184
	3 uninc.	9.6	7.7	8.8	3.6	0.4	0.1	17	147
	6 uninc.	9.4	6.9	9.3	5.0	0.2	0.0	17	175
N,N-dimethyl-2,2-diphenylacetamide (diphenamid).									
80W	4	8.6	6.4	8.3	3.5	0.6	0.6	18	170
	6	8.9	3.9	8.8	3.5	0.6	0.1	17	171
	8	9.4	6.7	9.6	6.7	0.2	0.4	18	172
5G	4	9.7	7.2	9.7	8.3	0.2	0.3	18	177
	6	9.3	6.3	9.0	5.8	0.3	0.5	18	148
	8	9.5	7.3	9.5	6.3	0.5	0.2	16	145
O-(2,4-dichlorophenyl)-O-methylisopropylphosphoroamidothioate(zytron)									
E.C.	10	9.7	8.4	9.0	4.2	0.3	0.2	18	164
	20	9.9	9.2	9.4	5.5	0.4	0.2	18	167
25G	10	8.6	6.0	7.2	1.6	0.2	0.1	18	184
	20	9.5	6.6	8.5	2.4	0.2	0.2	17	189
Dimethyl 2,3,5,6-tetrachloroterephthalate (dacthal).									
75W	6	9.3	5.3	7.8	3.3	0.3	0.2	19	182
	8	8.8	6.1	8.5	3.3	0.6	0.1	16	161
	24	9.6	8.7	7.7	2.0	0.7	0.6	15	154
2,4-(dichlorophenyl)-4-nitrophenyl ether (FW 925).									
	2	8.6	3.2	8.6	3.3	0.2	0.2	18	172
	4	8.1	4.4	8.7	5.2	0.3	0.3	17	168
	6	8.5	6.7	9.6	6.7	0.3	0.2	18	154
Check	-	6.9	3.6	7.7	3.2	1.1	0.1	18	162
Check	-	5.4	2.2	6.7	2.8	0.3	0.2	18	162

LSD 5% level = 32

** Average of 4 replications.
[1] Based on scale 0 to 10; 0=no effect, 10=reduced 100%.
[2] Based on scale 0 to 10; 0=no effect, 10= complete kill.
[3] Counted on day of treatment.

Table 2. The effects of a number of herbicidal treatments on the weed control, injury and the yield of cabbage*. Transplanted on June 15, 1962 and treated on July 5, 1962.

Treat-ment	Rate, lbs./A	Weed Control** Broadleaves Stand[1]	Weed Control** Broadleaves Vigor[2]	Weed Control** Grasses Stand[1]	Weed Control** Grasses Vigor[2]	Crop Injury** Stand[1]	Crop Injury** Vigor[2]	Plants per plot[3]	Crop Yields** # heads harvested	Crop Yields** Cwt/A[4]
2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine(trifluralin).										
E.C.	1 inc.	9.5	9.5	8.6	5.1	0.1	2.5	19	17	181
	2 inc.	9.8	9.5	9.6	8.0	0.0	1.2	20	17	217
	3 inc.	9.9	9.8	9.5	8.9	0.0	2.4	22	18	215
	2 uninc.	9.3	9.0	8.4	5.5	0.0	1.9	20	18	228
	3 uninc.	9.4	9.1	9.1	6.1	0.0	2.4	20	18	208
	6 uninc.	9.6	9.5	8.7	4.6	2.3	4.7	19	10	124
5G	1 inc.	9.6	9.5	9.2	9.1	0.0	1.9	19	17	229
	2 inc.	9.8	8.5	9.0	6.5	0.3	1.8	21	18	210
	3 inc.	9.9	9.8	9.4	6.1	0.0	1.9	21	17	193
	2 uninc.	9.8	9.6	8.6	5.8	0.8	3.3	19	14	177
	3 uninc.	9.8	9.3	8.6	6.2	0.4	1.4	18	17	217
	6 uninc.	9.9	9.3	9.3	8.5	0.0	2.4	19	17	207
N, N-dimethyl-2,2-diphenylacetamide (diphenamid).										
80W	4	9.4	9.4	8.7	6.3	0.0	1.2	20	18	237
	6	9.5	8.9	8.9	7.3	0.0	1.8	20	14	170
	8	9.8	9.9	9.0	6.5	0.1	2.1	19	18	243
5G	4	8.6	8.4	8.5	6.2	0.0	1.7	19	18	227
	6	9.7	9.6	8.9	6.6	0.8	2.5	19	16	191
	8	9.6	8.6	9.7	8.6	0.4	2.0	18	15	202
O(2,4-dichlorophenyl)-O-methylisopropylphosphoroamidothioate(zytron).										
E.C.	10	9.8	9.9	7.8	6.6	0.0	4.2	24	16	160
	20	9.9	9.6	8.4	5.4	0.8	3.2	22	14	153
25G	10	5.4	3.4	6.4	4.8	0.3	1.8	21	17	232
	20	6.8	6.8	6.6	5.2	0.0	2.2	21	17	247
Dimethyl 2,3,5,6-tetrachloroterephthalate (dacthal).										
75W	6	9.9	9.9	8.9	5.8	0.0	2.0	21	20	227
	8	9.7	9.7	6.8	6.2	0.0	1.1	21	17	227
	24	9.8	9.8	9.5	8.6	0.1	1.6	21	17	203
2,4-(dichlorophenyl)-4-nitrophenyl ether (FW 925).										
	2	8.2	8.0	6.9	3.8	0.0	2.4	19	16	178
	4	8.8	7.7	7.8	4.9	0.5	2.5	18	15	166
Check	-	1.9	3.3	3.6	1.3	0.0	0.4	21	19	246
Check	-	3.8	1.6	3.2	1.0	0.0	0.7	19	19	246

* Ratings made on Aug. 14, 1962 and harvesting started Aug.15, 1962.
** Average of 4 replications.
1 Based on sacle 0 to 10; 0=no effect, 10=reduced 100%.
2 Based on scale 0 to 10; 0=no effect, 10= complete kill.
3 Counted on day of treatment.

Table 3. The effects of a number of herbicidal treatmetns on the weed control, injury and the yield of cauliflower*. Transplanted on July 3, 1962 and treated on July 25, 1962.

		Weed Control**				Crop Injury**		Crop Yield**
		Broadleaves		Grasses				
Treatment	Rate, lbs/A	Stand[1]	Vigor[2]	Stand[1]	Vigor[2]	Vigor[2]	Plants per plot[3]	Crates[4]/A
2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine(trifluralin).								
E.C.	1 inc.	9.3	9.5	9.2	9.5	0.3	13	348
	2 inc.	9.5	9.4	9.6	9.5	1.8	14	285
	3 inc.	9.8	9.6	9.8	9.4	4.3	14	331
	2 uninc.	9.2	9.2	9.3	9.6	0.1	15	285
	3 uninc.	9.6	9.4	9.6	9.7	1.3	16	322
	6 uninc.	9.8	9.8	10.0	10.0	3.9	15	302
5G	1 inc.	9.3	9.6	9.5	9.6	0.2	15	359
	2 inc.	9.6	9.5	9.5	9.8	2.2	13	365
	3 inc.	10.0	10.0	9.8	9.8	4.7	14	261
	2 uninc.	9.6	9.7	9.4	9.9	0.0	15	292
	3 uninc.	9.8	9.9	9.8	9.8	1.2	15	262
	6 uninc.	10.0	10.0	10.0	10.0	2.9	15	312
N, N-dimethyl-2,2-diphenylacetamide (diphenamid).								
80W	4	9.0	9.5	8.8	9.0	0.0	16	403
	6	9.7	9.4	9.6	9.4	2.2	15	352
	8	10.0	10.0	10.0	10.0	3.0	14	310
5G	4	8.6	9.0	8.7	9.0	0.0	16	374
	6	9.5	9.2	9.2	9.2	1.8	15	365
	8	9.6	9.4	9.8	9.6	2.8	14	343
O(2,4-dichlorophenyl)-O-methylisopropylphosphoroamidothioate(zytron).								
E.C.	10	9.5	9.2	8.0	8.3	0.0	17	470
	20	9.6	9.3	8.2	8.5	0.0	13	328
25G	10	8.4	8.0	7.8	5.2	0.0	15	396
	20	8.6	8.2	7.5	6.6	0.0	15	413
Dimethyl 2,3,5,6-tetrachloroterephthalate (dacthal).								
75W	6	9.8	9.2	9.2	9.3	0.0	16	422
	8	9.8	9.7	9.6	9.6	0.0	14	321
	24	10.0	10.0	10.0	10.0	0.0	14	369
2,4-(dichlorophenyl)-4-nitrophenyl ether (FW 925).								
	2	8.3	8.0	8.9	9.0	0.3	15	422
	4	8.4	8.2	9.2	9.2	0.5	15	356
	6	8.5	8.2	9.4	9.0	1.6	16	406
Check	-	---	---	---	---	---	14	403
Check	-	---	---	---	---	---	12	329
						LSD -	5% level =	114
							1% level =	151

* Observations made on Sept.19, 1962; harvesting started on Sept. 20, 1962.
** Average of 4 replications.
1 Based on scale 0 to 10; 0=no effect, 10=reduced 100%.
2 Based on scale 0 to 10; 0=no effect, 10=complete kill.

incorporating trifluralin. The six pound, unincorporated rate of the emulsified concentrate and the three pound, incorporated granular rate of trifluralin caused a slight amount of bolting.

Zytron granular produced higher yields than the rest of the herbicide treatments with the same number of heads harvested. On the other hand, this material gave the poorest weed control. The emulsifiable concentrate form of zytron decreased the vigor of the crop. This, plus the fact that there is a large difference between the original number of plants per plot and the number of heads harvested, accounts for the low yield.

A residual effect of herbicidal treatments was observed when a rye cover crop was sown after harvesting. The two and three pound, incorporated rate and six pound, unincorporated rate of granular trifluralin decreased the stand and vigor of the rye. The wettable powder and granular form of diphenamid, at all rates, showed even a greater residual effect.

Cauliflower

All treatments with the exception of dacthal and zytron produced a decrease in crop vigor with increase in rate of application.

Better weed control was achieved by the granular form of trifluralin than by the emulsifiable concentrate.

The incorporated applications of trifluralin caused a greater loss in crop vigor than the unincorporated applications.

Zytron and FW925 gave the poorest weed control.

Summary

The effects of a number of herbicidal treatments on three transplanted cole crops were evaluated. Observations and data were taken on weed control, crop injury and crop yield.

In most cases, zytron and FW925 gave the poorest weed control. Only slight differences were observed between the form of herbicidal application and weed control; the emulsifiable concentrate form of zytron on cabbage gave better weed control than the graunlar, and the granular form of trifluralin on cauliflower was better than the emulsifiable concentrate.

Broccoli was not very susceptible to injury by the herbicides. On the other hand, trifluralin caused injury on both cabbage and cauliflower. Zytron was responsible for some injury on cabbage but did not cause any on cauliflower.

The granular form of zytron was the best treatment on broccoli for increasing yields. On cabbage, none of the treatments produced yields much greater than the checks; zytron granular again was the better treatment. No one particular herbicide treatment on cauliflower could be regarded as the best one for increasing yields.

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Chemical Weed Control in Sweet Potatoes 1/

J. D. Riggleman and W. A. Matthews 2/

Sweet potatoes are one of the most important vegetable crops grown on the eastern shore of Maryland. Annually about 3800 acres are harvested representing a value to the farmer of 2 million dollars. Weeds not only reduce yield by competition, but interfere with the harvesting operation. Because of the vining habit of sweet potatoes, frequent cultivations (from 4-8 per season) are necessary to train the vines so that subsequent cultivations can proceed without injury to the crop. Sweet potatoes could be produced without cultivation, if the weeds could be controlled until about 8 weeks after planting at which time the vines have covered the ground sufficiently to form a natural barrier against further weed infestation.

Materials and Methods

The trials were conducted at the University of Maryland Vegetable Research Farm, Salisbury, Maryland, on a well drained loamy sand, low in organic matter. The rainfall was about one-half normal for each month. Although the vines were wilted during several periods, the plots were not irrigated. Nemagold sweet potato slips were planted May 15. All treatments were applied in late evening to the surface of dry soil. None was incorporated. The plots were rated for injury symptoms and control of weeds monthly through-out the season.

Advanced trial. A randomized complete block in 4 replications was used with a single plot being composed of 3 rows 30' long (26 plants/row) treated alike with only the center row used for records. The herbicides were applied (50 GPA) with a broadcast boom-sprayer mounted on a tractor, or with a fluted-roller granular applicator (2). Applications were made May 15 (after planting) and June 20 following hoeing on June 18, and cultivation on June 19. Because commercial sweet potatoes are usually side-dressed later than the early "lay-by" used in this experiment, two cultivated checks were used. In the first, the sweet potatoes were cultivated and side-dressed at the last fertilizer applications as might be done commercially. In the second cultivated check, the fertilizer at the last application, was top-dressed as the plots receiving herbicides. The checks were cultivated June 4, 19, July 7, 23, and hoed on June 18. The plots were harvested September 12.

Logarithmic trial. Single row plots, 85' long were used in duplicate. The materials were applied immediately after planting on May 15 with an exponential sprayer (1) and received no further treatments. These plots were not harvested for yield.

1/ Scientific Article No. A 1021, Contribution No. 3414 of the Maryland Agricultural Experiment Station, Department of Horticulture.

2/ Research assistant, and associate professor (respectively), University of Maryland Vegetable Research Farm, Salisbury, Maryland.

Results

Advanced trial

The data are presented in Table 1.

Check plots. Essentially no difference in yield was found between the two check (side-dressed vs. top dressed at last fertilizer application) plots. To measure the effect of the herbicides, however, one should use check 2 as the standard for comparison.

CIPC 5 G 4+4 lbs AI/A. The vine growth was reduced considerably. The control was acceptable for only 4 weeks after each application and yield was less than the check.

CIPC 4 E 4+4 lbs AI/A. Slightly more stunting was produced by this material than with CIPC 5 G. Control was slightly better, but not good enough by the end of the season to be commercially acceptable. Though apparently reduced, the yield was not significantly less than the check.

Dacthal 75 W 9+9 lbs AI/A. No injury to the foliage was observed and the control was excellent for the entire season. The yield was greater than the check.

Zytron 3 E 10+10 lbs AI/A. The first application caused no injury but the second injured the foliage. Control was not acceptable by the end of the season. The yield was less than the check.

Diphenamid 80 W 4+4 lbs AI/A. The foliage was not injured. Control was excellent for the entire season. The yield was greater than the check.

Amiben 10 G 4+4 lbs AI/A. Amiben caused no apparent injury to the vines. Control was good for the entire season. The yield of No. 1 was the same as the check, but was less than the yield where Diphenamid, Amiben 2 S or Trifluralin were used. The total yield was not affected.

Amiben 2 S 4+4 lbs AI/A. No injury could be found. Control was good for the entire season. The yield was not different from the check.

Trifluralin 4 E 4+4 lbs AI/A. The vines were not injured. The control was excellent for the entire season and the yield was not different from the check.

Logarithmic trial

The data are in Table 2. None of the materials caused any visable injury to the foliage. Lorox 50 W at 1 lb AI/A gave acceptable control for 6 weeks, but 2 lbs AI/A were barely satisfactory at the end of the season. R1607 6 E and R1607 SE7 2E behaved almost alike; 3 lbs AI/A gave adequate control for 8 weeks, but 5-8 lbs AI/A were necessary for full season control. There was excellent control for the entire season from U4513 50W at 4-5 lbs AI/A.

Summary and Conclusions

Two applications(one at planting and one at lay-by) of CIPC or Zytron caused too much injury and did not give adequate control for the periods of time studied. Two applications of Dacthal, Diphenamid, Amiben or Trifluralin gave adequate control without injury to the crop. In the logarithmic trial where only a single application of herbicide (at planting) was made, Lorox, R 1607 6E and SE7 2E, and U 4513 gave good control with no visable injury to the crop.

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Table I

The effects of herbicides applied to sweet potatoes at planting and at "lay-by" on freedom from injury, control of weeds, and on yield and number of roots[1].

Treatment	Lbs AI/A [2]	Freedom from Injury [3]			Control [4]				
		6/14	7/5	7/26	6/14	7/5	7/26	8/17	9/12
1. Side dressed[5] Check		10.0	10.0	10.0	9.8	10.0	10.0	8.0	7.5
2. Top dressed[6] Check		10.0	10.0	10.0	10.0	10.0	10.0	7.5	6.5
3. CIPC 5G	4+4	9.3	7.0	8.0	8.3	10.0	10.0	5.8	4.8
4. CIPC 4E	4+4	9.5	6.5	8.8	9.3	10.0	10.0	8.3	5.5
5. Dacthal 75W	9+9	10.0	9.8	10.0	10.0	10.0	10.0	9.5	9.3
6. Zytron 3E	10+10	10.0	5.3	7.8	8.8	10.0	9.5	7.8	5.0
7. Diphenamid 80W	4+4	10.0	9.8	10.0	9.5	10.0	10.0	10.0	10.0
8. Amiben 10G	4+4	10.0	10.0	10.0	9.3	10.0	10.0	8.8	8.0
9. Amiben 2S	4+4	10.0	10.0	10.0	10.0	10.0	10.0	9.3	8.3
10. Trifluralin 4E	4+4	10.0	9.5	10.0	10.0	10.0	10.0	10.0	10.0

Treatment	Yield (Bu/A)		Number of Roots (Thousand/A)	
	No. 1	No. 1,2,3	No. 1	No. 1,2,3
1. Side dressed[5] Check	129ab	321abc	12.8abc	66.6ab
2. Top dressed[6] Check	128ab	297 bcd	13.2ab	57.5 bcd
3. CIPC 5G	72 c	243 de	6.9 d	51.1 cd
4. CIPC 4E	104 bc	259 cde	10.0 bcd	50.4 d
5. Dacthal 75W	123ab	358a	10.9 bc	68.7ab
6. Zytron 3E	72 c	220 e	6.5 d	47.0 d
7. Diphenamid 80W	153a	369a	14.0abc	69.6ab
8. Amiben 10G	100 bc	328ab	9.2 cd	69.3a
9. Amiben 2S	153a	338ab	15.6a	66.0ab
10. Trifluralin 4E	126ab	332ab	11.1 bc	61.9abc

1/ Sweet potato sprouts planted in 4 replicates May 15, followed by herbicide application late that evening. All plots hoed June 18, cultivated June 19 (lay-by) and followed by a second herbicide application in late evening on June 20. The plots were harvested September 12.

2/ Lbs AI/A applied at planting and at lay-by respectively.

3/ Rated from 1-10 where 10 = no apparent injury to the foliage.

4/ Rated from 1-10 where 10 = nearly perfect control and 7 = commercially acceptable control.

5/ Cultivated June 4, 19, July 7, 23; hoed June 18; side dressed June 19 and July 23.

6/ Cultivated and fertilized same as plot 1 (5/) on July 23 it was top dressed as were the herbicide plots instead of side dressed.

Table II

The effects of herbicides applied May 15, with an exponential sprayer to sweet potatoes immediately after transplanting on control1/, injury2/, and the acceptable range3/.

Treatment	Range lbs AI/A	June 14 Control Down to	June 14 Acceptable Range	July 5 Control Down to	July 5 Acceptable Range
1. Lorox 50W	2-1/8	0.8	0.8-2.0	1.2	1.2-2.0
2. R 1607 6E	8-½	2.3	2.3-8.0	2.4	2.4-8.0
3. R 1607 SE7 2E	8-½	2.3	2.3-8.0	2.6	2.6-8.0
4. U 4513 50W	8-½	3.6	3.6-8.0	3.8	3.8-8.0

Treatment	July 26 Control Down to	July 26 Acceptable Range	August 17 Control Down to	August 17 Acceptable Range	September 12 Control Down to	September 12 Acceptable Range
1. Lorox 50W	1.7	1.7-2.0	1.9	1.9-2.0	2.0	2.0
2. R 1607 6E	3.7	3.7-8.0	3.7	3.7-8.0	5.0	5.0-8.0
3. R 1607 SE7 2E	3.1	3.1-8.0	3.8	3.8-8.0	4.5	4.5-8.0
4. U 4513 50W	3.4	3.4-8.0	3.4	3.4-8.0	4.5	4.5-8.0

1/ The lowest rate as lbs AI/A where there was acceptable control.

2/ There was no injury from any material in the range applied.

3/ The range as lbs AI/A where there was acceptable control and no injury.

EVALUATION OF SEVERAL NEW HERBICIDES FOR PRE- AND POST-EMERGENCE WEED CONTROL IN CARROTS

C. T. Dickerson and E. M. Rahn[1]

Stoddard Solvent is used extensively for weed control in carrots in Delaware. Generally, two post-emergence applications of 75 to 100 gal/A each are required for full-season weed control. This herbicide has two main objections. It is costly, about $30.00 to $35.00 per acre; and it does not control ragweed (*Ambrosia artemisiiflora*). Therefore, the major objectives of the experiment reported herein were to find a less costly herbicide and one that will control ragweed as well as other common weeds.

PROCEDURE

Waltham Hicolor carrots were planted May 23, 1962 at the Georgetown, Delaware, Substation on a Norfolk loamy sand. The herbicides listed in Table 1, except for Stoddard Solvent (Sun Spirits), were applied with a logarithmic sprayer at the rates indicated. Treatments were replicated twice in randomized blocks. Each plot consisted of two rows 3 feet apart and 75 feet long. Herbicides applied pre-emergence were applied just after seeding, with the exception of Trifluralin. This chemical was applied just before seeding and was soil-incorporated by two discings. The herbicides that were applied early post-emergence were applied June 14, 1962, when the carrots had one or two true leaves and were about one inch tall. At this time weeds were about 2 inches tall. The principle weeds were crabgrass, goosegrass, nutgrass, ragweed,pigweed, carpetweed, and lamb's quarters.

Records on weed control and crop injury of pre and early post-emergence treatments were taken on June 26, 1962, (Table 1). Late post-emergence applications of certain herbicides were made on July 6, 1962, when the carrots were about 5 inches tall. Many weeds up to two feet tall were appearing at that time. On the second replication, Linuron, 2 lbs/A in 100 gal., was applied to all plots. On the first replication, Stoddard Solvent (Sun Spirits) at 100 gal/A was applied to all plots except those that had previously received post-emergence applications of Linuron, Shell 6623, and Solan. These latter plots received repeat treatments of the same herbicides previously applied. Yields from the most effective treatments as well as the Stoddard Solvent check were recorded on August 29, 1962, (Table 2).

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RESULTS AND DISCUSSION

The outstanding herbicide in this test was Linuron, especially applied post-emergence when carrots were 5 inches tall, following an early post-emergence application of Stoddard Solvent when carrots had 1 or 2 true leaves (Table 2). Stoddard Solvent alone controlled all weeds but ragweed. Linuron alone, post-emergence, gave excellent control of broadleaf weeds including ragweed, but was weak on grasses, especially when grasses became several inches tall.

Carrot plants had an excellent tolerance for over-all post-emergence sprays of Linuron when they were 5 inches tall. Up to 6 lb/A were applied with no apparent injury, whereas only 2 lb/A were needed for good weed control. However, when applied early post-emergence Linuron had a much narrower margin of safety, (Table 1). In pre-emergence applications, Linuron had a fairly narrow margin of safety, 1 lb/A being needed for weed control early in the season (this was not enough for full-season control), while carrots tolerated up to 2.3 lb/A (Table 1).

Solan in early post-emergence applications was fairly effective, but needed to be supplemented by a late post-emergence application of Linuron, 2 lb/A, for full-season weed control. For control early in the season, an early post-emergence application of Solan of 2.63 lb/A was needed for weed control, whereas the crop would tolerate nearly 5 lb/A (Table 1). Solan, however, was not effective on grasses unless they were very small (less than 1 inch high) at time of application.

SUMMARY

Of the herbicides tested for both pre and post-emergence weed control in carrots, a combination of two over-all post-emergence applications of herbicides, Stoddard Solvent and Linuron was most outstanding. This combination gave full-season weed control without injury to the carrots. It consisted of Stoddard Solvent, 100 gal/A, over-all when carrots had 1 or 2 true leaves; and Linuron 2 lb. in 100 gal/A, over-all when carrots were 5 inches tall.

Table 1. Maximum Rate of Herbicide Tolerated by Carrots and Minimum Rate Needed for Weed Control (Ratings 5 weeks after seeding).

Herbicide and Rate	Method of Application	Max. Rate Tolerated By Carrots	Minimum Rate Required for Control of: Annual Broadleaves	Annual Grasses	Nutgrass
Dacthal, 3.75 to 25 lb/A	Pre-em.	N.I.1/	N.C.2/	4.75 lb/A	N.C.
Linuron, 0.6 to 4 lb/A	Pre-em.	2.3 lb/A	.8 lb/A	1 lb/A	2.95 lb/A
Trifluralin, 1.5 to 10 lb/A	Pre-em.	9.15 lb/A	8 lb/A	2.5 lb/A	10 lb/A
Zytron, 3 to 20 lb/A	Pre-em.	N.I.	N.C.	5.4 lb/A	N.C.
Alipur, 1.5 to 10 lb/A	Pre-em.	3.5 lb/A	2.1 lb/A	1.85 lb/A	6 lb/A
FW 925, 1.5 to 10 lb/A	Pre-em.	N.I.	N.C.	3.75 lb/A	N.C.
CIPC, 1.5 to 10 lb/A	Pre-em.	N.I.	N.C.	1.95 lb/A	N.C.
Linuron, 0.3 to 2 lb/A	Ea. Post-em.4/	.875 lb/A	.275 lb/A	.75 lb/A	1.38 lb/A
Shell 6623, 1.5 to 10 lb/A	Ea. Post-em.4/	2.5 lb/A	3/	2.5 lb/A	9 lb/A
Solan, 1.5 to 10 lb/A	Ea. Post-em.4/	4.92 lb/A	1.75 lb/A	2.63 lb/A	N.C.
Stoddard Solvent, 100 gal/A (Sun Spirits)	Ea. Post-em.4/	N.I.	Poor Control of Ragweed	Good Control	Good Control

1/ N.I.= No injury at highest rate
2/ N.C.= No control at highest rate
3/ No control of lambsquarters at highest rate, all other annual broadleaves controlled above 2 lb/A
4/ When carrots had one or two true leaves

Table 2. Yield of Carrots from Certain Herbicide Combinations That Gave Full Season Weed Control

Herbicide Combination and Average Rate			Marketable Yield From 20 ft. of Row		Remarks
5/23/62 Pre-Emergence	6/14/62 1/ Early Post-Emergence	7/6/62 2/ Late Post-Emergence	No.	Wt.	
Linuron, 1.4 lb/A 3/		Linuron, 2 lb/A	98	19.8	Excellent Control
	Linuron, .68 lb/A 4/	Linuron, 2 lb/A	95	18.4	Excellent Control
	Stoddard Solvent, 100 gal/A	Linuron, 2 lb/A	107	17.4	Excellent Control
	Solan, 2.75 lb/A	Linuron, 2 lb/A	70	13.4	Good Control
	Stoddard Solvent, 100 gal/A	Stoddard Solvent, 100 gal/A	49	3.1	Poor Control of Ragweed

1/ Carrots in 1 to 2 true leaf stage. Weeds 2 inches high

2/ Carrots 5 inches high. Some Weeds 1 to 2 feet high

3/ Fairly narrow margin of safety

4/ Narrow margin of safety

CHEMICAL WEED CONTROL IN LIMA BEANS

Charles J. Noll[1]

Weed control is one of the major problems in the growing of Lima beans. Weeds in the plant row can not be removed by cultivation. Growers have shown great interest in herbicides as an aid in reducing weeding costs. DNBP has been commonly used to weed this crop but a better, less expensive herbicide would be desirable.

Procedure

The seedbed was prepared June 6. The pre-planting treatment was applied and the field seeded June 8. This pre-planting treatment was incorporated in the soil immediately after application with a rototiller set shallow. Pre-emergence treatments were applied from 1 to 6 days following seeding and the post-emergence treatment was applied 15 days after seeding. The variety grown was Fordhook 242. Individual plots were 28 feet long and 3 feet wide. Treatments were randomized in each of 8 blocks.

The chemicals were applied with a small sprayer over the row for a width of 12 inches. Cultivation controlled the weeds between the rows. Irrigation was applied twice during the growing season. An estimate of weed control was made July 19 on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. Lima beans were harvested September 11.

Results

The results are presented in Table 1. Twenty-one chemicals or combination of chemicals were included in the trials together with an untreated check plot. All chemicals, with one exception, significantly increased weed control as compared to the recommended treatment DNBP. Two of the chemicals significantly reduced the stand of plants as compared to the DNBP treated plot. Seven chemicals or combination of chemicals produced a significant increase in yield in weight of beans as compared to the DNBP treated plot. These treatments were Diphenamid at 6 lbs. per acre and Dacthal at 8 lbs. per acre applied 1 day after seeding; Nia. 2995 at 8 lbs. per acre, Lorox at 2 lbs. per acre, and Atrametryne at 2 lbs. per acre applied 2 days after seeding; the combination treatment of 2 lbs. of DNBP and 2 lbs. of Amiben per acre applied 6 days after seeding and the split application of 2 lbs. per acre of Diphenamid applied 2 days after seeded followed by an application of Amiben G at 3 lbs. per acre 15 days after seeding.

Conclusion

Many chemicals offer promise in the weeding of Lima beans. The better treatments resulted in a 40% increase in yield on compared to the untreated check plot and a 20% increase in yield as compared to our recommended treatment DNBP.

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Table 1. Weed control, stand of plants and weight of beans in the pods of Lima beans under chemical herbicide treatments.

	Treatment	Active Rate Per Acres lbs.	Application Days from Planting		AVERAGE PER PLOT *Weed Control (1-10)	Stand of Plants	Wt. of Beans lbs.
1	Nothing	--	--		8.8	87.1	10.2
2	Tillam	6 (2' wide)	Soil Inc.	0	2.4	74.5	11.5
3	Diphenamid	6	Pre-emerg.	1	2.1	90.5	14.1
4	U-4513	6	"	1	1.5	95.1	13.8
5	Trifluralin	6	"	1	1.3	93.6	13.6
6	Decthal	10	"	1	1.4	91.5	14.0
7	G-34690	3	"	2	6.6	89.9	10.8
8	Hyvar	1	"	2	1.0	1.3	0.2
9	Nia 2995	8	"	2	1.6	89.3	14.4
10	Alipur	6	"	2	1.1	86.1	11.3
11	FW 925	8	"	2	2.9	90.8	13.3
12	Bayer 40557	8	"	2	1.1	84.8	12.5
13	Casoron	8	"	2	2.0	36.8	9.7
14	Lorox	2	"	2	2.0	88.6	14.2
15	Herc. 7531	4	"	2	1.0	86.8	12.8
16	Atrametryne	4	"	2	1.3	87.3	14.2
17	Trietazine	4	"	2	2.4	87.5	13.3
18	Prometryne	2	"	2	1.5	84.0	13.4
19	Amiben	3	"	2	1.4	92.4	13.6
20	DNBP	4	"	6	4.6	84.9	12.2
21	DNBP + Amiben	2 + 2	"	6	1.6	95.1	14.0
22	Diphenamid and Amiben (G)	2 + 3	Pre & Post	2 & 15	1.9	87.5	14.4
	Least significant difference 5%				1.0	11.5	1.8
	" " " 1%				1.4	15.2	2.6

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

EVALUATION OF TWO NEW HERBICIDES FOR BEANS AND SOYBEANS

A. Zaharchuk[1] and N. A. Ferrant[2]

PROCEDURE

Two locations were used to evaluate new herbicides for weed control in soybeans and snapbeans.

In the New Jersey test the field was planted by the grower to Perry soybeans. The test was sprayed the same day as planting with a CO_2 propelled small plot sprayer at the rate of 60 gallons of spray per acre. Plot size was 6 feet by 30 feet, four replications. Soil type sandy loam, soil surface wet one inch by shower immediately preceeding application, very dry below. Weeds - lambsquarter, ragweed, crabgrass, redroot.

In the Geneva, New York test, the area was planted with a hand planter to one row of Lincoln soybeans and one row of Tendergreen snapbeans. Sprays were applied two days after planting with a small plot sprayer. Plot size was 6 feet by 30 feet, four replications. Soil type loam, soil surface moist at the time of application. Extreme drought followed test. Weeds - very heavy stand of redroot, lambsquarter, purslane, quackgrass stand very erratic.

RESULTS

In the New Jersey test, amiben (3-amino-2,5-dichlorobenzoic acid) at 3.0 lbs. gave excellent control of both broadleaf and annual grasses. Injury in the form of stunted plant growth was evident at the time of rating, however by harvest time plants were normal in size. Linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) at 1.0 lb. gave very good broadleaf control, 2.0 lbs. was needed for both broadleaf and annual grass control.

Niagara 4607 at 4.0 lbs. was too low of a rate to give commercial control, the 8.0 lbs. rate gave very good broadleaf and annual grass control. Amchem's 62-79 gave good control of both broadleaf and annual grasses. (Table I)

In the Geneva test, mainly broadleaf weeds were present. Niagara's 4607 at the 5.0 lbs. rate and linuron at the 1.0 lb. rate gave excellent broadleaf control. Penn Salt TD-282 performed poorly. This may be due to formulation problems as the 2.0 lbs. rate gave poorer results than the 1.0 lb. rate. It was experienced that when rates higher than 1.0 lb. were applied, the spray resulted in the formation of soap-like bubbles that floated away. Amchem's 62-79 performance was poor, even at the 1.0 lb. rate. This was in direct contrast to the New Jersey test applied on a moist soil. Dinitro at 3.0 lbs. and amiben at 3.0 lbs. also gave poor performance in this test. (Table II)

CONCLUSION

Niagara 4607 appears very promising at the 5.0 lbs. rate for broadleaf control and 8.0 lbs. for both broadleaf and annual grasses. Linuron at 1.0 lbs. gave good broadleaf control, 2.0 lbs. is needed for both broadleaf and annual grass control. Under dry soil conditions, more than 1.0 lb. of Amchem's 62-79 is needed for weed control.

1/ Coop. G.L.F. Exchange, Inc. Research & Devel...

Table I - Results of Soybean Herbicide Test - Trenton, N. J.

Material	Rate	Broadleaf Weeds	Grasses	Injury
Check	--	0	0	0
Amiben	3.0	4.87	4.87	2.75
Linuron	0.5	2.12	1.62	0
"	1.0	3.25	2.75	0
"	2.0	3.62	3.00	0
Niagara 4607	4.0	2.62	2.25	0
"	8.0	3.37	2.75	0
Amchem 62-79	0.25	1.25	1.37	0
"	0.5	2.50	2.75	0
"	1.0	3.37	3.37	0

Average of 4 Replications
Date Rated: June 14, 1962
0 = No control - no injury 5 = Complete control - complete kill

Table II - Results of Soybean and Snapbean Herbicide Test - Geneva, N.Y.

Material	Rate	Broadleaf Weeds	Grasses	Injury
Check	--	0	0	0
Check	--	0	0	0
Niagara 4607	5.0	3.8	0	0
"	8.0	4.5	0	0
PennSalt TD-282	0.5	0	0	0
"	1.0	1.12	0	0
"	2.0	0.25	0	0
Amchem 62-79	0.25	1.9	0	0
"	0.5	0.0	0	0
"	0.75	0.0	0	0
"	1.0	0.9	0	0
Linuron	1.0	3.87	0	0
"	2.0	4.75	0	0
Dinitro	3.0	0.75	0	0
Amiben	3.0	1.87	0	0

Average of 4 Replications
Date Rated: August 3, 1962
0 = No control - no injury 5 = Complete control - complete kill.

A Small Plot Logarithmic Sprayer: Some Modifications[1]

J. C. Cialone, G. Bayer[2] and D. W. Davis[3]

In 1960 a logarithmic concentration sprayer for small plots was developed and a general description of this apparatus was published (1). This sprayer has proved to be a worthwhile tool in the study of herbicides and considerable interest has been shown concerning details of its construction and use. It was pointed out in the previous publication that this sprayer has no moving parts, is light weight and completely portable, requires only small amounts of chemical, is simple to use, and is very low in cost.

Since the previous publication, several modifications in construction and use have been adopted. It has been found that the concentrate chamber, previously of one pint volume, could be replaced by a 1/2 pint chamber with excellent results in the accuracy of spray concentration. Furthermore, this modification allows the number of half-dosages to be increased from the maximum of three, as previously reported, to about seven. It follows that any number of half dosages less than seven can be applied by decreasing the amount of diluent used. This significantly increases the utility of this sprayer.

Although no mixing problems have occurred, a precautionary modification was to build a small nozzle into the inlet to the concentrate chamber. It is felt that this device will insure excellent mixing even with very high rates of wettable powders.

Two further changes were the insertion of a valve between the two chambers to prevent mixing of the chmicals prior to spraying and the use of a polyethylene ball as the"float valve" in the diluent chamber. The polyethylene ball works as well as the wooden ball previously described and is less likely to be contaminated.

The one quart to 1/2 pint system has been used extensively in field tests with both wettable powder and emulsifiable concentrate formulations and excellent results have been obtained with both types of formulations. Plots of 3 x 60 or 4 x 60 feet have been used and the chemical is usually logged down so that 4 half-dose-distances of 15 feet result. For seasonable rates of chemical this gives an adequate length of plot on which accurate observations can be made. Half dose distances of less than 10 feet, however, result in very rapid changes in concentration per length of crop row and hence inaccurate or inefficient data, due to soil or plant variations, may result. This can be further complicated when a chemical has a sharp breaking point

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[4] The authors wish to acknowledge the helpful suggestions of Dr. E. Hagood of the Niagara Chemical Company.

between activity and no activity.

This apparatus has been used successfully in greenhouse and laboratory studies. Using a continuous moving belt, applications have been made to petri dishes for seed germination studies in the laboratory, as well as on flats and pots for greenhouse studies. The accuracy of these spray applications were checked by using appropriately treated standards and excellent agreement was obtained even in the petri dish studies.

Due to the simplicity and size of this sprayer, it is easily adaptable to a large number of diverse uses. A detailed plan of construction has been prepared and is available.

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A Gradient Distributor for the application of granular materials.[1]

J. D. Riggleman, G. J. Burkhardt, F. C. Stark [2]

Before a chemical can be properly used on a crop, control and crop tolerance ranges must be established. With the introduction of the logarithmic[3] and exponential [4] sprayers, it has been possible to screen a broad spectrum of rates in a single plot, thus saving considerable expense in obtaining information essential to the preliminary development of an agricultural pesticide. Unfortunately, this technique is limited to sprays. Dry chemicals, such as granular herbicides, insecticides or fertilizers have to be applied to individual plots at fixed rates over a wide range.

A modification of a standard Brillion clover seeder that would plant seed at a linearly increasing rate was reported by Swain et al. [5] Additional modifications have made possible the development of equipment that effectively applies dry, granular materials at either fixed rates or increasing rates. A suitable control device permits accuracy of ± 0.25 to ± 2.0% at the fixed rate, and with an automatic advancing device delivery rates deviate with ± 1.5% from linearity.

Plans are available from the Department of Agricultural Engineering, University of Maryland, College Park. Additional description of the machine will be made in a subsequent publication.

1/ Miscellaneous Publication No. 470, contribution No. 3412 of the Maryland Agricultural Experiment Station, Department of Horticulture.
2/ Research Assistant, University of Maryland Vegetable Research Farm, Salisbury; Professor of Agricultural Engineering, University of Maryland, College Park; Professor of Vegetable Crops, University of Maryland, College Park.
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The Relation of Certain Environmental Conditions to the Effectiveness of DNBP for Post-Emergence Weed Control in Peas.

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In general DNBP (4,6-dinitro-o-sec butylphenol) spray applied post-emergence to peas has been very effective and has been used extensively by growers for several years. On rare occasions, however, DNBP has caused crop injury, or failed to give good weed control, especially of annual grasses. The experiments reported here were conducted primarily to find the conditions under which DNBP injury might occur; also to find out why DNBP does not always control annual grasses.

DNBP Injury to Peas as Affected by Shading Prior to DNBP Application

All experiments were conducted on a Matapeak silt loam soil at the University of Delaware farm at Newark, Delaware. Peas, variety Dark Skinned Perfection, were seeded at 200 lb/A and overseeded with Hungarian Millet, *Setaria italica*, and rape, *Brassica napus*, to insure a good weed population. The individual plots were 75 feet long and 4 feet wide. All DNBP applied with the logarithmetic sprayer had a starting concentration of 4.5 lb/A decreasing to .675 lb/A 75 feet down the plot. The shading material was black polyethylene film in 1961 and Armex Saran shading material was used in 1962. The shading structures were approximately 2 feet high and 8 feet long. The peas were shaded for 0, 1, 4, and 8 days prior to DNBP application with logarithmetic sprayer in 1961, and for 0, 2, 4, 6, and 8 days in 1962 prior to DNBP application. The temperature at time of DNBP application was 68 deg. F. in 1961 and 60 deg. F. in 1962. In 1961 as little as one day of shade significantly increased injury, and decreased yield (Table 1). In 1962, as much as 6 days of shade were required for a significant increase in DNBP injury. Annual grass control was not affected by shade. In 1961, peas not shaded tolerated a maximum of 2.05 lb/A of DNBP, whereas the minimum rate necessary for weed control was .93 lb/A for grasses and 1.53 lb/A for broadleaf weeds. In 1962, peas not under shade tolerated 3.33 lb/A of DNBP, and the minimum rate necessary for weed control was 1.39 lb/A for grasses and .93 lb/A for broadleaf weeds.

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Table 1. The Effect of Varying Lengths of Shading Prior to DNBP Application to Peas on Crop Injury, Weed Control, and Yield in 1961.

Days Shade Prior to DNBP[1] Applic.	Percent Injury	Percent Weed Control Grasses	Percent Weed Control Broadleafs	Yield[2]
0	5	95	17	1.64
1	18	82	00	0.87
4	32	95	33	0.87
8	100	100	100	0.00
LSD .05	13	N.S.	43	0.45

1. DNBP at 1 lb/A
2. Lbs. of shelled peas per 20 sq. ft.

Peas were also shaded for 7 days and then treated with DNBP at 1.125 lbs/A after 0, 1, 2, and 3 days of sunlight in 1961 and 1962. The temperature at the time of DNBP application was 65 deg. F. in 1961 and 73 deg. F. in 1962. In 1961 there was no significant difference in crop injury, weed control, or yield. In 1962, yield was significantly reduced by spraying DNBP after 7 days of shade. Injury was then significantly reduced after 3 days of sun prior to DNBP application (Table 2).

Table 2. Effects of One Week of Shade Followed by Varying Days of Sunshine Prior to DNBP Application[1] to Peas on Crop Injury, Weed Control, and Yield in 1962.

Days of Sun Following 7 Days Shade	Percent Injury	Percent Weed Control Grasses	Percent Weed Control Broadleafs	Yield[2]
Check[3]	00	20	100	1.54
0	16	92	100	1.08
1	15	73	100	1.34
2	13	88	100	1.33
3	06	77	100	1.35
LSD .05	06	13	N.S.	0.31

1. DNBP at 1.125 lb/A
2. Lbs. of shelled peas per 32 sq. ft.
3. No shade

In peas that were not shaded, the rate necessary for weed control never exceeded the maximum rate tolerated.

DNBP Injury to Peas as Affected by Size of Pea Plants at Time of DNBP Application

In 1961, peas were planted on 5 dates. When three of the plantings had progressed to the approximate sizes of 3, 6, and 9 in. high, DNBP was applied with the logarithmetic sprayer. The temperature at the time of DNBP application was 70 deg. F. As shown in Table 3, the 3 in. pea size was significantly more tolerant than the 6 or 9 in. pea size. The 3 in. pea size tolerated DNBP at 2.0 lb/A whereas the 6 in. pea size tolerated .99 lb/A and the 9 in. pea size tolerated .90 lb/A. There was annual grass control in the 3 and 6 in. peas, but not in the 9 in. peas, probably because the grasses were too large when DNBP was applied. The broadleaf weeds were controlled in all plots.

Table 3. DNBP Injury as Affected by Size of Pea Plant at Time of DNBP Application.

Height of Pea Plants, in.	Max. Rate of DNBP Tol. by Peas, lb/A	Percent Injury at Recommended Rate [1]
9	0.90	15
6	0.99	12
3	2.00	02
LSD .05	0.42	06

1. DNBP at 1.125 lb/A

DNBP Injury to Peas and Weed Control as Affected by Intermittent Irrigation and Various Lengths of Sunshine Prior to DNBP Application

In 1962, 1/4 in. of irrigation was applied to peas twice daily for three days prior to DNBP application. This was done to simulate a rainy period prior to DNBP application. The plots were then treated with DNBP after 0, 1, 2, and 3 days of rain-free weather. The temperature at the time of DNBP application was 68 deg. F. There were no significant differences in injury; however, annual grass control was significantly better when DNBP was applied immediately after the plants had dried. Yield was reduced significantly as the number of days of sunshine increased after the irrigation, but this was due apparently to the increased size of grass plants.

DNBP Injury to Peas as Affected by Malathion Sprays at or Near Time of DNBP Application

In 1961, Malathion (0,0-dimethyl dithiophosphate) as an emulsifiable concentrate, was applied to peas 7, 3, and 0 days before and 3 and 7 days after DNBP application. The Malathion (e.c.) was applied at the constant rate of 1 lb/A. The DNBP was applied with the logarithmetic sprayer as previously described. The temperature at the time of the DNBP application was 80 deg. F. There were significant differences between Malathion (e.c.) treatments applied pre and post to DNBP application on DNBP injury to peas (Table 4). There were no significant differences between treatments in the minimum rate of DNBP required for weed control. The maximum rate of DNBP tolerated by the crop, when Malathion (e.c.) was applied before DNBP, decreased rapidly as the time interval between Malathion (e.c.) and DNBP application decreased. The Malathion (e.c.) had no adverse affects on DNBP injury to peas when the Malathion (e.c.) was applied after the DNBP.

Table 4. Pea Injury and Weed Control as Affected By Malathion (e.c.) Applied Either Before or After DNBP Application.

Time of Mal.[1] To DNBP[2] Appl.	Percent Injury	Percent Weed Control Grasses	Percent Weed Control Broadleafs	Yield[3]
(DNBP Check)[4]	15	20	100	1.50
7 Days Before	45	30	100	1.30
3 Days Before	45	50	100	1.65
Half-Hour Before	60	67	100	1.85
3 Days After	00	47	100	2.17
7 Days After	15	53	100	1.65
LSD .05	11	20	N.S.	0.34

1. Malathion (e.c.) at 1 lb/A
2. DNBP at 1.125 lb/A
3. Lbs. of shelled peas per 20 sq. ft.
4. No Malathion

Effects of Three Formulations of Malathion on Peas Treated With DNBP

In 1962, 3 formulations of Malathion were applied one-half hour prior to DNBP application. They were: 25 percent wettable powder, 5 lb/gal. emulsifiable concentrate, and 8 lb/gal. emulsifiable concentrate. All Malathion was applied at 1 lb/A and the DNBP was applied at 1.125 lb/A. The Malathion and DNBP was applied with a 3 gallon pressurized sprayer. The temperature at the time of DNBP application was 82 deg. F.

As shown in Table 5, the 5 and 8 lb/gal. emulsifiable concentrate Malathion applied prior to DNBP significantly increased injury and decreased yield.

Table 5. Pea Injury, Weed Control, and Yield as Affected by Three Malathion Formulations Applied Prior to DNBP Application.

Mal. Formulation Prior to DNBP[1]	Percent Injury	Percent Weed Control Grasses	Percent Weed Control Broadleafs	Yield[2]
1. (DNBP Check)[3]	7	90	100	1.16
2. 5 lb/gal. e.c.	45	100	100	0.88
3. 8 lb/gal. e.c.	58	100	100	0.70
4. 25% wettable pow.	21	100	100	1.24
LSD .05	22	N.S.	N.S.	0.25

1. DNBP at 1.125 lb/A
2. Lbs. of shelled peas per 32 sq. ft.
3. No Malathion

DNBP Injury to Peas and Weed Control as Affected by Gallonages of Carrier.

In 1962, DNBP at a constant rate of 1.125 was applied in 25, 50, and 100 gallons of water to determine the effect of gallonage of carrier on injury to peas. The DNBP was applied with a 3 gal. pressurized sprayer. The temperature at the time of DNBP application was 75 deg. F. There was no significant injury regardless of the gallonage of water. However, DNBP in 25 gal. of water gave better annual grass control than DNBP in 100 gal. of water. As shown in Table 6, significantly better control of broadleaf weeds were obtained with DNBP in 25 gal. of water than in 100 gal. of water. The decreased grass control, with the increased rates of carrier, was correlated with decreasing yields.

Table 6. DNBP Injury to Peas and Weed Control as Affected By Gallonages of Carrier.

DNBP[1] in Gal. of Water	Percent Injury	Percent Weed Control Grasses	Percent Weed Control Broadleafs	Yield[2]
(Unhoed Check)	00	00	00	0.54
25 Gal. of Water	07	95	100	0.93
50 Gal. of Water	10	92	88	0.73
100 Gal. of Water	03	78	67	0.73
LSD .05	N.S.	16	15	0.36

1. DNBP was constant at 1.125 lb/A
2. Lbs. of shelled peas per 32 sq. ft.

DNBP Injury to Peas as Affected by Calcium Chloride and Magnesium Sulfate Sprays Prior to DNBP Application

In 1962, calcium chloride and magnesium sulfate was applied 5 days prior to DNBP application because Richmond and Martin (1) and Lee and Priestly (2) reported that Calcium and magnesium affected the extrusion of wax from within the plant to the leaf surface. This experiment was conducted to evaluate this hypothesis. The two applications were made to determine the effect calcium and magnesium had on the movement of their respective soaps of fatty acids in terms of cuticle deposition as determined by DNBP injury and photomicrography. The calcium chloride and magnesium sulfate was applied at the rate of 10 and 15 lb/A, respectively, in 100 gal. of water. The calcium and magnesium sprays were applied with a 3 gal. pressurized sprayer. The DNBP was applied with the logarithmetic sprayer. The temperature at the time of DNBP application was 75 deg. F. There were no significant differences in yield, weed control, or injury.

Effect of High Temperature, Just After and 1 Day After DNBP Application to Peas

DNBP at 1.125 and 2.25 lb/A was applied to peas 6 inches high when the air temperature was 75 deg. F. Just after, and 1 day after DNBP application, the air temperature surrounding pea plants was increased to approximately 100 deg. F. for periods of about 6 hours in order to determine the effect of high temperatures following DNBP application on crop injury. Air temperature was increased by placing small tents of transparent Mylar over pea plants, and allowing heat furnished by the sun's rays to accumulate under these tents. Results are presented in Table 7. High temperature just after DNBP application greatly increased crop injury, whereas high temperature the day following DNBP application had very little effect in increasing crop injury.

Table 7. Pea Injury as Affected by High Temperature Just After and 1 Day After DNBP Application

DNBP, lb/A	Max. Temp. 0-6 Hrs. After DNBP Appl., Deg. F.	Max. Temp. Day After DNBP Appl., Deg. F.	Crop Injury Percent
0.0	75	75	0
0.0	100	75	0
1.125	75	75	5
2.25	75	75	35
1.125	100	75	30
2.25	100	75	100
1.125	100	100	20
2.25	100	100	85

Other observations concerning DNBP application at various temperatures were made during the 1961 and 1962 growing season. In Table 8, two temperatures at which DNBP was applied during 1962 were recorded and comparisons made for the minimum rate of DNBP required for weed control and the maximum rate of DNBP tolerated by the crop.

Table 8. Comparison of DNBP Effectiveness When Applied at High and Low Temperatures.

Temperature at Time of DNBP Appl.	Min. Rate Necessary For Weed Control, lb/A	Maximum Rate Tol., lb/A
60 Deg. F.	4.5	4.5
80 Deg. F.	1.3	1.9

Summary

Shade increased the susceptibility of peas to injury from DNBP sprays. The intensity of the injury was proportional to the duration of shading the plants had received. When plants were subjected to 7 days of shade, the plants were very susceptible to DNBP sprays. However, the pea plants regained their tolerance to DNBP sprays with each day of continuous sunshine they received after shade but before DNBP sprays were applied. Broadleaf weeds were more susceptible to kill by DNBP sprays following a short period of shade than were the grasses.

The most successful application of DNBP to peas was at the 3-in. size. At this stage of growth the peas were more tolerant to DNBP spray and the weeds were smaller and more readily killed.

Malathion, 4 lb/gal. emulsifiable concentrate (e.c.), applied prior to DNBP application increased the activity of the DNBP spray. Malathion (e.c.) did not affect DNBP activity when the Malathion (e.c.) was applied after the DNBP spray. Malathion, 25 percent wettable powder, applied before DNBP application did not affect the activity of the DNBP spray.

Irrigation applied for 3 days before DNBP application did not affect the susceptibility of peas to DNBP injury. Applications of calcium chloride and magnesium sulfate prior to DNBP application did not affect DNBP injury to peas.

In a comparison of 25, 50 and 100 gal/A of carrier (water) for a constant rate, DNBP (1.125 lb/A), less crop injury was obtained when DNBP was applied in 100 gal. of water. Greater weed control was obtained with DNBP in 25 gal. of water.

From observations during the above-cited studies, temperature had the greatest effect on injury to peas from DNBP spray than any factor studied. When the temperature was below 65 deg. F. at the time of DNBP application, activity was relatively low. Above 90 deg. F. at the time of DNBP application, activity of the DNBP was increased to the point that the crop was completely killed. Also, when the temperature exceeded 90 deg. F. within a few hours after DNBP application excessive injury occurred.

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The Influence of Soil Surface and Granular Carrier Moisture on the Activity of EPTC[1] [2]

J. C. Cialone[3] and R. D. Sweet[4]

The herbicidal activity of EPTC (ethyl N,N-di-n-propyl thiolcarbamate) has been studied extensively by many workers. It has been shown that soil surface applications of this chemical exhibit erratic and inconsistent behavior. For this reason soil incorporation has been utilized as a means of obtaining consistent and effective weed control. From the standpoint of grower use, soil incorporation is generally not well accepted, since it usually requires extra time, and or special equipment. Surface applications under certain conditions, however, have given outstanding weed control.

A great deal of work has been conducted to determine the factors influencing the activity of EPTC. Of the many factors which have been studied, moisture is particularly interesting. Havis, Ticknor, Bobula (3) in 1958 showed that if soil was irrigated prior to the application of EPTC to the surface, very poor weed control resulted, while on dry soil excellent weed control was obtained. Kohashi (4) found similar results when surface applications were made on moist soil. There are many such field reports in the literature, but little emphasis has been put on these results. Fang, Thiesen and Freed (2) have studied the loss of EPTC-S^{35} after application to dry soil. They showed that when increasing amounts of water were added to the dry soil which had been treated with EPTC-S^{35}, increased loss of the chemical resulted and the higher the rate of chemical at a given moisture level, the greater the loss of the chemical.

The work reported here deals with the relation of soil surface moisture to the activity of surface applications of EPTC. Both laboratory and field studies are presented.

Materials and Methods-Laboratory Studies

Granular formulations of 2.5% EPTC (technical in acetone) were prepared on 24-48 mesh attaclay RVM. The vapor activity of EPTC from the granules was studied using the bioassay technique of Danielson (1). Cucumber (var. Mosaic Res. Slicer) was chosen as the bioassay plant. Seeds were placed in petri dishes and incubated for 48 hours at 75-80°F. Small aluminum cups containing the particular granules to be studied were then placed in the petri dishes. No physical contact between the granules and the seeds was allowed to take place; therefore, only vapor activity was measured. The seeds were incubated in the presence of EPTC and after 48 hours root elongation was measured. An acetone-on-clay check, a clay check and a no-treatment

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[1] Paper No. 476, Department of Vegetable Crops, Cornell University, Ithaca, N.Y.
[2] This research was aided by grants in aid from G.L.F. of New York and the Stauffer Chemical Company.
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[5] The assistance of D. W. Davis, research technician, is gratefully acknowledged.

check were included. Four replications were used with ten seeds per replicate.

The above basic procedures were decided on as a result of numerous trial runs involving periods of germination, temperature, rates, solvents, etc. Two experiments utilizing the above refined techniques are presented here.

In the first experiment the vapor release of EPTC from wet and dry granules was studied. 1.5 grams of the granular formulation were used per dish giving 0.037 grams of actual EPTC. In the wet treatment, sufficient water was added to the granules prior to putting them into the petri dish so that they were thoroughly moist but no free water was present. Treatments consisting of about ¼ inch of wet or dry soil, covering the granules were also included.

A second experiment studied the vapor release from granules having various levels of moisture prior to the application of EPTC. Treatments consisted of a) air dry granules, b) plus 15 percent water and c) plus 30 percent water, on a weight basis, which were then formulated with the standard 2.5% EPTC (technical in actenone). Appropriate amounts of each formulation of granules were used to give 0.025 grams of EPTC per dish.

Results and Discussion - Laboratory Studies

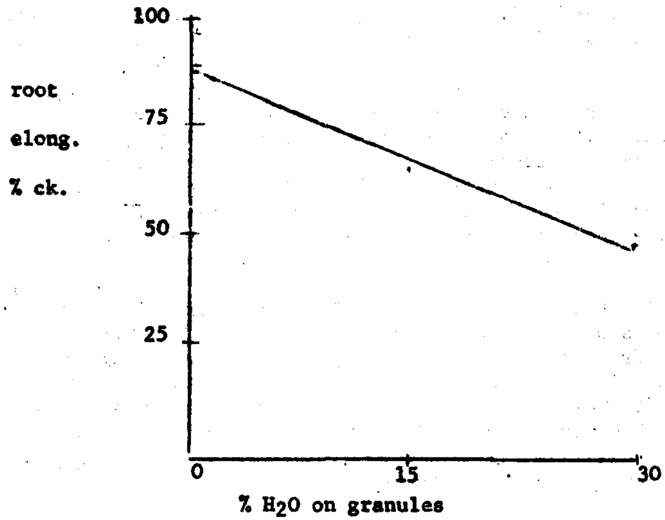
The results of experiment 1 are presented in table 1. It can be seen that there is no difference between the dry granules and those wet following formulation. This effect has been checked several times in other experiments with similar results. Where the granules were covered with dry soil, the amount of vapor released was greatly reduced as indicated by the longer cucumber roots, while the wet soil reduced vapor release only slightly.

Table 1. The effect of moisture and soil covering on EPTC vapor activity from clay formulations as measured by cucumber root elongation.

Water added	Soil covering	Root elongation % of check
None	None	62.7
Moist	None	61.3
None	Air dry	75.2
None	Field capacity	67.1

Graph 1 from experiment 2 results illustrates the effect of having varying levels of moisture on granules prior to formulation with EPTC. It can be seen that as the amount of moisture increases the amount of vapor lost from the granules is increased.

<u>Graph 1</u>. Effect of moisture present on granules prier to formulation with EPTC on the subsequent vapor release of the EPTC as measured by cucumber root elongation.



<u>Discussion - Laboratory Results</u>

Under the conditions of this experiment wetting the granules after formulation had little effect on the release of the EPTC vapors. Danielson (1) has shown that the physical properties of the granules are important in the vapor release of CIPC from various carriers. The greater the physical breakdown of the granules the greater was the release of CIPC. In these experiments the amount of moisture was low enough that the shape or size of the granules was not visually influenced. This might account for the fact that no differences in vapor release were noted between the wet and dry granules.

The results obtained when wet and dry soil was placed above the granules indicate that the dry soil was a factor in reducing the vapor activity of the EPTC. This might be due to the adsorption of the EPTC vapors by the dry soil. Evidence for this is found in the results shown in Graph I. It can be noted that high levels of moisture before formulation of the EPTC on the granules gave the greatest vapor loss. This further indicates that EPTC is not adsorbed to as great extent on a wet carrier as it is on a dry carrier.

In general, the laboratory results point to moisture as an important factor in the vapor release of EPTC. On the basis of these results field tests were conducted to determine the effect of soil surface moisture on EPTC activity under field conditions.

Materials and Methods - Field Studies

Experiment 1 - East Ithaca.

A Dunkirk fine sandy loam was spring plowed and under conditions of severe drought was allowed to become powdery dry to a depth of 5-6 inches. The land was fitted, staked into 3 x 15 foot plots, and 4 rows of oats were planted per plot. The 3x15 foot plots were assigned rates of EPTC of either none, 2 or 4 pounds per acre. One-half of each 3 x 15 plot first received either 0, 1000, or 2000 gallons of water to the acre. The water was applied with a hand sprayer and immediately thereafter the appropriate rate of EPTC (6 E in 50 gallons of water) was applied to the entire 3 x 15 foot plot. The 1000 and 2000 gallon water treatments wet the soil to a depth of about 2.5 and 5.0mm respectively. The entire experimental area was then allowed to dry about 18 hours at which time it was irrigated with about 1/2 inch of water. During the succeeding 4 days the plots received daily light irrigations to keep the surface moist during the continued hot, dry weather. Four replications were used in a randomized complete block design. As a measure of EPTC activity stand counts and visual ratings were made of both oats and naturally occurring weeds.

Results - Experiment 1

The results of water applications prior to the application of EPTC 6E at 2 lb/A are summarized in table 2. The results of the 4 pound rate were very similar and are not presented. It can be seen that the higher the rate of water the lower the effectiveness of the EPTC. It can be noted that when applied on the dry soil the EPTC gave near perfect weed control whereas at the highest rate of water, the weed control was the same as the check. A similar effect is reflected in the oat stand counts.

Table 2. Effect of pre-watering on the activity of EPTC 6E at 2 pounds per acre.

	H_2O on soil	Oat stand % check	Weed control A/
EPTC (6E)	0	1	8.7
"	1000 gal/A	14	5.2
"	2000 "	41	4.2
Check	-	100	4.2

A/- a rating of 9 = complete kill; 1 = no control.

The results obtained in this test are similar to those obtained in the laboratory. The higher the rate of moisture the greater the loss of activity. Since in the laboratory it was shown that the vapor loss was greatest where moisture was highest, it would seem possible that the loss of activity in the field was due to a similar loss. The high degree of effectiveness of EPTC at 2 lb/A shown here, has been consistently reproducible under dry conditions on this soil in the field. These results are in striking contrast to those with the 2000 gal/A rate of water. This rate of water is equal to only 0.07

of an acre inch, and the plots receiving this treatment were dry in about one hour. Since all plots were irrigated 18 hours after the treatments were applied, it would appear that the loss of activity occurs very rapidly, probably within minutes of application.

Experiment 2 - Freeville

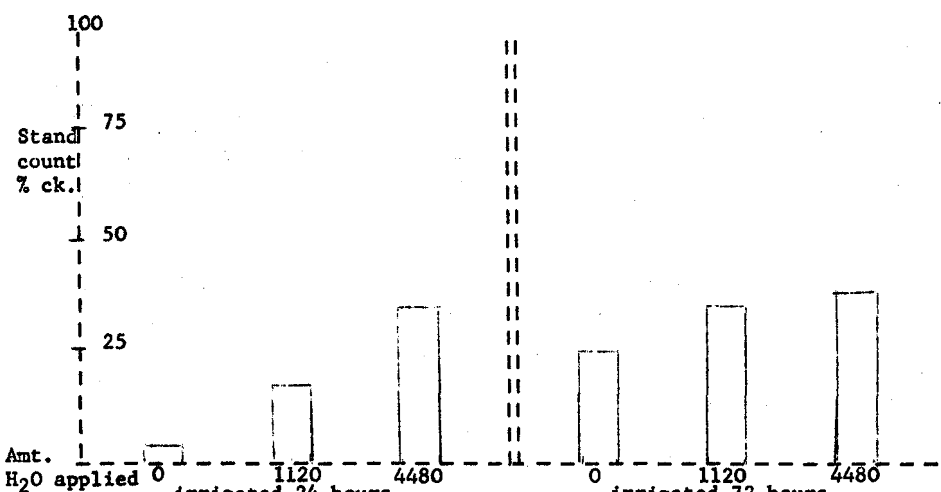
A second field test was conducted on a silt loam soil and dry conditions prevailed as in Experiment 1. Oats were planted at 1/2, 1 and 1 1/2 depths in 3 x 10 foot plots. Both 6E and 10G formulations of EPTC at 2 and 4 pounds per acre were applied immediately after water treatments of 0, 1120 and 4480 gal/A. In addition, a treatment consisting of wetting the soil, after EPTC applications, was included. In this treatment EPTC was applied to dry soil and three applications of 1120 gal/A of water were applied; each application made after the previous one had dried.

The above treatments were applied in two whole blocks, one receiving irrigation 24 hours after chemical application and the other receiving irrigation 72 hours after chemical application. Cloudy weather with temperatures of 75-80°F prevailed during the first 24 hour period following chemical application. There were 3 replications of all treatments in each whole irrigation block.

Results and Discussion

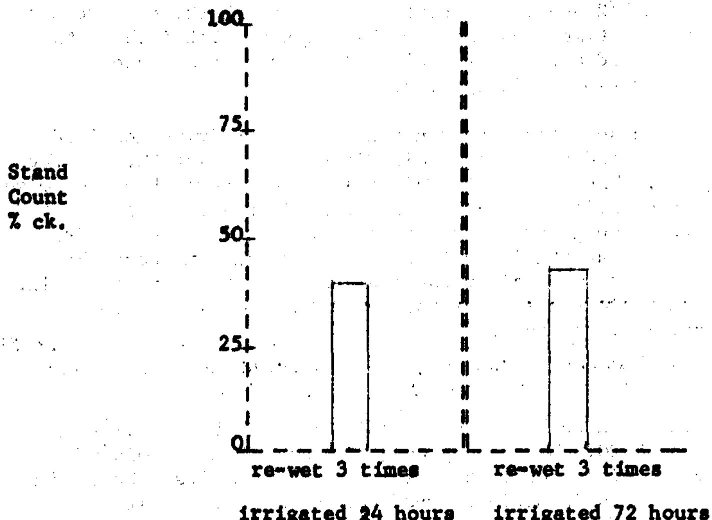
The results of the 2 lb/A rates of EPTC (6E) are presented in Graph 2.

Graph 2. Effect of irrigation and rate of pre-watering on the activity of EPTC (6E) at 2 lb/A.[1]



[1]Results are over three depths of planting.

Graph 3. Effect of wetting soil after application of EPTC (6E) 2 lb/A on the activity of the chemical.[1]



[1]Results are over three depths of planting.

It can be seen that a decrease in activity resulted from both the 1120 and 4480 gal/A water treatments. This was true for both irrigation treatments. The 72 hour irrigation treatment, however, showed generally lower activity than the 24 hour irrigation treatment. This was especially true at the 0 and 1120 gal/A pre-water levels. At the 4480 gal/A pre-water level no great differences in activity were noted between the two times of irrigation. It can be seen that this lack of difference was reflected in the relative differences between the 1120 and 4480 gallon water levels in the two times of irrigation. In the 72 hour time of irrigation the difference between the 1120 and 4480 gallon water treatments was much smaller than in the 24 hour time of irrigation.

Two main factors seem to be involved in the differences in EPTC activity between the two times of irrigation. In the case of 0 and 1120 gallon pre-water levels, further loss of EPTC from the soil after the initial 24 hour period, must have occurred. Where 4480 gal/A were applied, it is believed that the oats in the delayed irrigation time were able to obtain enough moisture from the pre-water treatment to germinate during the 72 hour period prior to irrigation. Evidence for this can be found in the fact that check plots having this pre-water treatment emerged sooner than did those on dry soil. This was especially true of the 1/2 and 1 inch depths of planting. Kohashi (4) has shown that oats pregerminated in the laboratory under continuous 80°F temperature exhibited increased sensitivity to EPTC up to pregermination times of 36 hours. It would seem possible that under field conditions with cooler temperatures and minimum moisture a similar pregermination stage could have resulted in the 72 hour period prior to irrigation. Under these conditions, greater activity of the EPTC could result in the 72 hour irrigation when this irrigation moved the chemical into the vicinity of the pregerminated oats. In the 1/2 and 1 inch depths of planting, the differences between the two irrigation times was smaller than in the 1 1/2 inch depth. This would agree with the idea that the 4480 gal/A treatment affected the oats prior to the 72 hour time of irrigation.

In Graph 3 it can be seen that substantial loss of activity resulted from the re-wet treatment and that only small differences exist between the two times of irrigation. The fact that small differences were observed, might also be explained on the basis of pre-germination as in the case of the 4480 gallon water treatment. The general lack of activity, as compared to dry soil treatment, indicate that significant loss of chemical can occur when light water applications are made after the chemical is applied to dry soil. The lack of activity even in the 24 hour water treatment indicates very rapid loss of chemical from the soil.

Summary

Moisture has been shown to have a great influence on the activity of surface applications of EPTC. Laboratory data indicate that if moisture was present on soil or clay, significant vapor loss of EPTC results. Under field conditions very rapid losses in activity were observed under conditions where light applications of water precede or follow chemical application. When EPTC (6E) is applied at 2 lb/A on dry soil and irrigated within 24 hours, a high degree of activity resulted on both a sandy and silt loam soil.

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THE INFLUENCE OF PETROLEUM MULCH UPON HERBICIDAL ACTIVITY

William V. Welker, Jr.[1]

When petroleum mulch is used on crops it is essential to incorporate an herbicide. As pointed out by Bayer et al.[2] weed growth is increased where the petroleum mulch is applied.

The influence of a petroleum mulch[3] system upon herbicidal activity was evaluated by application of each herbicide in three ways i.e., incorporated in the petroleum mulch, applied to the soil and then covered with petroleum mulch, and applied to the soil with no mulch applied. Various rates of each herbicide were used while the rate of petroleum mulch was held constant at 500 gallons per acre. All applications were applied pre-emergence to crops and weeds in bands 12 inches wide.

The primary weed species were lambsquarters (*Chenopodium album* L.), and pigweed (*Amaranthus retroflexus* L.) with crabgrass (*Digitaria sanguinalis* (L) Scap.) developing late in the season. Sweet corn, cantaloupe, and squash were used as test crops.

The chemicals and rates used were as follows:

Sweet Corn (var. N.J. 106)

simazine	(2-chloro-4,6-bis(ethylamino)-s-triazine	2 & 4 lb/A
atrazine	(2-chloro-4,ethylamino-6-isopropylamino-s-triazine)	1, 2 & 4 lb/A
DNBP	(4,6-dinitro-o-sec-butyl phenol)	3 & 6 lb/A
2,4-D	(2,4-dichlorophenoxyacetic acid)	½, 1 & 2 lb/A

Cantaloupe (var. Iroquois)

diphenamid	(N,N-dimethyl-α - α-diphenylacetamide)	2 & 4 lb/A
NPA	(N-1-naphthylphthalamic acid)	2 & 4 lb/A
dacthal	(dimethyl 2,3,5,6 tetrachloroterephalate)	6 & 12 lb/A
R-1870	(ethyl di-n-butylthiocarbamate)	4 & 8 lb/A

Squash (var. Table Queen)

DNBP	(4,6-dinitro-o-sec-butylphenol)	3 & 6 lb/A
amiben	(3-amino-2,5-dichlorobenzoic acid)	2 & 4 lb/A
dacthal	(dimethyl 2,3,5,6 tetrachloroterephalate)	6 & 12 lb/A

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[1] Horticulturist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture in cooperation with the New Jersey Agricultural Experiment Station, New Brunswick, New Jersey.

[2] Bayer, G., Hargan, R. and Cialone, J. Theinfluence of petroleum mulch on the performance of several herbicides. Proc.

Petroleum mulch increased crop tolerance to some degree with all herbicides. In most cases crop tolerance was greatest when the herbicide was incorporated in the mulch.

The length of effective herbicidal activity was increased when herbicides were either incorporated with the mulch or applied beneath the mulch. The level of herbicidal activity, however, was found to vary with the various herbicides when used with the mulch. This appeared to be an expression of the individual herbicide. Investigations examining the factors affecting herbicidal activity when associated with petroleum mulch would appear justified.

The Effect of Cultural Practices on the Herbicidal Activity of H-7531, Linuron and Trifluralin[1/] [2/]

G. H. Bayer[3/], R. P. Hargan[3/], J. C. Cialone[3/] & R. D. Sweet[4/]

The level of herbicidal activity is often affected by environmental factors and cultural practices. The purpose of this study was to evaluate cultivation, moisture and stage of weed growth as they effect the performance of linuron, 3-(3,4-Dichlorophenyl)-1 methoxy 1 methylurea (Lorox), Hercules 7531, 1-[5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl)] -3,3-dimethylurea, and Trifluralin,N,N-di-n-propyl-2,6-dinitro-4-trifluromethyl anilone. These materials were chosen because of their promising performance in 1961 and because of their differential activity.

Review of Literature

The activity of herbicides when they are soil incorporated varies depending on the nature of the chemical and method of incorporation.

Trifluralin. Pieczarka (3) incorporated Trifluralin by several methods and it was found that soil incorporation increased activity 4-6 times over surface sprays.

Linuron was evaluated by several workers in 1961 among them Sweet (4), Noll (2) and Trevett (5). The material was found to be effective pre-emergence with activity continuing for a period of several months. The effectiveness of this material when incorporated or cultivated was not extensively studied.

Hercules 7531 as reported (1) gives pre-emergence broadleaf and grass weed control. Foliar sprays on young plants were reported as being effective but soil incorporation was said to reduce weed control.

Experimental Method

Cultivation was studied at three levels: 1. no cultivation, 2. cultivation 1-2 hours following the application of herbicide, 3. cultivation delayed for three weeks. The plots were tractor cultivated, and resulted in considerable mixing of the herbicide with the soil.

Moisture was controlled by irrigating in relation to time of herbicide application as follows: 1. none, 2. 1-2inches of irrigation applied about 8-12 hours prior to spraying, 3. herbicide watered in by 1/2 inch irrigation

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[1/] Paper No. 478, Department of Vegetable Crops, Cornell University,Ithaca,N.Y.
[2/] This research was supported in part by grants in aid from Hercules Powder Company and Eli Lilly Company.
[3/] Research assistants, and [4/] Professor of vegetable crops, Cornell University. Ithaca, N. Y.
[5/] The assistance of D. W. Davis, research technician, is gratefully acknowledged.

immediately after spraying.

Stage of weed growth at time of herbicidal application was controlled by timing the application date. Three stages of weed growth were studied as follows: 1. pre-germination, 2. weeds with hypocotyls developed, 3. weeds in 2-4 leaf stage.

To permit a more precise control of the factors under study the experiment was carried out without including any crop except for the natural stand of weeds.

Weed growth was rather slow at first but by the end of the season a good stand of ragweed (Ambrosia artemisiifolia), redroot (Amaranthus rotoflexus), smartweed (Polygonum persicaria), lambsquarter (Chenapoduim album), and yellow rocket (Barbarea vulgaris) had developed. Ratings were made several times during the season but those on August 28 were felt to be most representative and were used for analysis of results.

Plot size was 4 x 15 feet. Plots were sprayed with a hand operated CO_2 pressure small plot sprayer.

The experimental design was a combination of nine small experiments, each experiment a randomized block with two replications. A test for homogeneity of variance of the final data indicated that at the 5 percent level, variances were not significantly different; therefore, the results shall be presented as a single experiment.

Results and Discussion

The weed ratings in tables 1 through 4 present the data in terms of the chemical as influenced by the factors under study. The data in tables 5 sumarize the effects of irrigation, cultivation, and stage of weed growth. For clarity of presentation, the results will be discussed by chemicals and then the effects of cultural practises will be presented.

H-7531 (See table on following page)

Cultivation and stage of weed growth had considerable effect on the performance of H-7531 (see table 1). In all instances where this chemical was applied prior to weed germination and then cultivated within 1-2 hours, weed control was decreased. The no-cultivation treatment gave good weed control but performance was further improved by the delayed cultivation. At all three stages of weed growth H-7531 performed well, but somewhat better control was noted at the seedling stage.

Differences due to irrigation were inconclusive although there was a slight tendency for better control without irrigation.

Table 1. Weed control with H-7531 as influenced by timing of irrigation and cultivation, rate of chemical and stage of weed growth[1]

	No. Irr. Dry Soil 3#	No. Irr. Dry Soil 6#	Irr. Before Wet Soil 3#	Irr. Before Wet Soil 6#	Irr. After Watered In 3#	Irr. After Watered In 6#	$\bar{X}$ for cul. over rate and irr. [2]
Weeds Not Germinated							
No cultivation	7.8	9.0	7.5	8.5	8.0	9.0	8.3
Cultivation	6.5	7.5	7.0	6.5	6.0	7.0	6.7
Delayed cul.	9.0	9.0	8.5	8.5	9.0	9.0	8.8
$\bar{X}$ for irr. over rate & cul.[2]	8.1		7.8		8.0		
Weeds Germinated							
No cultivation	9.0	8.5	7.0	9.0	8.0	9.0	8.4
Cultivation	8.5	9.0	7.0	8.0	7.0	8.5	8.0
Delayed cul.	8.5	9.0	8.5	9.0	9.0	8.5	8.8
$\bar{X}$ for irr. over rate & cul.[2]	8.8		8.1		8.3		
Seedling Weeds							
No cultivation	8.0	9.0	8.5	8.5	8.5	9.0	8.6
Cultivation	9.0	8.5	8.5	9.0	6.5	8.0	8.3
Delayed cul.	8.0	9.0	9.0	9.0	9.0	9.0	8.8
$\bar{X}$ for irr. over rate & cul.[2]	8.6		8.8		8.3		

[1] Weed ratings: 9 = perfect control; 7 = commercial control; 1 = no control.
[2] L.S.D. at 5% = 0.6 for both cultivation and irrigation $\bar{X}$.

Trifluralin (See table on following page)

At the rates used Trifluralin was not as effective as either linuron or H-7531 (see table 2). Cultivation either 1-2 hours after treating or delayed gave better weed control than the non-cultivation treatment. However, this increase in weed control can be attributed in part directly to the effect of cultivation itself, (see table 4).

When weeds were germinated, the application of Triflurlin on moist soil resulted in a significant decrease in weed control.

Trifluralin was significantly more effective on weeds which have either germinated or were in the seedling stage (Table 5).

Table 2. Weed control with Trifluralin as influenced by timing of irrigation and cultivation rates of chemical and stage of weed growth.[1]

	No Irr. Dry Soil 1#	No Irr. Dry Soil 4#	Irr. Before Wet Soil 1#	Irr. Before Wet Soil 4#	Irr. After Watered In 1#	Irr. After Watered In 4#	$\bar{X}$ for cul. over rate and irr.[2]
Weeds Not Germinated							
No cultivation	1.0	4.0	3.0	3.5	3.5	4.5	3.3
Cultivation	5.0	4.0	2.0	5.5	3.0	6.5	4.3
Delayed Cul.	5.5	7.5	7.0	7.5	7.0	8.0	7.1
$\bar{X}$ for irr. over rate & cul.[2]	4.5		4.8		5.4		
Weeds Germinated							
No cultivation	4.5	5.0	2.5	3.5	2.5	5.0	3.9
Cultivation	6.0	7.0	3.0	6.5	4.5	6.0	5.5
Delayed Cul.	8.0	7.5	7.0	7.0	7.5	8.0	7.5
$\bar{X}$ for irr. over rate & cul.[2]	6.3		4.9		5.6		
Seedling Weeds							
No cultivation	4.0	2.5	4.0	5.0	2.5	4.5	3.8
Cultivation	7.0	8.5	6.5	7.5	7.5	6.5	7.3
Delayed Cul.	6.0	6.5	4.5	6.0	5.5	7.5	6.0
$\bar{X}$ for irr. over rate & cul.[2]	5.8		5.6		5.7		

[1] Weed ratings: 9 = perfect control; 7 = commercial control; 1 = no control.
[2] L.S.D. at 5% = 0.6 for both cultivation and irrigation $\bar{X}$.

Linuron (See table on following page)

The data in table 3 indicate that cultivation 1-2 hours after spraying decreased the activity of linuron regardless of the stage of weed growth, although this was especially apparent when weeds had not germinated. The delayed cultivation, however, resulted in increased or equal weed control in relation to the no cultivation treatment.

Irrigation, while not so marked as cultivation, also influenced weed control. Irrigation after application was significantly inferior to the before or no irrigation treatment. This was probably due to washing the material off the foliage.

Linuron, when applied to weeds in the seedlings stage, gave significently better weed control over germination or non germination weeds. In fact, at the 2 pound rate a perfect rating was given to linuron plots sprayed at the seedling stage regardless of the levels of irrigation or cultivation.

Table 3. Weed control with Linuron as influenced by timing of irrigation and cultivation, rates of chemical and stage of weed growth.[1]

	No Irr. Dry Soil 1/2#	No Irr. Dry Soil 2#	Irr. Before Wet Soil 1/2#	Irr. Before Wet Soil 2#	Irr. After Watered In 1/2#	Irr. After Watered In 2#	$\bar{X}$ for cul. over rate and irr.[2]
Weeds Not Germinated							
No cultivation	8.0	8.0	7.0	9.0	6.0	8.0	7.6
Cultivation	4.0	6.0	3.5	7.5	3.5	6.5	5.1
Delayed Cul.	8.5	9.0	8.0	8.5	7.5	9.0	8.4
$\bar{X}$ for irr. over rate & cul.[2]	7.3		7.3		6.8		
Weeds Germinated							
No cultivation	7.5	9.0	7.5	9.0	5.5	8.5	7.8
Cultivation	7.5	8.0	5.5	8.0	6.0	8.5	7.3
Delayed Cul.	8.0	9.0	8.5	9.0	9.0	9.0	8.8
$\bar{X}$ for irr. over rate & cul.[2]	8.2		7.9		7.8		
Seedling Weeds							
No cultivation	8.0	9.0	8.0	9.0	8.0	9.0	8.5
Cultivation	8.0	9.0	7.0	9.0	7.5	9.0	8.3
Delayed Cul.	8.5	9.0	8.5	9.0	7.0	9.0	8.5
$\bar{X}$ for irr. over rate & cul.[2]	8.6		8.4		8.3		

[1] Weed ratings: 9 = perfect control; 7 = commercial control; 1 = no control.
[2] L. S. D. at 5% = 0.6 for both cultivation and irrigation $\bar{X}$.

Check (See table on following page)

The effect of timing of cultivation per se resulted in a significant increase in weed control at the delayed cultivation (table 4).

Irrigation had little effect on weed control prior to germination. A crusting effect caused by water probably accounts for the changes in weed control at germination.

Table 5 presents the data summarized according to the effects of cultivation, irrigation and stage of growth.

Table 4. Weed control in check as influenced by timing of irrigation, cultivation and stage of weed growth.

	No Irr. Dry Soil	Irr. Before Wet Soil	Irr. After Watered in.	$\bar{X}$ for cul. over rate & irr.[1]
Weeds Not Germinated				
No cultivation	1.0	1.0	1.0	1.0
Cultivation	1.5	1.0	1.0	1.2
Delayed cultivation	5.0	6.5	5.5	5.7
$\bar{X}$ for irrigation over cultivation[1]	2.5	2.8	2.5	
Weeds Germinated				
No cultivation	4.5	1.0	1.5	2.3
Cultivation	6.5	2.0	3.0	3.8
Delayed cultivation	6.5	6.0	7.0	6.5
$\bar{X}$ for irrigation over cultivation[1]	5.8	3.0	3.8	
Seedling Weeds				
No cultivation	3.0	2.5	2.0	2.2
Cultivation	3.0	6.0	4.0	4.3
Delayed cultivation	4.0	4.5	5.0	4.5
$\bar{X}$ for irrigation over cultivation[1]	3.0	4.3	3.7	

1/ L. S. D. at 5% = 0.8 for both cultivation and irrigation $\bar{X}$.

Table 5. The effect of cultivation, irrigation and stage of growth on chemical performance.

	7531	Trifluralin	Linuron	Check
The Effect of Cultivation[1/4/5]				
No cultivation	8.4	3.7	8.0	1.8
Cultivation	7.7	5.7	7.0	3.1
Delayed cultivation	8.8	6.9	8.6	5.6
The Effect of Irrigation[2/4/5]				
No irrigation	8.5	5.5	8.0	3.8
Irrigation before	8.2	5.1	7.9	3.4
Irrigation after	8.2	5.6	7.6	3.3
The Effect of Stage of Growth[3/4/5]				
Not germinated	8.0	4.9	7.1	2.6
Germinated	8.4	5.6	7.9	4.2
Seedling	8.5	5.7	8.4	3.7

1/ $\bar{X}$ for all rates, irrigation and timings.
2/ $\bar{X}$ for all rates, cultivations and timings.
3/ $\bar{X}$ for all rates, cultivations and irrigations.
4/ L.S.D. at 5% = 0.3 for chemicals.
5/ L.S.D. at 5% = 0.5 for check.

Summary and Conclusions

Weed control with 7531 was decreased by early cultivation but enhanced by delayed cultivation. Performance was further enhanced by applications when weeds were germinated or seedlings. Irrigation had little effect on performance of 7531.

Trifluralin accompanied by delayed cultivation resulted in acceptable weed control. Although application of this material on dry soil and where weeds have germinated or were in the seedling stage also enhanced weed control, the performance was generally inferior to the other two chemicals studied.

The effectiveness of linuron is increased as timing is moved from not-germinated to seedling weeds. A cultivation or irrigation 1-2 hours after application decreased the effectiveness of this material.

Cultivation as performed in this experiment was most effective at the delayed timing. For all chemicals and check treatments the delayed cultivation resulted in significantly better weed control than either the early or no cultivation treatment. Early cultivation was not beneficial over no cultivation except in the case of Trifluralin and check.

For all chemicals and check the no irrigation treatment resulted in better weed control than irrigation before and with the exception of Trifluralin better than irrigation after.

For all chemicals the weed control improved as weeds moved from non-germination to the seedling stage of growth. The most significant improvement in weed control was from non-germinated to germinated.

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RESULTS OF HERBICIDE TRIALS ON ONIONS, TOMATOES, AND STRAWBERRIES[1]

S. L. Dallyn and R. L. Sawyer[2]

Onions

METHODS

Seasonal and layby experiments were conducted on the Early Harvest variety and layby on the Sweet Spanish variety. Primary weeds during the earlier part of the growing season in this area were chickweed, purslane, lambs quarters and redroot. Control of these species has not been a problem. Annual grasses, especially barnyard, have become very troublesome and normally appear around June 15-20. Our main objective has been to develop a program which would take care of both classes of weeds through the entire growing and harvesting period.

Early Harvest onions for the seasonal trial were planted on Sassafras loam April 18 and treated at approximately three week intervals-May 11, June 4 and June 26. Since this variety normally matures July 20-30, the last date above was considered the layby application. Plots in the layby experiment were treated with CIPC, 4 lbs/A, on the first two dates and the final treatment put on June 26. Details on materials and rates are given in the tables of results.

Sweet Spanish plants received three applications of CIPC-May 10, May 29 and June 26, and the layby treatment July 25. Harvest date for this variety was August 27; for Early Harvest August 12.

Samples from all treatments of the three experiments were placed in common storage until November 13. They were then checked for rot, sprouting, scale color and coverage, firmness, size and shape.

RESULTS AND DISCUSSION

The data are summarized in tables 1 and 2.

In the seasonal trial good weed control was obtained from all treatments up until the time grasses became a problem. As evidenced from the ratings made July 21, CIPC and Randox did only a fair job on these species. Dacthal throughout the season and combinations of CIPC early with either Zytron or Casoron late looked good.

CIPC at 6 lbs. per acre layby was not satisfactory for grass control. Randox at a rate of 8 lbs. looked fairly good. A single late application of Dacthal did not give control, bearing out

[1]Paper No. 464, Dept. of Vegetable Crops, Cornell Univ., Ithaca, NY
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results of the two previous years. All other treatments looked promising with the exception of Rogue which injured the Early Harvest variety. Diphenamid caused a marked reduction in the growth of the rye cover crop.

None of the treatments had any significant effect on keeping quality of onion samples kept in common storage to November 13.

Table No. 1 Results of Seasonal Herbicide Experiment on Early Harvest Onions.

Treatment	Weed Control[1] 6/23	Weed Control[1] 7/21	Yield Bu/A No. 1 Onions
1. CIPC - 4 lbs. e.c. 5/11, 6/4; 6 lbs. 6/26	3.9	3.5	718
2. Randox - 4 lbs. gran. 5/11, 6/4; 6 lbs. 6/26	4.0	3.5	727
3. Dacthal - 12 lbs. gran. 5/11; 16 lbs. 6/26............	4.8	4.8	730
4. Dacthal - 12 lbs. gran. 5/11,6/4; 16 lbs. 6/26	4.8	4.8	750
5. CIPC - 4 lbs. 5/11, 10 lbs. Zytron 6/4 and 6/26	4.7	4.5	731
6. CIPC - 4 lbs. 5/11, 6 lbs. 6/4 and 8 lbs. 6/26............	4.0	3.7	702
7. CIPC - 4 lbs. 5/11, 5 lbs. 6/4; 4 lbs. Casoron 6/26	4.2	4.2	752
8. Check	1.0	1.0	752
			N.S.

[1] 1-no control
5-excellent

Table No. 2 Results of Layby Herbicide Experiment on Early Harvest and Sweet Spanish Onions.

Treatment	Weed Control[1] 7/21	Yield Bu/A #1 Onions E.Harvest	Yield Bu/A #1 Onions S.Spanish
1. CIPC - 6 lbs. e.c.	2.5	722	679
2. Dacthal - 16 lbs. w.p.	2.8	722	673
3. Zytron - 10 lbs. e.c.	4.0	807	656
4. Diphenamid - 6 lbs. w.p.	3.7	696	659
5. Diphenamid - 8 lbs. w.p.	4.1	725	662
6. Tillam - gran. incorp. 4 lbs.	4.4	688	670
7. Tillam - " " 6 lbs.	4.7	705	634
8. Randox - 6 lbs. gran.	3.9	764	667
9. Randox - 8 lbs. gran.	4.1	759	675
10. Amiben - 4 lbs. e.c.	4.2	844	642
11. Rogue - 4 lbs. e.c.	4.1	571*	641
12. Check	1.0	770	653

*significantly lower than check

[1] 1-no control
5-excellent

Tomatoes

METHODS

Moreton Hybrid plants were set in the field May 17. Soil type was a light Sassafras sandy loam. Pre-planting treatments had been applied the previous day -- Tillam incorporated, Diphenamid and Trifluralin on the surface. The post or layby treatments were applied June 20 to well established, vigorously growing plants. Granular materials were applied directly over the row, the rest as directed sprays from each side of the row. Ratings on crop response and weed control were made at intervals during the growing season. Harvesting was conducted during the period July 14 to September 10.

RESULTS AND DISCUSSION

The effects of the herbicides on weeds and the crop are given in Table 3.

Table No. 3 Summary of Results on 1962 Tomato Herbicide Trial

Treatment	Weed Control[1] Ratings 6/7	6/18	7/20	Crop[2] Response	Yield lbs/A #1 Fruit	Ave. Fruit Wt.
1. Tillam, 4 lb. Gran. inc., pre-plant	4.0	3.9	3.7	1.3	26,999	.39
2. Tillam, 4 lb. gran. inc., pre-plant & 4 post....	4.0	3.6	3.8	1.2	22,817	.39
3. Diphenamid, 4 lb. w.p., pre-plant	4.3	4.3	3.8	1.4	21,899	.35
4. Diphenamid, 6 lbs. w.p., pre-plant	4.5	4.6	4.0	1.3	29,539	.36
5. Diphenamid, 4 lbs. w.p., pre-plant & 6 post ...	4.2	4.0	4.0	1.0	28,560	.38
6. Trifluralin, 1 lb. e.c., pre-plant	4.0	3.8	3.5	3.3	19,849*	.37
7. Trifluralin, 2 lb. e.c., pre-plant	4.3	4.0	3.5	3.9	19,258*	.38
8. Trifluralin, 1 lb. e.c., pre-plant & 2 post ...	4.0	3.6	3.4	3.4	20,951*	.39
9. Tillam, 4 lb. gran. inc., post	---	---	3.8	1.0	30,294	.39
10. Diphenamid, 6 lb. w.p., post	---	---	4.3	1.0	28,274	.36
11. Trifluralin, 1 lb. e.c., post	---	---	4.0	1.0	24,674	.36
12. Trifluralin, 2 lb. e.c., post.	---	---	4.3	1.0	32,630	.41
13. Dacthal, 10 lbs. gran., post	---	---	4.4	1.0	26,918	.38
14. Dacthal, 15 lbs. gran., post	---	---	4.3	1.0	29,509	.39
15. Amiben, 4 lbs. gran., post	---	---	4.3	1.0	33,150	.37
16. Casoron, 4 lbs. gran., post	---	---	4.3	2.4	20,645*	.39
17. Zytron, 10 lbs. e.c., post	---	---	4.2	1.0	27,673	.38
18. Check	1.0	1.0	1.0	1.0	26,897	.40

[1]1-nocontrol [2]1-no injury *significantly lower than check

There was a tendency for the pre-plant applications of Tillam and Diphenamid to retard slightly the early growth of the transplants but this difference eventually disappeared. This time of treatment with Trifluralin, however, caused severe injury characterized by a corky abscission-like layer at ground level resulting in the break-off of about one quarter of the plants. The only material to cause damage in the late-applied series was Casoron which brought about some stunting and yield reduction.

From the standpoint of weed control, all materials did a satisfactory job with the overall performance of Diphenamid perhaps the most outstanding. However, treatments with this chemical, even those applied pre-plant in May, caused severe stunting of the rye cover crop. At the time of writing (November 10th) growth on these plots is still extremely sparse.

Strawberries

METHODS

Results are reported on growing season weed control and subsequent yields for the 1960-61 and 1961-62 crops. Weed control data for 1962-63 are also presented.

In 1960 Sparkle plants set April 23rd were treated (June 13) with single applications of Dinoben, Eptam and Trietazine; and triple applications (1, 2 and 3 months after planting) of Neburon and Sesone. Zytron, which arrived after the experiment had been set up, was used on adjacent plants of the Midland variety. See Table 4.

Table No. 4 Effect of Herbicides on Weed Control, and Yield of Strawberries, 1960-61 Crop.

Treatment		Weed Control Rating[1]	Yield -lbs/A #1 Fruit
1. Dinoben - 4 lb. gran.	Sparkle	2.5	9,562
2. Neburon - 3+3+3 lb. gran.	"	3.2	10,051
3. Eptam - 4 lb. gran.	"	4.2	10,176
4. Trietazine - 3 lb. gran.	"	3.8	10,310
5. Sesone - 3+3+3 lb. gran.	"	2.5	9,917
6. Check	"	1.0	8,957
7. Zytron - 10 lb. gran.	Midland	4.0	10,227
8. Zytron - 20 lb. gran.	"	4.5	10,816
9. Check	"	1.0	9,600
			N.S.

[1] 1-no control
5-excellent

In 1961 Sparkle, Empire, and Midland were set May 2nd and treated June 24 with single applications of a number of chemicals -- see Table 5.

Table No. 5 Results of Strawberry Herbicide Trial 1961-62

Treatment	Weed Control Rating[1]	Yield - lbs/A[2] #1 Fruit
1. Eptam - 4 lbs. gran. incorp.	4.2	13,623
2. Tillam - 4 lbs. gran. incorp.	4.0	13,536
3. Falone - 4 lbs. liquid	3.3	12,614
4. Trietazine - 3 lbs. gran.	3.7	13,344
5. Zytron - 10 lbs. gran.	2.8	13,220
6. Zytron - 20 lbs. gran.	3.3	12,605
7. Diphenamid - 4 lbs. gran.	3.3	11,270
8. Check	1.0	12,922
		N.S.

[1] 1-no control
5-excellent

[2] Average 3 varieties

The 1962 trial was conducted on Midland, Surecrop, and Jerseybelle. These plants were set April 27 and treated as outlined in Table 6. The Tillam in treatment #1 was applied the day before setting and incorporated in the soil with a garden rake.

Table No. 6 Weed Control Ratings and Crop Response to Herbicides Applied to Strawberries in 1962. Plants set in the Field April 27.

Treatment	Crop[1] Response	Weed Control Rating[2]
1. Tillam - 4 lb. gran. inc. before planting	4.0	2.2
2. Tillam - 4 lb. gran. inc. 6/22	1.0	3.5
3. Tillam - 4 lbs.gran. inc. 6/22 & 7/30	1.0	4.0
4. Tillam - 4 lbs.gran. surface, 6/22	1.0	1.8
5. Eptam - 4 lb. gran. inc., 6/22	1.0	3.5
6. Eptam - 4 lb. gran. inc. 6/22 & 7/30	1.0	4.0
7. Eptam - 4 lb. gran. surface, irrigated in	1.0	3.0
8. Zytron - 20 lb. gran., 6/22	1.0	3.0
9. Zytron - 20 lbs. gran. 6/22 & 7/30	1.2	3.7
10. Dacthal - 12 lb. gran. 6/22..........	1.0	3.5
11. Dacthal - 12 lb. gran. 6/22 & 7/30	1.0	3.6
12. Diphenamid - 6 lb. w.p., 6/22	1.0	3.8
13. Diphenamid - 6 lb. w.p., 6/22 & 7/30	1.0	4.1
14. Trifluralin - 3 lb. e.c., 6/22	1.5	3.8
15. Trifluralin - 3 lb. e.c., 6/22 & 7/30	2.0	4.1
16. Check	1.0	1.0

[1] 1-no injury
5-severe injury

[2] 1-no control
5-excellent

RESULTS AND DISCUSSION

None of the treatments used in 1960 and 1961 caused damage to the strawberries. Tillam incorporated in the soil before planting in 1962 caused severe damage, particularly to the Surecrop variety. Many of the mother plants were killed and runner production was reduced. Yields in 1963 will undoubtedly be low from these plots. Trifluralin also caused some early stunting of plants which may or may not reduce yields.

Eptam and Tillam incorporated on well established plants have given consistently good results. Zytron, Dacthal and Diphenamid looked promising.

Granular Tillam was used at 4 lbs. per acre on a trial basis in a commercial field. Immediately after application the ground was worked with a Buddingh In-row Weeder. Observations through November 10 indicated almost perfect weed control in a field heavily infested with grass.

SUMMARY

1. CIPC and Randox provided good early control of weeds in onions. When annual grasses began to germinate, CIPC gave poor control; Randox gave fair control when the rate was increased to 8 lbs.

2. Tillam, Diphenamid, Zytron and Amiben applied at layby effectively controlled grass. A single late application of Dacthal was ineffective. Rogue injured one variety of onions and Diphenamid caused severe retardation of the cover crop.

3. Preplant treatments with Tillam and Diphenamid showed promise for transplanted tomatoes but Trifluralin used in this manner severely injured the crop.

4. Post (5 weeks) transplanting treatments with Tillam, Diphenamid, Trifluralin, Dacthal, Amiben, Casoron and Zytron gave good weed control in tomatoes. Casoron caused some crop damage and Diphenamid severely stunted the rye cover crop.

5. Tillam and Eptam, soil incorporated, have performed well on strawberries for two and three years respectively. Zytron, Dacthal and Diphenamid are worthy of further testing.

Chemical Weed Control in Transplanted Tomatoes 1/

J. D. Riggleman and H. A. Hunter 2/

On the eastern shore of Maryland, there are about 8000 acres of transplanted tomatoes representing 3 million dollars to the farmer. Weeds can be a major problem throughout the season. Competing for nutrients and moisture, preventing adequate pesticide coverage and obscuring fruit from the pickers are but a few of the problems that weeds can cause. The weeds between the rows of tomatoes can be controlled for about 8 weeks by cultivation while the weeds within the row have to be controlled by hoeing. After lay-by the weeds may emerge in both the row and row middles, presenting a serious problem before the end of the harvest season. Depending on the cost of herbicides and the availability and cost of labor, a farmer may wish to apply herbicides at transplanting, at lay-by, or at both times.

Two experiments were performed to study the effects of herbicides applied at transplanting and at lay-by. In the first experiment the herbicides were applied 3 days after planting and after the lay-by cultivation with no other cultivations. In the second experiment weed control was maintained by cultivation and hoeing through lay-by, then a single broadcast application of herbicide was made. Two treatments in the second experiment received herbicides in the same manner as experiment 1. Because Stam F 34 is a contact herbicide, this treatment was applied postemergence to the weeds. Apart from the two main experiments, two herbicides were applied with an exponential sprayer at lay-by to rows previously cultivated.

Materials and Methods

The experiments were conducted at the University of Maryland Vegetable Research Farm, Salisbury, Maryland, during the 1962 growing season. The soil is a well-drained sandy loam. The rainfall each month was only about one-half of the normal. Supplemental irrigations were necessary May 18, July 11 and August 21.

KC 146 tomatoes were planted May 7. A randomized complete block with 4 replications was used for the plot design. A single plot consisted of 3 rows with 14 plants per row with only the center row used for records. The herbicides were broadcast over the entire 3 row plot with a tractor mounted sprayer at 50 GPA (except Stam F 34 which was applied at 120 GPA) or with a fluted roller granular applicator (2). All materials were applied to the soil surface without incorporation. The untreated (check) plots were cultivated

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May 18, 25, June 6, 18, 29 and hoed on May 25 and June 18. The plots were sprayed weekly with pesticides for control of major insects and diseases. Weekly harvests commenced July 23 and ended September 4. The fruit were graded into combined US No. 1 and 2 canning grades and weighed. Fruit were counted at 2 harvests to determine average size.

The first application of herbicides for experiment 1 was made in late evening of May 10 (3 days after transplanting) to dry soil. After a single lay-by cultivation, the second application was begun in the late evening of June 19, but because of rain, had to be finished the morning of June 20. The soil was dry for the materials (Dacthal, Diphenamid, Trifluralin, Casoron) being applied June 19, but was wet for those (Zytron, NIA 2995, R 1607) applied on June 20. Prometryne was applied only on May 10.

In the second experiment, Dacthal and Diphenamid were applied May 10 and June 19 with a single lay-by cultivation on June 18. Stam F 34, a contact herbicide, was applied June 4 and July 26 when grasses were 1-3" tall. The Stam F 34 plots were cultivated and hoed on June 18. The rest of the plots were cultivated until lay-by, followed by a single herbicide application. The herbicides were applied in late evening of June 19 (Dacthal, Diphenamid, Trifluralin) to dry soil or early morning of June 20 (Amiben, Casoron, CIPC) to wet soil.

The logarithmic plots were single rows, 75' long and not replicated. The materials were applied June 26 to wet soil with an exponential sprayer as described by Dedolph _et al_. (1).

Results and Discussion

The data for experiment 1 are presented in Table 1.

Dacthal 75W 9+9 lbs AI/A. Two applications (9 lbs each) of Dacthal gave good control for the entire season and caused no difference (from the check) in yield or size of fruit. About 4 weeks after the first application, a corky thickened area was observed on the stem at the soil line. Several of the plants in "guard" rows were broken off by a wind of 30-40 MPH. None of those plants in the rows used for records was affected.

Diphenamid 80W 4+4 lbs AI/A. Diphenamid gave outstanding control for the entire season with no apparent injury to the plant. The yield was greater than the check and size was unaffected.

Trifluralin 4E 4+4 lbs AI/A. No apparent injury was observed. Control was almost as good as Diphenamid, but lost some of its effectiveness toward the end of the season. The yield and size were no different than the check.

Casoron 50W 4+4 lbs AI/A. About 4 weeks after the first application, the same injury was observed in the Casoron plots as was found in the Dacthal plots. In addition to the swelling and brittleness, the leaves demonstrated typical benzoic acid injury symptoms. The yield was no different than the check. Fruit size was smaller than the check at both times of sampling.

Prometryne 1.5E 3+0 lbs AI/A. Prometryne caused so much injury that no second application was made. Control was good for 10 weeks.

Zytron 3E 10+10 lbs AI/A. No injury to the foliage was observed and the control was acceptable for 2-3 weeks after each application. Yield was not different from the check but size was smaller.

NIA 2995 5G 6+6 lbs AI/A. Control was good and the yield and size of fruit were no different than the check.

R 1607 6E 6+6 lbs AI/A. The control was acceptable until about August 1. There might have been better control if the material had not been applied to wet soil. The yield and size of fruit were no different than the check.

The data for experiment 2 are in Table II.

Dacthal 75W 9+9 lbs AI/A. Stem injury was the same as in experiment I. Control was slightly less than acceptable after August 1. The yield and size of fruit were no different from the check.

Dacthal 75W 0+9 lbs AI/A. A single lay-by treatment of Dacthal to plots previously cultivated was slightly more effective in controlling weeds than the 2 applications with a single lay-by cultivation. Acceptable control was obtained until about the last week in August. The yield or size of fruit were not affected.

Stam F 34 2+2 lbs AI/A. The first application caused only slight injury to the tomatoes and killed about 1/2 of the grass seedlings (about 2" tall). The second application (same rate as the first) severely injured the tomatoes and killed about 90% of the grass. Essentially no broadleaved weeds were present at either time of application.

Diphenamid 80W 4+4 lbs AI/A. See experiment 1.

Amiben 10 G 0+5 lbs AI/A. Good control was attained for the entire picking season with no effect on yield or size of fruit.

Casoron 4G 0+4 lbs AI/A. The single application at lay-by caused no injury. The control was good for the entire picking season. Yield was not affected, but fruit size was larger than that in the cultivated check.

Trifluralin 4E 0+4 lbs AI/A. Control was good for the entire season with no effect on yield or size of fruit.

CIPC 20G 0+8 lbs AI/A. Good control was obtained for about 8 weeks after application. Yield and size of fruit were not different from the check.

Logarithmic trial

Shell 7585 2S 4-1/4 lbs AI/A. Control was satisfactory for 2 months from 2 lbs AI/A with no injury.

Shell 7961 50W 4-1/4 lbs AI/A. There was no injury from 4 lbs AI/A. Control was satisfactory for about 2 months.

Summary

Diphenamid and Trifluralin gave outstanding control with no injury. Control from Dacthal NIA 2995 and Amiben was satisfactory. Casoron, R 1607, CIPC and Zytron gave good control of weeds for a short period of time. Prometryne and Stam F 34 caused severe injury to the crop. When applied at planting, Dacthal and Casoron resulted in a corky thickened area on the stems at the soil surface and winds of 30-40 MPH broke off about 10% of the plants.

Literature Cited

(1) Dedolph R. R., C. W. Basham and F. C. Stark. 1960. An Exponential Sprayer for Experimental Work. Proc. Amer. Soc. Hort. Sci. 75: 785-88

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Table I

The effects of herbicides applied to transplanted tomatoes 3 days after planting and at lay-by on injury, control, yield and size.[1/]

Treatment	Lbs AI/A	Freedom From Injury[2/] 5/28	6/14	7/23	Control[3/] 5/28	6/14	7/23	8/17	9/18
Cult. Check[4/]		9.5	10.0	10.0	10.0	10.0	6.8	4.8	1.8
Dacthal 75W	9+9	10.0	9.5	9.5	10.0	10.0	9.5	8.0	7.8
Diphenamid 80W	4+4	9.5	9.8	10.0	9.3	9.3	10.0	10.0	10.0
Trifluralin 4E	4+4	9.0	9.5	9.5	10.0	10.0	10.0	9.8	9.0
Casoron 50W	4+4	9.5	6.3	10.0	9.5	7.3	9.3	5.8	5.0
Prometryne 1.5E	3+0	2.0	5.0	4.0	10.0	8.0	7.0	2.0	1.0
Zytron 3E	10+10	10.0	9.5	9.3	8.0	6.3	10.0	6.0	5.8
NIA 2995 5G	6+6	9.5	9.3	9.5	10.0	10.0	10.0	7.8	5.8
R 1607 6E	6+6	10.0	9.8	9.8	8.8	9.0	8.3	5.5	3.8

Treatment	Yield (T/A) 7/23-8/7	8/14-9/4	7/23-9/4	Size (oz/Fruit) 8/7	8/27
Cult. Check[4/]	8.5a	9.6	18.2 bc	5.8a	4.2a
Dacthal 75W	7.8ab	12.8	20.6ab	5.9a	4.1ab
Diphenamid 80W	9.3a	13.3	22.6a	5.7a	4.1ab
Trifluralin 4E	6.3 bc	12.5	18.8abc	5.6a	4.2a
Casoron 50W	4.6 c	12.3	16.8 bc	4.6 b	3.5 c
Prometryne 1.5E	---	---	---	---	---
Zytron 3E	4.3 c	11.2	15.6 c	4.8 b	3.8 bc
NIA 2995 5G	6.1 bc	13.5	19.6ab	5.7a	4.0ab
R 1607 6E	8.1ab	10.5 NS	18.6 bc	5.2ab	3.9ab

1/ Planted May 7, (variety KC-146) treated May 10 and June 19 or 20 (except Prometryne which was applied only on May 10). All plots were cultivated, side dressed and hoed just prior to the 6/19 or 20 application. All data are presented as the mean of 4 replicates.
2/ Rated 1-10 where 10 represents no apparent injury to the foliage.
3/ Rated 1-10 where 10 represents nearly perfect control, 7 represents acceptable commercial control and below 7 would not be acceptable.
4/ Cultivated 5/18, 5/25, 6/6, 6/18, 6/29; hoed 5/25 and 6/18.

Table II

The effects of herbicides applied once or twice to transplanted tomatoes on injury, control, yield and size.1/

Treatment	Lbs AI/A	Freedom From Injury2/ 5/28	6/14	7/23	Control3/ 5/28	6/14	7/23	8/17	9/18
Cult. Check4/				10.0			6.3	4.3	1.3
Dacthal 75W	9+9	10.0	8.8	9.8	8.8	9.3	9.5	6.3	6.0
Dacthal 75W	0+9			10.0			9.8	7.3	5.3
Stam F 34 3E	2+2	10.0	8.3	10.0	5.0	0.0	6.0	8.3	5.0
Diphenamid 80W	4+4	10.0	10.0	10.0	9.3	9.5	10.0	10.0	9.5
Amiben 10G	0+5			9.3			9.3	8.5	6.5
Casoron 4G	0+4			9.8			10.0	8.3	6.0
Trifluralin 4E	0+4			10.0			9.3	8.0	7.8
CIPC 20G	0+8			9.3			9.5	7.0	2.0

Treatment	Yield (T/A) 7/23-8/7	8/14-9/4	7/23-9/4	Size (oz/Fruit) 8/7	8/27
Cult. Check4/	7.3	11.6ab	18.9	5.6	4.0 bc
Dacthal 75W	7.5	10.0 bc	17.5	5.4	3.7 c
Dacthal 75W	8.5	10.7 bc	19.3	5.3	4.1abc
Stam F 34 3E	---	---	---	---	---
Diphenamid 80W	8.4	12.6a	21.0	5.2	3.9 c
Amiben 10G	8.4	10.7 bc	19.1	5.9	4.4ab
Casoron 4G	7.8	9.5 c	17.2	5.3	4.5a
Trifluralin 4E	7.7	10.2 bc	17.8	5.5	4.1abc
CIPC 20G	8.3NS	10.1 bc	18.4NS	5.5NS	4.1abc

1/ Planted May 7, variety KC-146, all plots were hoed, cultivated, and side dressed on June 18. Plots receiving two applications (except Stam F 34) were treated May 10 and June 19 or 20. Stam F 34 plot treated June 4 and July 26. Plots receiving lay-by application only, received 4 cultivation up to the single application made June 19 or 20.

2/ Rated 1-10 where 10 represents no apparent injury to the foliage.

3/ Rated 1-10 where 10 represents nearly perfect control, 7 represents acceptable commercial control and below 7 would not be acceptable.

4/ Check cultivated 5/18, 5/25, 6/6, 6/18, 6/29 and hoed 5/25 and 6/18.

STUDIES WITH DACTHAL FOR WEED CONTROL IN TRANSPLANTED TOMATOES

H. M. LeBaron[1]

INTRODUCTION

Since 1959, Dacthal has proved to be a very effective herbicide for pre-emergent control of crabgrass in turf. Its effectiveness for the control of annual grasses and some broadleaf weeds and its high degree of crop tolerance have resulted in the development of Dacthal for commercial use in a number of horticultural and agronomic crops.

Among the crops to obtain label clearance on a "no residue" basis for the 1962 season was transplanted tomatoes(1). In eastern Virginia, the tomato is probably the crop which is most urgently in need of more effective and safe weed control measures. Most of the commercial herbicides previously available have been deficient either in weed control effectiveness or in crop tolerance.

Investigations with Dacthal prior to 1962 had indicated that while there were some limitations as to the weed species controlled and conditions under which satisfactory weed control could be expected, there was no question about the tolerance of transplanted tomatoes to Dacthal. Preliminary tests made at the Virginia Truck Experiment Station during 1961 supported these observations. When established tomatoes received broadcast applications of Dacthal five weeks after transplanting, no injury or effect was observed from rates as high as 32 lbs/A.

The label clearance obtained for 1962 specified that not more than 10½ lbs/A could be applied immediately after transplanting(3). It was reasoned that since the at-transplanting treatment had proven safe elsewhere and that no injury or foliar effects had been observed from 32 lbs/A of Dacthal at lay-by, the much lower rate required for grass control should involve no risk at transplanting time. In fact, Dacthal had displayed such a high degree of tolerance to a large number and variety of transplanted or established crop plants and ornamentals that it was assumed to have practically no phytotoxic or post-emergent effects whatsoever(1).

METHODS AND PROCEDURES

Three replicated field experiments and several log trials were carried out during the past season to further evaluate the possible effects on tomatoes and weed control from the use of Dacthal at various intervals after transplanting.

The first experiment was carried out on a Sassafras sandy loam soil on the Eastern Shore of Virginia. Homestead tomatoes were transplanted on May 2. Dacthal was applied at rates of 0, 4, 6, and 8 lbs/A at intervals of two weeks, four weeks, and six weeks after transplanting. Each application was immediately preceded by cultivation. Dacthal 75-W was applied with a knapsack sprayer having 8002 nozzles and 50 mesh screens, with an output of 35 gallons/A.

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The second replicated trial and some log plots were set out on May 14 in a Woodstown sandy loam soil at the Norfolk station. A Chesterford Logarithmic Spraying Machine operated from the p-t-o of an International 140 tractor was used for both the log and replicated constant rate studies. The log plots had a half-dosage distance of 20 ft. and were 120 ft. long by 5 ft. wide. The sprayer output was 125 gallons/A for both experiments. The replicated plots included two tomato varieties, Homestead 24 and KC 146, and were treated at rates of 0, 4, 6, 8, and 24 lbs/A. The log rates ranged from 32 to ½ lb/A and were duplicated in different locations. Both experiments included treatments with Dacthal at transplanting and one month later.

Since results from these early studies demonstrated that serious and urgent problems existed relative to the use of Dacthal on transplanted tomatoes, further investigations were undertaken to try and resolve some of the perplexing questions about what was happening, why, and how to prevent it. From previous observations there was a strong indication that varietal differences in Dacthal susceptibility existed. As a result, seven commercial tomato varieties were direct-seeded in the field on June 25. The varieties used were: Rutgers, Valiant, Homestead 24, Roma, Fireball, KC 146, Delsher, and Waltham 22. On August 8 they were transplanted in adjacent rows so that the seven varieties would be included in each plot with seven rows per plot. Replicated plots were treated at rates of 0, 4, and 8 lbs/A while log plots ranged from 32 to 2 lbs./A. The Dacthal was applied at transplanting, one week after, two weeks after, and four weeks after in both experiments. All applications were made with the tractor-mounted log sprayer as with the May 14th studies.

