BREAKDOWN OF HERBICIDES IN SOILS AND THEIR EFFECTS ON THE SOIL MICROFLORA

M. Alexander
Cornell University

Abstract[1]

Interactions between the microbial population of the soil and herbicides are of two kinds. Since these compounds are acting to suppress one type of organism, species of higher plants, there is always a possibility that secondary inhibitions will affect the soil microflora. Such inhibitions could have a deleterious influence upon crop production by eliminating those transformations necessary for fertility. On the other hand, any organic chemical regardless of its toxicity may serve as a substrate for the growth of some microbial group, and it would then be decomposed and ultimately disappear. This decomposition prevents indefinite persistence and serves as an important mechanism of detoxification.

Many procedures have been devised to measure the response of the total microflora or of specific physiological types to herbicide application. These tests are generally difficult to perform and require long periods of incubation. One of the major microbial processes in soil, the decomposition of organic matter, may be measured rapidly and with a minimum of operations by use of the Warburg microrespirometer. Further, the technique permits the differentiation of effects upon the indigenous flora and the population bringing about the decomposition of added organic materials. The method involves measurement of O_2 consumption or CO_2 production with herbicides at several concentrations. The data obtained demonstrate that levels of 2,4-D, 2,4,5-T, 2-(2,4-DP), 4-(2,4-DB), amino triazole and monuron required for microbial suppression were appreciably greater than those used in agricultural practice.

An investigation has been made of the decomposition of various phenoxy herbicides and related compounds by the general microflora of the soil. The disappearance of the compound was measured spectrophotometrically in soil-liquid systems using the specific ultraviolet absorption characteristics of the chemical. Several phenolic derivatives including 2,4-D and 4-(2,4-DB) were metabolized readily whereas 2,4,5-T, 2-(2,4,5-TP) and 4-(2,4,5-TB) seem to be inert. The concept of simultaneous adaptation has been extended to the characterization of intermediates in herbicide breakdown in mixed populations, the results indicating that 2,4-D is a naturally occurring intermediate in 4-(2,4-DB) breakdown.

A number of bacteria have been isolated which are capable of utilizing dalapon and TCA as sole carbon sources in mineral media although organic growth factors stimulate the rate of decomposition. These microorganisms have been characterized and some of the factors affecting the breakdown have been established.

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1 To be published in detail by J. S. Whiteside, M.I.H. Aleem, P. Hirsch and

SOME CANADIAN WEED SURVEYS, RESULTS AND SIGNIFICANCE.

E. G. Anderson, Secretary, National Weed Committee
and Associate Botanist, Science Service, Canada Agriculture
Ottawa, Ont.

The earliest attempts to survey the distribution and incidence of weeds in Canada, were those of an Agricultural Commission in Ontario in 1880. In 1911 the committee on Lands of the Commission of Conservation, Canada, made a survey of some three dozen weeds. During 1930 and 1931 a further survey was sponsored by the associate committee on weed control of the National Research Council and limited to seven major weeds.

In 1922 the Canadian Weed Survey was initiated by the Division of Botany. During the next 25 years Mr. Herbert Groh, a now retired botanist, made up collections and observations of 12,000 species in all settled areas throughout Canada. One basic aim of this survey was to determine objectively, by a percentage frequency method, the incidence of both actual and potential weeds in belts of meridians across the country. These data have been shown to be in close harmony with those of much more laborious procedures. When listing the weeds at any given site Mr. Groh felt, in general, that those observed earliest were present in greater concentrations.

"As a first step in assembling the data, field notes were mapped on squared paper numbered to indicate meridians, longitude and parallels of latitude. Each of these maps represented 7 degrees of longitude and sufficient degrees of latitude to cover our comparatively narrow north-south agricultural lands. For a widely distributed species eight such maps were needed to cover Canada from east to west. The percentage frequency of a weed in any 7 degree longitude belt could be readily ascertained by comparison of the total number of surveys as shown on master sheets with the number of occurrences of the weed in that belt. For instance milkweed was found at 570 survey sites in the 76°-83° longitude belt (central Ontario and northern Quebec) out of a total of 947 surveys, a percentage frequency of 60.2. These frequencies were recorded in tabular form in the seven reports of the Canadian Weed Survey. (1). This simple method produced a remarkable amount of data on weed incidence and distribution across Canada that is serving as a basis for studies on distribution." (2)

Much of our data concerning the incidence of persistent perennial weeds has resulted from the operations of the Dominion Provincial Cooperative Weed Surveys started in 1949. Under this agreement the Canada Department of Agriculture, through an extra-mural research grant, covered the expenses involved, and through the Division of Botany undertook the overall coordination, identification and taxonomic study of all plants collected during the survey. The recipients of the grants were the Provincial Departments of Agriculture in most cases. In Saskatchewan the cooperative arrangement was with the Department of Ecology of the University of Saskatchewan. The responsibilities of the recipient included the engaging of suitable survey personnel, transportation, immediate direction of the work and preparation of the reports.

As the provinces had considerable information concerning the distribution of some of their problem weeds, the weeds included in these surveys were not the same in each province. In Manitoba the survey covered leafy spurge, field bindweed and bladder campion. Leafy spurge, toadflax, hoary cress, Russian knapweed, field bindweed and poverty weed were included in the Saskatchewan surveys. Canada thistle and perennial sow thistle were two of the seven weeds surveyed in Alberta. (3)

In 1951 the province of British Columbia joined in these cooperative surveys and it was agreed that specimens of cow cockle and St. John's wort were to be collected in addition to the other perennial weeds.

In each case the survey teams were instructed to locate, list, map and collect specimens. Records were also to be kept of the more common weeds of the district and reports and collections made of any species not previously reported. Those survey teams operating in areas believed to be favourable for the growth of halogeton were issued special instructions concerning this weed.

We are indebted to Prof. R.T. Coupland, Head of the Department of Plant Ecology, University of Saskatchewan for the following information (4) concerning the method used in his province. The methods used in the other provinces have been similar in many respects. "Two methods of survey have been used - the detailed survey and the transect survey. In areas where the infestations are not numerous, a farm to farm survey is made in an effort to locate every infestation of each weed. Information obtained from agricultural representatives and municipal officials is used in finding the first infestations. A detailed survey is then made of the adjacent farms to which the weeds have frequently spread. In parts of the municipality where none of these weeds has been reported, a farm to farm survey is made in order to discover whether the lack of reports is due to the lack of knowledge concerning the identity of the weeds. Frequently new infestations are found in this way. In detailed surveys of this type, an average of about 40% of the farmers are contacted in each municipality surveyed. The transect survey is used where infestations are too numerous to warrant the investigation of every one. This method has only been used so far with respect to toadflax in R.M. 442 and municipalities (or parts of them) nearby. This involves sampling of the infestations in a mile-wide strip through the centre of each township. Every accessible farmer living or working in this strip is contacted and information is obtained concerning all the land which he operates. By this method information is obtained concerning an average of between 35-40% of the quarter sections in the municipality. These data are then used to calculate the probable extent of the total infestation.

Each survey is conducted on a municipal basis and a report is sent to the municipality together with a list, indicating the extent of each infestation, and a map showing the locations of all infestations.

Resurveys are made in some areas to obtain information concerning the rate of increase in abundance of these species. At that time detailed surveys are repeated, while from transect resurveys information is obtained concerning the same quarter sections which were visited in the original survey."

The acreages known to be infested with certain persistent perennial weeds in Western Canada are listed in Table 1. Most of this information has been revealed since the inception of the cooperative surveys. Although the situation, especially in Saskatchewan and Alberta, is alarming, each subsequent survey adds greatly to the totals and only small parts of each province have been surveyed.

Table 1

Acres infested with certain perennial weeds in Western Canada

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

Each survey report yields data of value to those conducting the control campaigns. It has been shown, for example, that 57% of the dropped from cultivation usually because of the weed. The other 16% occurs in land which has never been cultivated. By comparison eighty-six percent of the toadflax was on cultivated land at the time of the survey.

Resurveys have shown that leafy spurge doubles its hold in two years despite extensive control campaigns. In 1958 Saskatchewan used 215,000 lbs. of Atlacide, 2,500 lbs. of Monuron and 384,000 lbs. of concentrated Borascu against persistent perennials.

Sales of Herbicides

Another type of survey yields valuable information as to the amounts and value of the herbicides sold. Under the terms of the Pest Control Products Act, all herbicides have to be registered with the Plant Products Division of our Department of Agriculture before they can be offered for sale in Canada. All firms who register products are circularized by the Dominion Bureau of Statistics and are thus enabled to compile data as to the types, amounts and value of the herbicides sold each year. (5) Only reports from firms which showed sales in excess of $5,000 were actually used in developing the details shown in Table 2. It is estimated that this group accounted for at least 95% of the total sales.

This information is a further guage as to the sales and/or use of any particular product and any significant trends may be observed by comparing earlier reports. In 1957 the total value of herbicides sold was $6,450,423. This was only a half million dollars less than the figure for the sales of agricultural dusts and sprays. In 1958 a total of 405 herbicidal products were registered for sale in Canada, an increase of 50 over the previous year.

Types and amounts of herbicides used agriculturally

Each year since 1947, the Weeds Commission of the Manitoba Department of Agriculture has conducted a survey by correspondence to indicate details of the herbicides used agriculturally in Western Canada. All companies processing or distributing herbicides were asked to report the quantities of each product used, and the replies were treated confidentially. Table 3 is a sample of the questionnaire used and Table 4 gives the major part of their report for 1958.

Unfavourable weather conditions during the early part of the season was largely responsible for an 18% reduction in the use of hormone type herbicides. The total acreage treated with 2,4-D and MCPA was 12,737,000 acres as compared to almost 15½ million acres in 1957. Reductions were noted in the amounts of MCPA, TCA, and dust used. The acreage treated by aircraft also showed a reduction. Ninety % of the 2,4-D used was ester while 51% of the MCPA was amine and 41% ester.

Acreage of woody growth controlled

Another correspondence survey helps us keep up-to-date as to the acreages of woody growth treated with herbicides each year. Mr. J.W. Suggitt of the Hydro-Electric Power Commission of Ontario, a leader in research on woody growth control, has been conducting this survey for the past five years. Raw data (as gallons applied, miles sprayed etc.) from each of the Departments of Highways, railways, and public utilities etc., has been converted to provide a uniform basis of comparison. He reported that a total of 195,732 acres of woody growth were treated in 1957 at a final expenditure of over four million dollars for chemicals, equipment and labour. (6) This usage has increased steadily as more people learn that it is more economical and more satisfactory than cutting by hand. There are still large areas which have not been sprayed.

Seed drill surveys (7)

The seed drill survey is very helpful in our weed control program. Samples of the seed actually being sown by farmers are taken by weed inspectors and agricultural representatives, etc. These samples are analyzed at the seed laboratories where all seed offered for sale is graded. As this work is administrated by one division of our Department of Agriculture, all samples receive the same analysis at any of the eight laboratories. These farmers' samples generally are not very good when graded according to the Canada Seeds Act. Over 20 years ago, the percentage of seed grading number 1 varied from 8 in Manitoba to 47 in Ontario (Table 5, part A). Large amounts of the seed fell into the rejected category, chiefly because of the weed seeds found.

More recent surveys, as shown in Part B of Table 5, indicate that considerable improvement has taken place. Larger quantities of number 1 seed and fewer rejected samples have been encountered. This improvement has been due to the efforts of extension agencies and to more use being made of seed cleaning plants.

Survey of trade and official samples

From time to time the reports (control sample certificates, Canada Seeds Act) issued for seeds offered for sale and for samples taken by official inspectors are examined. The occurrence of noxious weed seeds in some of these samples is shown in Tables 6 and 7. For example, Night-flowering catchfly and ribgrass "show up" frequently in samples from Eastern Canada and stinkweed and ball mustard in those from Western Canada.

It is hoped that this outline of some weed surveys has been of interest. Further information may be secured by consulting the original sources as given below.

Literature cited

1. Canada, Department of Agriculture, Canadian Weed Survey Reports 1-7, 1942-1948.

2. Frankton, C. Weed control and weed biology in Canada. 3rd Br. Weed Cont. Conf. 1956 Proc. (1) pp165-173, 1957.

3. Craig, H.A. Federal-Provincial Weed Surveys in Western Canada. 4th West. Can. Weed Control Conf. 1950 Proc. pp144-148, 1951.

4. Coupland, R.T. The Saskatchewan Weed Survey. Mimeo. Circ. No. 35. Univ. of Sask., College of Agric., Dept. of Pl. Ecology, Saskatoon, Sask. Feb. 1955.

5. Canada, Dominion Bureau of Statistics. Sales of pest control products by Canadian registrants, 1957. Dominion Bureau of Statistics Memorandum, Ottawa, Ont. 1957.

6. Suggitt, J.W. Brush control acreage sprayed in Canada - 1957. 12th Meet. East. Section National Weed Cttee. 1958 Proc. in press.

7. Canada, Seed drill survey reports. Provincial Department of Agriculture, 1927-1958.

Table 2

Sales of herbicides by Canadian registrants#

Herbicides	Unit of Measure	Quantity	Value
			$
Arsenicals	Imp. Gal.	11,286	21,625
Borates, chlorates and borate chlorate mixtures	lb.	7,524,458	670,386
Cyanamides and Cyanates	lb.	5,755	7,974
Dinitros	lb.	58,881	82,691
I P C	lb.	7,331	18,301
PMA	lb.of acid	400	7,920
TCA	"	354,401	144,696
MCP*	"	903,711	1,157,324
2,4,5-T formulations,*ester	"	96,414	151,535
amine	"	45	218
2,4-D formulations			
*ester dust	"	112,476	156,703
ester liquid	"	3,034,130	2,411,875
amine liquid	"	688,216	522,641
other	"	--	5,252
2,4-D,2,4,5-T mixtures			578,563
2,4-D portion	"	209,906	--
2,4,5-T "	"	209,692	--
Other herbicides including mineral oils			512,719
Total value of herbicides			6,450,423

*Firms reporting M C P, 2,4,5-T and 2,4-D were asked to record their sales on a basis of acid equivalent ie.

(a) 10,000 gallons of a 64 oz ester were to be recorded as 40,000 lb.

(b) 100,000 lb. of a 2,4-D 5% dust were to be recorded as 5,000 lb.

(c) 5,000 gallons of an 80 oz amine were to be recorded as 25,000 lb.

Copied from "Sales of Pest Control Products by Canadian Registrants." 12 months ended September 30, 1957. Prepared by the Metal and Chemical Products Section, Industry and Merchandising Division, Dominion Bureau of Statistics, Ottawa, Canada.

Table 3

SAMPLE COPY OF QUESTIONNAIRE USED BY THE MANITOBA DEPARTMENT OF AGRICULTURE WEEDS COMMISSION

169 Legislative Bldg.,
Winnipeg 1, Manitoba,
September 8, 1958.

TO ALL COMPANIES PROCESSING OR ACTING AS MAIN AGENCIES OF HERBICIDES

Gentlemen:

We again seek your cooperation in connection with the Annual Survey having to do with chemical treatment of crops for the control of weeds in Western Canada. Due to the increased use of MCPA it is desirable that we subdivide it into the various formulations. An early return will be appreciated.

We thank you for your assistance in the past and will look forward to your continued help.

Yours truly,

H. A. Craig,
Chairman, Weeds Commission

QUESTIONNAIRE RE 2,4-D, MCPA AND ALLIED HERBICIDES USED IN WESTERN CANADA - 1958

(Please return as soon after season closes as possible to:
The Weeds Commission, 169 Legislative Bldg., Winnipeg, Man.)