RESULTS AND DISCUSSION

The 1962 season brought considerable surprise and disappointment to those who had taken for granted the absolute safety of Dacthal applications to transplanted tomatoes. It soon became apparent from research plots in several locations that a slow and indirect type of injury was being caused by Dacthal or an impurity in the formulation.

From the series of experiments at various times during the growing season, several theories or aspects of the Dacthal injury problem were investigated, and considerable information has been obtained.

The typical Dacthal injury symptoms have a number of perplexing characteristics. It has such a devious nature that you would not normally notice any effect, unless you knew what you were looking for, until almost the last stages of development. The injury develops slowly, with no definite effects observable for at least one to two weeks. The first typical symptom is a gradual increase in stem diameter, particularly at or near the soil surface. These swollen areas continue to increase in size, become brittle, and may partially split or separate longitudinally into three segments. In the final stages, this is accompanied by interior stem decomposition and proliferation of tissue, which is usually most intense at the nodes. In this condition, slight mechanical pressure from wind, cultivator, or the weight of fruit will sever the remaining connection between the root and topgrowth. There is usually no indication by observing the foliage that anything is wrong until the late stages of stem disintegration when some stunting may be noted. This often occurs, however, just prior to actual stem breakage. Usually associated with these developments are increases in the number, length and diameter of adventitious roots. Brown lesions on the stem are also frequently found.

An interesting observation which was quite consistently noted, was the apparent disregard of the tomato plants for the rate of Dacthal applied. In most tests, plant injury was only slightly more serious at extreme rates than at low rates. Some plants died even at 2 lbs/A, at rates too low for effective weed control. While some variation in the degree of injury resulted due to the rate of Dacthal applied and the condition of plants at transplanting, no plant treated at transplanting was found which completely escaped injury at rates sufficient for weed control.

The observations on differences in varietal tolerance to Dacthal indicate that while there do seem to be some significant varietal differences, with the Fireball displaying greatest tolerance, there is not likely sufficient true tolerance in any variety during the critical period of susceptibility to exploit or make any practical use of at present. It is believed that much of the early evidence considered to be varietal difference, and perhaps some of the later less striking differences, were actually due to the physical and physiological differences of the transplants rather than genetic make-up. It has become quite obvious that a plant with a long and slender stem which has to be bent when transplanted is more susceptible to Dacthal injury than a hardier plant or one with a short but thick stem which can be set in erect.

Since the critically susceptible period for the tomato appeared to be at transplanting, it was thought that the shock in having to produce new roots and becoming established,rather than the stage of growth, was perhaps responsible for its susceptibility to Dacthal. To test this theory, as the plants to be transplanted were removed from the rows where they had been direct-seeded, some plants were carefully left growing without being uprooted or disturbed. These were then treated at transplanting time like the others. While they did exhibit more tolerance to Dacthal than when subjected to the shock of transplanting, and only very few resulted in severe injury or death, they still developed the typical symptoms of swollen stems and brown lesions.

One theory considered was that, since the Dacthal injury had not been observed during the three previous years of testing, and since there had been several different formulations of Dacthal W-75 produced, the typical injury was possibly being caused by an impurity in the formulation. To test this, samples of a special formulation of Dacthal W-75 and a blank wettable powder was obtained from the Diamond Alkali Company. These were then logged on tomatoes at transplanting. The Dacthal W-75 Special resulted in crop injury of the same type and equal in degree to the commercial formulation, even though it appeared less effective for weed control, while the blank wettable powder showed no effect on any plants at any rate. This agrees with work done at Des Moines(2) where two formulations of Dacthal (W-50 and W-75) were compared, with no significant differences being observed.

There was also early speculation that only under particular soil and climatic conditions, such as in light soils under hot and dry weather accompanied by wind abrasion, would Dacthal injury develop. None of these tests in Virginia, however, were subjected to extreme dry conditions or serious winds. Soil moisture was fairly low when the spring transplantings and applications were made, and it remained warm and sunny with no rain for seven days. The only appreciable difference in the summer transplantings which were made in similar Woodstown sandy loam, followed by comparable temperatures, was that some rain fell the same day, 1.6 inches fell two days later, and it remained quite damp and cloudy during much of the next few weeks. A comparison of the results from both experiments indicate that no significant difference in crop injury could be directly attributed to the differences in climatic conditions. Though the Homestead 24 plants resulted in more serious injury and death from the earlier tests, the KC 146 plants were almost equally affected under both sets of conditions. Even under the wetter conditions, a few plants died at rates as low as 2 lbs/A. The increased injury to Homestead 24 plants from the early tests may, at least partially, be due to a more susceptible condition of the plants used.

Much more work is needed to determine what soil and climatic conditions cause or encourage Dacthal injury, but there was no strong evidence from these investigations that wind abrasion, sunlight, or dry conditions following application were responsible. This also agrees with research carried out at Des Moines[2] where treated transplants were grown under wet and dry field conditions. It can be quite definitely concluded that, at least on sandy loam soils, at-transplanting applications of Dacthal to tomatoes are not safe. While there are undoubtedly other factors which influence the susceptibility and extent of injury, soil type and temperature are believed to be of major importance.

In all experiments, the most important variable studied relative to reducing the Dacthal injury on tomato plants was the timing of application.

Dacthal applications at transplanting time resulted in serious injury or death of plants at weed control rates in all tests. The first replicated experiment showed no effect or only very minor stem enlargement when Dacthal was applied two weeks after transplanting. There were no visual effects on the foliage or fruit production, and no significant differences were detected in yield, as presented in Table 1.

Even upon close examination, no effects of any kind could be observed on plants treated at four weeks or six weeks after transplanting. Likewise, the second series of experiments showed no injury when tomatoes were treated one month after transplanting.

In the third and late series of tests, conditions were less favorable for the growth and development of tomatoes. This likely accounts for the more serious injury which developed on tomatoes treated at one week or two weeks after transplanting than was expected based on results from previous experiments. No tomato plants from these plots broke off and died, and no evidence of serious plant stunting was observed. Typical stem swelling and corking did occur, however, and became rather extreme in some cases, particularly on tomatoes treated one week after transplanting. As was true with the previous experiments, Dacthal injury failed to develop on tomatoes which were not treated until four weeks following transplanting.

These consistent results, together with those from similar tests in previous years, are strong support for the development and use of Dacthal for lay-by weed control in tomatoes, provided that application is delayed until one month following transplanting. It is quite possible that the early stages of the typical stem enlargement may occur, such as developed on tomatoes treated two weeks after transplanting, and still have no adverse effects on growth, yield, or quality of the crop. Until thorough investigation, however, an earlier application should not be suggested for commercial practice, even though Table 1 shows no significant differences in yield in this experiment.

Summary and Conclusions

1. Tomatoes treated with Dacthal at transplanting time were seriously injured and some plants died.

2. The typical Dacthal injury is a slow, devious development which would often go unnoticed unless you knew what to look for. The first symptom, which may not appear for a week or more after application, is a gradual swelling of the stem, especially near the soil surface. This swollen area increases, becomes brittle, often developing brown lesions or corky formation, and may form deep groves. In the advanced stages, interior stem decomposition and tissue proliferation takes place, sometimes resulting in complete separation and death of the plant.

3. All plants treated at transplanting were injured, and the effect of rate on the degree of injury was not great.

4. While minor varietal differences appear to exist, they are not likely of any immediate practical purpose. The physical condition of the plant at time of application is of greater importance.

5. Even undisturbed or established plants are susceptible during the early critical stage of development.

6. The typical injury is caused by Dacthal or a breakdown product, and is not the result of an impurity.

7. The predisposing factors necessary for the development or stimulation of the injury do not appear to depend on climatic conditions such as wind, drought, or sunlight.

8. Soil type, particularly light sandy loams, and perhaps high temperatures are believed to be important in encouraging Dacthal injury.

9. Under some conditions, injury may occur on tomatoes treated at least two weeks following transplanting.

10. There appears to be no risk of any injury when Dacthal is applied lay-by at least four weeks after transplanting.

Table 1. Tomato Yield and Grass Control from Dacthal, 1962, at Norfolk, Va.

Treatment	Rate (Lbs/A)	Timing*	Yield (Tons/A)	Significant Difference at 1%	Grass Control Rating at Harvest**
Dacthal	4	6	11.5		7
Dacthal	4	4	11.4		7
Dacthal	8	6	11.3		7
Dacthal	6	4	10.9		7
Dacthal	8	4	10.3		7
Dacthal	8	2	9.8		9
Dacthal	6	6	9.7		7
Cultivated Check			9.6		7
Dacthal	6	2	9.5		8
Dacthal	4	2	9.1		7
Check			7.7		0

* Number of weeks that application followed transplanting.

** 0 = complete infestation
7 = commercial control
10 = complete control

Literature Cited

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A COMPARISON OF SEVERAL HERBICIDES USED IN A FIELD OF TRANSPLANTED RUTGERS TOMATOES

Oscar E. Schubert[1]

Adequate weed control in tomatoes after lay-by has not been possible without uneconomical investments of hand labor and considerable mechanical damage to the fruit and plants. Weeds, if not controlled, interfere with spraying and harvesting operations, decrease production, and make conditions more favorable for insects and diseases. The purpose of this experiment was to obtain satisfactory weed control primarily with herbicides for the period starting four weeks after plant setting (late June) and ending at frost (late September) with only one hoeing during this three-month interval. A combination of several pre-emergent herbicides (applied a month after setting and after cultivation) with a post-emergent herbicide (applied when grasses and weeds were small) may be able to accomplish this goal.

METHODS and MATERIALS

This field experiment was conducted on a well drained, loam soil at the Medium Security Prison Farm, Huttonsville, West Virginia. Seven-weeks-old Rutgers tomato plants, field grown in southern Virginia, were set about three feet apart in rows four feet apart on May 31, 1962. Each plot was 20 feet wide and 100 feet long with 100 plants. There were four replications of ten treatments applied at random within each replication.

The first herbicide application was made on June 26 and 27 (Table 1). These treatments were all with pre-emergent herbicides except Solan. The granular herbicides were applied as uniformly as possible with a small crank-type duster and the wettable powder and emulsifiable concentrates were applied with a power sprayer and a 20-foot boom fitted with flat fan nozzles.

Several weeds were missed in the cultivation and hoeing prior to the first herbicide application. Since these weeds were not controlled by the pre-emergent herbicides the plots were hoed on July 26, the day before the second herbicide application.

The second application was made on July 27. Solan was applied as a post-emergent herbicide when grasses were no taller than 1-inch in the plots with the tallest grass. Solan was not applied to Treatment 5 (Diphenamid alone) and Treatment 1 (Hoed check).

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Table 1. Herbicide treatments applied to established Rutgers tomatoes at Huttonsville in 1962.

Treatment number	Treatment and formulation	Rate a.i. lb/A.	Date	Type of application
1	Hoed check		June 23	
2	Tillam 10G + Solan 4EC	4 + 4	June 27 July 27	Granular Eptam raked into soil immediately after application to each plot and Solan spray.
3	Dacthal 75W + Solan 4EC	10.5 + 4	June 26 July 27	Dacthal spray and Solan spray.
4	Diphenamid 50W + Solan 4EC	8 + 4	June 26 July 27	Diphenamid spray and Solan spray.
5	Diphenamid 50W	8	June 26	Diphenamid spray
6	CDAA 20G + Solan 4EC	6 + 4	June 27 July 27	Granular CDAA applied on surface without incorporation and Solan spray.
7	CDEC 4EC + Solan 4EC	4 + 4	June 27 July 27	CDEC spray and Solan spray
8	N-2995 5G + Solan 4EC	6 + 4	June 27 July 27	N-2995 applied on surface without incorporation and Solan spray.
9	Amiben 10G + Solan 4EC	4 + 4	June 27 July 27	Granular Amiben applied on surface without incorporation and Solan spray
10	Solan 4EC + Solan 4EC	4 + 4	June 27 July 27	Solan spray and Solan spray.

Table 2. Average per cent weed control for Rutgers tomatoes at Huttonsville.

Treatment Number Herbicide and Rate	July 24th Evaluation of weeds missed by cultivation prior to herbicide application	July 24th Evaluation of new weeds controlled by first herbicide application	October 1st Evaluation of over-all weed control by herbicides and hoeing July 26
1 "Hoed Check"	22bc	20c	14d
2 Tillam (4) + Solan (4)	45abc	48b	76bc
3 Dacthal (10.5) + Solan (4)	45abc	32bc	84bc
4 Diphenamid (8) + Solan (4)	62ab	88a	98a
5 Diphenamid (8)	68a	85a	89ab
6 CDAA (6) + Solan (4)	18bc	38bc	76bc
7 CDEC (6) + Solan (4)	32abc	38bc	71c
8 N-2995 (6) + Solan (4)	68a	88a	84bc
9 Amiben (4) + Solan (4)	60ab	42bc	78bc
10 Solan (4) + Solan (4)	50abc	52b	69c

The per cent weed control figures were converted to angles before computing analysis of variance and all comparisons among means. Percentages, in the same columns, followed by the same letter do not differ significantly from each other according to Tukey's "All Comparisons Among Means" as described

RESULTS and DISCUSSION

Diphenamid (Treatment 5) and N-2995 (Treatment 8) gave a significant degree of control of weeds missed by the cultivation as shown in the second column of Table 2. Other treatments were not significantly better in weed control than the "hoed check." The "hoed check" was hoed at the same time as the herbicide plots, namely, June 23 (before application) and July 26 (between first and second herbicide applications).

Diphenamid (Treatments 4 and 5) and N-2995 (Treatment 8) were significantly better than all other treatments in the control of new weeds for a period of one month. Tillam (Treatment 2) and Solan (Treatment 10) were better than the "hoed check" for the first month.

Diphenamid + Solan (Treatment 4) was considered the best herbicide treatment for control of weeds for three months; however, it was not significantly better (Table 2) than Diphenamid alone (Treatment 5). All treatments, when combined with hoeing at the end of one month, gave satisfactory weed control for three months.

The major weed control problems under the conditions of this experiment can best be summarized in Table 3.

Table 3. Major weed control problems and brief observations regarding treatments at the end of one and three months, respectively.

Herbicide	Major problems and notes after one month
Tillam	Inadequate control of purslane and galinsoga. Redroot pigweed may become troublesome. Good grass control.
Dacthal	No control of galinsoga. Good grass control.
Diphenamid	May be weak on control of galinsoga unless combined with cultivation. Excellent grass control.
CDAA	Inadequate control of purslane and galinsoga. Redroot pigweed and lambsquarters may become serious. Fair grass control.
CDEC	Inadequate control of purslane, galinsoga and grasses.
N-2995	May be weak on control of galinsoga and purslane. Good grass control.
Amiben	Inadequate control of galinsoga. Grasses may become a problem.
Solan	Inadequate control of purslane, carpetweed, galinsoga and grasses for more than 3 weeks.

Table 3. Continued

Herbicide	Major problems and notes after three months
Tillam + Solan	Inadequate control of purslane and carpetweed. Fair control of galinsoga. Good grass control.
Dacthal + Solan	Partial control of galinsoga. Good grass control.
Diphenamid + Solan	Excellent control of weeds and grasses.
Diphenamid	Galinsoga may become a problem. Excellent control of grasses.
CDAA + Solan	Partial control of galinsoga, purslane and carpetweed. Fair grass control.
CDEC + Solan	Inadequate control of purslane, galinsoga and grasses.
N-2995 + Solan	Galinsoga, lambsquarters and grasses may become problems.
Amiben + Solan	Inadequate control of galinsoga, lambsquarters and grasses.
Solan + Solan	Inadequate control of heavy galinsoga populations and grasses.

Galinsoga, purslane, redroot pigweed and grasses were so prevalent that any one, if not controlled, could cover the soil completely within three to four weeks.

SUMMARY

Diphenamid + Solan (Treatment 4) was considered the best herbicide treatment for control of weeds for three months; however, it was not significantly better than Diphenamid alone (Treatment 5). All treatments, when combined with hoeing at the end of one month, gave satisfactory weed control for three months.

ACKNOWLEDGEMENTS

The author is indebted and grateful to Mr. Waldo Ward, Farm Manager at the Medium Security Prison, for his aid and direction in setting the plants and weeding the plots.

The cooperation of the following companies in supplying the herbicides used in this field experiment is also gratefully acknowledged: Amchem Products, Inc., Diamond Alkali Company, Eli Lilly and Company, Niagara Chemical Division of the Food Machinery and Chemical Corporation, Monsanto Chemical Company and Stauffer Chemical Company.

CHEMICAL WEED CONTROL IN DIRECT SEEDED AND TRANSPLANTED TOMATOES

Charles J. Noll[1]

High plant populations of tomatoes appear to be necessary for high yields especially where mechanical harvesters are used. As a means of reducing the cost of high plant populations field seedings offers promise. Weed control is the greatest limiting factor in the successful growing of direct seeded tomatoes. The logical answer to the weed problem is chemical weeding.

An effective herbicide is also needed to control weeds in transplanted tomatoes. An adequate chemical weeding program could reduce production costs. The experiments reported in this paper is a continuation of work started a few years ago.

Procedure

In the direct seeded tomatoes the seedbed was prepared June 4. The preplanting soil incorporation treatments were applied June 6 and the tomatoes planted the same day. Pre-emergence treatments were applied 1 to 6 days after seeding. The variety grown was Fireball. Individual plots were 29 feet long and 3 feet wide. Treatments were randomized in each of 8 blocks. The growing season was dry and the plots were irrigated twice.

In the transplanted tomatoes, the seedbed was prepared June 4. The preplanting soil incorporation treatments were applied June 5 and the tomatoes transplanted the same day. The other treatments were applied 1 to 16 days after transplanting. The variety grown was Glamour. Individual plots consisted of ten plants spaced 3 feet apart in the row with rows 6 feet apart. Treatments were randomized in each of 6 blocks. The growing season was dry and no irrigation was applied.

Cultivation controlled the weeds between the rows. An estimate of weed control was made on the direct seeded tomatoes July 19 and on the transplanted tomatoes July 26. A rating of 1 to 10 was used, 1 being most desirable, and 10 least desirable. One harvest was made on the direct seeded tomatoes and two harvests on the transplanted tomatoes.

Results

The results in the direct seeded tomatoes are presented in Table 1. Eight chemicals were used in the test, each at two rates, together with an untreated check plot. Six of these, Tillam, Dacthal, Diphenamid (Lilly), Diphenamid (Upjohn), Trifluralin and Bay. 43034 gave excellent weed control throughout the growing season. Of these six only in the Diphenamid (Lilly and Upjohn) treated plots was there a normal stand of tomatoes at both rates of treatment 5 and 10 lbs. per acre. Tillam at 4 lbs. per acre and Trifluralin at 1 lb. per acre did not significantly reduce the stand as compared to the untreated check plot. The best yields were harvested in the Diphenamid treated plots at both rates of treatment.

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The results in the transplanted tomatoes are presented in Table 2. All chemicals significantly decreased the number of weeds as compared to the untreated check plot. With some treatments the plots were free of weeds throughout the growing season. Stand of tomato plants was unaffected by the treatments. Under the dry growing conditions, the number and weight of marketable fruits was greatly reduced by blossom end rot. The total weight of fruit, which includes fruits damaged by blossom end rot, is probably the better bases for a comparison of treatments. Four treatments were significantly better than the check in total weight of fruit. These treatments applied 1 day after transplanting were Vegadex at 3 lbs. per acre, RC-2990 at 3 lbs. per acre and Diphenamid (Lilly) at 5 and 10 lbs. per acre.

Conclusions

In the direct seeded tomatoes Diphenamid (Upjohn and Lilly) looks very promising as a pre-emergence application. This chemical gave good weed control at 5 lbs. per acre and there was no significant reduction of stand of plants or yield when applied at 10 lbs. per acre.

In the transplanted tomatoes taking into consideration weed control and total yield the outstanding treatment was Diphenamid (Lilly). Weed control was excellent and yields good.

Table 1. Weed control stand of plants, and weight of fruit of direct seeded tomatoes under chemical herbicide treatments.

	Treatment	Active Rate Per Acre lbs.	Application from Planting	Days	AVERAGE PER PLOT *Weed Control (1-10)	Stand of Plants	Wt. of Fruit, lbs.
1	Nothing	--	--		8.5	57.3	16.4
2	Tillam	4	Soil Inc.	0	2.3	62.9	32.9
3	"	8	" "	0	1.1	39.4	28.5
4	Dacthal	8	Pre-emerg.	1	2.0	12.3	5.8
5	"	16	" "	1	1.5	4.1	2.7
6	Diphenamid (Lilly)	5	" "	1	1.9	69.1	40.5
7	" "	10	" "	1	1.3	73.3	41.5
8	" (Upjohn)	5	" "	1	1.9	79.0	45.5
9	" "	10	" "	1	1.1	74.3	43.3
10	Trifluralin	1	" "	1	1.5	61.4	37.6
11	"	2	" "	1	1.6	49.8	34.1
12	Bay. 43034	4	" "	1	2.6	15.6	4.5
13	"	8	" "	1	1.3	0.9	0.4
14	Nia. 6370	6	" "	1	6.0	72.8	27.7
15	"	12	" "	1	3.0	51.0	29.0
16	Solan	4	" "	6	6.3	67.6	25.2
17	"	8	" "	6	3.9	60.1	25.2
Least signfficant difference 5%					1.5	11.3	3.1
" " " 1%					1.9	15.0	4.1

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

Table 2. Weed control stand of plants, number and weight of marketable fruit and total weight of fruit of transplanted tomatoes under chemical herbicide treatments.

	Treatment	Active Rate Per Acre lbs.	Application Days from Planting		*Weed Control (1-10)	Stand of Plants	No. Mkt. Fruit	Wt. of Fruit, lbs Mkt.	Wt. of Fruit, lbs Total
					AVERAGE PER PLOT				
1	Nothing	--	--		9.0	10.0	91.3	15.4	25.2
2	Tillam	4	Soil Inc.	0	2.2	10.0	81.5	17.4	35.3
3	"	8	" "	0	1.7	10.0	116.8	20.7	39.3
4	Trifluralin	1	" "	0	1.0	10.0	119.8	24.9	39.8
5	"	2	" "	0	1.0	10.0	112.3	26.4	40.2
6	"	3	Post Trans.	1	1.2	10.0	116.2	28.7	43.9
7	"	6	" "	1	1.2	9.3	128.5	27.5	41.4
8	Diphenamid (Upjohn)	5	" "	1	3.3	10.0	109.8	23.5	37.5
9	" "	10	" "	1	1.3	10.0	122.7	30.3	45.0
10	Diphenamid (Lilly)	5	" "	1	2.0	10.0	160.7	39.7	51.1
11	" "	10	" "	1	1.0	10.0	172.0	36.1	48.6
12	Dacthal	8 + 8	" "	1 & 16	1.3	10.0	107.2	25.7	38.5
13	"	24 + 24	" "	1 & 16	1.2	9.6	131.3	29.9	36.4
14	Casoron	4	" "	1	2.7	9.6	151.7	37.2	45.8
15	"	8	" "	1	1.2	9.2	83.7	18.3	21.9
16	Vegadex	3	" "	1	5.2	10.0	207.7	57.9	67.8
17	"	6	" "	1	3.5	9.8	112.6	27.7	44.3
18	RC-2990	3	" "	1	5.8	10.0	145.2	36.8	48.4
19	"	6	" "	1	6.3	10.0	96.5	19.3	33.1
20	Solan	4	" "	14	3.2	10.0	114.7	26.6	40.4
21	"	8	" "	11	2.0	10.0	144.2	39.2	47.6
22	Solan + Dacthal	4 + 8	" "	16	1.8	10.0	146.0	33.6	43.4
23	Stam F-34	4	" "	16	4.8	10.0	82.2	21.1	22.8
24	"	8	" "	16	3.8	9.8	52.3	12.7	13.6
25	Amiben G	4	" ""	16	4.3	10.0	94.0	22.2	31.5
26	"	8	" "	16	1.8	9.8	154.0	32.4	38.7
	Least significant difference 5%				1.8	N.S.D.	64.0	23.4	22.7
	" " " 1%				2.4	N.S.D.	84.8	31.0	N.S.D.

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

Chemical Control of Weeds in Transplanted Tomatoes

John F. Ahrens[1]

Several reports have indicated the promising uses of herbicides for weed control in tomato transplants (1,2,3). While tomato acreage in Connecticut is small, costs of controlling weeds in this crop are high. Growers can benefit greatly by means of weed control that are more efficient than the hoe and longer lasting than cultivation. The purpose of the work described herein was to evaluate the more promising herbicides for use in tomato transplants under local conditions.

Materials and Methods

The experiment was conducted on a Merrimac loamy sand in Windsor, Conn. The herbicide treatments were replicated three times in randomized complete blocks. The following herbicides were used in these tests:

a) tillam [propyl ethyl-n butylthiolcarbamate],
b) solan [N-(3-chloro-4 methyl-methylphenyl)-2-methyl pentonamide],
c) DCPA or dacthal [dimethyl-2,3,5,6-tetrachloroteraphthalate]
d) dichlobenil or casoron [2,6-dichlorobenzonitrile],
e) trifluralin [2,6-dinitro-N,N-di-n propyl-a,a,a,-trifluoro-p-toluidine],
f) R-1607 [n-propyl-di-n-propyl thiolcarbamate], and
g) amiben [3-amino-2,5-dichlorobenzoic acid]

Granular tillam was applied the day before setting and double-disced into the moist soil. Banded tomato transplants, variety Rutgers, were set on May 18, at distances of 3 feet between plants and six feet between rows. Plots consisted of a single row of 10 plants. Seeds of crabgrass (Digitaria spp.) and mixed broadleaf weeds were broadcast over the plot area.

The post-planting treatments were applied on June 8, three weeks after transplanting. At this time crabgrass was emerging and some seedlings were 1 to 2 inches high. Those weeds not removed or covered by cultivation were hoed out. The solan plots were cultivated, but not closely. Solan was applied on the existing weeds on June 8 and again on June 28. Tillam and R-1607 were applied before cultivating, whereas the other herbicides were applied on the dry soil surface after cultivating. The treatments were applied directly over the rows.

Granular herbicides were applied with a precision granular applicator[2] and sprays were applied in 70 gallons of solution per acre using a knapsack sprayer. No rain fell within three days after the post-planting treatments

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[1] Associate Plant Physiologist, Windsor Laboratory, The Connecticut Agricultural Experiment Station, Windsor.

[2] Modified version of a spreader described by Danielson and Chambers. Weeds 5:108-111 (1957)

and ½ inch of irrigation water was applied on June 8 to activate the herbicides. Rainfall at Windsor was close to normal in June (4 inches) but was about 2 inches below normal in July (1.5 inches). The plots were irrigated once in July and once in August.

Results and Discussion

Weed control - The weeds in this test were a mixture of small and large crabgrass. Few other weeds were present. Although stands of crabgrass had no significant effects on tomato yields, they did increase the time required for picking.

Weed control ratings were made on July 26 and are shown in Table 1. Results were much the same a month later. All of the herbicides tested except solan provided control of crabgrass that was equal to or better than the control provided by two hand hoeings. Solan killed only the smallest crabgrass seedlings, and those surviving grew uninhibited. A second application of solan three weeks after the first gave the same results. Granular tillam applied a day before planting provided excellent control of grasses for the season. Seedling grasses started to invade tillam plots in August but most of these did not grow very large.

Of the pre-emergence herbicides applied at layby, DCPA, dichlobenil and amiben were slightly but not significantly less effective than trifluralin, tillam, R-1607 and diphenamid. The higher rates of R-1607, diphenamid, DCPA, dichlobenil and trifluralin did not control crabgrass significantly better than the lower rates of these herbicides.

Injury and yields of fruit - Observations of injury were made three times during the season and yields of marketable fruit were taken weekly from August 6 to September 10. Yield totals to August 20 and September 10 are shown in Table 1. At the last harvest many green fruits remained on the plants. The data, therefore, do not reflect total plant yields.

Some plants treated with DCPA at 12 lbs. per acre exhibited slight epinasty and malformation of leaves, but plants treated with DCPA at 8 lbs. per acre were unaffected. Severe epinasty was noted in plants treated with dichlobenil, whereas slight epinasty and slight-to-moderate burning of lower leaves was noted in the plants treated with trifluralin. The second application of solan also burned many of the leaves hit with the spray. Average yields of the treatments causing injury were lower than those in the hoed checks but yields were significantly lower than the hoed checks only with the dichlobenil treatments.

At the rates tested, tillam, R-1607, diphenamid, and amiben did not cause visual injury to the tomato plants, nor did they reduce yields of marketable fruit.

Table 1. Effects of Herbicides on Weed Control and Transplanted Tomatoes, Variety Rutgers

Herbicide and formulation[1]	Rate a.i. lbs./A	Date applied	Weed control rating[2] 7/26	Injury 6/28	Yields marketable fruit - Tons/A	
					Totals to 8/20	Totals to 9/10
Tillam, g.	4	5/17 (pre-plant)	9.2	0	7.2	25.7
	4	6/8	9.2	0	6.8	28.0
R-1607, g.	4	6/8	9.8	0	4.9	27.2
	6	6/8	9.7	0	5.2	29.5
Diphenamid, w.p.	4	6/8	9.5	0	5.9	26.8
	6	6/8	9.5	0	5.9	26.5
DCPA, w.p.	8	6/8	8.2	0	7.4	26.7
	12	6/8	8.5	sl. epinasty	5.5	24.5
Dichlobenil, e.c.	3	6/8	8.3	epinasty	3.4[4]	21.8[4]
	4.5	6/8	8.8	epinasty	3.1[4]	20.0[4]
Trifluralin, e.c.	1.5	6/8	9.3	epinasty, burning	4.2	26.3
	2.25	6/8	9.3	" "	4.1	23.7
Solan, liq.	4	6/8 & 6/28	4.3	0[3]	4.8	25.5
Amiben, g.	4	6/8	8.6	0	7.2	28.2
Hoed controls			8.4	0	6.2	25.7
Weedy controls			0	0	5.4	23.5
L.S.D. .05			3.6		2.3	3.9
L.S.D. .01					3.2	5.3

[1]Tillam and R-1607 were incorporated, all others were applied on soil surface.

[2]0 - no control, 10 - 100% control.

[3]Slight burning of foliage noted several days after 2nd application of solan.

[4]Yields significantly different from the hoed controls at p = .05.

Summary

Several herbicides were applied just before or three weeks following transplanting of Rutgers tomatoes. Tillam,as a pre-planting or post-planting herbicide, and R-1607, diphenamid, and amiben as post-planting herbicides, provided good-to-excellent control of crabgrass with no injury to tomato foliage or yields. DCPA was satisfactory at 8 lbs. per acre but caused slight injury at 12 lbs. per acre. Solan, at 4 lbs. per acre, failed to kill crabgrass and injured the tomatoes slightly. Trifluralin and dichlobenil sprays caused injury and yield reduction.

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SPRAYING CHEMICALS FOR SOIL INCORPORATION WHILE CULTIVATING FOR LAY-BY WEED CONTROL IN POTATOES

Arthur Hawkins[1]

Spray application of chemicals on the soil surface for lay-by weed control for potatoes was discussed in a previous paper[2]. The equipment consisted of a low pressure power take-off pump, a mounted container for the spray solution, and spray nozzles mounted either on a six-foot boom at rear of the tractor or attached to spades held by the tool bar. The nozzles were directed to spray the soil behind the spades or hoes.

In 1962, with modifications of type and position of nozzles, a spray formulation of a weed control chemical that should be soil incorporated was applied just in front of the cultivators or hillers for soil incorporation while cultivating and hilling, and was found to give good control of weeds.

Four 80-degree nozzles, one for each side of each row, were mounted on the cultivator frames about 12 inches above road level. The nozzles were directed to spray the soil from the top of the ridge of one row to a point mid-way to the next row. The 55 gallon tank was located in a horizontal position on a frame behind the tractor seat, so as not to interfere with the power take-off pump.

The 2-row equipment was operated at a constant speed of 4 miles per hour and 21 gallons of solution per acre was applied. Long cone-shaped vine lifters or vine guards used to part vines away from the front wheels, also trained the vines away from the spray pattern, permitting the spray to reach the soil.

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2 Hawkins, Arthur. Equipment for Spraying Chemicals for Lay-by Weed Control While Cultivating Potatoes. Proc. NEWCC 16:164. 1962.

A grower who treated 30 acres of Katahdin potatoes in this manner obtained excellent control of late-germinating weeds with the chemical used. While making the final cultivation and hilling in some fields, the spray solution was turned on only in certain sections of the field where a weed population was expected on the basis of previous history.

With this arrangement a spray formulation of a weed control chemical can be directed for soil incorporation simultaneously while cultivating and hilling, and can be applied only where needed without an extra trip thru the fields.

PROMISING NEW HERBICIDE FOR LAY-BY WEED CONTROL IN POTATOES

A. Zaharchuk[1] and J. R. VanAllen[2]

With a potato variety like Katahdin, which has an open growth habit, weeds especially grasses develop rapidly after the last cultivation and become a problem at harvest. Growers continue to express a greater interest in lay-by herbicides than a pre-emergence material.

PROCEDURE

A field of Katahdins was selected that was being cultivated for the last time. Plots were sprayed, 70 days after planting, over-all with a CO_2 propelled small plot sprayer. Plot size was 6 feet by 30 feet, four replications. Materials were applied at 60 gallons of spray per acre. Being granular forms were not available for all materials, only sprays were used in this test to keep all materials comparable. Soil type, sandy loam, moist at time of applications. Weeds - lambsquarter, chickweed, ragweed, smartweed, crabgrass, bluegrass, and some barnyard grass.

RESULTS

Hercules 7531 (1-(5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl))-3,3-dimethylurea) at the 6.0 lbs. rate and BASF HS-95 (N-p-Chlorphenyl-N'-methyl-N'-isobutinylurea) at the 4.0 lbs. rate gave very good results. BASF HS-92 (1-Phenyl-4-amino-5-chlor-pyridazon-6) + (N-Cyclooctyl-N-dimethylurea) and BASF HS-119 (1-phenyl-4-amino-5-chlor-pyridazon-6) at the 3.0 lbs. rate gave fairly good results. Higher rates may give better performance. Penn Salt TD-282 even at the 0.5 lb. rate gave yellowing of foliage which resulted in dropping of the lower leaves. The 1.0 lb. rate giving slightly poorer performance than the 0.5 lb. rate, may be due to formulation difficulties. Sprays at the higher rate formed small soap-like bubbles that floated away. Linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) at the 1.0 and 1.5 lb. rate gave yellowing of the foliage about one week after application. This injury was not evident 30 days after application. The poor performance of eptam (ethyl di-n-propylthiolcarbamate) may be due to poor incorporation of the material. Incorporation was done with a hand rake. (Table I)

CONCLUSION

Of the newer herbicides, HS-95 and Hercules 7531 appear very promising for lay-by weed control in potatoes for both broadleaf and annual grasses.

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Table I - Results of Potato Lay-By Test - Calverton, L.I.,N.Y.

Material	Rate	Broadleaf Weeds	Grasses	Injury
Check	--	0	0	0
Hercules 7531	3.0	2.38	2.38	0
"	6.0	3.50	2.88	0
Linuron	0.5	2.63	2.50	0
"	1.0	2.75	2.75	2.0
"	1.5	2.50	2.25	2.5
BASF HS-92	1.0	1.13	1.13	0
"	2.0	2.25	1.88	0
"	3.0	2.88	2.50	0
BASF HS-95	2.0	1.75	1.75	0
"	4.0	3.88	3.88	0
BASF HS-119	1.0	1.38	1.38	0
"	2.0	1.75	1.75	0
"	3.0	3.25	3.25	0
PennSalt TD-282	0.5	0.38	0.38	3.0
"	1.0	0.25	0.25	3.5
Eptam	4.0	1.38	1.38	0

Average of 4 Replications
Date Rated: September 18, 1962
0 = No control - no injury 5 = Complete control - complete kill

CONTROL OF ANNUAL WEEDS IN POTATOES

C. Fred Everett[1]

The potato growing area in New Brunswick, Canada lies adjacent to Aroostock County, Maine. In New Brunswick, the germination of annual broadleaf weeds occurs mainly during the early part of the growing season. Infestation by either annual grasses or broadleaf weeds after final cultivation and ridging (layby) is seldom a serious threat to the immediate crop.

This test is conducted annually to evaluate new chemicals for their potential as selective herbicides in potatoes.

Materials and Methods

Keswick potatoes (a blight resistant variety) were planted in a sandy loam soil on 28 May, 1962. Seed pieces were placed 4 inches deep with 2 inches soil cover and 9 inches apart in rows 36 inches apart. "Planting" treatments were applied 29 May, "emergence" treatments 21 June, and "layby" treatments 6 August. Except for a check treatment which was handhoed 1 August, the potatoes were not cultivated or hilled throughout the growing season. The vines were killed with sodium arsenite on 5 September. The potatoes were dug 9 and 10 October.

The herbicide treatments listed in Table 2, replicated six times in randomized blocks of 6 ft. by 30 ft. plots. The herbicide sprays were applied with a single pass of a knapsack-type sprayer at 30 psi pressure and at 60 gallons of water per acre. The granular herbicides were applied with a hand-operated shaker.

The chief broadleaf weeds, in order of their abundance, were: ladysthumb (_Polygonum persicaria_ L.), lambsquarters (_Chenopodium album_ L.), corn spurry (_Spergula arvensis_ L.), and some hempnettle (_Galeopsis tetrahit_ L.), common chickweed (_Stellaria media_ (L.) Cyrill) and red sorrel (_Rumex acetosella_ L.).

Significance arrays, at the 1% level, were derived for effect of the herbicides on the yield of marketable (Canada No 1) tubers and on the control of the stand of annual broadleaf weeds from Duncan's New Multiple Range Test (1955). For statistical analysis, per cent control of the stand of weeds was converted to angles.

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Table 1. Herbicides Applied

Designation	Active Ingredient
amiben	3-amino-2,5-dichlorobenzoic acid
DCPA (Dacthal)	2,3,5,6-tetrachloroterephthalic acid
diphenamid	N,N-dimethyl-2,2-diphenylacetamide
diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea
DNBP	alkanolamine salt of 4,6-dinitro-o-sec-butylphenol
EPTC	ethyl N,N-di-n-propylthiolcarbamate
FW925	2,4-dichlorophenyl 4-nitrophenyl ether
G34361	2-chloro-4-allyamino-6-isopropylamino-s-triazine
HPC 7531	1- 5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl -3,3-dimethylurea
linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
prometryne	2,4-bis(isopropylamino)-6-methylmercapto-s-triazine
R1607	n-propyl-N-N-di-n propylthiocarbamate
Stam F-34	3,4-dichloropropionanilide
trietazine	2-chloro-4-diethylamino-6-ethylamino-s-triazine

Results and Discussion

The 1962 growing season at Fredericton, New Brunswick was one of the wettest, coldest and poorest on record. For example in July, the worst month, the mean temperature was down to 60°F from the 49 year average of 66.3°F; while rainfall was 5.00 inches and 19 days precipitation compared with the long term average of 3.40 inches and 11 days; and sunshine for the month at 138.6 hours was an all time low being 90 hours less than the average of 228.1 hours. The adverse weather delayed field operations sufficiently that the handhoed treatment was not carried out until the first of August and by this date it was impossible to remove all weed growth. Consequently, the yield of tubers from the handhoed treatment compared unfavorably with most treatments which provided adequate control of weeds. The lack of cultivation during a wet season along with early topkilling of the vines resulted in extremely low yields of tubers.

With the exception of FW925, the planting and layby herbicide treatments either reduced the yield or failed to provide effective weed control. In some cases such as with Stam F-34 the layby treatments could have been successful if the weeds had been adequately controlled until layby. However, since infestations of annual weeds occurring after layby are not a major problem, the layby treatments were tested to ascertain their effectiveness in controlling more mature weeds such as might be present due to weed escapes.

Effects of the herbicide treatments on the yield of potatoes are reported in Table 2, while their effects on broadleaf weeds are shown in Table 3. The following legend applies to abbreviations used in both tables.

<u>Legend for Tables 2 and 3</u>

Abbreviation	Description
S	stand - expressed as per cent of estimated complete stand.
V	vigor - expressed as per cent of estimated average luxuriant growth under ideal conditions of spacing, etc.
Range Test	Duncan's new multiple range test. In case of weed stand the percentage stand was transformed to angles before statistical analysis and range test was conducted.
sf	surfactant (X-77 at 0.6 ml per liter)
gr	granular - all herbicides not marked with gr were applied as a spray.
PL	treated after planting
EM	treated before crop emergence
LB	treated at layby period when last cultivation and hilling is made.
HN	hempnettle
CW	chickweed
RS	red sorrel
lambsqtr's	lambsquarters

<u>DNBP</u>: in the past the alkanolamine salt of this herbicide has consistently provided adequate and often excellent control of broadleaf weeds without reducing yields of potatoes. In 1962, DNBP, applied as a spray, gave excellent control of all annual broadleaf weeds present and the potato yield from this treatment was in the top range. DNBP applied in granular form to uncultivated soil did not control corn spurry or all of the ladysthumb. It is possible these weeds had emerged when the granular herbicide was applied and thus survived.

<u>FW925</u>: 1962 was the first season for this herbicide to be tested in this trial. Yield of potatoes from this planting treatment ranked first while control of broadleaf weeds was fair. More extensive testing of rates and periods of application are necessary to evaluate the potential of this chemical for potatoes.

Table 2. Potato yields, condition of vines and broadleaf weed control following applications of herbicides at various periods.

Herbicide Treatment			Yield of Tubers			Rank		
			Marketable		Total	Potato Vines		Broadleaf Weed
Chemical	lb ai/A	Appln.	cwt/A	Range	cwt/A	S	V	Control
FW 925	6	PL	148	a	197	2	5	6
trietazine	2	EM	141	ab	181	8	4	3
prometryne	2	EM	133	abc	178	1	3	1
linuron	1	EM	123	abc	157	1	1	1
DNBP	3.6	EM	115	abcd	146	1	2	1
diuron + sf	0.8	EM	112	abcde	149	1	8	2
G 34361	2	EM	110	abcdef	146	1	9	5
HPC 7531	3	EM	106	abcdefg	145	3	6	8
diphenamid	8	EM	105	abcdefg	152	7	7	11
amiben	4	EM	96	bcdefg	124	3	11	13
handhoed	-	-	94	bcdefg	132	10	19	10
HPC 7531	6	EM	89	cdefgh	131	4	9	4
DNBP gr	3.6	EM	87	cdefgh	109	4	6	9
diruon	0.8	PL	86	cdefgh	112	5	7	12
diuron	0.8	EM	85	cdefgh	124	1	10	9
diuron + sf	1.6	EM	70	defgh	97	2	14	2
DCPA	8	EM	69	defgh	99	8	12	17
amiben	4	LB	68	defgh	100	7	18	14
R 1607 gr	5	LB	66	defgh	102	3	15	18
untreated-2	-	-	62	efgh	95	4	16	18
Stam F-34	0.75	LB	59	fgh	82	7	17	15
EPTC gr.	4	LB	56	gh	85	8	15	16
untreated-1	-	-	56	gh	80	6	17	20
linuron	0.5	LB	56	gh	87	3	16	19
diuron	1.6	EM	55	gh	82	9	13	1
diuron	1.6	PL	42	h	60	7	19	7

<u>Trietazine:</u> although ranking second in effect on yield of tubers this chemical did not control ladysthumb and corn spurry as completely as prometryne did. It is understood this chemical is being withdrawn from testing.

<u>Prometryne:</u> controlled all broadleaf weeds present in this test, caused no reduction in stand and vigor of the potato plants and ranked 4th highest in the yield test. Considering this is the first time prometryne was included in this experiment, it is very promising for control of annual broadleaf weeds.

Table 3. Stand and vigor of broadleaf weeds generally and of individual species following application of various herbicides on potatoes.

Herbicide Treatment			Broadleaf Weeds Present - August 16									
			General			Ladysthumb		Lambsqtr's		Corn Spurry		Trace of Weeds
Chemical	lb ai/A	Appln	Stand	Range Test	Vigor	S	V	S	V	S	V	
			%		%	%	%	%	%	%	%	
prometryne	2	EM	0	a	0	0	0	0	0	0	0	0
linuron	1	EM	0	a	0	0	0	0	0	0	0	0
DNBP	3.6	EM	0	a	0	0	0	0	0	0	0	0
diuron	1.6	EM	0	a	0	0	0	0	0	0	0	0
diuron - sf	1.6	EM	3	ab	8	3	8	0	0	0	0	0
diuron - sf	0.8	EM	3	ab	20	3	13	0	0	1	7	0
trietazine	2	EM	15	abc	45	3	11	0	0	7	25	HN
HPC 7531	6	EM	18	bcd	64	3	18	0	0	15	61	RS
G 34361	2	EM	21	bcd	68	5	22	1	7	10	52	HN,CW
diuron	1.6	PL	30	cd	43	27	42	1	7	0	0	0
HPE 7531	3	EM	31	cde	59	8	32	2	14	19	58	HN
FW 925	6	PL	28	cde	76	11	52	2	16	13	60	CW
DNBP gr	3.6	EM	39	cdef	77	5	21	0	0	33	77	0
diuron	0.8	EM	39	def	79	18	63	11	61	4	26	0
handhoed	-	-	51	efg	73	23	68	3	18	20	70	HN
diphenamid	8	EM	61	fg	82	35	80	2	13	18	83	HN
diuron	0.8	PL	65	fgh	85	57	85	0	0	4	28	HN,CW
amiben	4	EM	70	ghi	82	5	27	13	73	42	78	HN,CW
amiben	4	LB	82	ghi	68	41	63	10	52	28	78	HN
Stam F-34	0.75	LB	86	hij	73	49	76	7	37	26	78	HN
EPTC gr	4	LB	88	hij	84	51	84	7	41	23	80	HN
DCPA	8	EM	91	hij	87	57	86	7	26	24	67	HN,CW
R 1607 gr	5	LB	93	ij	85	48	80	18	59	20	78	HN,RS
untreated -2	-	—	93	j	89	61	88	8	33	18	73	HN,RS
linuron	0.5	LB	97	j	52	63	34	6	28	23	51	HN,RS
untreated -1	-	—	98	j	89	63	91	6	23	24	87	HN,CW

<u>Linuron</u>: controlled all broadleaf weeds present, caused no reduction in stand and vigor of potato plants and ranked 5th highest in the yield test. Linuron is very promising for control of annual broadleaf weeds in potatoes.

<u>Diuron</u>: addition of surfactant gave variable results. It enhanced weed control when the lower rate of 0.8 pounds of diuron was used but did not control ladysthumb as effectively when the higher rate of 1.6 pounds was used. The safety range with diuron is ralatively narrow; increasing the rate of diuron from 0.8 to 1.6 pounds per acre resulted in severe reductions in yield of tubers. Period of application of diuron, either at planting or near emergence of potatoes, did not change the

effect on yield of tubers but the emergence treatments controlled broadleaf weeds better than the planting treatments.

G 34361: ranked 7th in the top range for effect on yield of tubers but at the rate used it did not provide complete control of any of the weeds.

HPC 7531: at 3 pounds per acre ranked 8th in the top range for effect on yield of tubers but 6 pounds significantly reduced yield. At the 6 pound rate, it eliminated lambsquarters, controlled ladysthumb and only partially reduced corn spurry and red sorrel but the 3 pound rate was less effective on all broadleaf weed species present.

Diphenamid: at 8 pounds per acre ranked 9th in the top range for effect on yield of tubers but the control of broadleaf weeds was inadequate. Testing at higher rates of application appears necessary.

The remainder of the treatments resulted in reduced yield of tubers. Usually this reduction appeared to be a result of inadequate control of broadleaf weeds.

Conclusions

DNBP applied as a spray at emergence of potatoes continued to control all broadleaf weeds without reducing yield of potatoes.

Prometryne and linuron were the two new herbicides which were most promising in this experiment.

FW 925, G 34361, and diphenamid were also promising but should be tested further at higher rates to obtain more effective control of broadleaf weeds. Of the herbicide treatments resulting in top yields of potatoes, HPC 7531 was least promising for control of broadleaf weeds at rates that would not significantly reduce yields of tubers.

LAY-BY WEED CONTROL IN POTATOES -- A TWO-YEAR SUMMARY

R. D. Ilnicki, J. C. Campbell, and J. F. Ellis [1]

ABSTRACT

Late-germinating grasses which invade potato fields after the last cultivation create a probelm which is a menace in the harvesting operation. Crabgrass, barnyard grass, fall panicum, and *Setaria spp*. are the species which create this problem. In the past two years extensive trials have been underway at the New Jersey Station to find effective herbicides for the control of these grasses and to determine the optimum time of application for maximum control. A substantial number of herbicides were evaluated and of these the following proved to be the most effective:

Herbicide and Formulation	Rate, lb/A
n-Propyl-di-n-propylthiolcarbamate (R-1607), 10G	4,6
Ethyl-di-n-propylthiolcarbamate, (EPTC), 5G	4,6
N,N-dimethyl-α,α-diphenylacetamide (diphenamid), 10G	4,6
2,6-Dinitro-N,N-di-n-propyl-α,α,α-trifluoro-p-toluidine (trifluralin), 5G	3,6
Dimethyl 2,3,4,6-tetrachloroterphthalate (dacthal), 75W	8,24

The most opportune time of application for the thiolcarbamate herbicides is at the time of the next-to-last cultivation. This can be prior to or just after the cultivation. Almost equally as good is the application at the lay-by cultivation. R-1607 has proved to be superior to EPTC.

Diphenamid has shown promise as a lay-by herbicide but its residual nature is injurious to the subsequent cover crops of small grain.

Trifluralin is a more recent promising herbicide and there appears to be no advantage in incorporating the treatments with the lay-by cultivation.

Dacthal applied at "drag-off" has shown residual activity up to and through the lay-by period.

There were no decreases in yield from any of these herbicidal treatments.

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LAY-BY CHEMICAL WEED CONTROL IN POTATOES WITH GRANULAR AND SPRAY APPLICATIONS[1/]

Arthur Hawkins[2/]

Granular formulations of some weed control chemicals applied on freshly tilled soil after the final cultivation of potatoes have been reported to give good control of weeds, especially crabgrass and barnyard grass, and an increase in yield of Katahdin potatoes in Connecticut in 1961[3/].

In 1962, both spray and granular formulations of EPTC were applied for soil incorporation on loosened, relatively dry soil immediately before the last cultivation of Katahdin potatoes. Granular and spray formulations of dacthal and granular formulations of CDAA and other chemicals were applied immediately after the final cultivation in several fields of Katahdin potatoes.

Procedure for Field Testing

Commercial potato fields of the Katahdin variety with a history of crabgrass (Digitaria Spp) infestation in the Connecticut River Valley were selected for test sites.

The chemicals were applied either just before the last cultivation for soil incorporation or as a soil surface application after the last cultivation before the late germinating weeds had emerged.

Chemicals incorporated at the time of last cultivation. Granular formulations containing 5 and 10% EPTC were broadcast on loose soil within a few minutes prior to the last cultivation and hilling with a Gandy Lo-Hi 8-foot granular chemical applicator on Farms C, N, & M. Stauffer R-1607 10G was also broadcast at Farms C and N.

The spray formulation of EPTC was applied in 21 gallons of solution per acre while cultivating using low pressure nozzles, one on either side of the row, mounted on the front cultivator gangs ahead of the cultivator teeth, on Farm N. See details in previous article "Spraying Chemicals For Soil Incorporation While Cultivating For Lay-by Weed Control in Potatoes".

The soil at the location on Farm C was a fine sandy loam, at Farms N & M - silt loams. On all farms the soil had been loosened shortly before the application of the herbicide and were mellow-moist or drier. About 1/2" of rain fell the day following the application at Farm N, and about .3 fell within a few days after application on Farms M and C. Irrigation was applied later on Farms M and N, but not at Farm C.

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3/ Lay-by Chemical Weed Control in Potatoes with Granular Formulations of CDAA, Dalapon and Other Chemicals. NEWCC 16:178-180. 1962.

Chemicals applied immediately after the last cultivation. Granular formulations of CDAA and dacthal and other materials at location C were hand spread with a midget duster on plots 3 rows wide x 12 feet long, replicated three times.

Granular formulations of CDAA and dacthal were also broadcast with a Gandy applicator in plots 6 feet x 50 feet long replicated 3 times on Farm N. In addition, CDAA was applied on an earlier planted field of Katahdin and on a field of Chippewa potatoes on Farm N. The gravity-feed type machine[4] was calibrated at the field speed used, 4 MPH, before entering the fields. Provision was made to brush granules off the plants.

The spray formulation of dacthal was applied on the soil surface at 4 and 8 pounds active per acre using low pressure spray equipment[5] mounted on the tractor at Farm H. The nozzles were directed behind the hillers. The 4 pound rate was applied in 2 1/2 gallons of water per acre while making the final cultivation. The plots which received 8 pounds of dacthal had two surface applications of 4 pounds each, applied within a few minutes of each other, with no cultivation between the first and second surface applications.

Results

Chemicals soil incorporated at time of the last cultivation or hilling: EPTC at 4 lbs. active per acre, soil incorporated with the last cultivation and/or hilling, gave excellent crabgrass control at Farms M and N, Table 1. On Farm N the spray formulation was sprayed on the soil while making the final cultivation and hilling; on Farm M, 5% granules were applied a few minutes before the final hilling.

Good control of crabgrass was obtained with either EPTC or Stauffer R-1607 applied at 4 lbs. active per acre in 10% granular formulations at Farm C. Control was good even though some of the granules slid down along the dry slopes of the ridges at the time of application and may have been unevenly distributed by the hillers which followed.

At location C, which was not irrigated, a considerable increase in yield of potatoes was obtained as a result of the reduced weed population. Lack of yield improvement in spite of good crabgrass control at location N may be related to moderate hail damage on August 17 followed by earlier than normal dying of the vines which were chemically vine killed on September 19.

Chemicals applied after the last cultivation:

Rates of Dacthal: Dacthal at 8 pounds per acre applied as a spray on the soil surface at Farm H gave fairly good control of weeds which consisted of a heavy stand of crabgrass with some pigweed (Amaranthus retroflexus) and lambsquarter (Chenopodium album), Table 2. The 24 lb. rate applied as granules gave complete control of the weeds. The potato plants on these plots showed yellowing earlier.

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[4] Use of Granular Chemical Applicator for Lay-by Weed Control in Potatoes. NEWCC 16:165. 1962.

[5] Equipment for Spraying Chemicals for Lay-by Weed Control While Cultivating Potatoes. NEWCC 16:164. 1962.

TABLE 1. Effect of EPTC or Analog Incorporated with Last Cultivation and/or Hilling on Control of Crabgrass and on Yield of Katahdin Potatoes - Connecticut - 1962

Chemical	Active lbs/A	Crabgrass Control 1/	Yield 2/ bu/A	Yield % of Check
		Farm N		
EPTC e.c.	4	10.0	542	101
Check		2.0	539	
		Farm C (no irrigation)		
EPTC 10G	4	9.0	365 3/	147*
Check		1.5	248 3/	
R1607 10G	4	9.0	349	121**
Check		2.0	288	
		Farm M		
EPTC 5G	4	10.0	4/	
Check		2.0		

* Significant at 5% level ** Significant at 1% level

1/ Weed rating: 10 = complete control; 7 = acceptable; 3 = poor control; 1 = heavy rank weed growth.

2/ Yield on Farm N and R1607 at Farm C: on 2 rows x 8 feet x 3 reps, in percent of adjoining checks.

3/ Yield of EPTC treated plot and adjoining check Farm C on basis of 1 row x 8 feet x 3 reps.

4/ No yields taken on Farm M.

Increased control of a relatively light infestation of crabgrass was obtained with increasing rates of application of Dacthal applied as granules at Farm C. Reduction in weeds resulted in some increase in potato yields.

Rainfall shortly after application followed by irrigation later at Farm H favored better control of weeds with dacthal as compared with location C where the soil was low in moisture during most of the time from date of application until about August 9. No weeds developed at the test area at Farm N.

Rates of CDAA: CDAA (Randox) at 4 lbs. per acre applied in a granular formulation on freshly tilled soil immediately after final hilling gave excellent control of grasses, primarily crabgrass, in a field of Chippewas and in a field of Katahdin potatoes on Farm N. Appreciable rainfall occurred within two or three days following application. The broadleafed weeds, of less importance, were not as effectively controlled as were the grasses with the 4 lb. rate applied.

At the test sites with rates and formulations of CDAA the weed population was insufficient to make comparisons.

TABLE 2. Effect of Spray and Granular Formulations of Dacthal, Applied on Soil Surface after Last Hilling on Weed Control and Yield of Katahdin Potatoes - Connecticut - 1962.

Chemical	Active lbs/A	Control 1/ of Weeds	Crop Rating 2/	Yield 3/ % of Check
Farm H - crabgrass heavy, some pigweed and lambsquarter				
Dacthal 75 W.P.	4	5	10	4/
	8	7	10	104
Dacthal 20G	24	10	8.5	96
	0	1.5		
Farm C - light population of crabgrass; no irrigation				
Dacthal 20G	4	5	10	109*
	6	6	10	
	8	6.5	10	
	24	9	10	
	0	3	10	

* Significant at 5% level

1/ Weed Rating: 10 = complete control; 7 = acceptable control; 3 = poor control; 1 = heavy rank growth.

2/ Crop Rating: 10 = no effect; 0 = complete kill.

3/ Yield on 2 rows x 8 ft x 3 reps in percent of respective adjoining checks, except, in 8 lb. treatment Farm H, 2 rows x 16 ft x 3 reps.

4/ No yield obtained.

Prometryne applied as a 4% granular formulation at one location, Farm C, gave fair control of crabgrass at 1 1/2 lbs. active per acre. The 3 lb. rate gave fairly good crabgrass control but with some yield reduction. The 6 lb. rate caused some yellowing of the foliage and a considerable reduction in yield.

Summary and Conclusions

Chemicals soil incorporated at time of the last cultivation or hilling.

EPTC applied at 4 lbs. active per acre applied either in a spray or granular formulation and soil incorporated with the last hilling resulted in excellent control of crabgrass, the only late germinating weed at the test sites.

With tractor mounted low-pressure spray equipment the spray formulation of EPTC was applied in 21 gallons of solution per acre just in front of the cultivators and hillers while cultivating and hilling.

Stauffer R-1607 applied at 4 lbs. active per acre in a granular formulation, soil incorporated with the last hilling, gave good control of crabgrass.

Considerable increases in yield of potatoes were obtained as a result of the reduced weed population with EPTC and R-1607 at a location which was not irrigated and was on the dry side until August 10.

Chemicals applied after the last hilling

Dacthal at 8 lbs. per acre sprayed on the soil surface behind the hillers while making the final hilling gave fairly good control of weeds consisting of a heavy stand of crabgrass, and some lambsquarter and pigweed. A slightly higher rate is suggested on the basis of excellent control with a very high rate applied in the granular form.

The spray formulation of dacthal was applied with low pressure equipment mounted on the tractor while making the final hilling; the nozzles were directed behind the hillers.

CDAA (Randox) at 4 lbs. per acre applied in a granular formulation to freshly tilled soil immediately after the last cultivation and hilling operation gave good control of crabgrass at two locations.

Yield reductions were obtained with application of three or more pounds per acre of prometryne.

Acknowledgement is made to the following companies who supplied materials: Monsanto Chemical Co., Diamond Alkali Co., Stauffer Chemical Co., and Geigy Co.

PREEMERGENCE WEED CONTROL IN POTATOES

M.F. Trevett, H.J. Murphy, and William Gardner[1/]

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on weed control in white potatoes. Annual grasses were not present in sufficient amount to permit a reliable estimate of control in all blocks. Control of *Agropyron repens* L. was estimated, in one block, and of *Cyperus Esculentus* L. in another.

Procedure

Katahdin potatoes were planted in either a loam or sandy loam soil. Seed pieces were spaced 12 inches in rows 42 inches apart.

Treatments were replicated 5 to 7 times in randomized blocks of single row plots paired with untreated plots. Herbicides were applied with one pass of a small plot sprayer at 40 pounds pressure and 50 gallons per acre volume. Potatoes were hilled three times. The final hill was approximately 24 inches wide at the base, 10 inches high and 6 inches wide at the top.

The principle weeds were: Wild Rutabaga (*Brassica rapa* L.), Red-root Pigweed (*Amaranthus retroflexus* L.), Lambsquarters pigweed (*Chenopodium album* L.), Ragweed (*Ambrosia artemisiifolia* L.), and Smartweed (*Polygonum pensylvanicum* L.).

Results

1. Annual broadleaf weed and annual grass control.

The amount of weed control obtained appeared to be determined by the rainfall pattern following spraying. Several herbicides that have been reported to be effective on the usual spectrum of annual weeds found in cultivated fields gave unsatisfactory control in Blocks 2 and 3, Tables 4 and 5, in which a significant amount of rain did not fall until 8 days after treatments were applied. Eight days after .14 inches of rain fell, followed by .24 and .14 inches on the two succeeding days, Table 2. Mean temperature for the period

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was 62.5 degrees F. It is assumed that in the absence of heavily leaching rains that the greater portion of the less mobile herbicides remained at or near the soil surface above the zone in which weed seeds were germinating, and if they were non-persistent compounds, lost phytotoxicity by photochemical decomposition or by volatilization.

In Block 1, that received 1.28 inches of rain four days after application, all treatments applied at planting gave excellent broadleaf weed control except FW-925 and 1 pound per acre active ingredient of Hercules 7531, Table 3.

In all blocks the standard treatment was 4.5 pounds DNBP plus 7.4 pounds of Dalapon applied at 5% emergence of potatoes.

In Block 1, plots receiving standard treatment were not surpassed in either broadleaf weed control or in yield by planting application of 1, 2, or 3 pounds per acre of Linuron, 3 pounds Prometryne, 6 pounds of Solan, or 3 pounds of Hercules 7531, Table 3. Estimate of annual grass control was inconclusive because of sparse infestation.

In Block 2, standard treatment and 3 pounds per acre of Stam were better than all others except 4 pounds of Stam applied post emergence and 2 pounds of Linuron applied at planting, Table 4. Stam usually cups, crinkles, and "burns"potato foliage but the injury did not lower yields in 1962.

In Block 3, 3 pounds of Stam per acre produced higher yields than all other treatments except standard 2 and 4 pounds of Atrametryne applied preemergence, 1, 2, or 3 pounds of Stam applied post emergence, and 4 pounds NIA 2995 applied preemergence, Table 6.

Four and 6 pounds of Dicryl and 4 and 6 pounds of CP-522 severely injured potatoes. CP-522 did not control Brassica rapa.

Linuron applied post emergence, and 2,4-DEP applied at planting injured potatoes moderately. Linuron, TD-282, and NP-475 gave poor barnyard grass control in Blocks 2 and 3.

Hercules 7531 appeared to control red-root pigweed and lambsquarters better than it controlled ragweed and Brassica rapa.

OMU controlled red-root pigweed but not lambsquarters.

2. Quackgrass control.

Four and one-half pounds of DNBP plus either 2.22 or 7.4 pounds of Dalapon per acre gave significantly better control of quackgrass than 1, 2, 3, or 4 pounds of Linuron applied at planting, 1, 2, or 3 pounds of Linuron applied preemergence, or 2, 4, or 6 pounds of CP-31675 applied at planting, Table 5.

3. <u>Northern Nutgrass and Wild Rutabaga control.</u>

Four or 6 pounds of Granular EPTC and 4 or 6 pounds of Granular R-1607 gave significantly better control of northern nutgrass than either 2 or 4 pounds of CP-31675, Table 7.

Six pounds of either EPTC or R-1607 apparently are needed for acceptable control of wild rutabaga.

Summary

Following planting dates in which relatively small amounts of rain fell during the two-week period after application of herbicides to Katahdin potatoes, no candidate material surpassed a standard treatment of 4.5 pounds DNBP plus 7.4 pounds Dalapon applied at 5 percent emergence, in either broadleaf weed control or in pounds of potatoes produced per plot. Herbicides that did not differ significantly in effect on either yield or broadleaf weed control from standard were 4 pounds Stam applied at emergence, 1, 2, or 3 pounds Stam post emergence, and planting applications of 2 pounds Linuron, 2 or 4 pounds Atrametryne, and 4 pounds NIA-2995.

Following a planting date in which 1.28 inches of rain fell four days after herbicide treatments were applied, 4.5 pounds DNBP plus 7.4 pounds Dalapon applied at emergence did not differ significantly in effect on either yield or broadleaf weed control from planting application of 1, 2, or 3 pounds Linuron, 3 pounds Prometryne, 6 pounds Solan or 3 pounds Hercules-7531.

Four and one-half pounds of DNBP plus either 2.22 or 7.4 pounds of Dalapon gave significantly better control of quackgrass than 1, 2, 3, or 4 pounds of Linuron applied at planting, 1, 2, or 3 pounds of Linuron applied preemergence, or 2, 4, or 6 pounds CP-31675 applied at planting.

Four or 6 pounds of Granular EPTC and 4 or 6 pounds of Granular R-1607 gave significantly better control of northern nutgrass than 2 or 4 pounds of CP-31675.

Table 1. Herbicides Used in Potatoes.

Designation	Active Ingredient
Alipur	(OMU) plus butynyl-N(3-chlorophenyl) carbamate
Atrametryne	A Geigy product
CP-31675	A Monsanto product
CP-522	Trichlorophenyl acetonitrile
Dalapon	2,2-dichloropropionic acid
Dicryl	N-(3,4-dichlorophenyl) methacrylamide
Diphenamid	N,N-dimethyl-diphenylacetamide
DNBP	4,6-dinitro-o-secondary butylphenol
EPTC	Ethyl-Di-n-propylthiolcarbamate
FW-925	2,4-dichlorophenyl 4-nitrophenyl ether
Hercules 7531	1-(5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl)-3,3-dimethylurea
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
NIA-2995	N-(3,4-dichlorophenyl carbamate
NP-1475	A Pennsalt product
N-4069-E	Emulsifiable form of N-3291
N-3291	A Stauffer product, water soluble
OMU	N-cyclo octyl-dimethylurea
Prometryne	6-methylmercapto-2,4-bis(isopropylamino)-s-triazine
R-1607	N-propyl-di-n-propylthiolcarbamate
SD-7585	A Shell product
SD-7961	A Shell product
Solan	N-(3-chloro-4-methylphenyl)-2-methyl-pentanamide
Stam	3,4-dichloropropionanilide
TD-282	A Pennsalt product
Trifluralin	2,4-dinitro-n-n-di-N-propyl-a,a,a-trifluoro-P-toluidine
2,4-DEP	Tris-(2,4-dichlorophenoxyethyl) phosphite

Table 2. Rainfall, Monmouth, Maine, May-June, 1962.

Date	Inches of rain	Date	Inches of rain
20 May	.46	12 June	.02
24 "	1.28	18 "	.16
31 "	.01	19 "	.45
1 June	.01	20 "	.04
5 "	.14	23 "	.09
6 "	.24	24 "	.57
7 "	.14	26 "	.04
11 "	.27	27 "	.02

Table 3. Yield, Broadleaf Weed and Annual Grass Control in Potatoes, Block I.

Treatment (lbs. active ingredient per acre)	Yield, lbs. per 25' of row	% Broadleaf weed control	Annual grass Number per 3 sq. ft. quadrat
1# Linuron, PL 1/	39.8a 2/	100.0 3/	3.8
2# Linuron, PL	39.5a	100.0	3.8
3# Linuron, PL	38.8a	100.0	2.2
4.5# DNBP + 7.4# Dalapon, EM	38.5a	100.0	2.5
3# Prometryne, PL	38.3a	100.0	7.1
6# Solan, PL	35.9a	100.0	8.2
Hand hoed	35.0a	--	--
3# Hercules 7531, PL	34.4a	96.4	2.3
2# Hercules 7531, PL	31.0 b	99.7	8.7
1# Hercules 7531, PL	24.9 b	69.0	7.3
4# FW-925, PL	18.4 c	29.9	4.2
2# FW-925, PL	16.4 c	40.4	3.4
Untreated	15.3 cd	--	8.4
Untreated	9.9 d	--	10.5
L.S.D. 5%	5.5	12.3	5.6

1/ PL = applied 25 June '62. Katahdins planted 21 May '62.
EM = applied at emergence, 11 June '62.

2/ Means having the same letter do not differ significantly at the 5% level (Duncan's Multiple Range Test).

3/ Rated 4 weeks after treatment. 43.7 annual broadleaf weeds per square foot in untreated plots.

Table 4. Broadleaf Weed Control and Potato Yields, Block II.

Treatment (lbs. per acre of active ingredient)	Yield, lbs. per 25' of row	% Annual broadleaf weed control 3/
4.5# DNBP + 7.4# Dalapon, Pre 1/	35.3a 2/	99.8
4.5# DNBP + 7.4# Dalapon, Pre	33.1a	99.9
3# Stam, Post	31.6a	90.6
Hand hoed	28.9a	100.0
2# Linuron, PL	28.8ab	97.1
4# Stam, Post	28.3abc	95.4
2# Linuron, PL	28.1abc	95.6
1# Linuron, PL	23.5 bcd	93.3
2# Linuron, Post	22.2 bcde	90.4
13# NP-1475, Post	20.4 bcde	65.7

Treatment (lbs. per acre of active ingredient)	Yield, lbs. per 25' of row		% Annual broadleaf weed control3/
4# 2,4-DEP, Granular, PL	20.2	cde	62.7
4# TD-282, Post	16.7	de	50.3
4# 31675, PL	15.4	de	74.2
0.5# Linuron, PL	14.5	de	77.6
2# Hercules, 7531, PL	11.2	ef	21.6
4# Diphenamid, PL	10.1	f	17.8
8# N-4069-E, PL	9.7	f	60.2
6# Diphenamid	8.9	f	14.3
1# S-7961, PL	8.9	f	39.2
L.S.D. 5%	3.4		12.3

1/ Pre = applied preemergence, 11 June '62; Post = applied post emergence, potatoes 2-4" tall; PL = applied 29 May '62.

2/ Means having the same letter designations do not differ significantly at the 5% level (Duncan's Multiple Range Test).

3/ Rated 4 weeks after treatment. Log transformations used in analysis. 30.6 annual broadleaf weeds per square foot in untreated plots.

Table 5. Ratings of Broadleaf Weeds and Quack Grass Control (*Agropyron repens* L.).

Treatments	Broadleaf Weeds	Quack Grass
Untreated	1.02/	1.02/
4.5# DNBP, Pre	4.8	1.5
4.5# DNBP + 2.22# Dalapon, Pre	4.9	3.2
4.5# DNBP + 7.44# Dalapon, Pre	5.0	4.4
1# Linuron, PL1/	4.0	1.9
2# Linuron, PL	4.7	1.4
3# Linuron, PL	4.8	2.2
4# Linuron, PL	4.8	2.1
1# Linuron, Pre	5.0	1.7
2# Linuron, Pre	5.0	2.2
3# Linuron, Pre	5.0	2.1
2# CP-31675, PL	2.0	1.2
4# CP-31675, PL	3.4	2.2
6# CP-31675, PL	3.5	2.1
Untreated	1.0	1.0
L.S.D. 5%	0.5	0.8
1%	0.7	1.1

1/ Planted May 17, '62.
Treatments - 5, 6, 7, 8, 12, 13, 14, applied May 31, '62.
2, 3, 4, 9, 10, 11, 15, applied June 7, '62.

2/ Code for ratings made 18 June, '62.

1 = no control; 2 = poor; 3 = fair; 4 = good; 5 = excellent

Table 6. Broadleaf Weed Control, and Potato Yields, Block III.

Treatment (lbs. active ingredient per 25' row)	Yield: lbs. per 25' of row	% Broadleaf weed control
3# Stam, Pre[1]	34.4a[2]	100.0
4# Atrametryne, Pre	30.5ab	100.0
Hand hoed	30.2abc	--
4.5# DNBP + 7.4# Dalapon, Pre	30.0abcd	100.0
2# Stam, Post	29.7abcd	95.4
1# Stam, Post	28.9abcd	84.2
4# NIA 2995, PL	28.4abcd	99.2
3# Stam, Post	28.1abcde	93.6
2# Atrametryne, Pre	27.9abcde	100.0
4# Stam, Post	26.3 bcdef	97.5
4# OMU, PL	25.1 bcdefg	84.1
2# Linuron, PL	25.0 bcdefg	99.2
6# NIA 2995, PL	24.7 bcdefgh	100.0
4# Atrametryne, PL	24.5 bcdefgh	92.2
4# Trifluralin, PL	24.1 bcdefgh	85.0
6# Alipur, PL	24.1 bcdefgh	86.8
4# Alipur, PL	23.0 cdefgh	70.2
6# OMU, PL	22.9 defghi	88.3
2# NIA 2995, PL	21.1 efghi	74.1
6# Dicryl, Post	21.1 efghi	86.7
4# Dicryl, Post	20.6 fghij	80.8
2# Atrametryne, PL	20.0 fghij	40.2
2# Trifluralin, PL	19.2 fghijk	63.2
2# OMU, PL	18.0 ghijkl	46.3
2# Alipur, PL	17.6 hijklm	25.0
2# Hercules 7531, PL	16.0 ijklm	20.5
3# CP-522, PL	14.1 jklm	14.5
2# Hercules 7531, Pre	12.9 klm	23.0
4# Diphenamid, PL	12.2 lm	19.6
6# Diphenamid, PL	11.7 lm	10.5
6# CP-522, PL	10.7 m	19.6
4# CP-522, PL	9.7 m	10.0
L.S.D. 5%	5.7	13.8

1/ Pre = applied 11 June, preemergence; PL = applied 28 May. Katahdin planted 26 May '62; Post = applied post emergence 2-4".

2/ Means having the same letter designations do not differ significantly at the 5% level (Duncan's Multiple Range Test). 45.6 annual broadleaf weeds per square foot in untreated plots.

Table 7. Broadleaf Weed and Nutgrass Control in Potatoes.

Treatment (lbs. active ingredient per acre)	Yield: lbs. per 25' of row	% Broadleaf weed control	Rating Nutgrass control 3/
6# EPTC Granular, Pre-plant 1/	43.6a	90.8 2/	5
4# R1607 Granular, Pre-plant	42.6a	75.0	4
4# EPTC Granular, Pre-plant	41.9a	75.0	4
6# R1607, Granular, Pre-plant	41.9a	83.3	5
4# CP31675, Preemergence	28.3 b	30.8	2
2# CP31675, Preemergence	21.4 c	21.7	2
Untreated	9.2 d	--	
L.S.D. 5%	5.8	14.2	1.9

1/ Planted 29 May '62. Katahdin variety.

2/ Weeds: Wild Rutabaga (Brassica rapa L.); Northern Nutgrass (Cyperus esculentus L.)

3/ 1 - No control
2 - Poor
3 - Fair
4 - Good
5 - Excellent

Potato Vine Killing in Maine - 1961

H.J. Murphy and M.J. Goven[1]

This paper is a progress report of potato vine killing studies made in Maine during the 1961 growing season. Evaluations of harvested tubers were made during the 1961-62 storage season.

Materials and Methods:

Nine potato vine desiccants were tested at Presque Isle, Maine in 1961-62. Three new materials were in trial for the first time, two materials for the second season, and all were compared against two approved standard vine-killers. The purpose of this trial was to bracket the rate levels and to determine their effectiveness for potato vine killing.

All materials were applied in 100 gallons of water per acre to green potato vines on the dates indicated in the various tables. A plot size compressed air sprayer with two fan-type nozzles on a boom assembly was used for application of all materials to single row plots.

Using the relative kill rating system as presented in Footnote 1 of Table 3, ratings for effectiveness of kill were made at seven, and again at fourteen days after materials were applied. From these two ratings weighted indices of killing effectiveness for each material and rate of application were prepared for this report.

Twenty pounds of tubers from each plot were obtained at harvest time and placed in 50°F. storage for internal and external examination during the winter months. Storage exmainations consisted of snipping the stem end from each tuber and classifying each tuber as to percent of vascular ring showing discoloration. From these ratings, weighted values were computed as reported in Tables 1, 2, and 3. In addition ten tuber samples were shipped shortly after harvest to the various companies supplying the desiccants, for residue analysis.

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Results and Discussion:

Data in Table 1 indicate the effect of several desiccants on vines and tubers of the Katahdin potato variety. Chipman arsenic acid applied at the 2 and 3 quarts per acre rate, U.C. 15303, and the lowest rate of Ammonium thiocyanate tested were not satisfactory for potato vine desiccation in 1962. The most satisfactory vine desiccants in this particular study in 1962 were Premerge (dinitro), Diquat sodium arsenite, Arsenic acid (Gen. Chem) and Ametryne. Ammonium thiocyanate at the ten pound per acre level also did a satisfactory job killing potato vines. Of this group Diquat Ametryne, Sodium arsenite and Premerge will remain in the 1962-63 vine killing trials in Maine. The suppliers of Ammonium thiocyanate have indicated that they will not seek F.D.A. clearance for its use on potatoes.

Table 2 contains the results of a study conducted to determine the best method and rate of application of Premerge and Sodium arsenite for maximum vine desiccation and minimum internal tuber discoloration. For the 1961 season it appears from the data presented in Table 2 that a total of 6 pounds of Arsenic trioxide as a split application six days apart was sufficient for maximum vine killing action. The highest kill rating with Premerge was obtained with the 4 quart rate applied as a split application. No tuber discolorations were found in the tubers harvested from these plots.

There has been an increasing trend by potato growers in Maine to use a light roller either before or after vine killers are applied. In addition to filling in the crocks in the top of the rows or hills thus preventing some sunburned and tuber greening, reportedly this practice improves the killing action of vine desiccants. Research people have questioned this practice because of the possibility of spreading late blight spores with the roller from infected to uninfected foliage.

A preliminary study of various combinations of roto-beating, top rolling, Sodium arsenite and Dethane fungicide were applied to a set of plots that were innoculated with blight spores. Results of this study are presented in Table 3. In general, where the potato vines were roto-beaten or rolled before or after the Sodium arsenite was applied the best vine dessication occurred. No serious tuber blight rot or internal tuber discolorations occurred under the conditions of this study in 1961. Because the field spread of blight spores was probably retarded by the existing weather conditions existing at the time the treatments were applied, no conclusions relative to blight spread by mechanical rolling could be made.

Table 1. - Effect of Several Chemicals Used for Killing Vines of Katahdin Potatoes.

Aroostook Farm, Presque Isle, Maine, 1961

Treatments1/	Rate/A.	Percent internal discoloration2/ Slight	Medium	Severe	Total	Kill Ratings3/
Sodium Arsenite	2 gal.	--	--	--	--	4.5
Premerge	2 qts. & 5 gal. oil	--	.9	--	.9	3.5
Diquat	2 qts	3.5	--	--	3.5	4.5
"	3 qts.	--	--	--	--	4.5
"	4 qts	--	--	--	--	4.5
Arsenic Acid (Chipman)	2 qts.	3.2	--	--	3.2	2.5
" " "	3 qts.	--	--	--	--	2.5
" " "	4 qts.	1.1	--	--	1.1	3.5
Arsenic Acid (Gen. Chem.)	2 qts.	1.7	--	--	1.7	3.5
" " "	3 qts.	.9	--	--	.9	3.5
" " "	4 qts.	--	--	--	--	3.5
U.C. 15303 (Union Carbide)	5 lbs.	--	--	--	--	1.0
" "	10 lbs.	1.9	--	--	1.9	2.0
" "	15 lbs.	--	--	--	--	2.5
Atratone (G32293)	2 qts.	--	--	--	--	3.5
" "	4 qts.	1.7	--	--	1.7	3.5
" "	6 qts.	.9	--	--	.9	4.0
Ametryne (G34162)	2 qts.	.7	--	--	.7	4.0
" "	4 qts.	.6	--	--	.6	4.5
" "	6 qts.	--	--	--	--	5.0
Ammonium Thiocyanate	2.5 lbs. & 4 oz. powder	--	1.1	--	1.1	1.5
" "	5.0 lbs. "	3.6	--	--	3.6	2.0
" "	10.0 lbs. "	.7	--	--	.7	4.0
Check - No treatment		3.2	--	--	3.2	1.0

1/ Material applied August 29. All treatments received 4 oz. plyac spreader sticker except Ammonium Thiocyanate which received powder.
Applied at the rate of 100 gal. of water per acre rate.
2/ Percent are of average of six replicates.
3/ Ratings are 1-5 - 1 is no kill; 5 vines completely killed.

Table 2. - Effect of Rate and Methods of Applying Premerge and Sodium Arsenite on Vine Desiccation of the Katahdin and Kennebec Varieties.

Aroostook Farm, Presque Isle, Maine, 1961

Desiccant[2]	Rate/acre	Activator	Killing Index[1]		Date of Applications
			Katahdin	Kennebec	
No treatment	--	4 oz. plyac	1.0	1.0	--
Sodium Arsenite	2 lbs. AS_2O_3	4 oz. plyac	2.0	--	8/17
"	3 lbs. "	"	2.0	--	8/17
"	4 lbs. "	"	2.5	2.5	8/17
"	6 lbs.	"	3.0	3.0	8/17
"	8 lbs.	"	2.5	3.0	8/17
"	3 + 3 lbs. "	"	3.5	--	8/17 & 8/23
"	4 + 4 lbs. "	"	4.0	4.5	8/17 & 8/23
"	6 + 6 lbs. "	"	4.0	--	8/17 & 8/23
"	8 + 8 lbs.	"	4.0	4.5	8/17 & 8/23
Premerge	1 qt.	5 gals. fuel oil	2.0	--	8/17
"	2 qts.	and S.S.	2.0	2.5	8/17
"	3 qts.	"	2.5	--	8/17
"	4 qts.	"	2.5	3.0	8/17
"	1 + 1 qt.	"	2.5	3.0	8/17 & 8/23
"	2 + 2 qts.	"	3.5	4.0	8/17 & 8/23

1/ Top Kill Rating Scale.
- 1.0 - No kill of stems or leaves.
- 2.0 - Poor kill of leaves and stems.
- 3.0 - Most leaves killed and poor stem kill.
- 4.0 - Most leaves killed and fair stem kill.
- 5.0 - Good kill of both leaves and stems.

2/ Indice ratings made 8/28/61 - No tuber discoloration.

Table 3. - Effect of Rotobeating and Rolling Potato Vines Before or After Application of Sodium Arsenite on Late Blight Spread in Vines and Tubers of the Katahdin Variety.

Aroostook Farm, Presque Isle, Maine, 1961.

Treatments 1/	Percent internal discoloration 2/ Slight	Medium	Severe	Total	Percent Late Blight 2/	Kill Ratin
Arsenite only	--	--	--	--	.8	3.0
Arsenite followed by rotobeater (12 days after)	--	--	--	--	.5	3.0
Rotobeater followed by arsenite	--	--	--	--	.9	5.0
Tops rolled followed by arsenite	--	--	--	--	--	4.0
Arsenite followed by top rolling	--	--	--	--	.6	4.0
Arsenite plus Dithane tops rolled	--	--	--	--	1.0	4.0
Tops rolled followed by arsenite p plus dithane	1.2	1.2	--	2.4	1.1	4.0
Check - No treatment	3.6	1.2	--	4.8	2.7	1.0

1/ Arsenite applied at 8 lbs. per acre rate.
Dithane M22 applied at 1.5 lbs. per acre rate.
Rotobeater was assimilated by cutting vines with a hand sickle.
Rolling was done with a lawn roller.

2/ Percent discoloration and percent late blight are average of four replicates.

Potato Response to Linuron and Hercules 7531 [1] [2] at Four Stages of Growth on Muck and Mineral Soils

G. H. Bayer[3] and R. D. Sweet[4]

Weed control practices for potatoes in upstate New York depend primarily on cultivation either alone or after a pre-emergence spray of dinitro amine. Varying results with this program have shown the need for a herbicide with enough residual activity to maintain weed control throughout the growing season and into harvest.

As a result of 1961 trials, two of the more promising potato herbicides Hercules 7531, 1- [5-(3a,4,5,6,7, 7a-hexahydro-4, 7-methanoindanyl] -3, 3-dimethylurea and linuron, 3-(3,4-Dichlorophenyl)-1 methoxy 1 methylurea (Lorox) were selected for more detailed study. The objective of the 1962 experiments was to test herbicidal activity of these compounds in relation to time of application as measured by weed control and crop yield.

Experimental Method

Two areas were selected. One a well drained gravelly loam mineral soil near Ithaca, and the other a muck soil in the potato growing area of Savannah, New York. Hercules 7531 at rates of 3, 6, and 9 pounds active per acre, and linuron at rates of 2 and 4 pounds active per acre were applied at four timings as follows: 1. at planting; 2. pre-emergence; 3. early post-emergence; 4. lay-by.

The design was a randomized block with four replications. Individual plot size was 3x20 and 3x25 feet, on the mineral and muck soil respectively.

Plots were sprayed with a hand CO_2-pressure small plot sprayer. At each timing the materials were sprayed on soil that had been cultivated in the previous 24 hours. Thus all plots received three cultivations in addition to a hilling operation.

Weed species present on the mineral soil included ragweed, (*Ambrosia artemisiifolia*), lambsquarters (*Chenapoduim album*), and redroot, (*Amaranthus retroflexus*). Weed species at the muck location were lambsquarters and redroot.

Samples were taken at harvest for specific gravity readings and for observations on keeping qualities in storage.

1/ Paper No. 474 of Department of Vegetable Crops, Cornell University, Ithaca, N.Y.

2/ This research partially supported by a grant in aid from Hercules Powder Co.

3/ Research assistant; 4/ professor of Vegetable Crops, Cornell University, Ithaca, N. Y.

4/ The assistance of D. W. Davis, research technician is gratefully acknowledged.

Results and Discussion

On the mineral soil, both H-7531 and linuron gave essentially perfect weed control at all rates and at all timings as shown in table 1. The combination of CDAA and CDEC performed well at planting but less satisfactorily at the lay-by application.

Since weeds were eliminated in all linuron and H-7531 plots, the yield data should be a refelction of potato tolerance to the chemicals relative to rate and time of application. It can be seen in table 2 that potato yields decreased with both materials either as the rate increased or as the time of application was moved from at planting to lay-by. On the muck soil weed control was not so effective as on the mineral soil (table 3 vs.table 1). However, the CDAA+CDEC combination and linuron gave better weed control than did H-7531. Lay-by application of H-7531 and linuron depressed yields on the muck as they did on the mineral soil, table 4.

Table 1. Potato yield and weed rating - mineral soil.

Chemical	Active lbs/A	Time of Application	Lbs. per plot[A]	Weed Control[B]
Hercules 7531	3	At planting	40.72	9.0
" "	6	" "	33.25	9.0
" "	9	" "	27.27	9.0
" "	3	Pre-emergence	38.37	9.0
" "	6	" "	28.62	9.0
" "	9	" "	23.67	9.0
" "	3	Early post-emerg.	36.92	9.0
" "	6	" "	29.52	9.0
" "	9	" "	22.42	9.0
" "	3	Lay-by	34.17	9.0
" "	6	"	25.50	9.0
" "	9	"	-	-
Linuron	2	At planting	38.32	9.0
"	4	"	37.25	9.0
"	2	Pre-emergence	36.50	9.0
"	4	"	33.55	9.0
"	2	Early post-emerg.	35.37	9.0
"	4	" "	27.40	9.0
"	2	Lay-by	23.80	9.0
"	4	"	17.30	9.0
CDAA+CDEC	4+4	At planting	39.42	8.0
"	4+4	Lay-by	37.30	6.5
Check			41.75	3.2
L.S.D.	5%	Yield	8.04	
L.S.D.	5%	Weed Control		3.8

A Multyply by 120 for bushels to the acre.
B Ratings based on : 1=no control, 7=commercial control, 9=perfect control.

Table 2. Summary of yield and weed control - mineral soil.

Ave. of timings

H-7531 lbs/A	Yield per plot	Weed rating	linuron lbs/A	Yield per plot	Weed rating
3	37.6	9	2	33.5	9
6	29.2	9	4	28.9	9
9	24.4	9			
LSD 5%	4.08			4.08	

Ave. of Rates

	H-7531		linuron	
At planting	33.7	9	37.8	9
Pre-emergence	30.2	9	35.0	9
Early Post	29.6	9	31.4	9
Lay-by	29.8	9	20.6	9
LSD 5%	4.72		4.72	

Table 3. Potato yield and weed rating - muck soil Savannah, N. Y.

Chemical	Active lbs/A	Time of Application	Lbs.per plot A/	Weed Control B/	Specific Gravity
Hercules 7531	3	At planting	44.67	7.3	1.065
" "	6	" "	41.70	6.8	1.066
" "	9	" "	45.45	6.8	1.066
" "	3	Pre-emergence	43.32	5.0	1.066
" "	6	"	49.57	7.5	1.066
" "	9	"	44.85	8.0	1.066
" "	3	Early post-emergence	44.60	5.8	1.066
" "	6	" "	42.93	7.3	1.068
" "	9	" "	45.83	8.0	1.065
" "	3	Lay-by	41.48	5.3	1.065
" "	6	"	38.62	6.0	1.065
" "	9	"			
Lorox	2	At planting	43.25	8.0	1.067
"	4	" "	42.87	7.8	1.066
"	2	Pre-emergence	42.80	8.5	1.065
"	4	"	46.82	8.8	1.065
"	2	Early post-emergence	41.97	8.3	1.067
"	4	" "	40.42	8.8	1.065
"	2	Lay-by	31.65	8.5	1.065
"	4	"	21.20	8.8	1.065
CDEC+CDAA	4+4	At planting	46.75	8.3	1.066
" "	4+4	Lay-by	42.60	6.0	1.065
Check			42.92	5.0	1.066
L.S.D. 5%	Yield		5.51		
L.S.D. 5%	Weed Control			NS	

A/ 20 foot of row harvested. Multiply by 120 for bushels per acre.

B/ Ratings based on: 1 = no control; 7 = commercial control; 9 = perfect control

Table 4. Summary of yield and weed control - muck soil:

Ave. of Timings

	H-7531			linuron	
lbs/A	Yield per plot	weed rating	Lbs/A	Yield per plot	Weed rating
3	43.5	5.6	2	39.9	8.3
6	43.2	6.9	4	37.8	8.6
9	43.7	6.5			
L.S.D. 5%	N.S.	N.S.		N.S.	N.S.

Ave. of Rates

	H-7531		linuron	
At Planting	43.9	7.0	43.1	7.9
Pre-emergence	45.9	6.8	44.8	8.7
Early post	44.4	7.0	41.2	8.6
Lay-by	39.6	4.8	26.4	8.7
L.S.D. 5%	2.78	2.9	2.78	N.S.

Because mechanical cultivation missed some weeds, the excellent weed rating given linuron at lay-by in relation to H-7531 and CDAA+CDEC is an indication of the comparative post-emergence activity of these materials.

Chemicals did not influence specific gravity at harvest.

Summary and Conclusions.

1. H-7531 and linuron when used in combination with cultivation gave outstanding control of broadleaved weeds on mineral soils, and better than cultivation alone on muck soils.

2. The combination of CDAA+CDEC at planting is very promising for weed control particularly on muck, whereas linuron and H-7531 are relatively less effective on muck as compared to mineral soils.

3. Potato tolerance to H-7531 is in the range of 3 - 6 pounds.

4. Linuron caused decreased potato yield when used at 4 pounds early post-emergence or as low as 2 pounds at lay-by.

5. No treatments resulted in specific gravity readings different from the check.

LAY-BY WEED CONTROL IN POTATOES[1]

R. L. Sawyer and S. L. Dallyn[2]

This report is a continuation of work included in previous proceedings to find materials to control late germinating weeds in potatoes which became a problem after last cultivation. Under Long Island conditions with its long growing seasons, these weeds rarely cause a decrease of total yield in the field. They markedly decrease the number of marketable tubers by the extra agitation to separate potatoes from a soil tightly held together by weeds when combine harvesting.

MATERIALS AND METHODS

Planting Date: April 10, 1962 Harvest Date: Sept. 7, 1962
Varieties: Katahdin and Teton
Fertilization: 2500 lbs. per acre of 7-7-7 analysis
Cultivation: 6 cultivations including weedings and ridging
Irrigation: 4 applications of 1 inch
Plot Size: Single rows, 30 feet long - check on either side.
Statistical design: Randomized Block
Herbicide Applications: Soil incorporated materials were applied June 8 before next to last cultivation and June 19 before last cultivation. Materials for application shortly after last cultivation were applied on June 22nd and 23rd. Contact materials were applied on June 29 after weeds had germinated. Granular materials were applied with a "Gunkle" applicator.

Other:

Materials were applied at the Research Farm for data on yield, quality and storage effects to Katahdin potatoes. Materials were also applied on a commercial farm where the weed population was very high to determine herbicidal ability. Weed population consisted of both broadleaves and annual grasses. Barnyard grass was the most prominent annual grass, however both foxtail and crab grass were adequately represented. Ratings on per cent weed control based on checks at either side were made on Aug. 4 and Aug. 24.

Results and Discussion:

Both Eptam and Tillam did a better job in weed control applied before next to last cultivation than before last cultivation. Prometryne, Falone, Randox and CIPC of the lay-by treatments gave good weed control. CIPC tended to fall down with time. This was probably due to the reduction of top growth caused by CIPC which gave a better chance for weeds to germinate. The reduced top growth did not reflect in yield reduction as much as was expected. Similar results were obtained with Stam which gave pronounced foliage damage without the expected large yield reduction.

[1]Paper No. 479, Cornell University, Vegetable Crops Dept., Ithaca, New York
[2]Cornell University Long Island Vegetable Research Farm, Riverhead, N.Y.

Both contacts Lorox and Stam gave good weed control. The problems with both of these materials would be to get the herbicides through the potato foliage onto the germinating weeds. With directed sprays and the foliage growth in 1962 in the Research plots, there was not the vine problem which would normally be encountered in a commercial application. A dosage of 1 pound per acre was necessary with Lorox. As the dosage of Lorox was increased from 1/2 to 2 pounds per acre, the yield was reduced.

Casoron gave considerable vine damage which resulted in a large yield reduction. Diphenamid at 6 pounds per acre did not control the weeds as well as most of the other herbicides. Control was better at the second reading than the first. Hercules 7531 at 2 pounds per acre did not give satisfactory weed control. At 4 pounds 7531 was much better but tended to decrease yield.

Yields from the checks were higher than any of the weed treatments except Randox and Diphenamid. Good commercial weed control was obtained with most of the materials at the expense apparently of some reduced total yield potential.

Results are given in Table 1.

TABLE 1. Herbicidal Field Results with Potatoes in 1962.

Material	lbs. Active Acre	Timing	% Control of Weeds Aug. 4	% Control of Weeds Aug. 23	Yield Grd'd. U.S.1/Cwt/A
Eptam G	4	Before next to last cultivation	98	97	
Tillam G	4		96	90	
Tillam G	6	" " "	100	97	
Eptam G	4	Before last cultivat'n	93	93	
Tillam G	4	" " "	95	92	
Tillam G	6	" " "	82	90	
Prometryne G	2	After last cultivat'n	100	98	344
Prometryne G	4	" " "	85	92	327
Casoron G	2	" " "	47	50	277
Casoron G	4	" " "	60	48	144
Falone G	4	" " "	95	93	315
Alanap G	4	" " "	73	73	357
Randox G	4	" " "	93	82	374
CIPC G	4	" " "	87	75	325
CIP6 G	6	" " "	100	93	332
Hercules 7531 G	2	" " "	68	67	358
Hercules 7531 G	4	" " "	87	85	307
Diphenamid, w.p.	6	" " "	50	70	377
Stam, w.p.	3	8 days after last cultivation	100	90	317
Stam, w.p.	6		80	88	341
Lorox, w.p.	1/2	" " "	82	65	364
Lorox, w.p.	1	" " "	97	93	335
Lorox, w.p.	2	" " "	90	88	302
Check			0	0	389
Check			0	0	403
Check			0	0	373
L.S.D. 5%					44

Summary:

1. Tillam and Eptam were better applied before next to last cultivation than last cultivation.

2. Of the new materials, Prometryne, Lorox and Stam look very promising for control of weeds.

3. All materials which controlled weeds except Randox and Diphenamid did so at the expense of reduced total yield potential.

POTATO VINE KILLING[1]

R. L. Sawyer and S. L. Dallyn[2]

This report is a continuation of work included in previous reports on potato vine killing. Major emphasis is aimed at finding materials strong enough to kill weeds and vines over a 7 to 10 day period but selective enough on potato foliage to make the kill slowly. Materials in commercial use at present when used strong enough to kill weeds, kill potato vines rapidly. Associated with rapid killing of potato vines are decreased quality, poor skin characteristics for storage and increased vascular discolorations in the tuber.

MATERIALS AND METHODS

Planting Date: April 11, 1962 Harvest Date: Sept. 6, 1962
Varieties: Katahdin
Fertilization: 2500 pounds per acre of 7-7-7 analysis
Cultivation: 6 cultivations including weedings and ridging
Irrigation: 4 applications of 1 inch
Plot Size: Twin rows 30 feet long
Statistical Design: Randomized block
Vine Killing Application: Applied August 7, 1962. On August 9 and 10 there was over 2 inches of rain.
Vine Kill Rating: Ratings were made on August 10, August 13 and August 17, using the following index: 1 = no kill; 3 = 50% kill of leaves; 5 = 100% kill of leaves; 7 = 100% kill of leaves, 50% kill of stems; 9 = 100% kill of leaves and stems.

Results and Discussion:

Promytron, Amytron and UC 20299 appear to have potato vine killing characteristics which are desired. Amytron at the dosages used gave an end kill stronger than Promytron. Neither Promytron or Amytron had as much kill as is desired 10 days from application. UC 20299 exhibited a more severe initial kill and a more severe end kill than Amytron or Promytron.

Diquat and Paraquat both gave a fast initial kill at all dosages. Approximately .75 pounds per acre is necessary to give the desired kill ten days from application. These results indicate that dosage cannot be manipulated to give a slow early kill and have the desired total kill in ten days.

Sodium Arsenite gave the fastest initial kill even down to a dosage of 2 pounds per acre. Sodium Arsenite does not normally kill this fast at the lower dosages used, however there is a great deal of variability depending on the maturity of the vines. The more mature the vines, the lower is the dosage required to trigger fast killing.

Yield results indicate considerably less variability in the total yield than in the yield of 2 to $3\frac{1}{2}$ inch size. Materials which kill quickly would be expected in general to have a smaller total yield and a relatively higher yield in the 2 to $3\frac{1}{2}$ inch size than slow vine killers, dependent on the stage of the crop at killing.

Results are given in Table 1.

TABLE 1. Vine Killing Field Results with Katahdin Potatoes in 1962.

Material	lbs.Active per Acre	Vine Kill Rating 3 days	6 days	10 days	Yield CWT/A U.S. No. 1	2-$3\frac{1}{2}$" size
Promytron	2	1	2	4	328	183
	4	1	3	6	323	171
	6	2	4	5	321	168
Amytron	2	2	4	5	311	173
	4	2	5	6	338	185
	6	1	4	6	301	171
UC 20299	1	2	5	6	356	199
	2	4	7	8	347	190
	3	4	6	7	331	154
UC 15303	1	2	2	3	333	151
	2	2	3	3	335	158
	3	3	4	6	347	189
Diquat	.25	4	5	6	321	165
	.50	5	6	6	287	168
	.75	6	7	7	369	196
	1.00	6	7	8	337	166
Paraquat	.25	4	6	6	337	163
	.50	6	7	7	319	200
	.75	6	7	7	283	159
	1.00	6	7	7	328	163
Sodium Arsenite	2	7	8	8	297	166
	4	7	8	9	328	177
	6	8	9	9	333	162
	8	8	9	9	311	197
L.S.D. 5%			1.3		29	34

WEED CONTROL IN KENNEBEC POTATOES - (R.I. 1962)[1]

R. S. Bell and J. B. Regan[2]

The testing of new herbicides to determine the tolerance of both potatoes and weeds to these materials is necessary to develop more efficient methods of weed control. Bell and Gardner (1) reported that pre-emergence applications of prometryne at 3 lb/A active toxicant allowed maximum yields of Kennebec and Delus potatoes during the 1961 season. Trevett, Murphy and Littlefield (2) of Maine found that the most promising new herbicides for 1961 were DuPont 326 (linuron) and solan when applied to potatoes at emergence.

Emergence Herbicide Trials

Procedures

The area used was in haytype pasture for many years and was plowed during October, 1961, to start the decay of sod. While essentially level, there were variations in microtopography and by early August potato plants in the lower areas were dying, probably due to a disease complex. Sodium arsenite was applied to all plots on August 17 to prevent wide divergences in yields between live and dead plants. This also allowed the tubers to harden off for harvest, which began August 30.

Sevin at 2 lb/A was applied as needed for insect control while manzate at 2 lb/A was used for late blight which was discovered in the weedy plots on August 7. Satisfactory control of blight and insects was not obtained in those plots which had weeds 3 to 4 feet tall. Reinfestation of weed free plots occurred from these areas. To enable satisfactory mechanical harvest, the tall weeds were cut off before digging.

The soil in the experimental area was Bridgehampton silt loam. Cyanamid at 200 lb/A was broadcast and disced in on April 13. A granular 10-10-10-2 IC fertilizer at 2000 lb/A was banded while planting certified Kennebec potatoes on April 19.

The area was divided into 4 blocks and each treatment was randomized once in each block, making 4 replicates. The plot size was 15' x 48' with 5 rows, 3' apart, running east and west.

To simulate annual grasses a mixture of Japanese and Hungarian millets were broadcast and disced in lightly before the potatoes were planted.

Herbicides were applied with a low pressure sprayer at rate of 40 gal/A. The potatoes were 50% emerged at the time of spraying and annual weeds had their first set of true leaves. The prometryne formulations which were applied

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[1]Contribution No. 1074 R.I. Agricultural Experiment Station.

[2]Associate Professor and graduate assistant in Agronomy, respectively.

May 21 were followed by 1/2" of rain that evening. The other weedkillers were used on May 22.

Four plots were hand hoed on May 31, June 8 and June 20 to free them from weeds. It was planned to hill all the plots, but weather and other conditions conspired against this, so these plots received no machine cultivation or hilling. One week after application of the herbicides, a rotary hoe was used along the non-harvest rows of potatoes to give an indication of effects of cultivation at this time.

Results

The herbicides used, amounts of active toxicant per acre, bushels per acre of US #1 tubers and estimated weed control on August 8 are shown in Table 1.

Table 1. Pre-emergent herbicide test. Average bushels per acre of US #1 Kennebec potatoes and final weed control rating. Kingston, R.I. 1962. (These potatoes were not cultivated or hilled.)

Herbicide	Active Toxicant lb/A	Weed Rating* Aug. 8	Av Bu/A
1. Diphenamid (U-4513) 50W	4	0.0	385
2. SD7961	2	0.0	303
3. Prometryne 25E	2	8.5	571
4. Prometryne 25E	4	9.0	529
5. FW-925	4	4.0	449
6. Zytron	9	4.0	534
7. Hand hoed	-	9.0	658
8. Linuron	2	9.0	622
9. SD7585	2	0.0	414
10. Linuron	4	10.0	571
11. Prometryne 50W	2	8.5	590
12. Prometryne 50W	4	9.3	583
13. Prometryne 50W	8	10.0	598
14. No treatment	-	0.0	275
L.S.D. 0.05			52

*0 = no effective control 10 = complete kill

Table 2. Average of 4 random weed counts on June 18 and weed control rating where herbicides were incorporated with a rotary weeder one week after application of the pre-emergence chemical.

	Av. weeds per square foot[1]				Control rating[2]	
	Dicots		Grasses		June 18	
Materials	Weeder	No Weeder	Weeder	No Weeder	Weeder	No Weeder
1. Diphenamid (U-4513) 50W	6.2	13.8	4.0	6.5	7.4	0.0
2. SD7961	4.1	11.4	10.0	12.5	7.2	1.0
3. Prometryne 25E	0.9	2.7	5.5	7.6	9.2	8.3
4. Prometryne 25E	4.0	3.2	3.9	9.6	9.3	7.9
5. FW-925	3.0	8.5	5.6	4.3	8.6	6.3
6. Zytron	2.5	6.0	4.6	6.0	9.2	6.1
7. Hand hoed	3.2	1.7	1.4	1.5	9.7	9.5
8. Linuron	2.2	0.5	4.2	4.9	9.8	9.1
9. SD 7585	6.5	11.7	8.9	8.4	7.6	0.0
10. Linuron	0.6	0.2	1.3	2.9	9.9	9.6
11. Prometryne 50W	3.4	5.2	6.5	6.3	9.6	8.5
12. Prometryne 50W	2.0	3.2	2.9	2.3	9.8	9.1
13. Prometryne 50W	0.2	0.0	0.5	2.1	9.9	9.8
14. No treatment	7.9	13.9	11.2	6.1	4.5	0.0
AV.	3.3	5.9	4.8	5.8	8.7	6.1

[1]4 random counts

[2]0 = no control; 10 = 100% control

Linuron and prometryne turned the young potato foliage yellow where contacted. FW-925 burned and blackened the emerging sprouts. Within two weeks these damaging effects had largely disappeared.

Japanese millet was the dominant annual grass. Very few other annual grasses were found. Ragweed and ladysthumb (Polygonum persicaria) were the most common dicots. A small amount of lambsquarters, redrooted pigweed and common chickweed were scattered through the area. Quackgrass was fairly evenly distributed through the plots. The quackgrass stand was not heavy enough to lower yields, but apparently was not affected by the herbicides. The check plots and those receiving diphenamid had the widest range of weed species. The bushels of US #1 tubers from the check area (no chemical, no hoeing) averaged only 275 bushels per acre. This contrasts sharply with the 658 bu/A from the hand-hoed plots. The hoed checks, linuron at 2 lb, prometryne 50W and 25E at 4 lb/A were rated as 90-93% weed free. The potato plants all looked well.

level. The weed control where prometryne 50W at 8 lb/A or linuron at 4 lb/A was used was judged to be 100%. The bushels per acre from these treatments were 598 and 571, respectively.

It appears that the prometryne 25E may be more active on potatoes than the prometryne 50W. The yield from the 2 and 4 lb/A treatments of 25E were 571 and 529, respectively. Yields of 590, 583 and 598 were obtained where prometryne 50W was applied at 2, 4 and 8 lb/A. Four pounds per acre of linuron gave a significant reduction of yield compared to 2 lb/A. These yields averaged 571 and 622 bushels, respectively. Yields from adjacent lots cultivated twice and hilled yielded 645 bu/A. Very weedy plots developed where diphenamid at 4 lb and SD7961 or SD7585 at 2 lb/A were used. The yields were 385, 303 and 412, respectively. The SD treatments contained rather heavy stands of common ragweed and Japanese millet. A greater variety of weeds was found in the diphenamid areas.

On the plots receiving FW-925 or Zytron, a rather heavy stand of ragweed developed with a trace of Japanese millet. The yields from these were 449 and 534 bu/A, respectively. Handhoeing, linuron and prometryne were the three outstanding treatments. Excellent weed control and high yields of US #1 potatoes were obtained without cultivation of the chemically treated areas.

Inspection of the data in Table 2 indicates a trend toward fewer weeds in areas stirred with a rotary hoe one week after application of the emergence herbicides. This trend was still evident at the end of the experiment. Incorporation of the herbicide and the young weeds improved the performance of SD7961, SD7585 and diphenamid. The weed rating on June 18 where only the rotary hoe was used showed 45% control, while better than 70% resulted where they were incorporated with the weeds. The influence of early incorporation was negligible where prometryne and linuron were used. Stirring the soil after application improved the action of zytron and FW-925 compared to the check.

With an emergence herbicide, such as linuron or prometryne, and a good soil condition, it was possible to grow a satisfactory, weed free crop of potatoes without any cultivation. Excellent weed control and yields were also obtained from standard cultivation or hand hoeing. The use of a weeder of some type at emergence to knock out weed seedlings is helpful for weed control. It is difficult to use insecticides and fungicides efficiently where tall weeds overshadow the potatoes. This, coupled with plant competition and difficulty in harvesting, lowers yields and increases production costs.

Post-hilling Treatments

The post-hilling treatments were applied to potatoes just north of the emergence herbicide test. All conditions of the experiment were similar to the first with the exception that the plants were cultivated on May 23, June 8 and just prior to hilling on June 20. The application of the herbicidal materials started immediately after hilling, and required 2 days to complete because of showery weather. Enough granular material was weighed for each individual plot, mixed with sand, and spread by hand. The "granular" linuron

Table 3. Post-hilling herbicide test. Average bushels per acre of US #1 Kennebec potatoes. Kingston, R.I. 1962.

Herbicide	Active Toxicant lb/A	Av.
1. Diphenamid (U-4513)	6	618
2. Eptam (gran.)	6	650
3. Zytron	9	644
4. Amiben (gran.)	5	659
5. Prometryne (gran.)	4	604
6. Linuron (sand)	4	433
7. Falone (gran.)	4	615
8. Eptam (gran.)	4	597
9. Prometryne (gran.)	6	556
10. Stam-34	4	580
11. R-1607 (gran.)	4	648
12. Prometryne (gran.)	2	635
13. Stam-34	2	598
14. Check (regular cultivation)	-	645
15. *Randox (gran. 20%)	4	558
L.S.D. 0.05		55

Results

No weed problem developed. The Kennebec potato vines filled over the area giving excellent competition. A few leaves were temporarily yellowed where splashed with the linuron-sand mixture. Linuron at 4 lb/A caused a considerable reduction in yields of US #1 tubers. This treatment averaged 433 bu/A. Nine different treatments allowed average yields greater than 600 bu/A. The average for the check plots being 645 bushels. The averages for 2, 4 and 6 lb/A of active prometryne as the granular formula average 635, 604 and 556 bu/A respectively. This is a significant reduction over the 2 lb/A rate, as 55 bushels were necessary for significance at the 0.05 level.

Summary

During 1962 an excellent crop of Kennebec potatoes was grown without any mechanical cultivation where adequate amounts of linuron or prometryne were used at emergence. Cultivation, however, continued to be a satisfactory

Proper weed control facilitates control of insects and diseases of potatoes as well as improving conditions for harvest and storage of tubers.

Literature Cited

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Appendix

Herbicide	Company	Chemical
Amiben (gran.)	Amchem	10% 3-amino-2,5-dichlorobenzoic acid
Diphenamid (U-4513)	Upjohn	50W N,N-dimethyl 2,2-diphenyl acetamide
Eptam (gran.)	Stauffer	5% ethyl N,N-di-n-propyl thiocarbamate
Falone (gran.)	Naugatuck	10% tris-(2,4-dichlorophenoxyethyl phosphite)
FW-925 (e.c.)	Rohm & Haas	2 lb 2,4-dichlorophenyl 4-nitrophenyl ether
Linuron	DuPont	50W 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
Prometryne 50W	Geigy	2,4-bis (isopropylamino)-6-methylmercapto-s triazine
Prometryne 25E	Geigy	1.5 lb/gal ditto
Prometryne 8 gran.	Geigy	8% ditto
R-1607 (gran.)	Stauffer	10% N-propyl di-n-propylthiocarbamate
Randox (gran.)	Monsanto	20% 2-chloro-N, N-diallylacetamide
SD 7961	Shell	50W Code 1-4-5-7
SD 7585	Shell	2 lb/gal Code 16-4-1
Stam-34	Rohm & Haas	3 lb/gal 3,4-dichloropropionilide
Zytron	Dow	3 lb/gal O-(2,4-dichlorophenyl) O-methyl-isopropyl phosphoramidothioate

CHEMICAL WEED CONTROL IN STRAWBERRIES

Oscar E. Schubert[1]

Inadequate weed control is the primary factor limiting increased production and yield of strawberries in West Virginia. This experiment was designed to evaluate several herbicides, or combinations of two herbicides, for their ability to control weeds during the entire growing season.

METHODS and MATERIALS

The strawberry plants were set May 3-4, 1962 on a heavy clay loam soil at the West Virginia Horticulture Farm, Morgantown, West Virginia. Three varieties (Catskill, Pocahontas and Surecrop) were planted in twelve blocks--four blocks or replications of each variety. Each block was divided into twelve plots; however, only ten plots were set with strawberry plants. Plots to receive Diphenamid at 6 pounds per acre and plots to serve as non-hoed checks were not planted with strawberries. In each "planted" plot 24 plants were set 18 inches apart in rows 4 feet apart. To minimize spray drift from adjacent plots, the plots were separated by an additional 4-foot border at the sides and 3-foot border at the ends of each plot.

The strawberry planting was cultivated and hoed on June 4. All herbicide treatments, except the second 6-pound application on June 18 in Treatment 8, were applied at random within each block on June 4. (Table 1) The herbicide plots and the non-hoed check plots were neither cultivated nor hoed for a period of 19 weeks (June 4 to October 15, 1962). The granular herbicides were applied as evenly as possible with a salt shaker having large holes. Wettable powder and emulsifiable concentrate herbicides were applied with a power sprayer and a 16-foot boom fitted with flat fan nozzles.

RESULTS and DISCUSSION

Seven weeks (July 22, 1962) after the herbicides were applied three treatments--Eptam + Simazine (Treatment 2), Diphenamid + Simazine (Treatment 9) and R-1607 + Simazine (Treatment 10) were considered to have given excellent weed control (Table 2). Only a few small grasses (1-3 inches high) and two or three small broadleaved weeds (redroot pigweed and black mustard) were to be found in any of these plots 15 x 16 feet (240 square feet each). Diphenamid alone (Treatment 4) and R-1607 alone (Treatment 5) were satisfactory in their weed control although these plots had more small grasses and broadleaved weeds than Treatments 2, 9 and 10. Grasses in the Dacthal + Simazine (Treatment 3), Falone (Treatment 6) and N-2995 (Treatment 7) plots were becoming too numerous, although still small (2-5"), for acceptable weed control. The split applications of N-6370 (Treatment 8) were not controlling grasses (4-10" tall) and nearly all broadleaved weeds found in non-hoed plots were present. Barnyardgrass was 8-12" tall and dense enough for a cover crop in the non-hoed check plots. The most common annual weeds in the non-hoed plots were redroot pigweed, purslane, lambsquarters, black mustard and smartweed.

Table 1. Herbicide treatments applied June 4, 1962[a] to established Catskill, Pocahontas and Surecrop strawberries

Treatment number	Treatment and formulation	Rate a.i. lb/A.	Type of application
1	Hoed check	None	
2	Eptam 10G + Simazine 80W	5 + 1	Granular Eptam raked into soil 1/2-1" immediately after application to each plot (2:00-4:00 p.m.) and Simazine sprayed on surface (7:30-8:45 p.m.)
3	Dacthal 75W + Simazine 80W	9 + 1	Dacthal spray (6:30-7:30 p.m.) and Simazine spray (7:30-8:45 p.m.)
4	Diphenamid 50W	8	Spray (4:00-5:30 p.m.)
5	Stauffer R-1607 10G	5	Granular R-1607 raked into soil 1/2-1" immediately after application to each plot (2:00-4:00 p.m.)
6	Falone 44E	4	Spray (6:00-6:30 p.m.)
7	Niagara 2995 5G	6	Granular N-2995 applied on surface without incorporation
8	Niagara 6370 5G	6 + 6	Split applications of 6 pounds each applied June 4 (8:45-9:30 p.m.) and June 18 (10:00-11:00 a.m.) in granular form on the surface without incorporation.
9	Diphenamid 50W + Simazine 80W	8 + 1	Diphenamid spray (4:00-5:30 p.m.) and Simazine spray (7:30-8:45 p.m.)
10	Stauffer R-1607 10G + Simazine 80W	5 + 1	Granular R-1607 raked into soil 1/2-1" immediately after application to each plot (2:00-4:00 p.m.) and Simazine spray (7:30-8:45 p.m.)
11	Non-hoed check		Not set to strawberry plants.
12	Diphenamid 50W	6	Diphenamid sprayed on 6 plots in two replications (4:00-5:30 p.m.)

Table 2. Weed control in strawberries following application of various herbicide treatments.

Treatment number	Treatment and application rate	Weed control rating by rank 1=poorest, 10= best on July 22, 1962 (7 weeks after application)	Average weed control October 15, 1962 (19 weeks after application) As per cent	Means converted to angles
1	Hoed check	(10.0)	(100)	(90.00)
2	Eptam + Simazine (5 + 1)	8.5ab	58.8b	50.43
3	Dacthal + Simazine (9 + 1)	4.8d	21.7d	26.04
4	Diphenamid (8)	6.5c	81.8a	65.37
5	Stauffer R-1607 (5)	7.2bc	40.8c	39.35
6	Falone (4)	4.2d	19.6d	25.67
7	Niagara 2995 (6)	3.5de	13.8de	21.02
8	Niagara 6370 (6 + 6)	2.2ef	7.0e	14.66
9	Diphenamid + Simazine (8 + 1)	8.2ab	91.8a	74.24
10	Stauffer R-1607 + Simazine (5 + 1)	8.9a	56.2bc	48.72
11	Non-hoed check	1.0f	00.0f	00.00
12	Diphenamid 50W (6)	(5.0)	(70.0)	(58.60)
		D= 1.6		D= 10.6

( ) Figures in parenthesis were not included in analysis of variance and all comparisons among means.

Treatment averages followed by the same letter are not significantly different from each other using Tukey's test of "All Comparisons Among Means" as described by Snedecor.

Nineteen weeks (October 15, 1962) after herbicide applications, the control of barnyardgrass and redroot pigweed was the major problem in sprayed plots. Lambsquarters, purslane, ragweed, smartweed, black mustard, threeseed mercury and carpetweed also were present in large numbers in most non-hoed check plots. Treatments 2, 3, 5, 6, 7, 8 and 10 were not satisfactory in the control of barnyardgrass for the 19-week interval. Treatments 5, 8 and 12 were not as good as desired for control of redroot pigweed. A few redroot pigweed plants were found in all other herbicide plots but they did not offer serious competition. Where barnyardgrass was not controlled it was so tall (4-4.5 feet) and dense that broadleaved weeds and other grasses were seldom present. Diphenamid + Simazine (Treatment 9) and Diphenamid alone (Treatment 4) gave the best weed control for the entire period of 19 weeks (Table 2). Many grasses and weeds found in Treatment 4 plots at the end of the 7-week interval (noted earlier in this paper) died or did not develop fully by the end of 19 weeks.

There was no observable herbicide injury to any of the three strawberry varieties. The number of runner plants in some treatments (particularly Treatments 6, 7 and 8) were less than in adjacent plots but it is not known whether herbicides were partly or largely responsible since barnyardgrass was dense in these plots.

Roots of strawberry runner plants in Treatments 4 and 9 sometimes were less branched than in other treatments. It is possible that these herbicides were interfering with the root development and growth of new runner plants.

Barnyardgrass roots were short (often less than one-inch long) in Treatments 4, 9 and 12 where Diphenamid was included compared to roots 3-5 inches long in the non-herbicide-treated plots. The barnyardgrass plants in the "Diphenamid" plots were easily pulled from the soil.

All herbicides were applied by 9:30 p.m. on June 4 and a heavy shower started at 9:40 p.m.--ten minutes after the first 6-pound application of N-6370 (Treatment 8). Twenty-two hundredths inch of rain fell within a period of an hour and another 0.71-inch was recorded on the following day (June 5). The effect of these two rains on the degree of weed control achieved by the various herbicide treatments can not be determined; however, Eptam + Simazine was less effective in over-all weed control than in the previous two years when rain did not occur soon after application.

Rainfall recorded at Morgantown Airport (less than 1/2 mile away) was: 1.92 inches for May (52 year average 4.09); 2.21 for June (average 4.39); 2.73 for July (average 4.52); and 2.84 for August (average 4.09). Rains of 0.1 inch or greater in June, July and August were recorded on: June 4 (.22); June 5 (.71); June 11 (1.11); July 3 (.57); July 9 (.11); July 12 (.23); July 13 (.50); July 14 (.55); July 15 (.29); July 23 (.38); August 4 (.16); August 8 (.44); August 9 (1.65); August 13 (.45); and August 21 (.10).

SUMMARY

Three treatments (Eptam + Simazine, Diphenamid + Simazine and R-1607 + Simazine) were effective in weed control for a period of seven weeks.

Diphenamid + Simazine and Diphenamid alone gave the best weed control for a period of nineteen weeks after treatment.

ACKNOWLEDGEMENTS

The cooperation of the following companies in supplying the herbicides used in this experiment is gratefully acknowledged: Diamond Alkali Company, Eli Lilly and Company, Geigy Agricultural Chemicals, Naugatuck Chemical Division of United States Rubber Corporation, Niagara Chemical Division of Food Machinery and Chemical Corporation and Stauffer Chemical Company.

THE RESPONSE OF THREE VARIETIES OF STRAWBERRIES TO SEVERAL HERBICIDAL TREATMENTS

R. D. Ilnicki, C. R. Smith, and J. F. Ellis [1]

ABSTRACT

From previous work conducted at this station, several herbicidal treatments proved effective for the control of annual weeds in newly transplanted strawberries. The work was further expanded in order to determine the susceptibility or tolerance of three popular strawberry varieties grown in New Jersey to some of these promising herbicides.

Jerseybelle, Midland, and Sparkle plants were set on May 9, 1962 and on June 7, following an initial cultivation, the following herbicide treatments were applied in quadruplicate:

Herbicide and Formulation	Rate, lb/A
N,N Dimethyl-α,α-diphenylacetamide (diphenamid)	
80W and 5G (Eli Lilly and Co.)	4,6,8
50W (Upjohn Co.)	4,6
2,6-Dinitro-N,N-di-n-propyl-α,α,α-trifluoro-p-toluidine (trifluralin) 4 lb/gal E.C.	
Soil incorporated	1,2
Unincorporated	2,4,6
Dimethyl 2,3,4,6-tetrachloroteraphthalate (dacthal)	
75W	6,8,10
n-Propyl-di-n-propylthiolcarbamate (R-1607)	
6 lb/gal E.C.	4,6
10G	4,6,8
Propyl ethyl-n-butylthiolcarbamate (Tillam)	
6 lb/gal E.C.	4,6
O-(2,4-Dichlorophenyl)-O-methylisopropyl phosphoroamidothioate (zytron)	
25G	7½,15

Several untreated checks were included per replication. All thiolcarbamate treatments were incorporated immediately after application.

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Outstanding treatments and their effects on the strawberry varieties were as follows:

diphenamid - 6 to 8 pounds of both preparations, but the wettable powder was superior to the granular. It also caused greater reductions in plant vigor. Midland and Jerseybelle were slightly injured; Sparkle was unaffected.

trifluralin - rates of 2 to 6 pounds were necessary for weed control and there appeared to be no advantage of incorporation. Midland and Jerseybelle were injured a little at the highest rates; Sparkle was injured slightly at the 6 pound rate.

dacthal - only the highest rate was effective for weed control. No injury to any variety.

R-1607 - rates of 6 pounds and above produced good control. The granular was more effective than the emulsifiable concentrate. Jerseybelle was injured at the highest rate; Sparkle was not injured at any rate; Midland was intermediate in injury response.

Tillam - effective only at the higher rate. The granular was superior to the emulsifiable concentrate. Jerseybelle only slightly affected at the higher rate; no injury to Midland and Sparkle.

Zytron - effective only at the higher rate. No injury to any variety.

This study will be continued through the first harvest year. After yield determinations and analyses more complete information will be presented.

HERBICIDES FOR DECIDUOUS ORCHARDS

Frank N. Hewetson[1]

The use of chemicals to control undesirable vegetation around deciduous fruit trees is fast becoming a commercial practice, and justifies greater attention by research personnel and the chemical industry.

Fruit trees differ from annual crops in several important respects. In the first case, these trees have to be grown for several years before they bear a crop of fruit. During this period, the prime consideration is the production of a large bearing surface for future crops, when there is no need to consider the effects of herbicides on fruit. The absence of fruit on non-bearing trees permits considerable leeway in the selection of herbicides around the trees, so that the chief consideration is the effect on growth and foliage of the tree. The second stage in the life of a fruit tree is when it begins to bear a crop of fruit. The presence of the fruit limits the nature of the chemical which can be used as well as the time of application of the herbicide. And finally, because fruit trees remain in the same location for many years, the continued annual application of herbicides could produce a cumulative effect which might be detrimental to the tree and fruit.

With the above situation in mind, the research program with fruit tree herbicides at the Pennsylvania State University Fruit Research Laboratory has now been expanded to include studies on bearing and non-bearing trees of the major fruits grown in the South Central Pennsylvania fruit area. These investigations will consider the short and long time effects of herbicides around apple, cherry, peach, pear and plum trees as occasion permits.

The weed population in most orchards is a mixture of grasses and broadleaved weeds, so that a good orchard herbicide must be effective on all undesirable vegetation around the base of the tree for an entire season, preferably for an entire year or more.

An experiment with non-bearing Delicious apple trees, first reported at this Conference in 1961 (1), is now in its third year. This experiment is now basically a study of the cumulative effect of amino triazole plus simazine at various multiples of the present recommended rates, designated in Table 1 as B, 2B and 4B.

In this experiment, Amitrol T and Cytrol, which are both amino triazole in a liquid formulation and contain ammonium thiocyanate, have given somewhat better weed control, at least at the lower rates, than amino triazole in the powder form as Amino Triazole 50 and Amitrol 90. The increased rates (2B, 4B) of the various materials gave improved weed control without showing any harmful effects on tree growth

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or foliage.

Table 1. Weed control with various herbicides around some three year old Delicious apple trees.

No.	Treatment Materials	Rate AI/A	Weed Control* B	2B	4B
1	Amitrol T	1 lb.			
	Simazin 80	3	4.4		
2	Amitrol T	2			
	Simazin 80	6		7.6	
3	Amitrol T	4			
	Simazin 80	12			9.6
4	ATA 50	1			
	Simazin 80	3	2.2		
5	ATA 50	2			
	Simazin 80	6		6.4	
6	ATA 50	4			
	Simazin 80	12			9.1
7	Amizinine	4.2	1.1		
8	Amizine	8.4		3.9	
9	Amizine	16.8			6.8
10	Cytrol	1			
	Simazin 80	3	3.5		
11	Cytrol	2			
	Simazin 80	6		6.8	
12	Amitrol 90	1			
	Simazin 80	3	2.8		
13	Amitrol 90	2			
	Simazin 80	6		4.6	
14	Hoed,				
	Amizine	4.2	8.1		
15	Hoed,				
	Amizine	8.4		8.8	
16	Check				
	Hoed only	----	0.2		

*0 - No control
10 - Complete control

It is desirable to determine the carry-over effect of the various treatments from one year to the next in order to find out if it would be possible to withhold an annual application every so often. In Table 2 is shown the results of an experiment in which one half of trees treated in 1961 were re-treated in 1962, and the other half left without any herbicide treatment. It is very evident from the results of this work that there was not enough residual effect from the one year treatment to be effective in controlling the weeds around the trees in the following year.

Table 2 - Residual effect of herbicides applied around apple trees.

No.	Treatment Material	Rate (AI/A)	Weed Control I[1]	II[2]
1	Amitrol T	1 lb.		
	Simazin 80	3	0.0	5.8
2	Amitrol T	2		
	Simazin 80	6	0.0	4.4
3	Amitrol T	3		
	Simazin 80	9	0.0	5.0
4	Amino Triazole	1		
	Simazin 80	3	0.0	4.5
5	Amino Triazole	2		
	Simazin 80	6	0.0	4.6
6	Amino Triazole	3		
	Simazin 80	9	0.0	6.4
7	Amizine	4.2	0.0	3.2
8	Amizine	8.4	0.0	7.1
9	Amizine	12.6	0.0	6.0

*0 - No control
10 - Complete control
1 - Treated in 1961 only
2 - Treated in 1961 and 1962

Although combinations of amino triazole in various forms plus simazine have continued to give good results, other materials must be continually tested for future use. In Table 3 are shown some of these materials which were tested in 1962 on some 2 year old apple and peach trees.

Casoron was tested in these plots for the first time this year and gave very encouraging results, especially when used alone on ground free of weeds at the time of application. Diphenamid and Karmex had been used in 1961 as well as in 1962 on these same plots. No visible injury was observed on any of the trees in this experiment.

Table 3 - New herbicides for fruit trees.

No.	Treatment Material	Rate AI/A	Weed Control * Apple	Weed Control * Peach
1	Casoron 50 (1)	4 lbs.	8.8	7.5
2	Casoron 50 (1)	8	8.8	9.5
3	Amitrol T Casoron 50	1 4	4.0	0.5
4	Amitrol T Casoron 50	2 8	5.75	1.5
5	Diphenamid 80	10	8.5	6.0
6	Diphenamid 80	20	8.2	8.5
7	Karmex 80 (2)	4	9.5	9.5
8	Karmex 80 (2)	6	9.2	9.0
9	Check	--	0	0

*0 - No control
10 - Complete control
(1) - Applied on weed free soil
(2) - Second consecutive year of application

The use of herbicides around bearing fruit trees requires meticulous attention to timing and rates of application in order to comply with government regulations designed to prevent any possible contamination of the fruit. At the present time, herbicides used around fruit trees must be applied prior to bloom or after the fruit has been harvested. In an experiment designed to evaluate materials for continued annual application on bearing fruit trees, the area around the base of some fourteen year old Stayman and York Imperial trees was sprayed with Dowpon, 2,4-D amine, amino triazole and simazine in various combinations in 1961 and 1962, as shown in Table 4.

Good weed control was obtained with amino triazole and simazine either used as individual materials mixed together, or in the commercial mixture of Amizine. Dowpon may be relatively effective against grasses early in the season, but in a mixed weed population broadleaved weeds will soon move in, so that the grass population is just replaced with broadleaved weeds and the area is again infested with unwanted vegetation.

Table 4 - Weed control around mature fruit trees

No.	Treatment Material	Rate AI/A	Weed Control*
1	Dowpon 2,4-D amine	8.5 lbs. 0.75	1.75
2	Dowpon Amino triazole 50	8.5 1.0	5.0
3	Amino triazole 50 Simazine 80	1.0 4.0	7.4
4	Amizine	4.5	8.5
5	Check	---	0.0

*0 - No control
10 - Complete control

The results of these experiments serve to verify earlier work on the value of amino triazole with simazine for weed control in deciduous orchards in Pennsylvania and point to the future possibilities of these and other materials in reducing maintenance costs and thereby improving profits of the fruit grower.

Literature

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CONTROL OF POPULUS SPECIES IN LOW BUSH BLUEBERRY FIELDS

J. Lincoln Pearson[1] and W. W. Smith[2]

Introduction

One of the most difficult problems facing low bush blueberry producers in New Hampshire is that of weed control. The control of woody species is especially difficult, because most chemicals tried have not been specific for them and damage to the blueberry plants becomes a problem. After the competition of other woody weeds has been eliminated, the common poplar, *Populus tremuloides*, becomes a major weed. It seeds in easily and then suckers freely from underground roots. Standard brush cutting procedures tend to force suckering, thus creating a rapid establishment of new young growth of poplar which often stops all harvest operations.

Generally, New Hampshire low bush blueberry fields are located at elevations of 1000 feet or more, and usually on very rocky terrain. The average field cannot be worked by power-drawn equipment, necessitating weed control methods designed for back-packed equipment. Hand mowing and spot stump or basal treatment with 2,4-D; 2,45-T in diesel oil are standard practices.(1)(2) These methods are expensive because of high labor costs and often they are not wholly effective. Information regarding the time of treatment, in the case of *Populus tremuloides*, has been lacking. *Populus*, with its network of roots, requires active translocation of chemicals to get an effective kill.

Objectives

1. To determine if *Populus tremuloides* can be controlled by chemical or other means without permanent damage to the low bush blueberry plants.

2. To determine at what time during the season applications of various chemicals should be made to obtain maximum control of *Populus tremuloides*.

3. To test new herbicides.

Materials Used

The herbicides used were: 2,4-D amine formulation; 2,4-D; 2,45-T low volatile esters; Fenuron, 3 phenyl 1-1, 1-dimethylurea "Dybar."(3)

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[1] Graduate Assistant in Horticultural Research, University of New Hampshire.

[2] Professor of Horticulture, University of New Hampshire. (Now deceased)

Procedures

In 1959, a field of approximately three acres supporting an eight-year-old poplar stand was selected for weed control experiments. Eight years previously, this field had produced a fair crop of blueberries without any noticeable interference of weeds. After eight years of neglect, the poplar stand had become so well established that many poplar stems had reached a diameter of two inches and harvesting of the blueberries had stopped completely.

In June of 1959, the field was laid out into twelve blocks 40 feet by 300 feet, and nine of the twelve blocks were mowed with a brush mower mounted on a farm tractor. Each block was separated from neighboring blocks by control strips of 12 feet by 300 feet. The control strips were mowed at four-week intervals during the growing seasons of 1959, 1960, and 1961. All remaining blocks were allowed to send up shoots, and by the spring of 1960 each block had a large population of *Populus tremuloides*.

2,4-D Amine:

In 1960, twelve plots of 40 feet by 40 feet were laid out to be treated with 2,4-D amine. On June 22, four plots were treated with 1000 ppm 2,4-D amine in water, four plots were treated with 2000 ppm 2,4-D amine, and four plots were left as controls. The 2,4-D amine and water application was made with a standard back-pack sprayer. All foliage was wet to the point of run-off with no regard for the underlying blueberry plants. Observations were made during 1960 and data taken during 1961.

2,4-D; 2,45-T Brush Killer:

In 1960, one of the original unmowed blocks was laid out into plots of 25 feet by 40 feet. Each plot was separated from the next plot by a 10-foot control strip. The poplar stems in each plot were counted. The size of the stem ranged from one-quarter inch to two inches. Each stem was given a basal treatment with 2,4-D; 2,45-T brush killer at a concentration of one pint of material in three gallons of diesel fuel oil. Individual plots were treated on each of the following dates: July 22, July 30, August 15, August 30, and September 15, and one was left as a control plot. Observations were made during 1960 and kill counts as well as resprouting and new shoot data were taken in 1961.

Fenuron (Dybar):

Preliminary tests with "Dybar" pellets. In 1960, unmowed test plots of large poplar (two inches in diameter) were treated with Fenuron "Dybar" in pellet form. Plots that had been mowed and had sent up new poplar shoots were also treated. Where the population of plants was sparse (less than one plant each three feet), individual plants received one teaspoon of the material. However, where the plant population was heavy, a broadcast system was used at a rate of 50 pounds of material per acre. The treatments were made in mid-July. Observations were made during 1960 and 1961.

Amounts of "Dybar". Preliminary results of the 1960 Fenuron experiments were encouraging, and new plots were laid out in 1961 to test the amount of material needed to get effective control of poplar without permanent damage to the blueberries. The plots, 25 feet by 12 feet, allowed for four replications of each treatment. Twenty-five percent Fenuron DuPont "Dybar" pellets were broadcast because the stand of poplar was continuous throughout the plots. Treatments were at the rate of 75 pounds of material per acre, 50 pounds, 25 pounds, and no treatment. The treatments were made on August 22.

Further tests with "Dybar" pellets. In June of 1962, eight plots each 12 feet by 40 feet were laid out with 12-foot-wide control strips between them. The poplar plants in these plots had grown for three years and ranged from two feet to eight feet in height. The plots were randomized, and four were treated on June 15. The method of treatment was by the grid system of one teaspoon of Fenuron (Dybar 25% pellets) per nine square feet, or approximately 50 pounds of material per acre. The remaining four plots were treated in identical fashion on July 15. Observations were made in September of the same year.

Continuously Mowed Treatment:

One block was set aside for continuous mowing; i.e., every four weeks this block was mowed with the cutter blade set at six inches above the ground. The number of original poplar plants was counted and a final count was made in 1961 previous to the last mowing. In addition, the control strips between the twelve blocks were mowed at the same time as the latter. This treatment was continued for 1960 and 1961.

Results and Discussion

2,4-D Amine:

The 2,4-D amine plots were observed during the late summer and fall of 1960 following the June treatments. Poplar in the treated plots appeared to be stunted, while the plants in the control plots continued their growth. In the spring of 1961, many plants failed to recover, and during June and July susceptibility symptoms continued in the treated plots.

The results presented in Table 1 were taken in September of 1961. There is a significant difference between the treated plots and the control plots, but no significance between the 1000 ppm amine-treated plots and those plots treated with 2000 ppm, and no significant difference between plots within treatments.

The data shows that some of the poplars remained alive, but there was a definite suppression of growth when compared with the plants in the controls.

The blueberry plants were observed carefully during the experiment. During the 1960 growing period, the blueberry plants in the treated plots showed a premature reddening of their leaves, but no leaf drop was observed. In 1961, they appeared to be growing normally when compared with other plants in the controls.

Table 1. Percent Survival of Populus tremuloides When 2,4-D Amine Foliar Spray Was Applied.

Replicates	Control[1/]	1000 ppm	2000 ppm
1	186.5	78.6	78.8
2	101.3	79.4	78.3
3	125.1	78.8	75.0
4	103.2	69.6	86.8
Mean	129.3[2/]	76.6	79.7

[1/] Controls indicating more than 100% survival are the result of new shoot growth.

[2/] Indicates a highly significant difference.

Results of this experiment indicate that when 2,4-D amine in water is applied at 1000 and 2000 ppm, it will control a high percentage of the poplar without permanent damage to the low bush blueberries. There appears to be a distinct advantage to the use of 2,4-D amine as a foliar spray when compared with low volatile esters of 2,4-D; 2,45-T as foliar sprays. The esters may cause much loss of blueberry plants.(2) In the case of poplars, an herbicide which is taken up slowly without defoliation may also be an advantage, as it appears that the total root system must be killed to prevent new shoot growth.

2,4-D; 2,45-T:

The results of the 2,4-D; 2,45-T basal spray are shown in Table 2. Observations show that when Populus tremuloides is treated in July, new shoot growth and resprouting is very light. However, when poplars were treated from late August through September, results indicate that translocation of chemicals was not complete enough to reach all of the root system and therefore new shoots continued to appear. There was also excessive resprouting evidenced in the late-August- and September-treated plots. This is further indication that when growth slows down, the chemical is not translocated and therefore application during the growing season is necessary to obtain control.

The observations made from this experiment involving large numbers of poplar indicate that poplar can be eliminated by basal spray treatments. It should, however, be noted that due to a thick stand of poplar, an excessive amount of time was required to apply the material and this cost could well be prohibitive in a commercial operation.

Table 2. Results from 2,4-D; 2,45-T Treated Plots Where Chemical was Applied as a Basal Treatment on Various Dates to *Populus tremuloides*. (Data taken one year from date of application)

Date	1	2	3	4	5	6	7	8
July 22	220	15	0	16	207	1.3	94.09	29
July 30	125	1	0	7	124	.8	99.20	8
Aug. 15	231	27	0	57	204	11.6	88.30	84
Aug. 30	263	30	4	102	229	11.4	87.07	132
Sept. 15	318	70	30	151	218	22.0	68.50	221
Control	202	0	261	59	0	0.0	0.0	320

1. Poplar stems present at beginning of experiment.
2. Stems showing one or more sprouts from ground level or above ground level.
3. Stems unaffected by basal spray (treatment misses are possible here).
4. Shoots coming up more than six inches from original stem.
5. Dead stems.
6. Percent of original stems resprouted.
7. Percent of original stems dead.
8. Number of plants alive, including shoots and resprouted clumps (clump counted as one).

Fenuron "Dybar" Pellets:

Preliminary tests with "Dybar" in 1960 were promising. The large poplars began to defoliate within six weeks, and in early September, plants were pulled to determine the extent of root injury. In many instances, browning of the roots had occurred, showing evidence of damage by the translocated chemical. Regrowth in the spring of 1961 was slight and no suckering had occurred. It was evident that blueberry plants were also susceptible to the chemical, but in spite of defoliation, the plants revived in 1961 and made enough growth to set fruit buds for the 1962 fruit crop.

The experiments in 1961 to determine the amount of "Dybar" needed to get poplar kill without blueberry plant damage were ineffective. There has been previous evidence that rainfall is an important factor with pellet application of "Dybar."(3) It appears that the lack of rainfall during the late summer and fall of 1961 was responsible for the limited absorption of the chemical by the plant. It is perhaps sufficient to say that no poplar plants died and no blueberry plants were damaged. Further observations in the spring of 1962 revealed no evident susceptibility of either poplar or blueberry to the "Dybar" treatment.

Results of the 1960 preliminary experiments indicated that further experimentation should be carried out. In 1962, plots were laid out to recheck the preliminary observations of 1960. Data on the 1962 plots will not be complete until another growing season; however, preliminary results are encouraging. As in the 1960 findings, the poplars appear to be very susceptible and observations in September indicated that nearly all of the plants were susceptible to "Dybar" injury. Blueberries were defoliated, as in the 1960 test plots, but their root systems did not appear to be affected.

It will be necessary to observe and record data on these plots in 1963 in order to determine the extent of susceptibility of both poplar and blueberry plants. Blueberry plants appear to show a degree of resistance to "Dybar." The mode of application of "Dybar" is such that it would be attractive to grower use. In complete cover stands of poplar, it could provide growers with a very effective control at a much lower cost than the basal spray method.

Continuous Mowed Experiments:

One plot 40 feet by 300 feet was mowed every four weeks during the 1959, 1960, and 1961 growing seasons. A count of poplar plants was made in 1959 and twice during each of the three successive growing seasons. The results appear in Table 3.

Table 3. Poplar Plant Population Count Taken Twice During Each of Three Growing Seasons Where Continuous Mowing Was Practiced.

July 1959	Sept. 1959	June 1960	Aug. 1960	June 1961	Aug. 1961
349	462	450	320	204	92

It has previously been stated that the mowing of New Hampshire blueberry fields holds little promise since the terrain is usually rocky and at very extreme elevations. However, for the occasional field that can be mowed, the data presented indicate that the population of poplar can be reduced considerably if the leafy part of the plant is removed. The data indicate that the first year shows an increase in poplar stand, but that the next year a decline can be expected, and during the third year it is indicated that a blueberry crop can be harvested. It is doubtful if growers would adopt this procedure as the equipment damage to the blueberry crop is extensive. However, if a field was under poplar cover, a few years of mowing might well salvage it for future years of production.

Summary

When 2,4-D amine was applied as a foliar spray in water at 1000 ppm or at 2000 ppm, the percentage of *Populus tremuloides* controlled was 76.6 and 79.7, respectively. The remaining plants were suppressed in their growth. In the control plots, there was an increase in plant population. The blueberry plants fully recovered and set fruit buds the following year.

Applications of 2,4-D; 2,45-T low volatile esters in fuel oil as a basal spray to *Populus tremuloides* appeared very effective when applied in July and early August, but much less effective in late August and September.

Fenuron (25% "Dybar" pellets) appeared to give control of large and small poplar as either a spot treatment of one teaspoon per stem or broadcast at 75 pounds of material per acre. Damage to the blueberry plants was evident, but there appeared to be normal recovery the next year. It appears that rainfall is necessary to aid in movement of the "Dybar" into the root zone. Observations on "grid method" application of "Dybar" at 50 pounds per acre will continue during 1963.

Results of three years of continuous mowing indicate that poplar can be controlled when fields are adapted for this control method.

Acknowledgement

Appreciation is extended to William Boyd of DuPont Chemical for the experimental Fenuron "Dybar" supplied and for advice on methods of application.

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Weed Control In Newly Established Strawberry Plantings 1/

G. J. Stadelbacher and J. D. Riggleman 2/

Sesone, the standard herbicide for first year strawberries has many limitations. These limitations plus the high cost of mechanical weed control necessitated a continued search for a superior herbicide.

Dormant, cold storage Pocahontas plants were planted on April 5 in Lakeland loamy sand (87.4% sand, 7.0% silt and 5.6% clay). Trifluralin, Dacthal Diphenamid, and Zytron treatments were applied immediately after planting. A second application of Trifluralin, Dacthal, and Zytron was made on July 2, whereas, the second Diphenamid application was not made until July 25. The Sesone treatment was delayed until May 14 and was followed by a second application on July 25. The delay in making the first Sesone application was due to natural limitations of the chemical and drought conditions that prevailed at time of planting. Sesone was included in the test to provide a chemical as well as cultivated check.

All plots were cultivated, hoed and side-dressed with fertilizer and Nemagon on June 5 and July 2. The cultivated check was cultivated on April 19, May 14, June 5, 19, 29, and July 2, and 25. A rating of 1 to 10 was used to indicate injury which was expressed as reduced plant vigor. One denoted death and 10 no injury of any type. Weed control was also rated on a 1 to 10 basis with 10 being nearly perfect control and 7 being lowest acceptable commercial control. Daughter plants were counted on May 28, June 15, July 5, July 26, and August 30 to measure amount and length of inhibitory effect on plant production. Effects of the various chemicals on flower initiation and yield will be recorded in the spring of 1963 by counting and weighing the fruit.

Most of the growing season was rather dry, therefore, weed control was better in all plots than would normally be expected. In a normal season the differences of weed control between Sesone which has a short residual life and the other chemicals which have a longer residual life would have been greater. The drought was beneficial as far as test purposes were concerned because it indicated the amount and extent of injury that could be expected under prolonged poor growing conditions. The first Diphenamid application caused a severe reduction in growth but this stunting effect was not evident after the second application. The reduced daughter plant population was due to the early injury. Trifluralin did not produce the pronounced reduction in growth as did Diphenamid but it did inhibit daughter plant production. This inhibition remained throughout the entire growing season. Growth reduction due to Zytron was negligible but weed control probably would not have been acceptable on a normal year. Dacthal inhibited early growth slightly but the inhibition was so slight that final daughter plant production was greater than the Sesone or cultivated check plots. Injury and weed control ratings as well as daughter plant production are given for specified periods throughout the growing season in the following table.

2/ Assistant Professor of Horticulture, Research Assistant in Horticulture, University of Maryland, College Park, Maryland

1/ Scientific Article No. 1023, Contribution No. 3416 of the Maryland

The effects of herbicides applied to newly established Pocahontas strawberries in 1962 as related to freedom from i
control of weeds and daughter plant production 1/

	lbs AI/A		Freed. from inj.2/			Control of weeds3/					Daughter plants per acre				
	1st. appli.	2nd. appli.	5/14	5/28	6/15	5/14	5/28	6/15	8/17	10/21	5/28	6/15	7/5	7/26	8
Cult. Check			10.0	10.0	10.0	10.0	10.0	7.8	6.3	8.3	1,690	23,000	47,600	115,000	16
Sesone 90S	2.7	2.7	10.0	9.5	9.8	10.0	9.8	9.8	7.8	8.3	1,520	15,200	35,100	103,400	16
Trifluralin 4/	5.6	4.0	9.8	9.0	8.8	9.5	9.8	10.0	10.0	9.8	507	5,052	16,200	67,600	9
Dacthal 75W	9.0	9.0	10.0	9.5	9.5	9.5	9.0	9.5	8.5	9.8	1,158	15,200	30,400	101,300	17
Diphenamid 80W	4.0	4.0	8.5	6.5	6.0	9.8	10.0	10.0	9.0	9.5	85	1,350	3,710	36,800	9
Zytron 3E	10.0	10.0	10.0	9.3	9.0	9.5	9.3	8.0	7.0	9.0	2,125	14,540	30,100	89,400	16

1/ Figures are averages of four replications.
2/ Rated 1-10 where 1 = death and 10 = no injury.
3/ Rated 1-10 where 7 = lowest value for acceptable commercial control and 10 = nearly perfect control.
4/ First application made as 5G at 5.6 lbs AI/A and second application as 4 E at 4 lbs AI/A.

PRELIMINARY STUDIES ON THE CONTROL OF POISON IVY UNDER BEARING APPLE TREES WITH FULL BLOOM AND POST-HARVEST APPLICATIONS OF AMITROLE

W. J. Lord[1]

Poison ivy (Rhus radican L.) is a prevalent weed in bearing apple orchards in Massachusetts. It makes luxuriant growth and, if allowed to grow unmolested, produces a solid mass 2 to 3 feet deep under the trees and, supported by aerial roots, climbs the trunk of apple trees. Its presence greatly hampers orchard operations because the poison ivy presents a health hazard.

Numerous experiments have shown that poison ivy is easily controlled with Amitrole (3-amino-1,2,4-triazole) when applied to vigorously growing poison ivy during late June and July. However, label acceptance for this herbicide limits its use in bearing apple orchards to applications prior to fruit formation or after fruit harvest. Whether sufficient poison ivy foliage is present before fruit formation to obtain adequate absorption of Amitrole for effective top and root kill of this weed in Massachusetts orchards is not known. Also, more data are needed to determine the limitations of Amitrole in regard to the timing of post-harvest applications.

Pridham (2), in New York, found that applications of amino triazole to poison ivy on September 21 while the foliage was still green caused little injury even to the small, current year's stems. He concluded that, "For effective control of poison ivy, applications appear most likely to be effective when made to foliage during spring and early summer". Meyers, et al (1), reported that Amitrole sprayed on poison ivy plants possessing only immature leaves gave relatively no control even at high rates.

The principal purpose of this study was to evaluate the effectiveness of Amitrole to control poison ivy applied when apple trees are at full bloom or shortly after they are harvested.

Methods and Materials

In September 1961, 100 square foot plots were laid out in a solid mass of poison ivy under bearing apple trees in a Massachusetts orchard. Spray treatments of Amitrole were applied at the rate of 4 pounds of 50 per cent wettable powder per acre with a 3-gallon compressed air sprayer using 1/3 to 1/2 gallon of spray solution per plot. The time of application of treatments are given in Table 1. Each treatment was replicated six times.

On August 16, 1962, the percentage control of poison ivy was ascertained by determining from 100 stems per plot the number making growth.

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Results and Discussion

The poison ivy leaves were green at the time of treatment on September 27, 1961. However, a frost preceded the October 11, 1961 treatments and an estimated 90 per cent of the poison ivy foliage was showing red or reddish-yellow fall coloration.

At full bloom of McIntosh apple trees, May 15, 1962, the buds on the poison ivy were at various stages of development with the most advanced stems having terminal leaflets starting to expand.

The percentages of poison ivy control with Amitrole are given in Table 1.

Table 1. Per cent Poison Ivy Control on August 16, 1962 Following Amitrole [a] Applications on September 27, 1961 or October 11, 1961 and/or May 15, 1962.

Time of Treatment	% Control
September 27, 1961	99.5[a*]
September 27, 1961 and May 15, 1962	99.6[a]
October 11, 1961	90.5[b]
October 11, 1961 and May 15, 1962	88.3[b]
May 15, 1962	41.0[c]
D at 5% -- 8.59	
D at 1% --10.74	

[a]Amitrole applied at the rate of 4 pounds of 50% W. P./acre.
*Differences between treatments having the same letter are not significant.

The September 27, 1961 treatment and the September 27, 1961 treatment with a second application on May 15, 1962 resulted in almost complete control of poison ivy. The poison ivy control obtained with the October 11, 1961 treatment of Amitrole was surprisingly good considering the condition of the ivy foliage at the time of treatment.

A second application of Amitrole on May 15, 1962 on plots previously treated October 11, 1961 failed to increase the poison ivy control compared to a single treatment on October 11, 1961.

Amitrole applied to poison ivy when McIntosh trees were in full bloom delayed foliation of the poison ivy stems but failed to give satisfactory control. Apparently, the foliage at the time of treatment was not sufficiently expanded to obtain adequate absorption of Amitrole for adequate control.

The amount of expanded poison ivy foliage present under apple trees may vary considerably in the same orchard. It is of interest to note that the writer observed better poison ivy control in orchards of two growers, when

Amitrole was applied at full bloom of McIntosh than obtained under conditions of this experiment.

Observations made on June 6, 1962 revealed that some stems treated in September or October had buds showing development. The terminal buds apparently were killed which induced the lateral dormant buds to grow. A few of these stems had reduced chlorotic leaves with a high apparent concentration of anthocyanin. Repeated observations of these stems showed no further bud development and many were dead by August 16, 1962.

Summary

A preliminary study was designed to test the effectiveness of Amitrole for the control of poison ivy under McIntosh apple trees when applied after harvest or at full bloom of the apple trees. Excellent control of poison ivy was obtained for 11 months following treatment with Amitrole on September 27, 1961. The percentage of control obtained with an October 11, 1961 treatment was surprisingly good considering the fact that a foliage injuring frost preceded the treatment. Treatments applied at full bloom of McIntosh trees in 1962, at which time many of the poison ivy plants had not produced foliage, gave unsatisfactory control.

Future studies will be directed toward substantiating the results reported herein, testing wetting agents as a means of increasing the effectiveness of Amitrole and testing the effectiveness of other herbicide formulations, containing Amitrole, for the control of poison ivy.

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SURVEY OF WEEDS OF NORTHEAST AND OTHER NURSERIES

A. M. S. Pridham[1] and Arthur Bing[2]

Nursery Defined

For the purpose of this survey, a nursery is considered to include the propagation and growing on of ornamental trees, shrubs, herbaceous plants and bulbs. Many of these plants remain in one bed, frame or field for 3 years or more. Soil may be cultivated frequently but plowed infrequently - certainly not yearly, hence perennial weeds are a problem. Ornamental crops of many kinds are specially susceptible to injury from herbicide applied during the early growing season at budbreak and first flush of growth. Nursery operations in digging and sale of plants, setting out new plantings and conducting other activities in pest control, creates problems in timing and in methods of applying herbicides. Production of many species and varieties in relatively small acreage and at a variety of planting distances further complicates generalizations beyond one, namely, that during fall, following thorough mechanical cultivation, the use of herbicides, or granular formulations particularly, has resulted in practical weed control with minimum damage to dormant plants and to mature crop foliage. Granular applications to freshly planted dormant ornamentals in spring is practical and comparable to "pre-emergence to crop" application familiar in vegetable and spring sown field crops, except that banding plant rows is preferred to overall treatment.

Names of Nursery Weeds

A list of weeds familiar to New York State was prepared in June 1962 and used as a basis for the present survey. Discrepancies in scientific names of weeds between the June list and listing in "Weeds," Journal of the Weed Society of America, Vol. 10, No. 3, pp. 255-274, 1962, have been changed to agree with "Weeds" listing. Vernacular or common names are not given at this time. Probably *Artemisia vulgaris* L. is the one serious weed in nurseries which nurserymen are more likely to know as artemisia than as mugwort and most likely to recognize as chrysanthemum weed, at least in the Northeastern U.S.A., i.e. locally.

The lists used in the present survey do not include weeds of lawns. Weeds are considered as plants out of place and the list included a few out of place ornamentals that become difficult to control under landscape garden conditions. This refers to *Aegopodium podagraria* L., goutweed, and to *Polygonum cuspidatum* Sieb. & Zucc., Mexican bamboo, on which the public's question is "how do you get rid of the 'darn thing'" - 100 and more letters per year. The survey added one more to this group - *Rosa multiflora* Thunb. and led to suggestions on keeping an eye open for giant foxtail, *Setaria faberii* Herrm. and for Johnsongrass, *Sorghum halepense* (L.) Pers.

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[2] Associate Professor of Floriculture, Cornell Ornamentals Research Laboratory, Farmingdale, Long Island, N. Y.

Who took part in the survey

1. Twelve nurserymen in the Northeast (Virginia to Maine, New York through Ohio) selected largely on the basis of correspondence, etc. with Drs. Arthur Bing and A. M. S. Pridham.

2. Eight research and experiment station personnel in essentially the same area as noted above.

3. Eighteen Department of Agriculture "regulatory" personnel primarily to survey regulations concerning movement of nursery stock interstate. Nursery stock grown in New York may be shipped to the midwest and be planted in a customer's garden almost anywhere in the U.S.A., including New York. Young plants move from the southern states and California to New York, etc. to be grown on for a year or more. Large production units (nurseries) now use sterilized rooting and growing media and production patterns rather than individual plants might become basic in interstate as well as "common market" international trade.

Noxious Weeds Lists

A complete list has been assembled by U.S.D.A. Agricultural Marketing Service and carries the title "State Noxious-Weed Seed Requirements Recognized in the Administration of the Federal Seed Act." The report is dated October 1960. Recent (Oct. 1962) revisions include Hawaii - Noxious Weed Seeds. Many of the Hawaii group are not listed in "Weeds" as noted on page 259 of that publication, 1962.

For present purposes noxious weeds are noted and the list includes most of the problem weeds of Northeast nurseries except *Artemisia vulgaris* L.

What was asked for

1. Cross off those weeds from the list if in your experience they are of no real concern.

2. Write in the names of other weeds that you commonly find difficult to control.

3. Star the names of perennial weeds you find difficult to control.

4. Remarks on herbicides and control procedures are welcome.

5. The present aim is to compile a working list of weeds in nurseries in Northeast U.S.A.

List of Weeds of Nurseries, Northeast U.S.A.

The original list contained names of 54 weeds. Twelve nurserymen did star many of the perennial weeds and crossed off only 14 of the 54; 4 names were added to the list. Eight experimental station personnel crossed off fewer weeds and added 4 new names. Eighteen Department of Agriculture personnel in five areas used the Northeast list as a basis for checking weeds found during inspection of nurseries in their own state; they added some 10 names.

Comments by Participants

A. From nurserymen:

"I don't know the weed. How many do know all these weeds?"

"We have used Simazine for the past two years and if soil is free of weeds when applied at 3-4 lb./acre, almost complete control is effected for up to a year's time. We apply in late fall. We have several fields that have not seen a hoe for two years while others not clean at application are still problems."

"Bindweed is particularly bad because it is so difficult to treat among planted stock."

"Our problem here is how far to go with chemical weed control in our closely planted nursery beds of deciduous and evergreen seedlings and transplants one to three years old."

B. From Experiment Station personnel: The notations made were namely on additional weeds and control measures.

C. From regulatory personnel:

"Our present nursery inspection law covers only insects and plant diseases, and I doubt very much if it contains legal authority to regulate movement of weeds either within or from outside the state. I would hope that this matter could be handled without the red tape of quarantine and regulatory measures."

"I have added multiflora rose with the intent of putting it in your 'darn thing' classification. In this office we feel that this is a growing problem and eventually there is going to be considerable interest in its control. Johnson grass might well have been added to the list since it is spreading northward and poses a potential problem in weed control in nurseries and elsewhere. I have inserted in your list one which is relatively new, giant foxtail. I might say in passing that our inspectors are trained to identify weeds and other noxious plants which they may find in our nurseries or elsewhere."

"Nursery stock entering Nevada is examined for content of the weeds on the Nevada noxious weed list and for those governed by Federal regulation."

"We have a specific law governing Convolvulus arvensis and it would be a violation to transport bindweed or parts capable of propagation in nursery stock."

"It is our policy not to furnish shipping certificates for transportation of nursery stock (except sold bare rooted) where field inspections have found noxious weeds do occur."

"We have checked the nursery weed list and return it marked (1) weeds that are prohibited weed seeds under our seed law, (2) represents primarily noxious weeds. Those checked are weeds our nursery inspectors find in nurseries. Those starred are ones our inspectors feel are difficult to control."

Additional Weeds of Importance to Nurserymen

Aegopodium podagaria L.	unwanted
Cuscuta sp.	noxious
Cynodon dactylon L.	" spreading northward
Cyperus rotundus L.	"
Lonicera japonica Thunb.	escaped or naturalized
Polygonum cuspidatum Sieb. & Zucc.	if unwanted, the darn thing is difficult
Rosa multiflora Thunb.	naturalizing - unwanted
Rubus fruticosa sp.	noxious - West Coast - transportable
Senecio jacobaea L.	" " "
Sorghum halepense (L.) Pers.	noxious - spreading
Tribulus terrestris L.	" - West Coast

Weeds of Northeast Nurseries

Key: 1 weed noted by nurserymen
2 weed noted by experiment station workers
3 weed noted by Department of Agriculture personnel
N noxious weed - weed seed, etc.

1	2	3	N	Agropyron repens (L.) Beauv.
1	2	3	N	Allium canadense L.
1	2	3	N	" vineale L.
1		3		Amaranthus retroflexus L.
1				Ambrosia artemisiifolia L.
1	2			Anthemis cotula L.
1	2	3		Artemisia vulgaris L.
		3	N	Avena fatua L.
	2		N	Barbarea vulgaris R. Br.
	2	3	N	Brassica kaber (DC.) L. C. Wheeler var. pinnatifida (Stokes) L. C. Wheeler
1	2	3		Cerastium vulgatum L.
	2			Chenopodium album L.
		3	N	Chrysanthemum leucanthemum L.
1	2	3	N	Cirsium arvense (L.) Scop.
1	2	3	N	Convolvulus arvensis L.
1	2	3	N	" sepium L.
1	2		N	Cyperus esculentus L.
1	2		N	Digitaria sanguinalis (L.) Scop.
1		3		Echinochloa crusgalli (L.) Beauv.
	2	3		Equisetum arvense L.
1				Erigeron canadensis L.
1	2	3	N	Euphorbia esula L.
		3		Galinsoga ciliata (Raf.) Blake
1			N	Galium mollugo L.
1	2			Glechoma hederacea L.
		3	N	Ipomea sp.
1	2			Lactuca scariola L.
1				Lamium amplexicaule L.
1		3	N	Lepidium campestre (L.) R.Br.
	2			Matricaria matricarioides (Less.) Porter
1				Oxalis stricta L.
1	2			Panicum capillare L.
1		3	N	Plantago lanceolata L.
1		3		Poa annua L.
1		3		Polygonum aviculare L.
1		3		Portulaca oleracea L.
	2	3		Rhus radicans L.
1	2	3	N	Rumex acetosella L.
1		3	N	" crispus L.
	2			Senecio vulgaris L.
1		3		Setaria viridis (L.) Beauv.

Weeds of Northeast Nurseries (continued)

1 2 3 N	*Solanum carolinense* L.	2 3	*Taraxacum officinale* Weber
2 3 N	*Sonchus arvensis* L.	3 N	*Thlaspi arvensis* L.
2 N	" *oleraceus* L.	1	*Veronica filiformis* L.
1 3	*Stellaria media* (L.) Cyrill	2	" *peregrina* L.

Summary

1. Nurserymen and others need to recognize weeds by their correct name -- scientific name

2. Forty-nine weeds are on the present list compiled from 38 returns. Twenty-three of the forty-nine are noxious weeds

Ten weeds noted most frequently include:	total
1. *Agropyron repens* (L.) Beauv.	22
2. *Allium canadense* L.	10
3. *Artemisia vulgaris* L.	16
4. *Cirsium arvense* (L.) Scop.	13
5. *Convolvulus arvensis* L.	22
6. " *sepium* L.	14
7. *Cyperus esculentus* L.	11
8. *Digitaria sanguinalis* (L.) Scop.	7
9. *Rumex acetosella* L.	7
10. " *crispus* L.	7

Of the ten weeds, nine are perennials and one an annual. Four other annuals include two fall annuals, *Poa annua* L. and *Stellaria media* (L.) Cyrill; two summer annuals, *Panicum capillare* L. and *Portulaca oleracea* L.

3. Purposeful planting of these and other troublesome weeds for screening and field test purposes among specific nursery crops could yield significant information.

4. Since nurserymen report success with fall application of herbicides to clean cultivated soil as a practical procedure, further exploration of the effectiveness and limits of preparing and protecting clean soil are likely leads toward effective control programs, particularly when perennial weeds are of major importance.

5. Several serious southern weeds are likely to become more widespread and control measures need to be developed in advance for giant foxtail, *Setaria faberii* Herrm., Bermudagrass, *Cynodon dactylon* L., and Johnsongrass, *Sorghum halepense* (L.) Pers.

The authors wish to acknowledge the cooperation of those who participated by furnishing information as well as checking the list of weeds. Since returns are still being received, a final report will be made at a later date.

FIELD TRIALS FOR CONTROL OF *ARTEMISIA VULGARIS* L.

Arthur Bing[1] and A. M. S. Pridham[2]

Artemisia vulgaris L. is commonly called chrysanthemum weed because its foliage closely resembles that of the garden chrysanthemum. Muenscher (1) describes *Artemisia vulgaris* L. mugwort, or wormwood as a "Perennial; reproducing by seeds and short rootstalks. Widespread across the northern and western United States. Introduced eastward:" This weed has become very troublesome in nursery plantings in the northeast and is easily spread by the movement of short pieces of stolon by cultivation or by moving plants with a ball of soil. This weed has become widespread and is difficult to control.

A few nurseries have kept *Artemisia vulgaris* under control by frequent cultivation and hand weeding in dry weather. Most nurseries find it difficult or impossible to control *Artemisia* by mechanical means. Chemical control methods for *Artemisia* have been under investigation for many years and have been reported by Pridham (2). The most suitable method for controlling this weed has been by repeated directional spraying with 3-amino-1,2,4 triazole, amitrole of young *Artemisia* shoots that were growing under and between nursery plants. Where there is no crop in the soil the authors have found a sodium-N-methyldithiocarbamate, SMDC drench to give good control when used for spot treatment.

Some preliminary laboratory studies on the effect of various types of herbicides on the growth of *Artemisia vulgaris* were carried out at Ithaca and on the basis of these unpublished results, it was decided to make some field trials in the New York metropolitan area using the more promising chemicals. Duplicate field trials were made at Orchidwood Greenhouses, Pelham, New York and Hicks Nursery, Westbury, New York. The treatments on young growth in crop free but heavily *Artemisia* infested areas were made in mid May 1962 and are listed in table I. Treatments that gave a fair degree of control were repeated in the fall of 1962.

Some of the materials showed definite promise others were not effective. Granular ethyl N,N-di-n-propylthiolcarbamate, EPTC rototilled into the dry soil gave excellent control at Hicks Nursery when a rotovator attached to a Ford tractor was used for soil incorporation. At Orchidwood, control with EPTC was poor, probably due to large stones that prevented the small garden rototiller from doing a good job.

In both locations 2-(2,4,5-trichlorophenoxy) propionic acid, silvex gave a very good control at 4 and 8 lbs per acre, and fair control at 2 lbs per acre. A mixture of silvex and the sodium salt of 2,2 dichloroproprionic acid, dalapon gave good control at both locations. An application of 2-methoxy-4-6-bis (isopropylamino)-S-triazine, prometone burned down the tops but did not do

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much to the underground rootstalks and there was heavy regrowth later in the season. Granular 3,amino-2,5-dichlorobenzoic acid, amiben gave no control. Granular 2,3,6-trichlorophenylacetic acid, fenac and later spray applications caused severe distortion of foliage but no apparent control during the current season. A spray of 3-amino-1,2,4-triazole, amitrole especially at 4 lbs per acre caused bleaching of weed foliage and produced fair to very good control but there was some later regrowth. Rototilling calcium cyanamide into the soil after treatment did not improve the effectiveness of amitrole. A foliage spray of 3-(3,4-dichlorophenyl)-1,1-dimethylurea, diuron only slightly stunted the chrysanthemum weed at the 4 lb rate. The mixture of amitrole and 2-chloro-4,6-bis (ethylamino)-S-triazine, simazine gave fair control. The mixture of amitrole and silvex was effective when used as a foliage spray.

In summary, the results show rototilling in EPTC or spraying with silvex to be very promising for chrysanthemum weed control.

References

1. Muenschler, W. C. 1955. Weeds. The MacMillan Co., New York. 560 p.

2. Pridham, A. M. S. 1940-1962. New York State Nursery Notes

Table I. Materials used for chrysanthemum weed control.

Chemical	Rate	Method of Application
	lb per A ai	
amiben 2 lbs ai per gal	4, 8	granular
amitrole 50%	4,8	foliage spray
amitrole 50% cyanamide 47%	8 250,500,1000	spray incorporated granular
amitrole 50% silvex 3/4 lb ae per gal	4 4	foliage spray
amitrole 15% by wt[3] simazine 45% by wt	5, 10	foliage spray
diuron 80% WP	4	foliage spray
EPTC 5% gran	10, 15, 10	soil incorporated granules
fenac 10% gran on clay $1\frac{1}{2}$ lb ae per gal	4, 8 4, 8	granular foliage spray
prometone 25% E	20	foliage spray
silvex 3/4 lb ae per gal	2, 4, 8	foliage spray
silvex $\frac{1}{2}$ lb per gal[4] dalapon 4 lb per gal	$1\frac{1}{2}$ 12	foliage spray

3 Amchem's Amazine

4 Dow's Garlon

PRELIMINARY RESULTS WITH CASORON FOR WEED CONTROL IN WOODY ORNAMENTALS

A. M. S. Pridham[1]

Screening Techniques

Preliminary or screen testing of herbicides for use in control of weeds in nurseries usually begins with treatment of stolons of *Artemisia vulgaris* and of *Agropyron repens*; also with germination of crabgrass seed, *Digitaria sanguinalis* on media containing herbicides of known concentration. These tests are conducted under greenhouse and laboratory conditions. Other tests are made to determine crop response and are followed by field tests on 100 sq. ft. plots and later in replicated plots in comparison with herbicides of established performance levels under nursery conditions. During 1962, Casoron was among the unfamiliar nursery herbicides tested.

Stolon Treatment

In February 1962 4" stolons of *Artemisia vulgaris* and *Agropyron repens* were soaked 24 hours in solutions of herbicides at a range of 3 or more concentrations. The stolons were then planted in 5x7x2" Market Pacs (plastic) in a 50% mixture of peat moss and perlome. The cultures were labeled and placed under a water regime of intermittent misting 10 seconds in 5 minutes. Table 1 presents the response of specific herbicides at rates used, the general performance of 90% to 100% control as complete, 75% partial and less than 75% as not effective over the range of dosage levels tested.

Table 1. Screening herbicides for artemisia and quackgrass control.

Degree of control	Artemisia	Quackgrass
Complete Control	Amiben 4+	Amiben 8+
	Amizine 5	Amizine 5+
	Amino triazole 10	Amino triazole 10
	Casoron 10+	----------
	Dalapon 16+	Dalapon 16+
	Eptam 20+	Eptam 20
	Fenac 4	Fenac 8
	---------	Simazine 16
	2,4,5-TP 20 Silvex	2,4,5-TP 20 Silvex
Partial - 75% Control	Atrazine 5+	Atrazine 5+
	Dacthal 32	Casoron 20+
Ineffective Control	Diphenamid 30	Diphenamid 30
	Herbisan 20	Herbisan 20
	Prometone 15	Prometone 15
	Solan 32	Solan 32

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Laboratory tests in the fall of 1962, using 4" stolons of Agropyron repens indicate retardation of budbreak where perlite substrate was saturated with Casoron w.p. 10 ppm active ingredient. This was also true of C.I.P.C. used at 10 ppm. Stolon sections soaked in Casoron w.p. 10 ppm, 100 ppm, or 1000 ppm failed to show budbreak or chlorophyll formation in 7 days. This was true also of stolons soaked in amino triazole and in Dalapon as compared to untreated in which budbreak and green color developed. Stolons treated with 2,4,5-TP or with Fenac 1000 ppm also failed to develop chlorophyll promptly but this was not true of simazine at 1000 ppm dosage level.

Control of Established Weeds in Roses - Single Plots

During July, five herbicides (Amizine 2½ lbs. A/A, Casoron 5 to 20 lbs. A/A, Diuron 2 lbs. A/A, Simazine 5 lbs. A/A, and 2,4,5-TP Silvex 10 lbs. A/A) were used in granular form or for directional spraying for garden roses. Plots of 100 sq. ft. were treated to reduce annual summer grasses, yellow rocket and miscellaneous weeds, including quackgrass. The plots were irrigated periodically over night with Rain Bird equipment covering 30' radius. Irrigation followed herbicide application within one week. Weed kill in Amizine and in Casoron treated plots was estimated to be 75% and better, July-November. Growth of roses proceeded normally without discoloration or necrosis. Liquid formulations of Casoron were not effective. Granular formulations were effective.

Control of Weeds in Nursery Stock - Replicated Plots

In late July grass and broadleaf weeds were cut with a rotary mower from a 230x40' patch of nursery stock (Thuja, Taxus, Tsuga and Ligustrum ovalifolium). Regrowth of Agropyron repens, Sonchus arvensis, Trifolium pratense, Ambrosia artemisiifolia took place and germination of Avena fatua and Poa annua began.

Plots 10x40' were laid out across the rows of nursery stock and weed populations which tended to follow the rows of stock. Casoron was used in duplicate plots in both liquid and granular formulation at 2½, 5, 10 and 20 lbs. active per acre.

In addition to Casoron, Amizine 2½ lb. A/A was used as directional spray. Diuron granular was used at 1 and at 2 lbs. active, also Diuron w.p. spray at 2 lbs. A/A granular; Atrazine granular 1½ lbs. A/A; Simazine granular 3 lbs. A/A; C.I.P.C. granular 8 lbs. A/A. By November 1, annual bluegrass, Poa annua, was killed in response to treatment with Amizine, Diuron 2 lbs. A/A, C.I.P.C. and with only granular formulations of Casoron but at 2½, 5, and 10 lbs. active ingredient. Quackgrass, Agropyron repens, was rated as reduced by Amizine, Atrazine, and Simazine as well as by Casoron granular at 5 and 10 lbs. A/A level.

Casoron liquid and Diuron granular did not modify Agropyron repens September-November 15. Avena fatua growth was discolored and retarded as per quackgrass. Crop response has been negative for the herbicides and rates used.

Reduction in Germination of

2 Year Old Crabgrass Seed - Large Crabgrass, *Digitaria sanguinalis*

Casoron was studied by sowing seed from a salt shaker on wet perlite in specimen dishes or on Kimpac as a substrate. In either case, herbicide solution was used to moisten the substrate, hence the seed, and to maintain contact during germination in constant light, 3 fc at 85°F.

Casoron (2,6-dichlorobenzonitrite) solutions of as low as 10 ppm to 1/10 ppm eliminated crabgrass germination. Fenac (2,3,6-trichlorophenylacetic acid, sodium salt) also eliminated germination of seed. C.I.P.C. was effective at 10 ppm and higher; so, too, 2,4-DP. Amino triazole, 2,4-D, I.B.A., N.A.A. were effective at 100 ppm and at 1000 ppm bathing solutions for crabgrass seed. Amiben 1000 ppm, Niagara 2995, Methyl N-(3,4-dichlorophenyl) carbamate 1000 ppm, Zytron O-(2,4-dichlorophenyl)O-methylisopropylphosphoroamidothioate, also indoleproprionic acid and naphthaleneacetic acid 1000 ppm eliminated germination.

Standard Nursery Practice Test

Fall application of herbicides to weed free soil (cultivation) depends upon adequate herbicide coming in contact with annual bluegrass, *Poa annua*, seed and that of other weeds under moist soil conditions of late autumn. In 1962 granular D.N.B.P. 4 lbs. A/A, Diuron 2 lbs. A/A, C.I.P.C. 8 lbs. A/A, and Caroson 5 lbs. A/A all as granular formulations were applied by Scott spreader with 3' diameter wheels. One month after treatment, Casoron treated plant rows are third to D.N.B.P. and Diuron but more complete in kill of *Poa annua* than C.I.P.C.

Summary

Granular Casoron used in established woody nursery stock appears to have possibilities as a useful addition to presently recommended herbicides.

Reference

New York Nursery Notes. October 1962.

Chemical Control of Weeds in Deciduous Nursery Plantings

J. F. Ahrens[1/]

Although we now have safe and effective herbicides for a number of nursery plants, especially evergreens and shade trees, there remains a wide variety of plants for which we can suggest no treatment. In the experiment described we compared several herbicides in plantings of eight deciduous shrubs.

Materials and Methods

The experiment was conducted in a block of deciduous liners growing in a Windsor loamy fine sand at a commercial nursery in Bloomfield, Connecticut. The plants were rooted in 1961 and planted in the field on May 15, 1962. The plants and approximate sizes at the time of herbicide application on July 20 were as follows:

a) Prunus glandulosa (Flowering pink almond), 18" to 24"
b) Weigelia vaniceki (Diervilla), 12" to 18"
c) Philadelphus virginalis (mock orange), 12" to 18"
d) Kolkwitzia amabilis (Beauty bush), 6" to 12"
e) Spirea vanhouttei, 6" to 12"
f) Deutzia gracilis, 10" to 12"
g) Forsythia intermedia var. Lynnwood Gold, 6" to 8"
h) Salix niobi (willow), 18" to 24"

Plots consisted of single rows 10 to 15 feet long in the closely planted Salix and Forsythia liners and 8 to 10 plants long in the other species. The treatments were arranged in randomized blocks and were replicated two or three times in each of the eight species.

The following herbicides were compared in this experiment:

a) simazine [2-chloro-4,6-bis(ethylamino)-s-triazine]
b) DCPA or dacthal [dimethyl 2,3,5,6 tetrachloroterephthalate]
c) dichlobenil or casoron [2,6-dichlorobenzonitrile]
d) diphenamid [N,N-dimethyl-2,2-diphenylacetamide]
e) trifluralin [2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine]
f) neburon [1-n-butyl-3- (3,4-dichlorophenyl)-methyl urea]

The herbicides were applied as sprays in 70 gallons of solution per acre using a knapsack sprayer with a 3-foot boom. The sprays were applied directly over the nursery plants, without regard to foliage. Before applying the treatments the rows were hoed and cultivated to remove all weed growth. The soil was very dry at treatment on July 20 but it started raining the next day and 0.8 inches of rain fell within the week after treatment. Injury evaluations

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were made a month later and in the fall.

Results and Discussion

As shown in Table 1, simazine at 3 or 4.5 lbs. per acre injured every species except Kolkwitzia. Simazine injury consisted of slight chlorosis on the basal leaves of Forsythia and Prunus, slight-to-moderate chlorosis or necrosis on Weigelia, Spirea, and Deutzia, and severe necrosis and leaf drop on Philadelphus and Salix. Simazine at 3 lbs. per acre did not injure Prunus and did not affect growth of Forsythia, Deutzia, and Weigelia despite the injury observed. Because of the long residual effects of simazine, however, injury and growth effects must be observed further in the spring.

Neburon at 4 or 6 lbs. per acre was less injurious than simazine to Salix, Weigelia, and Spirea but was equally injurious to Philadelphus, Forsythia, Prunus, and Deutzia. Except on Philadelphus, the chlorosis caused by neburon did not seem to affect growth.

Trifluralin at 3 or 4 lbs. per acre produced epinasty and leaf distortion on Forsythia with a resulting decrease in growth. Trifluralin also caused slight necrosis on Weigelia and discoloration on Philadelphus and Spirea, but did not affect growth of these species. At the rates tested, trifluralin did not injure Kolkwitzia, Deutzia, Salix, or Prunus.

Dichlobenil at 4 or 6 lbs. per acre, DCPA at 10 or 15 lbs. per acre, and diphenamid at 5 lbs. per acre caused no visual symptoms of injury or growth depression on any of the eight species. However, diphenamid at 7.5 lbs. per acre caused slight discoloration in Forsythia and Prunus and discoloration and growth depression in Philadelphus.

It is possible that granular formulations of some of these herbicides would have caused less injury to the shrubs, but this remains to be determined. In the case of neburon, however, granular formulations, although less injurious to nursery stock, have seldom controlled weeds satisfactorily.

Unfortunately few weeds invaded the plot area in this experiment and good evaluations of annual weeds could not be made. All of the herbicides controlled the sparse population of lambsquarter (Chenopodium album) and chickweed (Stellaria media) that invaded the plots in August and September. Fleabane (Erigeron spp.) invaded some of the plot areas in the fall. Only neburon and simazine controlled fleabane to a high degree, but some control was evident in plots of diphenamid and dichlobenil.

Other nursery experiments were conducted in 1962 in which some of the above-mentioned herbicides were included. The weed control evaluations of these tests are shown in Table 2. In both experiments the treatments were applied in early June on a sandy loam soil. The weeds in Experiment A were

Table 1. Effects of Herbicides on Deciduous Liners Planted 5/15/62 and Treated 7/20/62[1/]

Herbicide and formulation	Rate a.i. lbs/A	Forsythia	Salix	Prunus	Weigelia	Philadelphus	Kolkwitzia	Spirea	Deutzia
none		0	0	0	0	0	0	0	0
simazine, w.p.	3	SD	MB,G	0	SB	MB,G	0	MD,G	MD
	4.5	SD	Sev.B,G	SD	MB,G	Sev.B,G	0	MD,G	MD,[illegible]
diphenamid,w.p.	5	0	0	0	0	0	0	0	0
	7.5	SD	0	SD	0	SD,G	0	0	0
DCPA, w.p.	10	0	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	0
dichlobenil,w.p.	4	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0
neburon, w.p.	4	SD	SD	SD	SD	MD	0	0	MD
	6	SD	SD	SD	SD	MD,G	0	0	MD
trifluralin,e.c.	3	SG	0	0	SD,B	SD	0	SD	0
	4	MG	0	0	SD,B	-	-	-	-

1/ 0 - none, S - slight, M - moderate, Sev. - severe, D - discoloration of some leaves, B - burning of foliage (necrosis), G - growth depression.

Table 2. Effects of Herbicides on Residual Control of Weeds in 1962

Herbicide and formulation	Rate a.i. lbs./A	Weed Control Ratings 1/			
		7/4	8/7	9/5	11/10
Experiment A, herbicides applied 6/11					
none	0	0	0	0	-
simazine, g.	3	9.4	9.2	8.9	-
diphenamid, g.	4	8.8	9.3	8.4	-
	8	8.8	9.4	8.8	-
DCPA, g.	12	5.5	7.1	5.3	-
Experiment B, herbicides applied 6/15					
none	0	2.0	0.6	-	0.8
simazine, w.p.	4	9.5	8.8	-	10
diphenamid, w.p.	4	8.4	8.0	-	1.6
trifluralin, e.c.	4	8.8	9.3	-	0

1/ 0 - no control, 10-100 per cent control predominantly pigweed (*Amaranthus* spp.), crabgrass (*Digitaria* spp.), and stinkgrass (*Eragrostis cilianensis*). In Experiment B, carpetweed (*Mollugo verticillata*), crabgrass and stinkgrass were predominant during the summer and fleabane was present in the late fall. The weeds were removed by hoeing after each evaluation.

As shown in Table 2, diphenamid and trifluralin compared favorably with simazine in controlling weeds during the summer. Neither one controlled fleabane in the fall following application in June, however. DCPA controlled the grasses well but not pigweed, a common weed in many nurseries.

DCPA, diphenamid, trifluralin, and dichlobenil, all are worthy of further testing in deciduous shrubs and in other plants known to be susceptible to injury from simazine. It seems wise to continue these comparisons with simazine as a standard since the use of this herbicide is rapidly becoming a part of nursery production.

Summary

Simazine, neburon, diphenamid, trifluralin, DCPA, and dichlobenil were sprayed over the rows of eight recently planted deciduous species.

All of the herbicides tested appear to be safe for use in *Kolkwitzia amabilis* but only DCPA at 10 or 15 lbs. per acre, dichlobenil at 4 or 6 lbs. per acre and diphenamid at 4 lbs. per acre failed to injure any of the species tested.

Simazine at 3 lbs. per acre injured *Salix niobi*, *Forsythia intermedia*, *Weigelia vaniceki*, *Philadelphus virginalis*, *Spirea vanhouttei*, and *Deutzia gracilis*, but not *Prunus glandulosa* or *Kolkwitzia*.

Neburon at 4 or 6 lbs. per acre discolored all of the above species except *Kolkwitzia* and *Spirea*.

Trifluralin at 3 or 4 lbs. per acre injured *Forsythia*, *Weigelia*, *Philadelphus*, and *Spirea*, but none of the other species.

Diphenamid and trifluralin compared favorably with simazine in the control of annual weeds and grasses but DCPA did not control pigweed.

Pre-Plant Weed Control in Annual Flowers

Chiko Haramaki[1]

The use of pre-plant herbicides have given promising results in plantings of petunias and marigolds during the past 3 years. The tests were continued in 1962 using three of the more promising chemicals. The number of plant species tested were increased to nineteen.

Material and Methods

The soil, which was a Hagerstown silt loam, was roto-tilled several times prior to the application of the herbicides. The plots were 500 square feet and each treatment was replicated six times. Three herbicides treatments and a control were used in each replication. The herbicides and concentrations used were: EPTC at 10 pounds per acre, Stauffer R-1607 at 10 pounds per acre, and Casoron at 2 pounds per acre. The plants tested were: Ageratum - Blue Mink, Celosia - Toreador, Celosia - Firefeather, Dianthus - Snowball, Marigold - Spry, Marigold - Sunkist, Nasturtium - Golden Globe, Pansy - Coronation Gold, Petunia - Comanche, Petunia - Paleface, Phlox - Glamour, Portulaca - Double-Flowered Pink, Sweet Alyssum - Carpet of Snow, Salvia - Blaze of Fire, Snapdragon - Bronze Rocket, Dwarf Snapdragon - Golden Queen, Verbena - Floradale Beauty, Zinnia - Trailblazer, and Lilliput Zinnia - Rose Gem.

The herbicides were applied on June 18, 1962. The air temperature was in the low 90's and the soil temperature 2 inches below the soil surface was in the high 80's. The chemicals were sprayed on the soil and immediately incorporated into the top 2-3 inches with the use of a rototiller. The area was irrigated with ½ inch of water after rototilling.

On June 28, 1962, which was 10 days after soil treatment the annuals were transplanted in all the plots. Ten plants of each species were planted in each of the 24 plots. The area was irrigated with ½ inch of water after transplanting. The plots were periodically watered thereafter.

Results and Discussion

The plots were checked for weed prevalence on October 2, 1962, which was approximately fifteen weeks after soil treatment. The data on weed prevalence is summarized in Table 1. EPTC and R-1607 at 10 pounds per acre gave excellent weed control. Of the few weeds found in these plots the predominant weed was wild carrot. Casoron at 2 pounds per acre gave fair weed control with yellow foxtail as the most prevalent weed. The most prevalent weeds in the control plots were: tumble pigweed, lambsquarter, and yellow foxtail.

The annual flowers were examined on July 24, 1962, and September 20, 1962, which were approximately 4 and 12 weeks after transplanting. The data on plant injury are summarized in Tables 2 and 3. In almost every case the plants exhibited some injury when examined four weeks after

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Table 1. Effect of pre-plant herbicides on weed prevalence, fifteen weeks after treatment, 1962.

Herbicide	Weed Prevalence*	Weeds Present in Decreasing Frequency
0	10.0	tumble pigweed, lambsquarter, yellow foxtail, yellow rocket, large crabgrass, tomato, buckhorn plantain, common ragweed, Canada thistle, smooth pigweed, wild carrot, common milkweed, Pennsylvania smartweed.
EPTC 10#/A	1.0	wild carrot, yellow rocket, buckhorn plantain, lambsquarter, tumble pigweed, Canada thistle, tomato, purslane, common ragweed.
R-1607 10#/A	1.0	wild carrot common ragweed, yellow rocket, yellow foxtail, Canada thistle, tumble pigweed, Pennsylvania smartweed.
Casoron 2#/A	2.8	yellow foxtail tumble pigweed, yellow rocket, large crabgrass, purslane, tomato

*Weed Prevalence Scale:

1 = Less than 10% weed coverage.
10 = 100% coverage by weeds.

Table 2. Effect of EPTC and R-1607 on annuals which were transplanted ten days after soil treatment, 1962.

Plant	Time After Transplanting			
	EPTC, 10#/A		R-1607, 10#/A	
	4 weeks	12 weeks	4 weeks	12 weeks
Ageratum - Blue Mink	1.7	0.0	1.5	0.0
Celosia - Toreador	0.6	0.0	0.7	0.0
Celosia - Firefeather	0.7	0.0	0.8	0.0
Dianthus - Snowball	1.1	0.0	1.1	0.0
Marigold - Spry	1.0	0.0	1.1	0.0
Marigold - Sunkist	1.6	0.2	1.8	0.2
Nasturtium - Golden Globe	2.1	1.0	2.3	0.8
Pansy - Coronation Gold	1.9	1.0	1.9	0.8
Petunia - Comanche	1.1	0.0	1.3	0.0
Petunia - Paleface	1.0	0.0	1.5	0.0
Phlox - Glamour	2.5	2.0	2.8	2.3
Portulaca - Double-flowered Pink	0.6	0.0	0.8	0.2
Sweet Alyssum - Carpet of Snow	1.7	0.3	1.3	0.0
Salvia - Blaze of Fire	3.5	4.7	3.4	4.3
Snapdragon - Bronze Rocket	1.8	0.2	1.8	0.5
Snapdragon, dwarf - Golden Queen	1.7	2.0	2.3	1.8
Verbena - Floradale Beauty	1.8	1.2	1.9	1.2
Zinnia - Trailblazer	1.8	0.2	1.6	0.0
Zinnia, Lilliput - Rose Gem	1.2	0.2	1.2	0.2

Plant Injury Scale:

0 - No injury
1 - Very slight distortion, necrosis or stunting.
2 - Slight distortion, necrosis or stunting.
3 - Moderate distortion, necrosis or stunting.
4 - Severe distortion, necrosis or stunting.
5 - Dead.

Table 3. Effect of Casoron on annuals which were transplanted ten days after soil treatments, 1962.

Plant	Time After Transplanting			
	Casoron, 2#/A		Control	
	4 weeks	12 weeks	4 weeks	12 weeks
Ageratum - Blue Mink	1.7	0.0	1.4	0.3
Celosia - Toreador	1.2	0.3	0.3	0.0
Celosia - Firefeather	1.0	0.3	0.6	0.0
Dianthus - Snowball	1.3	0.0	1.1	0.2
Marigold - Spry	1.5	0.0	0.9	1.2
Marigold - Sunkist	1.9	0.2	1.4	0.8
Nasturtium - Golden Globe	1.9	0.3	1.7	1.0
Pansy - Coronation Gold	1.9	0.5	1.7	1.2
Petunia - Comanche	1.3	0.2	0.7	1.2
Petunia - Paleface	1.6	0.0	1.2	0.5
Phlox - Glamour	2.0	1.7	1.4	1.7
Portulaca - Double-flowered Pink	0.7	0.3	0.3	0.2
Sweet Alyssum - Carpet of Snow	1.5	0.0	0.9	0.2
Salvia - Blaze of Fire	1.7	0.2	1.6	0.3
Snapdragon - Bronze Rocket	0.9	0.7	0.3	0.2
Snapdragon, dwarf - Golden Queen	1.7	1.0	0.5	0.3
Verbena - Floradale Beauty	1.8	1.5	1.4	0.7
Zinnia - Trailblazer	2.0	0.2	1.4	0.0
Zinnia, Lilliput - Rose Gem	1.7	0.2	1.1	0.2

Plant Injury Scale:

0 - No injury.
5 - Dead.

transplanting. This was due primarily to insufficient water either by rainfall or by overhead irrigation and in some cases to herbicidal activity of the chemicals. Twelve weeks after transplanting most of the plants had recovered and showed little or no injury, except some which were injured by the herbicides.

The tolerances of the annual flowers to EPTC and R-1607 were approximately the same for all plants. The phlox plants had distorted buds after 4 weeks and after 12 weeks the distortion had disappeared but some of the phlox exhibited poor growth. The leaves of the salvia plants turned black at the edges and in the interveinal areas then defoliated. The buds and stem tips also turned black which eventually resulted in death of the plant. The root growth was poor on these plants. The snapdragon showed severe distortion of the axillary buds as they sprouted. After twelve weeks the distortion had disappeared with the resulting shoots having normal leaves and flowers on vigorous stems. The dwarf snapdragons had almost all of their apical buds killed, but after 12 weeks the axillary buds had developed into normal stems with normal flowers and leaves. The other plant species tested showed little or no injury to EPTC and R-1607.

The annual flowers in the Casoron treated plots exhibited little or no injury after 12 weeks except for the phlox which exhibited some injury in all treated and non-treated plots.

Summary

Casoron at 2 pounds per acre, EPTC and R-1607 at 10 pounds per acre were applied 10 days prior to transplanting of 19 species of annual flowers.

Excellent weed control was observed in the EPTC and R-1607 treated plots and fair weed control in the Casoron treated plots.

The plant species treated showed little or no injury to the herbicides used, except for phlox, salvia, snapdragon and dwarf snapdragon which were injured by EPTC and R-1607.

RESIDUAL EFFECT OF HERBICIDES ON GROWTH OF ORNAMENTALS

A. M. S. Pridham[1]

Both nurserymen and research personnel have observed modification of crop growth following application of herbicides at reasonable rates. Release from weed competition stimulates growth and improves quality but on occasion growth may be retarded or discolored as compared to untreated controls. Residual control of weeds over several months to a year also contributes to the question of how long do herbicides remain at levels high enough to influence growth. This is not a new problem and Crafts and others have investigated the subject for older herbicides such as chlorates and arsenicals as used in California during the 1940's and earlier (1).

Recently triazines have been widely used in eastern nurseries and cases of modified growth and foliage color are common knowledge. In nursery crops, privet, lilac, euonymus, Kurume azaleas, and other shallow rooted plants are recognized as "intolerant." The writer has used *Ligustrum ovalifolium* and *Euonymus fortunei* as indicator plants in triazine plots where *Agropyron repens* control was attempted. Red kidney beans and oats have also been used as indicator plants. Irregular stand, slow growth, etiolation or yellowing is common response in oats, while in seedling leaves of beans rapid graying of leaf margins, wilting and necrosis are typical of simazine, etc. injury. Older leaves follow a similar pattern if roots meet simazine during growth.

Present studies were begun to determine the relationship, if any, between the amount of atrazine present and the intensity of discoloration in *Euonymus fortunei*. Plastic trays 7"x5" were used as containers. Atrazine wettable powder was applied at rates from 0 to 10 lbs. active ingredient per acre, using 7"x5" in relation to an acre 43,560 sq. ft. aliquot. This amount was used in 10 cc of solutions (suspension) per 7"x5" "pac" (essentially 400 gallons per acre). Archer Daniel Midland slow release fertilizer 10-10-10 was incorporated in the surface perlite using $\frac{1}{2}$ gram for low nitrogen level and 10 grams (20-20-20) for maxi i.e., 1 gram nitrogen per culture.

Six to 8 inch cuttings of *Euonymus fortunei* were rooted in perlite under intermittent mist. The cuttings were washed free of perlite before planting. Four were used per pac and replicated 5 times. Cultures were held under automatic watering by intermittent mist 8 A.M. to 5 P.M. Old leaves were removed and 4 vigorous ones left in each plot at planting. Cultures were set up March 10 and observations made April 10 and later. (Table 1)

From the response observed it is evident that yellow foliage in *Euonymus fortunei* may be related to inadequate nitrogen level or to atrazine levels of over 2 lbs. active ingredient per acre.

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Table 1. Number of yellowed leaves present on twenty Euonymus fortunei after 30 days growth in perlite fertilized with slow release, complete fertilizer and treated with atrazine from a wettable powder source.

Atrazine applied lbs. A/A	Nitrogen level from slow release fertilizer: Low	Moderate	Ample*
0	89	6	0
¼	71	47	0
½	86	37	0
1	74	33	0
2	75	21	8
5	131	36	65
10	119	95	117

* 1 gram nitrogen per unit 7x5" pac.

Table 2. Response of Euonymus fortunei after 90 days growth in perlite to which slow release fertilizer and atrazine have been added.

Atrazine lbs. A/A	A. Green wt./gram normal foliage			B. Response as no. yellow leaves		
	Nitrogen level			Nitrogen level		
	Low	Moderate	Ample	Low	Moderate	Ample
0	15.5*	25.2	28.4	41*	31	52
¼	13.1	26.1	33.9	51	31	51
½	14.3	24.5	37.5	36	54	35
1	9.0	23.5	37.4	54	33	33
2	9.2	23.6	39.9	44	45	40
5	5.1	11.2	27.3	54	63	30
10	2.9	14.5	8.0	106	60	22

* Figures are totals in grams for 4 plants each of 5 replicates

Euonymus response as green weight of functional foliage and as foliage color are related to both nitrogen and herbicide level. Thus, when nitrogen is low, application of atrazine at 1 and 2 pound rates reduces the amount of green foliage proportionally more than in similar plants at higher nitrogen status. In this case (Ample Nitrogen) 5 and 10 lbs. rates of atrazine definitely result in clear cut reductions of weight of green functional foliage.

Preliminary tests were run at low nitrogen levels but with the addition of both clay colloid and atrazine or peat moss and atrazine over a range of rates. Response followed low nitrogen level, at which these tests were run.

Triazine injury in Euonymus fortunei begins with both normal green and yellow sectors in a leaf. Yellowing may proceed with senescence to a dull green to yellow-green, particularly under misting.

Red Kidney Beans as Indicator Plants for Triazine

Red kidney beans growing in field soil to which simazine or atrazine has been added will germinate and grow to juvenile foliage stage. In bright weather seedling leaves often develop a grayish margin. The tissue may wilt and brown within a day or two. The leaf margin or the entire leaf and sometimes the stem as well will die and dry. Graying is often accompanied by areas of yellow or aged tissue appearance. On occasion juvenile foliage will remain green but trifoliate leaves show gray color and wilted sections. Normal beans at seed leaf stage can be cut and the stem ends placed in herbicide solution with similar response to that noted above. For rating purposes, three stages were recognized: stage 1 - marginal discoloration stage 2 - marginal wilting stage 3 - collapse of leaf tissue and usually of petiole as well.

Beans were planted in the Euonymus cultures (see preceding section). Beans in the control were rated normal. The remainder at atrazine rates over ½ lb. A/A were rated stage 1 - some discoloration.

When newly germinated beans were grown to juvenile foliage stage and then cut and placed in atrazine or simazine solutions at low (1/100) and high (1 gram) . liter nitrogen levels, atrazine symptoms occurred only at 1000 ppm level with low nitrogen regime but at 1 ppm and more with high nitrogen. Results with simazine were variable within the nitrogen regimes.

Field Plots

Beans and oats were seeded outdoors in midsummer through plots previously treated (2) with simazine or atrazine, at 5 lb. or 10 lb. active, in granular or liquid (w.p.) formulation, surface or incorporated, 1959. No clear cut evidence of residual herbicide was found in bean or in oat plantings in 1961 and none in 1962. Evidence was found localized in 1960 though grasses and weeds were killed in 1959 and vegetation was sparse in 1960.

Plants of Taxus media hicksii in sandy loam were badly injured by a winter 1959-60 application of granular atrazine. Soil samples taken in 1961 and planted to red kidney beans showed response to atrazine by gray color, tissue collapse, and plant death at seedling or later stages. Soil samples and plantings in 1962 failed to show clear cut evidence of atrazine damage. Taxus plants initiated new growth of normal green color even though portions of the tops were dead.

Summary

It would seem doubtful that the use of a single application of simazine or atrazine of 5 lb. A/A or less would interfere with nursery crop growth the second year after application. Indicator crops do not appear reliable for detection of simazine or atrazine in soils at less than 2 lbs. active ingredient per acre incorporated.

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Post-Transplant Applications of Granular Herbicides in Annual Flowers.

Chiko Haramaki[1]

The use of annual flowering plants by home gardeners is undoubtedly limited due to the excessive amount of time required in weeding. During the first two years we have ran preliminary trials on the use of a few granular herbicides on approximately 40 annual flowers. Some of the granular herbicides which were applied as a post-transplant treatment on clean cultivated soil, showed good weed control without excessive damage to the annual flowers. In 1962 the tests were enlarged to include 6 granular herbicides and 13 annual flowers.

Materials and Methods

The experiment was conducted on Hagerstown silt loam soil, which was rototilled several times prior to planting and once after planting just prior to herbicide application. The plots were 450 square feet in area and the herbicide treatments were replicated 5 times.

The plants were seeded and transplanted once while in the greenhouse, and shifted to cold frames prior to transplanting in the field on June 29, 1962.

The granular herbicides were applied on July 11, 1962, which was 12 days after transplanting.

The herbicides used were: Stauffer R-1607, 10%; Amiben, 10%; EPTC, 5%; CIPC, 5%; Dacthal, 1.5% and Simazine, 4%. The granular herbicides were broadcast over the clean cultivated plots 10 days after transplanting. The area was irrigated with 1 inch of water immediately after herbicide application. The air temperature was in the low 90's and the soil temperature 2 inches below the soil surface was in the high 80's.

Results and Discussion

The plots were examined on September 21, 1962 for weed control which is summarized in table 1. The weed control 10 weeks after herbicide application was acceptable in the following treatments: Simazine at 2 pounds per acre, EPTC at 5 pounds per acre, R-1607 at 5 pounds per acre and Amiben at 5 pounds per acre. Many of the plots treated with CIPC at 5 pounds per acre had acceptable weed control, but the rest did not. The weed control in plots treated with Dacthal at 8 pounds per acre were in general unsatisfactory. The check plots were heavily infested with weeds, of which the predominant ones were tumble pigweed, yellow foxtail and lambsquarter.

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Table 1. Effect of granular herbicides on weed prevalence ten weeks after treatment, 1962.

Herbicide	Weed Prevalence*	Weeds Present in Decreasing Order of Frequency
Simazine, 4G 2#/A	1.8	lambsquarter, tumble pigweed, yellow foxtail, smooth pigweed, yellow rocket, Pennsylvania smartweed, wild carrot, Canada thistle, wild buckwheat, tomato, common ragweed, buckhorn plantain, barnyard grass.
EPTC, 5G 5#/A	1.8	tumble pigweed, lambsquarter, yellow foxtail, smooth pigweed, wild carrot, yellow rocket, wild buckwheat, Pennsylvania smartweed, common ragweed, buckhorn plantain, purslane common milkweed, smooth crabgrass.
R-1607, 10G 5#/A	2.4	lambsquarter, tumble pigweed, yellow foxtail, smooth pigweed, wild carrot, common ragweed, Canada thistle, buckhorn plantain, Pennsylvania smartweed, tomato, yellow rocket.
Amiben, 10G 5#/A	2.6	lambsquarter, tumble pigweed, yellow foxtail, smooth pigweed, tomato, yellow rocket, Pennsylvania smartweed, wild carrot, purslane, large crabgrass, fall panicum, Canada thistle, common ragweed, buckhorn plantain.
CIPC, 5G 5#/A	3.2	tumble pigweed, lambsquarter, yellow foxtail, smooth pigweed, yellow rocket, wild carrot, Canada thistle, common ragweed, common milkweed, fall panicum, barnyard grass, purslane, smooth crabgrass.
Dacthal, 1.5G 8#/A	4.2	tumble pigweed, yellow foxtail, lambsquarter, smooth pigweed, wild carrot, Pennsylvania smartweed, yellow rocket, fall panicum, large crabgrass, common ragweed, Canada thistle, purslane.
0	7.5	tumble pigweed, lamgsquarter, yellow foxtail, Pennsylvania smartweed, smooth pigweed, large crabgrass, yellow rocket, wild carrot, fall panicum, wild buckwheat, buckhorn plantain, purslane, tomato, barnyard grass, common ragweed.

*Weed Prevalence Scale:
1 - Less than 10% coverage by weeds.
10 - 100 percent weed coverage.

Table 2. Effect of post-transplanting applications of granular herbicides on annuals. Checked ten weeks after treatments, 1962.

Plant	Simazine 2#/A	EPTC 5#/A	R-1607 5#/A	Amiben 5#/A	CIPC 5#/A	Dacthal 8#/A	0
Aster	0.05	0.00	0.15	0.05	0.20	0.05	0.00
Balsam	0.00	0.00	0.00	0.00	0.07	0.00	0.00
Celosia, Crested	0.60	0.00	0.00	0.40	0.40	0.40	0.00
Celosia, Plumed	0.20	0.00	0.00	0.40	1.00	0.40	0.00
Dahlia	0.40	0.00	0.00	0.20	0.20	0.00	0.00
Marigold, American	0.10	0.05	0.00	0.05	0.05	0.00	0.00
Marigold, French	0.20	0.13	0.00	0.20	0.00	0.07	0.00
Pansy	0.40	0.20	0.40	0.20	0.60	0.00	0.20
Petunia	0.27	0.17	0.17	0.40	0.70	0.03	0.03
Scarlet Sage	0.60	1.00	1.00	0.20	0.40	2.00	0.20
Snapdragon	0.07	0.07	0.20	0.07	0.20	0.13	0.07
Snapdragon, Dwarf	0.20	0.00	0.40	0.00	0.67	0.00	0.00
Zinnia	0.20	0.33	0.13	0.10	0.22	0.07	0.13

Plant Tolerance Scale:

0 - No injury.
1 - Very slight distortion, necrosis or stunting.
2 - Slight distortion, necrosis or stunting.
3 - Moderate distortion, necrosis or stunting.
4 - Severe distortion, necrosis or stunting.
5 - Dead.

Ten weeks after herbicide application, the plants were examined for plant injury. Table 2 summarizes the data on plant tolerance. All of the plants tested showed little or no injury to the application of granular herbicides on established annual transplants. Of the thirteen species tested, scarlet sage appears to be the least tolerant.

The injury to the other plant species, aster, balsam, crested celosia, plumed celosia, dahlia, American marigold, French marigold, pansy, petunia, scarlet sage, snapdragon, dwarf snapdragon, and zinnia was negligible.

Even though the weed control was good under some treatments, there appeared to be no relationship between the effectiveness of a chemical as a weed killer and injury to the annual flowers. The lack of severe injury to the annual flowers may have been due to the infrequent, and sporadic rainfalls throughout the summer, although overhead irrigation was periodically used. The plots also were relatively weed free for the first month, regardless of whether they were treated with herbicides or not.

Summary

Granular formulations of simazine, EPTC, R-1607, CIPC, amiben, and dacthal were applied on clean cultivated plots of transplanted annual flowers. The annual flowers used were: aster, balsam, crested celosia, plumed celosia, dahlia, American marigold, French marigold, pansy, petunia, scarlet sage, snapdragon, dwarf snapdragon, and zinnia.

Acceptable weed control for at least ten weeks were obtained with simazine at 2 pounds per acre, and EPTC, R-1607 and amiben at 5 pounds per acre. Little or no plant injury was observed on any of the plant species tested in any of the treatments.

Trizone - A New Broad Spectrum Fumigant

By Robert P. Harrison [1]

Trizone[R] a recent development of The Dow Chemical Company is one of the most promising soil fumigants to come along in the last few years. Trizone is a mixture containing 60% methyl bromide, 30% chloropicrin and 10% propargyl bromide and is applied beneath gas proof covers at 140 to 200 pounds per acre. This material represents the culmination of several years effort to find a fumigant that would control the wide range of weed, nematode and fungus parasites that methyl bromide controls plus those such as Verticillium wilt (*V. albo-atrum*) and red stele (*Phytophthora fragaria*) of strawberries against which methyl bromide is relatively ineffective. Over 150 large scale tests and commercial applications in the northeast have shown that Trizone is equal to methyl bromide in weed control, somewhat better for nematode control and far superior in controlling soil borne fungi. These study areas have ranged from 800 square feet to more than 11 acres in size. The fumigant has been applied to most of the major soil types in the area under widely differing moisture and temperature conditions and to most of the high value per acre crops grown in the region. In only one case that I have examined has there been what I would consider a failure. More than 90% of the treatments have been outstanding and successful.

Although more studies have been made of Trizone in the northeast than any other, results from other sections have confirmed our findings. Darby (3) has shown that Trizone at 140 pounds per acre provides excellent control of damping off (*Pythium* sp.), root rots (*Pellicularia* spp.), root knot nematodes and weeds and grasses in tomatoes. Greenhouse tests in Michigan by Potter et al (7) indicates that better plant production is obtained with Trizone fumigation than with steam sterilization. Reports from Clifford and Howe (1) concerning three years research with various fumigants in forest tree nurseries indicates that Trizone is outstanding in terms of both weed control and seedling vigor. In these tests weed counts were reduced from an average of 27 per square foot in the untreated to 0.6 in the

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treated red pine beds and seedling counts were increased from 32 per square foot to 94 where the fumigant was used. Hodges (5) work in North Carolina confirms the superiority of Trizone for seedling production and vigor in conifer plantings although better weed control was obtained in his work with a herbicide. In the northeast both Morris (6) and Ferrell (8) have reported excellent results with this fumigant in forest tree nurseries both in terms of weed control and plant production.

According to reports received in my office, both published and unpublished, Trizone has performed equally well in ornamental nurseries. Perhaps the most noteworthy of these was from Haasis (4) in North Carolina. There the value of Japanese Holly was increased from $4,305 per acre to $11,354 through fumigation. In addition weeds were reduced from 31 per square foot to about 1 at the end of three months and the plants were marketed a year earlier than the untreated planting.

In the northeast more tests have been conducted in ornamental nurseries than any other type of culture. Weed control has ranged from 74% in one test to 99.8 percent in another. The average degree of control has been around 95 percent. These tests have encompassed most of the more common ornamental shrubs and a wide variety of annuals and perennials. To date there has been no evidence of phytotoxicity on any of these.

Strawberry fumigation is of course one of our major interests. It is our belief that if weeds, nematodes and fungi are adequately controlled strawberries can be economically fruited for three or even four years in this area. Although our tests have not been in long enough to demonstrate this the evidence to date looks promising. Plantings that are going into their second fruiting year are still almost weed free and there is no indication of parasitism. In addition, in every test to data berry production has been at least doubled over untreated berries and in one large scale tests production increased from 2500 quarts per acre to 13,000 per acre.

Red stele control has been reported by Converse (2) using Trizone at 200 pounds per acre from three locations in the northeast. In addition, examination of two large areas heavily infected with red stele that were treated with this fumigant appears to be completely free of the disease after two years.

Excellent results have also been obtained in vegetable and tobacco plant beds, in nursery lining out stock, in cantaloupe and tomato plantings and in turf culture.

The following table summarizes some of the data collected from various studies that are being carried on at the present time.
Table 1. Weed control and crop response from Trizone[R] fumigation.

Crop and No. Tests	Weed Control Range	Units	Production (Range) Check	Treated
Hard Pine (10)	87-99.9%	Per Sq.Ft.	8-35	39-112
White Pine (10)	83-97.3	"	15-45	54-110
Spruce (3)	95-97	$ per acre	57	90
Azaleas (7)	82-99.4	"		-$5000 to $10000
Japanese Holly (1)	87			-$18,500
Yews (6)	93-99			
Roses (2)	97			
Various Annuals and Perennials (7)	54-99.3			
Turf (3)	Good to Excellent			
Strawberries (7)	Excellent	qts/acre	2500 qts/ac	10,000-16,500
Tomatoes (4)	93-99	tons/acre	4	32
Peppers (2)	99	Plants/sq.ft.	0-54	152-180
Cantaloupe (2)	--			
Curcifers (15)	80-99.5			

Needless to say we are most enthusiastic over the potential utility of this new fumigant.

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RESIDUES OF LINURON IN BLUEBERRIES AND POTATOES FOLLOWING TREATMENT FOR WEED CONTROL[1]

P. B. Manning, R. S. Bell, T. W. Kerr and V. G. Shutak[2]

Linuron, 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea, is a new herbicide being evaluated for control of annual grasses and other weeds in plantings of various crops. The investigation reported here was undertaken to determine whether measurable amounts of the herbicide would accumulate in potato tubers and blueberry fruit following soil application in the field.

The tubers analyzed were obtained from an experiment on chemical weed control in Kennebec potatoes reported by Bell (1) elsewhere in this volume of the Proceedings. The potatoes were planted in late April, 1962 using four randomly replicated plots per treatment. The treatments and the amounts of linuron (active ingredient) and the form in which it was applied are presented in table 1. The pre-emergent treatment was made on May 22 and the post-hilling one on June 20. Harvest of the potatoes was September 6 and 7 and analyses of the tubers was made on October 18.

The blueberries were obtained from an experiment on chemical weed control in several varieties in an eighteen year old plantation. Single plots, one-two hundredths of an acre in area and containing one plant of each of three varieties were used. One plot was cultivated and another was left in a weed and grass sod before applying the herbicide. Untreated checks containing an equal number of plants were provided. Four pounds (active ingredient) per acre of linuron was applied to the soil surface as a spray on May 7. Harvest of the fruit was on July 23; the fruit was immediately frozen and maintained in that condition until analysis on October 24.

At harvest, 15 potatoes from each replicate, totaling approximately 6.5 pounds, were selected at random from the yield of each treatment and held in storage at 40°F. Of these, seven from each replicate were washed and cleaned in tap water, quartered lengthwise and one-quarter of each potato finely chopped. After mixing, a representative 100 gram sample was analyzed. The fruits harvested from all three blueberry plants in each treatment were mixed and a representative 250 gram sample taken for residue analysis.

The analytical method was a modification (3) of that published by Bleidner et al (2) for monuron and was supplied by the E. I. duPont de Nemours and Company. It consisted essentially of disintegrating the samples of blueberries or potatoes by strong alkali digestion and hydrolyzing the linuron to 3,4-dichloroaniline, the resultant aromatic amine being steam distilled by liquid-liquid extraction from the alkaline solution into hexane. It was then extracted into dilute hydrochloric acid, diazotized, coupled with N-(1-naphthyl)ethylenediamine and determined colorimetrically using a Coleman Universal spectrophotometer. In addition to the field samples, two samples of untreated potatoes

[1]Contribution #1072 from the Rhode Island Agricultural Experiment Station, supported in part by funds from Regional Research Project NE-36.

[2]Agricultural chemist, agronomist, entomologist and horticulturist, respec-

were fortified with 0.5 ppm of linuron to test the accuracy of the method. This was not done in the case of the blueberries. With potatoes, excessive foaming due to high starch content was experienced. This was overcome by pre-digesting them with dilute hydrochloric acid in an autoclave at 20 p.s.i. for one hour, and later in the process by increasing the amount of alkali and antifoaming agent in the steam distillation step. Work with potato samples, and with reagents only, fortified with linuron indicated negligible loss of the chemical by this technique. A plant blank value was subtracted from each treatment sample result.

The results presented in table 1 show that residues from both blueberry treatments were less than 0.02 ppm, the limit of sensitivity of the method. With potatoes, there was less than 0.02 ppm at the 2 pound level of application, but a small, measurable amount of linuron in both the pre-emergent and post-hilling treatments at the 4 pound application. Recovery from the fortified samples was 0.49 ppm in one case and 0.36 ppm in the other.

The herbicide controlled the weeds in the cultivated blueberry plot for approximately 6 weeks, after which time crabgrass began to invade the area. Nine weeks after application the plot was completely covered with crabgrass and a few broadleaved weeds. In the sod or uncultivated plot the killing of grass and other weeds was much slower than in the cultivated plot and weed control persisted for approximately 8 weeks. However, after that period of time new weeds began to appear.

Table 1. Residues of linuron in potato tubers and blueberries following application in various treatments. Kingston, R. I. 1962.

Crop	Treatment	Formulation	Active Toxicant lb/A	Residue ppm
Potato	Pre-emergent	50% Wettable powder	2	$<$ 0.02
			4	0.36
	Post-hilling	Granular*	4	0.32
Blueberry	After cultivation	50% Wettable powder	4	$<$0.02
	No cultivation	50% Wettable powder	4	$<$0.02

*Preparation made by adding the wettable powder to dry sand and applying by hand.

Literature Cited

1. Bell, R. S. 1963. Weed control in Kennebec potatoes. (R.I. 1962). Proc. NEWCC Vol. 17.

2. Bleidner, W. E., H. M. Baker, M. Levitsky and W. K. Lowen. 1954. Determination of 3-(p-Chlorophenyl)-1,1-dimethylurea in soils and plant tissue. Jour. Agr. and Food Chem. Vol. 2: 476-479.

3. Personal communication. 1962. Industrial and Biochemicals Department, E. I. duPont de Nemours and Company, Wilmington, Delaware.

RESIDUE ANALYSIS OF POTATOES TREATED WITH PROMETRYNE FOR WEED CONTROL[1]

T. W. Kerr, R. S. Bell and P. B. Manning[2]

The compound prometryne, 2,4-bis(isopropylamino)-6-methylmercapto-s-triazine, is a new herbicide being tested for the control of annual grasses and other weeds in potato fields. The investigation reported here was undertaken to determine whether measurable amounts of the herbicide would accumulate in potato tubers following application in the field.

The tubers analyzed were obtained from an experiment on herbicidal weed control reported by Bell (1) elsewhere in this journal. The potatoes, variety Kennebec, were planted in late April, 1962 using four randomly replicated plots per treatment. The treatments and the amounts of prometryne (active ingredient) applied either as sprays of emulsifiable concentrate or wettable powder, or as a granular formulation are presented in table 1. The pre-emergent treatment was made on May 21 and the post-hilling one on June 20. Harvest of the potatoes was September 6 and 7.

From each replicate at harvest 15 tubers, totaling approximately 6.5 pounds, were obtained at random from the grader as the yield from each treatment was being cleaned and graded. On October 6, seven tubers from each replicate were washed and cleaned in tap water, quartered lengthwise and one-quarter of each potato selected and finely chopped. After mixing, a representative 200 gram sample was taken. The sample was then tumbled with n-pentane after which an aliquot of the extract was taken, evaporated to dryness and carried through the analytical method supplied by the Geigy Chemical Company (2). The method consists essentially of converting prometryne to hydroxypropazine by acid hydrolysis and quantitatively measuring the latter in a

Table 1. Residues of prometryne in potato tubers following application in various treatments. Kingston, R. I. 1962.

Treatment	Formulation	Active toxicant lb/A	Residue (ppm) in tubers
Pre-emergent	25% Emulsifiable concentrate	2	<0.05
		4	<0.05
	50% Wettable powder	2	<0.05
		4	<0.05
		8	<0.05
Post-hilling	8% Granular	2	<0.05
		4	<0.05
		6	<0.05

[1]Contribution #1071 from the Rhode Island Agricultural Experiment Station. A

Beckman DK-2 spectrophotometer using the base line technique. In addition to the field samples, two samples of untreated potatoes were fortified with 0.6 ppm of prometryne to test the accuracy of the method.

The results presented in table 1 show that residues in all treatments were less than 0.05 ppm, the limit of sensitivity of the method. Recovery from the fortified samples was 0.56 ppm in one case and 0.48 ppm in the other.

Literature Cited

1. Bell, R. S. 1963. Weed control in Kennebec potatoes. (R. I. 1962). Proc. NEWCC, Vol. 17.

2. Personal communication, 1962. Analytical Department, Geigy Chemical Corporation, Ardsley, New York.

RESIDUE ANALYSIS OF CARROTS AND TOMATOES TREATED WITH SOLAN FOR WEED CONTROL[1]

T. W. Kerr, P. B. Manning and A. E. Griffiths[2]

Solan, N-(3-chloro-4-methylphenyl)-2-methylpentanamide, is a new, experimental chemical, the outstanding feature of which appears to be the fact that it is a post-emergent herbicide. The investigation reported here was undertaken to ascertain whether measurable amounts of the chemical would accumulate in carrots and tomatoes following application in the field.

The carrots and tomatoes analyzed were obtained from an experiment on chemical weed control conducted during the season of 1962. The carrots, variety Royal Chantenay, were planted in late April using four randomly replicated 20 foot rows for both the check and herbicide treatment. The tomatoes, variety Summer Sunrise, were transplanted on May 25 using two 12-plant rows each 40 feet in length for the chemical treatment and one for the check. Solan at the rate of 4 pounds (active ingredient) per acre was applied as a spray to the carrots and the soil on both sides of each row for a width of 18 inches on May 29 and similarly to the tomatoes on June 11.

Harvest of the carrots was July 26 when the roots were 4 to 6 inches in length and weighed 84 to 100 grams each. The tomatoes were harvested as green fruit on July 26 and as ripe fruit on August 30. On both dates 3 fruits were taken from each plant. Ten carrots from each replicate were washed and cleaned in tap water before being combined in a plastic bag and frozen for later analysis on November 2. Prior to analysis both the carrots and tomatoes were chopped finely and 250 grams taken for analysis. In addition to the field samples, both carrot and tomato check samples were fortified with 0.4 ppm of solan to test the accuracy of the method.

The analytical method, which was supplied by the Niagara Chemical Division of the Food Machinery and Chemical Company (1), was modified to utilize the liquid-liquid steam distillation technique described by Bleidner et al (2) for monuron. The principle consists of strong alkaline disintegration of the carrot or tomato samples and the hydrolysis of solan to 3-chloro-4-methylaniline, the resultant aromatic amine being steam-distilled from the alkaline solution into hexane by liquid-liquid extraction. It was then extracted into dilute hydrochloric acid, diazotized, coupled with N-(1-naphthyl) ethylenediamine and determined colorimetrically using a Coleman Universal spectrophotometer. A plant blank value was subtracted from each treated sample result.

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[1]Contribution #1073 from the Rhode Island Agricultural Experiment Station, supported in part by funds from Regional Research Project NE-36.

[2]Entomologist, agricultural chemist and horticulturist, respectively.

The results presented in table 1 show that residues in tomatoes were less than 0.02 ppm, the limit of sensitivity of the method. In carrots, a trace of the chemical was found. Recovery from the fortified samples was 0.35 ppm in the case of carrots and 0.30 ppm for the tomatoes.

Table 1. Residues of solan in carrots and tomatoes following application as a post-emergent herbicide treatment. Kingston, R. I. 1962.

Crop	Formulation	Active Toxicant lb/A	Residue ppm
Carrot	46.5% EC	4	0.04
Green tomatoes	46.5% EC	4	$<$ 0.02
Ripe tomatoes	46.5% EC	4	$<$ 0.02

Literature Cited

1. Personal communication. 1962. Research and Development Department, Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, New York.

2. Bleidner, W. E., H. M. Baker, M. Levitsky and W. K. Lowen. 1954. Determination of 3-(p-chlorophenyl)-1,1-dimethylurea in soils and plant tissue. Jour. Agr. and Food Chem. Vol. 2: 476-479.

ANNUAL BROADLEAF WEED CONTROL IN SNAP BEANS AND SWEET CORN

M.F. Trevett and William Gardner[1/]

Introduction

This paper is a report on the effectiveness of the herbicides listed in Table 1 on the control of annual broadleaf weeds in snap beans and sweet corn.

Procedure

Plantings were made in a loam soil June 1, 1962. Treatments were replicated five times.

Herbicides were applied with one pass of a small plot sprayer at 40 pounds pressure and 50 gallons per acre volume. Snap beans were sprayed June 4th; sweet corn, June 1st.

The principal weeds included: Wild rutabaga (*Brassica rapa* L.), Red-root pigweed (*Amaranthus retroflexus* L.), Lambsquarters pigweed (*Chenopodium album* L.), and Smartweed (*Polygonum pensylvanicum* L.).

Weed counts were made eight weeeks after spraying.

Results

In the corn block (Table 3), 2 pounds of Atrazine per acre, applied at planting, produced significantly higher yields than all other treatments except hand hoeing, or planting applications of 3 or 6 pounds of NIA 2995, or 2 pounds of Linuron.

In the snap bean block (Table 4), six pounds per acre of NIA 2995 applied four days after planting, produced significantly higher yields than all other treatments except hand hoeing, or four-day-after-planting applications of 1 pound Linuron, or 3 pounds NIA 2995.

1/ Associate Agronomist and Technical Assistant, Department of Agronomy, University of Maine.

Six pounds Alipur per acre, and 4 pounds FW-925 severely injured beans and reduced stand. Four pounds of Alipur and 2 pounds FW-925 injured beans slightly, but did not reduce stand.

Stand of corn was significantly reduced by SD-7583 worked into the soil after planting. Plots receiving 2, 4, or 6 pounds of Alipur, 6 pounds N-4069-E, or 3 pounds of Atrametryne or Prometryne had a numerically lower stand than all other treatments except SD-7585.

Wild rutabaga was not adequately controlled by 2 or 4 pounds per acre of Trifluralin, 2 pounds of FW-925, 10.5 pounds of Dacthal, or 3 pounds Amiben. Four pounds per acre of N-3291 did not control smartweed.

Treatments giving unsatisfactory weed control for the spectrum of weeds in these tests included:

2 or 4 pounds Alipur
(4 pounds on border line)

2 or 3 pounds Hercules 7531

4 or 6 pounds N-4069

2 pounds SD-7585

4 or 6 pounds Trifluralin

3 pounds NIA 2995 (Table 3)

4 or 6 pounds N-3291

3 pounds Amiben

4 or 6 pounds Diphenamid

4 pounds FW-925

10.5 pounds Dacthal

Herbicides giving at least acceptable broadleaf weed control included:

2 pounds Atrazine

1 or 2 pounds Linuron

2 or 3 pounds Prometryne

2 or 3 pounds Atrametryne

6 pounds NIA 2995

4 or 6 pounds Alipur
(4 pounds on border line)

Summary

Six pounds per acre of NIA 2995, or 2 pounds of Linuron applied at planting, produced as high yields of sweet corn as the standard treatment of 2 pounds Atrazine.

Snap beans receiving 3 or 6 pounds of NIA 2995 per acre four days after planting, or 1 pound of Linuron, did not differ significantly in yield from hand hoed plants.

Table 1. Herbicides Used in Snap Beans and Sweet Corn.

Designation	Active Ingredient
Alipur	(OMU) plus butynyl-N(3 chlorophenyl) carbamate
Amiben	3-Amino-2,5-dichlorobenzoic acid
Atrametryne	A Geigy product
Atrazine	2-chloro-4-ethylamino-6-isopropylamino-s-triazine
Dacthal	2,3,5,6-Tetrachloroterephthalic acid
Diphenamid	N,N-dimethyl-diphenylacetamide
FW-925	2,4-dichlorophenyl 4-nitrophenyl ether
Hercules 7531	1-(5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl)-3,3-dimethylurea
Linuron	3-(3,4-dichlorphenyl)-1-methoxy-1-methylurea
NIA 2995	N-(3,4-dichlorophenyl carbamate
N-4069-E	Emulsifiable form of N-3291
N-3291	A Stauffer product, water soluble
Prometryne	6-methylmercapto-2,4-bis(isopropylamino)-s-triazine
SD-7585	A Shell product
Trifluralin	2,4-dinitro-n-n-di-N-propyl-a,a,a-trifluoro-P-toluidine

Table 2. Rainfall, Monmouth, Maine, May-June, 1962.

Date	Inches of rain	Date	Inches of rain
May 20	.46	June 12	.02
" 24	1.28	" 18	.16
" 31	.01	" 19	.45
June 1	.01	" 20	.04
" 5	.14	" 23	.09
" 6	.24	" 24	.57
" 7	.14	" 26	.04
" 11	.27	" 27	.02

Table 3. Yield of Sweet Corn and Broadleaf Weed Control.

Treatment (lbs. active ingredient per acre), applied at planting[1]	lbs. per 25' of row	Percent broadleaf weed control[3]	Height corn, inches[4]
2# Atrazine	26.1a[2]	100.0	56.4
Hand hoed	23.7ab	--	55.0
6# NIA 2995	23.3ab	99.1	52.7
2# Linuron	22.9abc	100.0	53.7
3# NIA 2995	19.9abcd	53.5	56.1
1# Linuron	18.3abcde	97.6	51.9
2# Atrametryne	16.8 bcde	71.0	50.3
2# Prometryne	15.9 bcde	78.0	51.8
3# Prometryne	15.2 cdef	91.7	52.1
3# Atrametryne	14.2 defg	87.1	45.9
6# N-4069-E	12.6 defg	3.1	51.7
2# Hercules 7531	10.9 efg	8.2	49.0
4# Alipur	10.9 efg	3.6	45.3
2# Alipur	10.4 efg	13.3	46.1
6# Alipur	7.6 fg	96.1	36.4
2# SD 7583, incorporated	7.5 fg	5.0	45.8
3# Hercules 7531	7.2 g	6.5	44.1
L.S.D. 5%	6.6	13.6	2.8

1/ Goldcrest hybrid 79, planted 1 June, '62.

2/ Means with some letter designation do not differ significantly at the 5% level (Duncan's Multiple Range Test).

3/ Weeds present: Wild rutabaga (*Brassica rapa* L.); Red-root pigweed (*Amaranthus retroflexus* L.); Lambsquarters pigweed (*Chenopodium album* L.); Smartweed (*Polygonum pensylvanicum* L.). Ratings made 8 weeks after planting.

4/ Height from soil level to top of tassel.

Table 4. Yield of Snap Beans and Percent Broadleaf Weed Control.

Treatment (lbs. active ingredient per acre), applied 4 days after planting 1/	Yield lbs. per 25' of row	Percent broadleaf weed control 3/
6# NIA 2995	19.1a 2/	95.9
3# NIA 2995	18.7ab	89.4
Hand hoed	17.0ab	--
1# Linuron	16.4abc	93.9
6# Trifluralin	13.2 bcd	41.8
6# N-3291	11.9 cde	40.8
4# N-3291	11.2 def	39.8
4# Trifluralin	10.6 defg	14.1
4# 4069	10.5 defg	36.1
6# 4069	10.4 defg	40.1
2# 7531	10.2 defg	48.3
10.5# Dacthal	7.5 efgh	2.5
3# Amiben	7.3 fgh	14.8
4# Alipur	6.5 gh	64.7
2# Alipur	6.4 gh	32.[illegible]
4# 4513	5.0 hi	11.8
2# FW-925	4.8 hi	1.5
6# 4513	4.7 hi	12.1
Untreated	3.4 hi	--
4# FW-925	3.4 hi	4.4
6# Alipur	1.9 i	97.7
L.S.D. 5%	3.8	16.6

1/ Tender crop beans planted 1 June, '62.

2/ Means having some letter designation do not differ significantly at the 5% level (Duncan's Multiple Range Test).

3/ Weeds as for corn, Table 4.
Ratings made 8 weeks after planting.

Chemical Control of Weeds in Connecticut Shade-Grown and Stalk-Cut Tobacco

John F. Ahrens[1]

Cigar tobacco has been grown in the Connecticut River Valley for about 200 years. To the present day cultivation and hand hoeing is the accepted method of weed control for the approximately 2000 acres of stalk-cut (binder type) and 8000 acres of shade-grown (wrapper) tobacco. Two and sometimes three hoeings are required to control weeds in most fields. Many growers of shade-grown tobacco especially consider cultivation to be necessary above and beyond its effect on weeds. However, production costs could be reduced by the elimination of hoeing.

Experiments were initiated several years ago at this Station to evaluate the use of pre-emergence herbicides as a substitute for hand hoeing in tobacco. This report summarizes results of replicated field trials conducted since 1958.

Procedure and Results

Pre-emergence herbicides were applied over rows of newly transplanted tobacco mostly in granular forms but sometimes in sprays using a modified lawn spreader, a knapsack sprayer, or a precision granular distributor. Pre-planting treatments were applied in one experiment. In stalk-cut tobacco, plot sizes usually consisted of two 20-foot rows with plant spacings of 22 inches and row spacings of 39 inches. Plot sizes in shade-grown tobacco varied from 10 to 66 feet of row with plant spacings of 12 to 14 inches and row spacings of 36 to 40 inches. In all experiments the treatments were arranged in randomized blocks. Cultivation was practiced in all experiments, but in shade-grown tobacco cultivations were intensive and the herbicides were therefore incorporated within a few days of application. The soils in all tests were characteristically well drained, ranging in texture from loamy sands to silt loams. Data were obtained on weed control, crop injury, crop yields, and crop quality (grade index).