Pounds Acid Equivalent	Manitoba	Saskatchewan	Alberta	British Columbia
2,4-D Ester	____	____	____	____
2,4-D Amine	____	____	____	____
MCPA Ester	____	____	____	____
" Amine	____	____	____	____
" Sodium Salt	____	____	____	____
2,4-D Dust (lbs. Acid)	____	____	____	____
MCPA Dust (lbs. Acid)	____	____	____	____
TCA (total lbs. material)	____	____	____	____
2,4-D, 2,4,5-T or brush control mixtures for brush control, etc. and not included above.	____	____	____	____
Any other chemical	____	____	____	____

Remarks____

____

____

Reporting Company ____________________________________

Address____

Per_________________________ Date_____________________

Table 4

HERBICIDES USED AGRICULTURALLY IN WESTERN CANADA FOR THE CONTROL OF WEEDS

Compiled by Manitoba Weeds Commission, Winnipeg, Canada

FIELD CROPS TREATED DURING 1958

Prov.	2,4-D and/or MCPA Acres	Percent of 1957	Method of Application % Sprayed	% Dusted	% Aircraft
Man.	2,089,000	69.4	97.4	2.6	.3
Sask.	5,223,000	62.8	96.3	3.7	1.7
Alta.	5,307,000	130.5	98.3	1.7	.7
B.C.	118,000	143.9	-	-	-
	12,737,000	82.3	97.3	2.7	1.0

ACREAGES ACCORDING TO FORMULATIONS

	2,4-D Ester		2,4-D Amine		TCA	
Prov.	Acres	%	Acres	%	Pounds	% 1957
Man.	1,333,000	81.4	305,000	18.6	49,000	27.7
Sask.	4,431,000	91.9	390,000	8.1	23,000	23.5
Alta.	4,246,000	93.2	309,000	6.8	17,000	63.0
B.C.	73,000	68.9	33,000	31.1	3,000	150.0
	10,083,000	90.7	1,037,000	9.3	92,000	30.3

	MCPA Ester		MCPA Amine		Sodium Salt	
Prov.	Acres	%	Acres	%	Acres	%
Man.	98,000	21.7	265,000	58.6	89,000	19.7
Sask.	171,000	42.5	223,000	55.5	8,000	2.0
Alta.	388,000	51.7	330,000	43.9	33,000	4.4
B.C.	-	-	7,000	58.3	5,000	41.7
	657,000	40.6	825,000	51.0	135,000	8.4

DETAILS OF APPLICATION
2,4-D & MCPA

	% Spray		% Dust		% Ground Equip.		% Aircraft	
Prov.	1957	1958	1957	1958	1957	1958	1957	1958
Man.	97.3	97.4	2.7	2.6	99.5	99.7	.5	.3
Sask.	96.6	96.3	3.4	3.7	97.8	98.3	2.2	1.7
Alta.	98.1	98.3	1.8	1.7	98.7	99.3	1.3	.7
B.C.	-	-	-	-	-	-	-	-
	97.2	97.3	2.8	2.7	98.4	99.0	1.6	1.0

Formulations 1958

	Acres	%
2,4-D ester	10,083,000	79.2
2,4-D amine	1,037,000	8.1
MCPA ester	657,000	5.1
MCPA amine	825,000	6.5
MCPA Sod. Salt	135,000	1.1

SUMMARY OF ACREAGE TREATED

1947	500,000	1953	12,121,000
1948	4,000,000	1954	11,179,000
1949	8,200,000	1955	14,002,000
1950	13,566,000	1956	16,347,000
1951	11,326,000	1957	15,476,000
1952	13,497,000	1958	12,737,000

Table 5

A comparison of seed drill survey data from two different periods

Province	No. of Samples	Percentage grading No. 1	No. 2	No. 3	Rejected
Part A, previous to 1934					
Prince Edward Island	1,044	9.0	7.0	16.0	68.0
Nova Scotia	1,009	26.0	8.0	13.0	53.0
New Brunswick	109	23.0	11.0	9.0	57.0
Quebec	737	11.0	2.0	10.0	77.0
Ontario	785	47.4	10.0	21.0	21.6
Manitoba	1,007	8.0	8.0	17.0	67.0
Saskatchewan	847	29.0	1.1	39.1	30.8
Alberta	1,225	13.3	15.4	22.3	49.0
British Columbia	322	13.4	20.2	17.1	49.3
Part B, since 1954					
New Brunswick	263	29.0	10.0	14.0	47.0
Quebec	976	26.4	11.2	16.5	45.8
Ontario	746	49.0	10.0	10.0	31.0
Manitoba	568	4.0	28.0	23.0	45.0
Saskatchewan	1,377	13.9	16.8	26.6	42.7
Alberta	--	40.0	13.0	16.5	30.5
British Columbia	296	12.0	21.0	21.0	46.0

Occurrence of primary and secondary noxious weed seeds in trade and official samples of red clover, 195

PRIMARY NOXIOUS

Seed Laboratory	No. samples tested	Bladder Campion	Couch Grass	Johnson Grass	Ox-eye Daisy	Per. Sow-Thistle	White Cockle	Wild Mustard	Wild Radish	Winter Cress
Sackville	51	3	3	-	4	-	-	2	-	1
Montreal	353	7	14	-	4	-	4	39	2	2
Ottawa	449	40	17	-	7	2	12	42	-	-
Toronto	281	30	1	-	-	-	13	9	-	-
Total	1134	80	35	-	15	2	29	92	2	3
% Occurrence		7.0	3.1	-	1.3	.2	2.6	8.1	.2	.3
Hay and Pasture Mixtures										
Sackville	88	4	-	-	8	-	1	2	-	7
Montreal	147	5	9	3	16	-	1	10	-	12
Ottawa	60	6	12	-	16	-	1	5	-	2
Toronto	95	3	7	-	11	1	3	6	-	7
Total	390	18	28	3	51	1	6	23	-	28
% Occurrence		4.6	7.2	.8	13.1	.2	1.5	5.9	-	7.2

SECONDARY NOXIOUS

Seed Laboratory	Ball Mustard	Blue Weed	Canada Thistle	Chicory	Common Ragweed	Cow Cockle	Dock	Dog Mustard	Downy Bromegrass	False Flax	Field Peppergrass	Flixweed	N.-F. Catchfly	Ribgrass	Russian Thistle	Stickseed	Stinkweed	Wild Carrot	Wild Oats	Yellow Cress
Sackville	-	1	2	7	4	-	-	-	-	-	-	-	12	20	-	-	3	1	-	-
Montreal	1	-	8	109	92	5	21	3	-	1	8	-	78	68	1	2	17	11	3	-
Ottawa	-	9	7	54	54	1	24	1	-	4	6	-	173	78	-	3	8	10	-	-
Toronto	-	-	1	27	49	-	40	-	-	2	16	-	66	195	1	-	2	64	1	-
Total	1	10	18	197	199	6	85	4	-	7	30	-	329	359	2	5	30	86	4	-
% Occurrence	.1	.9	1.6	17.4	17.5	.5	7.5	.4	-	.6	2.6	-	29.0	31.6	.2	.4	2.6	7.6	.4	-
Hay and Pasture Mixtures																				
Sackville	3	-	6	2	2	-	1	1	-	22	2	-	48	30	-	-	11	2	-	-
Montreal	-	-	6	15	11	2	12	-	-	12	1	-	61	41	3	-	12	3	1	-
Ottawa	-	1	9	8	4	-	15	1	3	6	3	-	21	17	-	-	4	-	2	-
Toronto	1	1	9	11	5	-	20	3	-	8	11	1	26	39	-	1	5	14	1	1
Total	4	2	30	36	22	2	48	5	3	48	17	1	156	127	3	1	32	19	4	1
% Occurrence	1.0	.5	7.7	9.2	5.6	.5	12.3	1.3	.8	12.3	4.4	.2	40.0	32.6	.8	.2	8.2	4.9	1.0	.2

Table 6

Plant Products Division, Canada Department of Agriculture, Ottawa, Ontario.

Table 7

Occurrence of primary and secondary noxious weed seeds in trade and official samples of wheat, 1957-58

Seed Laboratory	No. samples tested	PRIMARY NOXIOUS: Couch Grass	Darnel	Great Ragweed	Per. Sow Thistle	White Cockle	Wild Mustard	Wild Radish	SECONDARY NOXIOUS: Ball Mustard	Blue Weed	Canada Thistle	Cow Cockle	Dock	Dog Mustard	Downy Bromegrass	False Flax	Field Peppergrass	Flixweed	Hare's-ear Mustard	N.F.-Catchfly	Per. Ragweed	Poverty Weed	Russian Thistle	Stickseed	Stinkweed	Tumbling Mustard	Wild Carrot	Wild Oats
Winnipeg	125	10	6	4	6	-	21	-	-	-	1	-	-	1	-	-	-	4	-	5	1	-	-	5	3	1	-	102
Saskatoon	1114	15	15	-	6	-	56	1	12	-	4	23	-	-	-	1	-	4	6	11	-	-	71	78	39	6	-	300
Edmonton	361	-	-	-	-	-	14	-	16	-	1	13	1	-	1	-	-	1	3	-	-	1	27	14	30	3	-	74
Vancouver	27	1	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	-	-	3
Total	1627	26	21	.4	12	-	91	.1	29	-	6	36	1	1	1	.2	1	9	9	16	1	1	98	97	73	10	-	479
% Occurrence		1.6	1.3	.2	.7	-	5.6	.1	1.8	-	.4	2.2	.1	.1	.1	.1	.1	.6	.6	1.0	.1	.1	6.0	6.0	4.5	.6	-	29.4

OATS

Seed Laboratory	No. samples tested	Couch Grass	Darnel	Great Ragweed	Per. Sow Thistle	White Cockle	Wild Mustard	Wild Radish	Ball Mustard	Blue Weed	Canada Thistle	Cow Cockle	Dock	Dog Mustard	Downy Bromegrass	False Flax	Field Peppergrass	Flixweed	Hare's-ear Mustard	N.F.-Catchfly	Per. Ragweed	Poverty Weed	Russian Thistle	Stickseed	Stinkweed	Tumbling Mustard	Wild Carrot	Wild Oats
Winnipeg	324	7	1	-	2	1	38	-	6	-	-	-	1	-	-	-	-	4	-	8	-	-	12	2	6	-	-	292
Saskatoon	263	2	5	-	19	1	18	-	4	-	2	5	-	-	-	-	-	1	2	-	-	-	18	14	22	2	-	89
Edmonton	595	11	1	-	4	-	6	2	118	2	-	-	-	-	-	3	-	5	1	8	-	-	7	49	97	3	1	218
Vancouver	96	9	-	-	1	-	4	3	15	-	1	-	2	-	-	1	-	-	-	-	-	-	-	1	6	-	1	23
Total	1278	29	7	-	26	1	66	5	143	2	3	5	3	-	-	4	-	10	3	16	-	-	37	66	131	5	2	622
% Occurrence		2.1	.5	-	1.9	.1	48	.4	10.4	.1	.2	.4	.2	-	-	.3	-	.7	.2	1.2	-	-	2.7	4.8	9.5	.4	.1	45.1

Plant Products Division, Canada Department of Agriculture, Ottawa, Ont.

NEW RESEARCH ON THE TRANSLOCATION OF HERBICIDES

A. S. Crafts *

Research carried out during the past ten years on the translocation of 2,4-D in plants seems consistently to indicate that this compound is moved in the assimilate stream from regions of food synthesis to regions of food utilization. Short distance movement, such as that from epidermis of leaves to the phloem and from phloem to meristems and storage tissues, apparently takes place within the interconnected cell system, the symplast. Long distance rapid translocation takes place in the sieve tubes of the phloem.

Using C^{14} labeled 2,4-D, a freeze-dry technic for plant preparation, and the autoradiographic method for following the tracer, we at Davis have been able to show that 2,4-D* applied to a leaf will penetrate the cuticle, migrate to the phloem and move with foods from a mature leaf in the light to the apical meristem, to the roots, or to both, depending on the location of the leaf on the plant. The tracer will not move out of a young leaf that is still importing food, nor from a chlorotic leaf of a variegated plant.

Movement to roots depends upon their activity; if they are growing rapidly 2,4-D* may move into them and become widely distributed; if they are growing slowly or not at all 2,4-D* may move toward them along the stem but may never arrive in the roots.

Results of our tracer studies with 2,4-D* substantiate many field results with this compound and account for successes and failures of field applications. When amino triazole was made available for trial it proved to translocate in plants, and in some instances seemed to move more extensively than 2,4-D and under somewhat different conditions. This naturally led to the question, do all compounds move similarly in plants or are there fundamental differences in the mode of their transport?

Comparative mobility of labelled tracers. We have always thought of 2,4-D as a translocated herbicide and we have not been able to tell how well it translocates. When we obtained labelled samples of amino triazole and maleic hydrazide we were able to put on comparative tests and we found that of the three 2,4-D is the least mobile.

A group of mature Zebrina plants was selected for this experiment. They were healthy but somehat pot bound and the roots were not very active. When three mature leaves on the stem were treated with 2,4-D* the tracer stayed near the region of application moving only throughout the treated leaves and for a way along the stem. Similar application of amino triazole* resulted in movement into all active shoot tips and into the root system as well. All mature leaves along the stem were bypassed.

In the case of maleic hydrazide* the tracer moved in considerable amounts to all actively growing shoot tips, it moved into the root system, and all intervening leaves show to varying degrees in the autograph. According to our interpretation the 2,4-D* moves in the phloem but when movement is slow it is absorbed out of the moving stream by active cells along the way and it does not get very far unless movement is very rapid.

Amino triazole seems less subject to absorption and hence moves to the various sinks even though transport is slow. It does not enter actively exporting leaves. Maleic hydrazide also is not subject to uptake by living cells and it moves throughout the phloem system. However, it apparently leaks from phloem to xylem and hence is carried via the transpiration stream to all transpiring leaves. Since it may subsequently move out of such leaves it seems apparent that it may circulate in the plant. We are certain that phosphorus does this and maleic hydrazide apparently attains the same distribution. This is the ideal distribution for systemic herbicides, insecticides and fungicides.

When this experiment is repeated using barley seedlings we obtain a similar picture except that in these plants amino triazole also seems to leak from phloem to xylem. Both ATA* and MH* accumulate to high concentrations in the root tips.

In the above experiment the second leaf of each plant was treated. At Oxford an experiment was performed in which 2,4-D* was applied to leaves number 1, 2, 3 and 4 of separate plants. The autographs showed an interesting relation, namely that the first expanded leaf moved the tracer to the roots in high concentration indicating rapid flow of the assimilate stream. The second and third leaves also gave evidence of feeding the roots. From the fourth leaf, in contrast, there was no movement of the tracer to the roots; but there was a high concentration in the basal portion of the leaf and in the young fifth leaf. It seems that there is a division of labor in these grass plants. As they start off the first expanding leaves very actively nourish the roots whereas, as successive leaves come along, they become more involved in feeding the young leaves and inflorescense and less in feeding the roots. As older and older plants are treated movement of 2,4-D* from leaves to roots becomes less pronounced until, as flowering occurs movement of foods from leaves to roots must be very slow.

With this relation in mind a comparative study on seven labelled compounds was made using barley plants with five fully expanded leaves. Since leaf number one on these plants was starting to dry up, treatment with each chemical was made to leaf number 2 and leaf number 5 on separate plants. Autographs of these plants showed the following results. From leaf number 2 a slight amount of 2,4-D* reached the roots; from leaf number 5 none. In the case of indole acetic acid*, an appreciable amount of the labelled compound reached the roots from leaf 2, none from leaf 5. ATA* from leaf 2 was present in the roots at an intermediate concentration; from leaf 5 it was present in appreciable quantity. MH from leaf 2 was highly concentrated in the roots; from leaf 5 it was in medium quantity. Urea* produced a strong image in the roots from leaf 2, an appreciable image from leaf 5. We suspect in this case that the urea is rapidly hydrolized in penetrating the leaf and that the labelled CO_2 is converted to sugar. Chromatography of roots of urea* treated plants has produced a sugar spot, not a urea spot.