The following herbicides were tested over the five-year period:

a) EPTC [ethyl N,N-di-n-propylthiolcarbamate]
b) CDEC [2-chloroallyl diethyldithiocarbamate]
c) NPA [N-1-naphthylphthalamic acid]
d) 2,4-DEP [tris(2,4-dichlorophenoxyethyl)phosphite]
e) amiben [3-amino-2,5-dichlorobenzoic acid]
f) dichlobenil or casoron [2,6-dichlorobenzonitrile]
g) DNBP [4,6-dinitro-o-sec-butylphenol]

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[1]Associate Plant Physiologist, Windsor Laboratory, The Connecticut Agricultural Experiment Station, Windsor.

h) CIPC [isopropyl N-(3-chlorophenyl) carbamate]
i) sesone [sodium 2,4-dichlorophenoxyethyl sulfate]
j) DCU [dichloral urea]
k) CDAA [2-chloro-N,N-diallylacetamide]
l) neburon [1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea]
m) DMPA or zytron [O-(2,4-dichlorophenyl)-O-methyl isopropylphosphoramidothiote]
n) DCPA or dacthal [dimethyl 2,3,5,6-tetrachloroterephthalate]
o) simazine [2-chloro-4,6-bis(ethylamino)-s-triazine]
p) atrazine [2-chloro-4-ethylamino-6-isopropylamino-s-triazine]
q) trietazine [2-chloro-4-diethylamino-6-ethylamino-s-triazine]
r) trifluralin [2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine]
s) R-1607 [n-propyl di-n-propylthiolcarbamate]
t) diphenamid [N,N-dimethyl-2,2-diphenylacetamide]

Experiments in 1958 and 1959 - stalk-cut tobacco:

The initial experiments sought to determine effects of commercial pre-emergence herbicides on stalk-cut tobacco. Broadleaf tobacco was set in the field on June 7, 1958 and June 8, 1959. The herbicides were applied in 24-inch bands over the rows four days after setting. The treatments were replicated four times in 1958 and three times in 1959.

The weed population consisted largely of lambsquarter (*Chenopodium album*), carpetweed (*Mollugo verticillata*), barnyard grass (*Echinochloa crusgalli*) and crabgrass (*Digitaria spp.*). However, the weeds were much more abundant in 1958 than in 1959. In both years three sets of controls were included: (a) close cultivated, not hoed, (b) middle cultivated, not hoed, and (c) middle cultivated and hoed. In 1958 weeds in the unhoed control plots reduced yields of tobacco by 16 percent, but in 1959 weeds reduced yields by only 3 percent. Close cultivation decreased weed yields by 60 to 70 percent both years but also decreased tobacco yields by 14 percent in 1959.

A summary of 1958 and 1959 results is shown in Table 1. Sesone sprays and granular applications of EPTC, CDEC, NPA, simazine, amiben and 2,4-DEP controlled weeds satisfactorily with no visual effects on tobacco or significant decreases in tobacco yields or quality. Several other materials either injured the tobacco or failed to control weeds.

In 1959, herbicides also were applied at 10 days after setting and in a separate experiment either 4, 14, or 19 days before setting. Effects of herbicides applied before or after the first cultivation (10 days after setting) were no different from effects of herbicides applied 4 days after setting. However, pre-planting treatments with CDEC, EPTC, simazine and trietazine largely were unsuccessful. Applied before planting and incorporated, CDEC did not control the weeds and EPTC injured tobacco planted 4, 14, or 19 days later. Applied on the soil surface, trietazine at 4 lbs. per acre and simazine at 2 or 4 lbs. per acre provided satisfactory weed control without

Table 1. Formulations, Rates and Methods of Application of Herbicides Tested on Broadleaf Tobacco in 1958 or 1959[1]

Treatments providing satisfactory weed control and no crop injury	Treatments injuring the crop	Treatments that did not control weeds or injure the crop
A. Treatments applied 4 days after transplanting		
EPTC,g.,3 or 6 lbs/A,inc.	neburon,w.p.,2 or 4 lbs/A. s.[2]	neburon,g.,2 or 4 lbs/A, s.[3]
CDEC,g.,4 or 8 lbs/A,inc.	sesone,liq.,6 lbs/A,s.	DCU,w.p.,5 lbs/A,s.[2]
NPA,g.,3 or 6 lbs/A,s.	trietazine,w.p.,2 or 4 lbs/A,s.[3]	CDAA,g.,6 lbs/A,s.[2]
sesone,liq.,3 lbs/A,s.	DNBP,g.,3 or 6 lbs/A,s.[2]	
simazine,g.,2 or 4 lbs/A,s.	CIPC,g.,4 or 8 lbs/A,s.[2]	
amiben,g.,4 lbs/A,s.[3]	2,4-DEP,g.,6 lbs/A,s.[3]	
2,4-DEP,g.,3 lbs/A,s.[3]		
B. Treatments applied 4, 14 or 19 days before transplanting[3]		
trietazine,w.p.,4 lbs/A, s.,19 days	trietazine,w.p.,2 or 4 lbs/A,s.,4 or 14 days	trietazine,w.p.,2 lbs/A, s.,19 days
simazine,g.,2 or 4 lbs/A, s.,19 days	simazine,g.,2 or 4 lbs/A, s.,4 or 14 days	CDEC,g.,4 or 8 lbs/A, inc.,4,14 or 19 days
	EPTC,g.,2 or 4 lbs/A,inc., 4,14 or 19 days	

[1] s.-surface application, inc.-incorporated, g.-granular, w.p.-wettable powder.
[2] Treatments applied in 1958 only.
[3] Treatments applied in 1959 only.

injury to tobacco planted nineteen days later. Tobacco was injured by these treatments when planted 4 or 14 days after treatment, however, indicating that timing would be critical in the use of pre-planting applications of simazine or trietazine.

Experiments in 1960 - shade-grown tobacco:

Eleven herbicides including those that looked promising for use in Broadleaf tobacco were applied in plots at four locations. Three of these locations were in fields of commercial shade growers. A total of eight replicates of the eleven herbicides plus hoed and weedy controls were included. The treatments were applied 4 to 10 days following setting in all locations. Since the purpose of these trials was to evaluate herbicides for use under the varying conditions prevalent in Connecticut, different strains of tobacco were grown at each location, according to the grower's preference.

The weed populations also varied greatly but consisted mainly of the annual weeds most commonly found in tobacco fields according to a study by Vengris(2). The yield and crop value reductions from weeds at these four locations (weedy vs. hoed controls) varied from 0 to 25 percent depending upon the size of the weed population. The average reduction at all locations was 13 percent.

A summary of the results obtained in the 1960 trials is shown in Tables 2 and 3. Granular amiben at 3 lbs. per acre was the only one of the eleven herbicides that did not injure tobacco at any of the four locations. Amiben at 3 lbs. per acre controlled weeds as well as two hand hoeings, the normal commercial practice, without reducing crop values (yield x grade index).

Table 2. Treatments Injuring Shade-Grown Tobacco at One or More Locations in 1960, 1961 or 1962

Herbicides - formulations and rates (active ingredient)

a) 2,4-DEP, g., 3 lbs./A-'60, '61	g) simazine, g., 2 lbs./A-'60
b) NPA, g., 4 lbs./A-'60	h) atrazine, g., 2 lbs./A-'60
c) sesone, powder, 3 lbs./A-'60	i) trietazine, g., 2 lbs./A-'60
d) DMPA, g., 15 lbs./A-'60, '61	j) neburon, g., 4 lbs./A-'60
e) DCPA, g., 8 lbs./A-'60	k) CDEC, g., 6 lbs./A-'60
f) EPTC, g., 3 lbs./A-'60	l) dichlobenil, g., 3 lbs./A-'61
	m) amihen, g., 4 lbs./A-'62

Experiments in 1961 - shade-grown and stalk-cut tobacco:

Trials were conducted in shade-grown tobacco at Windsor and Windsorville and in stalk-cut tobacco at Windsor. In the shade-grown trial at Windsorville the strain 7BX5 was planted on June 2 and treated on June 10 after the first hoeing. The whole area over the 2-row plots was treated with granular applications of amiben and 2,4-DEP at 3 or 4 lbs. per acre and DMPA at 15 and 20 lbs. per acre. The treatments were replicated 3 times. The main weeds

Table 3. Chemical Weed Control in Shade-Grown Tobacco

Herbicide and formulations	Rate a.i. lbs./A	1960: Average relative crop value index three locations	1960: Average weed control four locations %	1961: Crop injury[1] V	1961: Crop injury[1] W[2]	1961: Weed control % V	1961: Weed control % W[3]	1962: Crop injury[1]	1962: Weed control %
Hoed control		100	58	0	0	-	-	0	85
Weedy control		87	0	0	0	0	0	0	0
Amiben, g.	3	101	56	0	0	47	0	-	-
	4	-	-	1	-	80	-	1.5	60
	6	-	-	-	0	-	40	2.5	85
Diphenamid, g.	3	-	-	-	0	-	25	-	-
	4	-	-	-	-	-	-	0	77
	6	-	-	-	0	-	55	0	78

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[1] 0-no injury, 5-dead plants.
[2] V-Windsorville 7BX5 strain, W-Windsor Conn.49 strain.
[3] Main weed was *Galinsoga parviflora*.

were lambsquarter, ragweed (Ambrosia artemisiifolia), smartweed (Polygonum pennsylvanicum) and barnyard grass.

DMPA and 2,4-DEP injured the tobacco at Windsorville while amiben at 4 lbs. per acre caused only slight distortion of the lower leaves (Tables 2 and 3). Amiben at 4 lbs. per acre also provided satisfactory control of weeds.

At Windsor the shade strain, Connecticut 49, was planted on June 23, 1961 and treated on June 26. Treatments of amiben, diphenamid and dichlobenil were replicated twice. The only weed in this test was galinsoga (Galinsoga parviflora). Dichlobenil at 3, 4 or 6 lbs. per acre controlled galinsoga but severely injured the tobacco. Neither amiben nor diphenamid controlled galinsoga or injured the tobacco (Table 3). Although abundant at this location, Vengris (2) found galinsoga in only about 13 per cent of tobacco fields studied in Massachusetts.

The stalk-cut strain tested in 1961 was Connecticut All-Purpose. The plants were set on June 23 and treated the same day. The treatments were applied in 24-inch bands over the rows and replicated three times. Weeds were sparse and not uniformly distributed in this test, the main ones being witchgrass (Panicum capillare) and carpetweed. The weeds were weighed after harvest of the tobacco crop but the results cannot be regarded too seriously.

The results of this test are shown in Table 4. Dichlobenil controlled weeds better than amiben or diphenamid but also injured the tobacco. Amiben and diphenamid did not affect tobacco growth, yields, or quality.

Experiments in 1962 - shade-grown and stalk-cut tobacco:

Tests were continued in shade-grown and stalk-cut tobacco with diphenamid and amiben and two new materials. The shade strain, 7BX5, was set on May 21, 1962 and treated on May 24 with granular amiben and diphenamid in two replicates. Plots were two rows wide and 33 feet long and were treated over the entire area. As shown in Table 3, both materials controlled weeds well but amiben at 4 or 6 lbs. per acre caused stunting and irregular growth. Diphenamid at 4 or 6 lbs. per acre did not appear to injure the tobacco. Yields of three primings were taken but have not yet been evaluated.

Stalk-cut tobacco (Broadleaf) was set on June 7, 1962 and treated on June 9. Granular formulations of diphenamid and amiben, trifluralin and Stauffer R-1607 were applied over four replicates. The plots were 2 rows wide and 20 to 30 feet long and were treated over the entire area. In this test the field was cultivated immediately after applying the granular herbicides, thus incorporating the herbicides to a depth of about 2 inches. This differed from past trials in stalk-cut tobacco in which diphenamid and amiben were left on the surface and only row middles were cultivated. The results of this test are shown in Table 4.

Although weeds again were sparse, all of the herbicides controlled the crabgrass and witchgrass. Significant stunting of tobacco was observed in plots treated with amiben at 4 or 6 lbs. per acre, trifluralin at 4 lbs. per acre and R-1607 at 4 or 6 lbs. per acre. However, plants stunted early with amiben at

Table 4. Weed Control in Stalk-Cut Tobacco with Granular Herbicides

Herbicide and formulations	All-Purpose 1961 Rate a.i. lbs/A	Weed control %	Crop injury[1] 7/7/61	Yield lbs/A	Broadleaf 1962 Rate a.i. lbs/A	Weed control %	Crop injury[1] 7/26/62	Yield lbs/A
Hoed controls		75	0	2193		97	0	2045
Weedy controls		0	0	2267		0	0	2029
Diphenamid	3	42	0	2340	4	97	0	1909
	6	61	0	2291	6	96	0	2058
Amiben	3	0	0	2193	4	71	2.5[2]	2054
	6	58	0	2193	6	90	3.0[2]	1434[3]
Dichlobenil	3		1.7 stunting	2145	-	-	-	-
	4		2.3 stunting	2120	-	-	-	-
	6		3.0 stunting	1967	-	-	-	-
Trifluralin	-	-	-	-	2	84	0	2057
	-	-	-	-	4	100	3.0[2]	1730[3]
R-1607	-	-	-	-	4	96	1.0[2]	1912
	-	-	-	-	6	100	2.25[2]	1858
L.S.D. .05				N.S.D.				225
.01								302

[1]0-no injury, 5-dead plants.
[2]Plants stunted.
[3]Figures significantly different from hoed controls at p.=.01.

4 lbs. per acre produced as much tobacco as control plants. Diphenamid at 3 or 6 lbs. per acre and trifluralin at 2 lbs. per acre appeared to have no effects on tobacco growth or yield.

In addition to the above trial, a small test was run in 1962 in a commercial field of Broadleaf tobacco. Diphenamid was applied 2 days after setting in 600-foot rows across a field. The wettable powder formulation was applied over one row and the granular form was applied over an adjacent row, both at rates of 4 lbs. per acre. Check rows were left on either side. No difference between the tobacco in the treated and untreated rows was noted during the season and 95 per cent control of purslane (Portulaca oleracea) was obtained with both formulations of diphenamid. Yield and quality comparisons are yet to be determined.

Discussion and Summary

Over a period of five seasons, twenty commercial herbicides have been evaluated for use in stalk-cut and shade-grown tobacco. A material was sought that will be useful under both types of tobacco culture, largely because variations in strains of these types are common in the Connecticut Valley and considerable insurance against injury is needed. Crop injury of any kind often affects leaf quality, if not yield. Most materials that appeared safe for use in Broadleaf tobacco in 1958 or 1959 and were reported by DeHertogh, et.al., to look promising for use in flue-cured tobacco (1), injured one or more commercial strains of Connecticut shade-grown tobacco. Amiben appeared promising in one or both Connecticut tobaccos for three seasons but then caused injury in 1962. At this time, diphenamid looks most promising but must be evaluated further.

It appears that degree of herbicide incorporation into the soil around the transplants is a significant factor in determining herbicide selectivity in tobacco. With the current cultural practices in shade-grown tobacco, thorough incorporation of herbicide is inevitable. This decreases the safety margin of herbicides such as EPTC, the triazines and probably amiben. Amiben has injured tobacco only in those tests where cultivation thoroughly incorporated the herbicide. The selectivity of diphenamid appears to be less affected by soil incorporation than any of the other herbicides tested in Connecticut tobacco. Further work should be directed toward determining the extent of this selectivity. The possibilities of growing tobacco with cultivation practices that avoid excessive herbicide incorporation should not be overlooked.

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Acknowledgement

The cooperation of the following companies and their representatives in supplying and evaluating tobacco used in these experiments is gratefully acknowledged:

LEGUME ESTABLISHMENT IN 1962 - A PROGRESS REPORT[1]

D. L. LINSCOTT AND S. N. FERTIG[2]

ABSTRACT

The effects of herbicides on alfalfa and birdsfoot trefoil establishment were studied in the field. Treatments follow: Preplanting incorporated-EPTC, R-1607, R-2061, R-1910. All preplanting-incorporated herbicides were evaluated at 4 and 6 lb/A. Preemergence - diphenamid, 4 and 6 lb/A.; G-36393, 1/2, 1 and 1/2 lb/A. Postemergence - dimethylamine salt of 4-(MCPB), 1 and 1 1/2 lb/A., iso-octyl ester of 4-(2,4-DB), 1 and 1 1/2 lb/A.; dimethylamine salt of 4-(2,4-DB); 1 1/2 lb/A.; alkanolamine salt of 2,4-D, 1/4 and 1/2 lb/A., dalapon, 2 lb/A.; dalapon + dimethylamine salt of 4-(2,4-DB), 2 lb. + 1 1/2 lb/A.

Early-season weed control effected by preplant herbicides EPTC and R-1607 allowed for establishment of both alfalfa and birdsfoot trefoil in spite of drouth from the time of planting until first cuttings on July 17. On the basis of stand counts EPTC appeared slightly more effective than R-1607, but the difference is not significant statistically. Legume plant populations for these two compounds averaged over 10 plants per square foot. Both compounds gave effective nutgrass control at the 4 lb/A. rate. R-2061 and R-1910 were not as effective as the previously mentioned thiocarbamates. R-1910 was more effective than R-2061 in controlling nutgrass and annual grasses but less effective on broadleaved weeds.

Both diphenamid and G-36393 were unsatisfactory as preemergence treatments for controlling grasses and broadleaved weeds. Birdsfoot trefoil was seriously set back by G-36393 and was injured by diphenamid. Alfalfa was slightly more tolerant.

All phenoxy compounds evaluated as postemergence treatments gave satisfactory broadleaved weed control but no grass control. Grasses were in fact stimulated by removal of broadleaved weed competition. All the phenoxy butyric analogs reduced legume stands at the 1 1/2 pound rates. Dalapon plus 4-(2,4-DB) treatments resulted in satisfactory legume establishment in one experiment and failure in another. The difference was attributed to timeliness of precipitation in the former case. Dalapon at 2 lb/A. was effective in controlling nutgrass. However, the secondary effect of increased competition of broadleaved species was suspected to have been a primary factor in reducing the nutgrass population.

[1] Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the New York State College of Agriculture at Cornell University.

[2] Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Professor of Agronomy, New York State College of Agriculture at Cornell University, Ithaca, New York.

The Influence of Drought on the Behavior of Herbicides Used in Legume Establishment

R. A. Peters[1,2]

While the Northeastern states are generally considered to be in the humid zone, periodic droughts are not infrequent. The summer of 1962 was a notable example of such a drought period. Legume seedings are particularly susceptible to drought because of their relatively slow development during the first few weeks of growth compared with commonly associated weeds.

The influence of prevailing moisture conditions on the effectiveness of herbicides is well established (1, 2, 3). Very little information is available, however, on the influence of moisture conditions on the effectiveness of herbicides used during legume establishment.

The following paper reports results obtained during the summer of 1962 from an alfalfa establishment experiment at three loactions within the state of Connecticut. Two of the locations were in rainfall deficit areas.

PROCEDURE

Alfalfa was planted by conventional means as follows: at Storrs on April 19, at Ellington in the Connecticut River Valley on May 8 and at Harwinton in the northwestern uplands on April 18. The variety Dupuits was used At Storrs and Vernal at the other two locations.

The timing of the chemical applications is given in Table 1.

Table 1. Dates of Herbicide Application

Type of Treatment	Location		
	Storrs	Ellington	Harwinton
Pre-plant	April 18	May 8	April 18
Pre-emergence	April 27	May 8	April 18
Post-emergence	May 28	May 31	May 25

[1] Associate Agronomist, Department of Plant Science, University of Connecticut, Storrs, Conn.

[2] The cooperation of Jeff Nye, Associate County Agent, Litchfield County and John Elliott, County Agent, Tolland County, in carrying out these experiments is acknowledged.

Scientific Contribution No. 10 , Agricultural Experiment Station, University of Connecticut, Storrs.

Rainfall for the 1962 season is given in Table 2.

Table 2. Monthly Precipitation at the Experimental Sites

Location	Month					
	April	May	June	July	Aug.	Sept.
Storrs	3.65	2.45	4.39	1.84	3.67	3.06
Ellington	2.63	1.11	5.30	1.28	4.43	3.52
Harwinton[1]	3.80	1.80	4.05	1.20	4.30	2.91

[1]Data actually from Torrington, a few miles away from the plots.

The soil type at Storrs and Harwinton was a fine sandy loam while at Ellington it was a very fine sand.

The stage of development and predominant species at the time of the post-emergence treatments were as follows:

1. Storrs

   Alfalfa - 2nd true leaf stage, 1½ in. tall.
   Yellow foxtail (Setaria lutescens) 3-4 leaves. 2 in. tall. A few plants tillering.
   Lambsquarter (Chenopodium album) 6 leaves. 1-2 in. tall. Other species included small crabgrass (Digitaria ischaemum) and rough pigweed (Amaranthus retroflexus).

2. Ellington

   Alfalfa - 1-2 leaf stage. ½-1 in. tall.
   Lambsquarter - 6 leaf stage. 1-2 in. tall.
   Pigweed - 4-5 leaf stage. 1-2 in. tall.
   Barnyard grass (Echinicoloa crusgalli) was present in several plots.

3. Harwinton

   Alfalfa - 4th true stage. 4 in. tall.
   Lambsquarter - 8-10 leaf stage - 4 in. tall.
   Yellow foxtail 4-5 leaf stage. 1-3 in. tall.

RESULTS

At Storrs the weed population included both broadleaf and grassy weeds. Total weed density was less than at the other two sites. This combined with a more favorable rainfall resulted in less repression of the alfalfa.

Significant increases in yield in the first cut (Table 3) were obtained at Storrs from dalapon 3 lb., 2,4-DB 1 lb., 2,4-DB 1 lb. + dalapon 2 lb., EPTC at 2 and 4 lb., dacthal at 4 and 8 and diphenamide at 4 lb. per acre. Temporary alfalfa injury was found following applications of 2,4-DB at 2 lb.

The specificity of the various herbicides followed the expected pattern. In general, 2,4-DB controlled broadleaf weeds but not grasses, dalapon controlled grasses but not broadleaf weeds, and the combination controlled both. Diphenamide controlled both, as did EPTC under the prevailing conditions. Dacthal was active on both types as well but was weaker on broadleaves. Poor control of ragweed was particularly obvious.

The regrowth harvested on October 3 showed no significant differences between treatments. This recovery of plots originally repressed by weed competition is in line with the response found before with alfalfa in the humid East (4). Usually any gain from the use of herbicides must be realized in the first cutting of the seeding year.

The soil moisture stress prevailing at Ellington and at Harwinton was apparent soon after planting. While all species were visibly affected by the low water availability, alfalfa was most severely restricted. As measured on August 3 the moisture level was down to less than 3 per cent in soil having a moisture equivalent of 15 per cent at Ellington.

Table 4. Stand Density Estimates[1], [2]

Treatment (lb. a.i. or a.e. per A.)		Ellington July 20 Alfalfa	Ellington July 20 Broadleaf Weeds	Ellington July 20 Grassy Weeds	Harwinton June 7 Alfalfa	Harwinton June 7 Broadleaf Weeds	Harwinton June 7 Grassy Weeds	Harwinton Oct. 12 Alfalfa
Check		0.1	10.0	0.0	4.0	6.0	8.5	1.7
Dalapon	2	1.0	9.7	0.7	6.0	4.0	9.0	2.0
2,4-DB	1½	5.0	5.3	2.0	8.0	0.5	9.0	3.0
2,4-DB +Dalapon	1½ 2	6.3	2.0	5.0	3.0	1.5	7.5	4.3
DNBP	1½	1.3	8.0	4.0	6.0	0.5	9.0	2.3
EPTC	4	8.0	2.3	0.0	8.5	2.0	2.0	8.7
Dacthal	8	1.3	9.3	0.0	8.0	4.0	2.5	7.0
Diphenamide	4	3.0	5.0	4.0	8.5	1.0	4.5	8.7

[1] 10 - Stand over entire plot and maximum vigor; 0 - no stand.

[2] Each estimate is an average of 3 replications.

Table 3. Yields of Alfalfa and Associated Weeds Following Treatment

Chemical (lb. a.i. or a.e. per A.)		Dry Matter per Acre (lb.)							
		Storrs				Ellington			
		July 25, 1962			Oct. 3, 1962	July 27, 1962			Oct. 1, 1962
		Alfalfa	Broadleaf Weeds	Grassy Weeds	Alfalfa	Alfalfa	Broadleaf Weeds	Grassy Weeds	Alfalfa
Check		1470 de[1]	1380	1860	1510	0.0	6070	0.0	140
Dalapon	2	910 e	2330	40	1750				86
Dalapon	3?	2290 cde	2550	86	1610				
2,4-DB	1	2940 abc	170	1120	1750				
2,4-DB	1½								1370
2,4-DB	2	1300 de	86	2770	1650				
2,4-DB	1½					290	1510	880	1200
+Dalapon	2	3460 abc	0.0	0.0	1670				
2,4-DB	1								
Dalapon	+2	1300[2]	1040	910	1650				
DNBP	1½								
EPTC	2	3150 abc	95.0	730	1720				
EPTC	4	3890 a	0.0	0.0	2000	1110	800	0.0	1570
Dacthal	4	3630 ab	300	40	1780				
Dacthal	8	2890 abc	910	130	1900				
Diphenamide	2	2460 bcd	650	390	1900				
Diphenamide	4	3630 abc	0.0	0.0	1610	513	2080	1110	1230
				N.S.					

1/ Yields followed by the same letter are not significantly different at the 5 per cent level as measured by Duncan's Multiple Range Test.

2/ No test of significance made.

Table 4 gives stand density ratings made on July at Ellington. Pigweed and lambsquarter dominated the check plots so completely that it was almost impossible to find either grass or alfalfa plants. At this time the two broadleaf species were 3 feet or more in height. In contrast, at Harwinton 75 per cent or more of the weed stand was yellow foxtail. While the heavy stand of foxtail did not eliminate the lambsquarter, it was clearly repressed. Both moisture and light were involved in the differences between locations. The dense tall growing stand of broadleaf weeds at Ellington caused much heavier shading of the associated species than at Harwinton. At the latter location the grass was dominant but because of its habit of growth, it did not shade the broadleaf weeds.

The effect on the alfalfa was similar in either location, namely, severe repression of growth and reduction stand. This was reflected in yields both in the initial cut and in the regrowth.

By far the most effective herbicide in the two drier sites was EPTC (Table 3 and 4). While the plots reported in this paper were disked after EPTC application, adjacent areas not disked after spraying also had very good weed control. At Ellington where broadleaf weeds were predominant, 2,4-DB, 2,4-DB + dalapon and diphenamide were also quite effective as shown by the yield data in Table 3. In contrast, at Harwinton, EPTC, dacthal and diphenamide (Table 4) were the only effective materials. Dalapon was not effective on the foxtail in this experiment because of the advanced stage of development (4-5 leaves) at the time of spraying. While 2,4-DB gave good broadleaf weed control, this was of little significance because of the dominance of foxtail.

While EPTC activity was increased by the dry soil conditions, the activity of the pre-emergence materials, diphenamide and dacthal, was clearly reduced. Stunting of broadleaf weeds which did germinate was general but enough plants recovered to give considerable competition to the alfalfa by the time of the first harvest. Yellow foxtail was eventually controlled by dacthal but emergence did occur with the small plants surviving for several weeks on a very restricted root system. Barnyard grass control was quite poor with recovery general of this species.

In all tests DNPB was only moderately effective despite weather conditions which maximized its activity. It was particularly poor in controlling pigweed and grasses.

The impact of controlling weeds at the two dry locations was dramatic (Table 3). At Ellington yields ranged from 0 to 1200 pounds for the first cut and from 140 to 1500 pounds for the second cut in October. The yields at Storrs with more nearly normal rainfall varied from 900 to 3900 pounds for the first cut but no significant differences persisted at the time of the second cut in October.

DISCUSSION

The data show that the benefits to be realized from the use of herbicides on alfalfa are maximized during periods of moisture stress. The water shortage at Ellington and Harwinton was most acute during May and July. May was particularly critical since the alfalfa was becoming established during this period and most of the herbicide treatments were applied. Post-emergence herbicides such as dalapon and 2,4-DB will be more effective for weed control when moisture is limited than will pre-emergence materials such as diphenamide and dacthal. Since the former are foliar absorbed, they are not dependent for entry into the plants on H_2O. A disadvantage of post-emergence materials is that weeds are not eliminated during the critical 3 to 4 weeks after legume emergence. The latter materials of low solubility require sufficient rainfall after application to carry them into the soil. In the experiments reported weed control was decreased but injury to the legumes was increased. While no satisfactory explanation can be given, the slow growth of the young alfalfa plants may have been a factor. EPTC is a soil applied material but because of unique properties its activity is enhanced by the fixation which occurs on dry soils.

In the experiment with birdsfoot trefoil, 2,4-DB at 1½ lb. had a severe effect especially in combination with dalapon. Dacthal and diphenamide also caused stunting of trefoil. Alfalfa did not show indications of injury, however, at rates up to 1½ lb.

SUMMARY

Comparisons were possible in Connecticut during 1962 in the effectiveness of chemical weed control in locations of both nearly normal rainfall (Storrs) and of severe drought (Ellington and Harwinton). While gains from control of the weeds gave significant increases in alfalfa yields at all locations, the greatest gains were realized in the drier sites. While the gain was no longer evident in regrowth at Storrs as measured in October, the gain was still very marked at the Ellington site even after rainfall again became abundant.

The activity of the various herbicides was effected differently by the range in moisture conditions. EPTC activity was enhanced by the dry conditions and was the best chemical treatment for the season. Diphenamide and dacthal, which were nearly equal to EPTC in effectiveness at Storrs, were less effective in weed control at the dry sites and less selective on alfalfa. Dalapon and 2,4-DB were least affected by the moisture status.

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SOYBEAN WEED CONTROL IN MARYLAND [1/]

J. A. Meade and N. C. Glaze [2/]

The interest in finding a satisfactory herbicide for soybeans continues to be intense. With increased acreage being devoted to the production of certified seed beans the need for a good, long term weed control chemical which will stop green weeds and green weed seeds from contaminating the harvested beans increases.

The results from field trials in 1961 and 1962 are very encouraging.

PROCEDURE

The conditions and timing of the two experiments are listed in Table 1.

TABLE 1

	Experiment	Seeding	Treatment	Harvest	At treatment	
					Air temp	Soil Moisture
1961	Marlboro	June 12	June 13	Oct. 24	85° F	Moist
1962	Hurlock	June 5	June 5 June 6	Oct. 29	80° F	dry on top wet

The soil at Marlboro on the Western shore is an Adelphia fine sandy loam. The soil at Hurlock, on the Eastern Shore, is a Sassafras silt loam.

The first major precipitation at Marlboro in 1961 was 0.19 inches on June 15, and 1.28 inches on June 22. Rainfall was near normal the rest of the year. At Hurlock in 1962, 0.5 inches of rain stopped work on June 5, and the rest of the treatments were applied June 6. Then on June 13, 2.20 inches fell and 1.70 inches occurred on June 20. The rest of the season was quite dry.

The sprays were applied with a bicycle sprayer in 30 gpa. The granulars were spread with a calibrated 18 inch lawn spreader with 36 inch plywood wheels. Where indicated as "inc", the materials were incorporated with a roto-tiller.

The plots were 3 rows by 20 feet with 3 replications. Eighteen feet of the center row were pulled for harvest.

The following companies furnished materials for these tests. Amchem Inc., Diamond Alkali Co., Dow Chemical Co., E. I. DuPont, Geigy Chemical Co., Eli Lily Co., Monsanto Chemical Co., Naugatuck Chemical Div., Stauffer Chemical Co., Swift and Co., and Upjohn Co. Appreciation is expressed to these companies.

1/ Scientific Article No. A1025 Contribution No. 3420, of the Maryland Agricultural Experiment Station, Department of Agronomy.

2/ Assistant Professor and Graduate Assistant, respectively, Department of Agronomy, Maryland Agricultural Experiment Station, College Park, Maryland.

RESULTS

Table 2 lists the treatments and results for those chemicals used in both 1961 and 1962.

Amiben continued to provide good, season-long control of grasses and broad-leaved weeds. Observations over the two years indicates that 3 lb/A is probably going to be a minimum. The granular did not seem to give as good weed control for as long a period as the liquid.

Dinitro performed as expected, giving good early control especially of broad-leaves and not retaining much activity through the season. The granular in 1961 gave better control of grasses than the liquid. PCP behaved about the same as DNBP except that control lasted longer than with DNBP.

Dacthal shows considerable promise as a soybean herbicide. At 8 lb/A control of grasses and broadleaves was very good through the season in both years.

U-4513 or diphenamid presents a problem since it exhibited poor weed control in 1961 but gave very good season-long control in 1962. Here again, the granular and liquid were about equal.

Linuron in 1961 was an outstanding herbicide with some early stunting at 3 lb/A. In 1962 the rate was lowered. The 3/4 lb/A rate did not give satisfactory control of grass. The rate for satisfactory control in soybeans has yet to be established since 1½ lb/A in 1962 also gave some early stunting.

Prometryne also varied between the two years since it did not give good weed control in 1961 but gave excellent control in 1962. This material at 4 lb/A practically eliminated the soybeans.

The combination of CIPC and NPA gave very good early weed control in both years but at harvest time the control was poor. The beans showed stunting early in 1962 and this effect was still evident at harvest time.

Table 3 lists the results from some chemicals used in 1962 only. Stauffer's R-1607 gave good weed control through the season. It was applied without incorporation on June 5, just prior to 0.5 inches of rain. This treatment was repeated on a different set of plots the next day and roto-tilled. It appears that the 0.5 inches of rain substituted for the incorporation. The high rate on the day before the rain caused some early stunting. The use of EPTC also resulted in very good weed control.

Monsanto's CP 17029 (2,4-Bis-(3-Methoxypropylamine)-6-Methylthio-s-triazine) produced essentially clean plots season long. The high rate caused some early stunting. Another new product, Naugatuck's Alipur, displayed potential as a soybean herbicide. The 5 lb/A rate caused some early stunting.

Trifluralin as a granular gave very good control of grasses and broadleaves at 2 and 4 lb/A.

The use of 2,4-D at ¼ and ½ lb/A did not give acceptable control. No bean injury was evident.

SUMMARY

The use of DNBP and its counterpart PCP are still considered satisfactory herbicides for early season control. Randox is good only in situations where grasses are the major problem.

Amiben, linuron and Dacthal after 2-3 years in the field appear to be the most promising new materials for soybeans. A satisfactory rate for linuron remains to be established.

Of the carbamates it appears that R-1607 performs better than EPTC.

Trifluralin, Alipur, U-4513 (diphenamid) and CP 17029 are worthy of further study.

One problem that remains is the control of morning glory in soybeans. None of the chemicals tested controlled this weed. R-1607, CP 17029 and Alipur gave some control but the weed still tied up the beans at harvest time.

TABLE 3 - Yield of soybeans and injury ratings of grass and broadleaf weeds from pre-emergence experiments in soybeans. George Osborne farm, Hurlock, Maryland. 1962.

Chemical	Form	Rate		6-25 Gr.	6-25 Brlf	7-10 Gr.	7-10 Brlf	10-29 Gr.	10-29 Brlf		bu/A
R-1607	Liq	3	b	9	9	9	7	8	5	a	29.1
R-1607	Liq	6	b	10	10*	10	10	9	9	a	23.0
R-1607	Liq	3		10	10	10	10	7	8		26.7
R-1607	Liq	6		9	10	10	10	6	6		29.5
EPTC	Liq	3		10	9	10	9	8	9		29.5
EPTC	Liq	6		9	9*	10	9	9	8		25.8
CP 17029	Liq	2		9	10	9	9	7	9		28.6
CP 17029	Liq	4		10	10*	10	10	9	10		25.3
Alipur	Liq	2.5		8	10	6	10	4	6		25.8
Alipur	Liq	5		10	10*	9	10	8	9		23.9
Trifluralin	Gran	2		9	9	9	9	9	7		32.4
Trifluralin	Gran	4		10	9	10	9	9	6		28.1
2,4-D	Liq	¼		3	3	1	3	0	2		29.1
2,4-D	Liq	½		4	1	5	1	4	1		23.9
Check											31.0

a - applied on 6-5 just prior to 0.5 inches rain. Others applied 6-6.

b - not incorporated

* - soybean injury

TABLE 2 - Continued

Chemical	Form	Rate lbs/A	1961 6-28 Gr.	1961 6-28 Brlf	1961 7-20 Gr.	1961 7-20 Brlf	1961 10-24 Gr.	1961 10-24 Brlf	1961 bu/A	1962 (a) 6-25 Gr.	1962 (a) 6-25 Brlf	1962 (a) 7-10 Gr.	1962 (a) 7-10 Brlf	1962 (a) 10-29 Gr.	1962 (a) 10-29 Brlf	1962 (a) bu
Randox	Liq	4								4	0	6	1	5	3	23
Randox	Liq	7	10	10	9	4	9	2	19.1							
Linuron	Liq	3/4								7	8	4	9	2	9	27
Linuron	Liq	1½	6	6	8	8	10	9	31.9	8	10*	9	9	5	8	24
Linuron	Liq	3	10	10*	9	9	9	10	28.8							
Prometryne	Liq	2	2	3	1	0	0	2	16.1	10	9*	10	10	5	6	31
Prometryne	Liq	4	10	9	6	3	4	0	19.2	10	10*	10	10	10	10	
CIPC + NPA	Liq	2+2	10	9	9	4	8	3	21.5	9	9*	8	8	4	6	26
CIPC + NPA	Gran	2+2								9	9*	7	7	2	3	24
PCP	Pellets	15	3	9	2	9	2	9	26.0	9	10	8	8	7	9	29
PCP	Pellets	20	4	9	0	9	0	7	23.8	8	10	8	8	5	9	31
Check hoes									33.0							
Check cult.									21.1							31.
Check Unt.									18.9							
			LSD_{05} = 8.1										N.S.D.			

* indicates bean injury

(a) all treatments applied just prior to 0.5 inches rain. Prometryne applied next day

TABLE 2 - Yield of soybeans and injury ratings of broadleaf and grass weeds from pre-emergence experiments in soybeans for the years 1961 (Marlboro research farm) and 1962 (George Osborne farm, Hurlock, Md.) (0 = no injury, 10 = complete kill).

			1961							1962 (a)						
		Rate	6-28		7-20		10-24			6-25		7-10		10-29		
Chemical	Form	lbs/A	Gr.	Brlf	Gr.	Brlf	Gr.	Brlf	bu/A	Gr.	Brlf	Gr.	Brlf	Gr.	Brlf	bu/A
Amiben	Liq	2								10	9	9	7	5	6	31.4
Amiben	Liq	3	6	7	8	7	7	4	26.8	10	10	8	10	9	9	29.1
Amiben	Liq	4	10	10	9	8	10	8	21.1							
Amiben	Gran	2								6	4	7	4	4	6	33.3
Amiben	Gran	3	8	7	7	8	6	3	23.8	9	8	5	5	9	9	29.0
Amiben	Gran	4	8	7	8	8	6	3	23.8							
Dinitro	Liq	4	7	10	2	7	1	1	23.4	5	5	3	0	2	3	28.2
Dinitro	Liq	6	5	2	7	7	3	3	21.4	8	9*	5	9	0	6	25.8
Dinitro	Gran	4	9	8	3	5	2	1	23.8							
Dinitro	Gran	6	9	10	6	7	4	0	15.4							
Dacthal	Liq	4	8	5	5	5	6	1	26.8	9	9	9	9	5	5	31.4
Dacthal	Liq	8	9	5	7	7	9	5	25.7	10	10	10	9	9	8	26.7
Dacthal	Gran	4	6	0	4	5	5	3	21.5	9	8	10	9	9	6	32.4
Dacthal	Gran	8	7	7	7	7	6	4	26.4	10	10	10	9	9	6	33.3
U-4513	Liq	2	2	3	0	1	2	2	20.4	8	9	6	9	6	9	31.0
U-4513	Liq	4	5	0	3	3	6	3	14.6	10	10*	10	10	8	9	24.0
U-4513	Gran	2	2	3	1	1	1	0	17.3	7	6	6	7	4	9	26.2
U-4513	Gran	4	4	0	0	0	6	3	16.4	9	10	9	9	8	8	26.7

DECOMPOSITION OF 4-(2,4-DB) IN SILAGE[1/]

D. L. Linscott and R. D. Hagin[2/]

Introduction:

Research workers in weed control are becoming increasingly aware of the need for information on factors influencing the degradation of herbicides. These scientists are cognizant of their responsibilities in developing herbicides and methods of weed control which will minimize the chemical residue problem.

Many studies have established the fact that herbicides are decomposed in soil as a result of microbial action (1). Therefore, it seemed likely that other microbiological processes such as silage fermentation would be capable of degrading herbicides. Considering this concept, a series of preliminary laboratory investigations were initiated in the fall of 1961.

Procedure:

Experiment 1. Alfalfa and birdsfoot trefoil plants were grown in an open air greenhouse. Plants were harvested at the bloom stage and chopped to $\frac{1}{4}$ inch pieces. One half of the forage was inoculated with minute quantities of finely ground air dry soil and thoroughly mixed. The other half was mixed only. Twenty five grams (wet weight) of chopped forage was tamped as tightly as possible by hand into small glass vials. During the tamping process a total of 375 μg of carboxyl labeled 4-(2,4-dichlorophenoxy) butyric acid, 4-(2,4-DB), in 50 per cent ethanol was added to each vial. Control samples were quick frozen and stored in a freezer at 5 degrees F. Experimental forage was allowed to ferment for 45 days. All treatments were in quadruplicate. At the end of the fermentation period silages were extracted 5 minutes with 50 ml of absolute ethanol in a small Waring blender. The blend was filtered with Whatman 1 paper, washed several times with hot ethanol and made to volume. Aliquots of filtrate were evaporated in planchets and counted with a thin end-window gas-flow counter.

Experiment 2. This trial was identical to Experiment 1 except that, in addition, labeled herbicide was added to previously fermented forage to serve as a control. After fermentation the silage and controls were blended with hot isopropanol and allowed to stand overnight. The blend was filtered, made to volume with isopropanol, and counted as in Experiment 1.

Experiment 3. Twenty five grams (wet weight) of alfalfa forage was treated with the following concentrations of herbicide: (A) 0.4 mg 4-(2,4-DB)-C^{14} (previously fermented silage, frozen immediately) (B) 1.0 mg 4-(2,4-DB) + 0.4 mg 4-(2,4-DB)-C^{14}, (C) 10.0 mg 4-(2,4-DB) + 0.4 mg 4-(2,4-DB)-C^{14}, (D) 100 mg 4-(2,4-DB) + 0.4 mg 4-(2,4-DB)-C^{14}. Forages were mixed and ensiled in test tubes for 30 days.

1/ Agronomy paper No. 607, Cooperative investigations of the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture and the New York State College of Agriculture at Cornell.

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After fermentation the silages were extracted with acetonitrile for a period of 48 hours essentially according to methods of Bach (2). Comparable quantities of extracted silage residue were made into bricks with a Carver press (6000 psi for 10 minutes). Bricks were counted for radioactivity with equipment described in Experiment 1. Acetonitrile was evaporated from the extracts and the remaining aqueous solution adjusted to pH 2 with HCl. The acid solution was shaken out 5 times with equal volumes of ether. The ether fraction was shaken out 5 times with equal volumes of 5 per cent sodium bicarbonate. The resulting bicarbonate fraction was placed in bags constructed from Fischer dialysis tubing (average pore size, 4 microns) and dialyzed with distilled water for 14 hours. The bags were agitated to facilitrate movement of compounds through open pores. A continuous drip and overflow system was used that allowed bathing the dialysis bag with fresh water. One liter of dialysate was collected over the 14 hour cleanup period. The dialysate was acidified to pH 2 and shaken out with ether. All fractions were made to volume and counted as previously described. Aliquots of the ether fractions were spotted on Whatman No. 1 filter paper and allowed to ascend to a constant distance from the source. Isopropanol, ammonia and water (80-10-10) was the solvent. Chromatograms were scanned with a thin end window gas-flow counter.

Results and Discussion:

In Experiments 1 and 2, 13 to 23 per cent of the radioactivity of the 4-(2,4-DB)-C^{14} applied to alfalfa prior to ensiling disappeared (Table 1). Birdsfoot trefoil silage degraded 49 to 54 per cent of the applied herbicide. If the forage was inoculated with soil prior to fermentation the loss was somewhat greater. It is evident that C^{14} losses were real, rather than extraction variables, as evidenced by low residual activity in the extracted silage. (Table 2, 3).

Experiment 3 corroborated evidence of herbicide degradation from the previous experiments. Approximately 63 per cent of the radioactivity from the 4-(2,4-DB)-C^{14} disappeared after ensiling for 30 days. (Table 3). Apparently the labeled carbon molecules were lost as volatiles resulting from microbial action. Experiments are in progress to determine the nature of the loss.

It was important to determine the nature of labeled compounds extracted in Experiments 1 through 3. First attempts to characterize the extractable C^{14} were inconclusive. Alcohol and ether extracts of herbicide treated silages and forage could not be resolved chromatographically into definite peaks. Activity was generally associated with green pigments spread in several regions over the paper. In all cases rF values were lower than controls. However, after cleanup by dialysis, definite free acid peaks were established on paper chromatograms (Figure 1). Quantitative analysis for the herbicide by isotope dilution now becomes a possibility. The identity of the C^{14} compounds extracted from the silage is uncertain at this time. However, it appears that the original herbicide is present plus one and perhaps two metabolites.

The authors do not claim that the herbicide decomposition evidenced in these experiments will take place under natural ensiling conditions though there is a definite possibility. The nature of breakdown in these experiments, whether aerobic or anaerobic in nature, has not been determined. Anaerobic microbial activity is of prime importance in producing good silage. Significant herbicide degradation under farm conditions probably would have to be induced by anaerobes.

That ensiling represents a possible means of inducing herbicide degradation is supported by the work of Derbyshire and Murphy (3). These investigators found that diazinon, an insecticide, is degraded by ryegrass silage. Only 3 per cent of the amount applied remained after 22 days of fermentation in quart glass jars. Again, the nature of decomposition was not established. However, as breakdown was rapid between 5 and 22 day fermentation periods it seems apparent that anaerobic organisms prevailed.

Summary:

Dialysis has proved a valuable technique in cleaning up silage prior to herbicide analysis.

Degradation of 4-(2,4-DB)-C^{14} by legume silage has been demonstrated under laboratory conditions. As evidenced by loss of radioactivity, ensiling resulted in degradation from 13 to 63 per cent of herbicide applied. The possibility of ensiling as a means of reducing herbicide residues is suggested.

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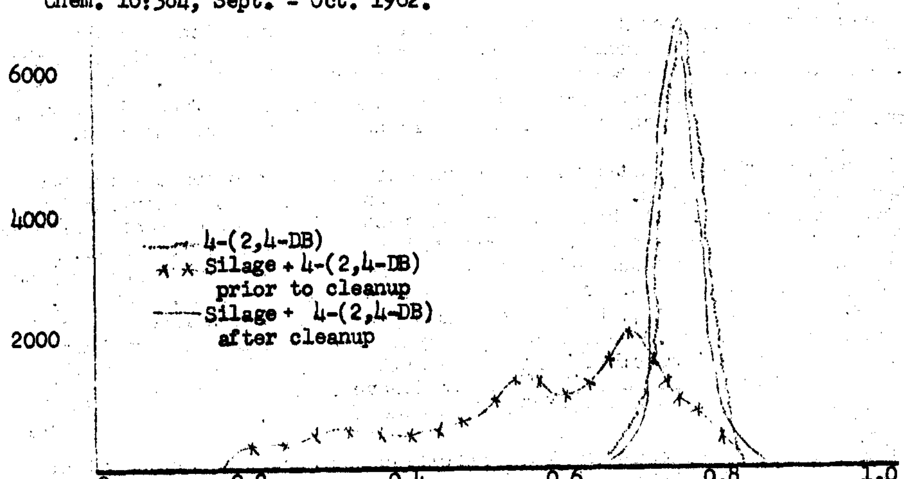

Figure 1. Dialysis as a cleanup method prior to determining 4-(2,4-DB)-C^{14} in silage by ascent paper chromatography. (Solvent isopropanol ammonia, water, 80-10-10 by volume).

Table 1. Effect of legume fermentation on the concentration of 4-(2,4-DB)-C^{14} applied during ensiling. (Fermentation period 45 days).

EXPERIMENTAL MATERIAL	EXPERIMENT 1 Net c.p.m.	EXPERIMENT 1 % of control	EXPERIMENT 1 % of initial	EXPERIMENT 2 net c.p.m.	EXPERIMENT 2 % of control	EXPERIMENT 2 % of initial
Alfalfa						
Control	1532	100		1682	100	
Silage Initial	1411	92		1635	97	
Silage	1222	80	87	1037	63	63
Silage Inoculated	963	62	68	1170	70	71
Birdsfoot trefoil						
Control	1532	100		1682	100	
Silage Initial	1504	98		1640	97	
Silage	765	50	51	740	44	45
Silage Inoculated	406	26	27	689	41	42

Table 2. Carbon^{14} in bricks of extracted silage residue.

EXPERIMENTAL MATERIAL	EXPERIMENT 2 net c.p.m.	EXPERIMENT 2 % of control
Alfalfa		
Control (Non-extracted)	1303	100
Silage Initial	1	0
Silage Inoculated	148	11
Birdsfoot trefoil		
Control (Non-extracted)	1320	100
Silage Initial	0	0
Silage	77	6
Silage Inoculated	51	4

Table 3. Effect of 30 days fermentation on varied amounts of 4-(2,4-DB) and 4-(2,4-DB)-C^{14} applied to alfalfa forage prior to ensiling.

EXPERIMENT 3

Fraction		Carbon^{14} detected in counts per minute 1/ A	B	C	D	Mean of B, C, D
I.	Total activity after acetonitrile extraction	109,342	36,002	42,926	43,210	40,713
II.	Water soluble fraction after ether shakeout	437	70	205	75	117
III.	Ether soluble fraction after $NaHCO_3$ shakeout	23,147	10,125	7,906	7,336	8,456
IV.	Non-dialyzed $NaHCO_3$ soluble fraction	7,573	1,870	2,630	2,125	2,208
V.	Dialyzed $NaHCO_3$ fraction (acidified to pH 2)					
	a) water soluble	309	191	147	241	193
	b) ether soluble	77,876	23,746	32,038	33,458	29,747
VI.	Pelleted plant residue - extracted	600	576	510	150	412
	not extracted	17,801	---	---	---	---
VII.	Adjusted counts (97% recovery)	112,723	37,115	44,253	44,546	41,971
VIII.	Per cent C^{14} remaining in silage	100	33	39	40	37
IX.	Per cent C^{14} missing from silage	0	67	61	60	63

1/ "B, C, D" represent respectively 1 mg, 10 mg and 100 mg quantities of 4-(2,4-DB) + 0.4 mg 4-(2,4-DB)-C^{14} added to 25 grams of alfalfa forage prior to fermentation. "A" represents 0.4 mg 4-(2,4-DB)-C^{14} added to previously fermented silage and immediately frozen.

THE DETERMINATION OF RESIDUES OF KURON IN BIRDSFOOT TREFOIL AND GRASSES 1/

M. G. Merkle2/ and S. N. Fertig3/

Introduction

Birdsfoot trefoil (Lotus corniculatus) has become increasingly important as a forage crop in New York during the last decade. However, the inability of seedling trefoil to compete favorably with broadleaved and grassy weeds has been a serious limitation in obtaining trefoil stands. To reduce weed competition, many farmers plant an oat companion crop, but some workers have reported the companion crop to be as detrimental as the weed competition.

Presently, the only herbicides approved by the Food and Drug Administration for use on birdsfoot trefoil are diuron, dalapon, MCPA, DNBP, IPC, CIPC and 4-(2,4-DB). However, the above chemicals do not give adequate control of some of the perennial weeds such as cinquefoil (Potentilla recta), bedstraw (Galium mollugo) ox-eye daisy (Chrysanthemum leucanthemum) and white cockle (Lychnis alba).

Kuron, the mixed propylene glycol-n-butylether esters of 2-(2,4,5-trichlorophenoxy) propionic acid, appears to be effective against these weed species if applied in the fall at the rate of three-quarters pound per acre. However, from a national standpoint the acreage of trefoil does not provide a sales market of sufficient potential to insure that a chemical company would receive a profitable return from the investment necessary to obtain clearance for kuron from the Food and Drug Administration. In New York State, the nation's leading trefoil producer, trefoil is grown on approximately 500,000 acres. Thus, trefoil is of special interest to agricultural workers in New York State even to the extent of developing methods for determining residues of promising chemicals. For this reason the author spent a month in the laboratories of the Dow Chemical Company studying procedures which had been developed for determining kuron in sugar cane juice. These procedures were modified somewhat and used along with others to determine kuron residues in trefoil and grasses.

Objectives

1. To develop effective methods for determining kuron residues in birdsfoot trefoil and grasses.

2. To determine the effect of rate and time of application of kuron on residues in birdsfoot trefoil and grasses.

Review of Literature

Residues of kuron in forage were investigated using total chlorine analysis, absorption in the ultraviolet region, colorimetric procedures and gas chromatography with an electron affinity detecting device. The total chlorine method is of value as a check for samples containing high kuron residues, but its low sensitivity limits its use as a general procedure.

1/ Paper is condensed from a thesis submitted as partial fulfillment of the requirements for the Ph. D. degree, Cornell University, Ithaca, N. Y.

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Absorption in the ultraviolet region is of no value in analyzing samples treated in the field. Neither of these methods will be discussed further.

The colorimetric procedure employs the same principle as that developed by Marquardt and Luce (5) for determining kuron residues in sugar cane juice. This procedure involves the cleavage of the ether linkage with pyridine hydrochloride to form 2,4,5-trichlorophenol which is determined colorimetrically using 4-amino-antipyrine and potassium ferricyanide as the color producing reagents.

In general the ethers are less reactive than the alcohols. The unshared pairs of electrons on the oxygen atom give the ether molecule some basic properties and provide a point of attack for an acid reagent which readily explains the cleavage of ethers by acid. When an ether is heated with hydriodic acid, the ether linkage is broken and a mixture of alcohols and alkyliodides is formed. This procedure, often referred to as the Zeisel Alkoxyl Method, is used as a test for the presence of an ether linkage in compounds of unknown composition. Ethers in which the alkoxyl groups are n-butyl or larger require a more vigorous reagent for cleavage. Audrieth (1) found that pyridine hydrochloride possesses acid characteristics in the fused state and that it reacts with metals just as does hydrochloric acid in the aqueous state. Prey (7) utilized this acidic property to attack various ethers which are difficult to cleave except at high temperature.

The use of 4-aminoantipyrine as a color producing reagent dates back to 1907 when Michaelis (6) found that it could be oxidized to antipyrine red. Emerson (2) found that under alkaline conditions phenols would condense with 4-amino antipyrine to form intensely colored compounds and that phenol concentrations as low as one part in 8 millions could be detected. Gottlieb and Marsh (4) utilized the above reaction to determine the quantity of phenolic fungicides in fabric and Marquardt and Luce (5) applied it to the determination of kuron in sugar cane.

Methods which would eliminate the necessity of a "clean-up" procedure and which would give simultaneous separation, identification and quantitative determination of the compound have a definite time advantage over the existing colorimetric methods. Gas chromatography with certain detector modifications appears to be such a method. Until recently the sensitivity of the method was limited by the thermal detector but the development of gas ionization detectors has overcome this limitation. The energy of ionization can be supplied by a flame, heated filament or bombarding beta particles. The detector is sensitive to compounds containing electron-capturing functional groups such as esters, ethers, ketones and halides. Goodwin (3) applied the method to hexane extracts of cabbage, potatoes, tomatoes and tea treated with 0.05 parts per million of aldrin and 0.1 parts per million of dieldrin and obtained satisfactory detection without a prior clean up.

Experimental Procedure and Results

Laboratory Methods

The colorimetric method of Marquardt and Luce was modified in the following ways:

1. Extracting solvent. Methyl alcohol was replaced by hexane and acetone. When green foliage is extracted with alcohol, many of the plant pigments are also extracted and the recovery of kuron is difficult. Hexane removes few pigments but apparently is not efficient in removing kuron. The best procedure is to extract the foliage with acetone which removes both pigments and kuron. Then add 5 percent sodium sulfate to make a highly polar solution. The kuron can then be extracted from this solution with non-polar hexane.

2. Distillation apparatus. The steam distillation apparatus of Marquardt and Luce was replaced by a direct steam distillation apparatus consisting of a 600-milliliter Erlenmeyer flask with a 24-40 joint and a matching condenser. This apparatus gave a more rapid distillation and required less laboratory space. The efficiency of the apparatus was found to be approximately 95 percent by comparing the optical densities of two equal amounts of phenol, one of which was determined directly, while the other was steam distilled and then determined.

The authors also attempted to modify the method by cleaving the ether with hydriodic and hydrobromic acid, but all attempts failed. The pyridinehydrochloride use by Marquardt and Luce was found to be about 50 percent effective. This is a somewhat higher cleavage than Prey obtained with anisol under similar conditions, but the presence of the electron withdrawing chlorine atoms would be expected to facilitate the reaction. In addition, the aliphatic carbon atom of the ether bond is adjacent to the positively charged carbon atom of the ester group.

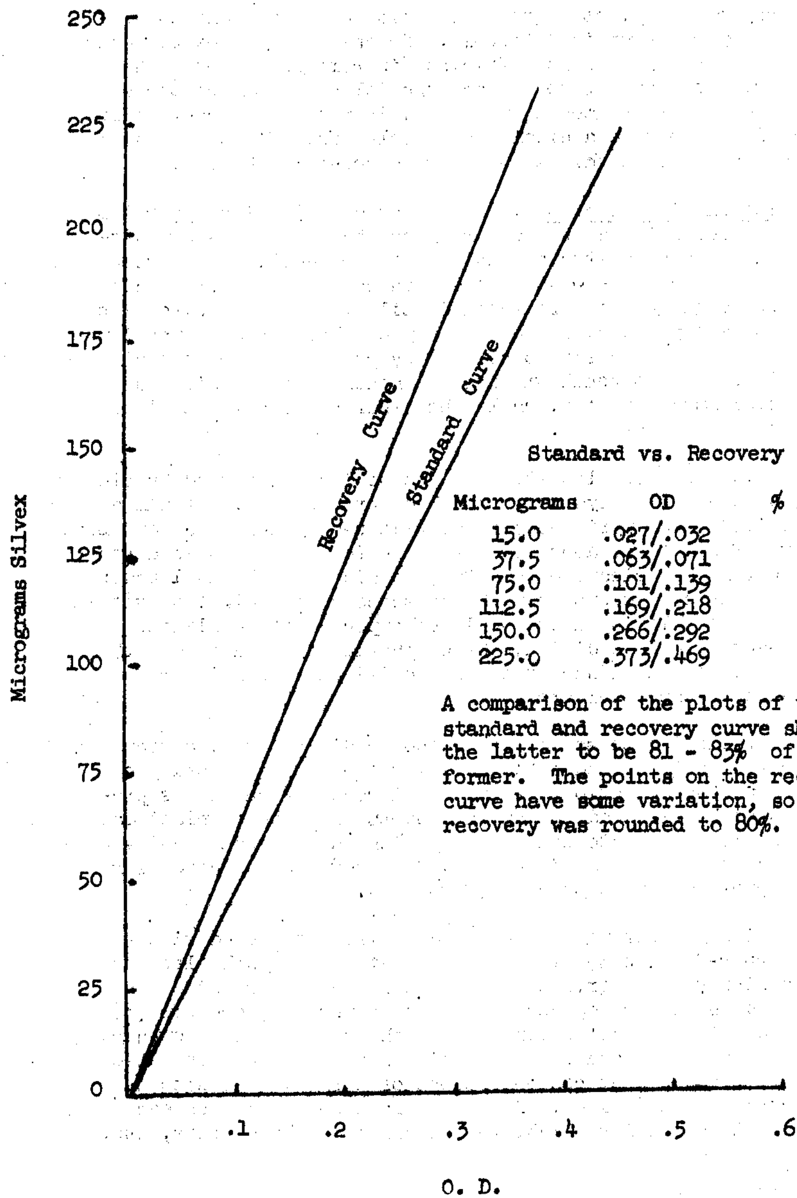
Following these initial method modifications, a standard curve was prepared by determining the optical density of known concentrations of kuron. A recovery curve was prepared by first adding known amounts of kuron to plant material, blending the material and comparing the optical density with that of the standard curve. The recoveries obtained were approximately 80 percent (figure 1).

The gas chromatography studies were conducted with a Barber-Coleman Model 10 gas chromatograph with electron affinity detector. Samples were prepared for injection into the chromatograph using the Reynolds procedure (3). Peak area and retention time of the samples were compared to peak areas and retention time from known concentrations of kuron so that concentrations of kuron in the samples could be determined. A new standard curve was run each day to allow for slight variations in nitrogen flow, etc.

Field Plots

All kuron applications were made with an Allis Chalmers-G tractor at a speed of four miles per hour and a pressure of 30 pounds per square inch. The carrier was water at the rate of 30

Figure 1. THE STANDARD AND RECOVERY CURVES FOR KURON.



Standard vs. Recovery Curve

Micrograms	OD	% Recovery
15.0	.027/.032	84
37.5	.063/.071	88
75.0	.101/.139	73
112.5	.169/.218	77
150.0	.266/.292	88
225.0	.373/.469	79

A comparison of the plots of the standard and recovery curve shows the latter to be 81 - 83% of the former. The points on the recovery curve have some variation, so the recovery was rounded to 80%.

samples contained only trefoil or grass. All samples were stored in a freezer at 0° F. from the time of harvest until residue determinations could be made.

A summary of the variation within plot samples would be as follows:

a. Rate of application from 0 to 3 pounds kuron per acre.

b. Time of application from April 21 to November 7.

c. Age of stand from seedling to two years old.

d. Time interval between application and sampling from 14 to 233 days.

e. Species sampled from birdsfoot trefoil to timothy and quackgrass.

Table 1 shows the results of analyses made on the trefoil samples using the colorimetric procedure. Both the 1.5 pound and the .75 pound rates left a detectable residue at the first harvest date, but neither rate left a residue in the regrowth. Since there was no residue detected in the regrowth, one could postulate that the extracting procedure was ineffective and that the only kuron detected was that on the external surface of the plants. Work done with ultraviolet absorption indicates that this is not a plausible explanation. Another possibility was that the kuron was present in the plant and extracted by the solvent, but that the concentration had been diluted below the sensitivity of the method. No explanation is offered as to whether this decrease in kuron concentration was due to a degradation by plant enzymes or to a simple dilution. This explanation is impeded by the sensitivity of trefoil to kuron. Thus, if one increases the concentration of kuron to a point that simple dilution is not a factor, one also has affected the enzyme system of the plant.

The results of analyses made using various methods have been summarized in Table 2. The residue in the check was subtracted from the sample residue in the gas chromatography procedure to make the procedure more comparable with other methods. Thus the residue reported for all these methods is actually the increase in residue in the sample over the residue in the check and not the absolute residue.

The colorimetric procedure using hexane as the extracting solvent and the gas chromatography procedure give kuron residues of almost equal value in most instances. There is no evidence that one method will consistently give higher residues than the other. However, the colorimetric procedure using acetone as the extracting solvent gives higher residues than either the hexane extractions or gas chromatography. Since the acetone

Table 1. The Analysis of Trefoil Samples Treated May 2, 1960 with Varying Rates of Kuron.

Rate per Acre	Harvest Date	Optical Density	Average Optical Density	Average Optical Density Minus Check	Microgram Silvex	Parts Per Million Assuming 80 Percent Recovery
1.5 lbs.	June 7, 1960	.265; .234; .248 .302	.262	.122	73	.91
.75 lbs.		.168; .163; .178 .172	.170	.030	15	.19
Check		.139; .142; .139 .142	.140	--	--	--
1.5 lbs.	June 22, 1960	.147; .142; .149 .194; .143; .138	.152	.009	--	--
.75 lb.		.150; .147; .149 .142	.147	.004	--	--
Check		.146; .140	.143	--	--	--
1.5 lbs.	Oct. 5, 1960	.138; .146; .141	.142	.001	--	--
.75 lb.		.148; .152; .139	.146	.003	--	--
Check		.140; .146	.143	--	--	--

Table 2. A Comparison of Methods for Determining Kuron Residues in Forage

Rate of Kuron Application	Crop Sampled	Total Chlorine Procedure	Hexane Extraction Colorimetric Procedure	Acetone Extraction Colorimetric Procedure	Gas Chromatography
1.50 lbs.	Trefoil	1.10	.91	3.61	1.10
.75 lb.	Trefoil	0.0	.19	.91	.41
.75 lb.	Quackgrass Regrowth	-	.19	.80	.24
.25 lb.	Quackgrass Regrowth	-	0.0	0.0	.22
3.00 lbs.	Timothy	-	3.36	-	2.65
1.50 lbs.	Timothy	-	1.16	-	1.10
.75 lb.	Timothy	-	1.10	-	.29
.75 lb.	Seedling Trefoil	-	1.19	3.60	1.14
.50 lb.	Seedling Trefoil	-	.66	-	.64
.25 lb.	Seedling Trefoil	-	.55	-	.19
.75 lb.	Trefoil Fall 1960	-	0.0	0.0	0.0
.50 lb.	Trefoil Fall 1960	-	0.0	-	.13
.25 lb.	Trefoil Fall 1960	-	0.0	-	0.0
.75 lb.	Trefoil Fall 1961	-	0.0	-	0.0
.50 lb.	Trefoil Fall 1961	-	0.0	-	0.0
.25 lb.	Trefoil Fall 1961	-	0.0	-	0.0

extraction procedure varies from the hexane extraction procedure only by the extracting solvent, it is apparent that acetone is more efficient in penetrating the plant material and extracting the kuron.

The explanation for the higher kuron residues in acetone extractions than in the gas chromatography is not as apparent. The ratio of acetone to plant material was increased from four to one in the extractions for gas chromatography to five to one in the extractions for colorimetric procedure. In addition, the sodium sulfate was increased from two percent to five percent in the colorimetric method. Other than this, the two extraction procedures are essentially the same. The higher residues in the colorimetric procedure must be due to some variation other than extraction procedure. This variation could be in the specificity of the methods. Gas chromatography is specific for kuron while the colorimetric procedure will detect kuron or its corresponding acid and phenol. If this explanation is valid, more than 50 percent of the kuron had been degradated to the acid or phenol in most samples. The validity of this assumption could be ascertained by applying kuron and harvesting the samples immediately. Since little degradation could take place, the two methods should then yield similar results.

Summary

Principal results from the analyses of field samples are summarized as follows:

1. Established trefoil treated with 1.5 pounds of kuron on May 2, 1960 and harvested 36 days later contained kuron residues of .91, 1.10, 1.10 and 3.61 parts per million as determined from hexane extracts with colorimetry, total chlorine analyses, gas chromatography and acetone extractions with colorimetry, respectively. Three-quarters pound of kuron per acre left residues of .19, 0, .41, and .91 parts per million for the above methods.

2. When trefoil and quackgrass were treated with similar rates of kuron, quackgrass showed higher levels of residue. This may be due to a variation in moisture content between the two species and not to a degradation of the kuron in trefoil.

3. The kuron residue is more closely related to the time interval between applications and harvest than to rate of application. For example, .25 pound of kuron per acre left a residue of .23 parts per million in seedling trefoil when harvested two weeks after application. In the same trefoil stand. .75 pound of kuron left a residue of .19 parts per million when harvested six weeks after application. It has not been determined whether the decrease of residue with time is caused by degradation or by a simple dilution with new plant growth.

4. The residue of kuron is considerably less in plant regrowth than in the plant material originally sprayed. However, kuron residues of 1.74 parts per million were found in timothy regrowth from plots

originally treated with three pounds of kuron per acre. The study of kuron residues in trefoil regrowth is impeded by the fact that at most stages of growth rates high enough to leave a detectable residue also injure the trefoil so severely that little regrowth occurs.

5. Rates of kuron as high as .75 pound per acre may be applied to trefoil in late October or early November without leaving a detectable residue in the following spring's growth and without serious damage to the stand.

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LOROX AND ATRAZINE COMPARISON IN EIGHT FIELD TRIALS

A. Zaharchuk[1], W. Baran[2], N. Ferrant[2], S. McCargo[2], J. R. VanAllen[2]

Eight tests were initiated in 1962 to study under farm conditions, the residual carryover on succeeding crops of linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) and atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) used for weed control in corn. This afforded an evaluation of herbicidal activity during the 1962 season.

PROCEDURE

Eight tests were conducted, two in New Jersey and six in New York State, under grower conditions. In all tests fields were fitted and planted by the growers. Plots were sprayed with linuron at 0.5, 1.0, 2.0, 4.0 and 8.0 lbs. and atrazine at 1.0, 2.0 and 4.0 lbs. using a CO_2 propelled small plot sprayer giving 60 gallons of spray per acre. Plot size was 6 feet by 30 feet, four replicates in each test.

Test conditions such as soil type, variety, days after planting and weed present, varied with each test.

Test 1 - Soil type sandy loam, moist, sprayed 1 day after planting. Variety of sweet corn - Gold Eagle. Very few weeds. Hurley, N.Y.

Test 2 - Soil type loam, moist, sprayed 3 days after planting. Variety of sweet corn - Carmelcross. Very few weeds. Accord, N.Y.

Test 3 - Soil type loam, dry, sprayed same day as planting. Variety - N.J. 9. Very few weeds. Columbus, N.J.

Test 4 - Soil type loam, dry, sprayed 6 days after planting. Corn germinating but not above ground. Variety - N.J. 9. Weeds - annual morning glory, giant foxtail, ragweed, some nutgrass. Columbus, N.J.

Test 5 - Soil type gravelly loam, moist. Sprayed 1 day after planting. Variety - M-3. Weeds - crabgrass, lambsquarter, barnyard grass, redroot, ragweed. Batavia, N.Y.

Test 6 - Soil type clay loam, moist. Sprayed 1 day after planting. Variety - M-3. Weeds - mainly quackgrass, some redroot, ragweed, lambsquarter. Batavia, N.Y.

Test 7 - Soil type silty clay loam, dry. Sprayed 1 day after planting. Variety - DeKalb 222. Weeds - mustard, lambsquarter, ragweed, redroot, quackgrass, nutgrass. Verona, N.Y.

Test 8 - Soil type loam, moist. Sprayed 4 days after planting. Variety - DeKalb 423. Weeds - mainly nutgrass. Canastota, N.Y.

1/ Coop. G.L.F. Exchange, Inc., Research & Development Soil Building Division, Ithaca, N.Y.

RESULTS

The rate at which control was obtained with linuron varied considerably. Broadleaf weed control was obtained at lower rates than grasses. At the rate at which grasses were controlled, unacceptable injury to the crop was experienced. In one test, Farm 7, no injury was evident even with the 8.0 lbs. rate. Atrazine gave good control at the 2.0 lbs. rate except for nutgrass and quackgrass.

CONCLUSIONS

The rate at which control was obtained and the rate at which injury occured varied with linuron. This will make it necessary to repeat testing before a recommended rate can be established for growers.

		Farm 1			Farm 2			Farm 3			Farm 4		
Material	Rate	BLW	GR.	INJ	BLW	GR.	INJ	BLW	GR.	INJ	BLW	GR.	INJ
Check	--	X	X	0.0	X	X	0.0	X	X	0.0	X	X	0.0
Linuron	0.5	X	X	0.3	X	X	0.8	X	X	0.5	2.0	2.0	0.0
"	1.0	X	X	1.3	X	X	2.1	X	X	0.3	2.5	2.3	0.0
"	2.0	X	X	2.3	X	X	3.3	X	X	1.1	4.1	3.5	2.6
"	4.0	X	X	3.5	X	X	3.8	X	X	1.0	4.4	4.5	2.9
"	8.0	X	X	4.0	X	X	4.0	X	X	2.5	4.9	4.5	4.0
Atrazine	1.0	X	X	0.0	X	X	0.0	X	X	0.0	3.5	2.6	0.0
"	2.0	X	X	0.0	X	X	0.0	X	X	0.0	4.6	4.4	0.0
"	4.0	X	X	0.0	X	X	0.0	X	X	0.0	4.6	3.6	0.0

		Farm 5			Farm 6			Farm 7			Farm 8		
Material	Rate	BLW	GR.	INJ	BLW	GR.	INJ	BLW	GR.	INJ	BLW	GR.	INJ.
Check	--	X	X	0.0	X	X	0.0	X	X	0.0	X	X	0.0
Linuron	0.5	2.5	1.1	0.3	1.37	0.4	0.0	0.4	0.0	0.0	X	0.1	0.0
"	1.0	4.0	2.9	1.0	3.3	0.4	0.0	0.9	0.1	0.0	X	0.6	0.0
"	2.0	4.5	4.4	2.9	4.0	0.1	0.0	1.4	0.3	0.0	X	1.0	1.0
"	4.0	4.8	4.3	4.5	4.6	1.0	2.5	2.5	1.8	0.0	X	2.5	3.0
"	8.0	4.9	4.6	5.0	4.9	2.1	4.6	4.1	2.8	0.0	X	3.5	4.3
Atrazine	1.0	4.5	2.6	0.0	4.3	0.3	0.0	0.9	0.0	0.0	X	1.4	0.0
"	2.0	5.0	4.5	0.0	4.6	1.6	0.0	2.3	2.1	0.0	X	1.8	0.0
"	4.0	5.0	4.5	0.0	5.0	2.9	0.0	3.6	2.9	0.0	X	2.3	0.0

Average of 4 Replicates
0 = No control - no injury   5 = Complete control - complete kill

SELECTIVE WEED CONTROL WITH "LOROX" LINURON WEED KILLER[1]

M. B. Weed, L. E. Cowart and H. L. Ploeg

"Lorox" Linuron Weed Killer, containing 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron), has proven to be a highly effective and versatile herbicide. It is equally effective for the control of both seedling grasses and broadleaved weeds. Extensive tests have confirmed that linuron can control weeds in corn and soybeans. Tests on sorghum, carrots, safflower, and cotton have also shown promise.

The versatility of linuron is demonstrated further by the fact that it can be used as a directed post-emergence spray on emerged weeds as well as in a pre-emergence application. As a post-emergence spray, linuron kills existing weeds and provides a residual herbicidal barrier to the development of weed seedlings that emerge after the application. Yet, this compound has shown a good disappearance pattern from the soil which permits seeding a winter cover crop or succeeding spring crop without hazard of injury from residual herbicide in the soil.

The use of herbicides such as linuron with contact activity in directed post-emergence applications in suitable crops has definite advantages to the grower over the use of other herbicides and methods. Obvious advantages are as follows:

1. Soil type is not limiting in post-emergence as it is for many pre-emergence herbicides.

2. Rainfall is not needed to activate linuron in foliar applications.

3. The weed problem can be assessed by the grower before he commits himself to the expense of a control procedure. Consequently, the cost of the total weed control operation is geared to the current weed problem.

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[1]Contribution from the Industrial and Biochemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

4. During unusually wet weather, which prevents timely mechanical cultivation, post-emergence herbicides provide insurance against crop failure, since spray equipment can often be used in fields too wet for cultivation.

The usual and most effective time to employ directed post-emergence applications of linuron is when the weeds are relatively small, not more than 8 inches tall, and the height of the crop is at least 15 inches. Small weeds have been controlled at lower chemical use rates than large weeds. The height differential between the crop and weeds can frequently be increased by an early cultivation with a rotary hoe.

The successful use of directed post-emergence sprays depends on properly designed and properly adjusted equipment. Many types of equipment can be used. For example, in the following tests the equipment consisted of tractor-mounted sprayers with booms and drop nozzles; cultivator-mounted skid attachments for stabilizing the spray tip; Hahn "Hi-Boy" sprayer with flexible and rigid drops from a fixed boom; and a bicycle sprayer for small plots. Good results were obtained with each type of rig.

Although "Lorox" Linuron Weed Killer applied alone has given good burn of weed foliage, tests over the past two years in the greenhouse and the field have shown that the contact herbicidal activity of linuron can be significantly increased on the tougher weeds by the addition of surfactants to the spray mixture. Du Pont Surfactant WK was found to be among the most effective adjuvants giving this response. Through the addition of a surfactant it has been possible to achieve commercially acceptable weed control with directed foliar sprays at reduced chemical rates and, thus, at a lower cost.

Methods

The following observations and conclusions are based on directed post-emergence tests in at least 25 field locations in 7 states. The tests were conducted by research and development specialists of the Du Pont Company. Some tests were located on Du Pont research farms, but the majority were in cooperation with major corn producers. Usually 35 to 40 gallons of spray were used per acre. Field plots treated with power-operated sprayers were 4 rows wide and about 500 feet long. Small plots were usually 3 rows by 50 feet long and replicated three times.

Most tests received an early rotary hoe cultivation. In band applications, the middles were mechanically cultivated twice, in a way that least disturbed the treated band. Du Pont Surfactant WK was used in most of the tests. The surfactant rates are stated as percent of the spray by volume. Linuron use rates are given in pounds active ingredient per acre treated.

Results and Discussion

Observations 2 to 4 weeks after treatment showed that 2 pounds per acre of linuron plus 0.5 percent surfactant gave equal or better weed control than 3 pounds per acre of linuron alone in 18 out of 19 test sites. (Tables I and II.) The control of annual weeds with linuron at 2 pounds plus surfactant ranged between 93 and 100 percent in all but two tests. These two exceptions gave 86 and 83 percent weed control. The lower ratings are attributed to weeds taller than 8 inches not adequately covered with spray.

Later observations, taken 6 weeks after treatment, followed the same general pattern, although the difference favoring the 2 pound rate of linuron plus 0.5 percent surfactant over 3 pounds of linuron alone was not as marked as it was earlier. This indicates that weed control once achieved with the lower rate of herbicide plus surfactant will persist throughout the season. Examination of the plots at harvest time confirmed this.

Linuron at 1 pound plus 0.5 percent surfactant gave acceptable commercial weed control for at least 6 weeks in 6 locations.

In replicated tests at Newark, Delaware, 0.5 pound of linuron plus surfactant gave better weed control than 1 pound of linuron alone. (Tables III and IV.) In one test, 0.5 pound of linuron plus 0.15 percent surfactant gave 60 percent weed control after 4 weeks and a yield of 73 bushels of corn. One pound of linuron alone gave 40 percent control and a yield of 60 bushels per acre. Two pounds of linuron gave 75 percent control and a yield of 75 bushels of corn.

Sprays containing surfactant in addition to linuron gave a faster burn to the weed foliage than linuron alone at equal rates. Increasing the concentration of surfactant from 0.5 to 1 percent did not give a corresponding increase in contact activity. Therefore, it appears that 0.5 percent of

Du Pont Surfactant WK is the economic optimum concentration for directed post-emergence sprays in crops.

In the application of directed sprays, it is important that the spray does not wet the corn foliage, particularly the tender bud or the corn may be killed. It is relatively simple to direct the spray under the corn leaves and on the weeds if the height differential between corn and weeds is sufficient. No significant injury to the corn occurred in these tests although the spray invariably wet the base of the corn stalk. In one test, a 1-pound per acre pre-emergence application was followed by three separate directed post-emergence sprays of 3, 3 and 5 pounds per acre, respectively, for a total of 12 pounds. This multiple application caused only minor injury to the lower leaves of corn. The last application was a late lay-by spray.

The principles observed in the directed post-emergence weed control in corn are applicable to other crops. Favorable results have been observed in limited tests in soybeans, sorghum, safflower and cotton. In carrots, good results have been obtained with overall post-emergence treatments.

Summary

Linuron at 1.5 to 2 pounds per acre plus 0.5 percent Surfactant WK in the spray mixture as a directed post-emergence spray provided effective, safe control of annual weeds throughout the growing season in corn.

Best results were obtained when the corn was 15 inches tall and the weeds no more than 8 inches.

Both band and broadcast applications were successful.

Increasing the concentration of surfactant above 0.5 percent did not result in marked improvement in weed control.

Linuron has been shown to have a favorable pattern of disappearance from soils.

Good spray coverage of the weeds through proper adjustment of the spray equipment is essential for optimum results.

Table I

Summary of Eight Directed Post-Emergence Tests in Corn with "Lorox" Linuron Weed Killer Plus Surfactant WK in Illinois - 1962

Linuron Lb. Active/A	Percent Surfactant WK	Number of Locations	Mean % Weed Control After 2 Weeks	After 6 Weeks
1.0	0.5	6	88	75
1.5	0.5	5	87	87
2.0	0.0	2	95	91
2.0	0.5	8	97	94
2.0	0.5 (X-77)	2	94	91
2.0	0.5 (Sterox AA)	2	96	93
2.0	1.0	2	98	93
3.0	0.0	8	93	93
3.0	0.5	6	99	97

Corn Planted: 5/1/62 - 5/17/62

Date Treated: 5/31/62 - 6/15/62

Height of Weeds When Treated: 1 - 10 inches

Height of Crop When Treated: 11 - 20 inches

Weed Species: giant foxtail, barnyard grass, smartweed, crabgrass, annual morning glory, ragweed, pigweed

Table II

Summary of Fifteen Directed Post-Emergence Weed Control Tests in Corn with Linuron Plus Surfactant WK Located in Ohio, Michigan, Minnesota, Indiana and Wisconsin - 1962

Linuron Lb. Active/A	Percent Surfactant WK	Number of Locations	Mean % Weed Control
0.75	0.0	1	60
0.75	0.5	1	85
1.5	0.0	2	73
1.5	0.5	5	94
2.0	0.0	7	74
2.0	0.5	11	93
3.0	0.0	10	83
3.0	0.5	4	94

Date Treated: 6/14/62 - 7/31/62

Height of Weeds When Treated: 1 - 16 inches

Height of Corn When Treated: 12 - 36 inches

Weeds Present: foxtail, crabgrass, barnyard grass, smartweed, ragweed, pigweed, quackgrass, velvetleaf, lambsquarters

Table III

Directed Post-Emergence Weed Control in Corn
Du Pont Research Farm - Newark, Delaware
1961

Material	Rate Lb./A (Active)	% Weed Control 4 Weeks	% Weed Control 8 Weeks	Av. Yield Bu./A
Linuron	0.5	27	25	53
	1.0	40	70	60
	2.0	75	75	75
Linuron + Surfactant WK	0.5 + 0.15%	60	67	73
Untreated Check	-	-	-	23

Eastern States Hybrid 830 - Planted 5/22 - Sprayed 6/19

40 g.p.a. broadcast - Corn 12 inches tall, weeds 8 inches tall.
Three replications.

Weed Species: nutsedge, annual morning glory, ragweed, purslane, velvetleaf, pigweed, crabgrass, rape, Japanese millet, etc.

Table IV

Directed Post-Emergence Weed Control in Corn
Du Pont Research Farm - Newark, Delaware
1961

Material	Rate Lb./A (Active)	% Weed Control 1 Week	% Weed Control 5 Weeks
Linuron	0.5	73	91
	1.0	80	95
Linuron + Surfactant WK	0.5 + 0.08%	82	95
	0.5 + 0.15%	83	97
	0.5 + 0.3%	85	97

U.S. Hybrid 13 - Planted 7/20/61 - Sprayed 8/11/61. Corn 16 inches tall, weeds 8 inches tall.

Three replications - 40 g.p.a.

Weeds Present: crabgrass, fall panicum, purslane, Japanese millet, mustard, velvetleaf, nutgrass, rye-grass, foxtail, pigweed, ragweed

TWO YEAR STUDIES ON RESIDUAL COMPARISON OF LOROX AND ATRAZINE ON SEVERAL CROPS

Alexander Zaharchuk[1]

Residual carry-over of herbicides used in corn growing may present a problem for succeeding crops. A study was undertaken in 1961 and 1962 to determine residual of linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) and atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine).

PROCEDURE

In the 1961 test, corn was planted on a sandy loam soil using a commercial two-row planter. The plot size was 6 feet by 12 feet, replicated three times, with a four-foot buffer between treatments. Half of the area was sprayed pre-emergence to the crop and weeds four days after planting with linuron at 0.5, 1.0, 2.0, 3.0 lbs. and atrazine at the same rates. The other half of the area was sprayed post emergence to the crop and weeds using directional sprays 28 days after planting with linuron at 1.0, 2.0, 4.0, 6.0 lbs. and atrazine at the same rate.

The field was fall-plowed to a depth of 8 inches, fitted and planked. Two rows each of rye, wheat, oats, cucumbers and beans were planted with a hand planter. Frost killed the oats, beans and cucumbers, but a good stand of wheat and rye remained. The area where the crops were winter-killed was roto-tilled the following spring and replanted to oats, beans and cucumbers.

The 1962 spring test was conducted on a gravelly soil. The plot size was 6 feet by 15 feet, four replicates, with a three-foot buffer row between plots. The area was sprayed May 14, 1962 with linuron at 0.5, 1.0, 2.0, 4.0, 8.0 and 16.0 lbs. and with atrazine at 0.5, 1.0, 2.0, 4.0 and 8.0 lbs. in 120 gallons of water per acre, using a CO_2 propelled small plot sprayer.

The next day the area was planted with a hand planter to two rows each of the following crops; corn, beans, oats, wheat, alfalfa, trefoil and timothy. Depth of planting varied with recommended good planting practices. The planting of crops after spraying may have resulted in movement of soil into contact with the seeds. Crops were left for the growing season. However, extreme drought, less than 0.5 inch of rain throughout the summer, resulted in extreme crop and weed injury.

The spring 1962 treated area was disced three times in September, 1962, to destroy remaining crop weeds. Area was hand-raked to remove remaining trash. The area was then replanted 120 days after initial application of herbicide to the same seven crops.

1/ Coop. G.L.F. Exchange, Inc., Research & Development, Soil Building Division, Ithaca, N. Y.

RESULTS

In the 1961 test, no injury was observed to any crop that fall, nor was there any visual effect on the five crops throughout the 1962 growing season.

In the spring 1962 test, injury was observed with linuron on corn starting at the 1.0 lb. rate and on all other crops injury was observed starting at the 0.5 lb. rate. With atrazine no injury to the corn was observed at any rate. Injury to the other crops were observed starting at the 0.5 lb. rate. (Table I)

In the fall replanted test, linuron at the 4.0 lbs. rate gave very slight injury to beans and timothy. The 8.0 lbs. rate gave no injury to corn but moderate injury to the other crops. At the 16.0 lbs. rate, residual was enough to give injury to all crops. Atrazine did not give any injury to any crop, even at the 8 lbs. rate. (Table II)

CONCLUSIONS

When the field was plowed, no residual was observed from linuron or atrazine even at the 6.0 lbs. rate. The residual carry-over in a dry summer 120 days after application was greater on linuron than atrazine. It appeared that timothy was the most sensitive crop to linuron and may be useful as an indicator crop for residual studies.

Table I Results of Spring 1961 Test

Material	Rate	Corn	Beans	Oats	Wheat	Alf.	Tre.	Tim.	BLW	Grasses
Check	--	0	0	0	0	0	0	X	0	0
Linuron	0.5	0	0.75	1.6	1.6	3.4	3.1	X	4.5	3.3
"	1.0	0.75	2.1	2.5	2.5	4.0	4.0	X	4.9	4.0
"	2.0	1.3	2.5	2.9	2.6	4.0	4.0	X	4.9	4.3
"	4.0	1.8	3.1	3.0	2.6	4.3	4.3	X	4.9	4.3
"	8.0	3.8	3.7	4.3	4.1	5.0	5.0	X	5.0	4.4
"	16.0	4.1	4.5	5.0	5.0	5.0	5.0	X	5.0	4.8
Atrazine	0.5	0.0	2.3	2.0	2.1	4.0	4.0	X	5.0	1.6
"	1.0	0.0	3.1	3.0	3.0	4.3	4.3	X	5.0	2.4
"	2.0	0.0	3.4	3.5	3.4	4.5	4.5	X	4.9	2.6
"	4.0	0.0	4.0	4.1	4.0	5.0	5.0	X	4.9	2.9
"	8.0	0.0	4.1	4.6	4.5	5.0	5.0	X	5.0	3.8

Average of 4 Replications. X - Crop Failure
Date Rated: June 6, 1962
0 = No control - no injury.
5 = Complete control - complete kill.

Table II Results of Fall Replanted Test - 1962

Material	Rate	Corn	Beans	Oats	Wheat	Alfalfa	Trefoil	Timothy
Check	0	0	0	0	0	0	0	0
Linuron	0.5	0	0	0	0	0	0	0
"	1.0	0	0	0	0	0	0	0
"	2.0	0	0	0	0	0	0	0
"	4.0	0	0.3	0	0	0	0	0.5
"	8.0	0	3.3	1.8	2.5	2.5	1.8	4.1
"	16.0	2.1	4.3	4.5	4.5	4.5	4.4	4.4
Atrazine	0.5	0	0	0	0	0	0	0
"	1.0	0	0	0	0	0	0	0
"	2.0	0	0	0	0	0	0	0
"	4.0	0	0	0	0	0	0	0
"	8.0	0	0	0	0	0	0	0

Average of 4 Replications
Date Rated: October 23, 1962
0 = No control - no injury
5 = Complete control - complete kill

ANNUAL WEED CONTROL IN FIELD CORN WITH ATRAZINE[1]

Jonas Vengris[2]

Although atrazine is an accepted and widely used herbicide, we still have to work out many details in using this chemical for annual weed control in field corn. Formulations, time and method of application are still controversial questions requiring answers.

This is a report of work done in 1961 and 1962 in Massachusetts with atrazine for the control of annual weeds in field corn. The objective of these tests was threefold: (1) to study different formulations, (2) to determine the influence of time of application and (3) to investigate the importance of mixing atrazine into the soil.

Procedure

The 1961 experiment was conducted at Amherst at the Brooks farm and in 1962 at South Deerfield, at the University farm. In both areas soil was fine sandy loam. Randomized block design was used in 1961 with three and in 1962 with four replicates. Each plot consisted of four corn rows 25 ft. long. Treatments at planting were applied on May 24, 1961 and on May 22, 1962 on well prepared seedbed. Soil in both instances was moist. Granulated 20% atrazine was applied by hand weighing the amount of material for each plot. Incorporating of atrazine into the soil was done immediately after application by rototilling 3-5 in. deep. Next day after application of herbicide, i.e., May 25, 1961 and May 23, 1962, Ohio M-15 silage corn was planted.

Post emergence treatments in 1961 were applied 14 days, and in 1962, 19 days, after corn planting. Weeds in 1961 at that time were two-leaved seedlings, less than one inch tall. In 1962, weeds were more advanced and were 3-4 in. tall. Weedy grasses were in the tillering stage of growth. In both years, rain occurred within two days after the application of herbicides. Hence soil moisture conditions were

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favorable for the effective action of atrazine. Precipitation data are given in Figures I and II. There was no cultivation during the growing season.

The weed population in the order of their relative frequency was made up of the following species:

Amherst, 1961: (1) rough pigweed (Amafanthus retroflexus), (2) large crabgrass (Digitaria sanguinalis), (3) lambs-quarters (Chenopodium spp.), (4) yellow foxtail (Setaria glauca), (5) barnyardgrass (Echinochloa crus-galli), (6) Witchgrass (Panicum capillare), (7) Pennsylvania smartweed (Polygonum pensylvanicum).

South Deerfield, 1962: (1) rough pigweed, (2) large crabgrass, (3) barnyardgrass, (4) lambsquarters, (5) common ragweed (Ambrosia artemisiifolia), (6) yellow foxtail.

All herbicide application rates presented in Table I are expressed in pounds of active ingredients per acre. The effects of different treatments on weeds and corn were observed throughout the growing season.

Results and Discussion

Weed control as well as yield results are recorded in Table I. All atrazine treatments were effective in controlling both grassy weeds and broadleaved weeds in both years. Relative yields of all treated plots were superior to the checks.

Incorporation of atrazine into the soil. In these experiments, mixing the herbicide in either the wettable powder or granulated form, did not improve their effectiveness. In 1961, the 1 lb./A rate of atrazine was even less effective when mixed into the soil than when left on the surface. It is quite possible that the relatively high rainfall 12.08 in. for the period May through July, may explain these results. At low rates of application leaching losses and reduced concentration the herbicide in the soil as a result of mixing appear to have reduced the effectiveness of atrazine. Ashton et al /1/ found that herbicides became less effective as they were incorporated deeper into the soil because the soil acted as diluting medium. In 1962 rainfall for the same period was only 5.25 in. and the unfavorable effects of mixing the atrazine with the soil were scarcely noticeable.

It appears that the herbicidal action of atrazine and the value of mixing it with the soil at time of application is closely associated with soil moisture relationships. If soil

TABLE I. FIELD CORN WEED CONTROL WITH ATRAZINE IN 1961 AND 1962

Relative Values Check = 100

	Treatments	Weed Stands 1961		Weed Stands 1962		Relative Yields	
		Dicot	Monocot	Dicot	Monocot	1961	1962
1)	Check	100	100	100	100	100	100
2)	Check, clean	0	0	0	0	146	528
3)	Atrazine 1 lb/A, 80 W. P., at planting	7	62	+	20	125	460
4)	Atrazine 3 lb/A, 80 W. P., at planting	+*	6	+	2	150	437
5)	Atrazine 1 lb/A, 80 W. P., at planting & mixed in	35	73	1	16	129	443
6)	Atrazine 3 lb/A, 80 W. P., at planting & mixed in	2	10	+	2	150	478
7)	Atrazine 1 lb/A, granulated, at planting	16	65	6	22	129	476
8)	Atrazine 3 lb/A, granulated, at planting	+	11	+	7	137	461
9)	Atrazine 1 lb/A, granulated, at planting & mixed in	55	82	7	28	130	459
10)	Atrazine 3 lb/A, granulated, at planting & mixed in	5	9	+	14	134	458
11)	Atrazine 1 lb/A, 80 W. P., post-emergence	5	37	13	28	136	447
12)	Atrazine 3 lb/A, 80 W. P., post-emergence	+	3	1	17	140	426
13)	Atrazine 1 lb/A, granulated, post-emergence	22	49	68	85	141	187
14)	Atrazine 3 lb/A, granulated, post-emergence	2	8	40	55	153	246
	L.S.D. at 5% level	9	10	8	9	20	44
	L.S.D. at 1% level	13	14	11	12	27	58

* + indicates weed stands less than 1.

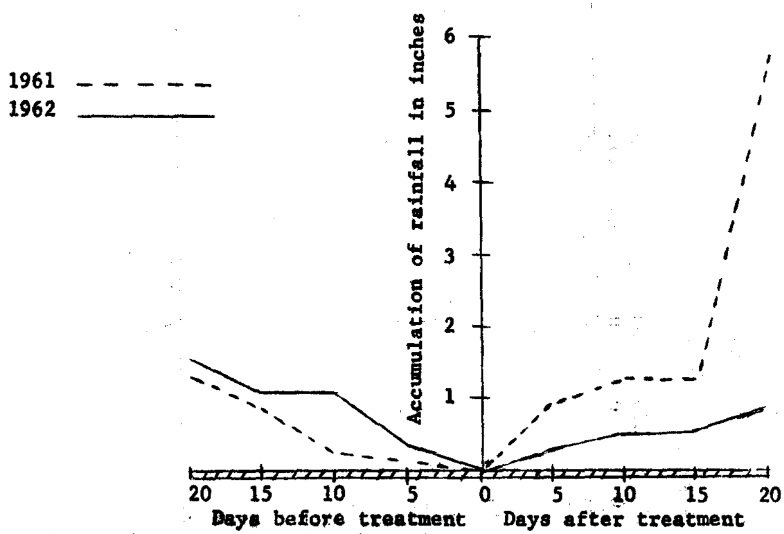

Figure 1: Accumulated inches of rain before and after application of atrazine at corn planting. 1961 and 1962.

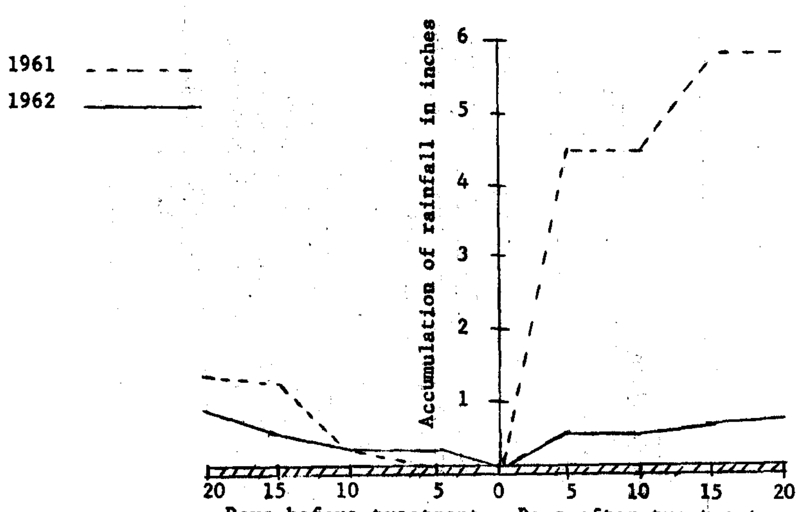

Figure 2: Accumulated inches of rain before and after application of atrazine as post-emergence treatment in 1961 and 1962.

moisture conditions are good both at the time of application and for a period of ten days following, there is little advantage to mixing atrazine with the soil. At low rates of application, herbicidal action may even be reduced. On the other hand if the surface soil is dry when the material is applied and little or no rainfall occurs for a period of ten days or more, mixing atrazine into the soil is often advantageous. It has been shown in previous experiments (4) that mixing atrazine with the soil can be helpful in controlling some perennial weeds, such as quackgrass (Agropyron repens). When the herbicide is placed closer to rhizomes and roots it is more readily absorbed.

Formulations. At 3 lb/A rate, with the exception of 1962 post-emergence treatments, there were no differences between granulated or wettable powder formulations of atrazine. Better performance of wettable powder formulations of atrazine 1962 in post-emergence treatments was due to the more advanced stage of weed seedlings at the time of application. Using water as carrier atrazine may have been able partly to enter the plants by foliage absorption /2/. On the other hand the herbicide from granules may have been released and absorbed more slowly, especially when 1962 dry weather conditions prevailed /Fig. I and II/.

In both years at low rate atrazine applied as wettable powder gave better annual weed control in corn than granulated form. This is in agreement with Sweet's /3/ statement concerning the performance of granulated atrazine. In both years with post-emergence applications differences in favor of wettable powder were greater and probably for reasons just discussed.

Time of Application. In 1961 atrazine applied as post-emergence treatment gave slightly better weed control than when applied two weeks earlier at planting. Better results with post-emergence treatments it seems were due to the heavy rain immediately after the application of atrazine. Differences in monocotyledonous weed control with 1 lb/A rate were clearly evident. The results for 1962 were just the opposite. Post-emergence treatments were poorer with both broadleaved as well as grassy weed control. These differences may be explainable by the drier weather conditions in 1962 and also by the fact that at the time of post-emergence treatment weed seedlings were more advanced in growth. Both formulations gave similar results. These results emphasize the importance of timing in applying atrazine as post-emergence treatment. Weeds should be small, just emerged seedlings. Water also is a very important factor with atrazine. In controlling weeds with atrazine, it seems rain shortly after application of the herbicide is more important than time of application.

Yields of silage corn were significantly increased by all atrazine treatments. Because of the dry growing season in 1962 weed competition for moisture was great and yield increases over checks with most of treatments were large. It is interesting to note that yield differences between various atrazine treatments are negligible. Only the 1962 post-emergence granulated atrazine treatments differed significantly from other treatments. This is explainable by poor weed control. It is reasonable to assume that small differences in yields between various atrazine treatments are due to the fact that even 1 lb./A of herbicide provides a rather good weed control especially the first 3-4 weeks after corn planting. In plots treated with 1 lb/A of atrazine broad-leaved and especially weedy grasses invade later in the growing season and apparently do not affect yields significantly. Thus under favorable weather conditions 1 lb/A of actual atrazine can give good practical annual weed control in field corn.

Summary and Conclusions

In 1961 and 1962 field trials were conducted with 1 lb/A and 3 lb/A rates of atrazine in controlling annual weeds in field corn. Formulations, time and method of application were investigated. The results warrant the following conclusions:

Incorporation of atrazine into the soil in these experiments by rototilling did not increase its effectiveness. In 1961 with ample rain following application, mixing atrazine with the soil at the 1 lb/A rate even reduced its effectiveness.

At 1 lb/A rate wettable powder using water as carrier gave better weed control than 20% granulated formulation. At higher rates of application differences were inclined to disappear.

Atrazine can be applied at planting as pre-emergence treatments or later as post-emergence treatments. No significant differences may be anticipated under the same soil and weather conditions if at post-emergence application weeds are in small seedling stage. A good rain shortly after application of atrazine is more important than the time of application.

Under favorable soil and weather conditions 1 lb/A of actual atrazine provide practical and economically sound annual weed control in field corn. The growth of some broadleaved and especially weedy grasses later in the season do not seem to affect yields markedly.

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EVALUATION OF TWO NEW HERBICIDES FOR CORN

A. Zaharchuk[1] and L. Curtis[2]

This test was conducted to evaluate several new promising herbicides for corn.

PROCEDURE

Variety M-4 corn was planted with a hand planter. On the pre-emergence plots application was made one day after planting. The post emergence plots were sprayed over-all 12 days after planting. The corn was 4 to 5 inches tall and the weeds 3/4 to 2 inches tall. A CO_2 propelled small plot sprayer was used. Plot size was 6 feet by 30 feet, 4 replications. Rate of spray was 60 gallons per acre.

Soil type - loam. The pre-emergence plots were applied on dry soil surface, with adequate moisture one inch down. The post emergence plots were applied when plants and weeds were dry and the soil moist.

Weeds present were mainly redroot, lambsquarter and purslane. Quackgrass infestation was too erratic for an accurate rating of grass control.

RESULTS

Pre-emergence applications of Niagara 4607 at the rate of 5 to 8 lbs. and BASF HS-95 (N-p-Chlorphenyl-N'-methyl-N'-isobutinylurea) at the rate of 2 to 4 lbs. gave results comparable to linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) at 1.0 lb. and atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) at 2.0 lbs. Non-uniform stand of quackgrass gave variable results. Stauffer R-4461, BASF HS-92 (1-Phenyl-4-amino-5-chlor-pyridazon-6) + (N-Cycl-ooctyl-N-dimethylurea) and BASF HS-119 (1-phenyl-4-amino-5-chlor-pyridazon-6) at rate applied gave poor results. (Table I)

Post emergence application of HS-95 at the 1 to 1.5 lb. rate gave results on broadleaf weeds comparable to atrazine at the 2.0 lbs. rate. With HS-95 at the 3 lbs. rate, slight injury was evident as burning of the tips of the first leaf. HS-119 did not exhibit the activity applied post emergence that HS-95 did. (Table II)

CONCLUSION

Pre-emergence, NIA 4607 and HS-95 appear very promising as corn herbicides. HS-95 can be used as either a pre or post emergence herbicide. When applied post emergence lower rates are needed than with pre-emergence applications.

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Table I - Results of Corn Herbicide Test (Pre-Emergence) - 1962

Material	Rate	Broadleaf Weeds	Grasses	Injury
Check	--	0	0	0
NIA 4607	3.0	4.12	1.75	0
"	5.0	4.62	2.00	0
"	8.0	4.37	2.12	0
Stauffer R-4461	5.0	1.12	0	0
"	8.0	1.75	0	0
"	12.0	2.87	0	0
BASF HS-92	1.0	1.75	1.00	0
"	2.0	1.62	0	0
"	3.0	2.62	0.25	0
"	4.0	2.12	0.12	0
BASF HS-95	1.0	2.62	0	0
"	2.0	3.75	0	0
"	3.0	4.50	0	0
"	4.0	4.62	0	0
BASF HS-119	0.5	0	1.12	0
"	1.0	0.75	0.75	0
"	1.5	1.12	0.75	0
"	3.0	1.50	0.62	0
Atrazine	2.0	4.75	2.50	0
Linuron	1.0	4.75	0	0

Average of 4 Replications
Date Rated: July 3, 1962
0 = No control - no injury 5 = Complete control - complete kill

Table II - Results of Corn Herbicide Test (Post Emergence) - 1962

Material	Rate	Broadleaf Weeds	Grasses	Injury
Check	--	0.87	0	0
BASF HS-95	1.0	4.62	1.12	0
"	1.5	4.37	0.25	0
"	2.0	5.00	2.00	0
"	3.0	5.00	1.75	1.25
BASF HS-119	0.75	1.00	0	0
"	1.5	1.62	0.25	0
"	3.0	2.37	0.50	0
Atrazine	2.0	4.75	3.62	0

Average of 4 Replications
Date Rated: July 3, 1962
0 = No control - no injury 5 = Complete control - complete kill.

QUACKGRASS CONTROL

S. M. Raleigh[1]

The summer of 1962 at University Park was very dry. Some areas of quackgrass were easily killed while other areas were hard to kill. Atrazine killed quackgrass better than most previous years, while the kill with Amitrol-T was somewhat poorer than usual.

A large field, heavily infested with quackgrass was sprayed with Amitrol-T and Atrazine at four and two pounds of active ingredient per acre when the quackgrass was four to six inches tall. Each treatment was three sprayer booms wide with a twelve foot non-treated area between treatments. There were three replications. The field was plowed ten days after treatment, seed bed was prepared and the corn planted the same day. The day the corn was planted and each week for four weeks after planting, Atrazine was applied to six rows of corn at two pounds per acre. There were three replications. It was impossible to observe any control by the pre-emergence or post-emergence application of Atrazine on the pre-plow treated or non-treated areas.

The control of quackgrass with the pre-plow treatments were Atrazine--4 pounds, 95%; Atrazine--2 pounds, 90%; Amitrol-T--4 pounds, 90%; Amitrol-T--2 pounds, 85%.

Another field was treated May 3 and plowed May 9. There were three replications. Atrazine at two pounds per acre was applied the day of planting and one week and two weeks after planting. There was no control observed by the pre-emergence or post-emergence application of Atrazine. The following control was observed the pre-plow treatments. Dalapon--8 pounds, 92%; Dalapon--8 pounds ≠ Duz, 96%; Dalapon--8 pounds ≠ All, 94%; Dalapon--4 pounds ≠ Duz, 93%; Atrazine--4 pounds, 98%; Atratone--4 pounds, 95%; Ametryne--4 pounds, 75%; Propazine--4 pounds, 98%; Promotone--4 pounds, 95%; and Prometryne--4 pounds, 60%.

The stand of quackgrass in the non-treated areas where the treatments were logged was so variable it was impossible to get satisfactory readings. The only sure observation from these plots was that Hyvar applied as a pre-plant treatment was much more severe on corn than Hyvar applied as a pre-emergence treatment.

QUACKGRASS SURVIVAL FOLLOWING FALL AND SPRING HERBICIDE TREATMENTS BEFORE CORN[1]

T. R. Flanagan[2]

The most frustrating aspect of quackgrass control has been the lack of a 100% effective treatment within economic reason, and without serious residue or carryover problems. Within these limits, no worker has reported complete quackgrass elimination for all replications. However, extremely low residual populations of quackgrass may possibly be tolerated.

The majority of the references to weed control, especially control of quackgrass in corn, have dealt with field corn only. Most recently corn yields have been recorded in terms of silage. Most of the experiments have dealt with the use of single applications of various herbicides at various rates and times of application. Combinations of herbicidal treatments have recently been observed to offer promise in controlling quackgrass (1, 2, 4).

Results of most experiments have recorded control of quackgrass in terms of estimated or counted stands based on above ground plant parts. Fertig (1) has used replicated 2 square foot quadrant counts. LeBaron and Fertig (3) dug one square foot samples of rhizomes for their fructose reserve studies.

PROCEDURE

A sandy loam area bearing a fairly uniform dense stand of vigorous quackgrass was selected. This area had not been cropped for two seasons but had been rototilled in the spring of 1961, and hayed in midsummer. Initial herbicide applications were made in late August, 1961 with a 20 foot boom on a jeep at a rate of 20 GPA. Atrazine was applied at 2 and 4 pounds per acre a.i.; dalapon as Dowpon, aminotriazole as Weedazol and MH30 were all applied at 4 and 8 pounds per acre a.i. Spring treatments were made in mid-May using 2 pounds per acre a.i. for aminotriazole and atrazine, and 4 pounds per acre a.i. for dalapon and MH30. The atrazine applications superimposed over certain fall treatments were made at 2 pounds per acre a.i. on May 11, 1962. The entire area was plowed two weeks later. Wisconsin 335 was planted in 36 inch rows on June 9, using 10-20-10 fertilizer in the planter. Stand counts indicated a stalk population of 20,000 per acre. All plots were split with one-half of each cultivated twice.

Visual observations on weed control and corn growth were made periodically. The corn was sampled for green-weight in mid-September, 1962, with triplicate 10 foot row samples taken mid-plot. Subsequent to total corn removal one week later, rhizome samples were dug from triplicate 18 x 18 inch square samples 3 inches deep. Rhizomes were screened out of the soil, washed, dried, and weighed.

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[2] Assistant Agronomist, Vermont Agricultural Experiment Station, Burlington.

RESULTS

Early May observations of the quackgrass stands surviving the previous fall's herbicide treatments indicated great variation in apparent control. The low rates of atrazine showed, on the average, 50% quackgrass. High rate plots averaged 27% quackgrass. These observations were made prior to the spring-overtreatments with atrazine.

The MH30 plots looked very clean, with 43% stunted quack surviving on the low rate plots and 5% average survival on the high rate areas. One plot was rated "no quack". This particular plot had a 5-10% quack stand the following September.

The aminotriazole treated plots varied from 13% light green stunted quackgrass on the high rate plots to 49% yellowish quack on the plots receiving the low rates the fall before. Again, one plot had "no quack" but with some slight amount of stunted quack shoots present in September.

Dalapon treated plots varied from 3% on high rate plots to 13% quackgrass on the low. The check or "no spray" plots varied from 95 to 100% quack stands.

Weed ratings made just prior to corn harvest show some resistant broadleaf and grassy weeds surviving. A moderate infestation of crabgrasses plus some barnyard and foxtail grass were present on the low rate of atrazine plots. These same weeds persisted but to a much lesser degree on the high rate atrazine plots. Wild buckwheat (Polygonum convolvulus) abounded on several of the low rate atrazine, aminotriazole, and dalapon plots!

MH30 plots showed incursions of redroot, galinsoga, lambsquarter, crab and barnyard grass. Slight amounts of crabgrass, barnyard grass and foxtail showed up in the aminotriazole plots, as well as some lambsquarter, redroot, and galinsoga. The dalapon plots looked about the same as those for ATA, plus the additional presence of some mustards and dandelions.

The check plots had some infestation of crabgrass, barnyard grass, foxtail, mustard, redroot, and galinsoga. Amounts and species varied considerably due to the persistence of much quackgrass in these unsprayed plots.

The effects of cultivation persisted till harvest, evident in from 20 to 50% less quack where cultivated. All broadleaf weeds present were present in the cultivated as well as the uncultivated halves of the plots, only to a much lesser degree.

Silage yields (Table 1, 2, and 3) were good on the whole averaging about 19 tons per acre. Rhizome weights are reported as means for replicated triplicates, and are not projected to a per acre basis due to the small size of samples taken. Multiplying the figures given in grams by 40 will approximate pounds of rhizomes per acre. Figures averaging 220 pounds per acre with a high of 400 pounds per acre can be obtained.

TABLE 1. WEIGHT OF QUACKGRASS RHIZOMES AND CORN SILAGE YIELDS AVERAGED FOR ALL TREATMENT DATES

HERBICIDE	RHIZOMES* Gms.	SILAGE** T/A
Atrazine	0.3	23.1
MH30	2.6	20.2
Aminotriazole	0.5	21.7
Dalapon	1.8	22.1
No Spray	4.2	19.1
LSD (.05)	0.3	1.7

*Dry weight yields for 1/20,000 A sample; averaged for reps.

**Green weights corrected to 80% moisture basis.

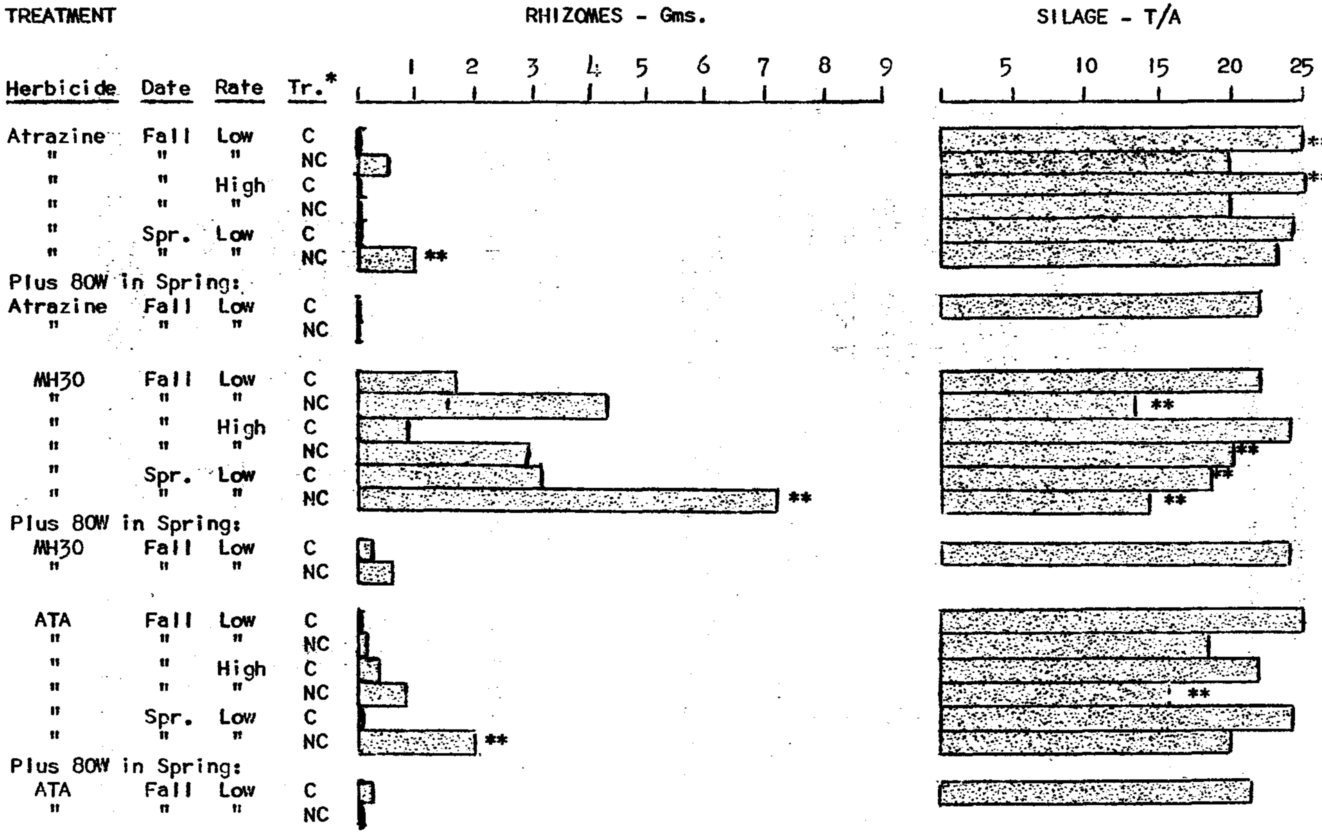
TABLE 2. WEIGHT OF QUACKGRASS RHIZOMES AND CORN SILAGE AVERAGED FOR ALL HERBICIDE TREATMENTS

TREATMENT Date	Rate	Post-emergence Treatment	RHIZOMES* Gms.	SILAGE** T/A
Fall	Low	Cultivated	1.7	23.9
"	"	Not Cult.	3.8	19.9
Fall	High	Cultivated	0.5	22.5
"	"	Not Cult.	1.4	19.3
Spring	Low	Cultivated	2.7	22.0
"	"	Not. Cult.	3.7	19.4
Treatments followed by 2.5 lb. Atrazine 80W in Spring:				
Fall	Low	Cultivated	1.9	21.4
"	"	Not Cult.	1.2	--
LSD (.05)			1.2	2.1

*Dry weight yields for 1/20,000 A samples; averaged for reps.

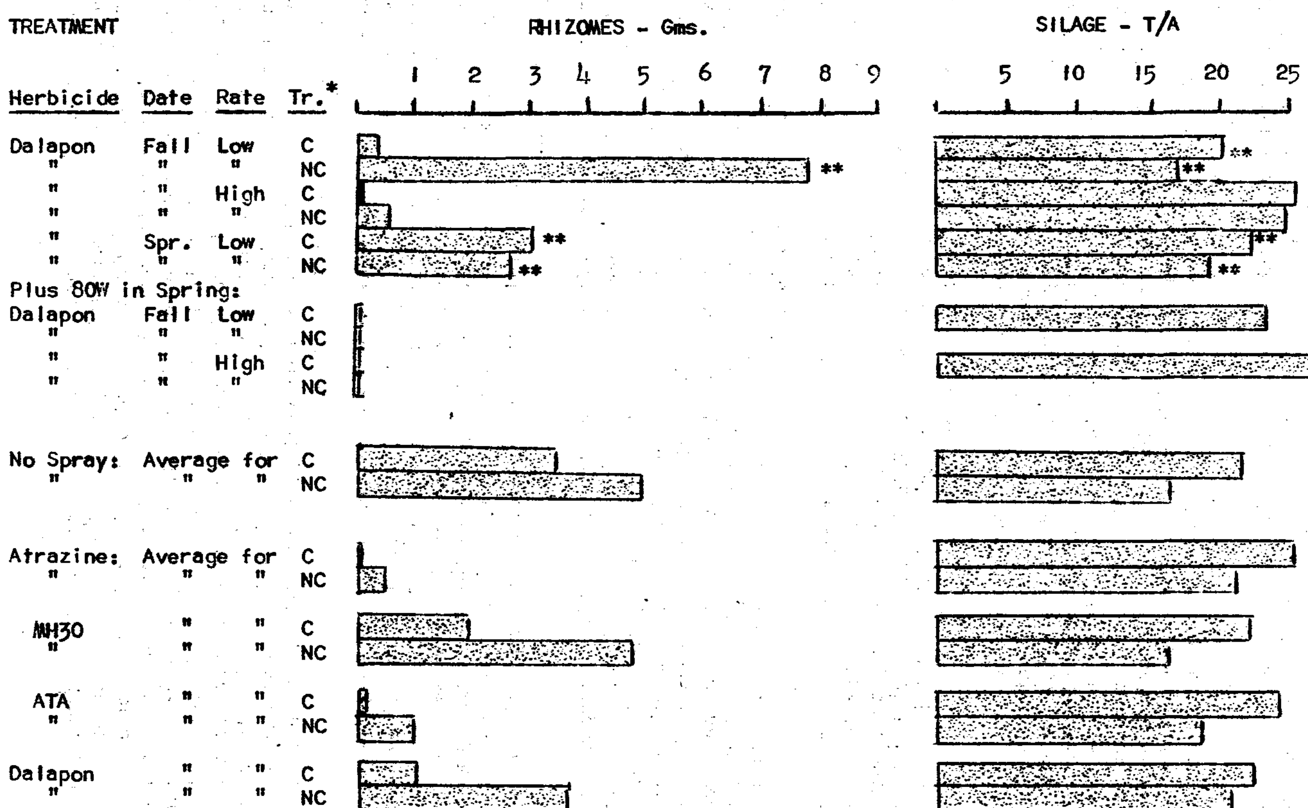
**Green weights corrected to 80% moisture basis.

TABLE 3. WEIGHT OF QUACKGRASS RHIZOMES AND CORN SILAGE - BY TREATMENTS



*Tr. = Post-emergence Treatment; C = Cultivated twice, NC = Not Cultivated.

TABLE 3. (Cont.) WEIGHT OF QUACKGRASS RHIZOMES AND CORN SILAGE - BY TREATMENTS



*Tr. = Post-emergence Treatment; C = Cultivated twice, NC = Not Cultivated
**Significantly different (5%) from treatment mean for "Plus 80W in Spring".

In general, all treatments offered some control of quackgrass. Individual plots showed complete elimination by virtue of no rhizomes present in the soil samples taken. This was on the following plots: low rate of atrazine in fall with cultivation; low rate of atrazine in the fall with additional atrazine in the spring, both with and without cultivation (5 plots); high rates of atrazine in the fall and in the spring; low rate of MH30 in the fall plus atrazine in the spring with cultivation; 4 plots of the low rate of aminotriazole in the fall plus atrazine in the spring; 4 plots of the low rate of dalapon in the fall plus atrazine in the spring; 3 plots of dalapon at the high rate in the fall followed by cultivation; and 2 plots of high fall rates of dalapon plus atrazine in the spring.

Degree of quackgrass control varied with the herbicide used (Table 1) as well as with time and rate of application (Table 2). In terms of over-all response as measured by silage yields, atrazine and dalapon were superior as was aminotriazole to those yields obtained from the MH30 treatments or from those plots receiving no herbicide. This same standing is reflected by the low average weights of rhizomes resulting from the use of these three herbicides. MH30, which in the fall looked very good, did not maintain its earlier favorable position.

In another comparison (Table 2) where data for herbicide response are averaged to show the influence of rate and time of application, all of the cultivated treatments were generally better than those plots left uncultivated. This is evident in both low rhizome and high silage yield figures for all cultivated treatments combined. Of interest here are the average figures for the check plots which received no spray (shown as histograms on the second page of Table 3). Means for cultivated plots yielded 3.9 grams of rhizomes and 21.6 tons of silage, while uncultivated controls averaged 5.0 grams of rhizomes and 16.4 tons of silage.

The differences between these figures and those appearing in Table 2 are significant in most instances. The implication here is that in general for all herbicides to be fully effective in controlling quackgrass, such treatments need accompanying cultivation. This is also born out by the averages for cultivation versus no cultivation for the individual herbicide treatments also seen on the second page of Table 3.

In addition, rhizome yields from low rates applied in the fall or spring without cultivation equaled those obtained from the noncultivated checks. This is somewhat in conformity with results noted elsewhere (3) for rhizomes sampled from dalapon treated plots in comparison with such yields from check plots. Particularly true in this regard are the even higher rhizome yields reported here for the low rate of dalapon appiied in the fall without subsequent cultivation, and also true for the low rates of MH30 applied either in fall or spring (Table 3), when compared with check plot rhizome yields. These herbicides used in this manner had no lasting effect on the quackgrass unless followed up by cultivation.

The interactions of each individual herbicide to the time of its application, the rates applied, and the presence or lack of cultivation are shown, together with the results of the additional superimposed spring treatments with atrazine, in Table 3. With the exception of MH30, and the one treatment for dalapon discussed above, all the herbicide treatments and combinations showed general reduction in quackgrass. The spring treatments were inferior to fall treatments with the exception of dalapon again as noted above. The uncultivated spring treatments were significantly poor in comparison with the fall treatments combined with the additional applications of atrazine made in the spring prior to plowing. The quackgrass rhizome yields from these latter treatment combination plots were also less than those from low rates of dalapon applied in the fall and from any of the other MH30 treatments.

Furthermore, low yields of rhizomes are generally associated with higher silage yields. This relationship was not explored statistically, but is most consistent for the majority of the treatments. There are some apparent exceptions, but upon close examination these are insignificant.

CONCLUSIONS

Herbicide treatments were applied in the fall or in the spring at low and high rates on a uniform quackgrass sod. Certain fall applications were followed up by an additional application of atrazine in the spring. All herbicide treatments were applied prior to plowing. One-half of every plot was cultivated twice before the corn was 12 inches tall.

Corn stand and weed ratings were made during the growing season. Corn yields were determined as silage. Weights of quackgrass rhizomes were obtained for each treatment following harvest.

Atrazine was the more effective herbicide. Low rates of atrazine or dalapon applied in the fall, followed by additional atrazine in the spring, were most effective in reduction of quackgrass. Several individual plots of these combination treatments gave 100% elimination.

All herbicide treatments were more effective when followed by cultivation.

Low rhizome populations were related to high corn silage yields.

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A SUMMARY OF FOUR YEARS OF QUACKGRASS STUDIES

Stanford N. Fertig 1/

Background

During the past 4 years, a total of 30 separate field experiments have been initiated on the control of quackgrass. The studies, specific for quackgrass control, have included 23 different herbicides and 582 different chemical and cultural combinations with a total of 2328 individual treatments. The investigations have included the following:

a. Time of treatment

Pre-plow (Fall and spring), pre-plant incorporated, at planting, pre-emergence and post-emergence.

b. Cultural operations

Timing of cultivation, frequency of cultivation, types of cultivating equipment.

c. Chemical

Rate of chemical, gallonage of water, addition of wetting agent.

d. Associated crops

Corn, oats, wheat, barley, beans, alfalfa, birdsfoot trefoil and forage grasses.

e. Chemical and cultural comparisons

Mechanical fallow, herbicides plus cultivation, herbicides alone, herbicides as split treatments, fall *vs.* spring treatments, fall plus spring treatments, mid-summer dormant treatments and stages of vegetative growth from dormant rhizomes to late seed stage.

The length of residual activity in the soil has been determined by the following methods:

a. Crop samples have been harvested for herbicide residues as silage and grain.

b. Soil samples have been taken for residue determination by chemical and bioassay methods.

Methods of Evaluation

The effectiveness and safety of treatment has been evaluated using the following criteria:

a. Visual observation and examination of the quackgrass plants.

b. Root reserve studies.

c. Green and dry weight of quackgrass foliage.

d. Green and dry weight of quackgrass rhizomes.

e. Crop yields as silage, forage and grain.

f. Injury to other crops in the rotation.

g. Residual weed control - initial and carry-over.

h. Individual plant or shoot emergence counts.

Chemical Effectiveness

Dalapon

The effectiveness of dalapon for the control of quackgrass has been evaluated each year since 1953. The treatments have included fall vs. spring, fall and spring, plow down vs. pre- and post-emergence with and without added wetting agent. The rate of chemical has been varied from 1 to 80 pounds per acre and the interval of plowing after application from 3 to 45 days. A summary of conclusions include the following:

a. Dalapon is effective for the annual suppression of quackgrass but is not dependable under a wide range of soil and climatic conditions for reducing quackgrass stands. The reduction in stand has varied with years and locations from essentially zero to as high as 90 percent. Efforts to define the causes of variation have resulted in equally variable results.

b. Following the spring application of presently recommended rates of dalapon, the time interval between plowing and planting to prevent injury to corn is four weeks. For the spring treatment to be widely acceptable for New York conditions, this interval should be narrowed to a maximum of 10 to 14 days. Results to date justify the conclusion that climatic and possibly soil differences introduce considerable variation in the rate of disappearance and that planting within an interval of less than four weeks would result in some degree of injury on many soils.

c. Fall applications of dalapon at rates of 10 pounds active ingredient per acre are promising for the annual suppression of quackgrass, providing the plants are making a flush of growth at the time of treatment. The best insurance of getting this growth under New York conditions is through the application of about 50 pounds of nitrogen in late August. Fall treatments should be considered only on well drained soils, where early spring plowing is possible or where the planting of susceptible crops would delay or prevent spring treatments being used.

Amino Triazole and Amitrole-T

The use of Amino Triazole powder or liquid formulation alone for the reduction of quackgrass stands has also produced highly variable results. Amino Triazole is an effective retardant to quackgrass regrowth when properly applied but must be accompanied with mechanical or supplemental chemical treatment for significant stand reductions. A summary of conclusions include the following:

a. For controlling quackgrass, the liquid formulation is definitely superior to the wettable powder, about 2 to 1 on an active ingredient basis. The time interval between application and plowing is influenced by the stage of growth and vigor of the quackgrass, and weather conditions but has ranged between 10 and 20 days.

b. Over the past three years, consistent stand reductions of 75 to 90 percent have been obtained by plowing down 2 pounds of Amitrole-T, followed by pre- or post-emergence application of 2 pounds of Atrazine and accompanied by 1 or 2 cultivations.

c. The number of cultivations cannot be predicted ahead of time but seem to be associated with the initial discoloration of the quackgrass foliage, the effectiveness of plowing and the interval between plowing and planting. Retardation of emerging shoots, chlorosis of emerging shoots and to a degree, reduction of quackgrass stands appear to be enhanced by the degree of chlorosis of the foliage at the time of plowing. How effectively the foliage is covered in plowing also affects stand reduction. Cultural operations to prevent recovery of the plants is advantageous when adverse weather conditions or more pressing farm operations delay planting.

Triazines

The Triazine compounds, particularly Atrazine and Propazine, have consistently reduced the stand of quackgrass when properly applied. Based on the data and observations being reported, the following points are significant:

a. Spring applications have been more effective than fall.

b. Split applications have been more consistent than single applications of the same total active ingredient.

c. Plow down treatments have been definitely superior to pre- or post-emergence treatments of the same total active ingredient.

d. A delay of 4 to 7 days between application and plowing would appear desirable. Longer intervals, up to 3 weeks, have not reduced effectiveness.

e. Split applications have resulted in the control of a wider range of weed species compared to an equal amount of active ingredient applied in a single application as plow down, pre- or post-emergence.

f. Stand reductions of 80 to 95 percent have been obtained consistently over a range of soil types, when proper application procedures are followed.

g. Where Atrazine applications exceed 2 pounds active ingredient per acre, field crops other than corn may show varying degrees of injury if planted that fall or the following spring.

h. In field crop rotations, where crops susceptible to Atrazine are to be planted the following season, the use of Amitrole-T as the spring plow down treatment plus Atrazine pre- or post-emergence is effective in reducing quackgrass stands. The treatment will give seasonal control of most annual broad-leaved weeds and annual grasses germinating from seed. The data and observations from the research trials show 1 to 2 cultivations to be necessary.

i. Atrazine has not controlled those weed species developing from vegetative parts, may not give seasonal control of some annual grasses (crabgrass and foxtail) and has not controlled velvetleaf (*Abutilon theophrasti*) germinating from seed.

j. Where desirable, a complete kill of quackgrass is possible by repeated applications of Atrazine as plow-down and pre- or post-emergence treatments. The same total amount of chemical in split applications has been far more effective in reducing quackgrass stands compared to a single application.

k. Fall treatments on fall plowed ground, spring treatments on fall plowed ground, incorporated spring treatments on spring plowed ground, and pre- or post-emergence treatments following planting have resulted in less dependable stand reductions compared to split plow-down plus pre- or post-emergence treatments.

Due to extended residual activity, poor weed control, crop injury or inconsistent and variable results, Ametryne, Atratone, the Benzoics, Eptam, Fenac, G-34360, G-34361, G-34698, Lorox, Prometryne, Simazine, TCA and Tillam are considered less satisfactory for quackgrass control.

NUTGRASS CONTROL IN FIELD CORN - 1962[1]

Jonas Vengris[2]

Nutgrass (Cyperus esculentus L.) is a common perennial weed in Massachusetts. In the last few years this weed has been increasing and has become one of the most noxious weed pests.

Preliminary tests (5) as well as results from research done elsewhere (1,2,3) indicate that atrazine (2-chloro-4,ethylamino-6,isopropyl-amino-s-triazine) and EPTC (ethyl N,N-di-n-propylthiolcarbamate) are effective herbicides for controlling nutgrass, at least for one growing season. EPTC, however, is injurious to corn (2,5). On the other hand, corn is not injured by atrazine, hence this herbicide is very promising for controlling nutgrass in corn fields.

Although atrazine enters the plants primarily through the roots, it is also absorbed by the foliage (4) and it is reasonable to assume that post-emergence applications might increase its effectiveness. Fertig (3) found that atrazine applied as post-emergence treatment was more effective than a pre-emergence treatment in controlling nutgrass. On the other hand Cole et al (2) in Delaware were not able to verify these results. Work in Massachusetts with atrazine on quackgrass (Agropyron repens) control showed that under dry soil and weather conditions mixing the chemical 3" to 4" deep into the soil increased its effectiveness (6).

The objective of our tests in 1962 was to determine the value of mixing atrazine with the soil and also to determine the effectiveness of post-emergence applications of atrazine on nutgrass.

Procedure

The experiment was conducted on a fine sandy loam with fair drainage. The area had a thrifty uniform stand of nutgrass. A randomized block design with four replicates was used. Each plot consisted of four rows of field corn 20 ft. long. On June 15 atrazine was applied on a limed, fertilized and well prepared seedbed. Immediately after the application of atrazine some plots were rototilled 3-4 inches deep in order to mix the herbicide with the soil. The soil was normally moist. Ohio M-15 field corn was planted on the same date. Post-emergence treatments were applied June 25, 1962. At that time, nutgrass seedlings were about 1-2 inches in height. To control annual weeds

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on the check plots, all plots were sprayed on June 27 with 6 lbs/A of DNBP. The corn at that time was in the coleoptile stage of growth.

Atrazine rates presented in Table II are expressed in pounds of acid equivalent.

Table I

Rainfall and Temperature Prior to and after Atrazine Treatments for Nutgrass Control
Amherst, Massachusetts 1962

Planting Treatment (6/18/62)	Total rainfall inches	Average mean temperature °F
14 days before treatment	0.85	64.4
7 days before treatment	0.55	65.7
7 days after treatment	0.08	69.3
14 days after treatment	0.13	68.5
Post-emergence Treatment (6/25/62)		
14 days before treatment	0.63	67.6
7 days before treatment	0.08	69.5
7 days after treatment	0.05	67.5
14 days after treatment	0.05	65.1

Table II

Nutgrass Control in Field Corn
Amherst, Massachusetts 1962
Relative values Check = 100

Treatments	Nutgrass stands Check = 100 1960	Nutgrass stands Check = 100 1962	Corn yields-1962 noncultivated check = 100
1. Check	100	100	100
2. Atrazine 2 lbs/A at planting	32	82	160
3. Atrazine 4 lbs/A at planting	18	68	173
4. Atrazine 2 lbs/A at planting & mixed in	37	26	212
5. Atrazine 4 lbs/A at planting & mixed in	16	12	247
6. Atrazine 2 lbs/A post planting		80	165
7. Atrazine 4 lbs/A post planting		61	200
L.S.D. at 5% level	8	10	29
L.S.D. at 1% level	11	13	40

Results and Discussion

The effect of different treatments on nutgrass and corn was observed during the entire growing season. Observations made six weeks after corn planting and relative yields are recorded in Table II. Two middle rows of each plot were harvested at silage stage on September 7, and air-dry yields were determined. All treatments gave significant control of nutgrass, but atrazine applied on the surface at planting time and also as a post-emergence treatment did not differ and nutgrass control from a practical point of view was not satisfactory.

From the very beginning, close observations showed that mixing atrazine with the soil increased its effectiveness. These two treatments were by far the best. On the contrary, our 1960 trials did not show any increase in effectiveness when mixing atrazine into the soil. It appears that soil moisture relationships at the time of application and for a short period of time thereafter explain these results. Atrazine is only slightly soluble in water (70 ppm) and moisture conditions in the soil at the time of application and the first ten days after application are critical for the effectiveness of atrazine. In 1962, after applications of atrazine at planting or post-emergence, there were only traces of rain during the first two weeks (Table I). Thus, the chemical was exposed on the dry surface soil for at least two weeks. On the other hand when atrazine was incorporated into the moist subsurface soil, the chemical was much more effective probably for at least two reasons: atrazine was close to the germinating nutgrass tubers and secondly adequate soil moisture helped to release chemical and thus it was more accessible to the roots of the weed. This postulation is clearly supported by our 1960 results (4). In this case there was no advantage from mixing atrazine with the soil (Table II). A few hours after the application of atrazine in 1960 a heavy rain fell (Fig. I) and thus the conditions were favorable for the chemical to act whether mixed with the soil or left on the surface.

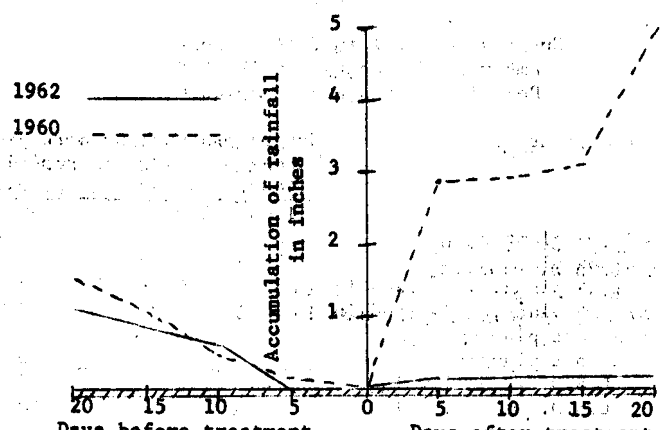

Figure 1. Accumulated inches of rain before and after application of atrazine. 1960 and 1962.

It appears as though the absorption of atrazine through the foliage of nutgrass seedlings was negligible and did not increase the effectiveness of the herbicide significantly.

The 1962 growing season at Amherst was rather dry and weed competition for moisture was strong. All atrazine treatments resulted in significantly increased corn yields. Treatments with the best nutgrass control produced the highest corn yields.

Summary and Conclusions

The 1962 as well as the 1960 tests clearly indicate that atrazine is an effective herbicide in controlling nutgrass for the growing season. Under favorable soil and weather conditions even 2 lbs/A provides practical nutgrass control. A rate of about 3-4 lbs/A is suggested. Applications should be made on a prepared seedbed at corn planting. Mixing applied herbicide with the soil to a depth of 3-5 inches is advantageous, especially if dry weather and soil conditions are anticipated. The time of application of atrazine is less critical than the soil moisture conditions at time of application and rain accumulation shortly after application. Irrigation of fields immediately after application of atrazine, where possible, is suggested.

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HERBICIDES AND CULTIVATION OF CORN

Collins Veatch[1]

Introduction

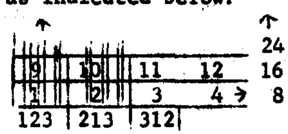
It is generally acknowledged that the main objective in cultivating corn is the control of weeds. If this is true, where weeds in corn fields are controlled by herbicides, cultivation can be eliminated. Meade and Santelman (1) reported in 1959 that "Plots scraped with a hoe outyielded all other treatments. Most pre-emergence treatments were not significantly different from the cultivated check." Meggitt (2) concluded that "One and sometimes two cultivations are needed to provide maximum corn yields on most soil types with the exception of those which are of a light texture." Fertig (3) reported that "Cultivation was most beneficial on those plots where poor chemical control was obtained." The 1961 results in West Virginia were conflicting in that the uncultivated plots at Point Pleasant outyielded the cultivated while at two other locations the early cultivated plots gave the highest yields. This 1962 trial was designed to gather further information on the question of benefits to be gained in yield or weed control by combining cultivation with the application of herbicides.

Material and Methods

This trial was set up as a split plot design. The herbicide treatments were randomized in each replication. The cultivation treatments were randomized in a manner so that the cultivation continued straight through the series of four or eight plots as indicated below.

1 uncultivated
2 early cultivation
3 late cultivation

cultivation



Variations in the trials at the three locations are indicated below:

Location	Variety	Plots
Point Pleasant	AES - 805	2 rows - 10 hills (checked) 42" x 42"
Reedsville	Ohio W-15	2 rows - 30' long (drilled) 36" apart
Wardensville	W.Va. 7802	2 rows - 30' long (drilled) 42" apart

Location	Harvested	Soil
Point Pleasant	picker sheller	Wheeling silt loam
Reedsville	hand	Atkins silt loam
Wardensville	hand	Philo silt loam

Early cultivation refers to cultivating when the corn was 6" to 8" high and late cultivation when 2' to 3' high.

The weed index, 0 indicates no weeds were present whereas 9 indicates complete coverage with weeds or no weed control.

The herbicide applications 2-14 were made pre-emergence while 15 and 16 were applied post-emergence as a directed spray when the corn was 12" to 18" in height. Only 12 treatments were applied at Point Pleasant.

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All yields were calculated on the basis of 15% moisture. No corrections were made for stand.

Results

There were essential differences in the weed populations at the three locations. At Point Pleasant the weeds were primarily annuals, at Reedsville weeds were not a serious problem, whereas at Wardensville perennial nutsedge, in addition to the annual weeds, complicated the problem.

At Point Pleasant (Table 1) the best average yield (111.6 bushels) was harvested from the plots treated with four pounds per acre of atrazine. However, plots treated with two pounds of atrazine, simazine, 2,4-D or Banvel D were quite satisfactory in yield and weed control at this location. As an average of all plots cultivation increased yields as indicated by the mean yields 92.05 bushels uncultivated, 98.36 bushels early cultivation and 100.42 bushels for the late cultivated plots.

However, on the plots in which the herbicide controlled the weeds as shown by a weed index of 5.0 or less without cultivation, there was no evident benefit from cultivation.

As a rule the late cultivation gave slightly higher yields and better weed control than the early cultivation. The F values indicate a very high relationship between yield and cultivation or herbicide treatment, as well as between the weed index and cultivation or herbicide treatment.

Weeds were no problem at Reedsville (Table 2) where the uncultivated check plots gave a yield of 123.5 bushels per acre and cultivation apparently reduced the production. The highest producing plots were those treated with simazine even though weeds were not a problem. Banvel D at rates of two and three pounds per acre seemingly reduced the yield of corn especially on the cultivated plots. Considering the mean yields cultivation did give a slight increase in overall yield of 1.33 to 2.48 bushels per acre. The F values indicate a significant relationship between yield or weed index and treatment. Cultivation made no contribution at this location.

At Wardensville where annual weeds and nutsedge were abundant cultivation did improve yields as indicated by the mean yields, -- uncultivated 61.90 bushels, early cultivated 72.30 bushels and late cultivated 72.41 bushels per acre. Cultivation also increased the weed control as indicated by a lower weed index. The plots treated with two pounds of atrazine or simazine or four pounds of promytrene averaged over 80 bushels per acre. Cultivation improved the weed control and increased the yields of these plots. Atrazine at four pounds per acre pre- or post-emergence gave yields averaging 79 bushels per acre with the pre-emergence (treatment 3) showing the best weed control as compared to treatment 16. Lorox at three pounds per acre, applied as a directed post-emergence spray gave as good final weed control as four pounds of atrazine applied pre-emergence and gave the highest average yield of any treatment at this location, 83.1 bushels per acre. The F values indicate that here cultivation was more effective than treatment although both cultivation and treatment were very significant factors in determining yield and weed control.

Summary

Where weeds are a serious problem cultivation may be very beneficial in supplementing or augumenting herbicide weed control and thereby increasing yield.

Where weeds are not a serious threat to crop production or where the herbicide is somewhat toxic to corn, cultivation may actually be detrimental.

Table 1. Yields and Weed Indexes of Uncultivated, Early Cultivated and Late Cultivated Herbicide Treated Corn Plots at Point Pleasant

	Herbicide	Lbs./A.	Average of Treatments Bu./A.	Average of Treatments Weed Index	No Cultivation Bu./A.	No Cultivation Weed Index	Early Cultivation Bu./A.	Early Cultivation Weed Index	Late Cultivation Bu./A.	Late Cultivation Weed Index
1	(Check, no Herbicide)		76.9	6.4	61.0	8.0	76.8	7.0	92.8	4.3
2	Atrazine	2	105.2	2.5	99.8	3.8	107.5	2.0	108.3	1.8
3	Atrazine	4	111.6	1.9	112.8	2.3	111.5	1.5	110.5	2.0
4	Banvel D	2	100.4	2.7	105.7	3.0	95.4	2.5	100.1	2.5
5	Banvel D	3	96.2	3.0	96.8	4.0	96.2	2.0	95.7	3.0
6	Banvel T	2	94.4	4.5	84.7	5.8	101.5	4.3	96.8	3.5
7	Banvel T	3	94.0	5.1	87.4	6.0	93.2	4.8	101.5	4.8
8	2,4-D	2	107.8	3.5	105.3	4.5	111.2	3.0	107.0	3.0
9	Shell 7585	2	92.6	5.1	79.4	7.5	99.1	4.8	99.2	3.0
10	NIA 6370	4	90.1	6.3	79.4	9.0	95.4	5.8	95.4	4.0
11	Simazine	2	99.8	2.7	102.3	3.8	97.8	2.3	99.2	2.0
12	2,4-D	1								
	Dacthal	10	94.4	3.8	90.0	5.0	94.9	3.3	98.4	3.0
	Means		96.94	3.97	92.05	5.21	98.36	3.58	100.42	3.1
	$L.S.D._{05}$	16.86								

Bu./Acre

F - cultivation	6.29**
F - treatment	6.86**

Weed Index (Oct.)

F - cultivation	31.25**
F - treatment	14.24**

Table 2. Yields and Weed Indexes of Uncultivated, Early Cultivated and Late Cultivated Herbicide Treated Corn Plots at Reedsville

			Average of Treatments		No Cultivation		Early Cultivation		Late Cultivation	
	Herbicide	Lbs./A.	Bu./A.	Weed Index	Bu./A.	Weed Index	Bu./A.	Weed Index	Bu./A.	Weed Index
1	Check	---	118.7	1.7	.23.5	2.5	118.9	1.0	113.7	1.5
2	Atrazine	2	122.2	.3	119.9	.3	122.9	.3	123.8	.3
3	Atrazine	4	116.0	0	113.0	0	112.7	0	122.2	0
4	Banvel D	2	94.8	2.2	101.1	2.5	85.9	1.8	97.4	2.3
5	Banvel D	3	84.9	1.3	91.8	1.0	87.0	1.5	76.0	1.3
6	Banvel T	2	119.5	1.3	117.2	1.3	120.1	1.8	121.2	1.0
7	Banvel T	3	121.0	1.3	114.7	1.5	118.6	1.3	129.7	1.0
8	2,4-D	2	110.4	1.3	103.9	1.3	118.0	1.5	109.3	1.0
9	Shell 7585	2	123.1	1.7	123.0	1.8	123.5	2.0	122.7	1.3
10	NIA 6370	4	119.8	1.1	122.5	1.3	114.6	1.0	122.4	1.0
11	Simazine	2	133.6	.8	126.5	.8	129.6	.3	144.7	1.5
12	2,4-D	1								
	Dacthal	10	122.7	1.1	113.6	1.0	131.8	1.0	122.7	1.3
13	Promytrene	2	118.2	.8	119.7	.8	121.9	.8	113.1	.8
14	Promytrene	4	110.2	.6	109.1	.5	112.0	.5	109.4	.8
15	Lorox	3	120.9	0	116.7	0	121.8	0	124.1	0
16	Atrazine	4	113.3	0	112.7	0	110.9	0	116.3	0
	Means		115.58	.97	114.31	1.01	115.64	.91	116.79	.92
	$L.S.D._{05}$	19.4								

Bu./Acre
- F - cultivation .51
- F - treatment 8.37**

Weed Index (Oct.)
- F - cultivation .24
- F - treatment 5.54**

Acknowledgement

Acknowledgement is made to the following companies for supplying the herbicides used in these trials: Amchem Products Company, Diamond Alkali Company; Dow Chemical Company; E.I. du Pont de Nemours and Company; Geigy Agricultural Chemicals; Niagara Chemical Division, F.M.C. Corporation; and Velsicol Chemical Corporation.

Table 3. Yields and Weed Indexes of Uncultivated, Early Cultivated and Late Cultivated Herbicide Treated Corn Plots at Wardensville

			Average of Treatments		No Cultivation		Early Cultivation		Late Cultivation	
	Herbicide	Lbs./A.	Bu./A.	Weed Index	Bu./A.	Weed Index	Bu./A.	Weed Index	Bu./A.	Weed Index
1	Check	---	59.0	6.9	52.8	7.5	68.8	6.8	55.5	6.5
2	Atrazine	2	81.1	2.8	74.8	5.5	81.9	1.5	86.5	1.5
3	Atrazine	4	79.2	.5	83.0	1.3	71.2	.3	83.3	0
4	Banvel D	2	53.0	4.3	49.3	5.5	51.6	3.5	58.0	3.8
5	Banvel D	3	49.5	4.3	43.8	6.3	47.3	3.5	57.4	3.0
6	Banvel T	2	53.7	7.0	43.2	8.5	58.5	6.8	59.5	5.8
7	Banvel T	3	78.5	5.3	68.9	6.8	91.4	3.3	75.5	5.8
8	2,4-D	2	69.1	3.9	67.4	6.0	71.4	3.0	68.7	2.8
9	Shell 7585	2	64.4	4.2	49.4	5.5	73.6	3.5	70.3	3.5
10	NIA 6370	4	61.1	4.3	48.5	6.0	66.9	3.8	67.8	3.0
11	Simazine	2	81.3	2.5	77.1	3.8	88.7	1.5	78.1	2.3
12	2,4-D	1								
	Dacthal	10	60.9	3.9	47.0	4.8	66.4	3.8	69.6	3.3
13	Promytrene	2	66.1	4.6	62.3	6.3	63.9	4.3	72.0	3.3
14	Promytrene	4	82.6	2.3	77.2	3.3	79.9	2.0	90.7	1.8
15	Lorox	3	83.1	1.1	74.4	1.3	91.8	1.3	83.3	.8
16	Atrazine	4	79.1	4.2	71.4	6.3	83.6	3.3	82.5	3.0
	Means		68.87	3.87	61.90	5.26	72.30	3.23	72.41	3.11
	$L.S.D._{.05}$	20.7								

Bu./Acre
- F - cultivation 10.60**
- F - treatment 7.67**

Weed Index (Oct.)
- F - cultivation 42.29**
- F - treatment 16.79**

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PRE-EMERGENCE WEED CONTROL IN CORN

S. M. Raleigh[1]

The weed control plots were disked and planted with a two row corn planter on May 17, 1962. The liquid sprays were applied with a six foot hand boom and the granular material was mixed with soil and applied by hand. The plots were laid out so there were an untreated two rows next to the two sprayed rows. Counts were made in two areas of the sprayed and unsprayed rows to obtain the per cent kill of weeds. There were three rates and three replications for each treatment.

The first 12 treatments were applied May 17 and 18. The 13th to 19th treatments were applied May 21. The last 8 treatments were applied May 25. The corn was just emerging. Many yellow foxtail seeds had germinated by this time which accounts for the poor grass control. There was a heavy stand of yellow foxtail and very few dicots.

Granular Simazine 4 g. and Atrazine, 10 g. were definately much poorer in controlling grass than the 80 w. Simazine and Atrazine. There was slight differences in Atrazine 20 g. and Atrazine 80 w. Hyvar stunted the young corn plants, but did an excellent job of controlling yellow foxtail. Linuron did not control grass as good as had been expected. Randox and Randox T did an excellent job this year. It is the first year that Randox and Randox T control has been satisfactory. Niagara 2995 stunted the corn slightly early but did a good job of Monocot control.

The 2,4-D control was poor because many yellow foxtail had germinated by the time the applications were applied.

Table I. Percent Monocot Control with Pre-Emergence Herbicides.

Chemical	Rate/Acre	Low rate	Medium rate	High rate
Simazine 80W	1, 2, 3 lbs.	37.1	74.4	71.4
Simazine 4G	1, 2, 3 lbs.	35.4	26.0	55.9
Atrazine 80W	1, 2, 3 lbs.	53.2	86.1	100.0
Atrazine 10G	1, 2, 3 lbs.	7.8	58.7	84.8
Atrazine 20G	1, 2, 3 lbs.	55.6	68.7	100.0
Atratone	1, 2, 3 lbs.	49.0	64.7	79.1
Ametryne	1, 2, 3 lbs.	63.6	71.1	89.3
Propazine	1, 2, 3 lbs.	14.7	80.1	82.2
Promotone	1, 2, 3 lbs.	25.2	73.7	88.6
Prometryne	1, 2, 3 lbs.	27.2	82.3	96.5
Linuron	1, 2, 3 lbs.	34.2	65.3	90.0
Hyvar	1, 2, 3 lbs.	73.9	94.9	97.0
Randox	2, 4, 6 qts.	26.0	84.8	86.3
Randox T	2, 4, 6 qts.	40.2	82.6	93.1
Amiben	2, 4, 6 lbs.	14.0	38.1	60.9
Niagara 2995	2, 4, 6 lbs.	17.0	60.1	82.9
Alinap 3	2, 4, 6 lbs.	27.6	19.5	34.7
Alipur	2, 4, 6 lbs.	20.8	48.7	55.7
FW 925	2, 4, 6 lbs.	45.1	42.8	60.2
Dacamine D	1, 2, 3 lbs.	23.5	11.9	45.8
Dacamine DT	1, 2, 3 lbs.	0	21.8	73.6
ACP-638 Aged	1, 2, 3 lbs.	4.5	21.9	72.1
ACP-638	1, 2, 3 lbs.	19.5	32.5	50.0
A-amine	1, 2, 3 lbs.	.9	28.1	26.7
LV-4	1, 2, 3 lbs.	10.0	28.1	34.9
Emulsamine	1, 2, 3 lbs.	0	32.7	58.0
ACP 61-207	2, 4, 6 lbs.	52.9		

MEASURING VOLATILITY OF HERBICIDES

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Introduction

Variable field conditions make separation of volatility and spray drift very difficult. Wind movement, temperature, droplet size, moisture, sunlight, the type of chemical, and the susceptibility of the adjoining vegetation are factors in the problem. In the western areas soil temperatures may reach 160° F one-half inch below the surface. Air temperatures of 120° F are not uncommon. The temperature in the uppermost soil particles can be quite high even in our area here in the East. Low volatile esters are usually considered safe under our conditions while low molecular weight alkyl esters may be hazardous on warm days. The proximity of very sensitive plants in large acreages is not the problem in our area as it is in the cotton land of the South.

The most positive and definitive test for volatility is an evaluation under field conditions. In 1950, Allen (1) and Tafuro, Van Geluwe, and Curtis (2) reported field data where moderate temperatures were encountered. Ten years later Day, Johnson, and Dewlen (3) and Day, Jordan, and Russell (4) conducted field tests in California with the chemicals carefully applied to well separated plots in a cotton field. Soil temperatures reached a maximum 158° F with an air temperature of 117° F. The vapor effect was evaluated in relation to the cotton leaf modification; observations were made at varying distances from the actual chemical plot. The high temperature conditions and sensitivity of the test plant made possible detection of volatility arising from very low volatile formulations. Low volatile esters such as the butoxyethyl ester and propyleneglycol butyl ether ester showed greater volatility than the 2,4-D acid emulsion. In 1959 the alkanolamine showed no volatility. In subsequent tests the alkanolamine salts as well as the alkylamine salts produced slight cotton damage but were described as less volatile than the 2,4-D acid.

In 1961 Leonard (5) used cotton plants and observed the development of strap-shaped leaves following a time sequence exposure to the 2,4-D chemicals in closed containers in the field. Volatility was reported in the following descending order: isopropyl ester, isooctyl ester, butoxyethyl ester, emulsifiable acid, acid crystals, and finally the sodium and alkanolamine salts with no volatility.

Official and Tentative Methods of Analysis (6) describes a method for measuring volatility of ester forms of hormone type herbicides. It is a variation of the method reported by Zimmerman and Hitchcock in 1939 (7). Tomato plants were exposed for 24 hours to the herbicide on a filter paper in a No. 20 paper bag. A 1 to 6 scale was used to rate the epinasty of stem and petioles.

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Baskin and Walker (8), Marth and Mitchell (9), Mullison and Hummer (10), and Linder (11) studied volatility. Linder evaluated the epinasty produced in pinto beans exposed in sealed cellophane cases for 24 hours. Exposures were made in the dark with room temperatures 80 to 90° F. Sixty-three pure phenoxyacetic acid esters were evaluated as well as 13 non-ester forms. Very careful measurements pointed out differences in volatility between the low volatile esters. The butoxyethyl ester of 2,4-D was slightly less volatile than the isooctyl ester. The acid was not volatile under Linder's conditions.

R. D. Hart[1] studied volatility under higher temperatures to evaluate ester formulations. Using closed polyethylene containers with herbicides in petri dishes, Hart found that temperatures near 120° F may make the plants rather immune to ester vapors. It also appeared that the condensate which collected on the inside of the bag could strongly influence results if it contacted the exposed plants.

Materials and Methods

Procedure and equipment was designed to permit the test plants to remain at approximately 75° F while the temperature of the herbicide was elevated to as much as 160° F. The test chambers were shaped like miniature Quonset huts. One inch mesh chicken wire, 18" in width and 36" long, was shaped by folding 2" in on each side giving a final size of 14" x 36". A 9.5" section of the wire 4" from the end was flattened for the base. The 4" section was bent upward with slightly more than a 90° angle with the base. The other side was bent to the same sharp angle and the remaining 22.5" of wire was drawn in a smooth curve to overlap the 4" section about 1". The side was secured with string or soft wire. The wire frame was then inserted into a heavy gauge 18" x 27" plastic bag.

Crystallization dishes 50 mm. in diameter were used as herbicide containers. Heaters were prepared by winding 36" of No. 30 B & S Nicrome or Chromel type resistance wire on a jig made from a 6-penny finishing nail. "Crimp-on" size 22 - 16 butt connectors were used to join the resistance wire to No. 20 solid hookup wire to serve as leads. The coiled resistance wire section was stretched in a circular shape with the lead wires extending upward and out of the dish. These leads were bent sharply at the top edge of the dish and fastened to the outside of the dish with masking tape. When the leads were firmly fixed to the dish, the loop of resistance wire was positioned about 5 mm. from the bottom of the dish.

The dishes were filled with 35 cc. of herbicide and placed on a 4" square of blotting paper in the center, 1" from the side of the chamber. The lead wires were pushed through the plastic bag and connected to a variable voltage AC power source. Usually a 5-watt 6-ohm rheostat was placed in the individual circuits to give better temperature control. The units were operated at 5 to 9 V depending on the temperature desired. Thermometers were inserted through the side of the plastic chambers and below the surface of the herbicide in the dish.

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Room temperature was maintained near 75° F in all tests except in tests where air temperature effects were studied. The usual variation during the course of an experiment was less than 4° F. The air temperature in the chambers with heaters ran 1 to 2° F above that in the chambers without heaters. The temperature in the dish was maintained when the energy input in the circuit balanced the heat loss from the surface of the dish to the air inside the chamber. At the completion of a test the entire chamber and heating unit was discarded.

Tomato plants 4½ to 6" in height were used as test plants. These were carefully selected for uniformity. Epinasty was rated 1 to 10, with 1 being very slight epinasty of leaf blades and petioles and 10 being severe epinasty of petioles, blades, and stems. Epinasty was chosen as the response to measure so the experiments could be completed in 48 hours or less. Six plants were used per chamber and pairs or individuals were withdrawn after an appropriate exposure.

Results and Discussion

Air movement was studied in the chamber with smoke generated over the dishes with ammonia and hydrochloric acid. The heat of the dish produced sufficient convection currents to raise the smoke to the top of the chamber in 1 or 2 seconds and fill the chamber uniformly in about 1.5 minutes.

A preliminary 70 minute exposure test was run with a maximum chemical temperature of 148° F. The pure isopropyl ester of 2,4-D, a 2,4-D - 2,4,5-T butoxyethyl invert emulsion with and without water, a 2,4-D - 2,4,5-T butoxyethyl brush killer, and the oil soluble primene salt of 2,4-D were compared. The isopropyl ester produced very severe epinasty; the brush killer and the D-T invert emulsion with water produced a slight to moderate response. The invert emulsion without water produced very slight epinasty; no response to the oil soluble amine was observed.

The condensate that formed on the sides of the chambers in the above experiment was checked for activity. After the vapor-exposed plants had been removed, fresh plants were thrust into the chambers to touch the walls and the condensate. The plants thrust into the isopropyl ester chamber momentarily showed as great a response as a plant that had been exposed to the vapor for 70 minutes. The concentration of ester or salt in the condensate from the other formulations was not sufficient to cause an effect. It may be possible to develop a satisfactory bioassay for volatility by using this condensate.

A study was made to determine whether plants were more receptive to 2,4-D ester vapors when the foliage was moist or dry. Plants were moistened with distilled water, 5% ethylene glycol, or a 1% emulsifier solution. Dry plants were also exposed to the isopropyl ester of 2,4-D for 70 minutes with a maximum temperature of 110° F in the dishes. There was very little difference in the plant response observed with the various treatments. The presence of moisture with or without the emulsifier or ethylene glycol did not enhance vapor activity strikingly. There was some slight evidence, however, that moist foliage was more receptive to vapors than dry foliage. During the experiment the plants and soil tended to saturate the air in the chambers even when no water had been added to the foliage. Gutation droplets were observed on the so-called dry leaves. Perhaps using a dessicant in the dry chamber would accentuate the slight difference observed in this test.

A time-exposure temperature study was run with the butoxyethyl ester of 2,4-D heated to 140° F and 158° F. Plants were withdrawn at 1, 2, 3, 4, 5, and 24 hours. The epinasty was rated after 2 and 5 days (Table 1). The change in epinasty ratings is typical of recovery that occurs after the treatments. The initial amount of herbicide absorbed by the plant was so high that no difference could be observed at other than the 1 hour exposure. As the plants began to recover it was apparent that the actual amount of herbicide absorbed by the plants depended on the temperature of the herbicide in the dish and the time of exposure.

TABLE 1

Epinasty observed 2 and 5 days after exposure to the vapor butoxyethyl ester of 2,4-D arising from heated dishes.

Exposure hours	Relative Epinasty			
	2 day observation Ester Temperature		5 day observation Ester temperature	
	140° F	158° F	140° F	158° F
0	0	0	0	0
1	5	6	1	2
2	9.5	9.5	3.5	5
3	9	9	5.5	6.5
4	10	10	6.5	7.5
5	9.5	9.5	7.5	8.5
24	10	10	10	10

Epinasty: 1 = very slight
10 = very severe

Under field conditions, when volatility is a problem the plants as well as the herbicide are hot. In the above-described laboratory test the plants responded to vapor readily at temperatures near 75° F. In exploring this plant temperature factor further the laboratory temperature was adjusted to 58° F. The herbicide temperature was adjusted to 150° F (av) in one set of chambers and 130° F in another. The air temperature in the two sets of chambers averaged 62° F and 61° F respectively during the 5 hour exposure. Reducing the air temperature in the chambers to 61 to 62° F (15° F below that of the previous experiment) seemed to have no effect on the epinasty (Table II). Results are essentially the same as that expressed in the previous test when one considers the variation in the herbicide temperature.

TABLE II

Epinasty observed after a 5 hour exposure of plant to butoxyethyl ester of 2,4-D with air temperature in the chambers 61 -62° F.

Exposure hours	Relative Epinasty			
	1 day observation		4 day observation	
	Dish temperature		Dish temperature	
	130° F	150° F	130° F	150° F
0	0	0	0	0
5	7	9	4.5	9

It appeared possible to study chemicals less volatile than the low volatile esters of 2,4-D by combining time of exposure and herbicide temperature. Table III shows the great difference between the volatility of the oil-soluble amine and low volatile ester. In four hours the ester had produced maximum response in the plants, while the oil-soluble amine showed no epinasty until it was exposed for 10 hours. The dish temperature in the experiment was 155° F ± 4° F after equilibrium was established.

Table IV shows a number of interesting results relating to the oil-soluble amine of 2,4-D (primene salt), the free 2,4-D acid in water, the primene, and a 2,4-D primene salt formulation (M-740). The 2,4-D acid was more volatile than the oil-soluble amine and the formulation itself further reduced the volatility of the oil-soluble amine. The amine (primene) alone produced rapid and severe tissue burn. The 2,4-D acid was later evaluated in two organic carriers by dissolving small quantities of 2,4-D in them. One carrier was a wetting agent and the other was a mixed high-boiling aromatic oil. At the 48 hour observation period the 24 hour exposure plants were rated 8 epinasty for the wetting agent combination and only 2 for the aromatic oil combination. Both samples were maintained near 157° F for the 24 hours. Both treatments, although held 27° F above the temperature of the 2,4-D water combination, produced less epinasty. It appears that the presence of water may increase the vaporization of 2,4-D acid, possibly as a steam distillation effect.

TABLE III

A comparison of epinasty produced by the low volatile butoxyethyl 2,4-D ester and the oil-soluble primene salt of 2,4-D.

Treatment	Relative epinasty after 48 hours					
	Exposure in hours					
	1	2	4	5½	10	24
Check	0	0	0	0	0	0
oil soluble amine	0	0	0	0	2	*
low volatile ester	1	7	10	10	10	10

* Severe leaf tissue burn, making an estimation of epinasty impossible, appeared to be excess amine in preparation.

TABLE IV

Plant response to the vapors of primene, oil soluble amine of 2,4-D and 2,4-D acid.

Treatment	Epinasty			% Leaf burn		
	Exposure in hours			Exposure in hours		
	2	6	24	2	6	24
Check	0	0	0	0	0	0
2,4-D Acid[1]	1	2	10	0	0	0
Primene[2]	---	---	---	90	100	100
Primene salt of 2,4-D[2,3] (OSA - 2,4-D)	0	0	7	0	0	20
Formulation M-740[2] (OSA - 2,4-D)	0	1	1	0	0	0

[1]Purified, ground 2,4-D acid in 35 cc. water; temp. max. near 130° F
[2]Temperatures maintained at 150° F
[3]Salt stripped of excess amine detected in previous test

Some of Amchem's new experimental formulations of 2,4-D have now been tested and are even less volatile than the oil-soluble amine. Plants showed no vapor effects after being held for 24 hours in the presence of the formulation at 155° F. After 48 hours' exposure there was an indication of slight epinasty.

With a water carrier, the dimethyl amine was found to have the same magnitude of volatility as the acid. Severe epinasty was observed after a 24 hour exposure with chemical temperature maintained near 127° F.

Difficulty with volatile fractions of formulations producing burn and obscuring or preventing epinasty has been adequately solved by using 1 cc of the formula in 34 cc water in each heating unit. Arochlor, a chlorinated aromatic solvent with an extremely high boiling point, could also be used. Temperatures can be maintained easily near 160° F but only 0.1 cc of the formulations can be used safely with Arochlor. The threshold concentration of vapor contact burn appears to be greater than for 2,4-D epinasty. Table V shows results of a test using formulations which previously could not be evaluated in undiluted form because of tissue burn.

TABLE V

Epinasty produced by vapor of various 2,4-D formulations.

Carrier	2,4-D Formulation	Relative epinasty		
		Exposure time in hours		
		2	6	24
H_2O	Emulsifiable acid (Weedone 638)	0	3	7
H_2O	Butoxyethyl ester (Weedone LV4)	2	4	8
H_2O	Isopropyl ester (Weedone 128)	9	10	10
H_2O	Oil-soluble amine (Emulsamine E3)	0	0	-*
Arochlor	Emulsifiable acid (Weedone 638)	0	1	6
Arochlor	Butoxyethyl ester (Weedone LV4)	0	0	4
Arochlor	Isopropyl ester (Weedone 128)	7	9	10
Arochlor	Oil-soluble amine (Emulsamine E3)	0	0	1

* Equipment failure

The volatility relationship with water as the carrier was the same as for the pure chemicals and as in field tests. Shorter exposure times or lower temperatures would be required to compare other volatile ester formulations with the isopropyl ester. Arochlor appears to change the volatility of the formulations. This was supported by a dilution series of Arochlor and 2,4-D acid formulation study in which it was found that the epinasty produced was strongly influenced by the concentration of the formulation in the Arochlor.

Summary

A laboratory volatility technique using tomato plants as the biological material and internal heaters for the herbicide sample has produced volatility relationships similar to those obtained in field tests.

Herbicide temperatures were raised to 160° F while the plants remain at essentially room temperature in wire and plastic chambers. The high temperatures in the herbicide dishes made possible evaluation of very low volatile 2,4-D type materials.

Moisture on the plant foliage did not strongly influence the plant response to 2,4-D vapor. Herbicide vapor appeared to affect the plants about the same degree whether they were held at 61° F or 75° F during the exposure.

Water as the carrier seemed to increase the volatility of 2,4-D acid. The oil-soluble amines were the least volatile of the commercial preparations tested. Other new experimental formulas of 2,4-D were even less volatile. Commercial formulations that contain components that cause severe leaf burn can be evaluated satisfactorily by diluting the sample with water.

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PRELIMINARY RESULTS IN CONTROL OF POLYGONUM CUSPIDATUM

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Polygonum cuspidatum Sieb. and Zucc. is listed by Muenscher (3). It is not in the recent list of weeds recognized by the Weed Society (4). Japanese knotweed or Mexican bamboo, as Muenscher indicates for vernacular names, is a cultivated plant which is difficult to eradicate when the human point of view changes and the plant is out of place, hence a weed. The seasonal nature of the weed aspect was evident to Muenscher and to others who answer questions for the gardening public. Gardener's patience wears out after continually cutting the plant back, digging out the roots 3-6' deep, and screening the soil, but finding continued regrowth.

Chemicals have been tried since 1945 (2,4-D days) but with little more effect than the grubbing out recommended by Muenscher. Recent correspondence indicates success with 2,3,6 TBA (2,3,6-trichlorobenzoic acid) (1) and also with ATA, Atrazine, also Neburon (2) in a recently graded drainage basin.

In many gardens, clumps of *Polygonum cuspidatum* are present along with garden flowers and woody plants so that the selection of herbicides becomes limited.

On May 9, 1962 treatments were made to the base of the regrowth in a patch approximately 30x50' adjoining a flower garden. Herbicides used included 2,4,5-TP 15 lbs. active per acre (A/A) Amiben 30 lbs. A/A, Fenac 30 lbs. A/A, Prometone 30 lbs. A/A, and Zytron 45 lbs. A/A.

Observations on July 14 indicated that growth of *Polygonum cuspidatum* was modified by Prometone - yellow-aged foliage, Fenac - twisted and crinkled new foliage, 2,4,5-TP - aged foliage to dull yellow color.

In August the regrowth, 6' tall since May basal spraying, was removed and root samples taken from untreated as well as from treated plants. The root sections and plant base were placed in separate containers in the greenhouse under a watering regime of intermittent misting. Root growth and budbreak was prompt in control plants but was greatly restricted in Fenac and 2,4,5-TP samples, slow in Prometone and comparable to the check in Zytron and Amiben.

Root samples taken in September and October from Fenac and 2,4,5-TP plots have failed to produce as many roots and shoots as samples taken from control plots. Additional plots were set up in October and November using Fenac and 2,4,5-TP separately at rates of 5 to 15 lbs. per acre both basal and foliar spray. The May treatments were all basal treatments without the foliage coming in contact with the herbicide.

Preliminary results from basal spraying with 2,4,5-TP and with 2,3,6-trichlorophenylacetic acid seem to indicate a practical control procedure for limited plantings in home gardens.

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The author acknowledges herbicides supplied by Anchem, Ambler, Pa., Geigy Co., Ardsley, N. Y. and Dow Chemical Co., Midland, Mich. Also for experimental plant material from Mr. and Mrs. Palmer of Niles, N. Y.

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POLYBORCHLORATE FOR THE CONTROL OF THE COMMON BRAKE, *TERIDIUM AQUILINUM L.*, IN LOWBUSH BLUEBERRIES

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The common brake, *Teridium aquilinum L.*, is a serious pest in many lowbush blueberry fields. In two previous papers (1,2) it was shown that (1) polyborchlorate could be used to control the common brake in lowbush blueberry fields, (2) that an application made the spring of the fruiting year would destroy the crop, (3) that an application in the fall preceding the year of burn would injure the blueberry plants least, (4) that an application made in the spring of the year of burn gives best control of brakes, and (5) that a 400 pound per acre rate was as effective as a heavier rate for brake control.

This experiment was initiated to determine if less than 400 pounds per acre of polyborchlorate applied before burn would give equally good brake control with possibly less injury to the blueberry plants.

In 1960 six square-rod plots were laid out in each of three growers' fields where the brakes were thick. On September 27, 1960, polyborchlorate was hand broadcast at the rate of 100, 200 or 400 pounds per acre on three plots at each location. On May 16, 1961, the remaining three plots at each location received similar treatment. On August 22, 1960 before treatment with polyborchlorate, the brakes on each plot were counted. At the same time the blueberry plant stand was estimated by counting the number of plants on four square-foot areas, selected at random on each plot. Brake and blueberry plant counts were repeated on August 17, 1961 and August 17, 1962.

The results of brake control at the three locations are summarized in Table I.

Table I. Per cent control of common brake, *Teridium aquilinum L.* following application in spring or fall of polyborchlorate at three rates.

Rate in lbs. per acre	Time of application	No. of brakes per square rod plot: Before treatment Aug.'60	After treatment Aug. 1961	After treatment Aug. 1962	Per cent control Aug. 1962
100	Spring	953	1486	760	20.25
200		1062.	677	315	70.34
400		780	112	51	93.46
100	Fall	932	1505	715	23.28
200		697	849	417	40.15
400		1060	354	157	85.19

Contribution of the Mass. Agr. Expt. Station, Amherst, Mass.

In order to treat the data statistically by analysis of variance the percentages were transformed to angles (angle = arcsine$\sqrt{\text{percentage}}$). The analysis showed that differences between locations and between times of application were not significant. The differences between rates were significant. When the values of the same rates for spring and fall were pooled and tested by Duncan's Multiple Range Test, the values for all three rates were found to differ significantly from each other. It is obvious from the table that satisfactory control of brakes was not obtained at a rate lower than 400 pounds of polyborchlorate per acre.

Since polyborchlorate applied at high rates has injured the blueberry plants and spring applications were more injurious than fall applications, the rate of plant recovery is of considerable interest. The data in Table II show that recovery after two years was surprisingly good.

Table II. Per cent recovery of blueberry plants following application in spring or fall of polyborchlorate at three rates.

Rate in lbs. per acre	Time of application	No. of blueberry plants per 4 sq. ft. Before Treatment Aug. '60	After Treatment Aug. 1961	After Treatment Aug. 1962	Per cent Recovery Aug. 1962
100	Spring	203	183	241	118.72
200		192	64	208	108.33
400		150	0	196	130.67
100	Fall	196	231	298	152.04
200		225	268	316	140.44
400		206	182	252	122.33

When the percentages of recovery after two years were tested by analysis of various, none of the differences, between locations, between times of application, or between rates of application, were significant. The table shows that after two years the plots at each rate, spring or fall treated, had more blueberry plants than before treatment.

Discussion

Since 400 pounds per acre of polyborchlorate gave as good control of common brakes, *Teridium aquilinum* L., as heavier rates (1,2) it was desirable to find out if less would do an equally good job. In this experiment 200 pounds or less failed to give satisfactory control. Unless there is some rate between 200 and 400 pounds per acre that will give satisfactory control, the 400 pound rate is indicated.

Previously applications made the spring of burn gave better brake control than applications made the preceding fall. There is a suggestion of this, especially at the 200 and 400 pound per acre rates but these differences are too small to have statistical significance.

The most surprising results of this experiment were provided by blueberry plant recovery. When blueberry plant counts were made in August 1961, it looked as if there had been some injury at the 100 pound rate, severe injury at the 200 pound rate, and complete death of the plants at the 400 pound rate. Since the blueberry plants had all been burned in the spring of 1961, the spring application of polyborchlorate must have retarded regrowth rather than killed the plants. An application the preceding fall had a slight retarding effect on the plants treated at the 400 pound rate only. By August 1962, the blueberry plant situation had entirely changed. Recovery following a 400 pound application in the spring was just as good as following a fall application. The blueberry plant recovery at the 100 and 200 pound rates was better following fall applications but these differences were not statistically significant.

In spite of the surprising recovery of the blueberry plants, spring applications are not desirable. The plants were injured enough so that in 1961 regrowth, even at low rates, was slow and the 1962 crop on the spring treated plots was reduced or lost. This substantiates previous results concerning the undesirability of spring applications.

Rates less than 400 pounds per acre resulted in unsatisfactory brake control. Therefore, a fall application of polyborchlorate at 400 pounds per acre would give the best results in relation to both brake control and safety to blueberry plants.

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PROPAGATION OF *ARTEMISIA VULGARIS* FROM STEM CUTTINGS FOR HERBICIDE TEST PURPOSES

A. M. S. Pridham[1]

Artemisia vulgaris can be a troublesome weed in nurseries where it is easily spread by cultivation equipment or natural growth from underground parts. Muenscher lists *Artemisia vulgaris* L., mugwort or wormwood, as a perennial reproducing by seed and short root stocks. Distribution is across the northern and western United States but native in the western United States where it is variable and represented by several forms which are sometimes designated as varieties or species.

In nurseries of the northeast, *Artemisia vulgaris* produces stolons in the upper 4 inches of soil in essentially the same growth pattern as quackgrass. Sections of *Artemisia vulgaris* stolons of 2 to 4 inches in length have been used by the writer for screening of herbicides toward control of this weed under field conditions. Stolon sections may be treated directly or plants growing from stolon sections can be used for foliar treatment by spray techniques or surface granular application. Under field conditions sprays applied to young foliage derived from regrowth after mowing or from the first flush of spring growth result in more uniform and effective control than treatments made to mature stems, example, at the time of flower and seed production.

During 1962 stem cuttings were made 4 to 6 inches in length and of tissue of several stages of maturity. The leafy cuttings were placed in perlite as a rooting media, using small peat bands as individual containers. Cuttings root freely under automatic watering by mist (Florida nozzles) in a 60°F greenhouse.

The rooted cuttings can be treated by either foliar spray of herbicide or by spray or dipping the roots. Stolon-like roots form along with normal roots after a period of a month to six weeks. Roots and stolons will form on stem sections devoid of foliage. Seeds have been collected and planted at various times but this method of propagation has not proved to be as satisfactory as cuttings made from stolons or from above ground stems.

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Some Factors Influencing Nutgrass Response to Chemicals[1/][2/]

by

R. P. Hargan[3/], G. H. Bayer[3/], J. C. Cialone[3/], and R. D. Sweet[4/]

One of the most difficult weeds for Northeastern vegetable growers to control has been Northern nutgrass (Cyperus esculentus L.). There is, therefore, considerable demand to develop suitable programs for its control in a wide variety of crops.

The objective of these studies was to determine the best usage program for each of several chemicals found in previous research (1,2,3,4) to be effective in controlling Northern nutgrass. Specific emphasis was placed on the stage of nutgrass growth at application and the effect of tillage both at the time of application and later in the season because both factors could readily influence nutgrass response and because these factors are readily controlled by farmers.

Materials and Methods

The plots were situated on a well drained silt loam soil at King Ferry, New York. The nutgrass infestation was extremely uniform and dense with few other weeds present.

The materials tested were: Atrazine (W.P.), EPTC (liq.), Hercules 7531 or 1-[5-(3a,4,5,6,7,7a-hexahydro-4,7-methanoindanyl)]-3,3-dimethylurea (W.P.) and Linuron (Lorox W.P.). Each chemical was applied according to the following schedule:

Treatment No.	Stage of nutgrass at application	Soil preparation at application	Subsequent disking
1	At sprouting of tubers	pre-plowing	None
2	" " " "	"	Once
3	" " " "	Post-plowing-prior to disking	None
4	" " " "	" " " "	Once
5	" " " "	Post-plowing-after disking	None
6	" " " "	" " "	Once
7	Post-emergence (5-10")	Post-disking-foliar application	None
8	"	" " "	Once

Initially the area was staked into 16x16 feet plots and the pre-plowing treatments applied. The stakes were removed and the entire area was plowed and disked. A second series of plots was then applied and the entire area immediately re-disked. A third series of plots was then treated and the

1/ Paper No. 475, Department of Vegetable Crops, Cornell University, Ithaca, N.Y.
2/ This research was aided by grants in aid from Stauffer Chemical Company and from Hercules Powder Company.
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chemicals were left undisturbed. A total of three days time elapsed during this series of applications. About three weeks later when the nutgrass had grown to 4-6 inches in height, a fourth series of plots, except for EPTC was applied. Six days later EPTC was applied. Immediately following the EPTC treatment, June 4th, one-half of the EPTC and all previously treated plots were thoroughly disked. Corn and beans were then planted as indicator crops in the disked areas. Thus every treated 16x16 foot area was split into a disked and non-disked portion.

The growing season was particularly dry. Rainfall as measured officially five miles distant from the experiment was under the normal by 4.23 inches for May, June and July.

All treatments were evaluated by visual ratings on the following scale: 1 = no control; 7 = commercial control; 9 = complete kill.

Results and Discussion

The results of the test are presented in a chemical by chemical basis. The data regarding the influence of rate, type of application, cultivation, and time of application are presented in Table form with appropriate discussion under headings for each chemical. No data are included on crop response.

Atrazine

The data obtained on nutgrass control with Atrazine are summarized in table 1. It can be seen from table 1 that at least four pounds of chemical were needed for acceptable nutgrass control. This is more chemical than has been found necessary in previous work by the authors at this same location. Also, this is a higher rate than reported necessary by Durfee, et al. (1). This may be due to the extremely dry season of 1962.

Disking after nutgrass emergence definitely increased control. Disking increased the effectiveness of those treatments applied at tuber sprouting, whereas plowing down the Atrazine decreased its effectiveness. Post-emergence applications were slightly superior to those made earlier.

Table 1. The influence of rate, time of application and disking on the control of nutgrass by Atrazine as measured by visual ratings.

	Subsequent disking					
Timing	None	Once	None	Once	None	Once
	1 lb.		2 lbs.		4 lbs.	
Pre-plow	1.0	3.0	1.5	4.5	2.0	6.5
Post-plow-disked	1.5	4.5	1.5	4.5	3.5	7.0
Post-plow surface	1.0	3.5	2.0	4.0	2.0	5.5
Post-emergence	2.5	6.0	2.5	6.5	6.5	8.5

Checks: No disking = 1.1; subsequent disking = 3.1.

EPTC

The ratings on nutgrass control obtained with EPTC are summarized in table 2. It is readily apparent that pre-plowing and surface applications gave inadequate control. Furthermore rate of chemical was not especially important as compared to timing and disking. Disking immediately following treating gave particularly good results when the EPTC was applied post-emergence to the nutgrass. Even two pounds proved effective. This is in general agreement with the work of Durfee (1) and Sweet (4).

Table 2. The influence of rate, timing, and disking on the control of nutgrass with EPTC as indicated by visual ratings.

	Subsequent disking					
Timing	None	Once	None	Once	None	Once
	2 lbs.		4 lbs.		6 lbs.	
Pre-plow	1.0	4.0	1.0	4.0	1.0	4.5
Post-plow disked	4.5	6.0	7.0	6.0	7.5	7.5
Post-plow surface	2.0	1.5	1.5	2.5	2.0	2.0
Post-emergence	4.0	7.5	7.5	8.0	7.0	8.0

Check = no disking = 1.1; disked once = 3.1

An unusual and very interesting observation was that the foliage application of EPTC not incorporated showed very poor results early, but by August began to show significant control as is shown in table 3. Although ratings of all plots were not made after August 6, these EPTC plots continued to improve in terms of nutgrass control.

Table 3. The influence of time elapsing after treating on nutgrass response to EPTC applied to foliage (not disked).

Date of rating	check	2 lbs.	4 lbs.	6 lbs.	Ave.
June 13	1.4	2.5	4.5	4.0	3.7
June 28	1.0	3.5	5.0	4.0	4.2
August 6	1.0	4.0	7.5	7.0	6.2

Linuron

Linuron (Lorox) results are presented in table 4. In general this material was very ineffective for nutgrass control when used pre-emergence. The post-emergence applications that were disked gave good initial control. However, there was a rapid decrease in effectiveness of nutgrass control as indicated in Table 5. These results are in marked contrast to those observed with EPTC.

A small supplemental foliage application test was conducted with linuron in an adjoining area. In this test the objective was to get an indication of the influence of immediate rainfall on the effectiveness of the chemical. The nutgrass was vigorous and had reached 20-24 inches in height with occasional seed stalks beginning to appear. Rainfall was simulated by applying the equivalent of 1/3 and 1 and 1/3 inches of water from a sprinkling can over the foliage immediately after spraying with linuron. It was hoped that the low rate of water would remove the linuron but not wash it into the soil. It was further thought that the heavy water rate might wash the chemical sufficiently deep into the soil so that nutgrass roots could absorb it.

The results are presented in table 6. It is readily apparent that water on the foliage immediately after spraying destroys the effectiveness of linuron. The excellent control obtained by treating 20-24 inch tall nutgrass held all through the remainder of the season. This further indicates that either size or physiological age of nutgrass governs the degree and longevity of control with linuron rather than rainfall that occurs several weeks following treating.

Table 4. The influence of rate, timing and disking on the control of nutgrass with linuron (Lorox) as indicated by visual ratings.

Timing	½ lb. None	½ lb. Once	1 lb. None	1 lb. Once	3 lbs. None	3 lbs. Once
	Subsequent disking					
Pre-plow	1.0	3.0	1.0	4.0	1.0	4.5
Post-plow disked	1.0	3.5	1.0	4.5	4.0	5.5
Post-plow surface	1.0	3.0	1.5	1.0	1.0	3.0
Post-emergence	2.0	4.5	2.5	5.5	4.5	6.0

check: no disking = 1.1; disking = 3.1

Table 5. The influence of time elapsing after treating on nutgrass response to linuron applied to foliage (not disked).

Date of rating		Check	1/2 lb.	1 lb.	3 lbs.	Ave.
June	13	1.4	5.0	6.0	8.0	6.3
June	28	1.0	5.0	5.0	8.0	6.0
August	8	1.0	2.0	2.5	4.5	3.0

Table 6. The effect of simulated rainfall on nutgrass control from foliage applications of linuron.

Water	1 lb. linuron	3 lb. linuron
None	6.5	9.0
1/3 inch	1.8	3.8
1 1/3 inchs	1.5	3.8
Untreated check	1.0	1.0

Hercules 7531

The data obtained with H 7531 are presented in table 7. Low rates were ineffective. At 4 pounds, only the post-emergence application disked in gave satisfactory control. At the 8 pound rate, timing was not important, except when applied pre-plowing, but incorporation significantly enhanced the results. Thus, either early pre-emergence or post-emergence applications seem feasible with this compound. H7531 was similar to Atrazine in that the control observed initially did not change greatly as the season progressed.

Table 7. The influence of rate, timing and disking on the control of nutgrass with H7531 as indicated by visual ratings.

	Subsequent disking					
Timing	None	Once	None	Once	None	Once
	2 lbs.		4 lbs.		8 lbs.	
Pre-plow	1.0	3.0	1.0	3.5	2.0	3.0
Post-plow disked	2.0	4.0	4.0	5.0	6.0	7.5
Post-plow surface	1.0	3.5	2.5	3.5	4.5	5.0
Post-emergence	2.5	3.5	5.0	7.5	7.5	7.5

Check: no disking = 1.1; disking = 3.1.

Summary

1. Chemicals applied pre-plowing proved ineffective for nutgrass control.

2. Post-emergence foliage applications were most effective provided they were coupled with disking.

3. Applications made to bare soil were ineffective unless they were disked in.

4. In contrast to earlier work, at least 4 pounds of Atrazine were required for adequate nutgrass control.

5. Rates of EPTC of 2, 4, and 6 pounds were almost equally effective or ineffective depending on the timing and disking.

6. EPTC foliage applications were ineffective when first rated, but after 60 days gave commercial kill.

7. Linuron was active only against the foliage. Only temporary control resulted from spraying plants 4-6 inches tall, whereas spraying 20-24 inch plants resulted in full season kill of tops.

8. The effectiveness of linuron is nullified by as little as 1/3 inch of water being applied to the foliage immediately after spraying.

9. Hercules 7531 performance was inadequate at 2 pounds, fair at 4 pounds, and excellent at 8 pounds, when it was applied post-emergence. Incorporation was beneficial at all times of application.

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Developmental Anatomy of Barnyardgrass Seedlings[1]

Alina K. Palacz[2] and Eugene C. Putala[3]

ABSTRACT

Using stained thin sections, the histology of the embryonic shoot apex of Echinchloa crusgalli (L.) Beauv. is described as it develops during germination and matures to the stage of floral initiation. In addition, the mature anatomy of the root, stem, and leaf organs is characterized. Observations on the initiation and developmental anatomy of tillers are also presented. These data are summarized in the form of a developmental calendar for the barnyardgrass plant which specifies maturation from the moment of germination, tillering, elongation, floral induction and heading to mature seeds. It is observed that barnyardgrass forms a total number of 8 leaves which appear during the first forty days after germination. Tillering is evident at the 10th day and continuing throughout the growing season. First adventitious roots appear at the 4th day after germination. Elongation, which is coincident with a change from a vegetative phase to a reproductive phase of the plant, is observed in the field about 30 days after germination. Heading is observed at the fortieth day; first mature seeds are formed about 60 days after germination.

An understanding of the developmental stages of barnyardgrass, Echinochloa crusgalli, is important in the cultural and chemical control of this weed.

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PRELIMINARY RESULTS ON THE CONTROL OF DOG FENNEL (ANTHEMIS COTULA) IN WINTER WHEAT AND WINTER BARLEY

S. N. Fertig and Armin H. Furrer, Jr.[1/]

Dog Fennel (Anthemis cotula) is becoming an increasing problem in the winter grain growing areas of New York State and particularly on fields where these crops are grown year after year in the rotation.

In the spring of 1962, treatments of promising and experimental herbicides were applied on two areas in Monroe County, New York; one on Avon winter wheat and the other on Hudson winter barley.

Materials and Methods

Twenty chemical treatments were applied in four replications on the winter wheat area as follows:

Chemical	Rate/A. (Pounds Active Ingredient)
2,4,5-TP	0.3
2,4,5-TP	1/2
2,4,5-TP	3/4
Banvel-D	1/2
Banvel-D	3/4
Banvel-D	1-1/2
ACP 62-70	1/2
ACP 62-70	1.0
ACP 62-70	2.0
ACP 62-70	3.0
2,4-D Propionic (Amine salt)	1/2
2,4-D Propionic (Amine salt)	3/4
4(MCP) Butyric	1/2
4(MCP) Butyric	3/4
2,4-D Acid	1/2
2,4-D Acid	3/4
2,4-D Ester	1/2
2,4-D Ester	3/4
2,4-D Propionic (Butoxy Ester)	1/2
2,4-D Propionic (Butoxy Ester)	3/4
Check	0.0
Check	0.0

The same treatments were applied on barley except for the omission of the three pound per acre rate of ACP 62-70.

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The individual plot size was 6 feet by 30 feet. Treatments were applied on April 27, 1962 with a boom type sprayer mounted on an Allis Chalmers Model "G" tractor. The sprayer was calibrated to apply 30 gallons of liquid per acre. Both the wheat and barley were 3 to 5 inches tall. Dog Fennel plants were in small rosettes one to two inches in diameter.

No yield data was obtained for either the wheat or barley. Visual observations were made on May 2, 5, 10, 19, 29, June 23 and July 3. Field notes on all treatments, including Dog Fennel control ratings and crop injury observations, were made on May 2, 10 and June 23.

Results and Discussion

Table 1 shows the Dog Fennel control ratings in barley made on June 23, 1962. At this time, Dog Fennel was 90 percent in blossom in the check treatments and barley was in the soft dough stage.

Table 1. Dog Fennel Control Ratings in Hudson Winter Barley, June 23, 1962.

Chemical	Rate/A. (Pounds Active Ingredient)	Dog Fennel Control Ratings* Average of Two Replications
2,4,5-TP	0.3	1.5
2,4,5-TP	1/2	4.0
2,4,5-TP	3/4	7.5
Banvel-D	1/2	9.0
Banvel-D	3/4	10.0
Banvel-D	1-1/2	10.0
ACP 62-70	1/2	4.0
ACP 62-70	1.0	7.0
ACP 62-70	2.0	8.0
2,4-D Propionic (Amine salt)	1/2	0.0
2,4-D Propionic (Amine salt)	3/4	1.0
4(MCP) Butyric	1/2	0.0
4(MCP) Butyric	3/4	1.0
2,4-D Acid	1/2	1.5
2,4-D Acid	3/4	1.5
2,4-D Ester	1/2	1.5
2,4-D Ester	3/4	4.0
2,4-D Propionic (Butoxy Ester)	1/2	1.5
2,4-D Propionic (Butoxy Ester)	3/4	2.0

*0 = no control of Dog Fennel
10 = complete kill of Dog Fennel

Three herbicides showed promise for controlling Dog Fennel. In order of effectiveness they were: Banvel-D, ACP 62-70, and 2,4,5-TP.

Banvel-D at one-half pound per acre and up gave excellent control. A few Dog Fennel plants survived at the lowest rate. The higher rates gave 100 percent control.

ACP 62-70 at the rate of 2.0 pounds per acre resulted in very good control. The one-pound rate reduced the Dog Fennel stand 70 percent.

Good to very good control was obtained with 2,4,5-TP at 3/4 pound per acre.

With regard to safety on barley and wheat, the above herbicides were evaluated in the following order: ACP 62-70, 2,4,5-TP, and Banvel-D.

ACP 62-70 caused an initial burn, resembling Dinitro, on both barley and wheat at rates of one pound per acre and up. However, these symptoms disappeared within three weeks after application. There was no visible permanent damage to the crops except for a slight delay in maturity of barley at the 2.0 pounds per acre treatment.

2,4,5-TP at 3/4 pound per acre caused an initial stunting of both barley and wheat. The recovery was good. A slight delay in maturity was observed in barley.

Banvel-D caused severe stunting and chlorosis of both barley and wheat at rates over one-half pound per acre. There was permanent stunting, reduction in stand, and an obvious reduction in yield at the one and one-half pounds application. The 3/4 pound per acre rate caused permanent stunting of the small grains, but the effect on yield was difficult to estimate by observation. Maturity of grain was delayed at the one-half pound per acre treatment.

Summary

Early spring treatments of a number of herbicides at several rates were applied to winter wheat and barley to determine their effectiveness for controlling Dog Fennel (*Anthemis cotula*) and their effect on the crops.

In these preliminary investigations, three herbicides gave effective control of Dog Fennel. In order of effectiveness, they were: Banvel-D at one-half pound per acre, ACP 62-70 at 1.0 to 2.0 pounds per acre, and 2,4,5-TP at 3/4 pound per acre.

In order of safety on barley and wheat, the above herbicides were evaluated as follows: ACP 62-70, 2,4,5-TP and Banvel-D.

Further trials will be conducted to obtain more detailed information on the effectiveness and safety of these herbicides.

The Crabgrass Problem Associated with the Use of Atrazine[1/]

R. A. Peters and P. E. Keeley[2/]

Crabgrass has been recognized for some years as a member of the warm season complex of annual weeds of agricultural lands. In recent years it has become increasingly prevalent in corn fields. This has been associated with the advent of atrazine as a widely used herbicide in corn. This material has generally done an outstanding job of controlling annual broadleaf and grassy weeds with crabgrass as the most obvious exception. Both because of less control and because of of the decreased competition from other weeds crabgrass has proliferated. This presents a problem not only in corn but also in crops within the rotation which are even less competitive to crabgrass than corn such as new seedings of forage grasses and legumes. This delayed effect is due to the heavy seed set from crabgrass.

Work is needed to determine: 1) just how competitive crabgrass is in corn; 2) why atrazine is not controlling crabgrass; and 3) what other herbicides of potential value in corn may offer for crabgrass control. The following experiments, part of the NE-42 Regional Project, is an attempt to answer these questions

PROCEDURE

The following experiments were conducted at the Storrs Agricultural Experiment Station during 1962. Both greenhouse and field experiments were involved.

Experiments concerned with the rate of rainfall were carried out in the greenhouse using simulated rainfall. The soil was Paxton fine sandy loam placed in bottom perforated 1 qt. 14 oz. cans with a 4 in. diameter. Water was applied by rotating the cans on a motor driven constant speed turn table under a fixed Spraying Systems nozzle. The 0 level was obtained by subirrigating the cans after treatment. Calibration of the amount of water applied was done by measuring the water accumulation in an empty can also rotated under the nozzle. A standard pre-emergence application of 2 lb. a.i. per acre of atrazine was applied on the soil surface immediately after seeding.

The field experiment concerned with several herbicides applied on three varieties of corn, Pa. 602A, Conn. 870 and Seneca Chief sweet corn was carried out on a Paxton fine sandy loam. One thousand pounds of 10-10-10 fertilizer was applied prior to seeding. Three replications of plots 5 by 14 ft. were used in a randomized block design. Fifteen stalks were taken from random from the center of each plot for yield determinations. Pre-emergence herbicide applications were made on June 11. Post-emergence applications were made on July 6

1/ This experiment was supported in part by Regional Project NE-42, Weed Life Cycles as Related to Weed Control in the Northeast.

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when the corn averaged 10 in. in height. The weed population was largely rough pigweed (Amaranthus retroflexous) and small crabgrass (Digitaria isohaemum). The crabgrass was 1 to 2 in. tall with 2 to 4 tillers per plant. The pigweed size was quite variable since some of the seedlings which germinated prior to the final seed bed germination had not been destroyed. Plants varied in size from 2 to 18 in. with the average size being 6 in.

RESULTS

Influence of Rainfall on Crabgrass Control

The greenhouse leaching experiment indicated that crabgrass has a greater resistance to atrazine than do some summer annual grasses such as foxtail. There were indications that small crabgrass had greater resistance than large crabgrass.

Table 1. Influence of Simulated Rainfall on Activity of Atrazine on Large and Small Crabgrass

	Large Crabgrass				Small Crabgrass			
	Check	None	1 in.	6 in.	Check	None	1 in.	6 in.
Maximum Height (in.)	3	0.75-1	0.5	3	5	0.5	0.5	3
% Kill		50	100	0		100	100	80

Atrazine had a delayed effect in all treatments. Emergence was not reduced by the atrazine but the rate of growth was reduced as shown (Table 1) by the maximum height reached. The appearance of the seedlings which were killed remained normal until a short time prior to death. Symptoms of necrosis started at the tip and rapidly advanced to the base of the blade with complete collapse soon following.

Control was reduced by either too much or too little rainfall. On the soil used (a fine sandy loam) maximum control was obtained with a 1 in. rainfall immediately after application. With no added water the atrazine did not contact the root system of the crabgrass seedling in sufficient time to be effective while with the 6 in. rainfall the atrazine became disperesed thru the soil thus reducing the effective concentration.

Crabgrass Control in Field

Table 2. Weed Control Ratings[1/]

Treatment (lb. a.i. per A.)				Small Crabgrass 13 July[2)]	Small Crabgrass 7 Aug.[2)]	Small Crabgrass 21 Sept.[3)]	Rough Pigweed 7 Aug.[2)]
Control				10.0	2.7	2.2	8.1
Atrazine		2	Pre-E	3.3	2.8	3.0	0.1
Atrazine		2	Post-E	8.0	5.2	6.4	1.3
Atrazine	+	1	Pre-E	0.6	1.0	1.0	2.3
Simazine	+	1					
Prometryne		2	Pre-E	1.1	0.8	0.7	0.1
Prometryne		2	Post-E	1.0	0.8	1.8	0.4
Linuron		1	Pre-E	3.8	2.3	2.2	0.8
Linuron		2	Post-E	5.8	3.5	5.0	1.2
Linuron		3	Post-E	2.1	0.7	1.3	0.3

1/ 0 - No stand; 10 - complete ground cover.

2/ Average of 9 replications.

3/ Average of 6 replications.

Three treatments were clearly superior in controlling crabgrass; the atrazine-simazine mixture and prometryne pre and post-emergent. Linuron at 3 lb. post-emergence gave good control. The poorest control was obtained from atrazine applied post-emergence. Pre-emergence control from atrazine was better in this experiment than usually observed. This was attributed to a favorable rainfall pattern resulting in a high concentration of atrazine remaining in the germinating zone. Based upon a residue analysis using an oat bio-assay test on soil samples collected September 10, definite residues were found in all the plots treated with atrazine. Very little evidence of residues was found in the linuron and prometryne plots. The superiority of these two materials cannot be attributed to a longer residual span in the soil surface. The low density of crabgrass in the control in August and October was associated with the competition from the heavy pigweed stand.

Growth of Corn

Very pronounced injury seen as stunting was obtained from prometryne applied post-emergent (Table 2). While no foliar burn was observed from the directed spray of linuron, there was some stunting at the 3 lb. rate. The check was reduced in vigor and height because of the weed competition. The observed injury was closely correlated with yields.

The maximum yields were obtained from the two treatments which controlled both crabgrass and pigweed. These, statistically greater than the check, were prometryne and the simazine-atrazine combination pre-emergent. While weed control was satisfactory yields, following the use of prometryne post-emergent and linuron 3 lb. post-emergent, were no greater than in the infested check. Injury to the corn from the herbicide was excessive.

Table 2. Effect of Treatment on Silage Corn Growth

Treatment	Av. Yield (lb) Dry Matter per Plot1/	Injury Rating2/
Check	6.1	8.7
Atrazine 2 Pre-E	7.3	9.8
Atrazine 2 Post-E	7.8	9.0
Atrazine + 1 Pre-E Simazine 1	8.5	9.9
Prometryne 2 Pre-E	8.4	9.6
Prometryne 2 Post-E	5.7	6.9
Linuron 2 Pre-E	7.9	9.9
Linuron 2 Post-E	7.1	9.4
Linuron 3 Post-E	6.7	7.7
LSD - 5% level	1.25	

1/ Average of 15 stalks per plot.

2/ 10 - No injury; 0 - Complete kill (average of 6 replications).

The atrazine alone treatments gave very good pigweed control but yields were limited by the crabgrass which was not satisfactorily controlled. While significantly greater than the check, they were lower than prometryne or atrazine-simazine.

SUMMARY

Crabgrass was found to have a greater tolerance of atrazine than many other annual grasses. Small crabgrass (Digitaria ischaemum) was found to have a greater tolerance than large crabgrass (D. sanguinalis).

The amount of leaching from simulated rainfall was found to influence the degree of kill. One inch of simulated rainfall killed both species but no rainfall or 6 inches of rainfall gave incomplete control.

In the field the standard rate of 2 lb. a.i. per acre of atrazine applied either pre or post-emergent did not give good crabgrass control. Excellent control was obtained from prometryne 2 lb. pre and post-emergent and a simazine-atrazine mixture of 1 lb.+1 lb. pre-emergence. Linuron 3 lb. post-emergence gave a satisfactory control.

The prometryne and linuron 3 lb. post-emergent caused excessive damage to the corn as shown by stunting and yield reduction.

THE USE OF HERBICIDES IN THE ESTABLISHMENT OF MIDLAND BERMUDAGRASS

R. W. Duell and R. D. Ilnicki[1]

ABSTRACT

Midland bermudagrass is a high yielding hybrid forage grass that produces essentially no viable seed but spreads by rhizomes and stolons. Vegetative propagation of bermudagrass is routinely employed in its establishment. The labor involved in setting out rows of Midland plus two or three cultivations create costs that are high relative to that for more conventional forages. This cost factor is probably more prominent in New Jersey and Maryland where Midland has been recommended only recently than further South where the bermudagrasses, notably Coastal, has been recommended. It is imperative that a weed control technique be developed to assure the establishment of the crop. Success in the use of herbicides in the establishment of Midland creates an opportunity for the mechanical broadcasting of "sprigs," thus reducing the cost of establishment through the elimination of much labor and cultivation and also shortening the time required to harvest a higher yielding crop.

Extensive tests have been underway at the New Jersey Station to find effective herbicides for the control of annual weeds during the early crucial stages of development of the sprigs. The following herbicides have proved to be the most effective:

Herbicide and Formulations	Rate, lb/A
2-Chloro-4,6-bis (ethylamino)-s-triazine (simazine),80W	1½,3
2,6-Dichlorobenzonitrile (2,6-DBN or Casoron), 50W	2,4
Dimethyl 2,3,4,6-tetrachloroteraphthalate (dacthal) 75W	10,15
2,6-Dinitro-N,N-di-n-propyl-α,α,α-trifluoro-p-toluidine (trifluralin), 4 E.C.	4,6
Ethyl di-n-propylthiolcarbamate (EPTC), 6E	3,6

The herbicides formulated as wettable powders were much more effective than their granular forms. Undoubtedly, distribution of the herbicide was the factor responsible for these differences. Both trifluralin and EPTC were incorporated immediately after application since the necessity for this operation has been proved from time to time, especially with EPTC.

Slight injury results from the high rate of simazine but this is short-lived. There is no apparent injury to the developing sprigs from the other herbicidal treatments.

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CHEMICAL CONTROL OF BERMUDAGRASS

R. D. Ilnicki and R. W. Duell[1]

Midland bermudagrass has produced more forage per acre than any other perennial forage in New Jersey. Production is greatest during midsummer when pasturage is most sorely needed and hay is easiest to cure. The relationship of Midland to common bermudagrass, a noxious weed in many states, casts aspersions on it so as to question the wisdom of recommending its culture.

Evidence, based on research, showing the success of a practical means of controlling Midland bermudagrass was prerequisite to recommending this crop in New Jersey.

In preliminary tests two replications of herbicide treatments applied November 7, 1960 to an established field of Midland bermudagrass were subjected to either fall or spring tillage and then planted to NJ 9 field corn. Ratings were made of the surviving Midland bermudagrass on June 9, 1962. Plots were photographed periodically. The herbicide treatments were as follows:

2,2-dichloroproprionic acid (dalapon) at 5, 10 & 15 lb/A.
" " " " at 4 lb/A plus
3-amino-1,2,4 triazole (amitrole) at 1 lb/A.

2,2-dichloroproprionic acid (dalapon) at 4 lb/A plus
3-amino-1,2,4 triazole with ammonium
thiocyanate (Amitrole T) at 1 lb/A.

2,2 dichloroproprionic acid (dalapon) at 4 lb/A plus
dimethylarsinic acid (cacodylic acid) at 2 lb/A.

2,3,6-trichlorophenylacetic acid (fenac) at 2 lb/A.
" " " " at 4 lb/A.

3-amino-1,2,4 triazole (amitrole) at 4 lb/A.

3-amino-1,2,4 triazole with ammonium
thiocyanate (Amitrole T) at 2 lb/A plus
2-chloro-4 ethylamino-6 isopropylamine-s-triazine
(atrazine) at 2 lb/A.

3-amino-1,2,4 triazole with ammonium thiocyanate
(Amitrole-T) at 4 lb/A.

2-chloro-4 ethylamino-6 isopropylamino-s-
triazine (atrazine) at 2 lb/A in fall plus 2 lb/A in spring.

Check - no herbicide.

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Dalapon at $7\frac{1}{2}$ lb/A, dalapon at 15 lb/A, dalapon at 4 lb/A plus amitrole-T at 2 lb/A, and amitrole-T 2 lb/A plus amitrole 2 lb/A all gave excellent control of the Midland bermudagrass. The atrazine at 4 lb/A and the cacodylic acid at 24 lb/A treatments had stands of Midland bermudagrass that were similar to the no-herbicide check under light tillage.

The interaction between herbicide treatments and intensities of tillage was statistically significant at the 5% level of probability. The herbicides mentioned above as effecting excellent control did so even under light disk harrowing, while other treatments were found to have a good stand of Midland bermudagrass where disking was light. Heavy disking controlled the Midland bermudagrass very well, and when coupled with an effective herbicide resulted in eradication from many of the 10' x 11' sub sub plots.

Varying the population of NJ 9 field corn from 10,000 stalks per acre to 20,000 per acre resulted in no detectable differences in the final stand of Midland bermudagrass. No adverse effects on the production of corn was detected from either herbicide treatment or remaining stand of Midland bermudagrass.

The following year, four replications of herbicide treatments applied October 26, 1961 were subjected to two intensities of cool season tillage by disk-harrowing and then planted to two population intensities of NJ 9 field corn on May 4, 1962. Ratings of the control of Midland bermudagrass were made on June 9, 1962, when corn was knee-high and again after the corn was chopped for silage on October 25, 1962. Plots were photographed periodically. The herbicide treatments were as follows:

2,2-dichloropropionic acid at $7\frac{1}{2}$ lb/A

2,2-dichloropropionic acid at 15 lb/A

2,2-dichloropropionic acid at 4 lb/A plus
3,amino-1,2,4, triazole with ammonium thiocyanate at 1 lb/A.

3,amino-1,2,4, triazole with ammonium thiocyanate at 2 lb/A plus
3,amino-1,2,4, triazole with ammonium thiocyanate at 2 lb/A.

2 chloro-4 ethylamino-6 isopropylamino-s-triazine (atrazine) at 4 lb/A.

dimethylarsinic acid (cacodylic acid) at 24 lb/A.

Check - no herbicide.

In the preliminary test, 1960 the Midland bermudagrass foliage had been thoroughly frozen the night before the herbicide application, and the plowing one week later buried the stolons and rhizomes rather than exposing them as was the intent. No herbicide effects could be seen in 1960, however, the following spring it was noted that the amitrole and amitrole-T treated plots, unplowed, contained new shoots exhibiting extensive chlorosis. Very little recovery could be found in several other treatments, but recovery from the no herbicide plots was excellent. At the same time recovery from fall-plowed plots was very sparse.

Ratings of surviving Midland bermudagrass the spring after the corn crop indicated that the tillage helped to subdue the crop. The 5 lb/A rate of dalapon was effective, but the two higher rates were consistently superior. Amitrole at 4 lb/A was also effective and slightly superior to amitrole-T at 4 lb/A. The no herbicide check, fenac, and atrazine treatments reestablished nearly complete sods of Midland bermudagrass.

In 1961, with herbicides applied earlier, and disked to expose stolons and rhizomes, even more striking differences in control of Midland bermudagrass were obtained. Dalapon and cacodylic acid treatments caused foliage to become brown before freeze-up. Amitrole-T plus amitrole caused extensive chlorosis of the foliage. Atrazine caused intense green color to develop in the foliage.

THE EFFECT OF STAGE OF MATURITY AND ENSILING ON THE VIABILITY OF YELLOW ROCKET (BARBAREA VULGARIS) SEED 1/

S. N. Fertig, J. Herbert Huddleston, Armin H. Furrer, Jr.2/

Introduction

Yellow rocket (*Barbarea vulgaris*) is a common weed in fall sown small grains and in established rotation pastures and meadows of the Northeastern States. It is a true perennial (12,8) but may function as an annual or biennial. It reproduces entirely by seed. One medium-sized plant may produce over 200,000 seeds (2).

Yellow rocket has become an increasing problem within the last 10 to 15 years (3,6,10). It not only competes with crop plants for moisture and plant nutrients, but the seed also germinates throughout the entire growing season (8). Furthermore, the plant matures in late June or early July, thus lowering the nutritive value of forage (3,9).

The literature contains only two reports on life history studies of yellow rocket. Lindsay and Basset (6) limited their investigations to observations. Most recently, Schreiber (8) concluded a study of various aspects of the growth, development, and perennial nature of the weed.

A number of investigations have been conducted involving the feeding value of yellow rocket and the effects of herbicides and cultural practices on yellow rocket control in legumes. Yellow rocket plants are high in protein during early growth but fiber content is high when forages are ready for harvest(9).Mowing is not an effective control measure. Plowing and subsequent disking and harrowing may be effective but cannot be performed in established legume stands. Chemicals such as 2,4-D, MCP, and Dinitro have given good control of yellow rocket when applied on plants in the rosette stage, but these compounds cause serious damage to legumes (3,7,10).

In view of these facts, several workers have stated that farmers would be wise to ensile legume stands infested with yellow rocket so that more nutritive value might be preserved and the seeds killed by the ensiling process (3,6,8,10).

The purpose of this experiment was to determine what effect the ensiling process would have on the germination of yellow rocket seeds harvested at various stages of maturity and to find out how long a period of ensiling was necessary to kill the seeds.

Materials and Methods

Twelve silos were used in this experiment, providing four replications for each of three stages of seed maturity. Each silo consisted of a steel can 44 inches high and 14 inches in diameter, a flat steel top, and a steel tripod

1/ Work supported in part by funds made available through NE-42 Regional Project administered under the Hatch Act.

2/ Professor of Agronomy, National Science Foundation Student, and Research

equipped with a large screw in the center which provided a means of applying pressure equivalent to conditions in a normal silo.

In order to be able to get into the silos each week to remove seed samples with minimum disturbance to the silage, the following procedure was developed. Wire baskets were constructed of 3/8 inch hardware cloth and fitted with wire handles. The baskets were 14 inches high. When in place, the bottom of the basket was in the middle of the silo and the top of the basket was 8 inches below the top of the silo, leaving sufficient room for compaction of the silage.

The baskets fit snugly against the inside walls of the silo. A block and tackle was used to lift the baskets when seed samples were removed. The basket, with its core of silage, was replaced after each sampling and pressure re-applied. The amount of air trapped by this procedure was not sufficient to cause any spoilage.

Plants of the first stage of maturity were harvested on June 15 and spread out in a greenhouse to dry. After one week, the seeds were shelled from the pods by hand. Two hundred seeds were placed in each of 32 4-inch by 4-inch nylon bags. About 50 pounds of a timothy-Viking birdsfoot trefoil mixture was chopped and packed into each of four silos. Eight bags of yellow rocket seed were placed in the middle of each silo. The wire baskets then were lowered into the silo and filled with the chopped legume-grass mixture. The steel tops were put on and pressure applied with the tripod mechanism.

The second and third stages of seed maturity harvested on June 25 and July 2, respectively, were handled in the same manner. The July 2 stage, however, received an additional treatment. Eight bags, each containing 12 whole pods,were added to each of the four silos; thus,each silo of the July 2 harvest date contained 16 bags of seed rather than eight, as in the two earlier harvest dates.

One bag of the June 15 and July 25 harvest dates and two bags of the July 2 harvest date were taken out of each silo every week for a period of eight weeks after ensiling. As the bags were removed, the pH of the silage was determined in each silo using chlorphenol red and bromcresol green indicators.

Seventy-five of the 200 seeds were counted out from each bag. In doing so, an attempt was made to select the largest seeds. Two weeks after the germination tests were initiated, all remaining seeds were treated with Arasan to prevent mold. To determine the effect of ensiling on seed viability, twenty-five seeds were planted one-quarter inch deep in soil in pots and placed in the greenhouse; twenty-five seeds were placed in a controlled germinator for three weeks; twenty-five seeds were placed in a refrigerator for two weeks at 2°C. followed by three weeks in the germinator. In addition, 100 non-ensiled seeds from the same stage of maturity were used as a check and given the same treatment as the ensiled seeds, plus a treatment to break seed dormancy, as suggested by Barton (1) and Steinbauer _et al_ (11). This treatment consisted of a 0.2 percent potassium nitrate solution as a substrate moistening agent, two weeks refrigeration at 2°C. and three weeks in the germinator at alternating temperatures.

The conditions for germination in the germinator were chosen from suggestions made by Everson (4) and Steinbauer et al (11). Seeds were placed in covered plastic dishes on a double thickness of blotters saturated with distilled water. A continuous water curtain kept the relative humidity inside the germinator at 100 percent. Three panels of fluorescent lights provided the continuous light recommended by Steinbauer. The alternating temperature treatment was as follows: 16 hours at 20°C. and 8 hours at 30°C.

Results and Discussion

The data in Table 1 show the results of the germination tests.

In the June 15 harvest, there was practically no germination after one week in the silo. Germination of the checks was relatively low. The seed pods of plants harvested at this stage were brownish green in color. Cold treatment did not increase the germination of the checks. No seedlings emerged in the pots from seed planted after six weeks of dry storage. The cause or causes need to be investigated. This stage appears too immature to be a problem under field conditions; however, in the June 25 harvest date, only 10 days later, the viability of seed increased greatly. The relatively high level of viability was maintained in the July 2 harvest. The seeds of this last harvest date were almost fully mature.

In the June 25 and July 2 harvest dates, four weeks of ensiling was sufficient to kill all seeds.

Emergence of seeds planted in soil was considerably lower than for the other two treatments.

The pH of the silage gradually decreased for five weeks and then leveled off to a constant pH of 4.5. The silage was of good quality at the end of the experiment except for 8 to 10 inches of spoilage at the surface.

Apparently, no dormancy developed in the non-ensiled check seeds because there was very little difference in germination between seeds treated with 0.2 percent solution of potassium nitrate and seeds treated with distilled water. This is not shown in Table 1.

Summary

The first objective of this experiment was to determine what effect the ensiling processes have on the germination of yellow rocket seeds harvested at various stages of maturity. The results indicate that yellow rocket seeds harvested at immature stages require shorter periods of ensiling to reduce germination to zero than do more mature seeds.

The second objective was to find out how long a period of ensiling was necessary to kill yellow rocket seeds. In this experiment, relatively mature seeds were completely killed after four weeks of ensiling and immature seeds required only two weeks.

Further germination and greenhouse tests will be conducted of the several stages of seed maturity and ensiling treatments to investigate the possibilities of dormancy of seeds that have been through the ensiling process.

Table 1.

Effect of Stage of Maturity and Ensiling on the Viability of Yellow Rocket (Barbarea vulgaris) Seed

Weeks in Silo	Treatment*	% Germ** Seed Harvested June 15	pH of Silage	% Germ*** in Check	% Germ Seed Harvested June 25	pH of Silage	% Germ in Check	% Germ Seed Harvested July 2	pH of Silage	% Germ in Check
1	G	0		0	54		60	62		52
	R	3		20	69		80	80		60
	P	0	--	0	11	5.8	36	43	5.8	44
2	G	0			35		80	70		72
	R	0		error	45		80	76		84
	P	0	5.2		14	5.4	44	16	5.1	36
3	G	0		20	13		68	21		72
	R	0		8	5		56	16		76
	P	0	4.8	8	0	5.1	24	1	4.9	52
4	G	0		16	2		68	0		92
	R	0		12	0		80	0		80
	P	0	4.8	8	0	4.8	32	0	4.5	48
5	G	0		24	0		76	0		68
	R	0		8	0		64	0		88
	P	0	4.6	0	0	4.6	52	0	4.6	36
6	G	0		8	0		80	0		68
	R	0		12	0		76	0		92
	P	0	4.6	0	0	4.5	40	0	4.5	4
7	G	0		28	0		76	0		84
	R	0		16	0		68	0		76
	P	0	4.5	0	0	4.5	26	0	4.5	32
8	G	0		8	0		56	0		64
	R	0		20	0		68	0		92
	P	0	4.5	0	0	4.5	44	0	4.5	44

*G = Germinator 3 weeks at alternating temperature 20°C. for 16 hours and 30°C. for 8 hours.
R = Refrigeration 2 weeks at 2°C. + germinator 3 weeks as in G above
P = Pots in greenhouse 3 weeks.

** average 4 replications of 25 seeds each.
*** average of 100 seeds

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ELEVEN YEARS OF SUMMER BASAL SPRAYING ON CENTRAL MAINE POWER COMPANY TRANSMISSION RIGHTS OF WAY

Clarence E. Staples[1]

History

Summer basal spraying on Central Maine Power Company transmission rights of way was started in 1952 when we basal sprayed approximately 1200 acres. The results were satisfactory enough to warrant continuing this method of brush control. We are now currently treating approximately 4000 acres of brush each year. We spray on a 4-year cycle which fits nicely into the 16,000 acres of brush on our transmission system.

Costs

During the period from 1952 through 1962 we basal sprayed approximately 45,000 brush acres at an average cost of $50 per acre.

Our last recutting figures showed an average cost of $140 per acre to cut, pile, and burn. This work was done on a 7-year cycle.

Comparisons: 4-year cycle - Spray - $12.50 per acre per year; 7-year cycle - Cutting - $20 per acre per year.

Chemical Used

All chemical brush control work in the Central Maine Power Company system involves the use of but one type of chemical - 2,4,5-trichlorophenoxyacetic acid, propylene glycol butyl ether ester; acid equivalent 4 pounds per gallon. This chemical is used at a concentration of 4 gallons (16 pounds of acid) in 96 gallons of kerosene, diesel or fuel oil.

Equipment

Inasmuch as all transmission spraying is highly selective, we have found that specialized knapsack sprayers are best suited to this type of work. The sprayers used are of 3-gallon capacity. We have tried sprayers which hold up to 5 gallons, but we feel that these higher gallonage sprayers are too heavy for efficient use.

These so-called garden type sprayers are purchased by our contractors from the manufacturers, and modified by our contractors in their own shops. Two reinforcing metal bands are soldered to the tanks, one near the top and one near the bottom. Two rings are riveted to each band and the carrying straps are hooked into them. Then the "Ashbaugh Wand" (developed by Fred Ashbaugh of West Penn Power Company) is put on in place of the conventional

1/Clarence E. Staples, Brush Control Engineer, Central Maine Power Company, Augusta, Maine

one-nozzle type which comes with the sprayer. The tube from the shut-off valve to the horns is 3/8-inch O.D. steel; the horns are either 3/8-inch O.D. copper or brass and the nozzles as a rule are TEEJET #8003.

The distance between the points of the horns may be increased or decreased by careful bending and is determined by the size of bush being sprayed. The two nozzles assure complete coverage around the basal portion of each stem. This results in a high percentage of kill and speeds up the work.

After filling the tank, the applicator pumps it up with a self-contained pump, puts the tank on his back and proceeds to spray with it. Generally the tank has to be pumped up again before it is emptied.

Many of our rights of way are rough, swampy, and inaccessible. We have found that 3-ton crawler type tractors are very satisfactory for supplying the spray men with the required mixed chemical. These tractors, for the most efficient operation, should be equipped with a blade and a winch.

Two-wheeled trailers or logging scoots are used to carry the 55-gallon drums of mixed chemical. Choice of scoot or trailer depends on the judgment of the foreman and on the terrain being covered.

Stump-Basal Spraying

This type of spraying is done from one-half to two-thirds of a growing season after capital clearing. Expenditures for this type of spraying are capitalized.

The bulk of our capital clearing is done during the winter months when snow cover permits brush burning along with the clearing operation. The heavy snows, common in our area, prohibit stump-spraying at time of cutting. Our capital clearing is contracted on the bid basis and frequently the bid is won by contractors with no spraying experience.

Stump-basal spraying consists of spraying the hardwood stumps and the basal portion of the sprouts which, after one-half to two-thirds of a growing season has elapsed, appear on them. Small stumps (two inches in diameter or less), when allowed to sprout are easily found and sprayed.

This type of spraying costs more than future treatments, to be sure, ($125 to $150 per acre), but the percentage of root-kill is high and we have been able to start our 4-year respray cycle after only two sprays with one year in between. This is one treatment less than we found necessary for converting to a 4-year cycle after recutting our rights of way.

Roadside Spraying

In 1954 we started converting to chemical control on more than 10,000 miles of roadside lines. All brush with more than one year's growth is recut, and the following summer the regrowth is sprayed. Here too we use 2,4,5-T. The first two or three applications are stem-foliage with water as a diluent. Concentration is one gallon 2,4,5-T (4 pounds acid) in 100 gallons of water. In general, the brush along roadsides is too thick to make selective treatments economically feasible until a fairly high percentage of the undesirable species have been eliminated by the blanket spray method. Because of the unsightly appearance of dead brush along roadsides after initial treatments, we start spot treating as soon as possible. Ultimate roadside spot-treating will be done with either knapsack equipment, as on transmission rights of way, or with power-basal equipment.

Public Relations

A successful brush control program, especially one which involves roadside spraying, must be coordinated with such organizations as the garden clubs, fish and game commission, highway commission, nature clubs, and, of course, the general public. The economic savings to all are of great importance, but not enough of an argument to sell dead brush along a highway to everyone. Fortunately, the hormone-type sprays of which 2,4,5-T is one, in normal usage, are harmless to all forms of animal life. Bees, birds, insects, rabbits, dogs, cats, and man are safe from harm when the hormone sprays are used to kill brush. Nevertheless the public must be informed of this fact, and in order for a utility company or any other organization to use this tool with a minimum of criticism, an extensive educational program must be carried out.

Summary and Conclusion

Selective summer basal spraying on Central Maine Power Company transmission rights of way has proven to be at least 40% cheaper than cutting.

No brush remains to interfere with line repair and other maintenance work, such as pole inspection or foot patrol when required. In addition, the selective nature of the spraying on rights of way provides excellent ground cover which tends to resist reinvasion by unwanted species of tall-growing brush, provides both food and cover for small game animals and food for larger game. These rights of way provide the all important edge effect which is so often stressed by wildlife management people; and when located through forested areas these chemically controlled rights of way are excellent fire breaks.

"PROGRAM, METHODS AND RESULTS OF 10 YEARS OF CHEMICAL BRUSH CONTROL BY CENTRAL HUDSON GAS & ELECTRIC CORPORATION

R. E. ABBOTT[1]

Central Hudson Gas and Electric Corp. serves 140,000 electric customers in the Mid-Hudson Valley in parts of eight counties on both sides of the Hudson River. The franchise territory covers a 2,600 sq. mile area including fertile valley land, rolling dairy land and parts of the Catskill Mountains. There is considerable variation in the types of vegetation found along the river and the type encountered back in the mountains. The entire area is generally heavily wooded; consequently, tree trimming and brush control costs are considerable. Central Hudson has a light customer density in these extensive heavily wooded areas; therefore, it is imperative to seek trimming techniques which give greatest value per dollar spent.

Prior to 1952 all transmission brush control consisted of mechanical cutting of brush (ex: brush saws, brush hooks, etc.). Because of the constant rise in labor costs, alternate methods of brush control were tested as early as 1949. The first technique tried was the use of ammate in a water solvent as a foliage spray. This method was discarded for several reasons:

1. Adverse public reaction to brown out. (A neighboring utility was criticized in local papers for their ammate foliage spray program.)

2. Non-selectivity of the chemical.

3. High initial cost per brush acre.

However, the chemical is used in our brush control program around watersheds, reservoirs and near vineyards, orchard and truck gardens; because of its non-volatility with a combination oil and water solvent.

Subsequently, in 1952 a dormant selective basal spray was tried on a 69 Kv. right of way in mountainous terrain. This application was made by contractors using back pack spray equipment and the 24D - 245T combination material in oil. The cost of this chemical treatment was 32% less than the lowest bid for hand cutting the same right of way. Many factors influenced the choice of dormant selective basal spray for this operation. Among them were:

1. An abundance of plant species which were difficult to kill with foliage sprays.

2. Large quantities of tall brush which were unsuitable for treatment by foliage sprays. 245T and oil used as a basal spray will kill larger size brush more economically than any other technique.

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[1]Arborist, Central Hudson Gas & Electric Corporation, Poughkeepsie, New York

3. Location of the line - a summer resort area - which made us reluctant to use a spray program which would result in extensive brown out. Our experience has been that the tourists and summer residents strongly object to any chemical spraying.

4. The mountainous terrain would have been difficult to spray with the equipment available at that time.

Following the dormant selective basal spray in 1952, other transmission lines were basal sprayed both in the dormant and foliage season. As a result of these applications, we found there is a 25% greater labor production applying basal spray in the dormant season mainly due to less foliage entanglement and better vision in finding and spraying the smaller stems. During this period, the company also purchased a brush hog for use on right of ways. This machine is a large heavy duty rotary mower mounted behind a tractor. Brush hogs are used extensively in this area to grind up twigs and branches from pruning operations in fruit orchards. Our experience was that this area was too stony and mountainous for effective use of this type of machine. After two years operation, it was decided to abandon this technique. <u>Since 1955, all brush control on transmission rights of way has been by chemical methods.</u>

In 1955 we discontinued the use of 24D - 245T combination material and standardized on the use of 245T almost exclusively. However, when spraying near numerous commercial vineyards and fruit orchards in the Hudson Valley, we use dormant basal, amine salt of 245T or ammate oil emulsion. Generally, when using the amine salt of 245T which is non volatile, it is at the rate of 6 lbs. of acid per 100 gallons of water. The ammate oil emulsion is used primarily on water sheds and around vineyards, orchards, and the mixture used is 40 lbs. of ammate plus 2/3 pint of Emulsifier A and 4 gallons of fuel oil to 100 gallons of water.

Because of difficulties in controlling root suckering plants (ex: poplar, locust, ailanthus, sassafras) it was necessary to use stem foliage spray for control of these species. For stem foliage spray we start the season using one gallon of 245T 4 lbs. acid equivalent (either Propylene Glycol Butyl Ether or Butoxy Ethanol Ester) per 100 gallons of water. As the season advances (beginning about the 15th of July) we add #2 fuel oil to the mixture until we reach a maximum of 15 gallons of oil per 100 gallons of mixture toward the end of August. Many companies do not add oil as the season advances but our experiences with the species we are trying to control shows that oil increases the effectiveness of the spray late in the growing season.

Company practice is to spray all stumps of trees or brush cut for maintenance as well as for capital clearing. On capital clearing of transmission rights of way, the line is re-stump sprayed within a year of original clearing on the capital account. On transmission rights of way, it has been found economical to remove large saplings (which will not then fall into line but which may if they continue to grow) by girdling and then applying the 245T and oil mixture in the frills. Any size tree can be killed by this frill and spray method.

As the tall brush and hard-to-kill species have been eliminated the brush control problem has changed. Consequently, our methods have changed where necessary and we try to use the best technique available to attain desired results at the lowest cost, whether summer basal, dormant basal or stem foliage spray.

This program has been extremely effective, and as a result we are spending 34% less to maintain 11% more miles of line than we were spending ten years ago. It must also be noted that this cost reduction has been realized in spite of rising labor costs during this ten year period.

In the period 1945 to 1952 the average maintenance cost was $105.08 per mile of transmission line per year. During the period of chemical conversion, these average yearly maintenance costs were reduced to $85.55 per mile of line per year. Now that chemical conversion has been completed and a chemical maintenance program is being followed, the average yearly maintenance cost per mile of line is $62.04. This is a 41% reduction in yearly transmission maintenance costs per mile of line from the 1945 - 1952 average, to the 1957 - 1962 average. The average cost of hand cutting an acre of brush was $93.60 in 1952, and the present average cost of chemically treating an acre of brush is $48.18.

Distribution Sapling Control

Our routine distribution trimming costs were continually mounting due to the ever increasing number of saplings to be trimmed or removed each year. Therefore, it was decided in 1955 to determine if chemical spraying could be adapted to the roadside sapling problem. A major factor to be considered in any roadside chemical program is that this area is a prime resort area. Because of this, it was decided to use a selective basal spray to minimize brown out and to remove only those species that grow tall enough to interfere with the distribution line. The first application of selective basal spray was made during the foliage season. Experience has shown that there is greater customer acceptance of dormant selective basal than foliage selective basal.

Because of successes with the early applications, the program of roadside sapling control by dormant selective basal spray was expanded. Today all distribution lines in rural areas and where feasiable in suburban areas are chemically treated in the dormant season. Generally our costs have been between $50.00 and $60.00 per basal sprayed mile of distribution line. The contract price is based on the miles of actual line treated and the contractor is required to secure all necessary permissions from the property owners. Since it is impossible to separate sapling trimming and tree trimming costs, it is difficult to put a dollar and cents value on this operation, but we are reasonably well convinced that this program has prevented tree trimming costs from increasing as a result of sapling growth into the distribution lines.

Contractors use low pressure power sprayers to treat those areas along the road and back pack equipment for the off-road portions of the line. Work is performed on an entire circuit basis; the crew treats all areas on the circuit which are to be sprayed. With power equipment we use 3 gallons of a low volatile ester, 4 lb. acid equivalent 245T per 100 gallons of oil. Using back pack equipment we increase the 245T to 4 gallons per 100 gallons of oil. Our experience has demonstrated that the most effective results are obtained by spraying 3' to 5' up the stem on the difficult species such as ash, red elm, etc. and we had not obtained the same effective control where we spray only the root, collar and ground. However, in order to retard root suckering of sumac, locust, etc. we spray the ground at base as well as stem of these species.