In the case of monuron* no movement into the roots of barley was found; only acropetal movement to the tips of the treated leaves. We think that this substituted urea is unable to enter the phloem and move in the assimilate stream. Dalapon* moved freely from leaves to roots of barley and we suspect that it approaches MH* in mobility. An interesting observation is that the more mobile compounds in this series appear in greatest concentration in the untreated mature leaves; evidently the more mobile a compound is, the more readily does it leak from phloem to xylem and move in the transpiration stream.

To study the relative roles of penetration and translocation in the movement of these labelled tracers an experiment was performed using blocks of potato tuber tissue. This represents a relatively unspecialized type of cellular tissue that expresses only the absorptive and accumulative capacity of non-vascular cells. When the first six of the above compounds were applied to these potato tissue blocks and allowed to react for periods of 2, 4, 8 and 16 days, it was found that 2,4-D* was absorbed by the living cells but moved very little; ATA* moved somewhat more extensively; MH* in 16 days permeated the whole block. IAA* moved a bit more freely than 2,4-D* and it accumulated and moved particularly in the phloem strands. Urea* was found to move only in low concentration and in 16 days was almost entirely gone from the tissue. Apparently it is split by urease and lost to the atmosphere as CO_2*. Monuron, on the other hand, did not enter the living cells but appeared to diffuse along the cell walls and concentrate around the outer surface of the tuber block. Apparently it moves only in the non-living cell-wall phase of the tissue.

From the fact that the series 2,4-D*, ATA*, MH* shows the same relation of increasing mobility in undifferentiated potato tuber tissue as is shown in barley, it seems that translocation per se is probably seldom limiting in plants. The factors of accumulation during the penetration process and absorption and accumulation from the assimilate stream during translocation apparently overshadow transport in determining distribution of these compounds. And the lesson to be learned is that in our screening programs we should ever be alert for more and more mobile compounds.

<u>Leakage of 2,4-D from roots</u>. Several additional observations on the use of labelled herbicides should be of interest. Back in 1950 one of my students found that if he put a droplet containing 2,4-D on the lower leaf of a cotton plant growing in a culture solution, symptoms appeared on a second cotton plant growing in the same culture jar. I was interested in checking on this phenomenon. I grew barley, bean, Zebrina and cotton plants in culture solutions and in each culture I had one cotton plant that acted as an untreated receptor. I treated the plants of the four species with 2,4-D* in replicated series with dosages of ½, 1 and 2 microcuries. After 24 hours I killed and freeze-dried one series and after 15 days I killed and freeze-dried the others. In each case the untreated receptor cotton plants harvested after 24 hours gave light but positive autographs after 8 weeks exposure on film. And samples of the culture solutions from the jars of treated plants gave positive counts when dried on planchets. The receptor plants allowed to go for 15 days gave more dense autographs and the 2,4-D* was concentrated in the young shoot tips that were beginning to show 2,4-D symptoms at the time of harvest. This is positive evidence

for the leakage of 2,4-D from treated plants into the culture medium. Similar evidence was found for leakage of trichlorobenzoic acid from roots of treated bean plants.

Duration of uptake. Another experiment involved 24-hour and 15-day treatments with 2,4-D* on the upper leaf surface of Zebrina. The autographs show that, even though the droplets were dried up within an hour or less, the 15-day treatment resulted in the uptake of much more 2,4-D* than did the 24 hour treatment. Because the upper leaf surface of Zebrina has no stomata, this means that penetration of the 2,4-D*, formulated in 50% alcohol and 0.1% Tween 20, continued for hours and even days after the droplets were dried down to a film. Subsequent time series running 1, 3, 9, and 27 hours and involving 2,4-D* and MH* confirm this continued uptake of these chemicals from such formulations.

Where 2,4-D* is applied to the roots of plants through the culture solution there is a high accumulation of the chemical in or on the root cells and a relatively small amount moves into the tops. In a comparative test on barley seedlings 2,4-D* and urea* showed this high accumulation in roots and little movement into tops. ATA*, MH*, IAA*, monuron*, and dalapon* moved into the tops in appreciably higher concentrations.

Additional tracer studies. One experiment involved use of two lots of labelled isopropyl ester of 2,4-D, one lot labelled in the carboxyl carbon, the other in the C_3H_7 chain. When these were spotted on barley leaves and left 24 hours the carboxyl labelled tracer moved into the roots in the same way as did carboxyl labelled 2,4-D acid. In contrast the alcohol label remained in the area of treatment. This indicates that the isopropyl ester of 2,4-D is hydrolized during penetration and that the alcohol chain remains in the foliage. It would be very interesting to repeat this using lots of a heavy ester of 2,4-D.

As mentioned above dalapon* was found to be freely mobile in barley plants. It also moves with ease in cotton seedlings and very notable is the fact that the opposite cotyledons that were untreated contained an appreciable quantity of the tracer, this despite the fact that the plants were freeze-dried. This supports the conclusion that the compounds that move most readily in plants apparently leak from phloem to xylem and circulate most readily.

Tests at Davis, California, with labelled E. P. T. C. show that this volatile compound may be absorbed by the leaves of bean plants and translocated throughout the plants with fair concentrations being held in the roots. This adds one more to our list of readily translocated herbicides.

Finally trials with labelled herbicides on the fronds of bracken fern have confirmed the relative mobility of the series MH* dalapon* ATA* 2,4-D* that seems to hold in barley. Undoubtedly the comparative autoradiography of plants using labelled herbicides holds tremendous promise as a method for studying the physiology of herbicidal action.

MODE OF ACTION OF VARIOUS HERBICIDES AND THEIR POSSIBLE SITES OF ACTION 1/

J. L. Hilton 2/

Abstract

A search for metabolites that will partially or completely reverse the inhibitory action of herbicides on growth of various organisms has implicated physiological processes that are probably inhibited by herbicides. The metabolites that have been found to reverse the inhibitory action of several herbicides and the physiological processes implicated as the growth-limiting processes in the presence of the herbicides are as follows:

Metabolite	Herbicide	Physiological Process
adenosine triphosphate	pentachlorophenol	oxidative phosphorylation
yeast nucleic acid, purines and purine precursors	amitrol	synthesis of purines
β-alanine, pantoate and pantothenate	chloro-substituted aliphatic acids	synthesis of pantothenate
carbohydrates	simazin	photosynthesis
carbohydrates	phenylureas	photosynthesis

The inhibition of pantothenate synthesis was investigated in detail and the pantothenate-synthesizing enzyme implicated as one of the sites of action for the chloro-substituted aliphatic acid herbicides. The mechanism of action was identified as competition between herbicide and pantoate for a site on the enzyme of synthesis. This discovery was utilized in the synthesis of new phytotoxic chemicals.

1/ To be presented at the Northeastern Weed Control Conference, January 7-9 in New York, New York as an invitational paper. Data to be published in extensia by J.L. Hilton, W.A. Gentner, D.E. Moreland, L.L. Jansen, and J.S. Ard in WEEDS and PLANT PHYSIOLOGY.

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

THE USE OF HERBICIDES IN CONSERVATION

Justin W. Leonard 1/

The term "conservation" is used in so many contexts as to require redefinition whenever it is employed by people concerned with different fields of endeavor. In this paper the term will apply to the efforts of an agency of state government to manage renewable natural resources on public lands in such a manner as to maintain or increase both supplies and utilization of forests, fish, and game birds and mammals. In such a program the dominating policy is that of multiple-use. Hence, problems are more complicated than they would be if the objective were to advance a single resource interest without regard for the welfare of others. For this reason, the observations made here will center largely on the situation faced by the Michigan Department of Conservation, with which the writer has greatest familiarity. In our present state of knowledge it would be foolhardy to depart from this admittedly provincial approach. But there would appear to be some close parallels between Michigan's problems and those of the Northeastern states.

Forestry. Herbicides have two major uses in forest management at present; (1) as a debarking agent for standing pulpwood, and (2) in the control of undesirable or unwanted trees and brush.

Chemical debarking agents would appear to have considerable economic value, since pulpwood stands so treated might be cut at almost any time of year and hence permit more efficient utilization of manpower. Satisfactory materials and methods, however, remain to be developed. Experiments have been conducted with various chemicals (McCulley, 1957) but only sodium arsenite gives reliable results. And for several reasons this material is out of favor with pulpwood operators in the Upper Great Lakes area. For one thing, repeated instances of mortality to wildlife have occurred, with attendant unfavorable public reaction, and hazards to human life have been noted in post-treatment inspections. It should be noted that these accidents and hazards are almost entirely attributable to sloppy, poorly supervised application of the chemical. Also, wood so treated sometimes requires additional treatment in processing plants, and these factors, coupled with the appearance of effective portable mechanical peelers have resulted in the use of chemical debarking agents dwindling to the vanishing point in Michigan. Development of an efficient, economical, chemical debarking agent free from the hazards of sodium arsenite would no doubt be welcomed by forest industry, and continued research seems well warranted.

1/ Assistant Deputy Director, Michigan Department of Conservation

The control of undesirable or unwanted trees and brush has application in a number of situations in both forest and game management. For the forester, obvious uses for herbicides include:

(1) Planting site preparation. Aerial or ground application of such herbicides as 2,4-D and 2,4,5-T has advantages in providing improved accessibility and visibility for planting operations, and in removing overgrowth which might weaken new plantings through competition and shading.

(2) Plantation release. Many pine plantations made some years ago, especially those performed by the Civilian Conservation Corps in the 1930's , are showing the adverse effects of overtopping by various species of non-merchantable trees now in advanced stages of growth. Aerial application of hormone-type herbicides is especially effective in achieving satisfactory release at moderate cost.

(3) Control of oak wilt disease. Girdle or frill applications of herbicides to trees infected with oak wilt and adjacent healthy oaks are effective in preventing spread of the disease to nearby trees by means of natural root grafts.

(4) Road, fire line and right-of-way maintenance. Herbicides applied in a variety of ways are effective in controlling brush and undergrowth where clearings must be maintained for fire lines or for road and other rights-of-way. This is another sensitive area in public relations, where close superivision of work crews will pay dividends.

Depending on the problem at hand, foresters may use any or all of the common methods of herbicide application----basal spray, stump treatment, girdles or frills made by axes or special cutting tools to receive direct application of the chemical, and foliar sprays delivered from ground sprayers or from aircraft.

There is an extensive body of literature dealing with the use of herbicides in forestry. Reference may be made especially to publications by Roe (1955); Arend (1956); Rudolf and Watt (1956); and by various authors in recent annual reports of the Lake States Forest Experiment Station.

At present, on National Forests in the Lake States, between 6,000 and 8,000 acres per year are being teated for plantation release. Michigan has not yet undertaken such treatment on its State Forests for two principle reasons: It is anticipated that scrub oak, the species responsible for most overtopping, may soon have greater value as a pulp species and hence constitute a valuable timber resource in itself; further, scrub oak are important mast producers for deer, and this value must be considered where multiple-use concepts prevail.

<u>Game management</u>. While the fact is not as widely recognized as might be desirable, modern game management is concerned to a very large extent with habitat improvement. The artificial propagation of game birds and mammals on government-operated game farms still has some place in contemporary operations, but it is the consensus of the profession that, under today's season and bag restrictions, natural reproduction has a good chance to keep up with gun pressure for years to come provided native species of game birds and mammals have optimum habitat. For this reason, budget allotments earmarked for game management are increasingly being plowed into manipulation of the environment; and game research expenditures are heavily slanted toward discovering better methods for achieving such manipulation.

In searching for tools which will permit manipulation of the environment with the game production in mind, a primary consideration is cost. In an intensive farming operation comparatively high costs may be a good investment; however, when public revenues must be spread over extensive acreages of public land, even sums which seem large dwindle to a niggardly figure when viewed on a per-acre basis.

Herbicides presently qualify as a game management tool in that they can be applied extensively, often by air, and frequently at a cost which appears reasonable. Thus their potential is good. As costs decrease and the effectiveness of chemicals increases their potential should also increase.

The use of herbicides in game management in the future is likely to depend on two considerations: (1) At present the cost of chemicals, while reasonable in many cases, is still often so high as to seriously limit their use; (2) while on occasion they may perform the desired job quite adequately, so little is known of how they operate and about how they should be applied that the game manager is still unable to predict with desirable confidence just what results he may get in a given situation. Unpredictability coupled with sizeable cost is still impeding a wider use of herbicides when large areas, and hence large costs, are involved. In Michigan, for example, there are something like 4¼ million acres of land in state ownership. Naturally, not all of this land could or should receive a specific herbicide treatment. Nevertheless, a program involving only a few hundred acres is likely to have value only to the research worker, and to have little effect on the success of the army of hunters who ultimately must pay the shot.

Some of the specific aspects of game management in which herbicides have been used and in which results offer promise for more extensive use may be listed:

(1) To create and maintain openings by killing vegetation. In lowland and upland terrestrial habitat, openings in both woody growth and in dense sod cover may be desirable to favor the woodcock. Openings in woody growth are generally beneficial for ruffed grouse, snowshoe hare, and cottontails. Sharp-tailed grouse and prairie chicken definitely require

openings free from trees and shrubs if they are to mate successfully; and deer, of course, do not find optimum conditions in unbroken forest. To create such openings we have tested 2,4-D, 2,4,5-T,"Brushkiller," Inverton, and for such hard-to-kill species as maple, Kuron.

(2) To eliminate or change succession in aquatic vegetation. Here the critical problem is to create and maintain open water in small water impoundments perhaps only a few acres for waterfowl, and incidentally for muskrats and certain other fur bearers. A whole spectrum of aquatic growth may present problems. Sedge and rush meadows, dense beds of cattail and phragmites, both submergent and emergent beds of various rooted aquatic plants, as well as shore-inhabiting shrubs including both ericaceous species and other forms such as button bush, dogwood, and willow often require control. We have used Dalapon and Amino triazole for sedge and rush control, Dalapon holding the advantage in cost. For ericaceous species, we have depended largely on Ammate.

(3) To encourage sprouting of food and cover species. In recent years we have learned that a sublethal aerial application of hormone-type herbicides by air to aspen stands may greatly stimulate the production of natural sprouts from roots. These sprouts provide an excellent supply of food for deer during months of heavy snow cover during the period when deer food supplies are generally at critically low ebb. Such sprouts are also of value as a winter food supply for rabbits and may in certain areas serve to divert rabbits from depredations on orchard stocks or other high-value species. In aquatic habitat such herbicides as Dalapon may be useful in elimination of cattail, which then is often followed by smartweed, a desirable food for waterfowl. Many conservation agencies like ours carry on extensive farming operations on state-owned hunting lands to provide food for various forms of wildlife. Herbicides may substitute for tillage on otherwise untillable land; they are helpful in clearing land of brush for intensive farming operations; and they may be helpful in releasing old plantings of food and cover shrubs from heavy sod development. We have tried Dalapon, TCA, and Amino triazole. It is obvious that in areas characterized by extensive tracts of wilderness land, where access from the ground is often extremely difficult, the adaptability of herbicides to aerial application makes them a most promising tool.

Fish Management. In the management of inland sport fisheries aquatic vegetation often poses a difficult problem. There is a very real need for effective, inexpensive herbicides which will eradicate both algae and higher aquatic plants without posing a hazard to fish and other aquatic life, to livestock, and to humans.

Aquatic weed control can contribute to fisheries management in several ways:

1. A considerable body of experimental evidence indicates that in certain important aquatic situations greater fish production can be attained by favoring microscopic algae rather than submerged higher plants.

2. Under-harvesting and over-population are serious problems in the management of many lake fisheries. Aquatic weeds afford shelter for young fish as well as for older, larger-size individuals. Eradication of all but a few isolated clumps of weeds serves to concentrate large fish from wide areas, and exposes small fish to more efficient predation. It seems likely, therefore, that aquatic weed control might be quite effective as a tool in the artificial manipulation of fish stocks.

3. It is not uncommon to encoutner potentially productive lakes which are under-fished simply because weeds interfere with boats, propellers, and tackle.

Riparian development of our inland waters for recreation has proceded at an explosive rate since the end of World War II. Interference of aquatic vegetation with boating, water-skiing, and bathing, presently accounts for more pressure on conservation agencies than does its deleterious effects on fish production.

Yet, we find ourselves still turning to copper sulfate for local algae control and to sodium arsenite for the rooted aquatics even though the latter material, because of its potential danger, is expensive in that the agency must supply personnel to insure proper treatment and to guard against risks.

During the past year our fisheries research staff has conducted experiments involving use of pelletized 2,4-D applied over ice to control submerged weeds, and has attempted to control emergent vegetation with 2,4,5,-T, Kuron, Silvex, and Dalapon. To date no success has been obtained with the 2,4-D pellets or with Kuron. Other tests will continue.

<u>Discussion:</u> It will come as no news to those attending this conference that the use of herbicides often provokes hostility from sizeable segments of the general public. Conservation agencies are not immune to public criticism when they use herbicides, even though in the main they use them with greater care than certain other operators. For one thing, there is a very general tendency for the public to confuse herbicides with highly toxic insecticides and to damn everything that might fit under the general pesticide label indiscriminately. The greatest obstacle to the use of herbicides in chemical debarking has been the perverse refusal of most field crews to follow even the most basic and rudimentary instructions as regards application technique. My department has not per-

mitted the use of sodium arsenite to debark standing pulpwood primarily for this reason: A few years ago, as an experiment, we authorized use of this material on a small timber sale involving only about 120 acres. Elaborate preparations were made, including the plowing of a wide furrow around the tract to aid in detecting movements of deer into and out of the area, and most explicit instructions with regard to precautionary measures were made a part of the written permit. In spite of all these apparent safeguards and the certainty of detailed post-application inspection, the operators spilled arsenite liberally on the ground between the trees. And since the job was undertaken rather late in the season, and ripening blueberries were affected, our people were actually more alarmed about the chances of killing Girl Scouts than about danger to wildlife. The experimental tract embraced a small lake, and at the public fishing site a rough table had been provided for cleaning fish. The operators elected to clean their equipment on the table and left it covered with chemical and with rags saturated with chemical. Two deer were killed in this small plot and in view of the aggravated hazard also provided to humans our policy against the use of this material on state forests remains in effect.

Injudicious use of hormone-type herbicides, especially on highway rights-of-way, has unnecessarily inflamed the public. County road commissions in particular are prone to use these materials without any advance explanation of how they may be expected to operate and how the taxpayer might ultimately benefit. More important, operators seem inclined to keep the valve open all the way down the road, dosing individual trees and shrubs which might better be left intact, or perhaps even worse, hitting vegetation a glancing "lick" which results, not in a clean kill, but in an eyesore which offends the traveling public and does not achieve the desired control.

The last example cites a use not under the control of a conservation agency but you may rest assured that conservation agencies often are held responsible by the public.

There is still considerable controversy as to whether the elimination of trees and woody shrubs along highway and powerline rights-of-way is injurious to wildlife, using the term "wildlife" in its broadest sense to include songbirds and small mammals as well as game species. Here the answer probably depends in large part upon the amount of wildlife cover available in the adjacent coutryside. In a state such as Michigan, which generally has an abundance of wildlife cover some distance removed from roads, it is often though that the elimination of cover along highway margins may result in no over-all damage to wildlife. When desirable wildlife habitat fringes highways, destruction of birds and mammals by automobiles may well outweigh the other advantages of good habitat.

Conservation agencies recognize that herbicides provide them with valuable tools for use in the management of renewable natural resources. Present products and techniques, while locally useful, are still not sufficiently predictable to permit their use on a scale commensurate with acreages deserving treatment.

In the past five years we have treated about 13,500 acres of game habitat with herbicides. Of this total, 11,000 acres were treated from the air, 2,500 from the ground. This is a small figure, but that is because most of it has been experimental. Results still cannot be predicted with sufficient reliability to let us think of large scale treatment on a routine management basis.

Further research is expecially needful in the field of aquatic herbicides. Aquatic biologists are inclined to feel put upon when they are asked to take hand-me-down chemicals developed for use in agricultue and test them on aquatics in largely empirical fashion. At the bottom of a lake the soil-water interface is a dynamic area where chemical equilibrium requires constant change. Water movements are a constant, complicating factor. There is constant competition for light and nutrients between higher plants and phytoplankton. The rich bacterial flora is continually degrading chemical compounds. The aquatic biologist has the additional problem of having to avoid significant damage to animal life, all the way from fish and fish food organisms to livestock and humans. Industrial research and development staffs would be improved by addition of someone competent in the chemical and physical aspects of limnology.

Conservation agencies generally are not staffed to conduct research on the development of new materials. They are usually well equipped to test new products and techniques. As a representative of this field of interest I hope that a rehearsal of the potential uses for herbicides in conservation matters will stimulate the industry to keep our requirements in mind and to continue their search for products which will better meet our needs.

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ECOLOGICAL ASPECTS OF ALLERGENIC PLANTS

The allergenic plants, for the purposes of this discussion, may be considered those which are normally harmless, but which upon frequent and massive exposure, may become highly irritating to some people. In other words, the hayfever plants and poison ivy. We frequently hear it stated that "the Indians had no hayfever." The statement was undoubtedly true and still is for those Indians who manage to live in something approximating their aboriginal environment; otherwise they can have hayfever just as we can. Poison ivy, on the other hand was well known to the Indians and had a name in their tongues which translated means "The plant which makes sores." Nobody cares much whether the Indians had hayfever or ivy dermatitis, but why they failed to have one and had the other is a matter of some ecological importance.

Originally the North American Continent was fully occupied by stable associations of plants known to ecologists as climaxes, which is another name for culminations, so called because they represent the ends of long series of sorting out of plants in relation to their environments. Every kind of environmental area became fully occupied by the plants best suited to it. As these areas differed in climate so they differed in their climax associations. For example, most of Canada was covered by the Boreal forest, dominated by spruce, larch, firs, pines, birch and aspen. The Great Lakes region of southern Canada and northern United States was covered by the Lake Forest Climax, dominated by pines and hemlock, including the famed white-pine forest of Michigan, long since vanished. Most of the eastern part of the United States was occupied by the Deciduous Forest Climax, dominated by such trees as oak, maple, beech and chestnut. The interior of the United States was Grassland Climax, dominated by prairie grasses which have largely vanished with the buffalo. The Pacific Coast area was occupied by the Coast Forest Climax, dominated by such trees as cedar, hemlock, Douglas fir, larch and pine.

It is to be noticed that each of these climaxes was dominated by only a few species, those which had gained the ascendancy by being best fitted to the conditions prevailing over the larger part of the area. Besides these there were hundreds of recessive species which found themselves relegated to small and scattered areas where the soil and moisture conditions were better suited to them than to the dominants. Among such were to be found most of our native weeds, including hayfever plants. They caused no hayfever under these conditions because there were too few of them, occupying only small and scattered areas. But because of this they developed the habit of producing the huge quantities of pollen necessary to reach across the broad spaces usually intervening.

Ragweeds, for example, are known to be partial to disturbed soil; only such areas can they dominate, and such are rare in ecological climaxes. So they found themselves relegated to eroded river banks, flood plains and occasional erosion rills and gullies which under climax conditions are rare. With the destruction of most of the climax vegetation we have provided over large areas, conditions which they can dominate, and as we continue to disturb the soil we virtually create an artificial condition which can be called a

Disturbance Climax, since the maintaining factor is not the climate so much as the continuing disturbance. Disturbance Climaxes are known to have occurred naturally. For example, the short-grass prairies of the Great Plains are believed to have been a Disturbance Climax maintained by the grazing of buffalo. It was dominated by such plants as buffalo-grass, the grammas, bromes and fescue grasses which are notorious for being able to endure excessive grazing. Some are said to even benefit by being occasionally eaten down to their roots, something which their competitors were not able to endure.

The balance between the grazing buffalo and the short-grass prairies lasted about 20,000 years, and all the time the soil was being deepened and enriched so that the prairie was self-perpetuating. How different is that from our artificially induced ragweed climax in which the disturbance causes the soils to be eroded and their nutrients leached away. It is self-destroying, and if not checked could very well spell the end of civilization, but probably not the end of hayfever because ragweed is curiously indifferent to top soil.

This is the sermon that all conservationists have been preaching for years, but mostly to deaf ears. They occasionally take a look at our national bank account and, in the light of their studies, find it growing alarmingly low. The glorious achievements of civilization have been built on borrowed capital. Others of us take a look and discover a lot of assets there that we didn't know we had. These we rapidly convert into embarrassing surpluses and laugh at the conservationist. The control of hayfever is a part of the much larger problem of conservation. Hayfever weeds find no more room under properly managed soil conditions than they did in the original climaxes.

Ragweed is undoubtedly our most important cause of hayfever so it will be worth while to examine it closely to see what manner of plant it is and how it is so well able to take advantage of our current desire to shatter the earth to bits and remold it nearer to the heart's desire.

Ragweeds are native American plants. All the true ragweeds, of which there are about 21 species, all potential hayfever plants, originated in the Americas. They belong to the great Compositae or Sunflower Family which stands at the summit of the evolutionary development of the Flowering Plants. They and their near relatives make up a compact little group of plants of the utmost importance to hayfever students because they cause the greater part of the hayfever in North America. Of these the only ones with which we are concerned in the eastern states are the tall and short ragweeds. Botanically they are very similar and closely related, so much so that their pollens cross react almost interchangeably. But by their superficial characters they are easily told apart. The short ragweed has divided fern-like leaves, and is usually not more than four or five feet tall, while the tall ragweed has a less divided leaf, usually three or four parted or even undivided, and may be 10 or 15 feet tall, sometimes more.

Both ragweeds are annuals and shallow rooted making their destruction easy, but a large proportion of their seeds may remain dormant in the soil for many years, or until suitable conditions for their growth obtain, so that one weeding is never completely effective. Their seeds are characteristic and easily recognized. They should be looked out for in seed grains. Each is enveloped in a fibrous coat which is the homologue of the involucre which surrounds the flower heads of other Compositae, for the female flower of ragweed is morphologically a one-flowered flower-head. The seed coat of the short ragweed is fragile and easily cast off. You may find their seeds in grains both with and without their outer coats. Not so the giant ragweed. Its seed is aquatic and designed to float on water. It is enclosed in a tough corky envelope which is difficult to remove. So much so that the seedling is provided with a special device for removing it, reminiscent of the egg-tooth on the beaks of some embryonic birds which they use to break out of their shells. When the seedling emerges from the ground the two cotyledons are generally partly enclosed in the seed coat which threatens to strangle the young plant. But it gets it off by wrapping itself around its own stem which is provided with a ridge into which the flairing tip of the seed coat is hooked and pulled off, leaving the seedling free to expand its cotyledons to the sunshine.

Ragweed is generally described as an 'unsightly weed.' This is purely subjective, an emotional response due to causes other than its appearance. It is wind pollinated so does not have attractive flowers and, as is usual with such flowers, has the sexes separated. The staminate or pollen-bearing flowers are borne in little heads in terminal spikes. They are very numerous and each head contains 15 to 20 little flowers. Though these flowers are entirely male and produce no seeds, the pistil is retained for its secondary function of forcing the pollen out of the flower, characteristic of the Composite family, even those with fertile pistils.

What has been said of the short ragweed applies almost equally to the giant. The two can generally be found competing with each other for waste places. The flowering spikes of the tall ragweed are larger and produce more pollen than those of the short. I once estimated that a single spike would produce 6 million pollen grains. And they say it takes only 25 grains per cubic yard of air to cause a sensitive person to sneeze.

Ragweed pollen grains are spherical, about 17 microns in diameter, which is unusually small among pollen grains. The outer coat is thick of a deep yellow color, tough and provided with three or occasionally four germ pores through which the pollen tube may emerge at time of fertilization. The outer coat is also provided with low conical spines which add greatly to its surface area. This and its small size account for the grain's extreme buoyancy and range of flight.

Short ragweed has a surprisingly wide distribution. It ranges from Nova Scotia southward to Key West in Florida, and even to the islands of the Caribbean sea, and from the Atlantic coast westward to the foothills of the Rocky Mountains, and even beyond though not in effective quantity. Its place there is taken by the western ragweed which is very much the same, except that it is perennial, spreading by underground stolons as well as by seeds. Short ragweed grows in all types of soil that can support vegetation, and even some that otherwise can not.

Tall ragweed has a more restricted distribution. It is scarcely found north of the Canadian border nor south of Georgia and is not found much east of the Connecticut river. It is less hardy, less versatile than the short ragweed and more partial to moisture.

The ragweeds are notable for flowering always at the same time in the same place, regardless of weather or other influences. In the New York area the time is about the 20th of August. At least that is when the plants reach a stage of flowering profuse enough to start hayfever. Further north they flower earlier, about the 1st of August in Nova Scotia. But farther south they flower later, and the farther south they grow, within certain limits, the later they flower. Along the Gulf coast it is well into September before they reach the hayfever-producing stage.

This precision of flowering with only latitudinal variation is not unique. Asters, marigolds, chrysanthemums and other late-summer plants do it too. In fact there is a whole group which are known as short-day plants because it is the shortening of the days in the late summer that stimulates them to stop growing and begin to flower; it is their warning of approaching frost. This can easily be demonstrated by giving the plants a few extra hours of artificial light as the natural daylight begins to shorten. An ordinary electric lamp is enough, turned on for a few hours just as it begins to get dark. But it is not necessary to take even this trouble because the experiment is being done for us under the street lamps in mostly any town. I once watched from day to day a clump of tall ragweed and another of short growing under street lamps in New York City. All the weeds beyond the influence of the light, about 18 feet, flowered at the appointed time, and by the end of September had ripened their seeds and the plants were dead and dried up. Not so those under the street lamps. All through October the weeds continued to grow, becoming much taller than those beyond the range of the lights, but they did not flower. When the first killing frost arrived on the 11th of November they were still green and with the flower buds beginning to show. So we see that it is not the frost, as frequently stated, that terminates the ragweed season. It is the frost-warning of the shortening days that does it some weeks before the killing frost arrives.

Artificial shortening of the days has the opposite effect. Early one spring, about the middle of May, I selected a dozen seedlings of short ragweed all about the same size. These were potted. Six were moved into a dark room every evening at five o'clock and out again at 9 in the morning. The other six were allowed to enjoy normal daylight. The plants which were treated to artificially shortened days stopped growing immediately, developing flower heads instead, and by the end of June were in full bloom shedding normal pollen which was shown by skin test to be capable of producing hayfever. The control plants had grown several feet in the meantime but showed no signs of flowering. The same experiment was tried with tall ragweed, with essentially the same results, except that the treated plants did not cease growing in height. They grew as tall as the controls but spindly without branching and came into flower at the same time as the short ragweeds.