The broadcast basal technique of dormant spraying was tested extensively last year. Further areas will be treated by this method this year using one gallon of low volatile ester 245T, 6 lb. acid equivalent per 100 gallons of oil. In this method, the entire stem of the plant is sprayed rather than the base only. The 245T and oil mixture used is more dilute than the basal mix. Because of our limited experiences, it is not possible to evaluate this method in comparison to basal spray at this time.

In a test conducted in 1956, we found that #2 fuel oil was more effective than kerosene in a dormant basal application. Old transil oil that has been removed from transformers is also used for dormant basal spraying and our experience has been that this heavier oil is more effective than #2 fuel oil. Occasionally, during very cold weather it is necessary to thin the transformer oil with #2 fuel oil to make it flow better.

Dybar pellets are used to treat evergreens and have proven to be most effective if applied in the early spring. We have had some but not serious problems with lateral movement of the material into untreated areas.

Written into and a part of all distribution spray contracts is the owners "Stipulations For Distribution Circuit Trimming, Clearing and Selective Basal Spraying" which list those species of brush to be removed and those to be retained. Also, similar specifications covering transmission basal spray or stem foliage spray are included in all transmission contracts. It is interesting to note that Central Hudson had and was using specifications for selective basal spray in 1955, long before Rachel Carson thought of writing a book.

Programing Brush Control

We have made effective use of the airplane as a means of surveying right of way brush problems, programing and evaluating chemical brush control and right of way improvement programs. A survey has been made to determine brush acres on all transmission rights of way and line maps marked showing brush locations.

Central Hudson employs a contractor flying light planes to conduct a twice monthly patrol of all transmission lines for 16 years. One flight is a wire patrol; here the pilot is looking for cracked insulators, rotted crossarms, etc. The other flight is a right of way check; here he looks for right of encroachments, house foundations, dead trees, etc. We are fortunate to have a veteran pilot with many hundreds of hours crop dusting experience to perform this work.

The patrol plane flies 50' to 100' above the line at 40 to 80 miles per hour. At this speed and altitude, it is possible to distinguish the species composition of the brush on the right of way. It is even possible to distinguish between sumac and ailanthus from the plane.

In order to program and evaluate chemical brush control, every year beginning the middle of June all the transmission lines in our system are reviewed on the routine monthly right of way patrol. Generally, the surveys are for two hours at a time, and it takes about 7 to 10 trips to cover the system. Experience has shown that after two hours of flying, the senses start to dull and all the brush begins to look alike. Key word notes are written of conditions observed from the airplane and these are rewritten into more complete notes the same day.

After having completed all the patrols, the conditions of various lines are reviewed and where necessary, adjustments of the spraying or right of way improvement programs are made. It takes such a short time to cover the entire system that that which was seen in the beginning is still fresh when the aerial survey has been completed.

Transmission brush control is programmed five years in advance. However, this schedule is flexible and individual lines may be either moved ahead or deferred as conditions warrant. Generally, respraying is scheduled on a three to five year basis as needed.

Distribution brush control is programmed on a three year basis, so that next brush kill is less noticeable to the public.

During July, August and September while the contractors are spraying the right of way, an aerial examination is made to evaluate the progress and thoroughness of the treatment. It is possible to check whether entire right of way was covered and the degree of coverage on brush on these flights.

Sometimes aerial observations are made in October when the leaves are turning because the various foliage colorations help indicate brush species composition and brush density on the right of way. The contractor flies the lines twelve months of the year (his plane is equipped with skis for winter operation) and it's possible to ride the right of way patrol any month. In addition to the aerial survey of contractors' spray operations, a spot check is made on the ground of work performance. Any locations requiring more detailed observation are visited on the ground, but the airplane has the advantage of allowing you to pin point these spots so you can walk or drive right to them.

Summary

A series of test plots utilizing several chemical growth inhibitors has been under observation for several years. Results have been encouraging and more tests will be conducted in the future. Chemical spraying has drastically reduced the costs of brush control. In the future, it is possible that chemical growth inhibitors may have the same effect on tree trimming costs.

While I have the privilege and the pleasure of presenting this paper, the final results which are described herein have been produced through the cooperative effort of many people in the company. I would like to mention specifically, Mr. R. Atkinson recently retired District Superintendent and Mr. R. Decker, Line Clearance Supervisor.

Central Hudson is satisfied; the chemical techniques used are effective, there has been excellent public acceptance of our program, costs have been reduced and last but not least there has been marked reduction in our interruptions to electric service which is the only reason for any brush control program.

THE PHYSICAL PROPERTIES OF HERBICIDAL INVERT EMULSIONS

by

Wade Van Valkenburg

THE DOW CHEMICAL COMPANY
Midland, Michigan

Invert emulsions have physical properties and characteristics quite different from conventional emulsions. Accordingly, it seems appropriate at this time to review such things as -- What is an invert emulsion? What is it good for? How is it made? Factors that affect viscosity or consistency of the spray, application methods and briefly a word about drift control as measured in a wind tunnel.

What Is an Invert Emulsion? Emulsifiable formulations containing esters of 2,4-D, 2,4,5-T and silvex are oil like in character. When conventional formulations are added to water this oil becomes finely divided droplets that are dispersed in water -- this is, the oil droplets are surrounded by water An invert emulsion is just the opposite In this case the water becomes the finely divided droplets that are surrounded by oil. We speak of this as a water in oil or invert emulsion with the oil and herbicide being the continuous phase. We can characterize an invert by saying that a very small insect could go from the top of the emulsion to the bottom, always keeping in the oil phase and never getting his feet wet by water.

What Is an Invert Emulsion Good For? The benefits of an herbicidal invert emulsion may be summarized in Table I.

Table I. BENEFITS OF INVERT EMULSIONS

1. Slower evaporation of sprays
2. Better adhesion of spray droplets to both dry and wet foliage.
3. Spray droplets resist wash off in a light rain.
4. Drift reduction.

These benefits mean that the custom applicator can apply his weed killers to foliage that is wet from dew or from a light rain. If a light rain falls after application, the emulsion will not wash off. Because the spray is less volatile, the spray droplets retain their size after they leave the nozzle and do not become smaller (and increasingly hazardous) due to evaporation of the water carrier as they descend. On hot days this evaporation with conventional sprays becomes appreciable and increases the hazards of drift. And, speaking of drift, or the physical movement of a spray off of the target, invert emulsions reduce drift but do not eliminate it.

How Is an Invert Emulsion Made? Sometimes these are formed by adding water directly to the formulation in the spray tank. If additional oil is added to an herbicidal concentrate, the oil and chemical are usually mixed first either in the spray tank or a nurse tank. Then, with agitation, the required amount of water is added to the oil mix. In other words, to make an invert we always add water to the oil. This makes it easier for the oil to literally fold itself around the water droplets.

Factors That Affect Viscosity:

1. Oil-Water Ratio: One of the features of an invert emulsion is that it is thick or viscous. This viscosity varies depending upon the relative amount of oil phase and aqueous phase in the emulsified system. Generally speaking, as one adds water to an already formed invert emulsion, the emulsion becomes thicker. Conversely, as one increases the amount of oil in the system, the thinner it is going to be. Incidentally, inverts are unique in that one may add oil or water to the spray and each will mix readily to form a stable emulsion.

The variation in thickness or the viscosity of invert emulsions and factors influencing it has been the subject of considerable investigation at The Dow Chemical Company. This research has been done on Verton® CE herbicide and mixtures thereof and therefore data reported here are specific for Verton CE. These results may not be indicative of the physical properties of competitive invert emulsions as these properties are influenced by the amount of free acid, type of emulsifier and type of solvent used in the concentrate.

To illustrate these viscosity changes Table II shows viscosity measurements as water is added to a constant volume of Verton CE and kerosene. Viscosity measurements were made with a Brookfield Viscometer Model RVF with the spindle rotating at two revolutions per minute. Spray mixtures were made with a small laboratory recycle apparatus utilizing a centrifugal pump.

® Trademark of The Dow Chemical Company. Verton CE herbicide is a concentrate containing two pounds acid equivalent of 2,4-D and two pounds acid equivalent of 2,4,5-T as propylene glycol butyl ether esters in a gallon.

In Table II notice that viscosity does not increase markedly until the aqueous phase gets above sixty per cent of the total composition. At that point viscosity increases rapidly with small additions of water A thick emulsion can be thinned readily by adding a small amount of oil.

Table II VISCOSITY OF EMULSIONS OF VERTON® CE

VERTON CE	Kerosene	Water	Water	Total Volume	Viscosity
1 Gal.	1 Gal.	2 Gal.	50%	4 Gal.	7,000 cps
1	1	3	60	5	13,000
1	1	4	67	6	26,000
1	1	5	71	7	34,500
1	2	1	25	4	2,000
1	2	2	40	5	2,100
1	2	3	50	6	3,700
1	2	4	57	7	4,800
1	2	5	62	8	6,000
1	2	6	67	9	8,100
1	2	7	70	10	14,500
1	2	8	73	11	23,500
1	2	9	75	12	27,000
1	2	10	77	13	46,800

2. Effect of Shear-Mixing: The viscosity of an invert emulsion is dependent upon the amount of shear the mix is subjected to. Shear is one way of stating how violently a composition is mixed or agitated. Violent agitation or high shear or high deformation of particles is accomplished by such things as a Waring blendor, a colloid mill or more practically a positive displacement pump. Mild agitation is represented by a laboratory stirrer or gentle paddle agitation. With the invert emulsion prepared from Verton CE, viscosity is greater with a larger amount of shear. This can be observed in Table III.

Note that in the column under gentle stirring, gentle stirring will only bring the viscosity of a mix containing one gallon Verton CE plus two gallons of oil plus four gallons of water to 3000 centipoise. A centrifugal pump, which causes more shear will raise the viscosity to 6300 cps while a colloid mill which represents maximum shear, will raise the viscosity to 10,000 cps

Table III. EFFECT OF MIXING ON VISCOSITY

VERTON CE	Fuel Oil	Water	Total Volume	Gentle Stirring	Centrifugal Pump	Colloid Mill
1 Gal	1 Gal	4 Gal	7 Gal	3,000 cps	6,300 cps	10,000 cps
1	2	5-1/3	8-1/3	5,500	8,300	13,500
1	2	6-2/3	9-2/3	8,600	24,600	25,700
1	2	8	11	18,300	34,400	36,700

The highest viscosity is obtained when the water droplets become as small as possible. This subdivision of particles is accomplished by the high shear of the colloid mill in a short period of time. The gentle stirring will not subdivide the particles as much as the colloid mill as evidenced in Table III.

Table IV. EFFECT OF TIME OF MIXING ON VISCOSITY

VERTON CE	Fuel Oil	Water	Total Volume	Stirring Time	Viscosity
				1 Min	4,000 cps
				2	5,500
				7	7,900
				12	10,500
				38	12,500
1.5 Gal	1.5 Gal	7 Gal	10 Gal	78	14,800
				101	14,700
				131	15,600
				193	15,000

It is further evident in Table IV that with gentle stirring the viscosity of this mix will not go above 15,000 cps. no matter how long the mix is stirred. However, one pass through a colloid mill or a gear pump and this mix would have a viscosity of 39,000 cps.

The principle of shear can be used beneficially by the applicator of herbicides. A relatively thin invert emulsion can be made with minimal agitation. Then, as the emulsion is subjected to the shearing forces in a positive displacement pump and the shearing forces of the nozzles, it will approach the maximum viscosity with the attendant benefits of better drift control.

3. <u>Effect of Temperature</u>: As the temperature of the spray mixture rises, the viscosity of an invert decreases. This is not surprising as most every viscous solution becomes more free flowing with increases in temperature. As the temperature rises it becomes easier for the water droplets to coalesce or merge or grow into larger droplets with the resultant decrease in viscosity. The actual variation in viscosity as a function of temperature is shown in Table V.

Table V. VISCOSITY TEMPERATURE RELATIONSHIPS

VERTON CE	Kerosene	Water	Total Volume	Temperature	Viscosity*
				90°F.	39,900 cps
				100	39,000
1.5 Gal	1.5 Gal	7 Gal	10 Gal	112	34,000
				115	30,500
				124	26,500

* Produced by a colloid mill.

Because of this marked decrease in viscosity it is recommended that invert emulsions be kept at below 100°F. Fortunately, this is easy to do as inverts conduct heat very poorly and in actuality a spray mixture would seldom reach a temperature of over 90°F.

4. <u>Effect of Aging of Inverts on Viscosity</u>: The viscosity of invert emulsions will decrease while the mixture stands. The amount of decrease will depend upon how close the viscosity is to its maximum. If close to a maximum, there will be a marked decrease in viscosity in a relatively short time. If the viscosity is intermediate, as would be obtained with common mixing equipment, then the decrease is barely perceptible. The rate of decrease of an emulsion containing 1.5 gallons Verton CE, 1.5 gallons kerosene and 7 gallons of water is shown in Table VI.

Table VI. VISCOSITY DECREASE OF VERTON CE
INVERT EMULSION HERBICIDE ON STANDING

Time	Viscosity	Time	Viscosity
1 Min	35,000 cps	30 Min	20,000 cps
3	31,700	40	18,800
6	28,500	50	18,000
8	26,500	60	17,000
15	23,500	90	15,800
20	22,300	120	15,000
25	21,000		

After two hours the above mix was given one pass through the colloid mill and immediately the mix returned to 37,500 cps.

Verton CE herbicide emulsions have remained in spray equipment for as long as a month and on brief agitation became a viscous emulsion suitable for spraying.

Application Methods: Most invert emulsions are applied in low volume (5 to 50 gallons per acre) by aircraft, mist blower or fixed nozzle. Aircraft application utilizes the centrifugal disk, bi-fluid nozzles or conventional equipment. Where conventional equipment is used on aircraft, the most satisfactory nozzles have been found to be Vee-Jet or Tee-Jet. All the application methods have merit and will not be discussed here.

Drift Control: The amount of drift that one obtains from any spray solution is dependent upon the viscosity of the spray solution, spray pressure, nozzle size, relative humidity, temperature, wind velocity and other factors. Spray drift may be reduced by (1) increasing the viscosity of the spray solution, as is accomplished by making an invert emulsion, (2) by reducing the spray pressure thus reducing the amount of very fine spray particles, and (3) use of large size nozzles or orifaces. However, in this discussion let us confine ourselves to the effect of viscosity of spray solution on drift control, or in essence, the amount of drift control obtainable with invert emulsions.

Dr. K. G. Seymour of The Dow Chemical Company, Texas Division, made some measurements of drift in a wind tunnel. In this wind tunnel a spray is directed straight downward and a portion of the spray is subjected to a wind moving in a perpendicular direction to the spray. In other words, the spray is vertical and the wind is horizontal. The horizontal wind (100 feet/min. velocity) carries the fine drops away from the spray and they drop at various distances from the source depending upon their size. The larger particles drop first and the smaller ones go farther. The very fine particles do not drop but are caught on collecting devices at the end of the wind tunnel. The sprays contain a dye to allow analysis of the amount of spray dropping at a certain site. In reporting these results Dr. K. G. Seymour gives the amount of spray which lands on the floor of the wind tunnel per inch of a given distance from the spray source. This allows us to make comparisons of the amount of drift from various types of sprays.

It was necessary to be sure that some fine particles occurred in the sprays that were tested. Thus, a fine nozzle (8004) and a higher than necessary pressure (40 lbs/sq.in) was used. The results of spray drift tests under these conditions may be found in Table VII. In Table VII, the invert designation 1-1-5 indicates one part Verton CE, one part fuel oil and five parts water.

Table VII. DRIFT COMPARISON FROM WIND TUNNEL TESTS
(Volume % of Spray per Inch)

Distance from Source	Particle Size	Water	Invert 1-1-5	Invert 1-1-6
21 In.	150 µ	169×10^{-3}%	149×10^{-3}%	36.3×10^{-3}%
27	128	78	51.6	10.4
39	105	39	14.2	1.47
51	95	16	4.5	.33
63	89	7.7	2.2	.20
69	87	4.3	1.7	.02
	Total	314.0	223.2	48.72

The fine particles (50-70µ) collected at the ends of the wind tunnel were as follows:

Table VIII. DRIFT COMPARISON - 50 TO 70 µ PARTICLES

System	Volume % of Spray on Three 11 mm. Rods
Water	2.4×10^{-3}%
Invert 1-1-5	2.98
Invert 1-1-6	1.71

There is some uncertainty concerning the small droplet fraction since these were collected by impaction on 11 mm. glass tubing. Pure water droplets of 50 µ initial size would have completely evaporated before reaching the glass rods. Therefore, collection efficiency of the dyed water residue was undoubtedly low (1).

Summarizing this drift evaluation work by K. G. Seymour, invert emulsions definitely reduce the amount of small particles in a herbicide spray. The amount of fine particles decreases as the viscosity of the invert emulsion increases. With this decrease in small particles, the hazards of spray drift are reduced through the use of invert emulsions.

To summarize, inverts are water in oil emulsions that offer some very desirable physical properties to the herbicide applicator. Their oily consistency allows them to adhere to foliage well in spite of dew or light rain. The fact that their viscosity decreases on standing but readily increases on passing through a pump allows them to be easily handled and still have maximum

[1] R. T. Jarman, [illegible]

viscosity when sprayed with the resulting decrease in the amount of drift. Drift control is a subject of continued interest and research is continuing with invert emulsions and other approaches to the problem.

Aerial Applications of Invert Emulsions for Brush Control

Harold F. Brown, R. E. Sayre, W. E. Chappell, and J. P. Sterrett /1

ABSTRACT

Applications of invert emulsions of 2,4-D - 2,4,5-T esters were applied with a helicopter in June, 1961. The rates used were 10 in 20, 12 in 24, and 16 lbs. in 32 gallons of total volume per acre. These rates were applied on different power lines as part of a commercial operation. Applications in June and July were made with a Bell G2A helicopter equipped with centrifigal type applicator /2.

Representative areas for each rate of application were selected and sub-plots were established for recording specie kill. All woody stems were counted during the summer of 1961 and then recounted in August, 1962, at which time the number of resprout and live stems for each species were recorded.

The rates used are not directly comparable since they were not used in adjacent areas but a definite trend was noted on species reaction. All rates killed the original stems of the root suckering species such as sassafras, sumac, black locust and black gum. Sassafras resprouted in at all rates whereas sumac and black locust resprouted less at the lower rates of 10 and 12 lbs. per acre. Oaks, maple, and hickory were controlled best at the higher rates of 16 pounds per acre. The percent of live stems in these and other non-root-sprouting species such as cherry, yellow poplar, ash, etc. were as follows: 10#, 22%; 12#, 13%, and 10#, 7%.

The overall control of brush as a result of these aerial applications was somewhat better on root-sprouting species then could be expected from conventional ground sprays and about equal to ground applications on other species of brush.

/1. President, Aerial Services Corp., Roanoke, Va.; Ass't. Manager, Bartlett Tree Expert Co., Roanoke, Va.; Professor and Ass't. Professor of Plant Physiology, V. P. I., Blacksburg, Va.

/2. Applicator and invert emulsions were produced by Amchem Products, Inc.

THE TRACTOR MOUNTED MIST BLOWER
A break through technique in brush control

Steven S. Hall[1]

During the past summer I was the crew leader and tractor driver on a transmission line brush control job that I think is unique in the northeast.

First, by way of introduction I would like to quote in part from "A Proposal for Cost Reduction" written in November 1961 and presented by the Tenney Mountain Corporation to utility companies in our locality:

"The problem of maintaining power transmission lines in a brush free condition in New Hampshire is difficult because of the many prolific tree species, almost all of which sprout vigorously from the cut stump. Added to this are adverse terrain, steep rocky slopes, ledges and occasional swamps, that deny access and limit the use of powered equipment.

"Cutting with hand or powered portable tools has the advantage of mobility and low cost per treatment. However, continued cutting encourages sprouting and the number of stems to be cut inevitably increases to the maximum the land will support.

"Chemical control is attractive because of the residual effect of killing the roots and preventing sprouting. The number of stems is reduced and further treatment is concerned only with killing the struggling seedlings.

"Chemical brush killing is apt to be expensive because of difficulty of effective application in the mountains. To be successful it must compete favorably with the cheapest acceptable method of brush control - perhaps cutting.

"Costs can be met on the most favorable terms by dealing with the problem as follows:

1. Use a general rather than a specific method of application. Broadcast the chemical whenever possible. Get away from individual plant application.

2. Use best, low cost rough ground vehicle available. At present Bombardier, muskeg model. Use light weight supply vehicles - Keep the crew small to reduce downtime costs.

[1]Student, Class of 1963, Yale University. Summer employee of Tenney Mountain Corporation, Plymouth, N. H.

3. Water is the bulkiest and heaviest spray ingredient. Ideally its use should be eliminated. When used it should not be carried far. Water is an inert ingredient used only as a diluent. Air is cheaper, lighter, and more available and can be used as a chemical diluent in brush killer application."

The proposed cost reduction depended largely on a broadcast application technique using air rather than water as the principal chemical diluent. This meant a tractor mounted mist blower.

The Green Mountain Power Corporation agreed to have the Tenney Mountain Corporation treat part of its transmission system and issued a work order on their right of way from McIndoe Falls on the Connecticut River westerly 25 miles to Barre. This is a single 110,000 volt line, 100 feet wide with wooden structures.

The job began in mid-July and ended in late August. The work was paid for on a brush acre basis of which there were 190 acres. With infrequent exceptions the crew consisted of only two men.

The terrain, rising from the Connecticut River and crossing both Groton Heights and Orange Heights, varied from easy to very difficult because of rocks, ledges and steep pitches.

The species were northern hardwoods, mostly rock maple, with associated conifers, spruce, balsam, a few white pine, and cedar. The brush was generally dense, on many acres it was six to eight feet high and ranged up to twenty feet. Since construction the brush had been cut and stump sprayed four growing seasons ago.

The availability of water would be classified as unfavorable for hydraulic spraying for foliage. In one case water was two miles between water holes and in another case it was barely sufficient, even for our limited requirement.

The equipment used consisted of a Bombardier Muskeg Carrier, Model HDW, a Potts Mist Blower, and a Willys Universal Jeep. The Bombardier is a track laying vehicle, about 13 feet long by 7 feet wide, having a ground bearing pressure of 3/4 of a pound per square inch. It uses a 115 hp Chrysler Industrial engine as prime mover. It weighs 2-1/2 tons without load. The track system is made up of rubber belts, reinforced by steel cable, steel cross links, rubber sprockets, and 4.50 x 16 tires as track idlers. Both sides are independent of each other and are very flexible, enabling it to traverse terrain obstacles easily. Although not especially impressive, this machine has gained a wide reputation as a successful off-the-road vehicle. Part of the line was so severe as to raise doubts about being able to traverse it even once. As it turned out, the machine made passes through this terrain in three different places, whereas a wheeled vehicle would have been unable to make one.

The Potts Mist Blower was mounted on the rear of the HDW. This is a 4,800 cubic feet per minute blower, powered by a 13 horsepower Wisconsin engine, and using a 10 gallon per minute supply pump. A nozzle configuration of one straight back and two at 45 degree angles was used. These nozzles could be raised and lowered and fan speed adjusted to fit brush, terrain and wind conditions. The supply tanks carried 180 gallons of mixture and were agitated by a small gasoline engine.

The Willys Jeep was used as a supply vehicle and for transportation of employees.

The chemical used on this job was "Ammate" X weed and brush killer. We chose "Ammate" X because it is non-volatile and because it is non-selective and is effective on maple, spruce, balsam fir, white cedar, and pine, important species to be killed on this line.

The formula we used, based on 100 gallons of concentrated mixture was:

42 pounds of "Ammate" X
5 gallons of No. 2 fuel oil
1 pint DuPont Emulsifying Agent A
2 quarts DuPont Spreader Sticker
Enough water to make 100 gallons of mixture.

After the spray tank was more than half full of water, "Ammate" X, which is highly soluble, was added, then with the mechanical agitator in operation the pre-mixed oil with emulsifying agent was added as the remainder of the water was going into the tank. Since our spray tank capacity was 180 gallons we actually used 660 pounds (11 bags) of "Ammate" X per load.

Oil was used in the mixture to increase the effectiveness of the "Ammate" X and to reduce risk of corrosion. Corrosion was not a problem on our equipment. It was limited to several friction points, namely on the floor where the mist blower operator stood, on the tank where a chain was used to secure the tank, and to some extent in the tool box. But it was not serious in either instance.

Since some are concerned about the corrosive characteristic of "Ammate" X, it seems proper to report here a study made by the Dupont Co. on this question. In this study they left standing for 120 days certain metals in a solution of one pound of "Ammate" X in a gallon of water. The results were: -

Aluminum 0.005 inches in 120 days
Steel 0.001 inches in 120 days
Copper base metal - No appreciable attack in 120 days
On brass, however, seasonal cracking occurs.

They further state that no complaints have been received due to corrosion to fences, guy wires, or telephone wires where "Ammate" X has been used. This is probably because of the inertness of copper to "Ammate" X and the only slight susceptibility of aluminum wire, coupled with the high solubility of "Ammate" X, permitting it to wash off readily with the first good rain. Also the amount actually deposited on these metal fixtures during the normal spray operation would be light.

Application was done with a two man crew, although severe terrain makes a three man crew desirable. A continuous 33 foot wide swath was made down the line, requiring that the tractor stay either in the center of the line or 16-1/2 feet from the side. The mist blower was turned on, the pressure, fan speed, and nozzles adjusted to suit the conditions; and the tractor was driven by hand signals over terrain obstacles. A third member of the crew, if used, rode the mist blower and adjusted fan speed and nozzle direction to suit the terrain and brush height.

One load covered an average of 7.5 acres, which would be 24 gallons of spray mixture containing 88 pounds of "Ammate" X per acre. We did, however, vary the rate through a range of 75 to over 100 lbs. of "Ammate" X per acre, depending on size and density of the brush to be killed. This variation was accomplished by pump pressure and speed of the vehicle.

One complete cycle of operation, including empty travel time, loading time and application time, averaged about four machines hours. Water demands and the amount of travel over the line were around one tenth that required for foliage treatment.

As might be expected, this job was not without problems. In order to make certain that our equipment would not be damaged by corrosion we hosed it down frequently, especially when it would be out of use for a day or so, but as has already been stated, the corrosion was slight.

Another problem was the bulk and weight of the chemical. It was of course necessary to carry the 660 lbs. of "Ammate" X in the service Jeep along with ten gallons of fuel oil, so the magnitude of hand transfers were inconvenient and time consuming. Coupled with this was the loading problem, that of opening eleven bags and getting them dissolved in the water before we added the oil and spreader sticker. The emulsifying agent was added to the oil in supply drums before it was carried to the field. This was both for convenience sake and assurance that no water got into the oil before the emulsifier was mixed with the oil.

It actually developed that only about one third to one half of the machine hours were spent applying the chemical. The rest of the time was spent travelling and loading.

Wind, although a problem, was a small one. We had originally been concerned over its effects, but due to the non-volatile nature of "Ammate" X, and the skill we developed in handling the mist blower, it did not seriously affect our operation.

Terrain, a large problem, was again less than expected. As I have mentioned, there was some doubt over the ability to traverse some of the terrain. In total we were unable to reach only five pole spans due to ledges, extreme steepness, and side hills. In all other places it was found that three separate passes could be made over the 100 foot right-of-way. This included brook crossings, swamps, ledges, rocky ground, stone walls, logs, stumps, very steep hills, and some side hills. In short, it was shown that the Bombardier tractor can cope with difficult terrain beyond belief.

Although it is a bit soon to speak of long range results, the top kill appears to be excellent. When we left our original work it was totally top killed; both the tall dense brush and the small conifer seedlings. Drift and accidental side kill was almost non-existent.

We feel that this job has shown that ground power equipment can cope with even extreme terrain and can do so in such a fashion as to allow broad-cast mist blowing to be used. We feel that we have greatly minimized the transportation and water problem by using air as part of the vehicle of application rather than all water.

As a final point, man hours per acre have been cut to one quarter of that required for hydraulic treatment. As a result of this our cost of application has been cut drastically allowing us to compete with other methods of brush control including helicopter and cutting. Much of this cost reduction is passed on to the utilities, bringing the day closer when a brush free line is not regarded as a luxury.

CONCLUSION

Tenney Mountain Corporation successfully used a tractor mounted mist blower to treat dense, high brush in a transmission line in mountainous Vermont with "Ammate" X weed and brush killer.

1. The results judged by top kill at the end of the season were excellent on both deciduous and conifer species.

2. Drift and side kill were controlled and presented no problem.

3. The Bombardier tractor was equal to the very rocky, steep terrain.

4. Compared to hydraulic stem foliage application, only 25% of the man hours and 10% of the total fluid volume were used.

A WAY OF MEASURING PERFORMANCE IN CHEMICAL BRUSH CONTROL FOR NEW ENGLAND

by

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Northeastern Weed Control Conference,
New York, N. Y., January 9-11, 1963

In most buyer-seller relationships, certain standards of quality or performance are accepted as a basis for doing business. These standards enable a buyer to describe what he wants and to recognize whether he has gotten it. In produce markets, some of the standard terms are U.S. Fancy, U.S. No. 1, and Utility. Meat is marked with such grades as Prime and Choice. In the chemical industry, the term C.P. means chemically pure by certain standards of analysis, while U.S.P. means that a product meets the standards described in the U.S. Pharmacopeaia.

Behind each of these brief terms is a set of detailed specifications or characteristics which are judged by experts to arrive at the brief rating which is the standard for doing business. In brush control, we are a long way from writing the standards for a Grade A job versus a Grade B. There are not yet any commonly used standards for measuring the performance of chemical brush control. This may be due to the youth of the practice, and its complexity is certainly a contributing factor. Another reason for the lack of definite standards is that buyers of chemical brush control have widely varying requirements, both in terms of what they need and in terms of what they are willing to pay for.

Generally, brush control programs in New England fall into one of three main categories:

1. Keeping tall-growing woody plants sufficiently retarded so they do not grow into overhead wires.

2. Eliminating tall-growing and certain objectionable low-growing woody species entirely, while protecting and encouraging most low-growing woody species and grass cover.

3. Eliminating all woody species, and developing only a grass cover.

Brush control is also part of a fourth category of vegetation control which seeks the elimination of all vegetation leaving only bare ground. Examples of such situations include areas along security fences and highway guard-rails; pole-yards, power substations and fuel storage areas. However, most New England brush control programs are applied to areas where ground cover is desirable for its aesthetic value as well as to prevent erosion and provide wildlife habitat. In areas where complete elimination of all vegetation is desirable, the principal measure of performance is the duration of the bare ground condition, and the price of maintaining it. Important other factors are the safety of the chemical treatment to people and animals in the treated area, and freedom of injury to desirable growth outside the treated area.

The first measure of performance of brush control should probably be in terms of our final objective. In most New England situations, we are chiefly concerned with the second of these three categories -- eliminating tall-growing and objectionable low-growing woody species entirely, while protecting and encouraging certain desirable low-growing woody species and grass cover.

Some of the common New England species that grow tall enough to create problems are:

CONIFERS (evergreens)

Eastern red cedar (Juniperus virginiana)
Northern white cedar (Thuja occidentalis)
Balsam fir (Abies balsamea)
Eastern hemlock (Tsuga canadensis)
Red pine (Pinus resinosa)
White pine (Pinus strobus)
Red spruce (Picea rubra)
White spruce (Picea glauca)
Pitch pine (Pinus rigida)

DECIDUOUS (usually hardwoods)

White ash (Fraxinum americana)
American basswood (Tilia americana)
Beech (Fagus grandifola)
Trembling aspen (Populus tremuloides)
Large-toothed aspen (Poplar) (Populus grandidentata)
Black birch (Betula lenta)
Grey birch (Betula populifolia)
Yellow birch (Betula lutea)
Black cherry (Prunus serotina)
American elm (Ulmus americana)
Black locust (Robina pseudo-acaria)
Pignut hickory (Carya glabra)
Shagbark hickory (Carya ovata)
Hop hornbeam (Ostrya virginiana)
Scarlet oak (Quercus coccinea)
Scrub oak (Quercus ilicifolia)
Chestnut oak (Quercus prinus)
Black oak (Quercus velutina)
Northern red oak (Quercus borealis)
Pin oak (Quercus palustris)
White oak (Quercus alba)
Red maple (Acer rubrum)
Sugar maple (Acer saccharum)
Sassafras (Sassafras variifolium)
Sycamore (Platanus occidentalis)
Black willow (Salix nigra)
Staghorn sumac (Rhus typhina)
Speckled alder (Alnus incana)

The common objectionable low-growing species include:

Greenbrier or bullbrier (Smilax rotundifolia)
Saw brier or cat brier (Smilax glauca)
Poison ivy (Rhus radicans)
Poison sumac (Rhus vernix)

Some would also include the upright growing blackberry (Rubus allegheniensis) in this group.

Some of the desirable low-growing woody species that usually should be protected are:

All Azaleas and Rhododendrons
All of the ferns

Arrow-wood (Viburnum dentatum)
Bayberry (Myrica pensylvanica)
Highbush blueberry (Vaccinium corymbosum)
Lowbush blueberry (Vaccinium augustifolium)
Chokeberry (Aronia arbutifolia)
Blackhaw (Viburnum prunifolium)
Elderberry (Sambucus canadensis)
Mountain holly (Nemopanthus mucronata)
Huckleberry (Gaylussacia baccata)
Checkerberry (Gaultheria procumbens)
Snowberry (Symphoricarpos albus)
Grey dogwood (Cornus racemosa)
Silky dogwood (Cornus amomum)
Mountain laurel (Kalmia latifolia)
Hazelnut (Corylus americana)
Common winterberry (Ilex verticillata)
Mapleleaf viburnum (Viburnum acerifolium)
Nannyberry (Viburnum lentago)
Virginia creeper (Parthenocissus quinquifolia)
Red osier dogwood (Cornus stolonifera)

While these lists are not all-inclusive, they represent most of the woody species involved in chemical brush control on roadsides and right-of-ways in New England.

Now what is the significance of these lists?

They are the first guide for determining brush control objectives and evaluating results. The objective is to eliminate the undesirable species, and retain or encourage the desirable ones. In one way or another, the results will probably be judged by determining how much of a population of each category remains after brush control operations are completed.

Performance of a chemical brush treatment is often expressed in terms of per cent control or kill. But perhaps we should actually be thinking in terms of survival and re-growth rather than kill. If we agree that the term per cent kill is to be applied literally, meaning per cent of plants with no life left in them, then is this really a good measure of brush control performance? Let's examine some figures and see what they suggest.

TABLE I

Tall Growing Woody Plants (or brush clusters) Per Acre Found in Several Massachusetts Locations

Location	Number of plots counted	Range in number of woody plants per acre	Average number woody plants per acre
Ayer	14	1,560 to 4,600	2,593
Leominster	14	1,280 to 3,240	2,049
Leominster	4	1,640 to 2,360	2,070
North Brookfield	10	5,738 to 14,360	9,253
North Brookfield	25	1,040 to 5,480	3,175
West Brookfield	18	1,070 to 20,197	7,932
	85	1,040 to 20,197	4,561

Table I gives the woody plant population (tall growing species) that have been found in six different brush control experiments, involving 85 counts of plots varying from 1/40 to 1/20 of an acre. These counts are of woody plants or brush clusters, and not numbers of stems. Stem count figures would have been many times these amounts.

Of the 85 plot counts reported in Table I, the number of woody plants that are of the tall growing species group varied from 1,040 to 20,197. Even a 90 per cent kill in the highest populated plot would leave 2,020 per acre not killed, almost twice as many as were found in the least populated plot before treatment. Even though a 90 per cent kill would ordinarily be considered excellent, this would suggest that the percentage yardstick is not always satisfactory. Of course, to know percentage kill, it is necessary to make counts in advance of treatment and then make counts in exactly the same place in due time after treatment. Unless actual counts are made it is impossible to know the per cent kill. We can be very much deceived by an eye appraisal of results. We only see what is left, and the 10 per cent that may be left may become 100 per cent in the mind's eye.

In the final analysis, the buyer of brush control is chiefly interested in the condition of his area after treatment. What was there before treatment may be of only academic interest. Since the percentage kill factor is based on conditions before treatment, an additional basis for measuring performance seems to be desirable.

This suggests the need for certain standards to be applied to areas after treatment. The buyer of brush control can then decide on the results he is willing to pay for, while the brush control operator (whether it's the buyer's own crew or a contractor) can offer results to meet any specified standards.

For example, the basic standard might be the killing of all tall-growing species found in the area before treatment with certain tolerances established for those not killed.

This can be considered in terms of the number of plants per acre (43,560 square feet) with reference to the following table. This table shows how the distance between plants can be used to estimate plant population per acre.

TABLE II

Woody Plants Per Acre at Various Spacings

Feet Between Plants	Plants (Brush Clusters) per Acre
2	11,780
3	4,840
4	2,722
5	1,742
6	1,210
6.6	1,000
10	436
14.7	200
15	194

To illustrate, if it is agreed that after a utility line has been treated, no pole span is to have more than 200 living plants of certain species per acre, this would mean that the surviving plants should be approximately 15 feet apart. It might be further agreed that none of the surviving plants should have living parts more than three feet tall.

A time factor should also be considered. Under typical New England conditions, results should be evaluated at least a year after the date of treatment, preferably in July. Then it would be reasonable to allow another six or eight weeks for re-treatment to correct human error in the application.

If condition one year after treatment is the first factor in measuring brush control performance, then the second factor is the question of when re-treatment will be necessary. This, of course, will depend on how soon new undesirable plants become large enough and numerous enough to justify re-treatment. Some of the following data may be a useful guide on this question.

TABLE III

Seedling Growth Present Four Growing Seasons Following Treatment with Fenuron on Upland Soil in Ayer, Mass.*

Species	Plants at time of treatment		New seedlings four seasons after treatment		
	Number	Per cent of total	Number	Per cent of seedling population	Number of seedlings over two feet tall
Oak	977	64	215	31	3
Grey birch	175	11	304	44	58
Maple	107	7	19	3	2
Poplar	101	7	54	8	2
Pine	95	6	49	7	16
Cherry	52	3	37	5	8
Shadbush	16	1	16	2	1
Willow	10	1	3	-	-
Hickory	4	-	1	-	-
Total	1,537	100	698	100	90
Per acre basis	2,049		931		120

*Data are total from thirty 1/40 acre plots or a total of 0.75 acre.

Many factors will govern the seedling problem. Among these factors are species present in the area, soil types, elevation, and rainfall. These factors will cause considerable variation among different locations. As is indicated in Table IIIthe species that will first present a problem in the upland soils of the southern half of New England will be grey birch, pine, and possibly cherry.

In the low land areas red maple, alder and willow are apt to be the first species to come back in sufficient numbers to be a problem. In Northern New England spruce, fir, pine, and red maple will appear first.

No arbitrary time can be given as to when re-treatment will be necessary, but if the results suggested earlier in this paper are obtained, it may be four to six years before re-treatment would be justified. Table II can again be used as a guide for determining when re-treatment is necessary. For example, it might be agreed that when there are 1,000 plants per acre of the tall-growing species at a height of more than three feet tall, a re-treatment should be considered. According to Table II this would be one plant every 6.6 feet. The population per acre in any pole span area can be used as a unit for determination. The survival standard for results should be the same as suggested for the initial treatment.

In certain, usually limited, areas root suckering species may aggravate the problem and appear as seedlings. Among these species are poplar, some species of sumac, sassafras, and black locust. These isolated locations may require special attention sooner than the right-of-way in general.

Knowledge of plant species and their growth characteristics is of basic importance in developing an efficient brush control program. This is often a difficult field for people without specialized training. More and more utility management people are recognizing the need for professional help such as a trained arborist in dealing with the complexities of vegetation control. The membership of the International Shade Tree Conference includes 107 utility arborists, and it is estimated that there are more than 120 additional utility arborists in the United States.

The more practical application of the foregoing standards we have been discussing is in long-term maintenance contracts between custom applicators and buyers of brush control, in which the contractor is paid so much a year to keep the vegetation under defined control. These contracts may be for ten years or longer. In these long term contracts each party can have protection against changing economic conditions, by using the negotiated price as a base, and adjusting the figure as necessary according to government labor indexes and published chemical costs.

If the contractor is to have the responsibility of results he should also have the liberty of choosing his chemical and method of application; of course in council with the utility arborist if one is available. Along with this choice should go the full responsibility of any consequences of his activity such as spray drift and public relations.

This suggests that utilities and highways should buy results and not chemicals. At the same time contractors should sell results and not chemicals.

To sum up, we have made the following four basic suggestions for accomplishing the desired results in brush control:

1. Determine the kinds of woody plants in the area before treatment. This requires a knowledge of plant species and their growing habits. The utility arborist can be helpful here.

2. Establish a workable tolerance for the population and height of plants surviving after treatment.

3. Determine, in terms of plant population and height, when re-treatment will be desirable.

4. Plan vegetation control on a long-term maintenance basis.

It is not the writer's thought that the suggestions made in this paper are infallible nor that they will fit all situations. But it is hoped that they may serve as guide lines for more efficient chemical brush control.

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SUBSTITUTED URACILS FOR INDUSTRIAL WEED CONTROL IN THE NORTHEAST

C. W. Bingeman, R. W. Varner and J. E. Prendergast1/

The discovery of a new family of very effective herbicides, the substituted uracils, was announced in December 1961 (Varner and Bingeman). At that time it was reported that 5-bromo-3-isopropyl-6-methyluracil (isocil) appeared to have the characteristics of an outstanding industrial herbicide. Subsequent commercial experience with "Hyvar" Isocil Weed Killer proved this to be true.

Continuing research work has demonstrated that 5-bromo-3-sec butyl-6-methyluracil ("Hyvar" X Weed Killer2/) also provides excellent long-term general weed control and is more effective than isocil on weeds in the family Compositae.

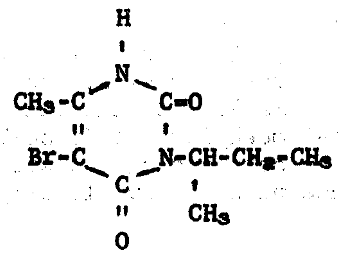
The purpose of this paper is to describe "Hyvar" X to workers in the Northeast and to define its utility relative to isocil for the region. The properties and characteristics of isocil previously published (Varner and Bingeman; Bucha et al.) will not be repeated here.

1/ Contribution of the Industrial and Biochemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

2/ "Hyvar" X Weed Killer is a wettable powder formulation containing 80% 5-bromo-3-sec butyl-6-methyluracil. This preparation was formerly coded as Herbicide 976. The K-62 Committee of the American Standards Association will be requested to establish "bromacil" as the common name for the active ingredient.

Physical and Chemical Properties

The structural formula for the active ingredient in "Hyvar" X is:



It will be noted that the new compound differs from isocil by having a sec butyl group in place of the isopropyl group.

Pure 5-bromo-3-sec butyl-6-methyluracil is an odorless, white crystalline solid with a melting point of 158-159°C. It is soluble in water at room temperature to the extent of 815 ppm and to a much greater degree in the presence of strong bases. It is also soluble in such organic solvents as benzene, methanol, acetone and acetonitrile.

"Hyvar" X is a stable material. Tests at elevated temperatures and long exposures to sunlight indicate that loss from soil due to volatilization and photo decomposition will be negligible with this herbicide.

Mammalian Toxicity

The LD_{50} for the active ingredient in "Hyvar" X by oral administration to male white rats is 5200 mg./kg. of body weight. Additional feeding tests as well as eye and skin exposure studies have provided good evidence that the compound will be safe to humans and animals when used according to directions for non-crop weed control.

Formulation and Application

"Hyvar" X has been formulated as an 80 percent wettable powder which may be applied in either water or an herbicidal oil. Spray concentrations of up to 50 pounds of commodity per 100 gallons of carrier can be handled successfully. Oil is preferred over water where a quick contact effect on existing vegetation is desired. The addition of a wetting agent such as Du Pont Surfactant WK to the water carrier (at levels of 0.5 to 2.0%) will also increase the contact effect under some conditions.

Combination treatments involving "Hyvar" X along with such herbicides as 2,4-D, 2,4,5-T, TCA, chlorates and boron compounds have been found to be entirely feasible.

Performance Characteristics

"Hyvar" X has been extensively tested on railroad rights-of-way and other industrial sites in the Northeast as well as in other major climatic areas throughout the United States and Canada. These tests have shown that "Hyvar" X has activity against grasses equal to or better than that demonstrated previously for isocil. Species such as broomsedge (*Andropogon virginicus*), Indian grass (*Sorghastrum nutans*), quackgrass (*Agropyron repens*) and purple top (*Tridens flavus*) have been controlled with rates in the range of 5 to 10 pounds of active ingredient per acre. Annual grasses are killed with as little as 2.5 pounds per acre.

In addition to being an effective grass killer, "Hyvar" X controls a wide spectrum of broadleaf plants. Annual species are eliminated by treatments of 2.5 to 5 pounds of active per acre. Most perennial species are killed by 5 to 10 pounds per acre. Some species such as bouncing bet, spurge and dogbane may require up to 20 pounds per acre.

An important advantage of "Hyvar" X over isocil is seen in the control of Compositae species such as Canada goldenrod (*Solidago canadensis*), flat top goldenrod (*S. graminifolia*), daisy fleabane (*Erigeron strigosus*) and chicory (*Cichorium intybus*).

"Hyvar" X is most effective when applied during or shortly before the period of most active growth. Applications made one month prior to the initiation of growth have indicated only a slight loss of activity where rainfall is abundant. Best results have been obtained in the Northeast region from applications made between mid-April and mid-June.

Applications of "Hyvar" X sufficiently large to kill mixed populations of vegetation in the spring (5-10 pounds active per acre) will persist through the growing season under the rainfall conditions of the Northeast. It has also been observed that

"Hyvar" X maintains an effective concentration in the upper soil layers longer than isocil under many conditions. On treated sites where the weed population was completely eliminated the first year, follow-up applications as low as 2.5 pounds of "Hyvar" X per acre during the second year have given good seasonal control of resurging seedlings. Low rates of diuron have also been highly effective as second-year treatments for maintaining these bare sites.

Availability

It is anticipated that "Hyvar" X, along with isocil, will be available for sale in 1963 for non-crop usage. Samples of "Hyvar" X will be available for general investigator testing.

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CHEMICAL MOWING BY THE MARYLAND STATE ROADS COMMISSION

Charles R. Anderson and Richard C. Moffett

Maryland highway vegetative maintenance problems increase each year with the construction of many miles of new modern highways. This new construction adds each year, at least a thousand acres of vegetative area to maintain. A large portion of these areas must be maintained at a low height for driving safety and attractiveness. Traditional mowing practices such as hand sickling and the use of slow mowing machines are no longer economically practical for maintaining these vast areas. Therefore, a more efficient means of controlling plant growth has to be utilized.

During the 1950's, the Maryland State Roads Commission started experimenting with herbicides. Our vegetative maintenance program now includes the use of selective weed killers, sterilants, and growth regulators.

OBJECTIVES

Chemicals can be used as another tool for the control of plant growth and also supplement the effectiveness of modern mowing equipment. This can be substantiated by the involvement of less labor for maintenance of vegetative areas, thus releasing this labor for other duties. For example, roadside areas adjacent to developed areas or cultivated fields, where mowing is costly and/or inaccessible for equipment, can now be maintained by use of growth regulators and herbicides at a lower cost than by time consuming hand labor.

"Chemical mowing" not only saves the state in dollars and cents, but makes a highway safer to travel when adequate sight distances and traffic signs are unobstructed by controlled weed and grass growth. Chemicals also improve turf cover and the general appearance of the highway. These not only reduce the factors condusive to trash and debris along the roadsides, but gives the motoring public an impression of a smoother pavement.

The state highway chemical weed control program in Maryland is under the general supervision of Mr. G. Bates Chaires, Assistant Chief Engineer of Maintenance and Mr. Charles R. Anderson, Chief Landscape Section. The Landscape Section, located in the main office building at Baltimore, is responsible for formulating chemical weed control policies and procedures for the entire state. Special trained personnel assigned to the Landscape Section apply all chemicals in the state except sterilants, which are applied by district forces. A landscape technician from the Landscape Section, is responsible for programming and supervising the work performed in the state.

ACCOMPLISHMENTS AND RESULTS

This past year, as in the years 1960 and 1961, our medians were treated with 2,4-D. In the spring of 1962 another spray rig was purchased for spraying 2,4-D on roadsides. Our program consists of making two applications of 2,4-D on the medians and roadsides each year for a period of two to three years. In succeeding years applications are made to those areas which warrant treatment.

In 1962, we sprayed 2,167 acres or 411 of a total 551 median miles and 1,416 acres of roadside. A second application of 2,4-D was applied to those areas which warranted treatment. As the figures show, we have treated nearly all of the median areas and 404 of our 4,813 miles of roadside.

The years previous to 1962, low volatile ester of 2,4-D was used. At the initiation of a program for spraying roadsides it was decided that a chemical with a greater safety factor was required. Therefore, the amine form of 2,4-D was chosen to be used. The results obtained from 2,4-D amine were very good in the herbicide action as well as the confinement of the chemical within the treated area.

Sterilant work has been confined to that performed by maintenance personnel in the districts. Our recommendations have been to use dry granular forms around sign posts on flat areas and liquid forms to the joints of concrete pavements. We do not recommend use of sterilants around guard rails. Our experience under experimental conditions has been that sterilants around guard rail only leads to erosion problems. This has led our thought to the use of maleic hydrazide around guard rail.

This previous fall, we applied MH-30 and 2,4-D amine around 12.5 miles of guard rail. We expect this treatment to relieve our grass mowing problems around guard rail to a large extent. We are giving serious consideration to combining the following chemicals in one spring application to all guard rail areas containing good stands of grass:

Dacthal W75 - for control of annual grassy weeds
2,4-D amine - for control of broadleaf weeds
MH-30 - for grass growth inhibition

We will initiate an MH-30 program in the spring. The following is a list of "area types" where this chemical could be used:

A. Roadsides - Aesthetically and for safety purposes roadsides would most likely not require any mowing except where there is an invasion of annual grasses.

   1. Areas adjacent to developed areas or cultivated fields where the mowing should be performed but is too costly and/or inaccessible for mowing.

2. Bridge abutments
3. Guard rail
4. Inner interloops of interchanges
5. Mowed roadside areas in general where good turf exists.

B. Medians - We do not recommend the spraying of these areas as a general rule except areas that are costly to maintain. In these areas our mowing standards would still be maintained for good appearance, but the frequency of mowing would be reduced under good absorption conditions. The area recommended is:

1. Curbed medians

Our experimental experience with maleic hydrazide has given us information worth mentioning. Our fall, 1960, applications to median areas were quite successful and very encouraging. The application in the fall of 1961 at 6 lbs. per acre of MH-30, was not a qualified success. Red fescue grass was killed considerably in the treated area. This can be explained perhaps by two factors. First, we had a very dry fall and early spring. Second, an overdose of MH-30 might have been given to the plants by a truck moving too slow.

Application of MH-30 at 4 lbs. per acre in the spring of 1962 gave excellent growth retardant results on good stands of K-31 fescue. Some foxtail was apparent in one area in late summer, but we do not think this shall be much of a problem in the future when drought is not experienced, for our usually good stands of grass were thinner than normal.

The work which we have performed on selective weed control in woody plant beds has been very limited. This year, 1963, we expect to start programs using Dacthal and Simazine for control of weeds in our shrub beds.

EQUIPMENT

The development of equipment for highway roadside weed control work has not kept in stride with the advance of demands for chemical weed control. Perhaps, this has not been a fault of the equipment manufacturer, but the lack of demand until the last few years for equipment which will spray distances from 30-100 feet and greater, with little hazard of drift.

An effective "Chemical mowing" program involves well designed equipment maintained at peak performance. For example, Maleic Hydrazide is a chemical which, to be effective as a grass growth retardant, must be present in each plant at concentrations of 15-50 P.P.M. (dry weight basis of roots). Therefore, the equipment must have such a fineness of design and operating performance as to apply the spray material evenly at varying distances.

Our equipment consist of the following:

1-Skid-mounted power sprayer with 500 gal. rust proof tank and 25 G.P.M. 700 lb. pressure pump for use with boom and broadcast spray nozzles.

AND

33 ft. left hand road-side mounted boom, hydraulically controlled.

1-Skid-mounted power sprayer with 1000 gal. rust proof tank and two stage centrifical pump, capable of producing 100 G.P.M. at 190 P.S.I. and six broadcast spray nozzles.

1-Trailer drawn power sprayer with 200 gal. rust proof tank and 10 G.P.M. 500 lbs. pressure pump with 200 foot length of hose and adjustable spray gun.

The first two units were designed for broadleaf weed control on medians and roadsides. Brush control by foliage treatment is done by the 200 and 1000 gal. sprayers.

COSTS

Since we have complete control over our broadleaf weed control and do all work by specially trained landscape personnel, our cost figures are very low. The below figures for the year 1962, are for average cost per acre for the entire state and they include labor, equipment, material and overhead.

Medians (1½ lbs. of 2,4-D low volatile ester)	- $2.88 per acre
Roadsides (2 lbs. of 2,4-D amine)	- $2.27 per acre

CONCLUSION

The use of chemicals in overall vegetative maintenance is a tool which can be used to lower equipment and labor costs, improve driving safety and appearance and thereby obtain a much higher maintenance efficiency. We are starting to obtain figures which prove that the use of chemicals are lowering the cost per acre to maintain highway vegetative areas in Maryland.

Chemical Control of Japanese Fleeceflower (Polygonum cuspidatum Sieb.)

John F. Ahrens[1]

Although formerly a cultivated ornamental plant used for hedges and screening, Japanese fleeceflower (also called Japanese knotweed and Mexican bamboo) largely is considered a weed today. It is found in backyards and along roadsides throughout the Northeast. A herbaceous perennial, fleeceflower spreads by creeping stems and is said to be resistant to most herbicides. However, the Connecticut State Highway Department has controlled it with heavy rates of erbon applied to run-down on the foliage when in full leaf. Our tests in 1960 and 1961 confirmed the effectiveness of erbon. Repeated applications have been required, however, to kill the sparse regrowth.

More recently 2,3,6-TBA and other polychlorobenzoic acids also have been found to be effective against fleeceflower. Foliage applications of polychlorobenzoic acids in 1961 completely killed stands of fleeceflower in spot applications at this Station. The objective of our 1962 trials was to determine whether these herbicides could be used to prevent growth of fleeceflower when applied at emergence or after cutting, thus eliminating the unsightliness of dying vegetation. This report summarizes our results from limited tests in 1962.

Materials

Three herbicides were tested in the greenhouse and in the field during 1960 and 1961. The herbicides are listed as follows:

a) the dimethylamine salt of 2,3,6-trichlorobenzoic acid in products called Benzac 1281 (Amchem) and Trysben (DuPont) both containing 2 lbs. of the acid equivalent per gallon.
b) Polychlorobenzoic acids in a mixture obtained under the name of Zobar (DuPont) and containing dimethylamine salts of 2,3,6-trichlorobenzoic acid (15.2%), tetrachlorobenzoic acids (20%) and other polychlorobenzoic acids (12.5%), with a combined acid equivalent of 4 lbs. per gallon.
c) Erbon [2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate], in a material named Novon Concentrate (Dow) containing erbon (30.5%) and related compounds (10.8%) with 4 lbs. of erbon per gallon.

Procedure and Results

Greenhouse Trials:

Erbon and 2,3,6-TBA were applied to the soil of crocks of fleeceflower that had been growing untreated for a year. In a 70°F. greenhouse these plants broke dormancy about February 20, 1962 and the soil was treated on March 2, 1962 with measured amounts of herbicide. Only a few shoots had emerged in the crocks

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at the time of treatment. Erbon was applied at rates of 44, 176 and 528 lbs. per acre and 2,3,6-TBA was applied at rates of 20 and 60 lbs. per acre based on the surface area of soil in the crocks (approx. 1.1 sq. ft.).

Three weeks after treatment growth in the untreated crocks was about a foot high with 10 to 12 shoots. The crocks treated with 2,3,6-TBA at 20 lbs. per acre contained about the same number of shoots but these were severely deformed and stunted. Terminal buds and leaves were dead on most of these shoots and within 2 months all shoots were dead. No shoots emerged from the crocks treated with 2,3,6-TBA at 60 lbs. per acre. At 44 lbs. per acre erbon only depressed the growth of shoots slightly, while at rates of 176 and 528 lbs. per acre erbon caused about a 60 per cent reduction in numbers of shoots and severe necrosis of the leaves. Plants in crocks treated with the higher rates of erbon were dead within three months. On the basis of this test it was decided to test further the effects of soil treatments in the field.

Field Trials:

Applications of polychlorobenzoic acids were made at three different locations during May and June of 1962. The required amounts of herbicide in one gallon of solution were applied on 10' x 10' plots, with one, two or three plots per treatment. Emergence of fleeceflower in north central Connecticut was first observed during the third week of April 1962. The treatments and results are summarized in Tables 1 and 2.

Treatments on soil and emerging shoots were made on May 3 at two locations, when about 10 per cent of the shoots had emerged and were up to 1 foot tall. Observations were made a month after treatment and existing stems then were cut back to the soil line. A month after treatment, fleeceflower shoots were 4 to 5 feet tall in the untreated plots. Although growth was evident in all treated plots at this time, the shoots in plots treated with 2,3,6-TBA or the mixture of polychlorobenzoic acids were severely deformed, showing the same symptoms of injury as those observed with 2,3,6-TBA in the greenhouse. However, the deformed shoots reached a height of 2 to 3 feet in a month's time and required cutting. When these deformed shoots were cut to the soil line only an occasional stunted shoot arose the rest of the season. These shoots never grew more than a foot tall.

Applied on May 3rd at 240 lbs. per acre, erbon caused only about a 30 per cent reduction in shoots a month later. Following cutting a 60 per cent reduction of fleeceflower shoots was evident in the fall, but shoots that escaped erbon injury grew to a normal height at 6 feet.

Treatments in late May or June were made either on the soil following cutting of all stems to the soil line, or on the existing foliage and soil. A month after treating, the treated foliage and stems and any regrowth from the cut plots was again cut to the soil line. As shown in Tables 1 and 2, soil applications of the chlorobenzoic acid materials were very effective in preventing regrowth of fleeceflower. Even at the lower rates of application the sparse regrowth never exceeded a foot in height. Complete control of regrowth was achieved by treating the foliage and soil and cutting back the dead foliage a month later. However, pending further observations in 1963, the soil applications following cutting also appear promising.

Table 1. Effects of Erbon and Polychlorobenzoic Acid Treatments on Injury to Japanese Fleeceflower One Month After Treatment

Herbicide	Rate lbs./A	Method and Date of Application: On soil and emerging shoots	On soil after cutting shoots		On foliage and soil	
		5/3[1]	5/26[1]	6/30[1]	5/26[2]	6/30[2]
2,3,6-TBA	20	-	85	-	-	-
	30	80	90	100	95[3]	95[3]
Polychloro-benzoic acid mixture	40	-	85	100	-	-
	60	85	90	100	95[3]	95[3]
Erbon	240	30	50	60	-	90[3]
Check		0	0	0	0	0

1 Percentage reduction of growth compared with untreated controls.
2 Percentage kill of existing foliage.
3 No new sprouts were evident.

Table 2. Effects of Erbon and Polychlorobenzoic Acid Treatments on Percentage Reduction of Japanese Fleeceflower in Fall of 1962[1]

Herbicide	Rate lbs./A	Method and Date of Application: On soil and emerging shoots	On soil after cutting shoots[2]		On foliage and soil[2]	
		5/3	5/26	6/30	5/26	6/30
2,3,6-TBA	20	-	95	-	-	-
	30	99	100	100	100	100
Polychloro-benzoic acid mixture	40	-	90	95	-	100
	60	99	100	95	100	100
Erbon	240	60	60	75	-	95
Check		0	0	0	0	0

1 All growth cut to soil line 1 month after treatment.
2 Shoots 5 to 6 ft. tall when cut or treated.

As a soil treatment in late May or June, erbon was considerably less effective than the chlorobenzoic acid materials. An application of erbon on the foliage and soil in June killed the foliage and reduced regrowth following cutting by 95 per cent. Past trials with erbon indicate that this regrowth would have to be treated. However, further observations of these plots must be made in 1963 to determine whether the underground portions of fleeceflower were killed by the 1962 treatments.

The following observations also were made in the plot areas:

(a) Ornamental junipers growing 3 feet from polychlorobenzoic acid plots were uninjured but fleeceflower growing there was greatly inhibited, (b) a large elm (12" DBH) growing in a plot treated with erbon at 240 lbs. per acre was uninjured as was a sugar maple (4" DBH) in a plot treated with 2,3,6-TBA at 20 lbs. per acre, (c) a border of at least five feet is required between check plots and chlorobenzoic acid plots, since translocation of these herbicides apparently occurs through underground portions of the fleeceflower. Erbon did not appear to injure adjacent untreated fleeceflower plants, (d) the polychlorobenzoic acid mixtures at 40 lbs. per acre did not kill established ground cover of orchardgrass.

Summary

Preliminary tests were conducted with soil and foliage treatments of erbon and polychlorobenzoic acids for the control of Japanese fleeceflower.

Soil treatments of 2,3,6-TBA or a polychlorobenzoic mixture during emergence or after cutting of fleeceflower in May or June greatly inhibited initial growth and regrowth after cutting. Treating the foliage and soil in May and June with 2,3,6-TBA or a polychlorobenzoic acid mixture resulted in a complete inhibition and probable root kill of fleeceflower following cutting of the dead foliage. Erbon at 240 lbs. per acre was more effective with a foliage and soil treatment than with soil treatments alone. Further observation and testing is required to determine second year effects and minimum dosage requirements for kill with the chlorobenzoic acids and erbon.

TRIALS TO DETERMINE IF MH-30 CAN BE USED IN A ROADSIDE MAINTENANCE PROGRAM IN NEW YORK STATE

E. W. Muller [1]

This report concerns the 1962 trials of MH-30 in District 6, New York State Department of Public Works.

In 1961 tests were conducted on state highway roadsides in various sections of New York State to observe the results of MH-30 on various species of grasses. Observations of these tests indicated that, while most treated grasses showed only a 20-25% reduction in the length of the leaf, dramatic results were obtained through elimination of seed heads. Based on these observations it was decided that relatively large area applications of MH-30 should be made in the spring of 1962 in selected districts to attempt to determine where MH-30 fits into the overall roadside maintenance program in New York State.

Trial applications were broken down into three major categories; (1) Overall application to cover all grass areas from edge of pavement to right-of-way line; (2) Grass areas immediately under guide rail; (3) Medians.

TRIALS ON GENERAL TURF AREAS WITHIN RIGHT-OF-WAY

The mowing schedule for secondary state highways is quite flexible. The first cut is usually made before the end of June and is generally limited to one or two swaths with a sickle bar mower back of the edge of the shoulder on flat or on fill sections and to a maximum of one swath back of the ditch line on cut sections. A complete mowing of the entire right-of-way, excluding heavy cuts or fills that cannot be machine mown is usually done in August and September.

The highway roadsides in District #6 are generally treated with 2,4-D once a year to control weed and volunteer brush growth. Chemical treatments under guide rail and around posts and signs keeps these areas free of vegetation to eliminate all hand mowing.

To determine if the use of MH-30 on these secondary highway roadsides would result in a satisfactory appearance without mowing for the entire growing season, extensive trial applications on selected highways were made.

Time of Application

Mid-May 1962

1. Landscape Architect, New York State Department of Public Works District 6, Hornell, New York

Rate of Application

1-1/3 gal. MH-30 plus 1/2 gal. (2 Lb. acid equivalent) of 2,4-D in 50 gal. of water per acre.

Area Treated

15 center line miles on which the entire R.O.W. was treated. Untreated checks were left at selected intervals.

Equipment

600 gal. capacity roadside sprayer using OC nozzles. R.O.W. was sufficiently narrow to enable equipment to reach the R.O.W. limits with one pass on each side.

Condition and Composition of Turf Cover

Old, well established cover. The primary grass was Orchard Grass with varying amounts of Red Fescue, Kentucky Bluegrass, Canada Bluegrass and Quack Grass.

Weather Conditions

Clear with temperature over 70° at time of application. No rain fell for the first two days following application.

Observations

1. The length of leaf in treated areas was 20-25% less than in untreated checks.

2. Seed heads were eliminated on Orchard Grass and Creeping Red Fescue. In untreated checks, the seed heads on Orchard Grass were 36 inches tall and on Red Fescue 12-18". In the case of Kentucky Bluegrass some seed heads were formed depending on how far advanced the plants were when treated. It was observed that some seed heads were just emerging from the sheath on Kentucky Bluegrass at the time of application. These continued to develop to their normal height. This would indicate that we were late in applying the material.

3. By July 24th, Orchard Grass was beginning to return to normal rate of growth for that time of year except that no seed heads were formed. However, on September 6th the grass was not unduly long and frosts a couple of weeks later made any mowing unnedessary.

4. Very pronounced browning occurred on Orchard Grass but looked no worse than the grass mowings left on an adjacent area receiving normal maintenance.

Conclusions

1. The treated secondary highways were judged to be satisfactory at the end of the growing season even though no mowing had been performed during the season. These unmowed, treated areas looked approximately the same as other secondary highways that had received the conventional mowing. Conversely, untreated check plots were judged decidely unsatisfactory with seed heads on Orchard Grass 30-36 inches tall, those on Red Fescue 12-18 inches tall and an assortment of weeds at various heights.

2. Timing is very important. Due to the rapid growth of the grasses in May and June, spring applications were limited to a very short period. To extend this application period in order to make treatment of large acreages practical, it was decided to make some fall season trials. Results of these trials will not be observable until spring and summer of 1963.

TRIALS ON TURF UNDER GUIDE RAIL

Maintenance of the shoulder area under guide rail is a continuing problem. Hand mowing to control the height of vegetation has been replaced in District 6 by chemical control, using either soil sterilants or systemic herbicides, such as Dalapon or Amino Triazole, to eliminate all vegetation in the treated area. Experience over a number of years has revealed shortcomings with each of these treatments. Soil sterilants tend to leach or otherwise move from the treated strip causing damage to the turf cover on the fill slope immediately back of the guide rail. Systemic treatments eliminate the danger of movement of the chemical from the treated area but affect only those plants growing at the time of treatment, thus giving something less than complete one year control. Also, some people consider the brown or sterile strip to be unsightly.

Trial applications of MH-30 were installed under guide rail to determine if a turf cover could be maintained at a height that would not require mowing.

Time of Application

Mid-May 1962

Rate of Application

1-1/3 gal MH-30 plus 1/2 gal. (2 lb. acid equivalent) of 2,4-D in 50 gal. of water per acre.

Area Treated

26-1/2 center line miles of one, two and three year old highways that had never previously received any kind of guide rail treatment. One of these trial sections was located in a median and was 1-1/2 miles in length. Untreated checks were left at selected intervals.

Equipment

600 gal. capacity roadside sprayer using two OC nozzles that placed the spray pattern under the beam type guide rail.

Condition and Composition of Turf Cover

The turf cover consisted mainly of Red Fescue with varying percentages of Tall Fescue, Perennial Rye-grass, Orchard Grass and Kentucky Bluegrass.

Weather Conditions

Clear with temperature over 70° at time of application. No rain occurred for five or more days following application.

Observations

Results were very satisfactory. In mid summer, grass that had been mowed once adjacent to the treated area was the same height as that under the guide rail and this relationship continued for the balance of the season.

In the case of the one median installation, the rest of the area was mowed three times during the season. In late September, the grass under the guide rail was perhaps an inch and a half longer than the rest of the area but this difference could not be detected by the passing motorist.

Conclusions

On the basis of one year's trial, it appears that MH-30 may be a desirable herbicide to use under guide rail, particularly on recently constructed highways. Its use permits retaining an attractive tuff cover which stabilizes the soil and reduces the possibility of erosion, without costly hand mowing or producing what some people consider an unsightly brown strip.

It is planned to treat these identical roads over several growing seasons with MH-30 to see if its continued

TRIALS ON MEDIANS

The treated median was slightly depressed for drainage but was easily maintained with gang-reel type mowers. Shrubs were planted on curves for headlight glare control. With the exception of these shrub areas, the median usually received one 2,4-D application per season. In 1961, it received eleven mowings.

We were interested in determining whether this amount of mowing could be appreciably reduced while retaining a satisfactory appearance.

Time of Application

Mid-May 1962

Rate of Application

1-1/3 gal. MH-30 plus 1/2 gal. (2 lb. acid equivalent) of 2,4-D in 50 gal. of water per acre.

Area Treated

Seven center line miles of median 30 ft. wide. Untreated checks were left at the shrub-planted curves.

Equipment

600 gal. capacity roadside sprayer using OC nozzles. To obtain even coverage only half the median was sprayed with each pass of the equipment.

Condition and Composition of Turf Cover

Old, well established cover consisting mainly of Kentucky Bluegrass and Red Fescue with some Red Top and other grasses.

Weather Conditions

Clear with temperatures in the 70's and no rain occurring for more than a week following application of the chemical.

Observations

1. Dwarfing or stunting of leaf blade growth amounted to 20-25%. However, seed heads were not formed which accounted for the great difference in appearance between the treated areas and the checks.

Observations (Continued)

2. The grass, consisting mainly of Kentucky Bluegrass and Creeping Red Fescue, began to come out of the treatment around mid-July, indicating that, in this situation, two months was the effective length of treatment. Some minor members of the plant population, like Red Top, began to send up seed heads before mid-July but these were not enough to affect the overall picture of the treatment holding to mid-July.

3. There was a very marked infestation of Foxtail (Setaria Spp.) in the treated areas that was not observed in the check areas. Whhther this was due to the maintenance of former years (probably unlikely), to the use of maleic hydrazide or to the excéptionally dry summer is not known.

Conclusions

At least five mowings were eliminated by the treatment. However, both last year and this year some difficulty was experienced in bringing the medians back to the condition they were in originally. Sickle bar mowers had to first go over the area and cut the seed heads produced by Red Top, Foxtail and other annual grasses and a few weeds because the gang reel mowers were unable to cope with them. This extra expense makes it questionable as to whether the use of MH-30 is economically practical where relatively inexpensive gang reel-type mowing is normally employed. If correct timing could be used to get the reels on early enough so that the sickle bars were not needed, then this added expense would be eliminated. However, when an operation depends on critical timing, its value is very much decreased since too often it is difficult to schedule due to the pressure of other work. Where a deep ditch median section prevails, eliminating the possibility of using gang reel type mowing, the MH-30 treatment would appear to have a place.

A Comprehensive and Effective

Highway Weed and Brush Control Program on State Highways

by Kenneth R. Mattern
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for presentation at
Northeastern Weed Control Conference
New York City
January 1963

The word "comprehensive" is defined "as embodying many things"; "inclusive"; "including a great amount". In this instance it does not imply that every single detail of a weed and brush control program has been thought of or that there have been items that have not been overlooked. It does mean, however, that the program developed for the Connecticut State Highway Department, and as practiced on the approximately 3500 miles of State-maintained roads, is broad in numerous aspects. Also, it has been developed over a period of several years in such a manner that improvements may be included and an even broader perspective can be developed.

The establishment, maintenance and control of valuable, functional vegetation within the State's highway rights-of-way is an ever increasing, essential and important activity. The demand for more high-speed traffic arteries, with the tremendous increase in traffic volume, is ever with us. And these arteries must be safe, efficient, and economical to maintain; they must be comfortable on which to travel; the environment must be healthful; for it is important that both the highway user, the abutting owner, and the employee not be subjected to allergy producing and toxic vegetation; and very important, the aesthetics must be such that each and every citizen can enjoy.

More and more the demands are made, and rightly so, that our roads be as perfect as possible -- the pavement must be flawless, the drainage systems well constructed, the marking system must be adequate, the safety factors shall be evident, and the roadsides must be desirable.

We all know that the roadway and roadside, with all the necessary appurtenances, must be molded together to give us the "complete highway" -- the road that we can travel safely, efficiently, comfortably through healthful, beautiful countrysides. And also we know that after these roads are built, it is important that they be maintained efficiently and economically.

The areas outside of the travel way are receiving more and more attention. These areas are becoming larger and larger -- our wider rights-of-way, with this vast acreage, are important segments in a highway system. It is these areas that contain our heavy fills and cuts, our separations of traffic lanes, our buffer zones from abutting properties, our functional plantings and many of our safety factors. These too, are the areas where the beauty of our countryside is made evident.

The most dominant feature in these roadside areas is vegetation -- plant growth that must be established, controlled and maintained. It is the maintenance and control of this vegetation where, in Connecticut and numerous other states throughout the northeast, the fairly recently developed chemical herbicides are becoming such important factors. These chemical tools are now a tremendous boon to the public servants charged with the responsibility of building and maintaining our highway systems.

Connecticut started its use of these materials a number of years ago. As in other states, it began as a program of protection of the health of our employees -- those men who are such a vital factor in our maintenance work. To eradicate the toxic growth (poison ivy and poison sumac) that occurred so abundantly within our bounds, and with which these men were in direct contact, was our goal.

Further, it was made evident that other plant materials, such as ragweed, were a serious menace to the health and welfare of our communities. Mowing these weeds, a difficult and expensive proposition, did not prove adequate. Now, with the sum of 50 cents per roadside mile for chemical materials, plus a safe, efficient but simple method of application, we are keeping these noxious weeds in check.

These are but a few examples of the types of advantages derived from these chemical tools that help promote the health and safety programs of our Department.

We now have a fairly comprehensive program with the use of these materials throughout the highway system. It is designed to accomplish numerous items of work in the interest of economy and efficiency in operations, as well as promote the safety, health and general welfare of the public and improve the appearance of our highways.

Our activities begin in the early spring and continue uninterrupted throughout the entire growing season and on into the dormant period, whenever we do not have climatic or weather conditions that make it impractical to operate.

This program is as follows:

1. The control of broadleafed weeds in established turf occurring in median strips, interchange areas, and locations where intensive mowing is performed.

Treatment Used:

The low volatile esters and amine salts of 2,4-D have been used almost entirely for this purpose. Application rate of 1.5 pounds acid per acre has given effective control of most weeds at low cost.

2. Roadside application of herbicides to eliminate early herbaceous weeds and improve the turf areas.

Treatments same as above.

3. Seasonal removal of grass and weeds under guide rails, at the base of sign posts, delineators, etc.

Treatment Used:

Combinations of 2,4-D low volatile esters or amine salts, dalapon and simazine have been very effective for control of plant growth under guide rails. Dalapon is a very effective grass killer, while 2,4-D controls the broadleafed weeds and simazine prevents the development of new seedlings.

Application Rates:

Eighteen pounds of Dalapon, 2 pounds of 2,4-D and 3.2 pounds of Simazine per acre applied in late April has proved most effective.

4. Eradication of poison ivy and poison sumac.

Treatment Used:

Amine salts or low volatile esters of 2,4-D plus 2,4,5-T in combination have proved most successful at 1 lb. and 1/2 lb. active in 50 gallons of water.

Spraying is carried out when plants are in full leaf and actively growing, in Connecticut this is between June 1 and September 15.

5. Control of ragweed and other annual weeds that develop during the summer months.

Treatment Used:

In Connecticut 2 pounds 2,4-D amine salt per acre is utilized from early July through August. Spraying of ragweed to prevent pollen dispersion must be done before flowering has started. In our area ragweed starts to flower about the middle of August.

6. Late summer application on brush regrowth.

Treatment Used:

The combination of 2 pounds 2,4-D and 2 pounds 2,4,5-T in 50 gallons of water applied between August 15 and September 15 gives good results and the danger of injury due to drift is at a minimum and time of brown out before fall coloring is greatly shortened.

7. Basal spraying of cut brush and trees.

Along narrow roads brush and trees readily create a hazard. The problem is to remove them at a minimum cost and with minimum labor, while preserving roadside beauty to the maximum degree.

Treatment Used:

Stump treatment involves the application of 2,4,5-T low volatile esters, 20 pounds acid equivalent per 100 gallons of spray in No. 2 fuel oil. This is generally carried out during late fall and winter.

8. Soil sterilization under guide rail with bitumen cover.

Treatment Used:

Simazine (wp) at 11.2 pounds per acre or diuron at 16 pounds per acre have proved effective for this use. Either compound has given successful weed control for at least 3 years and, in many cases, for longer periods along Connecticut highways. Placing a layer of tar or bitumen over the treated area prolongs the life of the treatment.

9. Selective weed and grass eradication in functional plantings.

Along highways, shrubs or trees are often planted to reduce headlight glare, create a buffer zone or to hide something distracting. While these plantings are becoming established, they are often hand weeded or mowed. A great amount of this hand labor can be eliminated by using carefully applied herbicides.

Treatment Used:

Two types of herbicides are used for this operation. Pre-emergence and post emergence in combination have given good results. Half pound of amitrol and 1.6 pounds of simazine per acre is the dosage now used.

10. Continued research and activity with growth inhibitors to reduce mowing operations.

Treatment Used:

Grass growth inhibition is accompolished by using MH-30T at 4 pounds per acre. Further work in this particular field of research is presently going on.

We are not remaining stagnant in our thinking. As new materials are developed and more efficient techniques of application are discovered, it is our intent to evaluate them and use them in the most advantageous way possible.

We look forward to the day when at least 75% of our vegetative maintenance will be performed with chemicals. With more selective materials, higher concentrations, further developments with growth inhibitors and pre-emergence sprays, we will be able to pinpoint a material for a specific use.

To summarize, the weed control program in Connecticut is based on the health and safety of our people, the economy of operations and the beauty of our countryside with the judicious and selective use of agricultural chemicals.

HERBICIDE PROGRAM ON NEW YORK STATE HIGHWAYS

BY
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The use of herbicides in the maintenance program on state highway roadsides in New York has been covered in detail in papers presented at this Conference in past years.

Briefly, our herbicide program falls into four major categories: Broadleaf Weed Control; Control of Vegetation in the Line of Guide Rail and Around Posts and Signs; Brush Control; and Poison Ivy Control.

Application is made by regular district maintenance personnel trained in this work and supervised by the district landscape architect. The equipment used has been purchased specifically for the application of herbicides and is assigned to each of the ten districts. In order to insure uniform practices, the Main Office of the Landscape Bureau has prepared a Herbicide Manual. This manual is written for supervisory personnel responsible for the application of herbicides to roadside vegetation and covers the herbicides used, the objectives of each type of application, the necessary precautions and detailed recommendations covering chemicals, rates, timing and related information.

A summation of work accomplished in 1962 and unit costs follows. Cost figures include labor, material and equipment at established rental rates.

Broadleaf Weed Control

Total Acres Treated	14,760
Average Cost per Acre	$ 3.74

Comments: Our basic program is the application of 2 pounds of 2,4-D acid as a low volatile ester in 50 gallons of water per acre once a year. While this does not completely eliminate all weeds, it does greatly reduce the number of the weeds and consequently reduces the number of mowings required in certain areas. Treatment each year for several years has resulted in roadsides free of perennial weeds. Interest in this program is increasing as the end result of improved appearance with less mowing becomes apparent.

Control of Vegetation in Line of Guide Rail and Around Posts and Signs.

Total Miles of Guide Rail Treated 4145
Average Cost per Treated Mile $17.40

Comments: Our program utilizes materials applied directly to the ground as well as those applied to the above ground parts of growing plants. The cost figures above are weighted averages of all treatments. Results are generally good and all hand mowing in these hard to mow areas has been eliminated.

Brush Control (Stem-Foliage)

Total Acres Treated 316
Average Cost per Acre $28.30

Comments: Our basic program calls for 2 pounds, 2,4-D acid and 2 pounds 2,4,5-T acid as low volatile esters in 100 gallons of water applied to brush under two feet in height. This restriction in height of brush is to minimize the unsightly "brown-out" resulting from this treatment.

Brush Control (Stump and Basal)

Total Acres Treated 66
Average Cost per Acre $74.50

Comments: We use the general industry standard of 4 pounds, 2,4-D acid plus 4 pounds 2,4-5-T acid as low volatile esters in 100 gallons of oil except on brush listed as resistant to 2,4-D where 8 pounds of 2, 4, 5-T acid in 100 gallons of oil is recommended. While the treatment is very effective and "brown-out" eliminated, the application is slow and unit costs are high. Despite the high cost we believe this treatment is still justified to prevent regrowth of cut brush.

Poison Ivy Control

Poison Ivy was treated on 1887 miles of highway.

Our recommended treatment is a foliage application using Amino Triazole at the rate of 2 pounds active ingredient in 100 gallons of water.

Results are excellent but a follow up application is recommended to kill any plants escaping the initial spraying.

We now have had five years experience in a coordinated, statewide program of applying herbicides to state highway roadsides. This background of experience indicates that, while our recommendations for the various uses of herbicides have become somewhat standardized, there is still much to be learned in the field of herbicidal control of vegetation on highway roadsides. In our opinion some of the major areas needing further research and development are as follows:

Equipment

Thanks to the efforts of the chemical industry and equipment manufacturers over the last few years, great strides have been made in developing equipment designed specifically for applying herbicides to the extensive grass areas found on modern highway roadsides.

While this equipment is a big improvement over the equipment available in the past, I think that everyone will agree that a great deal more development work is needed to produce equipment capable of applying a carefully controlled application over the wide rights of way and the varying road slopes found on highway roadsides, at a reasonable rate of speed.

Equipment for applying herbicides to control vegetation in the line of guide rail and for brush control is generally satisfactory to apply the chemicals currently in use.

Weed Control

The ideal herbicide for roadside weed control should (1) have a wide efficiency spectrum so that a single application would kill all broadleaf weeds commonly found on highway roadsides; (2) Be safe to use and non-volatile to eliminate damage to vegetation adjacent to the treated area; (3) Economical.

We realize that this is quite a large order but the efficiency of our broadleaf weed control program is restricted by the weakness of 2,4-D on the first two points. For instance, the inability of 2,4-D to control milkweed, bouncing bet and bedstraw, all commonly found on our roadsides greatly reduces the efficiency of the program. It is true that herbicides are available to control weeds resistant to 2,4-D but their cost is too high to permit widespread use in a general weed control program. Volatility is a serious problem and restricts our use of 2,4-D in urban areas and eliminates weed control altogether in vineyard and truck crop areas.

Control of Vegetation in Line of Guide Rail

Our program to date has been the elimination of all vegetation in a 3 foot wide strip through the line of guide rail by the use of herbicides applied to the soil as well as herbicides applied to the above ground parts of plants. While the program is successful, certain problems have shown up. Soil sterilants applied under the line of guide rail on a well drained shoulder tend to move down the backslope causing damage to the turf and opening up the damaged area to possible erosion. The use of herbicides applied to growing plants such as Dalapon or Amino Triazole eliminates all danger from movement but affects only those plants growing at time of treatment. Two treatments a year may be required to kill annual weeds and grasses seeding into the area after the initial treatment.

In areas where elimination of all vegetation is desired, the ideal herbicide would remove all vegetation with a single application for at least one year at a reasonable cost and without danger of movement of the herbicide to areas designed to be kept in grass.

There are many areas where a stand of grass is preferred in the line of guide rail to reduce the possibility of erosion and for appearances. In such areas a herbicide is required that would eliminate weeds and keep the grass at a height that would not need mowing for the duration of the growing season.

Growth Retardants

There is still a great deal of research and development to be done in this relatively new field, both in materials and application and equipment.

Our experience to date indicates that any herbicide applied as a growth retardant to turf areas, to be ideal, should also include control of weeds existing at time of application as well as some type of pre-emergent herbicide to control the growth of annual weeds and grasses germinating after the application has been made. It should be effective on all grass species commonly found on roadsides and should be capable of being applied in both spring and fall seasons before being considered as practical for use on a large scale. It should have no detrimental effect on the quality of the turf cover or cause an unsightly appearance to the treated areas.

There is one final point to make. Highway Department personnel are not specialists in herbicides nor do they have the time, training or facilities to conduct scientific experiments and evaluations of all of the herbicides now available. We must depend on the chemical industry to test and evaluate a new product until it reaches a stage of development where the manufacturer is convinced it has a definite place in a roadside maintenance program.

It is our opinion that the use of herbicides in roadside maintenance programs is just beginning and will continue to expand as new chemicals, techniques and equipment become available.

PENNSYLVANIA DEPARTMENT OF HIGHWAYS SPRAYING PROGRAM - 1962

R. E. Chamberlin[1]

Herbicide spraying in Pennsylvania was expanded considerably during the past year. That was particularly true of the use of soil sterilants. This material was used on areas where all vegetation is objectionable, such as concrete divisors, paved waterways, around highway signs, storage yard fences and especially on a two-foot wide strip immediately beneath guard fences.

A total of 65,500 pounds of soil sterilant was purchased and used. The material was applied at the rate of 30 pounds per acre. In the case of guard fence treatment, this averages about 7½ pounds per guard fence mile. The cost was approximately $25.00 per mile of guard fence for material and application. From past experience, it has been determined that this gives effective control for one growing season and extending to partial control the second year. Where areas had previously been treated or sprayed, about one-half the amount, as indicated for the first application, was used.

Maintenance forces have been particularly well pleased with this program as it has eliminated a great deal of expensive hand mowing operations and assisted in keeping drainage channels open. It also has contributed to the appearance of the highways where applications were made. This is especially true of the concrete divisors which become ragged looking from the occasional grass and weed stems which appear in the seams at the top of the divisor.

For foliage spraying, a total of 18,000 gallons of 2,4-D and 2,4,5-T was purchased and used. (This is exclusive of contract spraying.) Specifications for the material required 2 pounds acid equivalent of each of the above per gallon. Herbicide was mixed with water at the rate of one gallon per hundred gallons of water. It was used as a roadside foliage application from the edge of the shoulder to the right-of-way limits, particularly along secondary roads. The width of area sprayed varied, but averages about 8 to 10 feet. The material was applied at the average rate of about 100 gallons of mixture per mile, both sides of the road. Regulations provided that no vegetation be sprayed to a height exceeding five feet. Control also was exercised to prevent any spraying of material necessary for erosion control or of any plantings of crown vetch, shrubs, vines or deciduous or evergreen trees planted or maintained by the Department, or any desirable individual trees growing along the roadsides.

In addition to the above, contract spraying with the same kind of material was accomplished on a little more than 3,500 miles. With contract spraying, two applications were made. The first one beginning about June 1st and the second after July 15th. There were five contracts involved and the average cost was $20.00 per mile for the two applications on both sides of the road.

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[1]Chief, Division of Roadside Development, Pennsylvania Department of Highways

Only one application was made in the spraying with Department forces. Slightly heavier applications were used than in contract spraying and this was reflected in the cost which averages about $12.00 per mile for the one spraying on both sides of the road.

The Department also purchased and used 1,960 gallons of 2,4-D (4 pounds acid equivalent per gallon). It, likewise, was mixed at the rate of one gallon of herbicide to 100 gallons of water and applied 50 - 60 gallons per acre on medians and interchanges for weed control. On several miles, it was made a part of the experimental application of MH-30 in a medial area.

A total of 455 gallons of 2,4,5-T (4 pounds acid equivalent per gallon) was purchased and used. This was applied primarily as stump treatment in connection with the program for cutting and removal of trees and brush for sight distance and highway safety.

Criticisms of the foliage spraying program, of course, were received. These for the most part were confined to objections concerning "brown-out". In a few instances the criticisms were justified due to an unsightly condition resulting from improper spraying by certain crews. There were a few cases where material was sprayed higher than the regulations provided, thereby causing this unfavorable public reaction. It is realized that while brush and weeds are dying, the appearance of the sprayed area is somewhat undesirable and the condition has been magnified during the past summer owing to the drought. However, the end result in terms of safety and appearance is so satisfactory that most people realize that the temporary poor appearance is a small price to pay. Certainly roadside rights-of-way covered with grass, the growth of which is promoted by spraying, are much more attractive than those overrun with weeds, brush and plants of all description, some of which may be toxic or allergy producing and in other cases, including prohibited or noxious weeds as outlined in the State's Seed Act.

During the past two years the Department has conducted limited experimental spraying with dormant cane broadcast spray. This program will be somewhat expanded during the coming winter. The material is 2,4,5-T with 6 pounds acid equivalent per gallon. It is used at the rate of one gallon of chemical to 100 gallons of fuel oil. This mixture is sprayed on the basal parts of brush up to two to four feet from the ground line from a moving truck.

Because of the use of fuel oil, the grasses and other vegetation directly hit by the mixture are killed. This makes the use of the material undesirable where erosion is a serious problem and confines its use primarily to wooded areas. It is, however, desirable for controlling brush in those areas where foliage application presents a drift problem. There also is likely to be less criticism from the use of this material from an appearance standpoint.

That excellent results have been obtained with the use of herbicides on highway rights-of-way is attested to by the fact that there has been a steady increase in the amounts which Maintenance Superintendents have requested for use during the past several years. Many counties have proven, from experience gained in their spraying activities, that chemical vegetative control programs have given them great improvements in roadside maintenance, at lower costs per mile.

Today's heavier traffic requires an unobstructed view of the road and one of the most effective ways to provide this is through the selective use of herbicides. In the past, our Department, like many others, depended largely upon mowing and hand cutting to control roadside vegetation. Of course, a certain amount of this is still done. Cutting has the advantage of taking down the brush and weeds at once, but there is the ever recurring problem of regrowth. The method is costly and the slow moving tractors and mowers, in these days of high speed, create a traffic problem for other vehicles and for the operator of the equipment. Our maintenance people now realize that this job can be done safer, more economical and efficient by spraying with herbicides. The spraying, of course, retards or eliminates brush, whereas cutting usually results in a stimulation of sprout growth.

Our experience and observations during the past few years definitely indicate that herbicides constitute an important, valuable and almost indispensable addition to the category of methods useful in controlling or eradicating undesirable roadside vegetation. Hand mowing can be eliminated in those places not accessible to mechanical equipment. It also has been shown that chemical treatment is less expensive than mowing and the results are more permanent. It should be noted here that treatment by herbicides and mowing are hardly more comparable than the words temporary and permanent. Then, too, poisonous species of plants can be efficiently eradicated, thus materially reducing the lost-time accident rate among workers subject to infection. Where care is exercised in its application and by the use of well instructed, experienced crews, the number of complaints from motorist and garden clubs is held to a minimum.

THE ALLERGIST AND THE AIR POLLUTION PROBLEM
(with special reference to Ragweed)

Frank L. Rosen M.D.[1]

Air pollution, a major peril to all of us, is a far greater threat to the allergic person. The average man may cough for a few minutes after breathing polluted air; the hyper-sensitive one may react with an attack of hay fever or bronchial asthma severe enough to put him in the hospital.

Allergic people develop allergies to substances which exist in their immediate environment. The higher the amount of ragweed pollen in the air in August and September, the greater the number of sufferers from hay fever and asthma. For example, soldiers in the South Pacific (1) who were in contact with grass pollen developed more allergy to grass pollen than soldiers stationed in this country, where ragweed is the predominant pollen cause of allergy.

Allergic patients are more susceptible to changes in weather, and changing weather factors themselves may induce hay fever or asthma, without the existence of any air pollution problem. (2)

Air pollution causes losses in the United States (3) estimated at $1.5 billion a year. Human suffering from allergy to weeds, especially ragweed in this area, cannot be counted in dollars.

Air Pollution From Ragweed Pollen

Ragweed hay fever has been estimated to occur in 5-10 % of the population of the United States. Unfortunately, a patient may listen to the pollen count on the radio, read it in the newspapers and, if it is high, his symptoms are increased by power of suggestion. Often these pollen counts are taken many miles from his environment, and have little relation with the count in his immediate area. It is the pollen that is in his own environment that is important.

I have a large framed picture of a ragweed plant in my examing room. Not long ago, I saw a 30 year old woman with severe hay fever symptoms who looked at the picture and asked, "Is this ragweed? Does this cause my hay fever? It's growing very high right outside my bedroom window. It even comes into the bedroom." She was getting a pollen count of thousands when the reported count was 10. Her symptoms cleared dramatically when her husband cleared up the backyard.

Meteorologic factors are just as pertinent as the amount of pollen produced. The pollen is borne on the wind and it's direction is of primary importance. For example, hay fever patients who live in shore areas do well on days with an ocean breeze, but with a land breeze their symptoms are similar to those of their inland brothers in distress. Pollen can blow into a community from hundreds of miles distant. So local laws, even if they are strictly enforced, do not do enough to cut down the amount of pollen in the air.

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In a letter to the New York Times, dated August 2, 1959, Dr. Louis Mamelok stated, "Many years ago, after the first frost when hay fever sufferers (in New York City) stopped sneezing, their symptoms returned. The cause was a windstorm from Louisiana, bringing ragweed pollen from an area where frost had not appeared yet."

Dr. A. Nelson Dingle (4) concludes, "It has been shown that meteorological considerations figure prominently in the total problem of ragweed hay fever. They are important in the states of plant growth from germination to blooming, and their significance in this period is best established by means of phenological research. In this process atmospheric turbulence is predominant. Despite its complexity, theoretical development in the turbulence field is continuous, and some useful applications to problems of pollen dispersal are bring made. Experimental work designed to yield relationships between meteorological parameters and the special distribution patterns of aeroallergens is largely within the meteorological province."

Dr. Eugene C. Ogden (5) is conducting a 3 year research program in New York State whereby ragweed is grown out of season and labeled with radioactive isotopes. The travel pattern of the "hot" pollen is then correlated with meteorological data.

The higher the ragweed concentration, the more clinical symptoms of hay fever and serious bronchial asthma, we encounter.

Hay Fever & Asthma Following Maximum Exposure To Ragweed

According to Durham, (6) the highest ragweed pollen count in the United States has been recorded near Indianapolis. Clinical corroboration of this observation (7) was afforded me when I was the Allergist for the ragweed seasons of 1944 and 1945 at Wakeman General Hospital, Camp Atterbury, Indiana, some 35 miles south of Indianapolis.

The following case report is illustrative of many of a similar nature which I encountered and which will plague the Disability Rating Boards of the Veterans Administration for many years, requiring Solomonic wisdom for fair adjudication, both for the veteran and the government.

Report of Case

A 21 year old soldier was admitted on August 26, 1944 to the allergy ward of Wakeman General Hospital. He had been affected by severe sneezing, stuffed nose, redness and watering of the eyes for the past week. There was no previous history, personal or familial, of hay fever, asthma or other allergic manifestations. However, the patient admitted he might have had mild sneezing in the summer or autumn without distinctly recollecting it. This was his first summer in the middle west; previously he had always resided in Newark, New Jersey.

Physical examination on admission revealed that the patient had severe symptoms of hay fever. Intra-cutaneous ragweed tests were decidedly positive. The blood count was normal except for a 10% eosinophilia.

Acute symptoms of hay fever persisted for about two weeks, then subsided gradually. The patient was reclassified for limited service, then returned to duty on September 27, 1944.

He did well until October 23, 1944, when he was readmitted to the allergy ward. This was well past the end of the ragweed season for that area. He had been wheezing for the past few hours. Nasal and ocular symptoms were absent. This was the first asthma attack he had ever experienced.

Physical examination revealed a patient with moderate asthma; the lungs showed asthmatic rales and breath sounds throughout.

Moderately severe asthma which required epinephrine injections at least once a day persisted for about 10 days. The attacks tapered off, averaging about one a week for the next six weeks.

On January 8, 1945, after a three week symptom-free period, the patient was given a medical discharge from the Army because of bronchial asthma.

The patient was next seen, after he and I had both become civilians, in my office in Newark, N.J. on May 13, 1946 (sixteen months later). He had been perfectly well until one month previous, when he had begun to have difficulty in breathing at night.

<u>Comment</u>

In all probability, this patient will now require prolonged allergic management. The problem arises as to whether he and others like him are entitled to medical care from the Veterans Administration and to disability ratings if the asthma is on sufficient frequency and intensity.

The ragweed sensitive patient who is stationed in an area of dense ragweed pollenation may suffer accentuation of various allergic symptoms for many years.

Proper ragweed control will not only lessen hay fever but prevent many serious complications like bronchial asthma, which ultimately may develop in one third of hay fever patients.

Ragweed Eradication

A booklet on hay fever revised by the Allergy Foundation of America in August, 1962, states "Even well organized campaigns will fail to be effective if a only a single community takes part. The ragweed pollen is so light and floats so far that it is of little use to remove the weeds in a single village or city if they continue to propagate in the surrounding communities and countryside. Weed eradication, to be successful, will ultimately have to be state and nationwide. Many difficulties attend eradication, such as the fact that ragweed grows in grain fields and cannot be easily reached. The seed of ragweed may lie dormant in the soil for 20 years, so that weed eradication must be continued for many successive seasons."

John H. Ruskin, M.P.H. (8) reports, "Timely destruction of 3,000 acres of ragweed reduces the pollen pollution by some 75-100 tons. This is not to be sneezed at. This reduction has been accomplished in Detroit at an estimated annual cost per hay fever sufferer of less than 30 cents -- less than the bus fare for one trip to the allergists office and back."

The Air Pollution Code of my own State, New Jersey, (January 1962) certainly gives authority to eradicate ragweed.

Chapter 1. Section 1.

1.10 Air Pollution: The presence in the outdoor atmosphere of substances in quantities which are injurious to human, plant or animal life or property or unreasonably interfere with the comfortable enjoyment of life and property throughout the State.

Air Pollution From Leaf Burning

In the fall, in the suburbs, leaf burning becomes not only an outdoor sport but a menace for patients with allergic respiratory disease. Our Air Pollution Control Code referring to this activity states:

Chapter 6. Section 2.

2.1 Prohibition of Air Pollution: No person shall cause, suffer, allow or permit to be emitted into the outdoor atmosphere substances in quantities which shall result in air pollution.

OPEN BURNING OF PLANT LIFE GROWN ON THE PREMISES IS NOT INTENDED TO BE COVERED BY THIS CODE.

In other words, you can burn your own leaves in your own backyard, even if your neighbor gets an asthma attack from the smoke as several of my patients do.

Many towns have passed local ordinances prohibiting the burning of leaves because of a fire or pollution hazard. Some have passed laws that it may be stopped if it is a nuisance to a neighbor. My own town of Maplewood, New Jersey, like many others, does nothing because -- "We cannot afford the cartage and many people will not use the leaves for compost."

The allergist must take the lead in warning the health officers, the physicians and the public as to the dangers that leaf burning adds to the air pollution problem.

Air Pollution From Spray & Insecticide

Rachel Carson, in her controversial best-seller, "The Silent Spring," dramatically portrays the universally harmful effects of insecticides and sprays. The allergic patient suffers to a far greater extent not only from the toxicity but from sensitization reactions.

Recently, I saw a 9 year old boy who would come home with asthma after attending day camp. At first I thought it was due to exertion or exposure to pollens and molds in the fields. I later found that these factors were not the cause, but that he had been exposed to spray (3% Malathion, #2 Fuel fog machine) in the area. It seems that many day camps spray the grounds daily with insecticides before camp starts, and sufficient time was not allowed for complete dispersion of the vapor.

Air pollution from motor vehicles, factories, etc., also have drastic effects on our health and must be seriously considered in our fight against air pollution.

It is the allergists, whose patients are hit the hardest, who must initiate inter-disciplinary conferences where they can exehange information with health officers, engineers, weed control officers, botanists, etc., etc.

In many respects we are the cleanest people in the world. Our teeth glisten and gleam. We bathe often with the finest soaps, use millions of dollars worth of deodorants lest our perspiration offend--yet the air we breathe is dirty! And in this dirt there is danger!

The air is a giant open sewer and since we have no choice but to breathe it, it is high time we paid some attention to the garbage we spew into it.

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PUBLIC INFORMATION AND EDUCATION IN WEED CONTROL PROGRAMS

Charles N. Howison[1]

RAGWEED POLLEN IS AN AIR POLLUTANT

The Air Pollution Control League of Greater Cincinnati has for a number of years led the annual campaign to have ragweed destroyed during the spring and early summer months, so that people ~~may~~ breathe easier during the late summer and early autumn. Every year, preventable distress, irritation - and even disabilities - are visited upon thousands of residents because of ragweed and other noxious plants. Hay fever and asthma, the products of airborne pollen from ragweed, cause many persons to be chronically ill.

Effective means of curtailing and eradicating such weeds are now available. Such eradication produces economic, health and aesthetic benefits. To be effective, the effort should be community-wide. An estimated 60,000 hay fever and asthma victims in the Cincinnati area alone are being helped by this community-wide program (about 8% of the population are affected). August's hay fever should be attacked throughout the growing season. The chemical spraying and weed cutting program should be concentrated during the period starting in May and continuing throughout the summer season.

Pollen from ragweed is the cause of 90% of all late summer hay fever. About one in three of hay fever sufferers develops asthma. Asthma is the third most common chronic disease in the United States - preceded only by heart disease and cancer. One ragweed plant can pollute the air with billions of pollen granules which become airborne as soon as the weed pollen ripens - soon after August 1. Since each person breathes from 12,000 to 15,000 quarts of air a day, it becomes readily apparent why the pollen count should be reduced to a minimum.

AID OF THE PUBLIC IS ENLISTED IN "OPERATION RAGWEED"

Our efforts to control and abate this health menace receives a hearty welcome from the thousands of hay fever victims in the Greater Cincinnati area. It is not too difficult to persuade a great majority of our citizens that weed control is desirable, possible - and economically practical.

Our main objective is to motivate people to take action that will achieve weed control. Our continuing educational program to "Get Ragweed Before It Gets You," starting in April and continuing until the first frost (about October 1), enlists the aid of the public in this annual battle of "Operation Ragweed."

1. Charles N. Howison, Executive Secretary of The Air Pollution Control League of Greater Cincinnati, 2400 Reading Road, Cincinnati 2, Ohio.

This educational program has received splendid support from our daily and community papers and on Radio and Television. Editorials, feature stories, cartoons, interviews and spot announcements - all help to keep the subject constantly before the public. During 1962, the daily and community papers contributed 793 column inches of space to this subject. This is equivalent to more than 4 pages of news space -- and accounted for about 20% of all local news coverage pertaining to the subject of air pollution (3960 column inches) during the first ten months of 1962.

JUNE IS NATIONAL RAGWEED CONTROL MONTH

In June, 1952, we were successful in having the month of June established in the National Calendar of Events as National Ragweed Control Month. Since that time, the event is supported in many communities throughout the nation, and Proclaimed by the governors of a number of states and the mayors of many cities. The event serves to point up the importance of a continuing community-wide weed control campaign starting in June and continuing throughout the growing season.

During the last week of May, The Air Pollution Control League provides and distributes some 117,000 illustrated cards "THIS IS RAGWEED", showing how to recognize the plant, and telling how and why it should be destroyed. These cards, and other educational materials, are distributed in the schools and in the homes of Greater Cincinnatians with the assistance of the Public Health agencies, Municipal Fire Departments, Public Libraries, the Academy of Medicine, Police and Highway Departments, Camp Fire Girls - and other organizations. Over 66,000 of these cards were distributed to the school children in the primary grades during the first week of June.

Starting in early June, a series of information articles is prepared for all news media and these are released about every two weeks. The leads for some of these articles are as follows:

RAGWEED WAR OPENS
HOW THE CINCINNATI AREA IS MEETING THE RAGWEED MENACE TO BRING RELIEF TO 60,000 LONG-SUFFERING HAY FEVER VICTIMS
KIDS WAR ON RAGWEED
HAY FEVER IS A COSTLY BURDEN TO INDUSTRY
RAGWEED POLLEN FALLOUT IS SERIOUS HEALTH PERIL IN AREA
A COMMON ENEMY
GET RAGWEED BEFORE IT GETS YOU!
THE TIME IS NOW!
CUT WEEDS BEFORE POLLEN STARTS POPPING!
OPERATION RAGWEED

These materials are frequently used in company publications and are the basis for articles appearing in the newspapers. Both the Public and Parochial Schools discuss this problem in classes during the first two weeks of June. The "This Is Ragweed" cards are taken home by the children and help to alert the public to the importance of this seasonal campaign.

A CITIZENS' COMMITTEE PROVIDES EXHIBITS

Heading the League's Hay Fever and Weed Control Committee is Mrs. Kay Wright, a member of the League's Board of Trustees. Here are a few of the services performed by this Committee:

On May 7, forty (40) giant ragweed plants (provided by the Cincinnati Park Board), were potted and distributed for display, with large posters and the "Get Ragweed" cards, to:

The Fifth-Third Bank Building
The Cincinnati Public Library (in Health Alcove)
Pleasant Ridge School
Shroder, Jr. High School
Norwood Memorial Health Center
The Provident Bank
and
A number of other places, including: clinics, drug stores, hardware stores, delicatessens, insurance offices, etc.

On May 29, Postage Meter Slugs - "Destroy Ragweed-Protect Health" were installed by the Provident Bank and the Cincinnati Gas and Electric Company - and by six other large business firms.

The fifth grade classes of the Pleasant Ridge Grade School conducted a "Poster Contest" and "Exhibition", the subject of which was 'Stop Ragweed.' The Exhibition and the judging for prizes, in the school auditorium on June 7, was covered by two Television Stations, as well as by the daily papers and one community paper. The Poster Contest was a big hit with both children and parents who stayed up until the 11:00 P.M. newscast to see the event on television.

EDUCATIONAL CAMPAIGN STRESSES COMMUNITY-WIDE COOPERATION

On April 24, 1962, the City of Norwood (second largest city in Hamilton County) approved a new Weed Control Ordinance which was immediately placed into effect under the direction of the Norwood Board of Health. This is a more effective and workable Ordinance than the previous one - and has been most helpful in bringing the weed problem under control in that community during 1962.

Following receiving a call pertaining to weeds, or during the routine travel of a sanitarian through the City where these noxious weeds are located, the owner of the property is determined by the Health Commissioner from the County Auditor. Upon ascertaining the owner of the property, a form letter is sent to the owner, or owners, stating a time limit within which the weeds are to be destroyed. The time limit is made as short as possible to prevent pollen from being discharged into the air.

In the event the owner who is served a notice by certified mail does not respond to the notice, the matter is then forwarded to the City Service Department to have the weeds cut or destroyed. The owner is then billed by the Service Department for the cost of the material and labor charged to the destruction of the weeds. Should the property owner fail to pay for this service within thirty days, the Service Department then arranges to have it placed on the Tax Duplicate of the property owner.

To demonstrate how successful the program has been during the year, the Norwood Health Department issued thirty-five orders requesting the cutting of weeds. In all cases, the owners cut the weeds - and none had to be certified to the City Service Department for cutting.

Mr. Robert C. Quade, Health Officer in Norwood, advises that as the result of the educational campaign and word of the strict enforcement of the new Ordinance, property owners have a 50% better performance record for voluntarily cutting weeds on their properties this year. He states that the cooperation on the part of the property owners has been improving each year, and he believes that the educational program plus the new positive Ordinance has put the Norwood Weed Control Program on a well balanced scale. "This program has been accomplished without the employment of additional personnel by the Norwood Health Department," said Mr. Quade.

THE CINCINNATI WEED CONTROL PROGRAM ADVANCES

One of the most important factors in the metropolitan area-wide weed control program has been the cooperation and support of property owners and public officials in the several municipalities. This is especially true in the City of Cincinnati where we have the team-work and cooperation of several City departments, including Public Works and Highway Maintenance, Police, Fire, and Health Departments. It is vitally important that the City set a good example itself and destroy weeds growing on its own properties. This encourages the private property owners to cooperation in weed control.

During 1962, the Highway Maintenance Division of the City of Cincinnati expended $53,000. to cut and spray weeds - using approximately 550 gallons of concentrated weed killer. A total of 11,524 manhours of City labor and 3,862 manhours of Workhouse inmate labor was used on this project during 1962.

The Property Maintenance Division expended $2,492. - using 879 manhours of City labor and 4,480 manhours of Workhouse inmate labor. No weed killer was used by this Division.

A total of 18 parcels of private property requiring weed eradication were referred by the Police to this Division. Of this number, the Highway Maintenance Division was required to cut weeds on 14 parcels - and private owners took the necessary action on the other 4.

AN IMPORTANT STEP FOR HEALTH AND BEAUTY

In addition, the New Expressway Weed Control Program this year included the fall spreading of 25 tons of fertilizer as a preventative measure in order to encourage growth of grass during the annual weed dormant season. Only mulches of leaves, corn cobs and wood chips were used to reduce the spread of weeds germinating from manure.

Side slopes were re-forested with 30,000 sapling evergreen trees, 7-foot on center, since the tree roots and blanket of fallen needles will ultimately provide weed-free slopes without ground vegetation.

The Cincinnati Police Department is most helpful in both the promotion of the educational campaign and in helping to bring about voluntary cooperation in enforcement of Cincinnati's Weed Control Ordinance. Of the 1,414 locations reported as listed in the respective District Weed Files, it was necessary to send card notices concerning these locations and violations to 538 property owners. The others, presumably, responded to verbal notices.

The Police Department reported a total of 18 privately owned properties on Form 318 to the Highway Maintenance for cutting by the City. Of these, 4 took the necessary action with the remaining 14 being cut by the City Highway Department. Only 2 Citations to Arrest were issued by the Police Department, compared to 8 for the previous year.

COOPERATION OF INDUSTRY IS VITALLY IMPORTANT

Because hay fever is recognized as a costly burden to industry, due to absenteeism from illness and lowered efficiency on the job, industry is expanding its efforts to control this health menace. This is especially true with the railroad industry.

For example, during the month of April, the Louisville and Nashville Railroad Company applied 24,500 pounds of Nalco H-174 dry chemical weed killer on their properties and right-of-way.

The Baltimore and Ohio Railroad Company reports that during the month of April, they applied 7,000 pounds of Urox 11 Dry Weed Killer, and also sprayed all of the main tracks and freight mains with HY Kill 50 D.F. Weed Killer. In addition, they used the weed burner in the Terminal area. The weed mower was used in other locations.

The Pennsylvania Railroad Company, the Norfolk and Western Railway Company, The Chesapeake and Ohio Railroad Company, The Southern Railway, The New York Central and the Cincinnati Union Terminal all reported similar programs under way during the spring and early summer months.

The final Report received from the Cincinnati Superintendents Committee on November 19, 1962, reports that 648.8 miles of track and right-of-way were treated for weed control. This included chemical spraying, burning and mowing - and the second-time-around where weeds were mowed, and then sprayed later. The program also resulted in the treating, burning and mowing of 319.4 acres of railroad property during 1962.

This splendid cooperation of the railroads in the area-wide weed control campaign helps to not only reduce a serious health menace but also improves the safety program on the railroads. We are most grateful to all the railroads operating in the Cincinnati area for their cooperation.

OUR PROGRAM IS SHOWING POSITIVE RESULTS - RAGWEED POLLEN COUNT REDUCED

Here is a summary of the ragweed pollen counts taken by the Cincinnati Health Department and by Dr. I. Leonard Bernstein at the Convalescent Hospital for Children:

	Cincinnati Health Department	Childrens' Convalescent Hospital
August 22 - Sept. 30, 1958	5,833	-----
" " " " 1959	4,349	3,829
" " " " 1960	4,843	3,221
" " " " 1961	3,458	** 2,874
" " " " 1962	3,361	** 2,791

It will be noted that during the period August 22 through September 30, 1962, the official Cincinnati ragweed pollen count taken by the City Health Department was down 3% from the previous year. The cumulative totals went from 3,458 to 3,361. However, the 1962 pollen count was taken in Mt. Airy - a new location situated a few feet above ground. Pollen counts for previous years having been taken on the roof of Christ Hospital.

City Health Department records reflect a gradual reduction in the ragweed pollen count during the past 5 years. There has been a reduction of 23% in the cumulative count from 1959. The reduction is even greater when compared with 1958 when the cumulative pollen count for August 22 through Sept. 30 was 5,833, a reduction of 2,472 pollen grains - or 42% - by the year 1962.

Starting in 1959, Dr. I. Leonard Bernstein, Director of the Allergy Laboratory at the Convalescent Hospital for Children started taking ragweed pollen counts. While the totals differ from those taken by the City Health Department for the comparable period, the reduction pattern is very similar. Both Christ Hospital and the Childrens' Convalescent Hospital being located in Mt. Auburn, just a few blocks apart.

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** Note: During '61 and '62, Dr. Bernstein started pollen count Aug. 1. During first 21 days of Aug. '61, pollen count was 380. During period Aug. 1 to 21 inclusive, '62, the count was 790. Very heavy rainfall early this past summer followed by very dry weather in Aug. and Sept., undoubtedly, accounted for heavier ragweed growth in some areas and an earlier ripening season. Consequently, hay fever victims started feeling discomfort earlier this year.

... m o r e ...

During the comparable period, August 22 through September 30, 1962, the ragweed pollen count at this location was also down 3% from the previous year - from 2,874 to 2,791. The reduction at this station for the years 1959 through 1962 (3,829 to 2,791) shows a reduced pollen count of 1,038, or 27%, during this period. This compared with the 23% reduction reflected in the pollen count taken by the City Health Department.

I believe this continued reduction in ragweed pollen counts in what is known as the ragweed belt of the nation is significant. I believe it indicates that our annual campaigns to destroy ragweed have played an important part in this reduction record. We would prefer to have ragweed pollen counts taken at six or more geographic locations within the City - at breathing levels. Such comparisons over several years could be very meaningful. However, the City Health Department has as yet been unable to take these additional pollen counts because of shortage of both funds and manpower.

CONCLUSION

While it is true that some pollen may travel long distances on wind currents, the eradication of the offending ragweed pollen-bearing plant at the source of contact with susceptible persons will lessen the degree of antigenic response and, in fact, would aid allergists in the over-all treatment of persons sensitive to ragweed pollinosis.

Experiments conducted at the University of Michigan, In June, 1956, with ripe ragweed plants transplanted from green-houses demonstrated that the fallout or loss of pollen grains from ragweed is as much as 99% at a distance of 160' on the down-wind side. It is a well known scientific fact that the content of the air varies according to the square of the distance from the source. The pollen of ragweed in your neighborhood is the cause of most hay fever suffering in your area.

It is estimated that one square mile of ragweed growth may liberate as much as 16 tons of ragweed pollen during the season. To destroy this noxious plant before it ripens and pollinates is good preventive medicine. The plant can be eliminated by cutting or spraying with herbicides. More than 60,000 Greater Cincinnatians or one in every twelve persons are victims of ragweed pollen allergy. Aside from the cost involved in medical treatment of these sufferers, incalculable man-hours will be lost to business and industry because of the incapacitation of these workers. Through the cooperation of the citizenry, and of our public officials, in destroying ragweed, much suffering will be alleviated.

Every community can be safer, healthier and more attractive by waging an effective weed control program annually. In a few years, the growth of the ragweed plant can be reduced to a minimum. Not only hay fever victims will be helped. But all who breathe the common atmosphere will benefit by the eradication of this air pollutant. An active public information and educational program will help to obtain the cooperation needed to control this menace to our health, our comfort - and our pocketbooks.

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SOME EFFECTS OF PLANT GROWTH ON THE AQUATIC ENVIRONMENT [1]

M. G. Merkle [2] and S. N. Fertig [3]

Introduction

Most biologists agree that life originated in an aquatic environment and, from the viewpoint that water is the dispersion medium for protoplasm, life is still limited to its original habitat. Water possesses several characteristics including high specific heat, transparency to light, neutral pH and high solvent power which enables it to serve as "the homeland of life".

The effects of environmental factors such as temperature, light, oxygen concentration and pH on plant growth have attracted man's attention for centuries. In an aquatic environment changes in these factors are the result of a change in water depth or a change in the season of the year. The effects of plant growth on the environment have also received attention from ecologists and, in recent years, from microclimatologists. For example, it has been known for some time that plant growth can cause an increase in pH in an aquatic environment. However, these effects are probably less understood than are the environmental ones.