Because the ragweeds accept the shortening days as the frost warning, and are unable to flower until it is received, they are restricted in their northward range and in elevation, and that is why the White Mountains and northern Canada are good hayfever resorts. The season of far northern latitudes and high elevations starts too late and ends too early for them to complete their growth. In Nova Scotia the ragweeds never grow tall. They get a late start because spring comes late there, and they are forced to flower early because the short days come early, so we find them only about knee-high. In the south the ragweeds grow tall because they start early and have a long season to grow before they get the frost-warning which in the south comes late.

This is the way the ragweeds behave throughout the regions of winter frosts. This reaction to day-length enables the plants to take advantage of the full growing season, whether it be long or short. But this is not the whole story. The ragweeds which grow far south, beyond the range of killing frosts, flower almost throughout the year. In Miami, Coral Gables and Key West, for example, short ragweed may be found in all stages of development in March and April. Young seedlings may be growing beside mature plants ripening their seeds. The same is true in Cuba. South of the frost line the ragweeds behave like most other plants in tropical regions, in total disregard of the lengthening or shortening of the days. Why not? Why heed the frost-warning where frost never comes?

How can these plants adapt themselves to climates ranging from the cold of Nova Scotia to the heat of Cuba? How can they be so sensitive to day lengths throughout the northern part of their range and abruptly cease to respond when they find themselves south of winter frosts? The explanation is that short ragweed is a complex and variable species, consisting of a number of genotypes which under natural conditions tend to segregate out. These are not different species, though sometimes considered so, because they may be recognized among the progeny of a single plant. One of these segregates is the southern strain which ignores the frost-warning. Whenever it makes its appearance in the North it finds itself at a disadvantage so succumbs to the competition of others with better adjusted economy, but in the South this characteristic has real survival value.

The fact that short ragweed consists of many races which may be sorted out to suit any clime or situation explains its enormous geographic range and adaptability. Just as we can breed a dog for any purpose nature can breed a ragweed to suit any soil or climate.

Certainly ragweed is a successful plant and well able to adapt itself to a variety of conditions, but the question is: What good is it? This can best be answered by going back to its ecological aspects. It belongs to a group of hardy pioneers which play a very small role in the climax communities, but once the climax is lost it could never be regained without them.

From the ecological standpoint the climax is the most desirable association. It permits the largest number of plants to grow under the most suitable conditions, that is the greatest good to the greatest number.

The climax is the culmination of a long series of steps, known as the Ecological Succession. The story starts with such barren beginnings as bare rock or a fresh-water pond, plus a few lichens or simple water weeds. These slowly and painfully, through their growth and decay, accumulate a little soil. Their only reward is that it enables higher plants to successfully complete with and dispossess them. These in turn accumulate more soil enabling still higher plants to complete with them, the lowly always giving way to the more advanced as soil conditions improve. The succession is a dramatic story of the struggle of plants for their existence, often winning or losing by the narrowest of possible margins, but the story is too long and involved for us to follow through here. We will skip a few millenia and assume that we have soil enough to support the climax vegetation, but that it has all been removed and the soil abandoned, which is the stage in which we are most concerned. The rains come, the winds blow and the unprotected soil begins to be washed or blown away and its soluble nutrients leached out. Long before the climax vegetation could be reestablished the soil would all be gone and we would be back to the bare rock or empty pond, stage, were it not for the fast growing pioneer weeds which move in. Before the destruction occurred we may never have noticed them but they are always there on their seeds lying dormant in the soil. The destruction of the climax vegetation is the awakening kiss that breaks the magic spell of their slumber. This is their long awaited opportunity. All over the denuded area they spring into life, and in a single season may occupy the area and hold the soil against the rains and wind. These plants are all annuals, shallow rooted and fast growing. They are known to the ecologist as pioneers; they make up the Pioneer-Weed Stage in the ecological succession. They are such plants as wild mustard, the pigweeds, carelessweed, lambsquarters, marsh elder, cocklebur, Russian thistle and the ragweeds. Most of them are wind pollinated, for they move too fast to wait for even the rapid breeding habits of insects to provide enough individuals for their pollination. Foremost among them are the ragweeds. The important role that they play in saving the soil answers our question regarding their usefulness. The huge quantity of pollen which each plant had to disseminate when growing at wide and scattered intervals is now no longer necessary; most of it is surplus, and always it is surplus pollen that causes hayfever. However it is essential to these plants to have it in reserve for their lush times are soon over unless the disturbance that released them is continued. For, in the ordinary course of events, the Pioneer-Weed Stage lasts only two or three years, seldom more than five, because, by stabilizing and enriching the soil the pioneers prepare it for their more robust competitors such as the perennial weeds and grasses. So the Pioneer-Weed Stage gives way the Late-Weed and Grass Stage. It is a society principally of grasses, the agricultural grasses and numerous others together with such weeds as plantains, docks, dandelion and clovers. They are mostly deep-rooted perennials which gives them the advantage which they need to usurp the pioneered areas. It is an easy stage to render permanent by grazing or cutting, maintaining it as a Disturbance Climax. For example, a cow- or sheep-pasture, a hayfield, a golf course, a playground or a lawn are all ecologically a late-weed and grass disturbance climax. There is no hayfever and little poison ivy in it, and it can always pay for its keep and return a substantial profit requiring only to be properly grazed or cut, and all the time it builds humus. It is by far the most economical condition to keep required. Left to itself, however, woody plants find conditions favorable and invade from adjacent areas by rhizomes. Snowberries, sumac, poison ivy, brambles, catbriers and other shrubs shade out the grasses and weeds, inaugurating the Shrub Stage. The Shrub Stage is nearly useless, except for occasional raspberries, blueberries and elderberries. It is difficult to plough and, what is important to us, it harbors most of the poison ivy and, in swampy places, poison sumac. The only good thing about it is that, left to itself, it is gradually taken over by trees, and so goes back to the climax forest.

Poison ivy (Rhus radicans), poison oak (R. Toxicodendron) and Poison sumac (R. Vernix) differ in every way from ragweed. They belong to the Cashew family (Anacardiaceae) as does the familiar cashew nut. It is a large family of trees and shrubs, mainly tropical. Many of them carry the same or similar vesicant substance. The cashew nut, of course, is free from it, but their shells contain it in large amounts.

The vesicant substance of the poison ivy has been identified. It consists of four related substances, phenolic derivatives known as catechols, that is to say chemically related to phenol or carbolic acid. They have been isolated and two of them synthesised. They are solids, insoluble in water, soluble in oils, alcohol and acetone. All are vesicant in varying degree. It appears that the different species which have this substance possess the four components in different proportions, or may lack one or more, which probably explains their wide variation in toxicity. It is well known that some of the tropical species are much more toxic than ours.

Poison ivy reaches its best development in the Shrub Stage. When we see it on stone walls, climbing fences, shrubs and small trees or even forming thickets of its own, it is at its best and forms an important part of its ecological stage. Unlike ragweed, however, it also takes a more or less prominent part in most other stages of the succession; even in the Climax Forest we occasionally see it climbing to the tops of tall trees. That is why the Indians had poison-ivy dermatitis and knew the ivy as the plant-that-makes-sores long before it was seen by white man. It is least prominent in the Late-Weed and Grass Stage. Still it is not safe to go bare-foot through a pasture, a hayfield or even a lawn for it may be there too, even if you don't see it. Fortunately it can be controlled by hormone sprays, and, as far as I know, that is the only way.

What we can learn from this cursory examination of the ecological aspects of allergenic plants is best summed up in the words of Paul Sears who says, in Deserts on the March, "Nature will not tolerate idle surface on the earth, and She is not to be conquered save on her own terms."

Roger P. Wodehouse, Ph. D.
Orangeburg Road
Pearl River, N. Y.
November 19, 1958

ABSTRACT

WEED CONTROL IN SOUTH AFRICA

by

E.R. Hattingh
African Explosives and Chemical Industries
Johannesburg.

The greater part of the Union of South Africa lies between the tropic of Capricorn and 34°S, and although the latter latitude is generally taken as the limit for subtropical climates, the high altitude of interior plateau (Highveld) makes for a temperate type of climate over a wide area. Climatic variations give rise to five distinct ecological zones which in turn determine the type of agriculture and weed problem encountered. These zones are Fynbos (winter rainfall Macchia or Chapperal type); Forest; Karoo (steppe); Grasslands and Bushveld (Woodland).

Only 8% of the total land surface is under cultivation. Of this area, 6.4% or 18 million acres are cultivated by Europeans, and 45% of this area (8 million acres) are under maize. There are 110,000 farmers, one third of whom are engaged in commercial maize production (1). Weed control in maize is therefore important.

Wheat is the second most extensive arable crop, and is grown both in the winter rainfall area and summer rainfall areas - in the latter by means of summer fallowing. During 1954/55, nearly 3 million acres of wheat were grown.

Other field crops such as groundnuts, field beans, sunflower, potatoes and sorghum are grown, but are of minor importance compared to wheat and maize.

Sugar cane is an important crop in the Union, and is grown in the subtropical coastal zone of Natal on the eastern sea board. Almost 500,000 acres were under cultivation in 1955 (2).

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The greater part of the farmed area of South Africa is utilised for pasturage of sheep or cattle, and it is in this region that many of our major problems lie.

WEED CONTROL IN WHEAT

In the winter rainfall area, wild vetch - Vicia atropurpurea and other species, together with Raphanus raphanistrum, are the most widespread weeds. Because of the waterlogged fields, aerial application of herbicides is necessary. 2,4-D ester in an oil carrier at ½-lb. acid equiv. per acre is usually applied. There is no evidence that control of these weeds increases yields, or that the best control method is being used. About 200,000 acres are treated annually. A number of weeds resistant to 2,4-D at the usual rate of application appear to be increasing. These are Emex australis, Reseda spp, and Silene spp.

In the summer rainfall areas, discing is used to maintain a bare fallow for several months prior to autumn seeding of the crop. The weed problem occurs from very early spring to late spring, and consists of Polygonum aviculare, Polygonum convolvulus, Rumex angiocarpus and Chenopodium album. 2,4-D amine, or 2,4-D ester at ½-1 lb. acid equiv. per acre is applied either from the ground or air.

The culture of wheat in spring and summer is being undertaken and where this is so, the control of annual grasses which emerge with the crop, is the major problem.

WEED CONTROL IN MAIZE

The weed problem consists of annual grasses such as Eleusine indica and Panicum laevifolum, the sedge, Cyperus esculentus and broadleaved weeds such as Datura stramonium, D. ferox, Amaranthus paniculatus, and Xanthium pungens.

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There is no doubt that weeds are very depressing to the yield of maize under our conditions, and our low average yields (3.5 bags of 200 lb. per acre) are attributable to poor weed control amongst other factors. It has been shown in an experiment at Rietvlei (3) that unfertilized, weedy maize yielded 3.05 bags compared to 9.33 bags from unfertilized but weed free maize. When fertilized, the yield increased to 15.7 bags under weed free conditions, but with no weed control the crop yielded only 8.05 bags rather less, but not significantly so, than the yield obtained from unfertilized but weed free maize.

As to the actual time of most acute competition, Marais (4) has shown that the greatest reductions in yield occur by weed competition during the second month after planting. Weed control operations should be aimed at securing a weed free crop during this period.

Field experiments conducted by A.E.&.C.I. over a number of years (5,6) clearly show the depressing effect of weeds on maize, and the increases obtained from pre-emergence applications of 1-lb. 2,4-D or MCPA per acre. 1-lb. of selective weedkiller, combined with one or two subsequent cultivations, is normally sufficient to produce yields equivalent to that of continuously weeded maize.

At present, 1-2 lbs. of MCPA or 2,4-D is usually applied shortly after planting. The period of control obtained is 3-6 weeks. It is desirable that this period be extended, especially over the row, and experiments are in progress to determine whether this can be economically achieved using the newer herbicides.

Post emergence control of broadleaved weeds is undertaken, but because of the possibility of injury, actual application is restricted to the 3-4 leaf stage of growth using cover sprays, or to the taller stages using directed sprays. Witchweed (<u>Striga asiatica</u>) is a problem in the warmer areas, and is controlled by means of post emergence spot spraying using 2,4-D or MCPA.

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WEED CONTROL IN SUGAR CANE

Cyperus esculentus, Eleusine indica, Panicum spp, and broadleaved weeds are the problem. As many of these weeds emerge before the cane, contact pre-emergence or residual, or a combination may be used. Where annual grasses are the problem, 2-4 lbs. MCPA or 2,4-D may be applied immediately after planting, but where nutgrass is the problem application may be delayed and a combination of 2,4-D and 5% PCP applied, any time up to the flag stage.

After the flag stage where nutgrass is troublesome, 5% PCP at 4-5 gallons per acre or TCA at 15-lbs. per acre is used. On a cost: efficiency basis, Dalapon is uncompetitive at present.

Due to the steep topography, all application is made by hand using knapsack sprayers.

WEED CONTROL IN PASTURES

In the Bushveld (Woodland) areas, cattle ranching is the main activity. Because of an unbalance in the grazing system, the succession has been accelerated towards a thicket type of formation, at the expense of the grass species. This has considerably lowered the carrying capacity of the veld. Overgrazing, combined with the exclusion of fire, has been the main contributory factor. Invading species are mainly thorny - Acacia karroo; A. Heteracantha (≡ tortillis); A. arabica; A. detinens and Dichrostachys glomerata. Non-thorny species such as Euclea sp and Tarchonanthus sp are also troublesome. Over 40,000 square miles in Transvaal alone have been affected (7).

Grazing management alone does not rectify the problem, although there are indications that summer resting for three or more years may result in the death of certain Acacia species (3).

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Herbicides are required, but up to the present, useful results have not been obtained, except in localised areas. In many cases, diesel oil alone appears satisfactory (9). Consistent results with 2,4,5-T, either as basal or overall sprays, have not been obtained, and the problem is far from solved.

Jointed cactus (<u>Opuntia aurantiaca</u>) has invaded over 2 million acres in the Eastern Cape Province. Work undertaken by the Department of Agriculture has led to a national campaign using 2,4,5-T butyl ester in illuminating paraffin.

Slangbos (<u>Stoebe vulgaris</u>) is an invader of grassland, and may be controlled by using 2,4-D ester or by burning in early summer.

GENERAL

In general, weed control in South Africa receives insufficient attention both from the research and advisory sides, and its importance is not sufficiently understood by the average farmer. Contact with weed workers in the United States has helped in the past and the privilege of attending your conferences and visiting your research centres will be of great value to us in South Africa for the future.

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STUDIES ON THE DIFFERENTIAL RESPONSE OF STRAINS OF WILD CARROT TO 2,4-D.

Charles W. Whitehead and Clayton M. Switzer[1]

Strains of Wild Carrot exhibiting marked differences in response to 2,4-D were reported in an earlier paper (4). In morphology and growth habits the susceptible (S)[2] and resistant (R)[2] strains were similar, as they were in their physiological reaction to 2,4,5-T. It appeared, therefore, that a study of the physiological basis for this differential response might provide an important new approach to the problem of the mechanism of 2,4-D selectivity.

Methods and Results

Several avenues of investigation were explored in this study in order to characterize the differential response fully and help discover its physiological basis. These included overall spray treatments, soil applications, seed germination and radicle growth studies, and effects on respiration.

Overall Spray Treatments - Seeds of S and R strains were germinated in flats and transplanted to 3-inch pots when they had 2 true leaves. Five plants of each strain were sprayed with each solution being tested when they were 6-8 inches in height (5-8 leaves). Each experiment was replicated twice.

The butoxy ethanol ester, sodium salt and amine salt of 2,4-D, 4,MCPB butyl ester, 4-2,4-DB butyl ester, 2,4,5-T isooctyl ester and Silvex (2,4,5-TP) were tested at various concentrations. Sufficient spray material was applied to thoroughly wet all above-ground portions of the plants. Data on percentage kill, determined at the end of 6 weeks, is presented in Table 1.

Table 1 - Herbicidal Effects of Various Chemicals on 2,4-D-Susceptible and Resistant Wild Carrot Plants

	% of Treated Plants Killed*	
Treatment	S	R
2,4-D - Na salt	60	0
2,4-D - amine	80	10
2,4-D - L.V. ester	70	20
4-2,4-DB**	80	0
4-MCPB**	100	20
2,4,5-T	100	100
Silvex**	100	100

*Counted 6 weeks after treatment
** 2000 ppm - all others used at 1500 ppm.

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1 Graduate student and Assistant Professor, respectively, Department of Botany, Ontario Agricultural College, Guelph, Ontario.
2 The abbreviations R and S will be used throughout this paper to refer to 2,4-D resistant and susceptible strains.

Most S plants were killed by all of the chemicals tested but only 2,4,5-T and Silvex were equally toxic to S and R plants. All treatments brought about typical auxin-herbicide symptoms of about equal severity soon after application. Within one week, however, the R plants, except those treated with 2,4,5-T and Silvex, had begun to recover. This recovery was marked by the growth of new leaves which showed no herbicide effects, and by failure of the treated leaves to become chlorotic.

Application of Herbicide Through the Soil - The possibility was considered that the difference between S and R plants might be connected with their ability to translocate herbicide from the leaves to the crown. Consequently, 2,4-D was applied both on the surface and beneath the surface of soil in which well developed Wild Carrot plants were growing. In the former treatment, 10 ml. of a 2000 ppm solution of 2,4-D amine were pipetted into depressions in the soil surface surrounding the plant, taking care to keep it away from the crown. The sub-surface applications were made by pouring 10 ml. of the same solution through a glass tube which had been placed 1 - 1.5 inches into the soil near the root.

Similar responses to those brought about by spraying the leaves were obtained in the soil surface treatment. Characteristic 2,4-D symptoms developed in both S and R plants, with the R plants "growing out" of the effect within a few weeks. However, when the herbicide was applied below the soil surface, 40% of the R plants failed to recover. Evidently the placement of this high concentration of 2,4-D close to the roots resulted in near lethal levels of chemical accumulating in the cells. Nevertheless, this experiment indicates that the difference in 2,4-D effect on S and R plants is not influenced to a major extent by differences in absorption by leaves or translocation from leaves to crown.

Seed germination experiments - The germination of seeds of resistant species (oats, barley, rye) has been shown to be not as severely inhibited as that of susceptible species (yellow, charlock, plantain) (5). It was considered that information of a similar nature for seeds from S and R Wild Carrot plants would be of value. Seeds of each strain were placed in petri plates on filter paper moistened with the sodium salt of 2,4-D at concentrations of 10,25,50,100, 200,300,400, and 500 ppm. Counts were made of germinated seeds after 7-8 days and expressed as percentage of control.

Concentrations of 2,4-D above 100 ppm markedly inhibited germination of both S and R seeds (50% inhibition at 200 ppm) with no consistent difference bwtween the reaction of the two types. Apparently the resistance of the R strain to this herbicide differs from that of grasses in this respect.

In a further attempt to learn more about the response of Wild Carrot plants to 2,4-D early in their development, experiments on the effects of ther herbicide on radicle elongation were carried out.

The technique was the same as in the germination study except that lower concentrations of 2,4-D were used (from .005 to 1.0 ppm) and growth was allowed to proceed for one week after germination. The results of a representative experiment of this type (Table 2) indicates that, as with seed germination, there is no different in the response of the two strains to 2,4-D at this stage of plant development. Growth in each case was stimulated by 0.001 ppm and progressively inhibited at higher concentrations.

Table 2 - Effect of 2,4-D on the growth of radicle of S and R Wild Carrot Plants

	Length pf Radicle (mm)*	
Concentration of 2,4-D (ppm.)	S	R
0.0	7.1	8.9
0.0005	7.6	7.1
0.001	9.9	11.3
0.005	5.9	5.9
0.01	4.9	4.7
0.1	1.9	1.9
1.0	1.5	1.3

* Average of 20 radicles measured one week after germination.

Since well developed plants of S and R strains (5-8 leaves) show differential responses to 2,4-D, but germinating seeds do not, at least as expressed by radicle elongation, it would seem that the resistance must develop between these two stages of growth. In an effort to establish more closely the time at which such resistance first occurs, seedlings of both strains were sprayed with herbicide soon after emergence (when first true-leaf was barely visible). Concentrations of 25,50,100 and 200 ppm of 2,4-D amine were applied to counted S and R seedlings in flats (approx. 100 per flat). The percentage of plants killed by the various treatments was determined six weeks later.

Data from this experiment, presented in Table 4, show that a marked different in response to 2,4-D is exhibited by the two strains. Evidently the factor or factors making some Wild Carrot plants resistant, is present in the cotyledon stage. Whether this factor develops in the short period of time between radicle elongation and cotyledon expansion, or simply was not shown up in the germination experiments has not been determined.

Table 4 - Effects of low concentrations of 2,4-D on S and R Wild Carrot Seedlings

	% of treated plants killed *	
Concentration of 2,4-D (ppm)	S	R
25	62	9
50	59	3
100	49	7
200	98	27

* Calculated 6 weeks after treatment.

Respiration Studies - The possibility was considered that metabolic differences could exist between S and R plants that might account for the differential response to 2,4-D. Respiration is an easily measured part of plant metabolism and it is a part that is markedly influenced by 2,4-D (2). Of particular interest is the fact that respiratory responses to 2,4-D have been shown by Kelly and Avery (1) to differ between susceptible (pea) and resistant (oat) plants. Therefore, experiments were set-up to compare respiration of S and R plants under various treatments.

In vitro measurements of oxygen uptake by root slices and leaf sections were made in a conventional Warburg respirometer.. The body of each flask contained tissue, 0.1M buffer (KH_2PO_4 -Na_2HPO_4) (pH5.5) and 2,4-D (sodium salt). Pressure changes were recorded at 5 minute intervals for 30 minutes, then at one-hour intervals for 3 hours. Duplicate flasks were used in each experiment, and each experiment was replicated 3 times.

The results presented in Table 5 show that 2,4-D stimulated

Table 5 - Respiration responses of Wild Carrot Tissue to *in vitro* treatments with 2,4-D.

	Oxygen Uptake (% control)			
Concentration of 2,4-D(M)	S-leaves	S-roots	R-leaves	R-roots
Control	100	100	100	100
10^{-5}		113	-	121
10^{-4}	112	113	103	109
10^{-3}	85	103	83	98
10^{-2}	63	61	59	70

oxygen uptake of both leaf and stem tissue at low concentrations and depressed it at higher rates. Leaf tissue appeared to be slightly more sensitive to the herbicide as $10^{-3}M$ inhibited oxygen uptake about 15%. However, there were no differences between S and R tissues in their respiratory response. Therefore, these in vitro tests seem to show that the factor for resistance is not one connected with respiratory metabolism of 2,4-D by the R plants. However, other tests, now in progress, indicate that some respiratory differences may exist in vivo.

Discussion and Conclusions

The selective herbicidal action of 2,4-D has been related to several factors (2). Differences in leaf surface, leaf arrangement, accessibility of growing point to applied spray, absorption, translocation, adsorption on inactive sites or other detoxification reactions may regulate the degree of susceptibility and resistant strains within only one species, the first three of these possible explanations for the differential response may be discounted, In addition our studies indicate that differences in absorption, translocation and respiratory metabolism are small. It would appear, then, that the resistant strain of Wild Carrot may possess some 2,4-D detoxification mechanism such as that suggested by Leopold (3) which is not possessed by the susceptible plants. Such a mechanism would have to be specific for the 2,4-D type of herbicide as it has been shown that the resistant plants are killed by the closely related chemicals, 2,4,5-T and Silvex. Further studies on the exact nature of this detoxification are being carried on.

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THE EFFECTS OF PHENOXYBUTYRIC ACID DERIVATIVES ON CANNING PEAS IN SOME AREAS OF CANADA

J. J. Jasmin, W. J. Saidak and L. H. Lyall

The herbicidal activities of a number of substituted gamma (phenoxy) butyric acids were evaluated by Wain (5) working in the United Kingdom. Further reports on the selective herbicidal action in crops of gamma (4-chloro-2-methylphenoxy) butyric acid (MCPB) and gamma (2,4-dichlorophenoxy) butyric acid (2,4-DB) were published by Wain (6), Carpenter and Soundy (1) and other English workers. Fryer and Chancellor (2) have shown that the lethal action of MCPB and 2,4-DB equals or surpasses that of MCPA or 2,4-D for certain weed species. They also noted that MCPB was almost as toxic as MCPA when applied to Canada thistle, prickly annual sow thistle, wild buckwheat, lady's thumb, creeping buttercup and curled dock. Wain (5) suggested the possibility of using MCPB on peas. Jasmin and Lyall (3) observed that MCPB and 2,4-DB showed promise as herbicides when applied to Perfection peas under conditions prevailing in 1956 in Ontario and Quebec. Leefe (4) obtained similar results in Nova Scotia. This paper is concerned with the effects of MCPB and related compounds applied post-emergent to the canning peas.

PROCEDURE AND METHODS

The experiments were conducted at the Horticultural Organic Soil Substation, Ste. Clothilde de Chateauguay, Quebec, located approximately 30 miles south of Montreal and at the Horticultural Substation, Smithfield, Ontario, located near Trenton, on the north shore of Lake Ontario.

The soil on which the work was done at Ste. Clothilde is a poorly drained marginal muck with 6 to 18 inches of organic soil underlaid by a gravelly silt loam. The soil at Smithfield is a moderately well-drained Berrien sandy loam.

In 1957 the growing season was wet and warm at both Smithfield and Ste. Clothilde while both locations had a wet, cold growing season in 1958.

The peas were sown in rows spaced 7 inches apart at the standard rate used by the growers in each area for canning peas. At Ste. Clothilde they were planted on April 24, 1957, and May 5, 1958. Planting took place at Smithfield on April 27, 1958, and on April 23, 1958. The herbicides were applied at Ste. Clothilde with a boom sprayer mounted on an Allis Chalmers G tractor. A pressure of 70 psi delivered by a nylon roller pump was used. At Smithfield they were applied with a boom mounted on a small garden tractor using a pressure of 30 psi. The experimental designs used in both years were the latin square at Smithfield and randomized blocks at Ste. Clothilde. In addition, a split plot design with four replications was used for testing the action of MCPB on different varieties of canning peas at Ste. Clothilde in 1958. The plot size used at Ste. Clothilde in 1957 was 1:121 of an acre and in 1958 it was 1:182 of an acre. At Smithfield the plot size was 1:210 of an acre in 1957 and 1:260 of an acre in 1958. All post-emergence treatments were applied when the peas were approximately 4 to 5 inches tall. As nearly as possible weed counts were taken 3 weeks after treatment. They were obtained from 4 random square foot areas in each plot at Ste. Clothilde and 6 random square foot areas in each plot at Smithfield.

RESULTS AND DISCUSSION

No reduction in yield of Perfection W.R. peas was observed (Tables I, II, III) when MCPB sodium salt was applied at rates ranging from 12 to 36 oz. per acre. Slight dwarfing accompanied by more or less severe twisting of the stem was observed when MCPB was applied on peas 4 to 5 inches tall. Much more severe symptoms including dwarfing, twisting, formation of narrow pointed leaves, and a darker plant color were noticed when 2,4-DB was applied post-emergent to the peas. This tendency for more severe symptoms and the elongation of the leaflets, giving the plant a "hare ear" appearance, was reported previously by Jasmin and Lyall (3) and by Leefe (4). These early symptoms typical of phenoxybutyric and phenoxyacetic acid herbicides gradually disappeared and apparently did not affect the general growth of the plant since the yield data and earliness, indicated by texturemeter readings, were not significantly different between the MCPB, 2,4-DB and control treatments.

The herbicidal value of MCPB appears to vary with location, presumably due to differences in climate, soil, and plant growth conditions. At Ste. Clothilde where there was a plentiful, rapidly growing weed population the MCPB treatment significantly reduced the weed population in comparison with the DNBP, MCPA or control treatments, in some years. However, at Smithfield where the weed population was low, no significant difference in weed population was observed between the MCPB and control treatments, in 1957 and 1958. Jasmin and Lyall (3) observed that in 1956 significant reductions in weed population were obtained with MCPB, possibly due to the especially favorable growing conditions during this particular season.

Table I indicates that there is no significant effect obtained in the yield of shelled peas or in weed population, if the MCPB is applied in 15, 30 or 60 gallons of water per acre. However, there is a trend to better weed control as the water volume used is reduced.

The application of 2,4-DB at Ste. Clothilde in 1958 (Table II) resulted in no significant differences in yield of shelled peas or weed population, in comparison to MCPB treated plots. Similar findings were reported previously by Jasmin and Lyall (3) and by Leefe (4).

Yields of shelled peas were not reduced by rates of 4 to 6 oz. per acre of MCPA amine. However, it was not as effective on weeds as MCPB when applied at Ste. Clothilde in 1958.

DNBP treatment produced excellent weed control at Smithfield in 1957 and 1958. In both years, significantly lower weed populations were obtained in the DNBP treated plots than in the MCPB treated plots. The opposite effect was observed at Ste. Clothilde. However, at both locations the yields of shelled peas from DNBP or MCPB treatment were not significantly different.

MCPB was found to be a good herbicide on several standard canning pea varieties. It was safely applied on Perfection W.R. (Tables I, II, III and V), Wisconsin Early Sweet (Tables IV and V), and on Pride, Cansweet and Green Giant S.5.39 (Table V). In 1958 MCPB treatment of these varieties resulted in substantial yield increases, as indicated in Table V. The yield increases compared with the untreated controls were 19% for Green Giant S.5.39, 28% for Wisconsin Early Sweet, 49% for Pride, 62% for Cansweet, and 95% for

Sweet Late variety suggests that this variety may be more susceptible to the toxic action of this herbicide than any of the others tested.

CONCLUSION

Under the conditions of these tests MCPB appeared to be a safe herbicide to use on certain varieties of peas such as Perfection W.R., Cansweet, Pride, Wisconsin Early Sweet or Green Giant S.5.39 at rates of 16 to 24 oz. per acre. This herbicide must be applied when the peas are 4 to 5 inches tall. Dilution of MCPB in 15, 30 or 60 gal. of water had no effect on the yield of shelled peas harvested. When weed population is high the pea crop will benefit from the application of this herbicide. Results from MCPB were more consistent than with pre-emergence application of DNBP. The margin of safety for peas with MCPB is much greater than with MCPA and in some cases the weed killing properties of MCPB are better.

Further studies on selectivity of MCPB to weed species and varieties of peas under North American conditions would be valuable to the canning industry.