Experimental Procedure and Results

Under growth conditions near Ithaca, N. Y., on a clear summer day it was not uncommon to find pH values above 10.0 in shallow ponds with abundant plant growth. This increase in alkalinity was at first believed by the authors to be caused by the microbial production of ammonia. However, chemical analyses showed less than one part per million of ammonia in the samples.

Another possible explanation was that the removal of CO_2 by photosynthesis resulted in the formation of $CaCO_3$ and a high alkalinity. The perplexing problem was that at a pH of 10.0 there would be, for all practical purposes, no free CO_2 in solution and photosynthesis would be impossible. A review of the literature revealed that Ruttner (1) had observed pH's of similar magnitude. Ruttner's explanation for the observation was that aquatic plants, unlike terrestrial plants, can obtain CO_2 from HCO_3^-. With this in mind, experiments were conducted to see if the change in pH corresponded to the expected curve for photosynthesis.

Table 1 shows the results of pH determinations made on 0.1 acre ponds of various depths at time intervals throughout the day. The ponds were located near Ithaca, N. Y. and have been used for the production of aquatic plants, useful as food for wildlife. As seen from the table, there is a general increase in pH from 8:15 am until 4:30 pm. This gives some indication that photosynthesis is responsible for the increased pH. Furthermore, the shallow ponds had a greater change in pH than did the deeper ones. This could be the

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1/ This work was supported in part by Federal Grant Central Research Funds (CRF-1) administered under the Hatch Act.

2/ Research Specialist, Department of Agronomy, Cornell University, Ithaca, N.Y.

Table 1. The pH of Water Samples Taken from 1/10 acre (66 x 66 feet) Ponds of Various Depths and at Various Times, July 19, 1962

Pond No.	Water Depth	Time 8:15 am	9:45 am	10:30 am	1:15 pm	4:30 pm	Change in pH
11	1'	9.05	9.43	9.50	9.70	9.70	.65
20	1'	9.01	9.15	9.32	9.55	9.76	.75
15	2'	9.68	9.81	9.91	10.05	10.06	.38
1	2.5'	8.83	8.95	8.95	9.05	9.05	.22

result of greater photosynthetic activity in the shallow ponds or of a greater reservoir of CO_2 in the deeper ponds. It should be remembered that a change in pH is a function of the buffering capacity of the water as well as photosynthetic activity.

Following this experiment, samples were taken every 3 hours for 105 consecutive hours from a pool in the greenhouse which had an abundance of Elodea canadensis, Potamogeton spp., Myriophyllum sp. and Vallisneria sp. This pool was 9 feet in diameter with a muck bottom approximately 6 inches deep and a water depth of 2 feet. Samples were taken from the surface, one foot and two feet (bottom) depths. The probe type sampler used for taking samples the first two days resulted in so much mixing that samples from the lower depths were meaningless and are not given in Table 2. The last two days' samples were taken with a siphon system installed permanently in the pool which resulted in little mixing of water at the different depths. Unfortunately, there were no sunny days during the experiment; thus, maximum differences in pH and oxygen content were not observed. There was sufficient variation to allow one to state that, near the surface, the peak for pH and oxygen content occurs at 6 to 9 pm and the minimum at 6 to 9 am (see table 2). It was also observed that during the daylight hours the surface layer of water had a higher pH and oxygen content than did the water at greater depths. During the night the water approached equal concentrations at all depths and in some cases the water at the bottom was higher in pH and oxygen content than was the surface. This may have been caused by a thermal turn-over of the water due to a rapid cooling of the surface layer.

A comparison of pH and oxygen content in water samples taken on sunny and rainy days is shown in Table 3. Samples from Gulf Creek were taken from a depression in the creek and not from rapidly moving water. Plant growth was sparse. The stagnant pool was located in a pasture and was only two to three feet deep. The water had an offensive odor and the algae population was so great that the samples actually appeared green. The farm pond was approximately 1/10 acre in size, spring fed and several feet deep. There was an abundance of Potamogeton pectinatus and algae around the periphery of the pond.

From the data in Table 3 it is apparent that high light intensity had less effect on the pH in Gulf Creek than it did in the stagnant pool or farm

Table 2. The Analyses of Water Samples Taken from a Pool in the Greenhouse at Three Intervals for 105 Consecutive Hours.

		Time															
		3 am		6 am		9 am		12 n		3 pm		6 pm		9 pm		12 m	
Date	Depth	pH	O_2	pH	O_2	pH	O_2	pH	O_2	pH	O_2	pH	O_2	pH	O_2	pH	O_2
9/18/62	Surface	--	--	--	--	--	--	--	--	9.48	14.8	9.53	13.6	9.26	11.6	8.96	8.
9/19/62	Surface	8.78	6.8	8.71	6.2	8.80	6.3	9.3	10.7	9.60	14.7	9.6	14.1	9.41	10.6	9.08	7.
9/20/62	Surface	--	--	8.90	6.2	9.07	8.8	9.10	9.7	9.25	13.7	9.51	14.3	9.03	6.0	8.98	7.
9/21/62	Surface	8.91	7.2	8.96	7.1	8.92	6.7	9.05	8.7	9.57	14.2	9.73	15.2	9.17	9.3	9.18	8.
9/21/62	1'	8.95	7.3	8.96	7.0	8.97	6.2	8.95	7.0	8.99	7.4	9.00	7.4	8.73	4.7	9.20	8.
9/21/62	2'	8.87	7.0	8.97	6.6	8.85	5.9	8.79	5.0	8.80	5.6	8.80	5.9	8.79	4.8	9.15	7.
9/22/62	Surface	9.18	8.0	9.05	7.2	9.03	7.3	9.30	10.2	9.37	11.5	9.30	10.1	9.11	8.2	9.15	8.
9/22/62	1'	9.15	7.9	9.08	7.2	9.08	7.0	9.11	7.6	9.11	7.7	9.00	7.2	9.18	8.3	9.20	8.
9/22/62	2'	9.15	7.6	9.10	6.9	9.09	6.8	9.03	6.3	8.95	6.1	8.93	5.3	9.20	9.4	9.18	8.

Table 3. A Comparison of Oxygen Content and pH in Water Samples Taken from Various Water Sources on Days of Low, Intermediate and High Sunlight.

Date	Weather Condition	Area	pH	Parts per million oxygen
8/10/62	Rainy and overcast	Gulf Creek	7.85	7.3
8/10/62	Rainy and overcast	Stagnant Pool	7.55	2.1
8/10/62	Rainy and overcast	Farm Pond	8.00	6.9
8/17/62	Intermittent clouds and sun	Gulf Creek	8.05	9.7
8/17/62	Intermittent clouds and sun	Stagnant Pool	8.15	12.1
8/17/62	Intermittent clouds and sun	Farm Pond	9.15	11.8
8/24/62	Bright sunlight	Gulf Creek	8.73	10.1
8/24/62	Bright sunlight	Stagnant Pool	9.03	15.7
9/24/62	Bright sunlight	Farm Pond	9.53	11.5

pond. This is as expected since the vegetation was much more sparse in the creek than in the pool or pond. The higher pH in the farm pond than in the stagnant pool seemed to be a paradox since oxygen content indicated that photosynthesis was more rapid in the stagnant pool. This paradox doesn't exist if one considers the buffering capacity of the water from the two areas. The stagnant pool had a total alkalinity of 210 parts per million expressed as calcium carbonate while the farm pond had an alkalinity of only 106 parts per million.

To this point all evidence seemed to indicate that the increase in pH was due to a shift in the $HCO_3^- - CO_3^=$ equilibrium as a result of changes in the ionic equilibrium caused by the photosynthetic processes. If this were true, then one should be able to calculate the pH by determining the HCO_3^- and $CO_3^=$ concentrations and using the Henderson-Hasselbach equation which states: $pH = pK + \log \frac{salt}{acid}$. When applied specifically to the $HCO_3^- - CO_3^=$ equilibrium the equation becomes:

$$pH = 10.36 + \log \frac{CO_3^=}{HCO_3^-} \quad \text{Equation 1.}$$

The amount of $CO_3^=$ was determined by titrating to the phenolphthalein end point with .02 normal H_2SO_4. Since this end point occurs at approximately pH 8.3, there should be more than 100 times as much in another manner, the contribution from $CO_3^=$ should be insignificant. The amount of HCO_3^- originally present was then calculated using the formula:

$$HCO_3^- \text{ alkalinity} = \text{total alkalinity} - 2(\text{phenolphthalein alkalinity})$$

The total alkalinity was determined by titrating to the end point of an organic dye pH = 4.3. The phenolphthalein alkalinity was doubled because it was assumed that it would require as much acid to titrate the HCO_3^- produced from the $CO_3^=$ as it did to titrate the $CO_3^=$ to HCO_3^-.

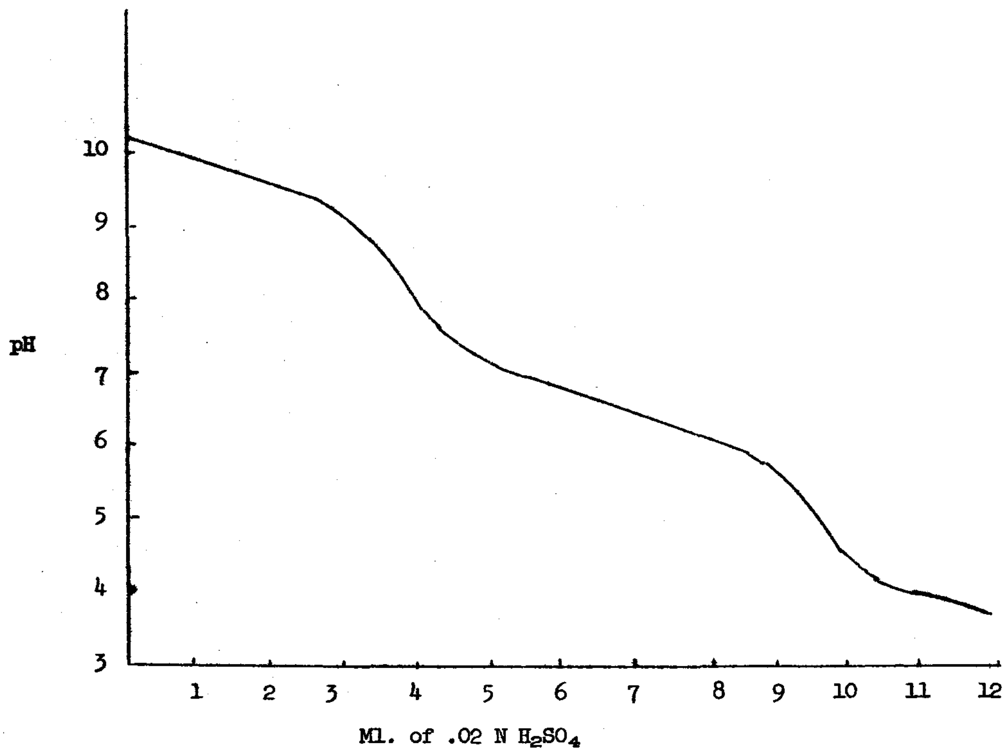
When this method was used for calculations, the pH so calculated was always considerably higher than the observed pH. This indicated that more acid was being used to titrate to the phenolphthalein end point than there was $CO_3^=$ present. The question again arose as to whether some other base such as ammonia was present.

Titration curves were run (figure 1) which follow closely the curves expected from a $HCO_3^- \rightleftharpoons CO_3^=$ system. It was then realized that a portion of the acid was utilized for lowering the pH to the phenolphthalein end point. For example, in the solution having an original pH of 10.23 there was a concentration of $10^{-3.77}$ moles of OH ions per liter whereas at the phenolphthalein end point there was a concentration of a $10^{-5.70}$ moles per liter. For 100 milliters, the sample size taken, this represents 1.7×10^{-2} and 2.0×10^{-4} millimoles, respectively. Thus, almost .017 milliequivalents of acid were required to lower the pH from 10.23 to 8.3. Since the acid used for titrating was only .02 normal, .85 milliliters of acid were required. Furthermore some of the acid used to titrate the HCO_3^- to H_2CO_3 also must have been required to lower the pH to 4.3, the pH at which one has approximately 100 times as much H_2CO_3 as HCO_3^-. At this pH there is approximately 5×10^{-3} millimoles of H+ per 100 milliliters. This would require about .2 milliliter of .02 normal acid. Thus, for the water sample titrated in figure 1 equation 1 becomes:

$$\begin{aligned}
\text{pH} &= \text{pKa} - \log \frac{\text{acid}}{\text{salt}} \\
&= 10.36 - \log \frac{(A - D) - [2(B - C) + C]}{B - C} \\
&= 10.36 - \log \frac{(10.2 - .2) - [2\,(3.8 - .8) + .8]}{3.8 - .8} \\
&= 10.36 - \log 1.07 \\
&= 10.33
\end{aligned}$$

Where: A = milliliters acid to final end point.
B = " " " phenolphthalein end point.
C = " " " lower pH from original to phenolphthalein end point
D = milliliter acid to lower pH from phenolphthalein end point

Figure 1. Titration of Water from a Pool in the Greenhouse.



When the theoretical pH is calculated in this manner, it is only 0.1 of a pH unit from the measured pH of 10.23. This variation could be due to a lack of sensitivity in the pH meter but is probably due to the titration of small quantities of organic compounds which exists as salts at the high pH but are converted to their acids as the pH is lowered.

There is a correlation between oxygen content and the expected photosynthetic curve just as there is for pH. In general, there is an increase in oxygen content throughout the day with the peak between 6 and 9 pm (see table 2). It is a common occurrence to find ponds supersaturated with oxygen in the late afternoon. Shallow ponds tend to have maximum oxygen concentrations near the surface but ponds 2-1/2 or 3 feet deep may have a maximum content near the bottom. Thus, oxygen content is more closely related to the vegetative growth pattern than to the water depth. During the night and on cloudy days the oxygen content is usually below the saturation point but seldom becomes less than 4 parts per million. Small stagnant pools have been an exception and lower oxygen contents were frequently encountered.

In summary plant growth in an aquatic environment alters that environment primarily through changes in oxygen content and pH which in turn alters the solubility of various salts and thus the mineral nutrition. It also has a significant effect on the light intensity and water temperature beneath it. The following variations were found in a pool in the greenhouse containing an almost solid mat of Elodea canadensis near the surface.

	Depth of Water	
Factor	Surface	2 feet
Water temperature	95 degrees Fahrenheit	75 degrees Fahrenheit
Oxygen content	11.2 ppm	3.3 ppm
pH	9.93	6.55
High intensity	7,840 foot candles	158.4 foot candles

Reference

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RELATION OF SCREENING TO FIELD TESTING IN DEVELOPMENT OF PLANT CONTROL METHODS

John H. Steenis[1/]

During recent years, increasing emphasis has been placed on screening chemicals for herbicidal activity. Screening is intended to be an expeditious selection of materials that are toxic to problem plants. Evaluation of promising chemicals then must proceed through a series of more critical tests. Thus, screening tests of chemicals for control of submerged, pad-leaf, and mat-growth species usually are conducted in jars and aquaria in the laboratory; follow-up studies may be made in growth pools and controlled ponds outside. Screening tests of upright emersed species, however, are conducted in the sites where these plants are found.

The next step, and a necessary one, is field testing. To take full advantage of basic screening studies that have been made as the first step in developing control methods for a problem plant, it is necessary to determine the time or times in its life history when it is most susceptible or vulnerable to a specific treatment, the effect of environmental conditions on the vulnerable period and on the treatment method, and the geographical range under which a control procedure is effective.

Vulnerable Period. Many plants are most susceptible to treatment during flowering and fruiting (Martin, Erickson, and Steenis, 1957). However, the vulnerable period may vary with the chemical used. Cattails are most susceptible to treatment with 2,4-D during the period of initial flowering. The susceptible period may be longer when certain other chemicals are used. For example, not only are better results obtained with dalapon at 20 lb ae/A, amitrole at 5 lb ai/A, and mixtures of amitrole at 5 lb/A with dalapon at 2 lb/A, but susceptibility starts during flowering and continues through the period when the staminate flowers are dry (or within 4 weeks of frost in northern States). Woody plants in wetlands generally respond best to treatments in late summer. Giant cutgrass is killed most readily during the period of maximum runner growth, which often occurs more than 2 months after flowering. The specific vulnerable period often must be determined for each species for each chemical.

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Environmental Conditions. Habitat often influences the period in which a plant can be controlled effectively. Control methods for phragmites, for example, often must be altered considerably in different environments. In terrestrial habitats, the vulnerable period extends from the time the plant is knee high to the time of early fruiting, a period of 5 months in Delaware (April into September). During this time, effective control can be achieved by use of dalapon at rates of 30 lb ae/A, by amitrole at rates as low as 15 lb ai/A, and by mixtures of dalapon and amitrole at 10 and 2 lb/A. In flooded or tidal habitats, however, the vulnerable period is limited to the flowering to early fruiting stage, a period of 2-3 weeks in Delaware (last week of August into the second week of September). In these flooded habitats, dalapon was ineffective at any of several strengths tested; amitrole was effective at 20 lb ai/A. A mixture of amitrole at 4 lb ai/A with dalapon at 20 lb ae/A was the most economical effective treatment.

Problems in controlling watermilfoil further exemplify how environmental conditions can affect control methods. In Lake Hopatcong, a non-tidal lake in New Jersey, Horrock and Smith (1961) reported effective control from treatments with 2,4-D granules from the middle of May into July. In the tidal waters of the Chesapeake Bay region, however, Eurasian watermilfoil could be controlled only during a short period, from the last 10 days of May into the first week of June. Differences apparently resulted from the movement of water due to tide and wind action so that control was effective only during the short vulnerability period that still remained after the plant had produced a loosely woven blanket growth from top to bottom that restricted water movement. The vulnerability period ended with flowering at the end of May or first of June; thereafter, 2,4-D treatments were erratic or not effective. Even within the vulnerability period, it often is necessary to restrict applications to periods of low tide, just before dead ebb, to take maximum advantage of containment of the chemical by vegetative friction. In small embayments, effective treatments can be made irrespective of tide, but in more open areas it may be necessary to increase dosage from 20 lb to 30 lb ae/A or to increase the size of the treated area. In some places there is so much water movement that no treatments are effective.

Changes in water level also may affect control methods. For example, where flooding occurs in the spring, buttonbush has been controlled by late summer treatments with ammonium sulfamate, but this same treatment is ineffective where there is no spring flooding.

Alligatorweed in the South is sensitive to some herbicidal treatments associated with raising water levels. For example, amitrole alone will only inhibit growth of alligatorweed, but will control it if treatment is followed by flooding. Combinations of amitrole at 4 lb ai/A with silvex at 10 lb ae/A were effective against alligatorweed when treatment was followed by a rise in water level from 12 to 18 inches. Under the same conditions, fenac-2,4-D combinations (2 lb ae and 10 lb ae/A) show promise. Granular silvex is an effective treatment against rooted alligatorweed when the plant is growing aggressively, provided the water is not over 18 inches deep.

Geographic Range. Control procedures for some few plants seem to be effective regardless of the regions where treatments are made. Needlerush, for example, has been controlled by 2,4-D at rates of approximately 20 lb ae/A throughout its geographic range. It is most susceptible to treatment immediately following flowering. Lotus also responds fairly uniformly in different areas to 2,4-D treatments at rates of 4 lb ae/A; the vulnerable period is during flowering and early fruiting. However, most other plants respond erratically to a set procedure. Cattail response in different areas is a good example. Grigsby, Reimer, and Cutler (1955) reported control of narrowleaf cattail in Michigan with dalapon at rates of 20 lb ae/A; the same method was effective in New York and Vermont. However, farther south, in the Maryland-Delaware region, cattail control with dalapon is erratic although amitrole (at rates as low as 5 lb ai/A) and the combination of dalapon (at 5 lb ae/A) with amitrole (at 2 lb ai/A) have been effective. Still farther south, in the Carolinas, cattail control is erratic with amitrole, dalapon, or a mixture of the two.

Effectiveness of control of phragmites also varies regionally. In Minnesota, Dill (1958) reported effective control of phragmites in wet flooded sites with amitrole at rates as low as 8 lb ai/A. In the Delaware area, however, 20 lb ai/A is necessary for control.

Conclusion

Screening and field testing both have an important place in the development of effective control methods. Screening permits expeditious selection of promising chemicals. Field testing shows which chemicals are effective under actual conditions and what methods, rates, and times of treatment are best.

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CONTROL OF AQUATIC VEGETATION WITH DIQUAT AND PARAQUAT IN BURLINGTON COUNTY, N. J. 1962

Richard D. Wessel[1]

The herbicidal effectiveness of diquat, 1:1'ethylene,2:2' dipyridylium cation and paraquat, 1:1'dimethyl, 4:4'dipyridylium cation has been evaluated in laboratory and field trials by many state and federal investigators over the past several years. One of the most interesting results of this research has been the pronounced effectiveness on aquatic plants.

The characteristics of the dipyridyl herbicides, including high water solubility, rapid action on a broad range of aquatic vegetation, safety to fish, low mammalian toxicity and residues of relatively short persistance in water are definite advantages for use on aquatic vegetation in a wide variety of situations.

Field trials have proven that diquat and paraquat can fit into aquatic weed control operations where trained operators have the experience and equipment to calculate water volumes and to accurately distribute the herbicide in the problem area.

Conversely, little was known about how these materials would perform in the hands of the occasional consumer. Most everyone connected with research, extension or the commercial aspects of aquatic herbicides has received requests for information on aquatic vegetation control from farm pond owners, lake front dwellers, fish hatcheries, commercial fish producers, etc. In general, these people experience difficulty in calculating dosages in parts per million and do not often have the equipment and/or the desire to spend the time needed to accurately apply aquatic herbicides. Nevertheless, it cannot be denied that their problems are important.

It was recognized that the majority of these problems could be solved by the discovery of simple techniques of dosage calculation and herbicide distribution. Therefore, a research program was established to determine whether the unique properties of diquat and paraquat could be usefully employed in these situations.

At the outset, the following objectives were considered: (1) determine the optimum time of year for dipyridyl herbicide application, (2) determine how far these herbicides will diffuse from the point of application, and (3) determine the dosage necessary for seasonal aquatic weed control.

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Lakes and ponds were selected for this research from the highly prized residential and recreational areas of Burlington County, New Jersey. Each year the majority of these water bodies accumulate a variety of submersed vegetation which by mid-summer seriously interferes with swimming, fishing, boating and detracts from the aesthetic value of being near these waters. The aquatic vegetation involved in these evaluations included: rooted and floating bladderwort, *Utricularia spp.*; rooted and floating watermilfoil, *Myriophyllum spp.*; pondweeds, *Potamogeton spp.*; cabomba, *Cabomba caroliniana*; spikerushs, *Eleocharis spp.*; common duckweed, *Lemna minor*; spatterdock, *Nuphar advena*; white waterlily, *Nymphaea tuberosa*; water smartweed, *Polygonum amphibium*; pickerelweed, *Pontederia cordata*; water bulrush, *Scirpus spp.*; burreed, *Sparganium spp.*; submersed mosses *Sphagnum* and *Drepanocladus* and a variety of filamentous algae.

The initial applications were made in three lakes in Medford Pines subdivision near Medford Lakes, N. J.

Lake No. 1 had a surface area of 1.42 acres and a maximum depth of 7 ft. At the time of treatment on May 10, new growth was visible on the massive submersed vegetation which included watermilfoil, waterbulrush, pondweeds and *Sphagnum* moss. Covering much of the submersed vegetation and about 30% of the water surface was a heavy mat of filamentous algae. Spatterdock and white waterlily foliage was reaching toward the surface. At mid-day the surface water temperature was 64°F and pH 5.5. Diquat cation at 0.6 ppmw (5.4 lb of cation per surface acre) was injected under the water surface from a pressure sprayer. Great care was taken to distribute the herbicide so that no points of injection were more than 20 ft apart. A small embayment, 150 ft long was not treated.

Fifteen days later strong herbicidal action was apparent, the lake surface was clear and all species were affected except spatterdock and white waterlily. The vegetation in the untreated embayment was equally affected. Continued surveillance of this lake through September 21 revealed decay and disappearance of the submersed vegetation, little regrowth and excellent commercial control for the season.

Especially encouraged by the herbicidal action in the untreated embayment, two additional lakes were treated in modified manner and dosage on May 31.

The first, Lake Lenipine, covered 7 acres with depths to 7 ft. New growth was readily visible on a heavy infestation of watermilfoil, bladderwort, needlerush, and pondweeds. A few plants of spatterdock and white waterlily were present. At 2 PM on the date of treatment the surface pH 5.5 and the water temperature was 70°F. Paraquat cation at 0.25 ppmw (2 lb of cation per surface acre) was injected under the water surface from a gravity flow container. Distribution of the herbicide was arranged so that no area of the lake was more than 80 ft from a point of injection.

Within 9 days (June 9) only a few sprigs of floating bladderwort could be found alive. By June 29 kill of vegetation except for spatterdock and white waterlily was complete. Continued observation through October 19 revealed little regrowth and this was restricted to bladderwort and some filamentous algae on the bottom.

Sape Lake was also treated on May 31. This lake covered 3.5 acres with depths to 9 ft. A heavy infestation of bladderwort, watermilfoil and needlerush was actively growing. Spatterdock and white waterlily were also present. At 4 PM the surface water temperature was 70°F and the pH 5.5. Diquat cation at 0.25 ppmw (2.3 lb of cation per surface acre) was slowly poured from a gallon jug over the side of a moving canoe. This distribution pattern was considered minimal since the lake was circled only once about 50 ft from shore, no agitation was provided, and certain areas of the lake were more than 150 ft from the point of herbicide application.

Within 9 days (June 9) only a few green plants of watermilfoil and bladderwort could be dredged from the bottom. The majority of the dredgings revealed dead and decaying vegetation. By June 29 the control of submersed vegetation was complete. As expected there was no effect on spatterdock or white waterlily. Observation through October 19 revealed excellent control of all submersed vegetation. A few bladderwort plants were found floating along the leeward bank and this was the only regrowth.

Upon reviewing the early season effects of these treatments the following theory was formulated to simplify the use of these dipyridyl herbicides: minimum distribution of diquat and/or paraquat cation on a surface acre, regardless of water depth, is a feasible and simple way to control a broad range of aquatic vegetation.

Two questions were immediately posed and subsequently investigated. (1) What is the minimum dosage of cation necessary to provide seasonal control of aquatic vegetation? (2) How little distribution is necessary? One gallon of diquat or paraquat contains 2 lb of cation and sells for approximately $25.00. This cost did not seem totally unreasonable for seasonal weed control on one acre, thus several more lakes and ponds were treated using various types of minimum distribution for one or more gallons of dipyridyl herbicide per surface acre.

Jennings Lake, Marlton, New Jersey which covered 4 acres with depths of 17 ft was totally useless for boating, swimming, or fishing. The surface was 60% covered with a rooted growth of watermilfoil in which bladderwort, cabomba, duckweed and filamentous algae were growing. In shallow margins, a submersed moss, Drepanocladus clogged the water and pickrelweed, smartweed, burreed, spatterdock and white waterlily were present. On June 29, diquat cation at 2 lb per surface acre was applied by slowly pouring the herbicide out of 1 gallon jugs as a canoe made one pass around the lake. Treatment time-15 minutes. Surface water temperature 73°F and pH 6.0.

Within 3 weeks, July 20, very definite improvement was noted with the surface of the lake 70% clear of the heavy mat. By August 1st the lake was completely useful for fishing, swimming and boating. Continued observation revealed slight regrowth of milfoil from heavy stems on the bottom and bladderwort and cabomba were washing in from the shallow swamp at the inlet area. Burreed and Drepanocladus in the shallow margins were completely destroyed as was duckweed and the filamentous algae. Spatterdock, smartweed, pickrelweed and white waterlily were unharmed. Restoration of this lake for recreation was accomplished for the season.

Two irrigation ponds at Evesboro, N. J. were found heavily infested with vegetation that threatened to clog the pump intakes. The first measured 0.15 acres with depths to 9 ft and was filled with pondweed, bladderwort and burreed. On June 29, one quart of diquat (3.3 lb of cation per surface acre) was thrown into the pond from a measuring cup while standing on the irrigation pump dock. Water temperature 74°F, pH 6.0. Within 4 days all vegetation around the pump intake had sunk. Burreed around the pond margins was dying. Within another month all bladderwort and burreed were gone but the heavy growth of pondweed was only 30% controlled, mainly in the area of the pump dock where the concentration was the highest.

The second irrigation pond measured 0.75 acres and was choked with watermilfoil. The water was cloudy with soil particles washed in by a recent rain. On June 29 two quarts of diquat (1.3 lb cation per surface acre) were thrown into the pond from a measuring cup, while standing at one location on the bank. Water temperature 78°F and pH 6.0. Very little effect of this treatment was observed and it was concluded that the suspended soil particles absorbed the diquat thus effectively inactivating the herbicide. This pond was again treated on August 3 using 1½ gallons of paraquat (4 lb cation per surface acre) by throwing the herbicide into the water at six locations from the bank. At this time the water was clear, water temperature 76°F and pH 6.5. By August 24 the control was complete and remained so through the season.

To evaluate whether slowly moving water would provide adequate distribution of these herbicides the following lakes were treated.

Lake Ashsheekam, Medford Lakes, N. J. had a surface area of 1.3 acres with depths to 8 ft. The water was clear and mats of bladderwort were floating on the surface and watermilfoil and pondweed covered the bottom. One acre of this lake was located between the inlet spillway from a lake above and the outlet spillway to a lower lake. An embayment of 0.3 acres extended off to the southeast. On July 26, three gallons of diquat (4.6 lb of cation per surface acre) were poured into the inlet spillway. Herbicidal action was slow on this maturing vegetation and was confined to the area between the inlet and outlet. By September 12 the watermilfoil was dead and the bladderwort mats were sunken and decaying. The pond weeds were 50% controlled but no herbicidal action was apparent in the southeast embayment out of the line of water movement.

In a second trial, the inlet area of Jennings Lake, mentioned previously, comprised a 2 acre swamp mainly covered with burreed and the shallow waterways were clogged with cabomba and watermilfoil. A swiftly moving stream fed this area. At one point a log had fallen across the stream and a 6 gallon pail of paraquat was perched on this log, punctured by a nail and the 12 lb of cation were allowed to dribble into the water on August 24. Within 3 weeks the entire area was cleared of burreed and watermilfoil. However, there was no visible effect on the cabomba which appears resistant to the dipyridyl herbicides.

This dosage of paraquat (2 lb of cation per surface acre) was observed to move on through the 4 acres of open water in Jennings Lake, killing the occasional regrowth of milfoil, which occurred after the previous diquat treatment of June 29th, flowing over the dam and killing a heavy concentration of pondweeds in the old mill race at the outlet.

From these experiences it was established that minimum distribution could be accomplished in several ways with these herbicides. Throughout the season several additional lakes were treated using 1 to 4 lb of cation per surface acre. Two reasons were responsible for the few trials where results were unsatisfactory. First, suspended soil particles or muddy water resulting from rains soon after treatment was found to quickly inactivate these herbicides. Second, dosages of less than 2 lb of cation per surface acre, applied after July 1 when plant growth was approaching maximum volume, were too low to destroy the entire mass. In these cases a mowing effect was observed followed by rapid regrowth from the unaffected parts of the plant.

From these trials it was evident that the time of year in which the treatment is applied determines the dosage necessary and the thoroughness of herbicide distribution required. A treatment applied to overwintering vegetation on which spring growth has started (May and June) requires less cation, i.e.

1 to 2 lb per surface acre, and may be applied with various minimum distribution techniques. As the season advances, and objectionable masses of vegetation develop, 3 to 4 lb of cation per surface acre are required and more thorough distribution will benefit the activity.

A final example of the versatility of these herbicides is in the treatment of objectionable vegetation in mid-summer.

Mirror Lake, Medford Lakes, N. J. covered 1 acre in a residential area. By mid-July a mat of floating bladderwort 10 to 12 inches thick covered 90% of the surface. The lake was repulsive to view and useless for recreation. On July 25, diquat at 0.5 ppmw (4 lb cation per surface acre) was applied out of gallon jugs from a moving canoe. Treatment time-15 minutes. Within 2 weeks the mat was sinking and by August 24 the aesthetic and recreational value of the lake was restored.

In all of these investigations no effects on fish, birds or other animal life associated with aquatic environments were observed.

Table I summarizes the data for all treatments mentioned.

SUMMARY: These trials have established a simplified and economical manner of dosage calculation for the occasional but important aquatic herbicide consumer. By using 2 to 4 lb of dipyridyl cation per surface acre, regardless of water depth, seasonal control of many important aquatic weeds may be achieved.

Distribution of these herbicides is uncomplicated, requires a minimum of equipment and saves time and labor.

Time of year, stage and vigor of plant growth and mass of vegetation will influence the amount of cation required and the distribution necessary. Optimum treatments, applied soon after spring growth starts, require minimum dosages and distribution. By using sufficient cation, infestations of susceptible aquatic vegetation may be controlled at any time during the growing season. In all cases it is necessary to avoid treatment of muddy water and agitation of bottom debris.

TABLE I

SUMMARY DATA OF AQUATIC WEED CONTROL WITH DIQUAT AND PARAQUAT. BURLINGTON COUNTY, N. J. 1962

LOCATION, STATISTICS AND TREATMENT DATE	MATERIAL, DOSAGE AND MANNER OF TREATMENT	WEED CONTROL 1 SPECIES	 2 RATING
Lake No. 1, Medford 1.42 A X 7 ft maximum. Treated May 10, 1962	Diquat @ 0.5 ppmw (5.4 lb ion/surface A). Power injection, excellent coverage.	Myriophyllum sp. S. subterminalis Potamogeton sp. Sphagnum sp. Algae N. advena N. tuberosa	C SR C C SR N N
Lenipine Lake, Medford 7A X 7 ft maximum. Treated May 31, 1962	Paraquat @ 0.25 ppmw (2 lb ion/ surface A) Gravity injection, moderate coverage.	Myriophyllum sp. Utricularia sp. Eleocharis sp. Potamogeton sp. Algae N. advena N. tuberosa	C SR SR C SR N N
Sape Lake, Medford 3.5 A X 9 ft maximum. Treated May 31, 1962	Diquat @ 0.25 ppmw (2.3 lb ion/surface A). Poured from 1 gal jug, minimum coverage.	Utricularia sp. Myriophyllum sp. Eleocharis sp. N. advena N. tuberosa	SR C SR N N
Jennings Lake, Marlton. 4 A open water X 17 ft maximum. Treated June 29, 1962.	Diquat @ 2 lb ion/ surface A. Poured from 1 gal jugs out of canoe, minimum coverage.	Myriophyllum sp. Utricularia sp. C. caroliniana L. minor Algae Drepanocladus sp. Sparaganium sp. N. tuberosa P. amphibium P. cordata N. advena	SR SR U C SR C C N N N N
Pond No. 1, Evesboro 0.15 A X 9 ft maximum. Treated June 29, 1962	Diquat @ 3.3 lb ion per surface A. Thrown in from dock, minimum coverage.	Potamogeton sp. Utricularia sp. Sparaganium sp.	U C C
Pond No. II, Evesboro 0.75 A X 12 ft maximum. Treated June 29, 1962	Diquat @ 1.3 lb ion per surface A. Thrown in from bank, minimum distribution.	Myriophyllum sp. (water muddy, treatment inactivated).	N

LOCATION, STATISTICS AND TREATMENT DATE	MATERIAL, DOSAGE AND MANNER OF TREATMENT	WEED CONTROL SPECIES [1]	RATING [2]
Retreated August 3, 1962	Paraquat @ 4 lb ion per surface A. Thrown in from bank, minimum distribution.	*Myriophyllum sp.*	C
Lake Ashsheekam, Medford Lakes 1.3 A X 9 ft maximum. Treated July 26, 1962	Diquat @ 4.6 lb ion per surface A. Poured into inlet spillway. Distributed by water movement.	*Utricularia sp.* *Myriophyllum sp.* *Potamogeton sp.*	C[3] C[3] U[3]
Mirror Lake, Medford Lakes 1 A X 5 ft maximum. Treated July 25, 1962	Diquat @ 0.5 ppmw (4 lb ion per surface A. Poured from 1 gal jugs from canoe, minimum coverage.	*Utricularia sp.*	SR
Jennings Lake, Marlton 2 A swamp plus 4 A open water X 17 ft maximum. Treated August 24, 1962.	Paraquat @ 2 lb of ion per surface A. Poured into inlet stream, distribution by water movement.	*Sparaganium sp.* *Myriophyllum sp.* *C. caroliniana* *Potamogeton sp.*	C C N C

1. Species listed in order of importance.
2. C = 100% control for season; SR = satisfactory control, regrowth noted; U = unsatisfactory control; N = no herbicidal effect.
3. This rating from area of herbicide distribution. In southeast embayment, out of water flow, no effects noted.

Progress Report of the Application of Fenac Granular to Six Small Plots in Long Pond, Dutchess County, New York

Madelene E. Pierce, Vassar College, Poughkeepsie, New York

The purpose of this study was to compare the results of the application of Fenac Granular upon six small experimental plots. An attempt was made to determine the effect of Fenac Granular upon the plankton and benthic organisms, as well as upon the pondweeds. The duration of this study was from April 5 to September 25, 1962.

Again I wish to thank Mr. Kenneth Wich of the Poughkeepsie Office of the New York State Conservation Department for his help in the field. Mr. Otto Johnson generously gave us the use of his boats. Amchem Products, Inc., contributed the Fenac as well as a small grant; and Vassar College, as always, provided a small grant as well as the use of laboratory supplies and equipment.

Conditions in Long Pond have been carefully described in previous papers. (Pierce 1958, 1959, 1960, 1961, 1962)* Three areas, each containing two plots of size 50 x 50 feet, were staked out along the shore line. One of these was located within the littoral zone of the west shore, which is choked with submerged and floating weeds near the shore, but which becomes less densely populated toward the middle of the pond. The other two pairs of plots were located on the east shore of the pond, within the littoral zone, where weeds of both floating and submerged types were very dense. The bottom consists of a deep layer of soft mud and decomposing plants. The dominant floating plant is Nymphaea odorata with occasional stands of Brasenia sp. and Nuphar advena. The most common submerged weeds are Utricularia purpurea, the moss Drepanocladus sp., and several species of Potamogeton (P. amplifolius, P. crispus, P. pusillus, and P. natans). Other submerged weeds are present but in shorter supply. (Chara sp. and Ceratophyllum demersum).

The control area selected was the original one which has been used each summer since 1958. The three pairs of plots were treated identically with Fenac (2, 3, 6-trichloro-phenylacetic acid).

* Pierce, 1958. 12 Ann. Meet. Northeast. Weed Control Conf. 338-343
1959. 13 Ann. Meet. Northeast. Weed Control Conf. 310-314
1960. 14 Ann. Meet. Northeast. Weed Control Conf. 472-475 and 483-487
1961. 15 Ann. Meet. Northeast. Weed Control Conf. 539-543
1962. 16 Ann. Meet. Northeast. Weed Control Conf. 435-441

One plot received 5.7 lbs., which is equal to 10 lbs. active ingredient/acre, or 1.5 ppm in the pond; the other received 8.6 lbs. equal to 15 lbs. active ingredient/acre, or 2.2 ppm. Since Fenac has been found to be useful as a pre-emergence herbicide in terrestrial conditions, this application was made early in the spring when the water temperature was 46°F, and before weeds had begun their burst of regrowth.

The application of Fenac Granular was made on April 17, 1962 by the use of a seed scatterer. Before this date water samples were taken. After this date routine observations of weeds, samples of water, plankton, and benthic organisms were repeated at intervals on the following dates: May 17-28; June 14-16; July 18-20; September 21-22.

In each area, temperature of water near the bottom was recorded. Both water samples and hauls of the dredge were taken near the center rather than the periphery of the plot. One water sample and two hauls with an Ekman dredge were made in each plot. A plankton haul was made and standardized as well as possible by rowing an equal number of times across the plot. The organisms from the dredges were sieved, identified, and counted in the field. The plankton was carried to the laboratory where it was identified within a few hours either under a dissecting microscope or the low power of a compound microscope. The water samples were treated in the field (Winkler Method), and carried to the laboratory where determinations for pH and O_2 in ppm were made at once by using the Hellige Testing Apparatus.

The results of the treatment with Fenac were puzzling and inconclusive. Although careful observations, accompanied by written notes, were made on April 17, May 17, June 7, June 18, July 20, and finally on September 13, it was most difficult to judge the effect of the Fenac upon the growth. Estimation of the number of plants per square meter was not satisfactory; neither was the estimation of the per cent of bottom surface which remained free of weeds and therefore visible. The only criterion which was considered at all reliable was a comparison of the weeds inside a plot with those closely surrounding it. From this comparison, the following conclusions were drawn. A general inhibiting influence on the plot was observed. This effect was more marked on the submerged weeds, than on the surface plants. The submerged weeds were shorter, and did not approach the surface as did those in the surrounding area. In some plots the number of submerged weeds was noticeably less than in the very dense surrounding masses. In plots where the bottom mud exhibited many patches clear of weeds in May, there was no obvious taking over by an onrush of plants as the season advanced. Although weeds already present may not have been killed, new ones apparently did not invade the area.

Surface weeds, namely <u>Nymphaea</u>, <u>Nuphar</u>, <u>Brasenia</u>, apparently showed little effect. However, in one plot, surrounded by an extremely dense covering of lily pads, a noticeable decrease of pads was observed. In most plots plants and surrounded by the same pattern, it was impossible to judge the effect of the weedicide.

The shore side of all plots contains a narrow border (4 feet wide) of an extremely dense mass of submerged weeds. As far as could be determined the weedicide did not inhibit or decrease this jungle of tangled weeds. It may be stated however, that even if some inhibition occurred, it would have been impossible to judge.

Only in portions of a plot where population is moderately dense can any opinions be formed and conclusions drawn.

In comparing a single pair of plots, no correlation of the general inhibiting effect with concentrations of the weedicide in ppm was observed. The concentrations used were 1.5 ppm and 2.2 ppm and each seemed equally effective.

The summer of 1962 in Dutchess County was relatively cool despite the drought which occurred in June and part of July. As temperatures were not extremely high as in some recent years, the water temperature of Long Pond reflected this general picture of the cooler climate, as well as the usual seasonal trend. On April 17, the temperature was 46° F, increasing during May to 64° F, in June to 66° F, and July to 72° F. No reading was taken in August, but by September 21 the temperature had dropped to 60° F.

The dissolved oxygen reflected in general the seasonal trend. As usual, the dissolved oxygen content of the control area was consistently the lowest. This varied from 9 ppm in April to a low of 2.5 ppm in mid-July, and returned to 5.0 ppm in September. In the experimental plots, all showed a uniform 10 ppm in April; in May the content had decreased to a range of 10 - 8.5 ppm; in June 7.5 - 5.5; in July 6- 3.5 ppm. By September 21, the content had returned to 5 - 9 ppm. A marked correlation of O_2 ppm with the seasonal change in temperature was evident. There appeared to be no correlation of O_2 ppm with the concentration of weedicide in ppm.

The records for pH in all areas reflected the seasonal trend. The acidity increased as temperatures rose and O_2 ppm decreased. Again the control consistently showed the lower figures, varying from 7.6 in April to 6.8 in July, and returning to 7.1 in September. The experimental plots varied from 8.2 - 7.6 in April and May; dipped to 7.6 - 7.2 in June; continued decreasing to a low of 7.6 - 6.8 in July and returned to 7.9 - 7.1 in September. There appeared to be no correlation of pH with the concentration of weedicide in ppm.

The plankters identified were representatives of the same large group as in previous years: Myxophyceae; Chlorophyceae; Protozoa; Gastrotricha; Rotifera; Annelida (bristle worms); Crustacea (Copepoda, Cladocera, Ostracoda, Amphipoda); Insecta

Arachnida (mites); Gastropoda. The same plankters, representing about fifty species, occur from year to year with marked regularity. This summer, there was no indication of damaging effects upon the population from the application of the weedicide. Of course it must be remembered that the first sample was not taken until 4 weeks after the early application. However, during May, June, and July there was no loss of any age group, nor was there loss in vigorous activity of individual zoo-plankters. The experimental areas showed slight qualitative variation of species, but paralleled the seasonal changes of the control. On September 21, the plankton population of both the experimental and control areas was sparse in numbers of individuals. The Copepoda and Cladocera were almost non-existent. However the usual number of species was present. No accurate quantitative studies were attempted in the study of the plankton. No correlation could be made between presence (or absence) of plankton and the treatment of experimented areas.

Large aquatic vertebrates, fish, frogs, and turtles, were present in both experimental and control areas. Adult fish, as well as many schools of young fish, were often observed.

Benthic organisms were members of the same large groups as in previous years, and indeed the same genera: Annelida (oligochaete worms and leeches); Gastropoda (Amnicola, Helisoma, Menetus, Physa, and Valvata); Pelecypoda (Sphaerium); Amphipoda (scud); Isopoda (Asellus); Insecta (larvae or nymphs of Mayfly, Damselfly, Dragonfly, and Midge). The seasonal trends of population were reflected in both experimental and control plots. In no experimental plot did any one group show any significant variation from the control.

Suggestions for Further Research

Based on the results of my experiments only, since at this time of writing I have not had opportunity to talk with others who may have used Fenac last summer, I would continue as follows. I would stake out along the shore four or five larger plots (100 X 100 ft.) for experimental use, with equal sized areas between to be kept for comparison as controls. I would select a portion of the shore line as uniform as possible with regard to the species of weeds present, and I would choose an area which had relatively few weeds. Under such conditions I believe I could make more accurate judgments concerning the growth and number of weeds. I would use one or at most only two concentrations of Fenac, probably 1.5 ppm and 2.5 ppm. Since I have the results of last summer's work on the variation of temperature, pH, O_2 in ppm, plankton, and benthic organisms, I would spend less time on this phase of the work and concentrate on the emergence and regrowth (if any) of the pondweeds.

Summary

1. Three distinct areas, each of two plots fifty feet square, were selected along the shore of Long Pond.

2. Observations on these plots were made from April 17 - September 25, 1962.

3. Each pair of plots was treated with Fenac in the same manner. One plot received a concentration of 1.5 ppm, the other a concentration of 2.2 ppm.

4. A study of the following factors and organisms was repeated at intervals during the summer: bottom temperatures, pH, dissolved oxygen content, plankton population, benthic population, large aquatic vertebrates, and pondweeds. The dates of the sampling were: May 17-28, June 14-16, July 18-20, September 21, 22.

5. A general inhibiting influence upon the weeds in the experimental plots was observed. This effect was more apparent upon the submerged weeds than upon the floating weeds.

6. This inhibitory effect was apparent in the more open, reasonably populated portions of the plot.

7. Within a narrow marginal border of extremely dense growth, plants did not respond to treatment.

8. The two concentrations of weedicide used appeared equally effective.

9. The temperature of the bottom water showed seasonal variation within 46° - 72° F.

10. The range of pH readings was between 8.2-6.8, and followed the pattern of the control.

11. The fluctuation of dissolved oxygen content was between 10-2.5 ppm, and paralleled that of the control.

12. The plankton was again represented constantly by the same forms as in previous years. Any change in number of species or individuals reflected seasonal trends, and was noted in both experimental and control areas.

13. The benthic population was continually represented by the same forms, and also relative numbers as in previous summers. Any significant increase (or decrease) of a single species was shown in both experimental and control areas.

14. Fish of all ages, frogs, and turtles occurred throughout the summer in both treated and control areas.

OBSERVATIONS ON SYNERGISTIC PROPERTIES OF VARIOUS ADDITIVIES "PHRAGMITES CONTROL"

Edward A. Powers [1]

Inspection of recent supplements of the Proceedings of this Conference will show that one of the paramount "problems needing investigation", is economical control. Phragmites control, presently requiring substantial amounts of expensive chemicals, therefore could benefit by more investigation. The following is a reasonably detailed account of the investigation conducted by me.

Since 1955 I have maintained records of various solutions used in day to day operations, including temperature, humidity, soil moisture, and wind conditions. These records showed evidence of compatibility of certain chemicals, if not synergistic properties. During those years, I have developed a so-called all purpose weed control spray by using adjuvants in varying proportions, and observing reactions under a wide range of conditions. Because of this familiarity with various selective weed killers and generally predictable results, I welcomed the opportunity to apply a Phragmites Control solution in a test area for the Port of New York Authority, International Airport, Idlewild, New York.

There are about 2000 acres of Phragmites in Idlewild with a number of problem areas. Present control measures consist of close cropping plant with 48" rotary mowers, when manpower is available, in order to maintain firebreak lanes, emergency vehicle access roads, and reduce encroachment on various lawn areas. Chief deterrent to the use of chemical control has been high cost of material, inexperienced applicators, and history of damage to some lawn and shrub areas, due to prevailing high winds at the airport.

Preliminary investigation disclosed there was little or no information available to me on Phragmites control in manuals, encylopedias, or local agricultural schools. The limitations on the labels of suggested chemicals listed many optimum conditions for application, such as young active growth, moist soil conditions, wide range of dosage rates and possibility of reapplication necessity, etc.

Further investigation, which included a personal interview with Mr. George Miller, Long Island State Park Commission at Jones Beach, disclosed that Dalapon, 25 lbs a.i./A applied at 300 lbs psi gave 85%

1/ Operator--Landscape Spraying Service, 4 Emerald Drive, Glen Cove, N.Y.

control. This was satisfactory to the commission. Two men could treat 10 acres per day, when manpower was available. Mr. Miller felt best results were obtained the latter part of June - first 10 days in July, on chest high plants. Mr. E. G. Johnson, Special Assistant Area Public Works Office, Dept. of the Navy, disclosed that he was well satisfied with the performance of a combination Dalapon plus Amitrole, 20 plus 3 lbs a.i./A in 200 gallons of water. However, in critical security and fire hazard areas, he anticipated 3 applications, spring, fall and following spring.

The problem as it appeared to me was twofold. Is it possible to increase the efficiency of well tested chemicals, developed over years of research, in order to reduce material cost? Is it possible to apply these chemicals in other than optimum conditions? The following applications were made under minimum conditions, with the feeling that whatever the results, they could be improved by closer adherence to the manufacturer's recommendations. The table below shows amounts of various additives included in a minimum suggested solution. Dalapon 14 lbs a.i.h.g. These solutions applied in drought conditions, on generally mature, dormant plants, during high temperatures. Flat Spray applied to leaves, wet no runoff, 50 lbs psi, 3½ gpm Marlow Centrifugal Pump. Spraying Systems Co. O.C. 40 nozzle and hand gun.

14 lbs DALAPON a.i.h.g./a
82-85° Temp.

AREA	DATE	PLANT HGT.	ADDITIVES
A.	5/29/62	3-4	No additives
B.*	"	5-6	100 oz. Miscible Oil
C.	"	6-7	" " plus 20 lb 45% Sol Nitrogen (mat.)
D.	6/6/62	5	Amitrole 3 lb. a.i., 20 oz. 2-4-5T, 32 oz Sod. Ars., 20 oz. wet agt., 20 lbs. Dimmonium Phosphate
E.*	6/18/62	5	Same as "D" Appl 93 deg. Idlewild Airport
F.	10/19/62	3	(Cut regrowth) Same as "D" No sod. ars.

INSPECTIONS:

6/1/62 — Area A, B, spotted, spots larger on B. Area C, leaves greener, abnormal droop in tips of 25% of plants.

* Denotes least potential regrowth.

6/9/62 — Area D, spotting and general chlorosis evident.

6/12/62 – Area D. Removal of 24" rhizomes comparatively easy. Root hair atrophy and decay evident. Root specimens in other test areas show no appreciable difference.

10/8/62 — All areas photographed. Areas B and E show least regrowth potential. Examination of Area F showed 1 sucker leaf on 1 plant in all of test area. Rhizomes now firmly rooted, and normal root hair structure noted. All plants appeared to be dead or dormant since end of July.

10/29/62 – Area F examined and appeared similar in appearance to area sprayed June 18. Untreated areas adjacent approaching dormant stage.

OBSERVATIONS:

Miscible tree oil added to solution, on the assumption that its penetrative properties would interfere with plant transpiration, without producing rapid burn, and permitting translocation of toxic material. It appeared to do this. Area B, compared to Area A.

Forty-five per cent (45%) soluble nitrogen: Included on the presumption it would help to stimulate circulation under drought conditions. Area C. reaction, not as pronounced as Area B. Ingredient probably unnecessary.

Amitrole: Used as additive rather than basic systemic herbicide only as field expedient.

Sodium Arsenite: Dosage of 32 oz. 45% a.i. may have little toxic effect. Incorporated in hope of generally weakening plant.

2-4-5T: As a systemic herbicide I had hoped for translocation of additional toxic material into the root zone. Contribution unknown at this time.

Wetting Agent: (Non-Ionic) Customarily used in my selective weed control operations. Hoped to increase leaf penetration and minimize runoff. Material applied in 93 deg. temp. absorbed in 10 minutes. Apparently effective.

Dimmonium Phosphate: Commercial formula 21-53-0 used with the contention that as a fertilizer compound affecting root growth development, it might further translocation of Dalapon into the root zone. Subsequent examination of Areas D., E., may justify this contention. A more scientific series of tests are indicated.

CONCLUSION:

It is probable that conclusions at this time are premature, as has been suggested. There is a definite possobility that one or more of the above described additives have contributed to the efficiency of the basic weed killer Dalapon. Whereas my observations show comparable results with a $28.00 or less, per acre, material cost, these formulas may interest some of you in the field. It is also possible that solution, Area D, could be diluted substantially and still give effective control.

SOME EFFECTS OF 2,4-D and 2,4-DCP ON DRINKING WATER QUALITY [1]

by Samuel D. Faust[2] and Osman M. Aly[3]

Water purveyors are concerned about the general effect of aquatic herbicides on the chemical quality of drinking water supplies. In particular, tastes and odors are important since these are the qualities by which the consumer judges water potability and palatability. Since, to the consumer, any off-taste or off-odor suggests that the water is unfit for human consumption, the purveyor is sensitive to any potential source of taste and odor in his water supply.

Ester derivatives of 2,4-dichlorophenoxyacetic acid (2,4-D) have proven to be successful aquatic herbicides. Since this compound is a phenoxy derivative, there is concern as to the occurrence of 2,4-dichlorophenol (2,4-DCP) as a formulation impurity or as a product of chemical or biological degradation of 2,4-D in surface waters. At concentrations less than 8 ug/1 and 2 ug/1, respectively, chlorinated phenols impart objectionable "medicinal" taste and odors to water (1).

Experimental Procedures: Various concentrations of esters of 2,4-D were added to 15 or 18 liters of tap or lake water that were stored in 5 gallon carboys at room temperature and maintained aerobically. Likewise, the three concentrations of 2,4-DCP; 100,500 and 1000 ug/1, were added to 18 liters of lake water that were stored in 5 gallon carboys at room temperature. One 2,4-DCP - lake water experiment was designed so that anaerobic conditions would develop whereas the second experiment was maintained aerobically by bubble aeration.

Threshold odor levels were made in accordance with "Standard Methods (4)". The 2,4-DCP was determined by a 4-aminoantipyrine colorimetric procedure (2).

Threshold dilution values were calculated according to the data of Burttschell (1). These values represent the dilution required by odor-free water for the odor or taste to be just detectable according to the "Standard Methods" test (4). A value of 1 or less means that no dilution is indicated; values greater than 1 indicate what amount of dilution is required.

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<u>Experimental Results</u>: Several liquid and granular formulations of 2,4-D were analyzed for 2,4-DCP. These data are reported as ug 2,4-DCP per gram of formulation (Table I). Liquid forms showed higher amounts of the phenol impurity, 70 to 4500 ug/gram , than did the granular forms 200 to 960 ug/gram . Using these figures to calculate the concentrations of 2,4-DCP that would result from the application of 100 pounds of 2,4-D per one million gallons of water (3.1 acre-feet), the amounts of phenol ranged from 8.4 to 539.3 ug/l. Subsequently threshold taste and odor dilution values for 2,4-DCP were calculated. In general, all formulations indicated high dilution values and, therefore, would presumably impart typical chlorophenolic tastes and odors to water.

Table II shows the release and persistence of 2,4-DCP from two granular forms of 2,4-D added to a natural lake water. Subsequently, these systems were analyzed for 2,4-DCP over a period of 218 days. Maximum concentrations of 14.7 and 20.7 ug/l of the phenol were observed after 148 and 218 days. Values of 9.5 and 16.7 ug/l after 7 days of storage indicated that phenol was released rather quickly. A high degree of persistence was indicated also by the levels of the chlorinated phenol that remained after 218 days of storage. Threshold dilution values show that very low, almost insignificant, taste levels were present, whereas the persistence of odor levels was significant.

Table III shows the release, occurrence, and persistence of 2,4-DCP from two iso-octyl esters of 2,4-D added to tap water that was seeded with settled sewage. These systems were stored for 59 days in an effort to show the influence of bacterial seeding on the persistence of the chlorinated phenol. In general, these systems exhibited lower levels of 2,4-DCP and threshold dilution values, and for a considerably shorter period of time, than did the systems shown in Table II.

Table IV shows the persistence of three concentrations of 2,4-DCP; 100, 500, and 1000 ug/l, in an unaerated and unbuffered lake water. Ethanolic solutions of the phenol were added in order to simulate the effect of excessive amounts of decaying organic matter on 2,4-DCP persistence. These data indicate that about 40-50 per cent of the original phenol concentration still persisted after 80 days in the 500 and 1000 ug/l systems whereas the phenol could not be detected after 43 days in the 100 ug/l carboy. Ultraviolet, examination of the 1000 ug/l system after 58 days verified that 2,4-DCP was still present.

Table V shows the persistence of 2,4-DCP in a lake water that was aerated and maintained at pH 7.1 to 7.6 with a phosphate buffer. These data showed that the phenol rapidly

TABLE I

2,4-Dichlorophenol Impurity in Formulations of 2,4-D

Type of formulation	%Ester	2,4-DCP per gram of formulation ug	2,4-DCP ug/1 (a)	Threshold Dilution Values (b) Taste	Odor
Liquid					
Iso-octyl ester	98.3	1250	149.8	18.7	74.8
Iso-propyl ester	98.5	4500	539.3	67.4	270.0
Iso-propyl ester	47.0	1500	179.8	22.5	90.0
Butyl	98.9	1000	119.8	15.0	60.0
Butyl	39.0	70	8.4	1.05	4.2
Iso-octyl	69.0	3250	389.5	48.7	195.0
Granular					
Butoxyethanol	-	560	67.1	8.4	33.6
Propylene Glycol Butyl Ether	-	200	24.0	3.0	12.0
Iso-octyl-A	30.15	960	115.0	14.4	57.6
Iso-octyl-B	-	650	77.9	9.7	38.8

(a) concentration at the rate of 100 lbs. of formulation applied per 1 million gallons of water (3.1 acre-feet).

(b) according to Burttschell et al (ref 1.).

TABLE II

Release and Persistence of 2,4-Dichlorophenol From Two Granular Forms of 2,4-D in a Natural Surface Water (a)

Time	Butoxy Ethanol Ester (b)			Propylene Glycol Butyl Ether Ester (c)		
	2,4-DCP (d)	Threshold Dilution (e)		2,4-DCP (d)	Threshold Dilution (e)	
Days	ug/1	Taste	Odor	ug/1	Taste	Odor
0	2.8(f)	1.0	1.4	1.0 (f)	1.0	1.0
7	9.5	1.2	4.8	16.7	2.1	8.4
14	10.3	1.3	5.2	3.5	1.0	1.8
21	11.9	1.5	6.0	14.1	1.8	7.2
28	10.3	1.3	5.2	14.5	1.8	7.2
88	9.7	1.2	4.8	7.8	1.0	3.8
148	14.7	1.8	7.2	9.2	1.2	4.8
218	8.7	1.08	4.32	20.7	2.6	10.4

(a) Laboratory carboy studies, 18 liters, room temperature

(b) Added as 1 mg/1 as the ester equivalent of 2,4-D

(c) Added as 1 mg/1 as the 2,4-D acid equivalent

(d) Corrected for interferences and volume depletion

(e) Calculated according to Burttschell (ref 1)

(f) Amount of 2,4-DCP added from the impurity in the formulation

TABLE III

Release and Persistence of 2,4-Dichlorophenol From Two Granular Forms of 2,4-D in Seeded Tap Water (a)

Time	Iso-octyl Ester - A (b)			Iso-octyl Ester - B (b)		
	2,4-DCP (c)	Threshold Dilution(d)		2,4-DCP (c)	Threshold Dilution (d)	
	ug/l	Taste	Odor	ug/l	Taste	Odor
0	14.4 (e)	1.8	7.2	9.75(e)	1.2	4.9
1 hr	0.0	0.0	0.0	0.0	0.0	0.0
2 da	9.1	1.1	4.4	5.6	1.0	2.8
7 "	6.3	1.0	3.2	3.9	1.0	1.95
9 "	11.6	1.5	5.8	8.9	1.1	4.4
11 "	9.0	1.1	4.4	2.2	1.0	1.1
19 "	13.8	1.7	6.8	13.8	1.7	6.8
24 "	4.2	1.0	2.1	13.5	1.7	6.8
31 "	4.7	1.0	2.4	10.6	1.3	5.2
59 "	0.0	0.0	0.0	0.0	0.0	0.0

(a) Laboratory carboy studies - 15 liters seeded with 5 ml settled sewage.

(b) Added as 3 mg/1 as the acid equivalent of 2,4-D.

(c) Corrected for volume depletion and interferences.

(d) Calculated according to Burttschell (ref 1)

(e) Amount of 2,4-DCP added from the impurity in the formulation

TABLE IV

Persistence of 2,4-Dichlorophenol in an Unaerated and Unbuffered Lake Water

Time	2,4-Dichlorophenol - ug/1 (a)								
Days	pH	Conc	% Oxid	pH	Conc	% Oxid	pH	Conc	% Oxid
0	7.3	100	0	7.3	500	0	7.3	1000	0
3	6.2	80	20	5.1	390	22	4.1	780	22
7	6.1	70	30	6.1	380	24	6.0	770	23
14	-	-	-	-	-	-	6.1	620	38
17	7.0	40	60	6.5	253	49	6.3	560	44
21	6.2	29	71	5.4	165	67	-	-	-
24	-	40	60	-	192	62	-	540	46
28	7.0	42.5	57.5	-	-	-	5.7	653	35
35	-	-	-	6.4	172	66	5.5	587	41
43	-	20	80	-	192	62	-	506	49
58	-	(b)	-	-	-	-	5.4	506(c)	49
80	-	-	-	-	-	-	5.2	573	43

(a) Ethanol solutions.

(b) Discontinued analysis.

(c) Verified by ultraviolet examination to be 2,4-dichlorophenol.

TABLE V

Persistence of 2,4-Dichlorophenol in an Aerated and Buffered Lake Water (a)

Time	2,4-Dichlorophenol - ug/l (b)								
Days	pH	Conc	% Oxid	pH	Conc	% Oxid	pH	Conc	% Oxid
0	7.4	100	0.0	7.4	500	0	7.4	1000	0
2	7.3	64	36	7.6	390	22	7.6	760	24
9	7.3	0	100	7.5	170	66	7.4	460	54
16	6.9	0	100	7.1	92	82	7.2	165	84
23	-	-	-	7.5	32	94	7.5	78	92
30	-	-	-	7.3	13	97.5	7.3	25	97.5

(a) Buffered by the addition of a pH 7.4 phosphate solution

(b) Dry chemical addition.

disappeared under aeration, stable pH conditions, and in the absence of excessive amounts of organic matter.

Figure 1 shows a semi-log plot of the rate of disapperance of the 500 ug/1 and 1000 ug/1 2,4-DCP concentrations versus time. These curves are typical of the aerobic biological oxidation of organic matter since straight line plots are observed (4). The parallel lines indicate that the rate of disapperance is the same for each system. Also, 50 per cent of the phenol was removed in 6 days in each system.

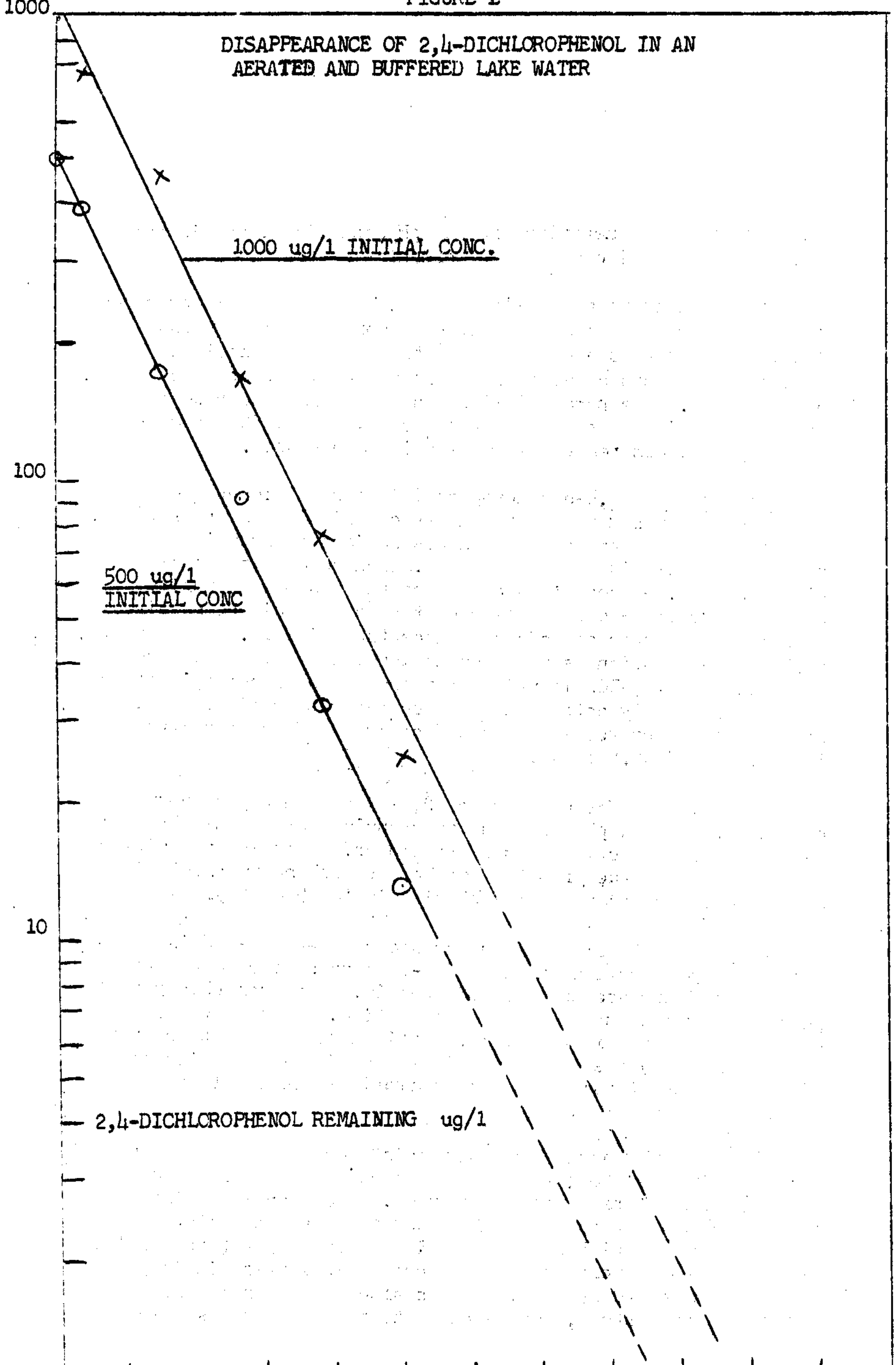
Discussion: 2,4-dichlorophenol is a significant factor affecting the taste and odor quality of drinking water supplies. That this phenol can occur in waters subject to aquatic plant control by 2,4-D is seen in Table I. Ten commercial formulations of 2,4-D contained enough of the phenolic impurity so that a several-fold dilution of the water would be required to bring the tastes and odors to acceptable levels. For example, a 38.8-fold dilution is required to lower the 77.9 ug/1 concentration of 2,4-DCP impurity from one of the iso-octyl esters to the just barely detectable odor concentration of 2.0 ug/1. Another way of expressing this effect is that the odor level is intensified 38.8 times.

Since liquid formulations of 2,4-D contain higher amounts of the chlorinated phenol than the granular forms, the threshold taste and odor dilution values are higher. This is in addition to the effect of the aromatic carriers (kerosene or fuel oil) on the taste and odor quality previously reported (5).

Subsequent laboratory studies showed that 2,4-DCP is released from 1 mg/1 dosages of 2,4-D to raise the odor levels of a natural surface water significantly. Moreover this phenol persists for a considerable period of time, as seen by the 218-day period in one of the systems (Table II). Qualitative data (not shown here) also indicated that, for the same period of time, the 2,4-D persisted in concentrations greater than 200 ug/1.

One of the reasons for the persistence of 2,4-DCP in natural surface water may be the lack of an adequate microbiological population to degrade these compounds. The phenol persisted at generally lower concentrations and for a shorter time in tap water seeded with sewage than in natural water (Table III). Tastes and odors were reduced to acceptable levels within 59 days in the seeded systems, whereas after 218 days in the natural water systems, considerable taste and odor was evident (Table II).

FIGURE I



DISAPPEARANCE OF 2,4-DICHLOROPHENOL IN AN AERATED AND BUFFERED LAKE WATER
1000
100
10
1000 ug/1 INITIAL CONC.
500 ug/1 INITIAL CONC
2,4-DICHLOROPHENOL REMAINING ug/1

Other reasons for the persistence of 2,4-DCP in a natural lake water may be the lack of aeration and an adequate buffering system to overcome the effect of excessive amounts of CO_2 evolved from the decay of organic matter. This is seen in Table IV where ethanol solutions of 2,4-DCP lowered pH values from 7.3 to the general range of 5.0 to 6.0 and anaerobic conditions developed as indicated by H_2S formation. Under these conditions unfavorable for biological oxidation, approximately 40 to 50 per cent of the original phenol was left after six days.

On the other hand, where "ideal"conditions of neutral and stable pH values, small amounts of organic matter, and aeration prevail, the phenol disappears quite rapidly. In Figure 1 the 100 ug/1 of 2,4-DCP disappeared within 2 to 9 days, and 50 per eent of the 500 and 1000 ug/1 quantities disappeared after 6 days. Also these curves can be extrapolated to the times at which the threshold taste and odor levels of 8 ug/1 and 2 ug/1 for 2,4-DCP are reached. These data are as follows:

	500 ug/1	1000 ug/1
Taste level	34.5 days	41.5 days
Odor level	46.0 days	53.0 days

Consequently it appears that 2,4-dichlorophenol can biologically disappear from a natural body of surface water under conditions of neutral and stable pH values and adequate aeration. Concentration of the phenol is not a factor affecting the rate of oxidation since the two lines in Figure 1 are parallel and reach the 50 per cent removal level at the same time. Concentration is a factor only in that the higher amounts of the phenol would persist longer thereby affecting the threshold taste and odor levels for longer periods of time.

<u>Summary and Conclusions</u>: Ten liquid and granular formulations of 2,4-D were analyzed for 2,4-dichlorophenol. Concentrations of this phenol ranged from 70 to 4500 ug per gram of formulation, and the liquid forms generally contained the higher phenol concentrations. Subsequent calculations indicated that levels of 2,4-DCP that ranged from 8.4 to 539.3 ug/1 would result in lakes dosed at the rate of 100 lbs. of formulation per one million gallons of water. In surface water these levels of the chlorinated phenol would produce significant threshold dilution values for tastes and odor.

Four granular forms of 2,4-D were placed in carboys containing tap water seeded with settled sewage and a natural surface water. Subsequent release, occurrence, and persistence of 2,4-DCP were observed. The seeded tap water systems indicated lower levels of the phenol for shorter periods of time than did the natural surface water systems.

Three concentrations of 2,4-dichlorophenol; 100,500 and 1000 ug/l were examined under conditions favorable and unfavorable for biological oxidation in laboratory carboy studies. The phenol disappeared rapidly under conditions of neutral and stable pH values, aeration, and small amounts of organic matter as shown by 50 per cent removal in 6 days versus a 50 per cent persistence for 80 days under anaerobic and unbuffered conditions.

The following conclusions are made from this laboratory study:

1. Commercial formulations of 2,4-D contain 2,4-dichlorophenol as an impurity. Liquid formulations contain more of the phenol than the granular forms per unit weight.
2. The 2,4-dichlorophenol released from granular forms of 2,4-D (1 and 3 mg/l dosages) persists at concentrations high enough to affect odor levels of a natural surface water for at least 218 days.
3. The persistence of 2,4-dichlorophenol released from granular forms of 2,4-D was decreased to acceptable odor levels within 59 days by addition of a sewage seed.
4. Threshold taste dilution values were not significantly affected by the 2,4-dichlorophenol released from the granular forms of (1 and 3 mg/l dosages).
5. Fifty per cent of the 2,4-dichlorophenol is removed from lake waters under conditions of neutral and stable pH values and aeration favorable for biological oxidation in six days.
6. From forty to fifty per cent of the 2,4-dichlorophenol can persist up to 80 days under conditions of acid pH values and anaerobic surface waters unfavorable for biological oxidation.

Acknowledgement: This work was sponsored by the National Institutes of Health, Bethesda, Maryland, under research grant WP 206. The technical assistance of C.N. Henderson and L. Rivela is also gratefully acknowledged.

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CRF-1 AQUATIC WEED PROJECT

Stanford N. Fertig 1/

Background

Senate Report No. 394 and Public Law 87-112 recommended that a portion of the increase in Federal-grant funds to State Agricultural Experiment Stations for fiscal year 1962 be used to step-up the research program on weed investigations. Part of these funds are normally allocated directly to the state stations, and part are designated as Regional Research Funds and are used to tackle problems of importance to two or more states in four designated regions of the United States. The regional funds are administered by a group of nine experiment station directors, representing all regions of the United States. It was the decision of the Committee of Nine directors that the portion of the appropriation designated for Regional Research be handled as a Central Research Fund (CRF) rather than being allocated, as in the past, to the four regions. The aquatic weed project is one phase of a coordinated research program initiated with support of these funds. Since this was to be the first effort with this type of funding, the designation of Central Research Fund No. 1 or CRF-1 was assigned.

Based in part on the recommendations of a Technical Weed Advisory Panel, two general areas in which weeds are a major problem were chosen (a) aquatic plants of irrigation and drainage canals, lakes and ponds, and (b) undesirable woody plants that infest the rangelands of the Great Plains. The Technical Weed Advisory Panel consisted of the following:

a. Two state experiment station research workers from each of the four regions, appointed by the Chairman of the Regional Experiment Station Directors Associations.

b. Two representatives from ARS, USDA.

c. One representative from Cooperative State Experiment Station Service (CSESS).

In view of the wide range of conditions of the aquatic environment, the growth habit of plant species (submersed, emergent, floating, ditchbank, etc.), and the number of plant species, the project was limited to four groups of submersed species, (_Elodea_, _Myriophyllum_, _Najas_ and _Potamogeton_), and filamentous algae. All projects were to deal primarily with these groups.

In September 1961, the state experiment station directors were informed by the Chairman of the Committee of Nine of the proposed program and were invited to submit project outlines covering either or both of the designated areas of research. Several stations submitted project outlines in both areas.

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Following receipt of the project outlines by the Committee of Nine, the Technical Weed Advisory Panel was asked to make recommendations on all projects submitted to the Committee. The final decision on which projects would be funded, the number to be funded and the level of funding was the responsibility of the Committee of Nine. From a total of 18 projects submitted on aquatics, four were funded: Alabama, California, New York and North Carolina.

Objectives

The objectives of the overall project (CRF-1) without regard to the individual participating states are:

1. To characterize the developmental stages of problem weed plants and determine the influence of environmental factors on their growth.

2. To evaluate promising mechanical, biological and chemical control methods, giving consideration to desirable plant and animal life.

3. To determine the relationships of soil, climatic and physiological factors to the action of herbicides on plants.

4. To determine the fate of promising herbicides in plants, animals, soils and water.

Procedure for Accomplishment

Work aimed at the accomplishment of the above objectives will be conducted within the specific framework of the selected station projects. The contribution and responsibility of each station project as outlined by that station are as follows:

ALABAMA

Effects of Herbicides on Submersed Weeds and Determination of Their Residues -- Controlled laboratory studies will be conducted using various concentrations of ten selected herbicides to evaluate the effects on five species of submersed aquatic weeds. Under field conditions, using plastic pool techniques, controlled experiments of several months duration will be conducted to determine herbicidal effects on submersed aquatic weeds, water quality, and toxicity to fresh-water fish and fish-food organisms. Concentration rates, as determined from results of laboratory studies, will be used for each chemical.

Samples of plants, fish, water and soil will be collected from plastic pools at intervals following treatment with herbicides and determinations of amounts of herbicide present will be made by appropriate chemical and/or bioassay techniques.

CALIFORNIA

Comparative Biology and Control of Submersed Aquatic Weeds -- The Botany Department of the University of California at Davis has special competence in the fields of morphology and whole plant physiology as revealed by autoradiography and other isotopic methods. The peculiar anatomical features of a few important aquatic plants will be studied and by comparative methods, the morphological and anatomical changes that result from use of herbicides will be characterized. Changes in tissue systems will be studied; for example, vascular tissues and aeration systems, as changes in these might be involved in herbicide responses.

By autoradiography of tracer treated whole plants, the absorption, translocation, and accumulation of labeled herbicides will be investigated in an effort to identify the sites of action of these compounds. By histoautoradiography, an attempt will be made to locate and identify any anatomical changes that might interfere with normal plant functioning and hence contribute to the decline and death of the plants. The effects of saline and alkaline environments on aquatic plants will be determined and comparisons will be made with findings of projects from the Eastern States to characterize any special requirements that these may impose on chemical control methods under Western conditions.

NEW YORK (CORNELL)

Principles in the Control of Submersed Aquatic Plants -- Laboratory and field studies will be initiated in experimental ponds to determine the effect of nutrient levels and ratios on the germination and growth of submersed aquatic plants. The concentration of major and minor nutrient levels will be varied as groups and individually to determine the effect on normal growth.

The influence of light, temperature, and depth of water on the development of aquatic plant and animal species will be investigated. Their influence on the kinds and amounts of aquatic species and their interrelationships will be evaluated.

Methods of accurately determining the populations of certain groups of aquatic life will be formulated and evaluated. Quantitative and qualitative determinations will then be made of the effects of promising herbicides on submersed weeds and animal life present.

In association with these investigations, analytical procedures will be developed for the determination of residues and breakdown products of promising herbicides in plants, animals, soil and water.

NORTH CAROLINA

The Fate of Herbicides in Soils -- The mechanisms involved in the fate of herbicides in soils will be elucidated. The process of adsorption on soil components will be studied with respect to the chemical and physical forces involved. The influence of adsorption on detoxication will be studied.

Attention will be given to the importance of organic chemical structure as related to the fate of herbicides in soil. The influence of environment on microbial breakdown of herbicides will be investigated. Research will be conducted in the laboratory, using plants and conventional techniques for chemical detection. The range of conditions to be studied will vary widely so as to include those occurring in aquatic soils.

The primary efforts to date have been the recruitment of personnel, purchasing of equipment and designing facilities required for the research program. All states have initial phases of the program underway, which will be helpful primarily in guiding additional experimental efforts toward solving phases of the aquatic problem.

Problems and Techniques in Growing Certain Aquatic Species Under Greenhouse Conditions[1]

M. G. Merkle[2] and S. N. Fertig[3]

Introduction

Before plants, either aquatic or terrestrial, can be grown successfully, an environment must be created from which the plant can obtain adequate moisture and nutrients and a suitable temperature, pH, light intensity and concentration of gases. In some instances the environmental requirements of aquatic and terrestrial plants are completely different, i.e. there is evidence that true aquatic plants do not require free carbon dioxide, but in most situations it is only a matter of degree.

The chances of creating an artificial environment suitable for the growth of aquatic plants depend on two factors; first, how well the needs of the plants are understood and second, the volume of water in the artificial environment. The first factor is self-explanatory and the second becomes obvious when it is recalled that depth of water influences light intensity, oxygen content, etc. Thus, if there is a sufficient volume of water, the plant can, within limits, select its own environment. With these thoughts in mind, attempts were made first to grow plants in a plastic swimming pool having a diameter of 9 feet and a water depth of 2 feet and later in small plastic bags using a volume of only 4 gallons.

Experimental Procedure and Results

A plastic swimming pool was erected in the greenhouse. Approximately 6 inches of muck were added to the bottom of the pool and water added to a depth of 2 feet. No attempts were made to control light, temperature, etc. Several submerged species including *Elodea canadensis*, *Potamogeton pectinatus*, *Potamogeton obtusifolius*, *Potamogeton crispus*, and *Potamogeton pusillus* were taken from 0.1 acre marshes and added to the pool. All species grew well for the first month but later the growth of *Elodea canadensis* and *Potamogeton crispus* became so dense that the other species began to disappear.

Table 1 gives the growth rate of stems of *Elodea canadensis* and *Potamogeton crispus* within one to three inches of the surface of the pool. It appears that *Elodea* grows somewhat more rapidly than does *Potamogeton crispus* and that terminal growth is more rapid than lateral. The continued growth of *Elodea* was somewhat surprising since the light intensity reached approximately

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[1] This work was supported in part by Federal-grant Central Research Funds (CRF-1) administered under the Hatch Act.

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7,000 foot-candles and some workers have reported that light intensities as high as 100 foot-candles resulted in the death of Elodea densa.

Table 1. The growth rate of Elodea canadensis and Potamogeton crispus in the greenhouse, 1962

Species	Length in centimeters								Average Growth Per Day
	8/15	8/18	8/21	8/24	8/27	8/30	9/4	9/7	
Elodea terminal bud	12.8	15.0	17.0	19.4	21.6	23.4	26.8	28.3	.71
Elodea lateral bud	1.8	2.6	4.4	5.4	6.5	7.9	10.1	11.2	.43
Elodea terminal bud	12.0	14.5	16.1	16.9	19.3	21.0	23.7	25.5	.61
Elodea lateral bud	5.5	6.8	7.8	8.7	10.1	11.4	15.1	16.9	.52
Potamogeton terminal bud	12.2	13.5	14.6	15.0	15.8	17.1	19.3	21.3	.41
Potamogeton terminal bud	13.9	14.4	15.4	16.2	17.0	17.8	19.4	20.7	.31

Table 2 gives a comparison of growth rates of Elodea at the top (1-3 inches) and bottom (2 feet) of the pool. Growth appears to be more rapid at the bottom than at the top probably because of different light intensities.

Another pool similar to the one described previously was erected and water added to a depth of one foot. Vallisneria sp., Myriophyllum sp., Chara sp., Najas sp. and Potamogeton pectinatus are being grown successfully in this pool. Algae also grew rapidly but the addition of 0.5 parts per million copper sulfate reduced their growth considerably.

Plastic bags 18 inches wide and 24 inches long were used primarily for nutrient studies. These bags are not well adapted for use in portions of the greenhouse exposed to the summer's sun, presumably because the water temperature frequently goes above 100°F or because of high light intensities. Sources of nutrients included muck, Hoagland's Number 2 nutrient solution at one-quarter strength plus EDTA and exchange resins (1). The exchange resin appears to be the most promising source of nutrients, since it maintains a constant pH, has little effect on light intensity, and an initial supply of

100 grams will sustain plant growth for a couple of months. The nutrient solution must be replenished at weekly intervals while the muck reduces the light intensity.

Table 2. A comparison of the growth rate of Elodea canadensis at the top (1-3 inches) and bottom of a pool in the greenhouse, 1962

Plant	Date and length in centimeters					Average Growth Per Day
	8/24	8/27	8/29	8/31	9/10	
Top 1	11.0	12.1	12.7	13.1	14.0	.18
Top 2	12.3	13.2	14.0	14.6	18.0	.33
Top 3	8.9	9.5	10.4	11.6	15.4	.38
Top 4	9.2	11.2	12.5	13.9	19.3	.60
Bottom 1	7.7	15.0	17.9	19.3	22.5	.87
Bottom 2	9.0	14.5	16.5	18.2	23.6	.88
Bottom 3	9.2	12.7	15.3	18.3	24.3	.89
Bottom 4	8.9	13.5	17.3	21.5	31.0	1.30

Table 3 shows a comparison of Elodea growth in tap water, tap water plus 100 grams of resin, tap water plus 3 inches of muck and Hoagland's Number 2 nutrient solution at one-quarter strength plus EDTA. All plants were grown at a surface light intensity of 65 foot-candles and were attached to short glass rods which anchored them at the bottom of the bags. The initial growth in muck was slower than in nutrient solution or resin. This is most likely the result of low light intensity. Growth in the muck increased as the plant grew to the surface and after some 50 days, plants growing in muck and resin were approximately the same length. After 10 to 15 days, growth in the nutrient solution was no longer as rapid as in resin and after 34 days growth ceased.

Following the favorable results obtained with resin in growing Elodea, attempts were made to grow other species with this medium (see Table 4). Of the plants tested at a surface light intensity of 65 foot-candles, Myriophyllum sp. and Elodea canadensis grew quite satisfactorily while Potamogeton pectinatus and Najas sp. grew very little and eventually died. Poor growth in the latter two species may have been caused by some factor other than nutrition. To date no successful method has been found for growing Najas sp. in plastic bags but Potamogeton pectinatus has been successfully grown in muck at a surface light intensity of approximately 1000 foot-candles.

Table 3. A comparison of the growth of Elodea canadensis using different nutrient sources, 1962

Nutrient Source	Date and length in centimeters													Average Growth Per Day
	8/7	8/10	8/14	8/17	8/20	8/23	8/27	8/30	9/4	9/10	9/17	9/24	10/1	
Tap water	6	6.8	7.6	8.5	9.5	10.2	11.4	12.3	13.2	13.6	13.8	-	-	.15
Tap water plus resin	6	8.2	15.7	18.7	21.4	24.8	29.5	31.8	36.1	39.4	43.5	45.9	46.6	.80
Tap water plus muck	6	8.5	11.9	13.3	15.3	17.4	20.2	22.1	27.4	32.7	38.4	45.4	47.4	.81
Hoagland's plus EDTA	6	8.9	15.5	18.3	21.0	23.6	25.6	27.2	27.7	28.4	28.4	-	-	.44

In all of the preceding experiments the resin used was a mixture containing 80 percent cation and 20 percent anion exchange resin. The results of an experiment conducted to determine whether the rate of growth of Elodea could be increased by altering the ratio of cation to anion resin are given in Table 5. The 70-30 cation to anion ratio gave slightly better growth in all instances. A more significant effect on the growth rate could probably be realized if the ratio of ions on the resin were altered.

Summary

A number of submerged aquatic species frequently found in the aquatic environment of New York State have been grown in artificial pools in the greenhouse. Some of these species including Elodea canadensis and Myriophyllum sp. have also been grown in small plastic bags at a surface light intensity of 65 foot-candles. Other species such as Najas sp. and Potamogeton pectinatus are more difficult to grow in the small bags.

Muck, nutrient solution and exchange resins have been compared as nutrient sources. The exchange resins produce good growth with a minimum of time and labor.

References

Table 4. The growth of some submerged aquatic species using exchange resin as the source of nutrients, 1962

Plant Species	Date and length in centimeters								Average Growth Per Day
	8/20	8/23	8/25	8/27	9/4	9/7	9/10	9/17	
Myriophyllum	9.4	13.4	16.7	20.4	28.8	30.6	31.1	33.2	0.85
Myriophyllum	9.1	10.3	11.5	12.8	21.5	24.8	25.7	27.1	0.65
Myriophyllum	8.1	9.5	11.5	14.1	25.1	27.6	28.4	30.8	0.81
Elodea	9.0	10.7	14.3	19.2	29.5	32.5	33.7	38.2	1.04
Elodea	9.0	10.0	15.2	19.9	29.2	32.4	34.1	42.2	1.29
Elodea	9.0	10.6	13.6	17.8	27.5	30.8	33.3	38.0	1.04
Potamogeton	13.0	13.1	13.1	13.1	10.8	10.8	—	—	—
Potamogeton	12.4	12.6	12.8	13.1	12.8	12.8	—	—	—
Potamogeton	11.5	11.5	11.5	11.6	12.6	14.7	—	—	—
Najas	8.9	8.9	9.0	9.0	5.1	5.1	—	—	—
Najas	12.0	12.3	12.3	12.7	8.4	8.4	—	—	—
Najas	9.0	9.2	9.2	9.2	9.3	9.3	—	—	—

Table 5. The effect of various ratios of cation to anion resins on the growth of *Elodea canadensis*

Cation-Anion	Date and length in centimeters										Average Growth Per Day
	9/26	9/29	10/4	10/8	10/12	10/15	10/19	10/22	10/30	11/3	
50-50	6	7.0	11.5	14.5	17.5	18.8	20.3	20.9	23.9	24.8	.49
50-50	6	6.5	11.3	14.2	17.1	18.5	20.6	22.6	28.0	29.5	.62
50-50	6	6.7	10.1	12.0	13.4	14.6	15.6	16.4	20.7	21.3	.40
70-30	6	6.7	11.9	15.3	18.2	20.7	22.9	24.9	31.5	33.1	.71
70-30	6	7.0	10.7	14.0	17.4	19.2	23.4	26.4	33.0	34.3	.74
70-30	6	6.7	10.9	13.9	17.0	19.0	21.9	24.6	31.5	32.8	.70
80-20	6	7.1	12.1	15.1	18.1	19.7	22.3	24.6	28.3	29.6	.62
80-20	6	6.6	10.2	12.9	15.3	16.6	19.0	20.5	26.5	28.2	.58
80-20	6	6.4	10.7	14.0	16.4	18.0	20.5	22.4	29.4	31.5	.67
Tap water	6	6.4	8.2	9.1	9.3	10.5	11.5	11.7	11.8	11.8	.15
Tap water	6	6.2	6.5	7.5	8.6	9.6	10.9	11.5	13.6	14.1	.22

FENAC - A POTENTIAL AQUATIC HERBICIDE[1]

John E. Gallagher[2] and Harold M. Collins[2]

Fenac (2,3,6 trichloro phenyl acetic acid) introduced several years ago as a terrestrial herbicide for the control of perennial broadleaf weeds, is active in several other fields of weed control. Of primary interest is its use and development as an aquatic herbicide.

Fenac was included in tests conducted in the Southeast for the control of alligator weed (Alternanthera philoxeroides) and water hyacinth (Eichornia crassipes). The initial studies showed fenac to be effective on both species at high rates. In current tests, it is finding more value when small amounts are used in combination with other herbicides. When used with phenoxy compounds such as 2,4-D and silvex for the control of alligator weed, it reduces the amount of the phenoxy material needed for control, but more important, it delays resprouting by several weeks. When used in combination with amitrole-T to control water hyacinth, it increases the rate of knockdown and subsequent sinking.

The limiting factor in the use of fenac for annual and perennial weed control in certain crops - long residual effect in the soil - has proven to be its most desirable characteristic in the control of submerged aquatic weeds. There are early indications of at least a two year carry-over.

Submerged Aquatics

The first positive evidence of the effectiveness of fenac for the control of submerged aquatics was provided by the USDA group at the Denver Federal Center. Finding that soil applications of herbicides were not controlling aquatic weeds in irrigation canals, Frank (1) developed an evaluation test which requires a minimum of time and material and is conducted in a greenhouse. Of the approximately 50 compounds he evaluated, those showing the most promise were fenac, fenac amide and silvex.

Field tests in the fall of 1960 and spring of 1961 by this same USDA group verified the laboratory findings. Frank, Hodgson, Comes and Timmons (2) found that 20 lb/A of the sodium salt of fenac applied to a canal bottom in the fall of 1960 provided 93 to 99% control of sago pondweed (Potamogeton pectinatus) during the 1961 irrigation season.

Tests in Missouri (3) and California (4) showed excellent control of mixed potamogeton species when fenac was applied to pond or lake bottoms following a drawdown. Rates of 10 and 20 lb/A have been effective in fall or spring applications.

Tests in the Northeast area during 1962 produced results varying from no control to complete control. The majority of the tests conducted were small plots in large bodies of water. In most of these tests, poor results were attributed to diffusion which diluted the soluble sodium salt formulation.

1. Paper presented at the Northeast Weed Control Conference at Hotel New Yorker, New York on January 9, 10, and 11, 1963.
2. Agricultural Chemicals Division, Amchem Products, Inc., Ambler, Pa.

Control was complete in small pond or shallow protected embayment tests with very low water exchange and where the total concentration was above 1 ppm. June and July applications to a ¼ acre pond and a ¼ acre bay in Toronto, Canada (5) provided 100% control of Potamogeton pectinatus in 3 to 4 weeks.

In a series of treatments applied to a lake bottom in southern New Jersey (6) 15 lb/A of fenac provided seasonal control of sago pondweed, elodea, water stargrass and bladderwort. Late June observations, with face mask and snorkel, of plots treated in mid-January showed an area treated at 15 lb/A clearly delineated. The plot area remained clean throughout the season.

The many tests conducted over the past two years have established certain limitations pertaining to the effective use of fenac for the control of submerged aquatic weeds.

1. The most consistent effective use has been as pre-emergent dry land applications to pond and lake bottoms following a drawdown.

2. A minimum soil fixation time following application to bottom soils is needed. It is not known whether this is due to precipitation and subsequent leaching or actual soil chemical bonding.

3. Applications to frozen soil have not been effective. It is theorized that the chemical has been washed away physically.

4. Ice or total water concentration applications to small ponds - up to 2 acres - have been effective when the concentration was above 1 ppm.

5. A minimum contact time is needed; too great a water exchange reduces its effectiveness.

6. Small plot treatments in large bodies of water have not been effective, apparently because of dilution of the herbicide.

Toxicology

Mammalian - The toxicological properties of the technical fenac are still being investigated. Current studies confirm a low order of toxicity. The LD_{50} for rats is 1780 mg/kg of body weight. Two year chronic feeding studies are being conducted with both rats and dogs.

Fish - Preliminary fish toxicity data indicates good tolerance by test species. Bluegill, trout, river and lake shiners, muskellunge and wall-eyed pike have shown 48 hr. TLM's to be above 20 ppm.

Potential Uses

Based on current findings, fenac should be tested in the following situations:

1. As a pre-emergent application to pond or lake bottoms following a drawdown (except to frozen soil), rates of 15 to 20 lb/A are suggested.

2. As a total application to small lakes or ponds, in the concentration range of 1 to 3 ppm.

3. As an ice application to small lakes or ponds, at 10, 15 and 20 lb/A rates.

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Single and Repeated Applications of Pre-emergence Crabgrass Killers on Turf
(Abstract)

J. F. Ahrens, R. J. Lukens and A. R. Olson[1]

Nine materials were tested from 1960 to 1962 on pure and mixed stands of turf grasses grown on soils ranging from fine sandy loams to loamy sands and maintained at various cutting heights. Effects of the herbicides on crabgrass (Digitaria spp.) and turf grasses were observed.

Applications of dacthal [dimethyl-2,3,5,6-tetrachloroterephthalate] and zytron [O-2,4-dichlorophenyl-o-methylisopropylphosphoramidothioate] in late April or early May have consistently controlled crabgrass without serious injury to turf even at twice normal rates in most tests. In 1962, but not in 1961, dacthal thinned Seaside bentgrass and fine-leaf fescues. At one location in 1962 zytron reduced the growth rate of Merion and Kentucky bluegrass and thinned Seaside bentgrass, but at another location zytron did not injure these same grasses.

Although tested only in 1961 and 1962, bandane [polychlorodicyclopentadiene isomers] at 30 lbs. per acre compared favorably with zytron and dacthal in controlling crabgrass and did not injure Merion or Kentucky bluegrass, creeping red fescue, Seaside bentgrass or stands of mixed turf. At 60 lbs. per acre, bandane caused slight injury in all of these grasses.

Trifluralin [2,6-dinitro-N,N-di-n-propyl-a,a,a-trifluoro-p-toluidine], also, has consistently controlled crabgrass, but at 1.5 lbs. per acre it thinned Kentucky bluegrass and at 3 lbs. per acre it severely thinned bluegrasses, Seaside bentgrass and creeping red fescue grown on loamy sand.

Diphenatrile [diphenylacetonitrile], calcium propyl arsonate, calcium arsenate, chlordane and an arsenical complex ("Pax") have not consistently controlled crabgrass to a high degree following applications in late April or early May. During the dry 1962 season, all four materials controlled crabgrass better on a loamy sand than on a fine sandy loam in adjacent experiments.

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Diphenatrile and calcium propyl arsonate have thinned pure stands of creeping red fescue, and diphenatrile also has thinned Seaside bentgrass. Applications of calcium arsenate and "Pax" depressed the growth of mixed turf in 1961 but applications in 1962 caused no injury. Single applications of chlordane have not injured bluegrasses, creeping red fescue, or Seaside bentgrass.

Single applications of zytron, dacthal, calcium propyl arsonate, diphenatrile, "Pax", calcium arsenate, and chlordane in 1961 all reduced crabgrass by at least 50 per cent in 1962. However, only calcium arsenate in 1961 provided satisfactory control of crabgrass in 1962.

Repeated applications of zytron, dacthal, calcium propyl arsonate and diphenatrile at normal rates in two successive years did not injure fescue-bluegrass turf the second season of treatment. However, applications of chlordane at 60 to 70 lbs. per acre in 1960 and 1961 or 1961 and 1962, and zytron at 20 lbs. per acre in 1960 and 1961 thinned turf in 1962, especially on a dry southern exposure. Bandane at 20 lbs. per acre in 1961 and 30 lbs. per acre in 1962 did not injure fescue-bluegrass turf in 1962 but two successive applications of bandane at 40 lbs. per acre thinned the turf.

Except where an herbicide merely depressed the growth of turf, without thinning it, lowering the height of cut increased the severity of herbicide injury. Much of the herbicide injury to turf also has occurred on the lighter soils where leaching of herbicide and severity of drought were greater.

CHEMICAL CONTROL OF CRABGRASS IN LAWN TURF [1/]

C. E. Phillips [2/]

A high percentage of the lawns in Delaware are infested with crabgrass. The intensity of the infestation is dependent on many factors and may vary from year to year to a considerable degree. On some lawns partial control of crabgrass has resulted from proper fertilization methods together with mowing to a height of about two inches. In most cases, however, chemical treatment is necessary to achieve satisfactory control. The experiments reported here were designed to secure information on the effect of various chemicals and time of application on crabgrass control in an established lawn.

<u>The 1962 Season</u> --

The first germination of crabgrass was on April 30 just after a 5-day period of 80°+ temperature with ample moisture. May was cool and quite dry until a 1.36 inch rain on the 24th but very little additional germination followed. The second major crabgrass germination period was just after a total of 2.06 inches of rain on June 12 and 13. These two germination periods produced most of the crabgrass that was present on the experimental plots.

<u>Methods and Procedure</u> --

The experimental plots were located on two areas of established turf on the University campus. Both areas were mostly Kentucky bluegrass and were infested with a fairly dense and uniform stand of crabgrass (mostly Digitaria sanguinalis) in 1961. Experiments 1 and 2 (Tables 1 and 2) were located on area 1 where the major germination periods were April 30 and mid-June. Experiment 3 (Table 3) was located on area 2 where there was practically no crabgrass until mid-June.

1/ Published as Misc. Paper No. 436 with the approval of the Director of the Delaware Agricultural Experiment Station.

2/ Professor, Agronomy Department, University of Delaware.

Both granular and liquid applications of chemicals were made in each experiment. A Scott fertilizer spreader was used for all granular materials. A Linck Liquid Sprayer was used for all materials applied in liquid form. To secure greater uniformity all liquid materials were applied by going over the plots twice. In Experiment 1 a total of 72 gallons of water per acre was used and in Experiments 2 and 3 the rate was 110 gallons per acre.

The plot size was 8 by 15 feet with a 2-foot untreated area between all plots and a 3- to 5-foot untreated area between all tiers of plots.

Estimation of percent control of crabgrass was obtained by visual observation made on September 28 and was based on the estimated area covered by crabgrass as compared to the adjacent untreated area.

<u>Discussion of Results</u> --

In Experiment 1 (Table 1) all the treatments were applied about one month before crabgrass emergence with the exception of Chipman 12161A. This material was applied only 3 days before emergence. Dacthal gave the best control both when applied as a liquid spray and in fertilizer. Zytron gave excellent control in one replication and not quite satisfactory in the other. Two experimental materials, Stauffer R4461 and Hercules 9573, gave quite satisfactory control and looked very promising. Trifluralin gave somewhat erratic control particularly when applied as a liquid. Bandane and the Bandane combinations did not in general give satisfactory control. The control with the CPA - CMA combination was better at the 98 pound rate than at the 65 pound rate but at its best did not seem worth further trials as an early applied material. Chipman 12161A showed no evidence of any control.

None of the treatments caused noticeable injury to the turf.

Table 1. Crabgrass Control with Chemicals Applied before Crabgrass Emergence.

Chemical		Rate a.i. Lbs/A	% Crabgrass Control 2/ Rep. 1	Rep. 2
Dacthal	75% WP	10	98	98
Dacthal	in fertilizer	11	98	98
Zytron	3 lbs./gal.	15	85	98
Stauffer R4461	4 lbs./gal.	10	90	90
Stauffer R4461	4 lbs./gal.	15	98	90
Hercules 9573	80% WP	10	90	95
Trifluralin	2% gran.	2	98	80
Trifluralin	8.92% liq.	2	40	98
Bandane + N	gran.	30	80	90
Bandane	7.5% gran.	30	60	85
Bandane + Chlordane	gran.	20 + 35	40	90
Diphenatrile	gran.	40	60	40
CPA + CMA	gran.	98	40	70
CPA + CMA	gran.	65	0	40
Chipman 12161A	5% gran. 1/	22	0	0
Chipman 12161A	5% gran. 1/	33	0	0

1/ Applied April 27, just before crabgrass emergence on April 30. All other treatments applied March 27.

2/ As estimated on September 28.

In Experiment 2 (Table 2) only one material, Trifluralin granular, could be considered as giving completely satisfactory control. This is not surprising, perhaps, since the results with PMAS and DSMA, both good post emergence chemicals, indicates that more than one-half the final stand of crabgrass emerged after the chemicals were applied. The CPA - CMA combination at the 65 pound rate showed a big increase in control for the May 15 application as compared to April 27 (Table 1). PMAS and DSMA undoubtedly killed most of the crabgrass present when the treatments were applied. However, there was a major germination of crabgrass after the June 12 and 13 rains and, since this germination occurred after the last spray was applied, the seasonal control was poor. Both PMAS and DSMA caused some discoloration of the turf. There were intensively damaged bands of grass caused by overlapping of the sprayer widths. These damaged bands would have been highly objectionable in a lawn. They pointedly called attention to the fact that recommended rates for some chemicals do not allow much leeway for carelessness and error in rate and method of application.

Table 2. Crabgrass Control with Chemicals Applied in Late Spring and Early Summer.

Chemical		Rate a.i. Lbs/A	Date of Application	% Crabgrass Control[1/] Rep. 1	Rep. 2
Trifluralin	gran.	2.0	5/15	95	98
Trifluralin	liq.	2.0	5/15	85	85
CPA	gran.	54.5	5/15	95	80
CPA	gran.	54.5	6/1	95	85
CPA + CMA	gran.	65.0	5/15	85	80
PMAS	liq.	.8	6/1, 8 & 15	40	40
DSMA	liq.	6.0	6/1, 8 & 15	40	30
Ansar A12	liq.	2.0	6/1 & 8	30	30
Ansar A12	gran.	2.0	6/1 & 8	0	0
Chipman 12161A	gran.	22.0	5/15	0	0

1/ As estimated on September 28.

In Experiment 3 (Table 3) several chemicals gave very satisfactory control. By referring to Tables 1 and 2 it can be noted that CPA and the CPA - CMA combination showed a decided increase in percent control with each delay in time of application. The combination of Trifluralin and DSMA is considered to be the most promising material used in 1962. This combination was also applied as a liquid to an 800 square foot area of a private lawn on June 27 and July 6. The area was somewhat low and damp and the crabgrass was in a solid, dense and vigorous stand. The treatment gave complete control of the crabgrass and the area was satisfactorily reseeded, part of it less than six weeks after treatment.

A careful study of the results of these experiments would seem to indicate that we can no longer classify all crabgrass herbicides as having exclusively pre-emergence or a post-emergence action. Trifluralin, CPA, and the CPA + CMA gave good control when applied shortly after emergence, and, as shown in Experiment 2, also gave pre-emergence control for the remainder of the season.

Table 3. Crabgrass Control with Chemicals Applied in Summer.

Chemical		Rate a.i. Lbs/A	Date of Application	% Crabgrass Control 1/ Rep. 1	Rep. 2
PMAS	liq.	.8	6/21, 28 & 7/6	99	99
CPA + CMA	gran.	65.0	6/21	98	98
CPA	gran.	54.5	6/21	95	98
Trifluralin + DSMA	liq.	.5 3.5	6/21 & 28	98	90
Trifluralin + DSMA	gran.	.75 3.5	6/21 & 28	98	90
Ansar A12	liq.	2.0	6/21 & 28	95	90
DSMA	liq.	6.0	6/21, 28 & 7/6	90	80
Ansar A12	gran.	2.0	6/21 & 28	90	50
Chipman 12161A	gran.	22.0	6/21	20	50

1/ As estimated on September 28.

Conclusions --

1. Dacthal gave the most satisfactory control of any chemical when applied before crabgrass emergence.

Two esperimental materials, Stauffer R4461 and Hercules 9573, gave almost as good control as Dacthal.

2. Trifluralin, CPA and CPA + CMA gave excellent crabgrass control when applied as "early post-emergence" granular materials.

3. A Trifluralin - DSMA combination was the most promising "summertime crabgrass killer".

4. Liquid applications of PMAS and DSMA are likely to cause very objectionable damage to lawns when applied at recommended rates with any equipment presently available to the average home-owner.

CRABGRASS CONTROL OBTAINED ON TURF TREATED WITH SEVERAL NEW AND DEVELOPMENTAL PRE-EMERGENCE HERBICIDES

Ralph E. Engel[1]

The rapid rise of pre-emergence herbicides has raised questions on some failures with several materials. Also, different chemicals continue to appear. A series of new and previously tested pre-emergence crabgrass chemicals were used in 1962, in an attempt to develop improved performances.

Procedure

Bandane, diphenatrile, Hercules 9573, Stauffer R-4461 (N-(Beta-0,0-diisopropyldithiophosphorylethyl)-benzene sulfonamide), and trifluralin were applied at varied rates on March 30. Also, bandane, diphenatrile, and trifluralin were applied on April 18 and May 8. The turf was predominantly Kentucky bluegrass with traces of bentgrass and red fescue. The treatments were replicated three times. The test area was overseeded in the fall of 1961 and some germination occurred in April and May of 1962. However, the abnormally dry period of April, May, June and early July did not permit significant development of crabgrass. The test area was watered during the second and third weeks of July to encourage crabgrass development and germination. Estimates of per cent crabgrass were made by three individuals in late September.

Results

Standard treatments of dacthal and zytron each gave 94% crabgrass control (table 1). Bandane was the equal of these performances when used at a rate of 60 pounds per acre in April (table 2). Rates of 30, 45, and 60 pounds per acre in March gave 69, 83, and 82% control. May treatment with 60 pounds of bandane per acre was a failure.

Diphenatrile approached the performance of dacthal and zytron very closely when applied at a rate of 60 pounds per acre. Treatment at 30 pounds per acre gave only 46% control. March, April and May applications at 60 pounds per acre performed very well and quite similarly.

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Appreciation is given to R. D. Ilnicki and R. N. Cook for their counsel and assistance, respectively.

Table 1. Crabgrass control obtained with several pre-emergence herbicides applied March 30, 1962.

Chemical	Rate/acre	% crabgrass control
Bandane	30	69
"	45	83
"	60	82
Diphenatrile	30	46
"	45	89
"	60	90
Trifluralin	1.5	87
"	3.0	97
"	4.5	97
Stauffer 4461	10	88
"	15	91
Hercules 9573	10	44
"	20	83
Dacthal	12	94
Zytron	15	94

Table 2. The effect of date of application on pre-emergence crabgrass control with bandane, diphenatrile, and trifluralin. New Brunswick, New Jersey. 1962.

Chemical	Rate/ acre	Date of application	% crabgrass control
Bandane - gr.	60	March	79
"	60	April	99
"	60	May	6
Diphenatrile	60	March	93
"	60	April	88
"	60	May	95
Trifluralin	3	March	97
"	3	April	95
"	3	May	98

Trifluralin at 3 and $4\frac{1}{2}$ pounds per acre was fully as effective as dacthal and zytron. Injury was recognized at these rates, but it was not critical. Application of this chemical at a rate of $1\frac{1}{2}$ pounds per acre was 10 percent less effective than the higher rates. Date of applying trifluralin appeared to make no difference in control.

R-4461 and H-9573 attained 91 and 83 percent control, respectively. Unfortunately, enough rates were not used to determine if the optimum rate was reached. No injury was observed.

Conclusions and Comments

(1) Bandane shows promise of a high degree of crabgrass control at a rate of 60 pounds per acre. Very early spring appears the best season for application. May can be too late.

(2) Diphenatrile appears capable of a more consistent performance when used at the higher rate of 60 pounds per acre.

(3) Trifluralin gives excellent control with 3 to $4\frac{1}{2}$ and somewhat less control at $1\frac{1}{2}$ pounds per acre. A degree of turf injury appeared to develop, especially at the higher rates.

(4) R-4461 and H-9573 show promise as pre-emergence crabgrass herbicides. Their potential control and safety should be of further interest to research.

INJURY TO ESTABLISHED TURFGRASSES FROM PRE-EMERGENCE HERBICIDES

R. E. Engel and R. D. Ilnicki[1/]

ABSTRACT

Pre-emergence crabgrass test treatments were made on lawn-type turf during the 1959, 1960, and 1961 seasons. The turf was predominatly Kentucky bluegrass with traces of red fescue and bentgrass. Calcium arsenate, chlordane, dacthal, diphenatrile and zytron were used in all three years of testing. Bandane and trifluralin were applied in the third season only. Significant to very good crabgrass control was obtained with all of these chemicals. During the 1962 season, which was very dry through spring and early summer, some plots appeared to show more injury than untreated areas. Estimates of the per cent green cover in August 1962, showed chlordane at rates of 40 to 120 pounds per acre was a consistent low. In two locations, where soil moisture or soil conditions were better, turfgrass injury was not apparent. This observation plus the failure to obtain results of this type previously, suggest the injury was associated with drought. Why such injury occurred is a subject of interest to research. Also, it would seem worthwhile to observe all pre-emergence treatments carefully for several years following application.

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INJECTOR TREATMENTS FOR KILLING NEW JERSEY AND EASTERN MARYLAND HARDWOODS

S. Little[1]

Since 1953 the standard method for killing undesirable hardwoods in eastern Maryland has been by application of 2,4,5-T in oil (8 pounds ahg[2] in #2 fuel oil) in ax frills made at convenient chopping height (Little and Mohr, 1956). While results have been reasonably satisfactory, more basal sprouting occurred than would have occurred if the cuts had been made near the ground. In addition, some of the treated trees have not died rapidly but have lingered on with partial crowns for 1 to 3 years after treatment.

In the South, the application of silvicides in ax frills has been largely replaced in recent yearsby the use of tree injectors. The design of these tools tends to ensure placing the cuts near the base of the stems where silvicides are most effective in reducing sprouting. Crew efficiency may also be greater because only one man, instead of two, has to walk to and work on each tree.

Several injectors are on the market. Probably the one most commonly used is the Little Tree Injector. For this injector the usual recommendations specify about 8 milliliters per cut of solution containing 4 pounds acid equivalent of 2,4,5-T ester in either 10 or 19 gallons of oil (Davis and Duke, 1955; Peevy, 1960). These concentrations are about 36 and 20 pounds ahg, respectively.

However, recommendations for the South could not with confidence be adopted in the Northeast without local trials. From past experience with other methods of silvicide treatment, we have found that chemicals and techniques that work well in one region do not always work well in another. Some of the variables that may affect results regionally include season of application, species, chemical, formulation of the chemical, carrier, concentration of chemical in the carrier, and dosage.

1/ Research Forester, Northeastern Forest Experiment Station, Forest Service, U. S. Dept. Agriculture.

2/ ahg = acid equivalent per hundred gallons.

To complicate the situation further, some authors have advocated using concentrated forms of 2,4,5-T or 2,4-D, eliminating what Starr (1961) called "the big job of mixing herbicide and carrier." Here the evidence is conflicting. Davis (1958) found that one 2,4,5-T ester was more effective on oaks and sweetgums at 19 pounds ahg in oil than the same amount of chemical when applied undiluted. On the other hand, Stephenson and Gibbs (1959) reported good kills with undiluted 2,4-D amine, and more recently Day (1960) and Peevy (1962) had good results with undiluted 2,4-D or 2,4,5-T amines.

Interest in injector treatment has been stimulated in the New Jersey-Maryland area by the recent development and promotion locally of a new injector, marketed under the name Cran-jector. This tool has a bit about twice as wide as that of the Little Tree Injector but is designed to operate with lower volumes of solution--about 2 ml. per cut.

Because of the continuing reports of successful results with injectors in the South, and the local promotion of the Cran-jector, New Jersey and Maryland foresters needed local information on which to base recommendations concerning injector use. Consequently, in 1961, tests were started in eastern Maryland and southern and northern New Jersey to determine the effects of season, species, chemical formulation of 2,4,5-T, and concentration. A supplemental test with undiluted formulations also was installed on one species. This report describes the first-year results.

STUDY METHODS

DILUTED MATERIALS

Major emphasis in the study was placed on: (1) two materials--a 2,4,5-T ester used with an oil carrier and a 2,4,5-T amine used with a water carrier[3/]; (2) three concentrations of each material--40, 80, and 160 pounds ahg; (3) four seasons or months of treatment--May, August, October, and January; and (4) three stand conditions--those typical of eastern Maryland, of northern New Jersey, and of upland sites in the Pine Region of southern New Jersey. Each of the 24 combinations of material, concentration, and season was tested on one 0.2- or 0.4-acre plot in a stand in each of the three localities. For all treatments, application of 2 ml. of solution per cut in cuts spaced about 1 inch apart was specified; however, in some treatments, less than 2 ml. actually was used. The injectors used were the locally made Cran-jectors. In North and South Jersey there were about 110 stems per treatment; on the Eastern Shore, about 200.

3/ These were furnished by Amchem Products, Inc., and are sold under the trade names of Trinoxol and Weedar Amine 2,4,5-T.

UNDILUTED MATERIALS

In southern New Jersey, in the same general stand referred to above, 160 black oaks were tagged and given measured dosages of undiluted materials in cuts made with an injector. In each season, 40 trees were treated--20 with each of the two materials used in the main study. Ten of each 20 trees received 0.5 ml. per cut and 10 received 1.0 ml. per cut. Chemicals were applied with a graduated syringe.

RESULTS

DILUTED MATERIALS

Southern New Jersey Oaks

The quickest and most striking effects observed during this study resulted from the May application of high-concentration (160 pounds ahg) amine to dry-site oaks in the South-Jersey stand. Within 10 days nearly all foliage on these trees was brown, as though seared by fire. A tally 4 months after treatment indicated that 88 percent of the treated trees were completely dead.