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Table I Rates of MCPB (Na) on Perfection W. R. peas at Ste. Clothilde in 1957

Treatments	Yield of shelled peas per plot lb.	Texturemeter readings	Weed pop'n. sq. ft.
1. Control, no treatment	18.85	110	98
2. MCPB 24 oz/A in 15 gal. water	12.85	108	45
3. MCPB 32 oz/A " " " "	14.75	110	33
4. MCPB 40 oz/A " " " "	17.13	112	51
5. MCPB 48 oz/A " " " "	13.20	110	30
6. MCPB 32 oz/A " 30 " "	14.88	110	50
7. MCPB 32 oz/A " 60 " "	15.38	109	56
8. MCPA (am) 6 oz/A in 15 gal. water	12.00	106	62
L.S.D. at P = 0.05	N.S.	N.S.	31

Table II Rates of MCPB (Na) and 2,4-DB (ester) on Perfection W. R. peas at Ste. Clothilde in 1958

Treatments in 60 gal. water	Yield of shelled peas per plot lb.	Texturemeter readings	Weed pop'n. sq. ft.
1. MCPA (am) 6 oz/A	10.7	97	38
2. DNBP $1\frac{1}{2}$ lb/A	12.9	89	53
3. MCPB 16 oz/A	11.0	92	19
4. MCPB 20 oz/A	8.9	93	13
5. MCPB 24 oz/A	9.9	92	18
6. 2,4-DB 16 oz/A	11.7	92	16
7. 2,4-DB 20 oz/A	9.0	90	21
8. 2,4-DB 24 oz/A	10.0	95	13
L.S.D. at P - 0.05	N.S.	N.S.	5

Table III Rates of MCPB (Na) on Perfection W.R. peas at Smithfield in 1957

Treatments	Yield of shelled peas per plot lb.	Texturemeter readings	Weed pop'n. sq. ft.
1. Control, no weed control	13.8	107	20
2. DNBP amine $1\frac{1}{2}$ lb/A	15.7	107	6
3. MCPB 30 oz/A	14.7	102	13
4. MCPB 36 oz/A	15.0	107	15
5. MCPA (am) 4 oz/A	15.8	102	17
6. MCPA 5 oz/A	16.0	102	13
	N.S.	N.S.	N.S.

Table IV Rates of MCPB (Na), DNBP and MCPA (am) on Wisconsin Early Sweet peas at Smithfield in 1958

Treatments	Yield of shelled peas per plot	Texturemeter readings	Weed pop'n.
1. Control	11.3	93	37
2. DNBP $1\frac{1}{2}$ lb/A	13.2	93	12
3. MCPA 4 oz/A	12.3	84	32
4. MCPB 16 oz/A	13.0	87	32
5. MCPB 20 oz/A	11.8	89	32
6. MCPB 24 oz/A	12.0	88	31
L.S.D. at P = 0.05	N.S.	6	10

Table V MCPB (Na) applied at the rate of 36 oz of acid equivalent per acre on different varieties of canning peas at Ste. Clothilde in 1958

Varieties	Yield of shelled peas per plot (lb.)	
	Sprayed	Unsprayed
Perfection W. R.	8.4	4.3
Alaska Sweet Late	3.2	3.4
Wisconsin Early Sweet	16.3	12.7
Pride	11.3	7.6
Cansweet	12.8	7.9
S-5-39 (Green Giant)	18.4	15.4
Mean x	11.8	8.6

x The F value shows a significant difference (P<.001) between the mean of sprayed vs. unsprayed plots.

CONTROL OF QUACKGRASS AND NUTGRASS IN HORTICULTURAL AND AGRONOMIC CROPS WITH EPTAM TM (EPTC)

By:

Antognini, J., D. F. Dye, G. F. Probandt, & R. Curtis*

Experimental and commercial applications during the past two seasons have shown Eptam (ethyl di-n-propylthiolcarbamate) to give excellent seasonal control of yellow and purple nutgrass (Cyperus esculentus and Cyperus rotundus) and both seedling and established quackgrass (Agropyron repens). In addition to controlling these weeds Eptam also controls most annual grassy and broadleaved weeds.

Saidak (2) in 1957 found that EPTC at 5 and 10 lbs./acre effectively controlled nutgrass when applied pre-emergence and that the control of nutgrass with EPTC in beans and potatoes was quite promising. Warren (3) reports workers at Oregon State College have found that when EPTC is incorporated into the soil it will control nutgrass and established quackgrass. Three lbs./acre disced in and seeded to beans gave excellent seasonal control of the nutgrass with excellent bean yields. Four, 6, and 8 lbs./acre disced in prior to seeding lotus and alfalfa resulted in no crop injury. The 8 lb. rate has controlled established quackgrass for nearly four months with the 4 and 6 lb. rates giving control for over sixty days. Coiteux (1) reported 75% control of quackgrass with pre-emergence rates of 3 and 6 lbs./acre.

During the 1958 season it was determined that for good results under a wide variety of conditions Eptam must be thoroughly incorporated into the soil. The majority of applications have been made as preplant soil incorporation treatments with the remaining applications being made as post-emergence soil incorporation treatments. Both the emulsifiable and granular forms have been equally effective with both methods of application.

The preplant method has been a broadcast application followed immediately by discing 4-6" deep in two directions followed by seeding. Crops which have been successfully seeded immediately following this method of treatment at rates of 3-6 lbs./acre include carrots, field and sweet corn, snap and dry beans (except Lima beans), potatoes, flax, alfalfa, trefoil, lespedeza and clovers.

Post-emergence treatments have been made using directed or overall applications followed by suitable cultivation equipment to incorporate the Eptam into the soil. With this type of application the soil must be clean cultivated prior to application to destroy

* Stauffer Chemical Co., Res. & Devel. Dept.

TM - Eptam is Stauffer Chemical Company's trade-mark for ethyl-di-n-propylthiolcarbamate.

established weeds. Crops which have been successfully treated in this manner at rates of 3-6 lbs./acre include field and sweet corn, strawberries, tomatoes, and potatoes.

Soil Incorporation Results on Yellow Nutgrass Obtained During the 1958 Season:

Crop*	When Applied	Lbs./ Acre	Interval Application to Observation	% Control
Beans, snap	Preplant	3	3 mos.	95
Beans, snap	Preplant	3	2 mos.	98
Beans, snap	Preplant	6	3 mos.	98
Corn, field	Preplant	3	1½ mos.	97
Corn, field	Preplant	5	3 mos.	90
Corn, field	Preplant	3	1½ mos.	100
Corn, sweet	Preplant	2	1 mo.	100
Strawberries	Post-emerg.	6	1 mo.	90
Strawberries	Post-emerg.	6	2 mos.	95
Strawberries	Post-emerg.	6	2 mos.	98
None		3	1½ mos.	90
None		6	2 mos.	100
None		6	3 mos.	100

* No injury was obtained on any of the crops.

Summary:

Eptam is effective in controlling nutgrass and established quackgrass in addition to many annual grassy and broadleaved weeds. For effective control under a wide variety of conditions the Eptam must be thoroughly incorporated into the soil. Rates of 3 and 4 lbs./acre for the control of nutgrass and quackgrass respectively have proven to be adequate in Western United States when thorough soil incorporation is used. Indications are that these rates will also prove to be effective in Eastern United States when thorough soil incorporation is used. Higher rates are required when conditions are such that thorough soil incorporation is not obtained.

At the above rates the nutgrass nutlets and the quackgrass rhizomes are not killed, they are prevented from sprouting. Research work is under way at the present time to determine the effect of repeat applications and high rates of application on these weeds.

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INFLUENCE OF SOIL MOISTURE ON THE ACTIVITY OF EPTC, CDEC, AND CIPC[1]

J. R. Havis, R. L. Ticknor, P. F. Bobula
University of Massachusetts, Waltham.

Results of 1957 field trials in the northeast with the new carbamate herbicide EPTC were extremely variable. A fairly typical report came from Long Island (2) where EPTC was tested on onions, corn, and tomatoes with unsatisfactory weed control. It was noted that herbicide treatments were applied to moist soil. On the other hand, the same chemical gave good weed control in New Jersey (5) where the application was made to moderately dry soil. Other reports, of which many were unsatisfactory, did not mention soil moisture conditions. Tests conducted in California (1) showed that EPTC gave "excellent" weed control when applied to dry soils and irrigated 7 days later, but poor results when applied to wet soils.

Field trials were conducted at Waltham to evaluate the influence of soil moisture on EPTC in the northeast. Two other carbamates, CDEC and CIPC, were also included to observe whether or not they were similarly affected. Since EPTC had been reported to perform well when incorporated into soil (7), this factor was also included.

GENERAL PROCEDURE

The experiments were conducted on Gloucester fine sandy loam. Emulsifiable liquid formulations of EPTC, CDEC, and CIPC were applied at the rate of 8 pounds active ingrediant in about 50 gallons of water per acre. Each chemical was duplicated on areas where soil moisture was controlled to produce dry or wet conditions, before or after application.

Immediately after being treated, one-half of each plot was cultivated about two inches deep using a scratcher attachment with staggered teeth. This tool appeared to mix dry soil fairly well. The mixing was probably less thorough in wet soil.

Applications were made to weed-free soil. The principal weeds that appeared later were species of <u>Portulaca</u>, <u>Amaranthus</u>, <u>Chenopodium</u>, and <u>Lamium</u>.

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[1]Contribution Number 1179. Massachusetts Agricultural Experiment Station.

MOISTURE AT TIME OF APPLICATION

This experiment was designed to measure the effect of application of the chemicals to dry and wet soils. The area chosen had recently been set to a group of miscellaneous small nursery plants at 4' x 4' spacing. Plots were 400 square feet. The soil surface was dry, but sub-surface moisture was ample for plant growth. The blocks indicated as "wet" were irrigated with about 1 1/2 inches of water the day before the treatments were applied on June 5. The soil was about as wet as could be cultivated without puddling.

Weed control was rated 22 days and 32 days after application of the herbicide. These ratings are given in Table 1 and 2.

Table 1. Average Rating of Weed Growth 22 days After Application of Herbicides to Wet and Dry Soils.

(1-clean; 3-"satisfactory"; 9-no control)

	SOIL WET		SOIL DRY	
	Cultivated	Not Cultivated	Cultivated	Not Cultivated
EPTC	8.5*	9*	1	4
CDEC	2	2	1	1.5
CIPC	3.5	3	5	4
Check	9*	9*	9*	9*

*Indicates plots that were hand weeded after this rating.

Table 2. Average Rating of Weed Growth 32 days After Application of Herbicides to Wet and Dry Soils.

(1-clean; 3-"satisfactory"; 9-no control)

	SOIL WET		SOIL DRY	
	Cultivated	Not Cultivated	Cultivated	Not Cultivated
EPTC	C	C	3	6.5*
CDEC	6.5*	4	1	3
CIPC	7*	3.5	7.5*	4

*Indicates plots that were hand weeded after this rating.

C Had been cleaned by hand 10 days prior to this rating.

EPTC applied to wet soil failed to control weeds. Furthermore, the attempt to incorporate the chemical into wet soil by cultivation did not improve the results. This chemical gave better weed control when applied to dry soil, and further improvement resulted from incorporation.

CDEC was more effective on dry soil than on wet soil, but the difference was not as great as with EPTC. Cultivation reduced the effectiveness on wet soil but enhanced weed control in dry soil. Of the combinations of materials and conditions in this experiment, CDEC incorporated into dry soil was rated the best treatment.

CIPC was not influenced by the soil moisture variant. Cultivation reduced the effectiveness of this herbicide about equally in both wet and dry soils.

No significant crop damage could be associated with the treatments.

MOISTURE FOLLOWING APPLICATION

This experiment was designed to evaluate the influence of irrigation, or precipitation, after application of the three carbamates to dry soil. Plots were 200 square feet. No crop was involved in this test There had been no rain for 6 days. The day before application on July 2, the entire area was disked thoroughly and smoothed. This resulted in a 2 to 3 inch layer of powder-dry soil on the surface. Immediately after the application of the herbicides, about 1 inch of irrigation was given the blocks designated to receive this treatment. The non-irrigated blocks remained dry for 8 days.

Weed control ratings 5 weeks after treatment are given in Table 3.

Table 3. Rating of Weed Growth Showing Effect of 1 Inch Irrigation Immediately Following Application of Three Carbamates at 8 lbs./A on Dry Soil. Ratings Taken 5 Weeks After Treatment.
(1-Clean; 3-"Satisfactory"; 9-No Control).

	IRRIGATED		NOT IRRIGATED	
	Cultivated	Not Cultivated	Cultivated	Not Cultivated
EPTC	2.5	1	2	3
CDEC	2	1	2.5	3.5
CIPC	6.5	4.5	3.5	4.5

EPTC and CDEC were strikingly similar in performance in this experiment. Weed control was rated from excellent to satisfactory under all conditions. When not cultivated, weed control in the irrigated plots was superior to the not irrigated. Similar results with CDEC were reported by Rahn (6). Irrigation had no effect when these chemicals had been incorporated with the soil.

CIPC did not respond the same as the other two carbamates. When not cultivated, the results were equal whether irrigated or not irrigated. Cultivation reduced the effectiveness of this chemical when followed by irrigation, but did not when the soil remained dry.

DISCUSSION

From a practical standpoint, the results of these tests indicate that: (a) EPTC is an effective pre-emergence herbicide when applied to dry soil, and its performance can be enhanced by irrigation immediately after application. Failure can be expected when application is made to wet soil. (b) CDEC is affected by soil moisture in the same way as EPTC, although the degree of effect is not as great, especially with regard to moisture at the time of application. These results agree with the observation on CDEC reported by Danielson (4). (c) CIPC is affected little or not at all by reasonable soil moisture variation. Temperature has been considered to be the most important factor affecting this chemical, as reported by Danielson (3). (d) Both EPTC and CDEC are promising herbicides for soil incorporation to a depth of 2 inches.

EPTC has been incorporated into soil in additional trials by disking and with rotary tiller and at various rates of liquid and granular formulations. Weed control has been consistently better on dry than on moist or wet soils.

The "wet" soil in these experiments might be considered an extreme condition, i.e. wetter soil than would normally be treated with a pre-emergence herbicide. Further testing is needed to find how moist a given soil can be at the time of application without reducing the effective weed control of EPTC and CDEC.

SUMMARY

EPTC, CDEC, and CIPC were compared at 8 pounds per acre under conditions of (a) dry and wet soils at time of application, and (b) irrigated and not irrigated immediately after application to dry soil. The factor of cultivation immediately after application was included under the various conditions of soil moisture.

EPTC failed to control weeds when applied to wet soil. Weed control was enhanced on dry soil by either cultivation or irrigation after application.

CDEC was more effective when applied to dry soil than on wet soil. Weed control was improved when incorporated into 2 inches of dry soil or when followed by irrigation.

CIPC was unlike EPTC and CDEC in that the variations in soil moisture had little or no influence on its effectiveness, and incorporation generally reduced weed control.

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Acknowledgment is made to Stauffer Chemical Company for financial assistance; and to Monsanto Chemical Company, Niagara Chemical Company, and Stauffer Chemical Company for supplying the chemicals used.

COMPARISON OF FIVE HERBICIDES USED TO KILL ESTABLISHED POISON IVY IN A MATURE APPLE ORCHARD

Oscar E. Schubert[1]

Five herbicides were applied to well established poison ivy in an old block of apple trees growing on a steep hillside. The sod in this orchard had not been disturbed for at least twenty years. The grass is mowed about twice each year. Since neither cultivation nor herbicides had been used to check the growth of poison ivy, many plots beneath trees had as much as 50 to 70 percent of the ground surface covered with poison ivy. Many tree trunks were completely covered with poison ivy which sometimes reached the top of the trees. No plots were selected for treatments or checks unless at least one-fifth of the surface had poison ivy plants.

The principal purpose of this study was to evaluate the ability of the herbicide to maintain the area free of poison ivy for at least one year after treatment. Only herbicides having known ability to kill poison ivy were used.