In this stand amine in water and ester in oil were about equally effective in the May, August, and October treatments; in January the amine was somewhat more effective (table 1). While the effectiveness of both materials tended to increase with concentration, generally the differences were greater between the 40- and 80-pound mixtures than between the 80- and 160-pound ones. The data in table 1 indicate that the 80-pound concentration is sufficiently effective to justify its recommendation over the other two that were tried.

Table 1.--First-year mortality of dry-site oaks in southern New Jersey1/

Treatment	Stems killed2/ May treatment	August treatment	October treatment	January treatment
	Percent	Percent	Percent	Percent
Amine 40 lbs. ahg	52 (81)	20 (55)	46 (49)	32 (41)
80 lbs. ahg	75 (84)	40 (78)	63 (65)	46 (51)
160 lbs. ahg	95 (97)	50 (88)	65 (68)	44 (51)
Ester 40 lbs. ahg	62 (79)	45 (65)	46 (56)	7 (13)
80 lbs. ahg	70 (80)	68 (88)	66 (67)	21 (37)
160 lbs. ahg	87 (90)	71 (89)	63 (67)	25 (37)

1/ Mostly black, white, and chestnut oaks with a few post oaks. Amount of material applied per diameter-inch varied from 1.3 to 3.7 ml., but in 17 of the 24 treatments the amount was between 1.5 and 2.5 ml. Tallies were made about one year after treatment except that January-treated trees were tallied in September of the same year.

2/ First figures in double columns include only killed trees that are

Chestnut oak proved much more resistant than the others; black, white, and post oaks showed little difference in susceptibility. Chestnut oak differed from the others in all seasons, especially in the 40-pound treatments. At this concentration, the kill of the other oaks commonly was 2 to 14 times the kill of chestnut oaks.

Eastern Maryland Hardwoods

For all hardwoods collectively in the eastern Maryland stand, the amine was less effective than the ester in about half of the comparisons (table 2). Poorer kills by amine are particularly apparent when the data for individual species or species groups are considered. For example, here are the data on kills by the 160-pound concentrations in each of two seasons:

Species group	January amine	January ester	May amine	May ester
	Percent			
Oaks	83	65	96	85
Sweetgum	79	70	100	100
Blackgum and sweetbay	71	78	94	95
Red maple	14	51	20	49
Holly	38	61	35	73

This breakdown shows that the two materials were about equally effective on the oaks, sweetgums, blackgums, and sweetbays; but on red maple and holly, relatively resistant species, the ester was appreciably more effective than the amine. Hence, for the usual stand conditions in that section, the ester is recommended over the amine.

Table 2.--First-year mortality of eastern Maryland hardwoods[1]

Treatment	Stems killed[2] May treatment	August treatment	October treatment	January treatment
	Percent	Percent	Percent	Percent
Amine 40 lbs. ahg	64 (64)	29 (34)	55 (58)	34 (35)
80 lbs. ahg	55 (57)	33 (37)	57 (60)	36 (38)
160 lbs. ahg	70 (74)	64 (69)	74 (85)	53 (54)
Ester 40 lbs. ahg	55 (56)	38 (45)	29 (33)	20 (23)
80 lbs. ahg	68 (68)	53 (58)	58 (61)	35 (37)
160 lbs. ahg	80 (82)	71 (77)	71 (73)	62 (66)

1/ Includes oaks, sweetgum, blackgum, sweetbay, holly, and red maple as well as scattered stems of hickory, sassafras, beech, shadbush, persimmon, hophornbeam, and dogwood. Amount of material applied per diameter-inch varied from 1.2 to 2.5 ml., but in 19 of the 24 treatments it was between 1.5 and 2.5 ml.

2/ See footnote 2, table 1.

Northern New Jersey Hardwoods

Kills in the northern New Jersey stand were not as good as they should have been, mainly because the amount of material applied in certain treatments was far less than that originally specified. This was especially true of the ester treatments made in May and October (0.7 to 1.3 ml. per diameter-inch in May, 1.0 to 1.2 ml. in October).

Even so, the data in table 3 do indicate that, as stand treatments, there is little difference between the two materials. The effectiveness of both materials again tended to increase with concentration, although frequently little difference was evident between the 80- and 160-pound concentrations.

Although, for many of the species, the amine appeared to be fully as effective as the ester, there were exceptions. On red and sugar maples, the ester was generally more effective, especially in the January treatments. The January applications of the two materials eliminated the following proportions of maples during the subsequent summer:

Concentration	Amine	Ester
	Percent	
40 lbs. ahg	4	29
80 lbs. ahg	9	38
160 lbs. ahg	9	50

In the January treatments, the ester has also been more effective to date on the dogwoods and most of the minor species than has the amine.

Table 3.--First-year mortality of northern New Jersey hardwoods[1/]

Treatment	Stems killed[2/] May treatment	August treatment	October treatment	January treatment
	Percent	Percent	Percent	Percent
Amine 40 lbs. ahg	45 (46)	61 (68)	38 (38)	19 (19)
80 lbs. ahg	37 (39)	78 (84)	42 (42)	18 (18)
160 lbs. ahg	57 (57)	80 (81)	66 (68)	32 (32)
Ester 40 lbs. ahg	36 (36)	56 (64)	40 (42)	20 (20)
80 lbs. ahg	62 (62)	60 (65)	42 (44)	46 (47)
160 lbs. ahg	57 (57)	73 (77)	51 (51)	46 (46)

1/ Includes dogwood, red and sugar maples, witchhazel, sassafras, and scattered stems of blackgum, beech, butternut, hickory, ash, basswood, black cherry, elm, black birch, northern red oak, chestnut oak, hornbeam, hophornbeam, and sycamore. Amount of material applied per diameter-inch varied from 0.7 to 2.5 ml., but in 10 of the 24 treatments was between 1.5 and 2.5 ml.

2/ See footnote 2, table 1.

More seasonal differences than are apparent in table 3 have been observed among these species in other tests. For example, red maples under a sweetgum stand in the upper Coastal Plain were treated on April 24 and on June 13, 1962, with an 80-pound concentration of ester in oil. Seven weeks after treatment, 83 percent of the April-treated maples were completely dead, but only 59 percent of the June-treated trees were dead after a comparable interval. By the end of the growing season the values were 98 and 87 percent, respectively.

Those trees had been completely frilled, and similar results can be expected from careful treatments of other problem species in New Jersey hardwood stands. For example, in August 1961, 136 dogwoods in a stand near Cranbury were treated with a 40-pound concentration of an ester in oil. Frills were nearly complete, and the amount of material applied was 2.7 ml. per diameter-inch. One year later all stems were dead with no resprouting.

UNDILUTED MATERIALS

Tests of undiluted formulations, as packaged by the manufacturer, were limited to black oaks, a susceptible species, in one stand. The results, given in table 4, vary with season. In May treatments, 80- and 160-pound concentrations of both materials were more effective than concentrates at 0.5 or 1.0 ml. per cut. In August the concentrate of amine was somewhat more effective than the same material at 80 or 160 pounds ahg, while 0.5 ml. of the ester concentrate was less effective than the diluted materials. October and January treatments showed relatively small differences between the concentrated and diluted materials.

Table 4.--One year effects of undiluted and diluted 2,4,5-T on black oaks in southern New Jersey

Date of treatment	Material	Stems killed[1/]: Undiluted material: 0.5 ml.[2/]	Undiluted material: 1.0 ml.[2/]	Diluted materials: 80 lbs. ahg	Diluted materials: 160 lbs. ahg
		Percent	Percent	Percent	Percent
May	Amine	20 (30)	80 (90)	80 (83)	100
	Ester	0 (0)	70 (70)	86 (91)	91
August	Amine	100 (100)	100 (100)	76 (94)	71 (93)
	Ester	0 (10)	90 (90)	81	76 (85)
October	Amine	70 (90)	100 (100)	100	87
	Ester	80 (80)	80 (100)	81 (85)	83 (91)
January	Amine	70 (80)	50 (60)	67 (78)	59 (82)
	Ester	10 (10)	20 (50)	23 (35)	28 (41)

1/ See footnote 2, table 1.
2/ Per cut.

At the dosages we used, somewhat less of the manufactured formulation was required to treat with diluted material than with undiluted: at 2.0 ml. per cut, the 80-pound concentration carried 0.4 ml. of the concentrate and the 160-pound concentration carried 0.8 ml.

For diluted materials the 80-pound concentration seems adequate. To obtain comparable results from the concentrates, the amine at 0.5 ml. per cut would be effective in August, October, and January, but apparently in May the amount would have to be 1.0 ml. per cut. In the case of the ester, only in October was the 0.5 ml. per cut as effective as the 80-pound dilution. In the other months 1.0 ml. per cut was needed for roughly comparable results.

This small test seems to indicate that:

1. Small quantities of amine concentrate, comparable to those in 80-pound dilutions, often may be effective on susceptible species.

2. Similar small quantities of ester would usually not be as effective as the dilutions. Both indications are, of course, limited to the formulations tested.

SUMMARY

Recent trials with a locally made injector have tested different concentrations of amine and ester formulations of 2,4,5-T for killing New Jersey and eastern Maryland hardwoods. For all species collectively the ester was the more effective formulation. The amine was about equally effective on some species, notably the oaks; however, the ester definitely was superior on maples and holly. An ester formulation, at a concentration of 80 pounds ahg in oil, is generally recommended, especially for the mixed stands found in eastern Maryland and northern New Jersey; amines also will give satisfactory results in the predominantly oak stands of southern New Jersey.

Application techniques are highly important. Especially on problem species, complete, low frills and use of at least 2.0 ml. of solution per cut are recommended.

Undiluted formulations, applied in smaller volumes per cut, offer promise, especially with amine. However, because of seasonal and species differences in effectiveness and difficulty in applying volumes as low as 0.5 ml. per cut, the use of concentrates is not recommended at this time.

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The Use of Undiluted Herbicides for Control of Undesirable Woody Plants

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Introduction

The invasion of pine sites by undesirable hardwood species has become a major land management problem in the South making the control of hardwoods for the establishment or release of established conifers essential in wide spread areas. Tree injection has become an accepted technique for the control of this competing vegetation. In 1960 over 100,000 acres of company-owned timber land in the South were treated with the tree injector. The popularity of the injector is due largely to its effectiveness, very high percent top kill and practically no resprouting, and its reduction of on-the-job accidents.

The most common treatments to date are to use a five percent or ten percent solution, by volume, of an ester formulation of 2,4,5-T in diesel oil. This solution is applied at the rate of approximately five milliliters per injection with the injections spaced two inches apart, edge to edge, around the base of the tree. The amine formulation of 2,4,5-T is being used to some extent where water can be used as a carrier.

The idea of injecting concentrated herbicides for woody plant control is not new. However, it has not been used on a large scale due primarily to the lack of a tool that could accurately meter extremely small amounts of the chemical. Injection of undiluted herbicides has several advantages over the use of solution. First, it will eliminate the refill time of the crews in the field. Second, it will solve the problem of mixing and transporting large volumes of solution. Third, it offers the possibility of using 2,4-D instead of 2,4,5-T which is considerably cheaper.

Method

In 1960 Mississippi State University in cooperation with Amchem Products, Inc. installed a series of plots to determine the effectiveness of herbicides applied in a concentrated form to cut surfaces made at the base of the tree and to compare these to the results obtained by applying a solution of the same chemical. The chemicals used were the amine salts of 2,4,5-trichlorophenoxyacetic acid and polychlorobenzoic acid and the butoxy ethanol ester formulation of 2,4,5-trichlorophenoxyacetic acid. Two seasons were included in the study - the month of June, representing the growing season, and January, representing the dormant season. Four species were included in the study - post oak (<u>Quercus stellata</u>), red oak (<u>Quercus falcata</u>), hickory (<u>Carya Spp</u>.), and sweetgum (<u>Liquidambar styraciflua</u>). The rates of application were 40 pounds of acid equivalent per 100 gallons of solution and 20 pounds of acid equivalent per 100 gallons of solution where a solution was used and 2.00 milliliters, .75 milliliter, and .33 milliliter where the concentrate was used. The injections at the base of the tree were made with empty injectors where the concentrate was used and the herbicides were applied with a hypodermic syringe, so that an accurate amount could be applied to each injection. An attempt was made to space the injections two inches apart, edge to edge, on all treatments.

After the first year's results of this study were analyzed, it was obvious that the 2,4,5-T amine, even at the low rate, gave satisfactory kill. An additional study using only the amine salts of 2,4,5-T, 2,4-D, as a four pound gallon, and the combination of 2,4,5-T and 2,4-D containing two pounds of D and two pounds of T per gallon was installed in 1962. The same rates were used in this study as in the previous study except that the 2.00 milliliter treatment was reduced to 1.00 milliliter. Only two species were included in this test - red oak (Quercus falcata), considered to be a hard-to-kill species, and post oak (Quercus stellata), considered to be an easy-to-kill species. The same technique was used in applying the chemical.

Discussion of Results

Table 1 summarizes the results of the initial study. The percent kills shown in the table are complete top kill with no resprouts. All species were combined in this table since there was no significant difference between species.

Both the 2,4,5-T ester and the 2,4,5-T amine, at all rates, gave satisfactory results for the growing season treatments. However, the amines were superior to the ester at the two lower rates of concentrate application.

For the dormant season application the results were satisfactory with all concentrate treatments. The concentrate applications were superior to the solution applications in both the ester and the amine treatments.

The amine salt of polychlorobenzoic acid did not give satisfactory results during the growing season, and it was excluded from the test for the dormant season applications.

Table 2 will give some idea of the savings on chemical and carrier alone. If the reduction in labor cost was added to this saving, it would amount to a significant reduction in total costs. The labor reduction should amount to more than the chemical and carrier savings since the use of concentrate will eliminate the fill-up and mixing time. In injection work the labor expenses are about 70 percent of the total cost. Since in this study the injections were spaced the same for both concentrate and solution applications, all of the time saved by not having to stop and refill could be used in treating additional trees. In operational injector jobs, one gallon of concentrate applied at the rate of .5 milliliter per injection with the injections spaced two inches apart will last approximately sixteen hours.

It was apparent that even at the .33 milliliter rate of 2,4,5-T amine applied as a concentrate the percent kill was satisfactory both during the growing season and the dormant season. The total savings would be in the cost of the carrier and the reduction in labor expense. However, if 2,4-D could be substituted for 2,4,5-T then the reduction in total cost would be much larger. In the second study we limited ourselves to the amine formulations but we added 2,4-D and the combination of 2,4-D and 2,4,5-T. We also limited ourselves to the dormant season, because from past indications, if it is satisfactory during the dormant season we can expect a slightly higher percent kill during the growing season.

Table 3 summarizes the one year results of this study. There was no significant difference between chemicals. So it appears that 2,4-D can be applied as a concentrate during the dormant season and obtain satisfactory kills.

In red oak, which we consider a difficult species to control, the 20 pounds per 100 gallon rate applied as a solution was significantly poorer than all other treatments. The concentrate applications of 2,4-D were better than the solution applications of 2,4-D.

For post oak, which is considered to be an easy-to-kill species, there was no difference between treatments.

Conclusions

From these two studies, it is felt that satisfactory control of post oak, sweetgum, hickory, and red oak can be obtained by applying .33 milliliter of concentrate of the amine salt of 2,4,5-T, 2,4-D or 2,4,5-T and 2,4-D to injections placed at the base of the tree with the injections speced two inches apart. The most economical of the treatments, of course, would be 2,4-D applied at the rate of .33 milliliter. Additional studies are needed to determine how far apart the injections can be spaced and still obtain satisfactory kills. This is critical since labor makes up the bulk of the total injection costs.

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Table 1. Percentage Kill of all Species

Chemical	Rate	June 1960 Treatments		Jan. 1961 Treatments	
		1st 1/	2nd 2/	1st 1/	2nd 2/
		percent 3/	percent 3/	percent 3/	percent 3/
T-Amine 4/	40# per 100 gals.	99	99	69	85
"	20# per 100 gals.	99	99	61	85
"	.33cc	99	99	69	92
"	.75cc	99	95	84	94
"	2.00cc	99	98	88	98
T-Ester 5/	40# per 100 gals.	100	100	90	95
"	20# per 100 gals.	99	99	48	78
"	.33cc	67	81	30	82
"	.75cc	99	91	54	98
"	2.00cc	100	99	90	98
Benzac 6/	40# per 100 gals.	3	59	--	--
"	20# per 100 gals.	1	34	--	--
"	.33cc	3	67	--	--
"	.75cc	4	74	--	--
"	2.00cc	4	76	--	--

1/ July 1961 evaluation

2/ July 1962 evaluation

3/ Percent kill, all species

4/ Weedar - 2,4,5-T - An amine salt of 2,4,5-T containing 4 pounds of acid equivalent per gallon.

5/ Trinoxol - A low volatile butoxy ethanol ester formulation containing 4 pounds 2,4,5-T acid equivalent per gallon. A special product designed for use in oil only.

6/ Benzac 354 - 4 pounds per gallon as an amine salt of Polychlorobenzoic acid.

Total number of sample trees - 3590
Average DBH of sample trees - 4.0" DBH
Cup spacing averaged 1.5 injections per 1" of DBH

Table 2. Chemical and Carrier Costs of Injector Work

Chemical	Rate	Carrier	Average Amount Concentrate Per Injection	Average Amount Concentrate Per 1" DBH	Chemical and Carrier Cost Per 1,000 Inches DBH 1/
T-Amine	40# per 100 gals.	Water	.576cc	.852cc	$2.33
"	20# per 100 gals.	"	.329cc	.478cc	1.50
"	.33cc	None	.33cc	.446cc	1.06
"	.75cc	"	.75cc	.900cc	2.15
"	2.00cc	"	2.00cc	2.380cc	5.68
T-Ester	40# per 100 gals.	Diesel oil	.629cc	.982cc	2.59
"	20# per 100 gals.	"	.352cc	.546cc	1.68
"	.33cc	None	.33cc	.370cc	.84
"	.75cc	"	.75cc	.892cc	2.04
"	2.00cc	"	2.00cc	2.960cc	6.76
Benzac	40# per 100 gals.	Water	.788cc	1.138cc	2.98
"	20# per 100 gals.	"	.443cc	.648cc	1.98
"	.33cc	None	.33cc	.396cc	.89
"	.75cc	"	.75cc	.960cc	2.17
"	2.00cc	"	2.00cc	2.460cc	5.56

1/ T-Amine at $9.04 per gallon
T-Ester at $8.64 per gallon
Benzac at $8.56 per gallon
Diesel oil at $.16 per gallon

Table 3. Percentage Kill of Two Species Treated During the Dormant Season

Evaluation Date: July 1962 Treatment Date: January 1962

		Red Oak			Post Oak		
Chemical	Rate	Average DBH	Average No. Injections Per Inch of DBH	Percent Kill [1]	Average DBH	Average No. Injections Per Inch of DBH	Percent Kill [1]
		inches	injections	percent	inches	injections	percent
T-Amine[2]	40# per 100 gals.	4.6	1.4	96	3.8	1.3	100
"	20# per 100 gals.	5.3	1.5	86	2.6	1.5	96
"	1.00cc	4.9	1.4	100	3.4	1.3	100
"	.75cc	5.9	1.4	96	3.4	1.4	100
"	.33cc	4.5	1.4	96	2.9	1.3	100
D&T Amine[3]	40# per 100 gals.	5.3	1.4	96	3.4	1.2	100
"	20# per 100 gals.	5.2	1.3	67	3.3	1.4	100
"	1.00cc	6.2	1.3	96	3.0	1.4	100
"	.75cc	5.3	1.3	93	3.1	1.3	100
"	.33cc	4.6	1.3	90	3.6	1.3	100
-Amine[4]	40# per 100 gals.	5.0	1.4	86	3.9	1.3	100
"	20# per 100 gals.	5.7	1.4	63	3.0	1.5	100
"	1.00cc	6.0	1.4	100	3.4	1.4	96
"	.75cc	5.5	1.4	96	2.8	1.4	100
"	.33cc	5.3	1.4	90	3.0	1.5	100

1/ Average percent kill all replications.
2/ Triethylamine salt of 2,4,5-trichlorophenoxyacetic acid containing 4 pounds of acid equivalent per gallon.
3/ Triethylamine salt of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid containing 2 pounds of 2,4-D and 2 pounds of 2,4,5-T acid equivalent per gallon.
4/ Triethylamine salt of dichlorophenoxyacetic acid containing 4 pounds of acid equivalent per gallon.

EXPERIMENTS IN WEEDING AND THINNING NORTHEASTERN FORESTS BY INJECTING HERBICIDES

By

Carle C. Zimmerman[1]

This is the third report on a continuing experimental program at Blackhawk Tree Farms, which consists of several tracts of former agricultural land, totaling about 1,400 acres, around Gilmanton, N. H. (1) (2). The goal of this program is an economical method of using herbicides selectively in Northeastern forests. There is great need for a sure-kill treatment for undesirable trees standing in the root zone of desirable trees. Among the criteria are low labor requirement and little or no hazard to humans, livestock, wildlife or desirable vegetation in the treated forests or surrounding countryside and settled areas.

Low-value "weed tree" species to be eliminated include soft red maple, white maple, gray birch, aspen, and wild cherry. Desirable species to be retained include oak, sugar maple, white birch, ash, beech, bass, and various conifers. Eliminating the weed trees is the first step in thinning the forest areas from 5,000 stems per acre down to 1,500 and ultimately less than 500 per acre.

On Blackhawk Farms, as in a good many other formerly cultivated areas which have been planted to seedlings or permitted to reforest naturally, the weed tree species shortly assume dominance over the conifers and many desirable deciduous species. Under any circumstances they deprive the desirable species of water, soil nutrients, and space. At first these weed trees help the others by breaking up the sod-root competition and providing nursing shade for the young conifers but they shortly outlive their usefulness, become a negative factor, and have to be eliminated. The first promising method of accomplishing this was the injection of fenuron previously reported, in which fenuron was injected at about 15 or 20 per cent of the soil application rate. However, the rates used in the 1960 and 1961 experiments proved effective enough only for severe chlorosis and defoliation, and many of the treated trees seem to have recovered.

Therefore, beginning in the fall of 1961, higher concentrations of fenuron have been injected and some other chemicals have been tried, including simazine and a new substituted uracil.

A total of 45 pounds of jellied liquid materials was used in the fall of 1961. These were mixed individually, to provide concentrations of fenuron or simazine ranging from 60 grams of active material per pound up to 200 grams per pound. About 100 trees were injected with each pound. One injection was made for each six inches of basal diameter, at a comfortable height for the worker. Thus the dosage per tree ranged from less than one

1. Blackhawk Tree Farms, R. F. D. No. 2, Box 180, Laconia, New Hampshire

gram of active material up to more than two grams. That starts from a little below the soil application rate and goes a little above.

Observations during the summer of 1962 indicated that this treatment was not successful although a great many trees became highly chlorotic, and a few died. However, this work did confirm our previous findings that chemicals capable of producing chlorotic symptoms when applied to the soil could also produce the same results when injected. However, the dormant season does not seem any better for injection than it is for soil application.

On May 11, 1962, injection trials were started on a new tract (Pavlick I) where no chemicals had been used previously. This is an upland three acres, declining about 45 degrees toward the northwest, and subject to full sun. It is estimated that these three acres had 1,500 volunteer white pine per acre, averaging about nine feet high. Over-topping these were about 4,000 weed trees per acre, mostly soft maple, aspen, and gray birch. From across the valley in the spring, the lighter green of the dominant weed trees completely hid the darker green white pines underneath. The fact that this pine under-stand was nine feet high was an exception to the general rule, because ordinarily weed trees assume dominance over conifers and shade them so that they are suppressed, and either killed or stunted. The exception arose here because the first competing woody vegetation was high-bush blueberry, a form of vegetation which white pines seem able generally to outgrow and surpass.

Three injection solutions were tried in this tract as shown in the following table. The solutions were made heavy and sticky by using the clay in fenuron pellets as the thickener.

TABLE I

Solution	Grams Per Pound of Injection Material		
	Fenuron	Uracil	Simazine
No. 1 (yellow)	34	72	--
No. 2 (pink)	34	36	36
No. 3 (blue)	34	--	72

On May 11, each solution was used on 100 trees of all sizes, ranging from ¼-inch d.b.h. to 12 inches. The trees were chosen in bands running up the slope, to keep the treatments separate. Injections were made at a convenient working height, 40 to 50 inches above the ground. For large trees, the dosage was about one gram of chemicals for each six inches d.b.h., or a little over half the rate recommended for soil application of fenuron. Small stems were treated by breaking the bark and touching the wound with the chemical. Very few trees received more than two injections.

With the left-over chemical, trees in a fourth band were treated the same way for checking purposes. Some fenuron pellets were also applied to the soil around some of the trees in this fourth band. By May 29, the nineteenth day after treatment, chlorosis was evident in the injected trees and in those which had been treated with fenuron pellets on the soil.

When it became evident that the experiment showed good chances for success (May 29) the whole three-acre field was completed. The "mixed" method was used: Fenuron pellets on the ground to enter through the roots for all trees considered safe, and injected solutions for the others. The injected solution used for this remainder of the field was No. 3 in the table above, the blue one. The whole three-acre plot required 10 pounds of pellets, seven pounds of injected chemical, and eight hours of work. The cost of the material was calculated at $7 per acre.

By the third week in July, when we looked at this field from across the valley, it appeared to be completely dead. Then a driving rain, lasting several days, removed the dead leaves, and a beautiful field of dark green pine emerged. The leafless stems were not evident from the distance, and the field looked like a successful hand planting without any weed penetration. Damage to pines was negligible, and none of it seems severe or permanent.

By August 15, weed trees on 40 or 50 adjoining acres were treated with either fenuron pellets or one of the injection solutions depending on the situation of each tree. Costs of materials remained around $7 per acre.

All of the work which was completed by June 15 (23 acres) showed favorable results in defoliation by the end of the growing season.

Probably this program at Blackhawk Farms will not produce entirely conclusive results until the end of a 10-year cycle, which will be in 1968. However, a few tentative observations seem definite, particularly since they have been discussed with various authorities, and verified by pertinent scientific literature.

1. Injection of chemicals which interfere with plant life by inducing chlorosis seems to be a promising practice for forest renovation. Some points in favor of this practice are as follows: The chemicals present little or no hazard to the user. They can be injected at a convenient height in the trunk. Injection seems to work as well as placing the chemical on the ground, killing the whole tree including the sprouting potential. Limbs below the injection become chlorotic also. Instead of frilling the whole tree, as some practices require, it seems that two or three injections up to 12 inches d.b.h. are sufficient. For small trees up to three or four inches d.b.h., one injection seems sufficient.

2. Injection should be tried with other chemicals of the same types alone or in combination.

3. Trees treated by injection seem to starve to death without adverse influence on desirable trees, insect life or the birds which feed on the insect life.

4. Costs of injection are low and may be reduced materially as the chemicals are used in greater volume, or experimental formulations move to commercial status.

5. A well-disciplined crew of skilled workmen can learn rapidly the proper techniques of selecting trees for injection, and treating them.

6. Injecting a tree is oftentimes more rapid than other methods which require marking treated trees with a blaze or paint.

7. On three acres, with eight hours' labor and $21 worth of chemical, this project at Blackhawk Farms has released a dominant white pine stand averaging nine feet tall. This compares with replanting costs of $100 per acre in seedlings and labor, which would take 10 years to produce an equal stand. Furthermore, red pine which is inferior economically to white, has been used in the replantings, simply because of its greater ability to survive when transplanted.

If the injection method proves successful, then a new approach to reforestation may take the place of hand planting. Weed trees can be utilized to shade natural seedings of pines and desirable hard woods and break up sod. Then when vigorous, desirable undergrowth has become established, the weed trees can be removed by injection. Thus the landowner would be relieved not only of the work and expense of hand planting, but also the disappointment of seeing new plantings succumb in their early years to sunlight, drought, and the competition of encroaching brush, shade, and top whipping.

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CHEMICAL CONTROL OF HARDWOOD SPROUTS USING AMMONIUM THIOCYANATE CRYSTALS

Jack J. Karnig[1]

In recent years the chemical industry has produced a succession of effective herbicides which have been quite successful in controlling woody plant growth. A partial list of these includes 2,4-D, 2,4,5-T, amino-triazol, sodium arsenite, sodium chlorate, ammonium sulphamate and ammonium thiocyanate. With few exceptions, application of these chemicals is effected in solution using some type of hydraulic sprayer or the more recently popular shoulder-mounted mist blower. Foliage spray, though effective, is a laborious method of brush control in rugged, inaccessible terrain.

Tree injectors, using concentrated solutions of herbicides in very small doses, have been quite successful in eliminating the drudgery of killing inferior hardwoods. Injectors are simple to operate, reliably selective and they effectively deaden when care is exercised in frilling the entire circumference of a tree.

Ammonium thiocyanate (NH_4SCN) has been recognized as an effective herbicide for many years. It has proven effective when used as a solution in axe frills (1). Ammonium and sodium thiocyanate solutions have been used in agriculture for weed control and temporary soil sterilization (2).

The use of any chemical as a solution creates immediate problems of bulk and weight which cannot be lightly discounted. It would seem that a direct, on the ground, application of concentrated crystals of a recognized herbicide might be successful. Ease of application as well as efficiency in transporting the concentrate would be two obvious advantages of this technique.

The following account describes both methods and results obtained from a study where ammonium thiocyanate crystals were broadcast or dumped at the base of hardwood sprout clumps at Harvard Black Rock Forest. Eight combinations were tested on as many plots in order to determine optimum application rates and techniques needed to produce an efficient control of sprouts.

Description of the flora

The study plots were staked out in an area supporting predominantly mixed northern red and white oak. Three years prior to the establishment of the experiment the stand was heavily thinned. Cordwood was harvested leaving a widely spaced residual stand of 12-14 inch DBH oaks whose crowns occupied about 50 percent of the canopy. At the time of cutting, all brush was cut and piled in order to facilitate the logging operation.

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1. Forest Manager, Harvard Black Rock Forest, Cornwall-on-Hudson, New York.

In June 1960, rank sprout growth covered the area with the exception of small patches where slash had been piled. The more vigorous red maple sprouts had grown to as much as 12 feet in height. Witch hazel and the oaks had attained about 8 or 9 feet; the remaining species were about 6 to 7 feet tall. Underneath the rapidly growing sprouts there were numerous seedlings of red and white oak. One hoped-for by-product of this experiment was the desire to release the seedling reproduction by either killing or enervating the dominant sprout growth.

Experimental design

A total of nine 1/20-acre plots were staked out in May 1960. All but one of these 66' x 33' plots were treated; plot #8 was untreated to test the effect of lateral movement of the ammonium thiocyanate in the soil. The chemical was applied on June 1 and 3, 1960. A description of the method of application and the quantity of chemical administered to each sprout clump appears in Table 1.

To qualify for treatment a minimum sprout height of approximately 5 feet was decided upon in advance. All time expended in spreading the crystals was carefully recorded so that some reliable per acre figures could later be calculated.

AMMONIUM THIOCYANATE USED IN SPROUT CONTROL
Treatments and Results

Treatment		No. of Sprouts Treated	Results in Percent		
			Not Affected	25%-75% Defoliated	Killed
4 oz.	at stump	68	65	29	6
4 oz.	1 ft. Rad.	32	78	19	3
4 oz.	2 ft. Rad.	37	100	-	-
8 oz.	1 ft. Rad.	50	60	6	34
8 oz.	2 ft. Rad.	36	56	25	19
12 oz.	at stump	53	19	24	57
12 oz.	1 ft. Rad.	34	26	21	53
12 oz.	2 ft. Rad.	41	69	24	7

Species treated included: red maple, witch hazel, black birch, red and white oak, sugar maple, dogwood, ash, hickory and American chestnut.

Results

The effectiveness of the eight different treatments varied from negligible to a maximum of 57 percent kill in the 12 ounce per clump direct application to the base of stumps. Apparently best kills can be realized by concentrating the chemical application close to the base of each sprout clump. It is also evident that a minimum dose per sprout of 8 to 12 ounces is to be recommended.

Ammonium thiocyanate in its dry form is actively deliquescent; therefore soon after application it is absorbed into the upper soil horizon. Rainfall is not needed to activate it by dissolving the crystals. Excess rainfall soon after treatment may, in fact, dilute it to such an extent that its killing action may be somewhat impaired.

Abnormally heavy precipitation during the summer of 1960 was measured at this forest. June produced 4.40 inches; July, 7.91; August, 4.98 and September, 7.39. Heavy rain may partially account for some of the drift effect reflected in the slight browning of leaf margins along the edge of the untreated plot (#8). This condition was most noticeable in September about four months after treatment. The damage was temporary, however, since in 1961 these untreated individuals developed healthy leaves.

One of the overstory red oaks (12" DBH) in plot #9 began to show leaf discoloration by late summer of 1960. A sprout clump near its base had been treated, so the assumption must be made that a sizable quantity of ammonium thiocyanate was absorbed by the root system of the large tree. Aside from discoloration, the only other evidence of distress displayed by the oak was premature defoliation. During the 1961 growing season this same red oak developed healthy leaves but showed a slight tendency toward sparseness in its crown.

On none of the eight treatments attempted was there any noticeable damage inflicted to the seedling reproduction within the plots. A considerable stocking of red and white oak in the 1 to 3 foot class escaped injury in spite of their close proximity to sprouts which were given doses of 4, 8 or even 12 ounces of ammonium thiocyanate.

Cost data

Combined labor and chemical costs per sprout clump for each of the three doses tried (4, 8 and 12 oz.) totaled 6, 11 and 16 cents respectively. The breakdown is as follows:

Chemical and Labor Cost Data
Using Three Strengths of Application

Dose per Clump (ounces)	Ammonium Thiocyanate	Labor Cost (cents)	Total
4	5	1	6
8	10	1	11
12	15	1	16

It is obvious from the above table that the cost of the ammonium thiocyanate compared to that of labor costs in applying it is quite high. One must, therefore, give primary consideration to consumption of the chemical which will depend upon dosage administered as well as stems per acre to be treated.

Specifically, the high density of sprouting in the study area, if given a thorough treatment, would raise costs to a high level. Average sprout stocking on the eight plots using a minimum height of 5 feet was 875 clumps per acre. Using 4, 8 or 12 ounce doses of ammonium thiocyanate crystals to treat such dense stocking would cost $52.50, $96.25, and $140.00 respectively. The foregoing amounts are based on NH_4SCN priced at 20 cents per pound.

Summary

Ammonium thiocyanate in crystalline form was tested to determine its ability to kill hardwood brush. Three dosages -- 4, 8 and 12 ounce -- were attempted using three techniques of application. These were scattering crystals around stump to a radius of 1 foot, 2 feet, and dumping directly at the base of a sprout clump.

An analysis of the results was made 15 months after treatment. The 4 ounce treatments resulted in very light kills with some partial defoliation. The 8 ounce dose was moderately successful having produced as much as a 34 percent kill. Most effective of the three strengths used was the 12 ounce. Two plots thus treated yielded 53 percent and 57 percent kills.

A direct, one-lump, application of 12 ounces NH_4SCN crystals was the most successful method tested.

None of the species tested showed evidence of resistance to the chemical. Ammonium thiocyanate seems to be non-selective in its toxicity toward many local broadleafed tree species.

Chemical and labor costs for 4, 8 and 12 ounce treatments were 6, 11 and 16 cents per individual sprout clump.

Conclusions

1. Preliminary tests using dry ammonium thiocyanate crystals to control hardwood sprouts in the 5 to 12 foot height class were reasonably successful.

2. Direct one-lump application at the base of a sprout clump appears to be most effective of the three techniques attempted.

3. A minimum quantity of 12 ounces (18 fluid ounces by volume) is needed to deaden more than 50 percent of actively growing sprouts.

4. Trees in the overstory may be affected by ammonium thiocyanate in cases where crystals are applied in heavy doses (12 oz.) within 3 or 4 feet of their trunks.

5. The cost of ammonium thiocyanate is relatively high if complete eradication is desired under conditions of medium to heavy stocking of sprouts. Labor cost in applying the crystals is comparatively low. The ease of employing this brush control method may attract adherents among individuals who have experienced the difficulties of spraying vegetation with back-pack spraying devices.

Addendum: Second year results

After two years, it was not possible to collect exact data on the behavior of all treated sprouts since growth had partially masked the initial effect of the herbicide. Some generalizations can be made, however, and these may be of some value to prospective users of this chemical.

The vast majority of sprouts which fell into the 25 to 75 percent defoliated class regained their foliage in 1962 after a one-year setback. The sprouts which were classified as dead in 1961 remained in this state with only a few exceptions. About 10 or 15 percent of the "dead" sprouts sent out weak shoots from their root systems during the 1962 growing season. This proves once again that in working with living organisms one rarely, if ever, subdues his adversary.

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MISTBLOWER TREATMENTS IN REGENERATING PREFERRED SPECIES IN THE FORESTS OF NEW JERSEY, EASTERN MARYLAND, AND EASTERN PENNSYLVANIA

S. Little[1/]

Mistblower applications of herbicides show great promise of becoming an essential tool in forest management. High-volume foliage sprays with hydraulic sprayers are of little practical value in managing most stands because they are so expensive. Mistblower treatments are relatively cheap, usually requiring only 1 to 3 pounds of the active chemical per acre in small amounts of carrier. Applied by machines that cover a swath, often 15 to 30 feet wide, they seem to be a logical, machine-age replacement for the hand cleanings of yesteryear.

However, to use mistblowers effectively and safely much needs to be known. Because sprays are dispersed as a mist, they settle on desired and undesired vegetation alike--especially from tractor-mounted blowers where direction and duration of spray cannot be as carefully controlled as from back-pack blowers. In some areas desirable tree seedlings or other vegetation that should be saved are present; here "selective" treatments are needed. In other areas, "conditioning" treatments that kill all understory vegetation are required to prepare sites for the establishment of desired reproduction. Because of differences in objectives, in susceptibility of the weed species, in the efficacy of different formulations and concentrations of herbicides, and in effects at different seasons, extensive testing is needed to provide a basis for prescriptions for the various forest conditions.

Drift problems must be recognized, too. Without proper precautions, the fine mist may drift out of a treated area and injure sensitive ornamental plants or agricultural crops. Unless such damage can be prevented, legal restrictions may be imposed that would greatly curtail the use of this potentially valuable forestry tool.

During the last 4 years, the Northeastern Forest Experiment Station, the Maryland Department of Forests and Parks, the New Jersey Bureau of Forestry, and the Pennsylvania Department of Forests and Waters have collaborated in mistblower trials in several of the forest types found in eastern Maryland, New Jersey, and eastern Pennsylvania[2/]. This report summarizes what has been learned and gives recommendations on future use of mistblowers in these forest conditions.

1/ Research Forester, Northeastern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, New Lisbon, N. J.

2/ Amchem Products, Inc., Allied Chemical Corp., and the duPont Company furnished materials for these trials.

LOBLOLLY PINE-HARDWOOD STANDS
ROLE OF MISTBLOWING

In the loblolly pine-hardwood stands of eastern Maryland mistblowing could be used as either a selective or conditioning treatment. The former is now its principal use, since established pine reproduction needs to be released in many stands, both in cutover areas and on sites where disking and individual-stem poisoning of large hardwoods have been done to favor conversion from hardwoods to pine. Because of the rapid growth of established loblolly pines, a fairly good top kill of competing vegetation ordinarily is sufficient; a complete root kill is not required.

In contrast, conditioning treatments should completely kill much of the treated vegetation. Such treatments are applicable in converting hardwood-pine stands to pine or in pre-harvest treatments of understories in pine stands. Here top kill of hardwoods and shrubs is not sufficient because regrowth usually would get ahead of pine seedlings starting after the treatment; thus a later selective job would be needed.

DESCRIPTION OF TRIALS

Northeastern Station trials started in 1959. These have been mostly screening tests to determine the relative effectiveness of different formulations and concentrations of 2,4,5-T in different seasons. The trials were limited to small (1/10-acre) plots and to treatments applied with back-pack blowers (KWH Model 75).

On the other hand, trials by the Maryland Department of Forests and Parks have involved only a few of the more promising materials but they have been far more numerous and extensive. While their initial trials were made chiefly with back-pack blowers (KWH Models 25 and 75), several of the 1961 and 1962 treatments were done with a Potts mistblower mounted on a D4 tractor. Size of area and composition of treated vegetation have varied greatly. In one instance, a single treatment was applied with the tractor-mounted blower to 80 acres. Dates of treatments ranged from late May to early September.

The Station and State tests together have involved many different formulations of 2,4,5-T. The following ones have been tried at least at 2-pounds and 4-pounds acid equivalent per acre both early and late in the season: (1) an emulsifiable acid in water carrier, (2) a triethylamine salt in water carrier, (3) a butoxy ethanol ester in an oil-water carrier, (4) another butoxy ethanol ester in an oil carrier, and (5) an isooctyl ester in an oil-water carrier. Also tried in oil-water carriers, but only in two areas during one month, were the butoxy ethoxy propanol ester and propylene glycol butyl ether ester.

RESULTS

Of the various materials tried, the isooctyl ester appears to be the most promising for selective treatments. For conditioning treatments, the most promising materials are: (1) a butoxy ethanol ester formulated specifically for oil carriers, (2) the isooctyl ester, and (3) the butoxy ethoxy propanol ester (the last tested only in 1962).

Our results have been similar to those reported by Starr (1961) in Mississippi. In his trials the isooctyl ester worked best in selective treat-our trials, as in Starr's, some of the formulations, notably the triethylamine salt, were relatively ineffective. Moreover, some formulations at some concentrations were nearly as damaging to pines as to the hardwoods.

Selective Treatments

Selective treatments are a ticklish proposition. The desired effect--top kill of hardwoods and shrubs without injuring the pines--is difficult to obtain. Stage of pine leader growth, species composition of associated hardwoods and shrubs, weather and season, as well as formulation and concentration of the spray, all affect the results.

Damage to Pines

Even with low concentrations and volumes, pine terminals may be damaged when extremely succulent. For example, in an application on May 22 with a backpack mistblower, using a mixture of isooctyl ester in oil-water carrier (2 pounds acid, 2 quarts oil, 4 gallons water), 2 gallons of this mix per acre caused appreciable deformation of new growth on the smaller loblolly pines (2 to 3 feet tall). The larger pine reproduction (5 to 8 feet tall) was not affected. Apparently growth of the smaller pines was slower or more prolonged, and still was succulent enough to be damaged.

In some cases relatively little distortion occurs and this will be overgrown. However, in other cases 1 or 2 feet of the new growth may curve out horizontally or in a big arc. This definitely is detrimental to potential crop trees. It can be even worse than death of the leaders because larger and longer lasting crooks often are formed.

To avoid causing crooked stems, selective treatments should not be made when terminal shoots are elongating rapidly. Timing of applications is particularly important to avoid damage to the long spring shoots. Deforming of summer shoots is not so detrimental because these are shorter; consequently they cannot form large crooks. The period when shoots are highly susceptible apparently is brief, possibly no more than 2 weeks.

Hardwood Control

The degree of control of competing hardwoods and shrubs varies with spray formulation and concentration, season and growing conditions, species, and application techniques.

In general, early-season applications are most effective, especially on relatively resistant species such as red maple but weather conditions at the time of treatment also may greatly affect results and even predominate over seasonal effects. For example, in 1960 the 2-pound-per-acre rate of isooctyl ester (in an oil-water carrier) caused the following top kill of hardwood reproduction and saplings in the Pocomoke Forest: (1) treated on June 15, 80 to 90 percent; (2) on July 8, about 50 percent; and (3) on July 25, nearly 80 percent. The kill after the June 15 treatment was typical for the best early-season applications in that section; the lower kill after the July 8 treatment was typical for midseason periods of inactive growth; and the higher kill after the July 25 treatment was typical for midseason periods when rains have stimulated the plants into renewed active growth. As Burns and Smiley (1962) stated, "during summer drought periods spraying is usually ineffective." This is particularly true with the low rates used in selective treatments. Just when selective treatments should end is uncertain. Scheduling most of the work in late May, June, and early July probably would be a prudent policy. Our late August and early September treatments often have been relatively ineffective. However, when late July or early August rains broke an extended dry spell, treatments in early or mid August were more effective than treatments made during the preceding dry period.

Species composition greatly affects the efficacy of mistblower treatments because of species differences in susceptibility. The susceptibility of the common associates of loblolly and pond pines on Maryland's Eastern Shore may be rated as follows:

Susceptible	Intermediate	Resistant
Yellow-poplar	Holly	Red maple
Oaks	Hickory	Mountain-laurel
Sweetgum	High-bush blueberry	Fetterbush
Herculesclub	Huckleberry	Arrow-wood
Blackgum	Dogwood	Maleberry
Sweet pepperbush	Azalea	
Sweetbay	Catbrier	
Winterberry		

Thus, the same treatment applied on the same day can be very effective in stands where the competition is from oaks, sweetgum, and pepperbush but it can be ineffective in areas dominated by holly, red maple, or certain tall shrubs. Because red maple is abundant on many sites it is a particularly important problem. As a rule, selective treatments substantially reduce crown cover of red maple only in early-season applications. Mid-season applications, even in moist periods, often kill only the terminal growth of the current season.

Application techniques are highly important. With back-pack blowers some operators have achieved twice as much foliage kill as others, apparently because they dispersed the spray more slowly and uniformly. Tractor-mounted blowers permit less directional spraying than back-pack machines; consequently, spraying with the tractor rigs has resulted in somewhat more damage to pines and somewhat lower kills of hardwoods. Of course, in practice, there is a tendency to use the tractor rigs in the areas of taller and denser growth, which should be recognized in comparing results with the two types of machines.

Height and density of the hardwood growth also influence spray-volume requirements. For the heavier growth, 4 to 5 gallons per acre are required for adequate coverage; whereas in more open areas with smaller stems, 2 or 3 gallons usually are sufficient.

Recommendations for Selective Treatments

On the basis of trials to date, we offer the following recommendations:

1. As a standard mixture in selective treatments, use 2 pounds acid equivalent of 2,4,5-T in an oil-water carrier (2 quarts #2 fuel oil, 4 gallons

2. When back-pack blowers are used in relatively open stands of small stems, apply about 2 gallons per acre. In dense stands where stems are 10 feet or more tall, use 4 to 5 gallons per acre, especially if treatments are made with tractor-mounted blowers.

3. Apply mist to the unwanted hardwoods as uniformly as possible. If back-pack blowers are used, direct spray toward the hardwoods and avoid the pines insofar as conditions permit.

4. Treat only when the hardwoods are relatively susceptible and when the pines relatively resistant.

5. In areas with many stems of resistant species such as red maple, treat early in the season.

6. Recognize that follow-up treatments with injectors may be necessary in areas with many resistant stems.

Conditioning Treatments

Conditioning treatments are much easier to do successfully than selective treatments because risk of damage to desirable species usually is not an important problem. Consequently, higher concentrations and greater volumes can be applied if required for good kills.

During the last 2 years the Maryland Department of Forests and Parks and cooperating landowners have made 14 trials of conditioning treatments, all with a tractor-mounted blower on areas of 10 to 80 acres in each treatment. While the number of trials is far less than with selective treatments, they have provided some valuable leads.

At least three formulations of 2,4,5-T seem promising for use in conditioning treatments: the butoxy ethanol ester formulated for oil carrier, the isooctyl ester, and the butoxy ethoxy propanol ester. Treatments involving oil-water carriers can be done effectively from late May through July, particularly if soil-moisture conditions are favorable. Apparently only an oil carrier should be used in August.

Concentrations and volume of spray needed for satisfactory results seem to vary with the amount of vegetation. Under fairly dense stands, particularly on the drier sites, hardwood and shrub understories are relatively open. There 2 pounds of acid in 4 or 5 gallons of spray per acre seem adequate. As understory density and height increase, larger volumes or greater concentrations appear necessary. In one treated area with an open overstory and dense, shrubby understory 15 to 20 feet tall, 2 pounds of chemical per acre in 5 gallons was far less effective than 4 pounds in the same volume. The latter killed the tops of 90 percent of the understory stems--about 30 percent more than the 2-pound rate. Possibly a higher volume or a higher concentration would have eliminated still more of the understory.

Height of effective crown kill varies greatly with formulation and concentration of spray, with species, and with stage of the vegetation. Frequently on susceptible oaks foliage has been killed to heights of 40 to and the lack of complete predictability in mistblower operations, any scheduled individual-stem treatment of large hardwoods in the same area obviously should be done after--not before--the mistblower results can be evaluated.

NEW JERSEY PINE REGION

In the Pine Region of southern New Jersey mistblowing trials have been made in three different types: (1) pitch pine-scrub oak (chiefly bear and blackjack oaks), (2) oak-pine (where the oaks are chiefly black, white, and chestnut), and (3) Atlantic white-cedar--hardwood. Again the Northeastern Station trials have been limited to small plots, each usually of 0.1 acre, and to early- and late-season tests of the various formulations and concentrations that were tried on the Eastern Shore. Some of the more promising materials have been tried at monthly intervals in one general area of each forest type. Additional trials, usually on small areas or on roadsides, have been made by the New Jersey Bureau of Forestry. In all these trials back-pack blowers (KWH) were used.

PINE-OAK TYPES

In the pine-scrub oak and oak-pine types, both conditioning and selective treatments might be used in silviculture. The different materials vary in effectiveness for these roles. For early-season treatments, the isooctyl ester in oil-water carrier (2 pounds acid, 2 quarts #2 fuel oil, 4 gallons water) is effective in both roles. An alternative for conditioning treatments in early season is the butoxy ethanol ester formulation for aerial application, used in oil-water. In our trials this was too damaging to pines to recommend as a selective treatment. For late-season treatments, the butoxy ethanol ester formulated for oil carrier was most satisfactory, although in selective treatments some damage to pines again occurred.

The 1961 results in one oak-pine stand indicated the seasonal differences that may be expected. All three above-mentioned formulations at 2-pound-per-acre rates in June caused 95-percent defoliation of oaks and 80-percent reduction in competition. In August and early September, efficacy of the oil-water mixtures dropped to 30- to 60-percent reductions in hardwood competition, while the oil solution was 75- to 90-percent effective. Of course, soil-moisture conditions and plant activity affect results, as on the Eastern Shore, so that sometimes a mid- or late-season treatment was appreciably more effective than one put on 2 weeks or a month earlier.

WHITE-CEDAR--HARDWOOD STANDS

In the white-cedar--hardwood type, effective selective treatments for releasing white-cedar reproduction have been the isooctyl ester in oil-water carrier during the early season, and a butoxy ethanol ester in oil for late-season applications. While both treatments have caused some injury to young white-cedars, it ordinarily was not serious. However, oil carriers in early-season applications were severely damaging.

The isooctyl ester, although it works well in June, does not perform well later in the summer. For instance, in one area a June treatment killed the crowns of many red maples and reduced most other species, including [illegible]

50-percent top kill of shrubs. In September the butoxy ethanol ester in oil was nearly as effective as the isooctyl had been in June.

Volumes used in selective treatments apparently should be increased with density and height of treated vegetation. In relatively light stands on recently cutover areas 5 gallons per acre of mix carrying 2 pounds of acid equivalent have been adequate, but that amount has been inadequate in dense thickets of shrubs and hardwoods taller than 7 feet. There volumes of 7 to 10 gallons per acre were required.

Because of the poor footing in the swampy white-cedar sites, mistblower applications are comparatively expensive. Therefore, aerial treatments should be considered as an alternative wherever feasible.

NORTH JERSEY HARDWOODS

On good North-Jersey sites, mistblowing offers great promise as a conditioning treatment, but here selective release of established reproduction is not feasible because the preferred species, especially yellow-poplar, are very sensitive to the chemicals. These sites can grow high-quality oaks, yellow-poplar, or sweetgum. Mature stands commonly have dense understories of the more tolerant hardwoods and such shrubs as sweet pepperbush and spicebush. These understories do not include much advance reproduction of the preferred species; hence they can be treated before a harvest cut in the overstory with little sacrifice of desirable seedling or sapling trees. Such a conditioning treatment shortly before a cutting, combined with injector treatments of large cull trees, may result in prompt establishment of an abundance of reproduction of the preferred intolerant species. And if the conditioning treatment is properly done, so that much of the understory is completely killed, the reproduction should require little or no subsequent release.

Such good hardwood sites are found especially in the upper Coastal Plain, Piedmont, and Highlands of New Jersey, in northern Delaware, in southeastern Pennsylvania, and eastern Maryland.

Northeastern Station trials on these sites have been confined to northern New Jersey, and they have involved small-plot tests of the same materials as were used in eastern Maryland and southern New Jersey. In addition, the New Jersey Bureau of Forestry has made a few additional tests of the most promising material.

Of the various formulations tried, the butoxy ethanol ester in oil has usually been the most effective. In early-season applications another butoxy ethanol ester (formulated for aerial applications) and the isooctyl ester, both in oil-water carriers, have also given good results. Where dense thickets prevail 2 pounds acid in 5 gallons of spray per acre are needed, but in area treatments the volumes used often are much less because of open spots.

The effectiveness of these treatments varies with species. Spicebush is very susceptible: complete top kill is common, and generally 50 to 80 percent of the clumps do not resprout. Maple-leaved viburnum is also susceptible. Smooth blackhaw, dogwood, and hawthorn are less susceptible, but still not highly resistant. Red maple is, of course, relatively resistant, although some stems of this will be eliminated, especially by early-season treatments.

The amount of understory control also is affected by plant vigor. Shrubs and suppressed hardwoods under good canopies are naturally less vigorous, and more susceptible, than open-grown plants of the same species.

Some damage to overstory trees, or to small trees outside a treated area, may occur if spraying is carelessly done. Nozzles should not be pointed upward at more than a slight angle; if aimed higher, the mist may carry into and injure some tree crowns, especially yellow-poplar. In one area some defoliation of yellow-poplars to a height of 30 feet resulted from too much upward-directed spraying.

On the whole, mistblowing with the more effective formulations and procedures is considered successful as a conditioning treatment in North-Jersey hardwood stands. In areas treated 2 years ago, the predominantly shrubby understories have been largely replaced by herbaceous species. Of course, in many areas injector treatments to kill large or resistant stems should supplement the mistblowing.

POCONO SCRUB OAK

In Pocono scrub-oak areas mistblowing could be one of the tools used in conversion to high forest. On sites too rocky to bulldoze and plant, conversion might be accomplished by (1) mistblowing to eliminate or set back existing vegetation and (2) direct seeding of the desired species. Besides bear oak and scattered red maples, aspen, and pitch pine, the stands characteristically have a dense cover of low shrubs--chiefly sheep-laurel and low-bush blueberry. Some elimination of the low shrubs, as well as of bear oak, is considered necessary for the success of direct-seeded conifers.

In the last 3 years the Northeastern Station, in cooperation with the Pennsylvania Department of Forests and Waters has made several mistblowing trials on this type of vegetation. Here plots were 1.0 or 0.5 acre in size, and applications were made in July with a tractor-mounted Potts mistblower or with a KWH 75 back-pack model.

First-year trials included ammate X (ammonium sulfamate) at 18 and 36 pounds per acre in an oil-water carrier, urab (3-phenyl-1, 1-dimethylurea trichloroacetate) at 4½ and 9 pounds active ingredient per acre in oil, a 2,4-D propionic at 2 pounds acid per acre in oil, and several formulations of 2,4,5-T at 1 to 3 pounds acid per acre in oil or oil-water carriers. None of the materials gave the desired results. At the rates tried, even the most effective treatment only top-killed the scrub oaks and some of the smaller shrubs.

Later trials have been limited to higher rates of the more promising 2,4,5-T formulations. At the present time two butoxy ethanol esters appear most effective: one formulated for aerial application and used in oil-water carrier, and one formulated specifically for use in oil. The former applied at 8 pounds acid in 10 gallons of spray per acre has so far been the best treatment. It top-killed nearly all woody growth and apparently root-killed 50 to 80 percent of the stems where the blower was definitely directed along lanes to be seeded. Five gallons per acre of the same mixture top-killed most of the shrubby growth but was appreciably less effective in preventing resprouting. The formulation for use in oil, applied at the same rates, also top-killed most of the brush but did not control resprouting as well as the aerial formulation.

CONTROLLING DRIFT

Drift definitely is a problem in mistblower applications. Even in large wooded tracts some drift outside a treated area may occur, particularly in situations favorable for air movement. For example, in scrub-oak areas, where the spray was consistently directed downward or horizontally, sensitive sassafras was killed as far as 200 feet to the leeward of the treatment. Slope may favor drift; this was observed especially in the hardwood stands, which occupied steeper slopes than the pine types. In the more open stands, spicebush may be killed 100 feet upslope from a treatment edge.

The drift problem is of greatest concern where isolated woodlots or forest edges near fields or homes are involved. On the basis of observations to date, the following procedures seem advisable:

1. Where dense growth has good vertical and horizontal continuity as a screen along the forest edge, treatments made with outlets pointed into the stand and held horizontally may be feasible to within 50 feet of the edge--if done on a relatively calm day.

2. In the absence of such a screen, do not treat with a mistblower unless nearby fields are fallow or in resistant crops such as corn or grass. Even then, do not treat the outer 100 feet. There other measures, such as high-volume sprays or disking, should be employed.

Possibly invert formulations would considerably reduce drift if applied as true invert emulsions. During the last year we tried these formulations in mistblowers, but we were not equipped to agitate the mixtures violently enough to obtain a thick, viscous emulsion. Although drift was somewhat reduced, it was by no means eliminated.

SUMMARY

Mistblower applications of 2,4,5-T can advantageously be used in regenerating preferred species in the forests of eastern Maryland, Delaware, New Jersey, and eastern Pennsylvania. In some stands their role would be in the selective release of conifers from competing hardwoods and shrubs; in others it would be in preparing sites for the establishment of desirable reproduction.

In trials of a number of 2,4,5-T formulations during the last 4 years, much variation in results occurred among formulations, rates of application, species, seasons of treatment, and soil-moisture conditions. Some formulations definitely were more effective than others for specific purposes and situations. For selective release, the isooctyl ester at 1 or 2 pounds per acre in oil-water carrier has been the most effective material in the loblolly pine-hardwood stands of eastern Maryland; in the pine-oak stands of southern New Jersey; and for early-season treatment in the white-cedar--hardwood stands of New Jersey. For conditioning treatments, highly effective materials include a butoxy ethanol ester (Trinoxol) in oil carrier at all test locations, the isooctyl ester in oil-water carrier in eastern Maryland and southern New Jersey, and another butoxy ethanol ester (formulated for aerial application) in oil-water carrier in the Pocono scrub-oak areas of Pennsylvania. Volumes and rates for effective conditioning treatments are in some areas appreciably more than those recommended for selective treatments.

Drift is a serious problem, and the treatments suggested should be used with caution. They cannot be safely used on the edges of stands near suscep-

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THE EFFECT OF CHEMICAL CONTROL OF AN UNDERSTORY UPON GROWTH RATES OF HEAVILY THINNED MIXED OAKS AT THE HARVARD BLACK ROCK FOREST * A PROGRESS REPORT.

Jack J. Karnig[1]

On the assumption that most of this audience has heard of and is rather well acquainted with the Harvard Black Rock Forest, I will only briefly describe its location, function, affiliation and physical character.

The Harvard Black Rock Forest comprises some 3,500 acres of forest land in the towns of Highlands and Cornwall, Orange County, New York. It is located about fifty miles north of Manhattan and is immediately adjacent to the United States Military Academy reservation at West Point.

Together with the Harvard Forest at Petersham, Massachusetts, the Black Rock Forest is owned and administered by Harvard University as a research facility available to its faculty and students. Over a period extending to nearly thirty-five years a wide variety of subjects have been investigated at this forest. Our findings have been published intermittently since 1930 in the form of Bulletins and Papers.

Nestled as it is in the Hudson Highlands, the Black Rock Forest can be characterized by an abundance of rock outcroppings, talus slopes, glacial erratics, steep slopes and upland swamps all of which manage to grow trees. As an after thought, nature veneered most of the terrain with a miserly portion of soil which is thoroughly mixed with boulders of all sizes. Fortunately, there are exceptions to the above described site condition and these exist on many of the north-facing slopes up to about 1100 feet elevation. Here glacial deposits of unassorted till and warp reach considerable depths (1) thus providing sites which retain moisture over longer periods of time than the thin soiled uplands. It is on such a deep till site that this tree growth study was initiated. It would appear that any practical answers derived from this research effort would produce optimum results on such a relatively productive site.

Previous Treatment

In 1956 the accessible portions of Compartment IV were heavily thinned according to a planned program instituted on this forest in about 1952. Cordwood volume was reduced by 16.6 cords per acre thus accounting for a cutting of 53% of the original stand. Leave trees were selected on the basis of dominance, good form and even spacing in that order of importance. Roughly fifty of the very best specimens were left per acre. The logging was followed up with a separate operation in which all brush was cut and permitted to decompose along with the slash left from the logging. By the end of 1957 the forest floor presented a park-like appearance similar to a grazed woodlot in its last stages of decadence.

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research.

Description of the Stand

The canopy trees within the study area consist mostly of northern red oak. Also present in lesser numbers are white and chestnut oak, red and sugar maple, black birch, hickory, tulip poplar and white ash. Most of the residual stand falls into the small sawtimber size class of 10" - 14" Dbh. The smallest tree is about 5" Dbh; the largest is 19" Dbh.

By the summer of 1959, when this study was initiated, sprout and seedling growth had developed with great vigor throughout the cutting. Sprouts varied in height from 6 feet to 10 feet with red maple clumps dominating all other species in terms of vigor and stocking.

The Hypothesis

A prior study by Stout[2] suggests that there may be a strong influence on growth (of residual trees) attributable to the presence or absence of undergrowth. This current study attempts to answer this question of the effect of an understory under conditions where optimum growth of leave trees is assumed due to complete crown release.

Treatments

By late summer 1959, sprouts seemed of proper size for an efficient spraying. In August a hydraulic spray of 2,4,5-T (4 lbs acid equivalent), low volatile ester was applied hydraulically to a three acre portion of the cutting. Formulation was one part 2,4,5-T in 200 parts water with one pint spreader sticker added to the mix. Using this concentration of the chemical, the kill was incomplete but about 60% of the understory was deadened.

In 1960 sprouts along the perimeter of the three acre treated area were cut and the stumps sprayed with 2,4,5-T in diesel oil. Formulation was 1 part T in 16 diesel oil. Cutting sprouts and spraying the stumps proved to be time consuming thus too expensive for application throughout the understory control site.

Reduction of living and partially defoliated understory seemed desirable once again in 1961, therefore a second area-wide spraying was launched using a shoulder-mounted mist blower of Dutch manufacture. Once again 2,4,5-T was used at a concentration of one part T to 16 parts water in addition to a dash of detergent.

Early in the 1962 growing season it was plainly evident that only about five percent of the original 1959 stocking of sprouts was still alive.

Calibration

Five one-fifth acre sample plots were established within the three acre treated area. Another five plots were placed in surrounding forest land where the understory was not disturbed. The latter henceforth will be referred to as control. Within each sample plot all trees were mumbered and Dbh marked with a horizontal paint mark.

Aluminum dendrometers(3) were fitted to each odd numbered tree on all the treated and control plots. This was done in mid-April 1961, before diameter growth at breast height became evident.

During the active growing seasons of 1961 and 1962, readings were made and recorded every two weeks on a total of fifty-six individual trees. An additional group of twenty randomly selected northern red oaks were banded in April, 1962. These were representative specimens located in adjoining forest land which had not been thinned in 1956 nor had the understory been disturbed for over twenty years. Growth comparisons will be made later showing 1962 increment for northern red oak unthinned, thinned with no understory control and thinned with understory eliminated.

Summary of findings: 1961 and 1962

Total diameter growth by two week periods for all banded trees in the treated and untreated plots show an interesting pattern when graphically illustrated. In 1961 growth reached a peak during the period June 17 - July 1. Trees in the control plots grew about equally as well as those in the area where the understory was all but eliminated. Cambial activity for ring porous species began during the April 22 - May 6 period and ceased at about the end of September.

Charting similar information as above for 1962 shows a dramatic change in growth with respect to timing. Peak growth occurred one month earlier than in 1961. Total diameter for the entire season is considerably less than that of the previous year. In 1962, trees in the treated plots consistently added more diameter than those in the adjoining plots where underbrush was undisturbed.

A seasonal cumulative growth curve of treated versus control trees for 1961 shows a parallelism which may appear contrived by some malevolent force. The spread as of October 7, the termination of the growing season, is insignificant. Average per tree growth for treated and untreated plots was 0.26 inches in diameter.

A similar curve of cumulative increment for 1962 indicates less total growth for the season, a more rapid leveling of the curve and most significantly a rather pronounced difference in end of the season totals. Synthesis of the data indicates that the average tree in the treated plots grew 0.20 inches at Dbh. as compared to 0.17 inches for its counterpart in the control plots. On a percentage basis, the trees in the control plots grew 16.7% more than those in the plots where the understory was left intact.

Graphic comparison of 1962 increment gained by northern red oaks under three different conditions shows a normal or expected relationship. Heavily thinned oaks with understory removed added the most increment. Thinned oaks with understory in place produced less total diameter gain. Unthinned or normally overstocked northern red oak grew at a much slower rate than either series of plots where thinning had taken place six years ago.

A percentage relationship between the resultant growth of each of the three conditions measured may be of some value. Let us assume that the unthinned oaks' growth is 100%. By comparison, the total per tree increment for thinned, untreated oaks is 159% and 177% for red oak which were thinned and where the understory was poisoned.

Gaining some insight into the growth behavior of our native species over time should be of value just as information. Man however is motivated to discover the causal relationships between biologic phenomena and ask the question -- Why? This built-in coriosity leads one to investigate the various factors which may contribute or detract from quantitative and periodicity of growth. The more obvious of the factors will probably include: rainfall or lack of it, air and soil temperatures, solar radiation, relative humidity, wind velocity and possibly some unknown contributors.

During the last two summers, rainfall and temperature have been carefully measured at this forest. By themselves or collectively these two environmental influences would seem to effect rate of increment to a noticable degree. At this writing, it appears as if temperature is more significant than rainfall due to peculiarities of the site chosen for this experiment. Ground water is generally abundant except for periods of prolonged drought. Temperature, on the other hand, seems to be the key in triggering growth sometime in April. This is indicated by an earlier and more rapid growth of trees during April and May 1962 as compared to identical dates in 1961. These two months were warmer in 1962 than in 1961. From mid-July until growth ceased in September, 1962 was consistently cooler than 1961. Lower average temperatures in 1962 seem to be reflected in less bi-weekly growth during this period. The same reasoning may account for the shorter growing season during 1962.

As the title of this paper indicates, this study will be continued for one or more summers. The idiocyncracies of tree growth will be cataloged and added to the knowledge already acquired. The basic question: whether elimination of an understory will stimulate growth of the residual stand, will remain as the prime goal of this study. In the meantime, environmental factors will receive closer scrutiny through refinements in measuring techniques. Statistically arrived at correlations will be sought after the data is collected. It is hoped that in the not too distant future, sufficient facts will be unearthed by this study to provide us a new insight into some of the relationships of trees to their environment. I look forward expectantly to the day when the completed version of this research is in hand and being read from this same rostrum.

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TIMBER STAND IMPROVEMENT BY AERIAL SPRAYING IN VERMONT[1]

Gordon Butler, Norman Hudson, and T. R. Flanagan[2]

In August 1961 an experimental spray project was carried out in Washington County, Vermont, to determine whether aerial spraying was an effective procedure to carry out the ACP Timber Stand Improvement Practice. The purposes were twofold: to reduce the competition from weedy hardwoods in softwood stands, and to determine if low rates of herbicides applied with fixed wing aircraft would be an effective and economical practice under northern Vermont conditions. The experiments were conducted on a field trial basis and were not designed to constitute a formal research project.

The use of airplanes to apply herbicides for releasing conifers has been reviewed by Arend (1)[3], Kirch (2) and by Sowers (6). Much work with fixed wing applications has been reported for other sections of the country, especially in the South (3, 5). White pine release and hardwood control by means of helicopter application of herbicide were reported to this conference in 1960 by McConkey (4).

The 1962 Agricultural Conservation Program for Vermont (USDA, Agricultural Stabilization Conservation Service) is designed to extend Federal cost sharing practices most needed to achieve maximum conservation benefits. The practice under consideration here is practice 6: Improvement of a stand of forest trees including improving a sugar grove or bush, on farm land. Federal cost share: (a) 70 percent of the cost of thinning, pruning, and removing or killing competing and undesirable vegetation, not to exceed $20 per acre. Federal cost sharing is allowed only for release of desirable tree seedlings and young trees by removing or killing competing and undesirable vegetation. The 1961 provisions allowed a Federal cost share of 80 percent.

A recent Conservation Needs Study indicates that timber stand improvement work should be carried out on nearly 1,000,000 acres in Vermont; 58,000 of which are located in Washington County. Washington County had been one of the more active Vermont counties as far as this practice is concerned. Over 1,200 acres of timber stand improvement work had been done in the four years preceding the work described in this report, at an average cost of $16.20 per acre. Although an impressive increase in the number of acres treated had been experienced over these previous years, conditions prohibited further significant expansion. High costs and limited supervisory time, among other conditions, precluded additional acres being treated by hand. Many potentially valuable acres were being left untreated. A new method of carrying out the work was needed. Since a fixed wing plane was available, a decision was made to conduct a field trial to determine what could be accomplished with aerial spraying under Washington County conditions.

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[1] Contribution from Department of Agronomy, University of Vermont, Vermont Agricultural Experiment Station Journal Series No. 117.

[2] County Agricultural Extension Agent, County Forester, and Extension Weed Spec.

[3] Literature cited.

The State program does not specify the means of accomplishing this practice, except that it must be carried out with the technical assistance of the county forester. It is further stated that, "Release of desirable seedlings and improvement cutting must be done in such a manner that there should be left on the average at least 200 young timber trees of desirable species per acre". The provisions for timber stand improvement in the Washington County ACP program do not differ from those of the State. The County ASC Committee reviewed this project, and the acreages concerned were approved for cost sharing under the ACP program.

Washington County is located in north central Vermont and is in the northern hardwood and transitional spruce-fir region as delineated in "Forest Cover Types of North America". The northern hardwood forest is made up of sugar maple, beech and yellow birch as component species. Associated are varying admixtures of red maple, hemlock, northern red oak, white ash, white pine, balsam fir, black cherry, paper birch, American elm, red and white spruce. White cedar and tamarack are also found.

Three main local associations treated were: 1. gray birch overtopping red spruce; 2. alder competition with softwoods; 3. hardwood brush competing with forest plantation.

PROCEDURE

Eight different landowners cooperated in this project. Following initial contact, each owner was given a careful explanation of the work. It was emphasized that this was a trial project with no guarantee of results given or implied. It was, however, explained that aerial spraying to release softwoods had been done successfully in other areas at a low cost. Such costs were considerably lower than current costs for timber stand improvement by hand cutting or other mechanical means.

In addition to the landowner, neighboring landowners were informed of the impending treatments. Local news releases were prepared and issued to inform the public. Most local concern has been relative to low flying of the aircraft rather than anxiety about the spraying itself.

A. Site acreages were determined by planimeter from scaled SCS aerial photographs. Species type and density determinations were made for each forest area by multiple observations made on the ground (Table 1). Ten to 15 acres were felt to be a minimum for efficient procedure, unless such acreage was contiguous with another landowner's.

B. Marking areas was by means of: 1. killing boundary and corner trees with sodium arsenite one week prior to spraying; 2. using pillowcases or white cotton grain sacks over the tops of long saplings. The saplings were fastened on boundary trees so that the pillowcase would show a few feet above the crown of the tree; 3. a combination of the two methods.

The first method was unsatisfactory; the pilot could not tell those trees killed with arsenite from those dead from natural causes. The second the dead trees contrasted with the white sacks, but the extra effort usually wasn't worth while.

Table 1. AREA AND COMPOSITION OF TIMBER STANDS BY PERCENT OVERSTORY

		Desirable Species			Competing Species				
Stand	Acres	Pine	Spruce	Balsam Fir	Gray Birch	Red Maple	Alder	Aspen	Other*
A	35		15R#		70	15			
B	50	20R	25N	5	30		20		Few
C	31	5W	10R	5	70			10	Few
D	35		10N		75	10		5	
E	53		10R		75	5		5	5
F	54	20W			40	35			5
G	15		10R	15	20	20+30H			5
H	17		NPW				95		5

*Hardhack, pin cherry, willow, thorn apple, wild apple, ash, elm.
#R = red, N = Norway, W = white, NP = new plantation, H = hard.

C. Herbicide used was 1 quart of 2,4,5-T (Weedone 2,4,5-T butoxy ethanol ester) in 7 quarts of #2 fuel oil applied at the rate of approximately 2 gallons per acre or an equivalent of 1 pound a.i. of 2,4,5-T per acre sprayed.

D. Applications were made on August 15 and 17, 1961 by a 450 hp. Stearman, with a 200 gallon tank, flying at 20 feet above tree top at a speed of 80-90 mph. The plane was equipped with an 18-nozzle boom and a wind driven pump. Flight days were provisionally selected in advance from weather predictions and confirmed at 3 a.m. by local weather observations. On both days, spraying started at daylight and was terminated at 9:30 a.m. because of the wind velocity increased to over 5 mph.

A fuel truck parked at the airport on the days spraying was done assured an ample and meterable supply of fuel oil. The 2,4,5-T was also stock piled at the airport in drums fitted with faucets. Measuring cans were provided.

E. Communications between ground and air were essential, and were provided by both hand signals and radio. Two ground observers and the pilot were equipped with radios (citizen's band) furnished by the Vermont Forest Service. Radio contact with the plane was continuous and used on 7 out of 8 trials. In a later study an additional plane flying 1,000 feet above the spray plane and with an observer in radio contact, both with the ground and the other plane, proved moderately useful.

F. Direction and management of the entire project was handled by the project leader. He served as contact man with the cooperating landowners, supervised site marking and spray preparation. Assistance was furnished by by several of the property owners. Extensive and pre-planned cooperation from all parties concerned is very important to the success of an undertaking of this nature.

RESULTS

All 8 areas started to show the results of spray within one week after application. Initial observations were made one month after application and again the following August (Table 2).

Table 2. ESTIMATED KILL OF UNDESIRABLE SPECIES IN PERCENT OF OVERSTORY

	30 Days after Spray				Year after Spray			
Stand	Small trees	Intermediates	Large trees	Total Release	Small trees	Intermediates	Large trees	Total Release
A	--	--	60	60	--	--	75	85
B	95	90	85	80	100	95	95	100
C	--	80	--	80	--	95	--	100
D	--	--	65	50	--	--	90	90
E	80	75	65	75	100	95	85	95
F	100	80	60	75	100	95	80	90
G	60*	--	70	70	85	--	85	95
H	90	90	70	90	100	100	95	100
Ave.	87	83	60	73	97	94	86	94

*Sprout clumps

Varying results were noted during both inspections. However, competition from the weed species was sufficiently reduced to make the overall results highly satisfactory.

Most weed trees were susceptible to the spray at the rate used with the exception of wild and thorn apple. These were of minor significance in the areas treated. Very small specimens did, however, succumb.

Resistance in other species varied somewhat with individuals. All of the treated trees appeared to be affected or were sufficiently weakened so as to die eventually. It was felt that these weak trees would not offer serious future competition. No resprouting showed in the areas in 1962.

Table 2 indicates degree of release in terms of small, intermediate and large trees affected. Small trees were in the 3 foot and less category and represented a cross-section of weed species encountered. Intermediate trees ranged from 3-15 feet; primarily alder and gray birch. Large trees were over 15 feet, mostly red maple and aspen, with some pin cherry and gray birch.

Degree of release was measured as reduction in competitive overstory. Evaluation was based on relative increases in the amount of sunlight now penetrating the overstory as a result of foliage reduction. This is a matter of judgment. Total release is not designed to indicate total kill of individual weed tree species. Instead it indicates whether enough of total overstory has been successfully eliminated to provide for maximum growth of the desirable species.

Extent and type of kill or dieback of individuals varies with the species and their size. Small seedling trees were almost completely eliminated. Sprout clumps, on the other hand, were slightly more resistant. About 85 percent of these clumps were killed or seriously retarded.

Of the intermediates, almost all alders were completely killed. Some birches and red maples exhibited slightly more resistance, but many were completely killed. As for the larger trees, almost all were somewhat alive. The bigger trees showed the top brown at the end of one month. Many of these trees leaved out the following year, but 50 percent of this subsequent foliage died back as the summer progressed.

In view of these results the project was repeated during August of 1962. Initial observations this year substantiated the findings reported above.

An itemized accounting of the cost is as follows:

COST STUDIES

Item	Gross Cost	Net Per Acre Cost
Plane and pilot	$ 725.00	$2.50
Fuel oil @ 16¢/gal.	83.13	.28
2,4,5-T @ $8.44/gal.	611.34	2.11
Pillowcases, telephone, etc.	19.31	.07
TOTAL COSTS	$1438.78	$4.96

Costs not normally charged are shown as follows:

	Supervisory time (Hours)	Landowner time (Hours)	Mileage
Marking areas	21	17	281
Spraying supervision	16.5	7	275
Spray loading	10	--	12
Communications (radio)	7	--	6
Pre-flight orientation**	2	--	6
Supply acquisition	2	--	4
TOTALS	58.5	24	584

**No charge made for plane and pilot.

Total "other costs" calculated at 58.5 hours supervisory time at $2.50 per hour (total $146.25), landowner time of 24 hours at $2.00 per hour (total

\$48.00), and mileage of 584 at 8¢ per mile (\$46.72). "Other costs" total \$240.97 and reflect approximately ¼ man hour of labor per acre. This plus mileage equals \$.83 per acre.

A cost of \$4.96 per acre is well within the range of attractiveness "circa \$10 per acre or less" reported by Sowers (6), less than that reported by Peevy (5), and just about that of the slightly less than the \$5 per acre figure reported by Arend (1) for the Lake States. It must be noted that such other costs as reported here reflect additional time required for carrying out the project on a research trial basis. Minimum costs can be maintained by purchasing materials at a discount, and by reduction in man hours and travel associated with ground supervision in areas where spray drift is not a critical problem. This was done in 1962 by use of a spotter plane.

CONCLUSIONS

1. Aerial application of 2,4,5-T at low rates was an effective means of reducing competition of weedy hardwoods in softwood stands.

2. Application by means of a fixed wing aircraft can be effective and economical on relatively small areas.

3. The techniques used proved an effective means of expanding timber stand improvement work in Washington County, Vermont, under the Agricultural Conservation Program.

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TIMBER STAND IMPROVEMENT

by Aerial Spraying with Helicopters in Maine

By W. Robert Dinneen [1/]

Since the dawn of organized forestry, foresters have been endeavoring to find methods of treating timber stands that were both economical and low in labor requirements. This search still goes on, its need intensified by the competition wood is facing in this everchanging world from metals, plastics and mass produced items. It is apparent that wood, as well as all other products, must constantly be seeking ways to improve its quality and quantity and at the same time reduce its costs. In addition, if our forests are going to reach the timber production goals for the Year 2000 as set by the U. S. Forest Service Timber Resource Review, means must be found to increase the rate at which Timber Stand Improvement is being accomplished.

One might liken the hand job the nation has been doing in Timber Stand Improvement to a man mowing his lawn with a small power mower and having just behind his house a hundred acre field which he feels he would like to mow, also. After a few spasmodic forays into it, he usually settles down to what he can mow easily with perhaps occasional extensions up into the field as time permits.

This is what seems to happen to the small woodland owner when confronted with his 25-50 or 100-acre woodlot that the forester recommends should be improved (and on weekends, no less). A few work faithfully on their project, but many fall by the wayside because of the magnitude of the job confronting them. And who can blame them? After all, their woodland, for the most part, is owned in conjunction with some other enterprise that produces their livelihood or their pleasure and it is not their major interest.

But power lawnmowers, power saws, power this and that, push buttons, etc., are becoming a way of life. It is becoming more difficult to find people to do the hard, dirty jobs in this world, and especially when they are the lowest paid. The progress of man apparently demands that as many jobs as possible be done by machines, by chemicals, etc., to relieve the problems of lack of time for physical work, the lack of willing manpower and the need to do things with a reasonable amount of time and money.

Problems beget answers and, characteristically, answers beget more problems. Fortunately, at this time, we in Maine are still working with the answers and one answer to some of our forestry needs appears to be the development of herbicides.

The interest of the Maine Forest Service in this subject was aroused by two separate points. One, an article in the Journal of Forestry about ten years ago discussing the aerial application of herbicides in California, and the distortion it caused to the leaders of the softwood understory; and, secondly, our personal observations of power line spraying which killed the

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hardwoods but miraculously did not appear to harm the softwoods to any degree. Discussions with the power companies indicated they were most unhappy with this development as additional expense was involved on their part of a return trip over the land to hand-cut the softwood growth. At that time, they did not know any method of killing the softwoods.

While they were unhappy, we were elated over the failure of the softwoods to be killed. In conference with the Massabesic Forest Experiment Station at Alfred, Maine, a branch of the U.S. Forest Experiment Station, it was agreed that the accidental results observed on power lines would be investigated further by them to see if practical applications to forestry could be made.

Work started in 1954 with the first experimental application of herbicides and continued through 1957. By 1957 the Maine Forest Service was doing its first practical commercial aerial spraying with helicopters. Due to the small size of the private landholdings that the Service Forestry Program works with, we have not attempted to use fixed wing aircraft. Naturally, various formulations were tried to obtain the best practical results for the lowest costs. The formulation now used is one quart of 2, 4, 5-T in $2\frac{3}{4}$ gallons of fuel oil.

Aerial spraying of herbicides is accomplished by cooperation of the private landowner:

1) With the State of Maine Forest Rehabilitation Act of 1957 which works in cooperation with the Title IV section of the Agricultural Act of 1956, Public Law 540. Under this program the state and federal government participate equally in the amount of money provided. Their total contribution has varied from 70-80%, with the landowner providing the balance.

2) With the U.S. Department of Agriculture, Agricultural Conservation Program, Agricultural Stabilization and Conservation Service Program. This comes under Practice B-10 Timber Stand Improvement with a cost-share of $5.00 per acre or approximately 75% of the costs.

3) By privately paying for the work themselves with the Maine Forest Service assisting in arranging for the work to be done.

<u>Field Procedures</u>:

Our Service Foresters carry on the field work of locating suitable areas for aerial spraying all year round. Approved areas are sent in currently and plotted on a master map in order to plan our program. The guidelines they use are as follows:

1) In making a reconnaissance of the woodland the Forester must judge carefully whether the area is in need of an aerial spray job or whether the treating and killing of individual trees will accomplish the needed silvicultural work easier and cheaper.

2) If there are merchantable hardwood trees in excess of 10% it is not considered for this program. (Over most of the state we are in the enviable position of being able to market practically any hardwood trees for pulpwood, boltwood or sawlogs; hence, the above guide.)

3) The stand structure should be such that softwood trees of desirable species are available to seed or reinforce the stocking of the area. Release of desirable softwood reproduction from overtopping or crowding by inferior quality hardwoods is also accomplished at the same time.

4) There should be at least 30 acres to be sprayed in multiples of 15 acres. (The helicopter can carry 45 gallons per trip and uses 3 gallons of spray material per acre; hence, the 15-acre figure.)

5) Spray areas should be at least 500 feet away from gardens, shade trees, etc., to avoid damage from drift. Chicken houses or ranges are also avoided.

At the time the reconnaissance is made and the area approved for aerial spraying, the boundary corners of the spray area are marked by the Forester with paint to avoid having to do this at a later date.

While it was mentioned earlier that the reconnaissance work is done all year round, the major portion is done in the autumn after leaf fall or in the spring before the trees leave out to facilitate observations of the site. To speed up our on-the-ground reconnaissance work, we usually line up as many lots as possible and look them over by helicopter in order to map areas that appear suitable for aerial spraying and worth follow-up ground surveys. It is possible to look over 4,000-8,000 acres or more on scattered lots in one day in this manner.

In June we plan our actual program. Our maps show where the areas to be sprayed are located and how many acres are involved in each lot. Using the guidelines of 150 acres within a two-mile circle of the landing field, we plan our working areas and eliminate the scattered lots that do not provide enough acreage. These are kept on file, however, to be used another year as a sufficient workload is built up.

When our planning is completed, the work is put out to bid with accompanying maps of the work areas and the acreage to be sprayed, flexible enough to allow for reasonable additions or deletions. The work is to be done between August 1 and August 30.

The responsibilities of the Maine Forest Service Service Foresters for the spray program are as follows:

1) Locate suitable landing fields for the helicopter with rights of ingress and egress.

2) Obtain a source for fuel oil and have it at the landing field. (This is usually done by having a local oil company bring its truck to the field, pump its oil directly into the helicopter tanks and provide metered slips for each individual's property sprayed.)

3) Boundary Corner Markers: While this is the responsibility of the landowner, it has been found that best results are obtained if the Maine Forest Service handles the entire job and charges the cost back to the landowner. Two types of corner markers have been used — flags and balloons.

(a) Flags are erected at the corners of the spray areas. Bright red cloth is made into pillow cases, filled with hay, and tied to long poles erected in the tops of trees. Professional tree men are employed at going rates for this work. Average costs of flag markers - \$2.08.

(b) Balloons filled with helium are used for markers, especially at easily accessible corners such as roads or fields. Average costs of balloon markers - \$1.80. These can be erected not more than a day before spraying whereas flag markers can be erected several weeks before, if necessary. Balloons are raised and lowered by using nylon fishing line and fishing reels mounted on short handles.

4) Maps: The Service Foresters provide the helicopter pilot with a map of the area to be sprayed on both U.S.G.S. maps and aerial photographs of the area. In any area with problems, the Service Forester will fly the area with the pilot. He also works with the pilot 100% of the time work is being done in his district.

5) On sample lots the Service Forester checks coverage of spray by use of spray cards.

The responsibility of the successful bidder, among many other things, will be to supply equipment and trained pilots and mechanics to service the helicopters, provide the 2, 4, 5-T to central locations and transport it as needed.

The aerial spraying must be done from a height between 25 and 50 feet above tree top level and when the wind is not more than five miles per hour. Hence, the work must be done very early in the morning before the wind comes up or in the evening after the wind goes down. The decision to spray rests with the Service Forester. If at all possible, we try to get the work done in early August. The later you wait, the more problems you have with morning fog delaying operations. The Contractor is required to respray without cost when respraying is necessary because of the Contractor's failure to perform satisfactorily.

A note of interest: Each year sees new and improved techniques. This year the Contractor came up with the idea of a "smoker." Formerly, the pilot had to pay extreme attention to details to be sure he returned to the correct spray line and at the same time execute a 180° turn. At the edge of a spray run the pilot now emits a jet of smoke from this "smoker" and after his 180° turn it lingers over his last spray run, giving him an excellent guide to go by. The pilot also uses it to test wind turbulence over the spray area. If he is in doubt about the wind speed and it appears to differ from that at the landing field area, which it often does, he emits a jet of smoke and notes the effect of the wind upon it.

Why do we do this type of work and why is it felt justified? Below is some information on the benefits to be obtained that all foresters know about and which has recently been written in pamphlet form.

(All the information below is taken from the publication, "Three Pine Release Experiments in Northern Minnesota," Station Paper No. 97 (April 1962) of the Lake States Forest Experiment Station.)

The Squaw Point Road White Pine Release Plots were established in a natural white pine understory averaging 28 years of age, overtopped by aspen and birch.

The Birch Lake Plantation Red Pine Release Plots were established in a 1915 planting of red pine planted 8 x 8. By 1931 an aspen overstory was competing strongly with the pine.

Plots were established on both areas with the following treatments: Full Release, Moderate Release (only trees removed interfering with pine), and No Release.

Item	Cordwood volume* on plots with --		
	No Release	Moderate Release	Full Release
		Cords per Acre	
		SQUAW POINT ROAD WHITE PINE	
After release at age 28:			
Conifers	0.2	0.4	1.0
Hardwoods	10.1	2.0	0
Total	10.3	2.4	1.0
22 years later:			
Conifers	4.5	14.8	33.2
Hardwoods	23.8	16.2	0.9
Total	28.3	31.0	34.1
		BIRCH LAKE PLANTATION RED PINE	
After release at age 19:			
Conifers	0.8	0.9	0.6
Hardwoods	1.6	.1	0
Total	2.4	1.0	0.6
25 years later:			
Conifers	17.6	26.3	34.2
Hardwoods	13.1	5.8	1.1
Total	30.7	32.1	35.3

* Cordwood volume per acre in trees 3.6 inches d.b.h. and larger immediately after release and at 22 to 25 years following release on two pine release studies in northern Minnesota.

For the full release treatment at Squaw Point 92% of the basal area was in white pine 22 years after release; the one at Birch Lake had 96% of the basal area in red pine 25 years following release.

Diameter Breast High

Item	No Release	Moderate Release	Full Release
Squaw Point Plots 22 years later	5.3"	6.9"	8.6"
Birch Lake Plots 25 years later	5.9"	7.8"	8.2"

Using a variation of the soil expectation-value method of economic analysis a comparison of release treatments can be made to determine how much can be invested profitably in release.

	Value* where treatment was --		
	No Release	Moderate Release	Full Release
		Dollars per acre	
		SQUAW POINT ROAD WHITE PINE	
Immediately after release	12	5	4
22 years later	41	97	222
Increase in value	29	92	218
		BIRCH LAKE PLANTATION RED PINE	
Immediately after release	4	3	2
25 years later	118	233	281
Increase in value	114	230	279

* Value per acre of timber on two release experiments in northern Minnesota immediately following release and at 22 to 25 years later.

Assume the following: (1) Future stumpage prices will be constant at $25 per MBM for pine sawtimber, $3 per cord for conifer cordwood, and $1 per cord for hardwood cordwood; (2) the forest owner discounts future returns at a compound interest rate; (3) following the first rotation, subsequent stands of pine can be established for $40 per acre; and (4) annual management expenses are $0.30 per acre.

Under these conditions and with a discount rate of 4 percent, the forest owner could invest profitably as much as $144 per acre for full release or $92 for moderate release on areas with the same conditions as the Squaw Point Road white pine plots. If release costs were less than this he would make more than 4 percent on his release investment. On the Birch Lake Plantation plots, however, release was not so effective from an economic standpoint. Here only $25 per acre for full release or $16 per acre for moderate release could be invested profitably.

With a discount rate of 6 percent the forest owner could have invested profitably only the following amounts: $70 for full release and $45 for moderate release per acre on the Squaw Point Road plots and $14 for full release and $8

With improved techniques the cost of release probably could be reduced. Cheaper release would mean higher investment returns.

Thus the cost of release, potential growth, and market expectations all greatly influence decisions about release. Careful estimates of these factors are required before a m aningful economic appraisal of release can be made. The release study areas evaluated here show a variation in investment opportunities. However, they also indicate that under some conditions release is an excellent investment opportunity in forestry.

* * *

While we as foresters know this, what of the landowner? After his land has been treated, we write him a letter, explaining what the woodlot will look like and what his costs are compared to expected returns. In part, we say,

"You might also be interested in an analysis of your costs and returns. For this reason the following two examples have been prepared. Your share of the costs in this cooperative program are, let us say, approximately $2.00 per acre. This is a very low cost for weeding inferior hardwoods from among high quality softwood trees. Hand weeding would cost five to fifteen times this amount. This $2.00 per acre investment cost can be easily justified.

Example I: $2.00 invested at 4% compounded annually for 50 years would yield $14.21. Therefore, $2.00 per acre invested in your land should return $14.21 in 50 years to equal a 4% return. With a stumpage on pine and hemlock of $20.00 per 1,000 board feet (present average stumpage price), you would require only 710 board feet per acre of added growth to return $14.21 and justify the $2.00 per acre invested in the spraying. Three pine trees 18" in diameter and 60 feet tall will yield 710 board feet of lumber. Therefore, if only three trees per acre are released and allowed to grow for 50 years, your investment is justified.

Example II: In case you wished a 6% compounded annually return in 30 years on your $2.00 per acre investment in spraying, you would need to receive $11.49. With a stumpage on pine and hemlock of $20.00 per 1,000 board feet, you would only require 575 board feet per acre of added growth to justify the $2.00 per acre invested. Seven pine trees 12" in diameter and 50 feet tall will yield somewhat over 575 board feet of lumber. Therefore, if only seven trees per acre are released and allowed to grow for 30 years, your investment is justified.

Well over 100 white pine are usually released per acre, so you can easily see the wisdom of aerial spraying to release valuable softwoods from weed hardwood species."

You may ask - what are the results, what are the repercussions, what is your future program? Physical accomplishments are as follows:

Year	Acres	100% Cost
1957	255	$ 2,168
1958	680	5,358
1959	745	4,236
1960	1,827	10,962
1961	2,430	13,712
*1962	1,250	7,450
	7,187	$43,886

* Lack of money curtailed the program.

The largest lot we have sprayed was 255 acres and the smallest was 9 acres. They average about 45 acres.

A critique of the silvicultural accomplishments on the ground was held a short time ago with the U.S. Forest Experiment Station, the University of Maine School of Forestry and the Maine Forest Service personnel participating. It was agreed that the results were satisfactory and the aerial spraying was accomplishing the silvicultural goals planned. Naturally, it is to be expected that due to many different factors some areas will need another treatment some years hence and this is in our work plans.

As far as repersussions, we have had none. While we are perfectly willing to give Lady Luck some of the credit, it is also felt that our public relations have been well handled and the people completely informed as to what we are doing and what we are endeavoring to accomplish.

For our future we can only say that it is hoped that adequate funds can be obtained to continue this important work. Without it, thousands of acres of our Maine forests will be growing only worthless, inferior sprout hardwoods for generations to come. Further, we will not be contributing our share of timber for the well being of our people, our state, and our nation.

Additional Information:

1) Landing Fields: Should be at least 100 feet x 150 feet in size. There should be openings in at least two directions for the pilot to approach the field without high hazards, such as trees, buildings and transmission lines.

2) Balloons: Type - Darex N-100, weight -10 grams; can be inflated to 2½ feet in diameter. Cost about 50¢ each in lots of 100 or more (1961 price). Can be purchased from Dewy & Alny Chemical Co., Div. of W.R. Grace Co., Cambridge, Mass; Bayshore Industries, Elkton, Md., and probably other sources. Strength - easily punctured, but strength and ability to hold helium improved by heating for five minutes in water "near boiling." A balloon 2½' in diameter contains about 3 cubic feet of gas. Colors available - red recommended. Balloons do not need to be deflated between jobs but can be placed in a 2' x 3' x 4' corrugated cardboard carton to be carried in a truck or through the woods.

3) Helium: Available at medical supply houses; size of container - "E" cylinder. Commercial helium available at welding supply houses; size of container - heavy tanks up to 300 cubic feet; cost - 10¢ per cubic foot.

4) Spray Cards: For more specific information contact either the author of this paper or your state entomologist who has had experience in their use. Basically, cards are placed across the line of flight of the helicopter, about 100 feet apart, and number of lines needed depending on size of area.

Presented at the Northeastern Weed Control Conference, New York City, New York, January 9, 10 and 11, 1963

An Evaluation Of The Aerial Application Of 245-T As A Timber Stand Improvement Tool In New Hampshire

Leslie B. Sargent [1]

Since 1957 foresters, both public and private, in New Hampshire have been debating the pros and cons of aerial applications of 245-T. Many of us have advocated it as an effective and relatively low cost method of getting timber stand improvement accomplished on large acreages. Others felt we were destroying potentially valuable hardwoods as well as the desirable mixed hardwood - softwood composition of our forests. Questions were raised by some people in the Agricultural Stabilization Conservation Service, the agency sharing 75% of the cost of doing this work, as to the effectiveness of this method. In other words the time had come to step back and look at this so called 'tool' with more careful consideration and on a broader basis than had been done previously.

This is the background leading up to the appointment of a three-man committee by K. E. Barraclough, Extension Forester, University of New Hampshire and Supervisor of the Cooperative Forest Management Program in the state. He selected Tudor Richards, Forester for Cheshire County, Arthur G. Dodge, Carroll County Forester and myself as chairman. The instructions to this committee were to find out just how effective the aerial spray program had been to date and to make recommendations necessary to improve it.

The committee held one meeting on the apron strings of another conference and decided immediately to call in some outside help. Since none of us had had much, if any, experience in the field of research, we decided to ask Thomas McConkey, Forester-In-Charge, at the Massabesic Experimental Forest in Alfred, Maine to guide us. He had pioneered in the use of this technique of helicopter application of 245-T as a tool for both timber stand improvement work as well as planting site preparation in some of the burn areas of Maine. Of course, this work had all been quite carefully evaluated and so it seemed to us that 'Tom' was the logical person to turn to for help.

Our first meeting with him showed us that we had better keep our efforts directed in a very general evaluation of the spray program if we hoped to cover much ground in our short allotted period for field work. We readily concluded permanent plots, random samples, etc. were for the research people and not for us to tangle with because we had only a week for field work and other time as we could find it in our schedules to summarize our findings.

Tudor Richards developed a field data sheet which gave us something on which to record our observations and opinions. We made a serious attempt to keep this field form as simple as possible in order to expedite the recording of information as we examined the areas and to further simplify the summarization of this material. I am inclined to think that this was no simple task as I look back on the whole matter.

We developed a simple questionnaire to be completed by the person in charge of each spray job, from 1957 through 1961. We circulated these through the County Foresters to be sure that we had complete coverage. These questionnaires were designed to help us inventory the areas treated as to location, size, stand composition by species and size, amount of chemical used, date of treatment, time of treatment, weather conditions at time of treatment, and an evaluation by the forester in charge as to effectiveness. When these were returned we again met and examined them in detail and set up our field itinerary. We attempted to lay out our route to allow us to cover from three to four areas each day.

Again we collaborated with Mr. McConkey, this time on setting up a field procedure. We came up with the following plan. The full committee in the company of the forester, whenever possible, who was in charge of the spray project, planned to make as thorough a reconnaissance of the spray area as possible. About half way through this examination, we were to stop to record our composite opinions as to the following factors we had decided to evaluate.

These factors included general information such as location of the area, name and address of the owner, acreage sprayed, acreage of the total ownership, accessibility, percent slope, exposure, altitude, general soil description, leading conifer species, leading hardwood species, and any additional pertinent information. We also recorded the average or range in height, density, thriftiness, percent of conifers free to grow in relation to the hardwood competition--this information was estimated for the stand before treatment as well as at the time of examination. We recorded our estimates of the percentage of the overstory and understory hardwoods which were thrifty, appreciably damaged, badly damaged but recoverable and dead or dying. We also recorded the percentage of conifers which were thrifty, suppressed, badly suppressed or suppressed beyond recovery.

Further information on individual species both before and after treatment included percentage of each hardwood species, percentage of each conifer species in reference to average height and to leader growth.

On the back of this form we answered the following questions. Would there have been a satisfactory conifer stand if not treated? Was ground spray or mechanical work justified on the area? Would another method of treatment have been more satisfactory? Does the area need further treatment? Was the overall evaluation of the spray area --- Excellent?, Good?, Fair?, Borderline?, Not Justified?.

We had decided to fill out the field form at about the mid-point of our reconnaissance in order to allow us an opportunity to verify or, if necessary, to reconsider our opinions after making the return trip over a different route.

I would like to mention that in all fairness to this committee and to Mr. McConkey that we recognized from the outset that more technical data gathered over a prolonged period would be necessary if we were to draw any substantiated conclusions as to the effectiveness of this technique of timber stand improvement. I expect that you could better classify our evaluation as an "opinion poll" rather than a research project. We are more convinced now than before that some system of continual evaluation is necessary with all timber stand improvement techniques, whether aerial spray, mist blower foliage treatments, basal spray, frill, girdling or just mechanical cutting. Follow-up inspections for several years after treatment on at least a sample of the areas is very necessary.

Perhaps it would be well to emphasize here that all of the aerial spray work accomplished to date in New Hampshire has been done with a spray boom - equipped helicopter. We have had no experience with fixed wing aircraft. The 1957, 1958 and 1959 spray work was all based on the formula of 2 quarts or 2 pounds acid equivalent of 245-T (Trichlorophenoxyacetic Acid, Butoxy Ethanol Ester) in 10 or 11 quarts of fuel oil. The 1960 and 1961 jobs with the exception of three were treated with 1 quart or 1 pound acid equivalent of 245-T mixed with 11 quarts of fuel oil per acre. We found no variations in effectiveness which we felt could be attributed to the formula used. There were enough exceptions to any pattern of results we attempted to develop so that the formulation seemed relatively unimportant. This may have been a false assumption on our part but we are quite confident we are safe in making it.

To get back to the actual evaluation in the field. We were fortunate in having Mr. McConkey with us for the first day in the field to help check out our sampling methods and work out a few problems. We were able to examine a total of 17 areas well distributed throughout the counties where substantial acreages had been done. Our distribution of samples as to year treated between 1957 and 1961 was not good. However, this was caused more by the fact that we had set up a very tight schedule of examining from three to four areas each day than for any other reason.

These areas ranged in elevation from a few hundred feet to between 3500 and 4000 feet above sea level. I mention this because we feel that there is some possible variation in susceptibility of individual species due to extremes of elevation. For instance, we found a very definite resistance of White Birch (Betula papyrifera) at elevations in excess of 3,000 feet.

Again before we develop any conclusions may I remind you that we realize we can only base them upon observations and experience over the last six years and not upon any technical substantiating data.

We feel that we can say with some degree of certainty that aerial application by helicopter of 245-T:

1. is effective when applied to the correct area.

2. is, as far as damage to conifer species is concerned, safe to apply in amounts of 1 to 2 pounds acid equivalent per acre. (The only exceptions observed were damage to hemlock, where only 1 pound acid equivalent of 245-T was used. This damage was not considered to be serious.)

3. should only be made on areas which have been carefully examined in detail prior to treatment to determine if species composition, height and density of overstory and understory is satisfactory.

4. should not be made on areas of much less than 25 acres. Aggregate areas of 100 acres to be treated from one landing point are preferred.

5. in general, cannot be expected to retard the growth of weed trees, not definitely killed, for a period in excess of three years.

6. cannot satisfactorily control resprouting or seed germination.

7. is not a miracle cure for the use of the forest manager, but does offer an economical method of treating areas difficult to handle by other means.

To further elaborate on these conclusions, we feel that it is necessary to select areas for treatment where there is not a definite high overstory of sufficient density to obstruct the penetration of the spray. If it is decided to spray such an area, it would be necessary to make at least two spray applications two or more years apart. The first to kill and the second to secure a sufficient release in the understory. This is, of course, assuming that a release is needed in the understory.

When the predominant weed specie is Sugar Maple (Acer saccharum), it is the opinion of the committee that it would not be practical to aerial spray the area with 245-T, due to the resistance of the Maple.

We would caution the forest manager from using 245-T where extensive stands of hemlock (Tsuga canadensis) are involved.

The committee feels that it is extremely important to make a very careful preliminary examination of the potential spray area. We feel that if the forest manager has a check list of guides to consider when he makes his reconnaissance, he can quite easily judge the practicability of spraying the area.

We believe that it is quite impractical to expect weed competition to be retarded for a period of much in excess of three years. It is not intended to infer here that effectiveness is not to be expected beyond this three year limit. It is here that we think the forest manager must decide if a three year period of release of the crop species on the area will be sufficient to bring through a good crop of softwood. If more than three years of release is necessary, then we expect that more than one aerial spray application will be needed, probably in the second or third year after the initial treatment. We found areas where the resprouting of weed trees killed back to the ground level and the germination of weed seeds had, after three years, created a situation about as bad as the original condition before treatment. We are confident that on these same areas the year following treatment the area appeared to have had a perfect kill, or release if you prefer.

There are species such as Mountain Maple (Acer spicatum), the Poplars or Aspens and undoubtedly others which send up vigorous sprout growth from the root crown and the root system during the second and third year after spraying which was in no way controlled by the initial spray. There is of course no question that seeds in the ground at the time of spraying will continue to germinate. The most serious problem of this was noted in cases of Pin Cherry (Prunus pennsylvanica).

In relation to susceptibility of various individual species I have included at the end of this paper a table showing our findings on, perhaps it would be best to say, apparent susceptibility of the species we encountered.

I am confident that when the ratio of cost to degree of release is considered, we have been successful with our spray program in New Hampshire. There are instances where better judgement in the selection of spray areas would have been desirable. However, since we expect to develop a set of guidelines for our foresters to use on future examinations, I am sure we will see less of this problem. It is quite apparent that there is also need to orient the thinking of many foresters and landowners as to just what they can expect from this relatively low cost method of doing timber stand improvement. We found on our tour several instances where failure or near failure had been reported and the committee felt that the degree of release, that was reasonable to expect, had been obtained. The regrowth on these areas is, we feel, nothing unexpected in the use of chemicals in any form. It will be necessary to remove the idea from some minds that this is a one-shot miracle cure for troubled forests. Personally, I believe that two or three aerial spray treatments at the same total overall cost of one ground treatment will give better results than any ground method yet devised. I would not say that this was the conclusion of the committee, but rather my own feeling.

There has been no effort made to put into numerical tabular form any of our feelings except for the susceptibility information at the end of this paper. The reason for this is simply that the committee feels that any tabulation of data may give a false impression of the accuracy with which it was obtained. We are only reporting our observations, opinions and experiences with aerial applications of 245-T over a period of six years or so, as well as a summarization of evaluation made this past summer.

Susceptibility of Hardwood Species
New Hampshire Aerial Spray Program Evaluation
Summer of 1962

Species		% THRIFTY	% APPRECIABLY DAMAGED	% BADLY DAMAGED	% DEAD OR DYING
Red Maple	o	7	18	23	52
Acer rubrum	u	11	21	29	39
S-I					
Sugar Maple	o	68	17	7	8
Acer saccharum	u	90	10	0	0
R					
Mountain Maple	o	-	-	-	-
Acer spicatum	u	35	55	5	5
I-R					
Gray Birch	o	20	13	15	52
Betula populifolia	u	13	11	26	50
S-I					
Paper Birch	o	22	11	11	55
Betula papyrifera	u	1	10	32	57
S-I					
Yellow Birch	o	5	8	12	75
Betula lutea	u	0	0	20	80
S					
Red Oak	o	2	6	7	86
Quercus borealis	u	2	2	5	91
S					
(Resprouts)					
Black Oak	o	5	10	25	60
Quercus velutina	u	20	20	20	40
S-I					
White Oak	o	5	5	-	90
Quercus alba	u	0	0	20	80
S					
Pin Cherry	o	5	6	8	81
Prunus pennsylvanica	u	(No noticeable difference in susceptibility relative to crown position)			
S					
Quaking Aspen	o	39	14	11	35
Populus tremuloides	u	22	17	15	47
I					
(Sprouts from roots)					

Note: Extreme variations in each area examined.

Species		% THRIFTY	% APPRECIABLY DAMAGED	% BADLY DAMAGED	% DEAD OR DYING
White Ash	o	70	5	12	13
Fraxinus americana	u	-	-	-	-
R					
American Elm	o	45	15	10	30
Ulmus americana	u	-	-	-	-
I					
(Resprouts)					
Speckled Alder	o	-	-	-	-
Alnus incana	u	5	10	27	58
S					

KEY

o - Overstory
u - Understory
S - Susceptible
I - Intermediate
R - Resistant

THRIFTY - Trees in good healthy growing condition at time observed.

APPRECIABLY DAMAGED - Trees with significant damage (up to 1/3 defoliated) from spraying which apparently would recover or had recovered at time of observation.

BADLY DAMAGED - Trees with severe (1/3 to 2/3) defoliated and probably would not recover sufficiently to cause further competition to crop trees.

DEAD OR DYING - Trees apparently dead or nearly so at time of observation (over 2/3 defoliated)

STUDIES ON GRANULAR FORMULATIONS OF 2,4-D

C.M. Switzer[1] and O.A. Fernandez

Introduction

The application of mixtures of 2,4-D and fertilizer in dry formulations to turf has become fairly widespread in the last few years and several commercial materials are available. Nevertheless, it is difficult to find official recommendations for the use of such formulations in most areas, and even more difficult to find information in the literature on their efficacy. In the Proceedings and the Supplements to the Proceedings of the Northeastern Weed Control Conference from 1949 to 1962, only 3 references were found that dealt with 2,4-D or related herbicides used in granular formulations on turf (1, 2, 4). These papers were all published by DeFrance and co-workers from Rhode Island so it seemed desirable to investigate such materials under other conditions.

The present paper presents the results of some experiments in which the activity of granular 2,4-D, with and without fertilizer, was studied on turf and in the laboratory.

Methods and Results

Experiments on turf:

Turf plots were located on the campus of the Ontario Agricultural College, Guelph, Ontario. The areas treated were infested with dandelion, ribgrass (*Plantago lanceolata* L.), black medick and red clover, with some mouse-ear chickweed and common plantain. Grass was a mixture of blues, red fescue and meadow fescue.

One difficulty frequently encountered in weed-control experiments on turf is the best way to compare treated and check areas. In the present study this was done by treating a 10 x 10 foot area in the centre of 12 x 12 foot plots. Thus a 2 foot check strip was present between each pair of plots. It is felt that this method is a good one in experiments where there are many plots over a large area and the weed population is not completely uniform.

One plot area was treated May 9 and 11, 1962, with 5 different formulations of 2,4-D: (A) propylene glycol butyl ether ester 20% on clay - diluted with 16 oz inert clay per plot; (B-1) ethyl hexyl ester 2% with fertilizer (9-5-3) 20-40 mesh; (B-2) same as B-1 but 12-20 mesh; (C) diethylamine salt - 1% with fertilizer (10-6-4); (D) isooctyl esters of 2,4-D and 2,4,5-T - 0.52% and 0.26% - with fertilizer (20-10-5); (E) amine salt of 2,4-D - 50% (liquid). The change in formulation B had no effect on the results so only those from the B-2

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treated plots are reported below, as this is the formulation on the market. All percentages given above are in terms of acid equivalent.

Table 1. Effects of Various Formulations of 2,4-D applied in Early May to Weeds in Turf.

Formulation	lb/A acid	Weed Control Rating (0-4)[1] June 19	June 27
A	1.6	0	1.5
	3.2	0.5	2.0
	4.8	1.0	2.0
	8.0	3.0	3.5
	10.0	3.5	4.0
	12.0	3.0	4.0
B	8.0	3.0	4.0
	10.0	3.5	4.0
	12.0	3.5	4.0
C	1.6	0.5	1.5
	3.2	1.0	2.5
	4.8	2.5	3.0
D	1.4	0.5	2.0
	2.8	1.0	3.0
E	1.0	3.0	3.0

[1]Rating 0-4 where 0 = no control; 1 = 0-50%; 2 = 50-80%; 3 = 80-95%; 3.5 = 95-100%; 4 = 100%.

Similar experiments were carried out on May 25 and July 10 with different rates of herbicide included. Representative data from these trials is presented below.

Table 2. Effects of Various Formulations of 2,4-D applied in May and July to Weeds in Turf.

Formulation	lb/A acid	Weed Control Rating (0-4)[1] August 30
A	4	2
	6	3
	8	3.5
B	4	3
	6	3
	8	3
C	1.6	1.5
	3.2	1.5
	4.8	2.5
D	1.4	2.0
	2.8	2.5

In these experiments a minimum of 4 to 6 lb/A acid equivalent was required for adequate weed control with the granular formulations. Injury to the turf was not apparent up to rates of 10 lb/A. The addition of fertilizer slightly increased the apparent activity of the 2,4-D

Response of wet plants to granular 2,4-D:

If the 2,4-D in a granular formulation enters weeds through the leaves, it would be expected that better control would be obtained if the materials were applied to wet leaves. To test this hypothesis, duplicate plots were treated during the afternoon of August 1. One of the plots was sprayed with water (1 litre/100 sq ft) immediately before application of the granular. The other was treated in the dry condition. Silvex granular (20% active on clay) was included in the trial. Also wet and dry plots were treated with lawn fertilizer (20-10-5) without 2,4-D. All treatments were replicated 4 times. The major weed present was dandelion, with some common plantain, black medick and white dutch clover.

On August 3 it was apparent that applying the fertilizer or the fertilizer-2,4-D mixture to wet leaves caused considerable burning. No burning was noted in the dry plots. Slight twisting of dandelions was apparent in all 2,4-D treated plots. The plots were observed August 20 and September 5 and no difference in the speed with which the weeds were killed was noted.

Table 3. Response of Wet and Dry Plants to Various Materials.

Formulation	lb/A acid	Condition of plot	Weed Control Rating (0-4)[1] September 5	Effect on Leaves (August 3)
C	1.6	dry	3.8	none
	1.6	wet	3.8	burned
	3.2	dry	3.7	none
	3.2	wet	3.9	burned
Silvex (Granular)	4	dry	3.5	none
	4	wet	3.5	none
	6	dry	3.5	none
	6	wet	3.5	none
Fertilizer	-	dry	0	none
	-	wet	0	burned

[1]See footnote, Table 1.

Since excellent control was obtained in both wet and dry plots, no conclusions on whether or not there was increased effectiveness due to wetting could be made.

Similar results were obtained when this experiment was repeated

The effects of application to wet and dry plants was studied further in the greenhouse. Young, actively growing, common plantain (<u>Plantago major</u> L.) plants in 4" pots were treated by applying 2,4-D granular at rates of 5 or 10 lb/A to the leaves or to the soil. Half the leaf-treated plants were sprayed with a fine mist of water before the 2,4-D granular was applied.

All plants with wet leaves treated with 10 lb/A were dead in 4 weeks. Plants with dry leaves treated with this rate were 60% killed and the rest appeared to be dying. The plants least affected were those where the 2,4-D was applied only to the soil surface. Considerable formative effects were noted but none of these plants died within 4 weeks. At the 5 lb/A rate, 50% of the wet plants were dead and the rest were badly distorted. At this rate the dry plants showed some formative effects but none appeared seriously damaged. Some formative effects were also produced by the 5 lb/A soil treatment.

Leaching experiments:

In many of the turf plots treated with 2,4-D granular, reinfestation of seedlings was noted 2 months after treatments, even in plots receiving 10 lb/A active 2,4-D. In this respect some information on the leaching of 2,4-D from granular formulations applied to soil might be of interest.

Various rates (1, 2, 4 or 8 pounds acid/A of the 2-ethyl hexyl ester of 2,4-D (20% on clay) were applied to the surface of Burford loam or Fox sand soil in special boxes with removeable sides. Water (a total of 2, 4, 6 or 8 surface inches) was then applied. After free drainage had ceased, soil was removed at various depths (0.5, 1.5, 2.5, and 3.5 inches) and tested for 2,4-D activity using a turnip seedling growth test.

The greatest activity was found in the top layer in both soil types. In the loam soil, little 2,4-D was found below the one-half inch layer, although at the higher rates some growth inhibition of turnip seedlings was brought about by the second layer (0.5 to 1.5 inches). However, in the Fox sand soil, as little as 2 inches of rainfall carried enough 2,4-D to the fourth layer to cause marked inhibitory effects on turnips.

The rate at which 2,4-D is removed from granules by water was studied by washing a weighed amount of formulation, placed on filter paper in a funnel, with successive 5 ml aliquots of water. The filtrate was collected and each 15 ml was assayed using a cucumber growth inhibition test. The initial washings were most effective in removing 2,4-D from the granules, but even after 25 washings (a total of 375 ml water) considerable activity was still evident in the filtrate. When a smaller quantity of herbicide was washed, it was found that after a time very little activity showed up in the filtrate. The granules were then removed from the filter paper and placed in a petri dish with cucumber seeds. It was found that subsequent growth of the cucumber hypocotyls was only 20% of control as compared to 12% of con-