The herbicides used were ATA, Ammate, 2,4,5-T Ester, 2,4,5-TP and 2,4,5-T Amine. The ATA was made up by using 4 pounds of a 50% formulation per 100 gallons. Ammate sprays were made with 75 pounds of Ammate per 100 gallons. 2,4,5-T Ester, 2,4,5-TP, and 2,4,5-T Amine sprays made at the rate of 2 quarts per 100 gallons for each of the herbicides, respectively. Preliminary trials indicated that an application rate of 200 gallons per acre was necessary to cover the dense growth of grasses and weeds. The applications were made at as nearly the same rate as possible over the entire plot (by timing the spraying operation) regardless of the density or even presence of poison ivy in the area being sprayed. The major obstacle to this procedure was encountered in plots with poison ivy running up the trunks. In these plots only the lower four feet were sprayed. This did not result in an appreciable reduction of spray available for the remainder of the plot and at the same time no effort was made to spray the poison ivy further up the trunk than four feet. This did not appear to be inconsistent with the other procedure since many of the weeds were three to four feet in height at the time of spraying.

The application equipment consisted of a 50-gallon power sprayer with a three-nozzle boom delivering the spray in a flat, fan pattern. The pressure was maintained at 75 to 80 pounds

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while spraying. The plots were classified according to their relative density of poison ivy, and then were grouped into twelve replications, each with similar poison ivy stands. Six replications consisting of six plots each were laid out around trees, and another six replications were laid out in spaces between the tree plots. These plots in the spaces were in tree rows and not between tree rows where orchard equipment normally travelled.

The sprays were applied between August 13 and 17, 1957. The treatments were made at random within each replication. The plots were given numbers to simplify later observations and stand counts, and to avoid bias.

Each plot was carefully inspected in October of 1957. No living poison ivy plants were observed in any of the sprayed plots. This was, of course, only the secondary purpose of the study since the extent of regrowth after a year was of greater concern.

In September, 1958, the density of poison ivy was recorded for each plot as the number of leafy stems that were visible. An estimation of the stand on the basis of percentage of ground surface covered did not seem feasible, except for check plots, because the areas covered in some cases was less than one percent of the surface and seldom was over 5 to 10 percent. Thus a count of 11 stems may indicate only a poison ivy plant or two, and extending over a relatively small amount of the plot surface.

In Table 1, the number of poison ivy stems is tabulated for each replication and treatment. All treatments differ significantly from the control or check plot, but do not differ significantly from each other.

Table 1. Number of poison ivy stems in 1/100th-acre plots one year following herbicide applications to established poison ivy in an apple orchard[a]

Replicate Number[b]	ATA	Ammate	2,4,5-T Ester	2,4,5-T Amine	2,4,5-TP	Check	Original Poison Ivy Rating[c]
1	0	4	28	8	46	128	70
2	2	18	0	5	3	182	60
3	0	4	26	35	15	172	50
4	0	3	1	3	0	168	40
5	0	0	20	14	8	104	30
6	0	6	0	10	0	66	20
7	0	0	3	8	24	115	40
8	1	3	3	2	33	53	30
9	0	0	3	11	5	64	30
10	0	10	6	1	2	32	20
11	0	0	2	9	0	38	20
12	1	0	0	7	3	28	20

a Applied at the rate of 200 gallons per acre.

b Replicates 1 to 6 are around apple trees and replicates 7 to 12 are spaces between tree plots.

c This rating denotes the relative stand of poison ivy on the basis of percentage of ground surface covered with poison ivy.

The Mode and Rate of Release of CIPC from Several Granular Carriers

L. L. Danielson[1/]

Abstract[2/]

Basic information on the mode and rate of release of herbicides from granular carriers is critically needed if we are to understand the reasons for the variable results obtained in field experiments. Experiments directed toward this goal were initiated with a study of the activity of CIPC [isopropyl N-(3-chlorophenyl)carbamate] formulated on granulated uncalcined attapulgite, calcined attapulgite, vermiculite, pyrophyllite, perlite, and activated charcoal.

A bioassay for CIPC based on the rate of elongation of the hypocotyls of germinating cucumber seeds in petri dishes was used to determine the activity of the chemical. The bioassay was used to measure the response of cucumber seedlings to vapor and contact activity of crystalline CIPC and CIPC formulated on the granular carriers. The pronounced contact and vapor activities of CIPC crystals were used as the standards for comparison. CIPC at the rate of 0.5, 5, 50, 500, or 5000 gammas to each 100-mm x 15-mm petri dish were used to establish a constant chemical-to-air-volume relation for the assay. These amounts of the chemical were introduced on 1 gm of each of the granular carriers studied. An aluminum foil container was placed in each petri dish to hold the test herbicide in the vapor studies.

Contact activity of CIPC from all the granular carriers, except activated charcoal, which did not produce growth responses at any of the formulation levels used, was approximately the same.

Vapor activity of CIPC from the formulated granular carriers was related to their physical structure and adsorptive capacity. Vapor action of treated attapulgite granules was enhanced by changing their physical structure by moistening with water. Carriers which did not change physical structure on contact with water remained unchanged in intensity of vapor activity.

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

2/ Paper to be offered for publication in the Journal of the Weed Society of America.

Relatively impervious carriers of low adsorptive capacity such as pyrophyllite and vermiculite were highly contact- and vapor-active. Mildly adsorptive clays such as the attapulgites were intermediate in vapor and contact activities. The highly adsorptive activated charcoal granules held the CIPC tenaciously and neither vapor nor contact activity was observed at the standard levels of concentration used in these experiments.

Use of the methods described in further studies including the effect of temperature, light, and methods of formulation on the level and duration of activity of CIPC and other carbamates from granular carriers is visualized.

EFFECT OF RECOMMENDED AND EXCESSIVE RATES OF CERTAIN HERBICIDES TO APPLE TREES OF VARYING AGES

Oscar E. Schubert[1]

Herbicides may sometimes be applied primarily to kill a particular weed without knowing what the relative safety of the herbicide may be when used over a period of several years or if excessive rates can be applied with safety. A study was initiated in 1957 at the West Virginia Horticulture Farm near Morgantown to obtain additional information concerning the tolerance of apple trees of varying ages to certain herbicides, and to determine what the effects of annual herbicide applications might be on these trees. Some of the herbicides were included since they were or could be recommended for control of weeds or grasses and others were tried for possible beneficial effects upon tree growth.

In 1957 and 1958, ATA, Ammate, 2,4,5-T Ester, 2,4,5-T Amine, 2,4,5-TP, DNBP Amine, DNBP Amine + Dalapon, and DNBP + Oil + Water were applied during July. These herbicides were mixed at the recommended concentrations and sprayed at the rate of 200 gallons per acre for the basic rate (X) and also at the rate of 1000 gallons per acre to obtain the five fold application (5X). It was thought that an orchardist or his workers would be more likely to overspray, by trying to cover the area thoroughly or by a calibration error, than he would to add five times as much of the herbicide to the spray tank.

The sprays were mixed with the following amounts of herbicides per 100 gallons of spray:

ATA--4 pounds of 50% W.P.
Ammate--75 pounds.
2,4,5-T Ester--2 quarts.
2,4,5-T Amine--2 quarts.
2,4,5-TP--2 quarts.
DNBP Amine--10 quarts to water previously softened with Calgon.
DNBP Amine + Dalapon--10 quarts Premerge + 5 pounds Dowpon (85% Dalapon) to water previously softened with Calgon.
DNBP + Oil + Water--3 pints Dow General + 20 gallons No. 2 fuel oil + 80 gallons water.

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[1]Associate Horticulturist, West Virginia Agricultural Experiment Station.

Trees were selected in three different age groups with two replications in each to study the possible variation in response due to age of tree. The circumferences of many trees in each potential replication were measured at a height of 15 inches from the ground and marked with paint for future measurements. Then replications were made up from trees having the smallest range in circumference. The six replications were: two of Double Red Delicious replants set out the previous winter (December 1956); one replication of young Red Rome trees and another of young Golden Delicious trees just starting to bear (set 1948); and two replications of mature Red Stayman trees (set 1937).

An area of 1/200th-acre was sprayed around the young replants and 1/100th-acre plots were sprayed around the young and mature trees.

A 50-gallon sprayer with a 3-nozzle boom delivering a flat fan spray pattern was used. The operating pressure was maintained at 75 to 80 pounds and a stop watch was used to apply the proper quantity of spray by timing the spraying of each tree. Calibrations were made before and occasionally between herbicides to be certain of the amount of spray delivered by the boom.

In July, 1958, small white-green to yellow-green chlorotic spots were observed on the young replant Red Delicious at both X and 5X concentrations of Ammate. Similar spots were found on the 5X Ammate treatment on young Golden Delicious and one of the two mature Red Stayman trees. By September, 1958, the other mature Red Stayman tree also showed the distinctive spots but no spots could be found on either of the Red Rome (X and 5X) trees or the two Red Stayman trees having had the X application rate. A more detailed description of the early symptoms of an excess of Ammate are: At 60X magnification these areas are roundish to elliptical in shape (not angular). The chlorotic areas may appear anywhere in small islets between veins, or even on veins, but do not fill the islet with chlorotic tissue. No evidence of necrosis was observed in these areas. Where the spots are more numerous they seem to merge but do not evenly cover one or more islets. Occasional spots may be found scattered anywhere on the leaf blade.

The previously described injury from Ammate has been the only visual foliar symptom of herbicidal injury observed in any of the treatments over a period of two seasons except where foliage was contacted directly by spray. This experiment will be continued by annual herbicide applications, periodic observations and trunk circumference measurements.

GRANULAR AND SPRAY APPLICATIONS OF CERTAIN HERBICIDES IN STRAWBERRIES AND RASPBERRIES 1/

W. E. Chappell and Fred L. Bower, Jr. 2/
Virginia Agricultural Experiment Station
Blacksburg, Virginia

The work reported herein includes two experiments on weed control in strawberries and two experiments in raspberries. The various chemicals used and the type of treatments included in each experiment are presented and discussed separately.

STRAWBERRIES

Experiment I - Spray vs. granular treatments of sesone and neburon

Strawberry plants of the Blakemore variety were planted in four-foot rows on April 15, 1958. Individual plots of 8 x 20 feet were staked out and treated on May 17, immediately following cultivation and hoeing. Four replicates were used. Weed control and plant vigor ratings were made on June 4 and again on June 24. On June 28 a second application of the herbicide was made. Weed control and plant vigor ratings were again made on July 17 and on August 27.

The chemicals were applied as a water spray in a volume of 40 gallons per acre and on No. 4 vermiculite at a rate of 60 pounds per acre. The chemicals used, along with weed control and vigor ratings of the plants are given in tables 1 and 2.

Table 1 - Weed Control Ratings. Granular vs. Spray

Chemical	Rate in lbs. per acre	Rating* June 4 1/	June 24	July 17	Aug. 27
Sesone (S)	3	7.75 a	6.75 bc	7.25 c	5.5 dc
Sesone (G)	3	6.88 b	6.00 c	7.00 cd	6.00 c
Neburon (S)	6	8.13 a	8.00 a	9.75 a	7.75 a
Neburon (G)	6	7.88 a	7.5 ab	8.25 b	7.50 b
Check		5.63 c	3.25 d	6.25 d	3.00 c

* 1 - No control, 10 - 100% control

1/ Figures followed by same letter are not significantly different.

1/ These studies were supported in part by a grant from the ZonoliteCompany.

2/ Plant Physiologist and Graduate Research Assistant

Table 2 - Plant Vigor Ratings.

Chemical	Rate in lbs. per acre	Ratings* June 24 1/	July 17	August 27
Sesone (S)	3	10.0 a	9.5 a	8.0 a
Sesone (G)	3	8.5 a	8.5 a	7.5 a
Neburon (S)	6	4.5 b	3.0 b	2.5 b
Neburon (G)	6	8.0 a	7.5 a	6.0 a
Check		9.0 a	8.5 a	7.0 a

* 1 - Plants dead, 10 - Vigorous plants

1/ Figures in a column followed by the same letter are not significantly different. Comparison should be made within columns and not between columns.

As shown in the data, neburon at 6 pounds per acre, was more effective in controlling the weeds than was the sesone. With both chemicals the spray application gave slightly better weed control than did the granular application. Plant vigor was seriously lowered in the case of the neburon spray as compared to the sesone and check plots. This was not true of the plots receiving granular neburon.

In this experiment granular neburon was the most satisfactory treatment.

Experiment II - Screening Test. This experiment was handled the same as experiment 1 except that four varieites of strawberries were used and only two replications were made. The varieties Blakemore, Pocahontas, Fairfax and Empire were used. The chemical treatments were applied on May 17 and again on June 28. Weed control and plant vigor ratings are presented in tables 3 and 4.

Table 3 - Screening - Weed Control

Chemical	Rate in pounds per acre	Ratings* (after 2 applications) July 17	August 27
EPTC (G)	5	8 b	8
EPTC (S)	5	8 b	7
Ortho (G) 2/	25	8 b	6
Ortho (G)	50	7 b	7
CIPC (G)	3	8 b	6
CIPC (S)	3	8 b	7
Sesone + CIPC (S)	2 + 1	8 b	8
Simazine (S)	1-1/2	8 b	5
CHECK		10 a	8
			NS

* 1 - Plants dead, 10 - N.S. vigorous plants

1/ Figuresin a column followed by the same letter are not significantly different.

2/ 6% Sesone and 4% Chloro IPC

Table 4 - Screening plant vigor

Chemical	Rate in pounds per acre	Ratings * June 4	June 24	July 17	Aug. 27
EPTC (G)	5	8.00	7.0 ab	7.0	6.5 b
EPTC (S)	5	7.25	5.5 bc	6.5	5.5 b
Ortho (G)	25	7.5	7.0 ab	7.5	6.0 b
Ortho (G)	50	8.00	8.0 a	7.5	6.5 b
CIPC (G)	3	7.75	7.0 ab	6.5	5.5 b
CIPC (S)	3	6.25	5.0 c	7.0	6.0 b
Sesone ≠ CIPC (S)	2 ≠ 1	7.50	7.0 ab	7.0	5.0 b
Simazine (S)	1-1/2	7.75	7.0 ab	7.5	9.0 a
Check		6.75	5.0 c	5.5	5.0 b
				NS	

* 1 - No weed control, 10 - 100% Weed Control

1/ Figures in a column followed by the same letter are not significantly different.

Of the chemicals used Simazine appeared to hold the weeds later in the season than any other. In this particular location weeds were very sparse, however. Simazin also stunted the plants moderately but the differences were not significant.

RASPBERRIES

Experiments were carried out on black raspberries at one location and on red raspberries at another location. In each case the canes had been cut off in the winter of 1957 and the new growth had reached a height of about two feet when the herbicide applications were made. Rates of chemicals used and results obtained are presented separately.

Experiment III - Red Raspberries

In this experiment granular herbicides were applied to new growth on the raspberries immediately following a cultivation on May 13, 1958. The materials were applied with a hand duster and no attempt was made to keep them off the foliage. Individual plots were 5 x 20 feet and four replications were made. Weed control ratings were made on June 4 and June 25 and plant vigor ratings weremade October 13. The data from these ratings are presented in table 5.

Table 5 - Weed and Vigor Ratings - Red Raspberries

Chemical	Rate in pounds per acre	Weeds 1/ June 4	Weeds 1/ June 25	Vigor 2/ October 13
		3/		
Dinitro (G)	7.5	6.75 d	6.50 bc	9.5
Dinitro (G)	9.0	7.30 bcd	7.75 bc	8.5
EPTC (G)	7.5	7.75 abc	7.00 ab	7.5
EPTC (G)	10.0	7.25 cd	7.00 ab	8.5
Neburon (G)	6.0	8.5 a	7.75 ab	8.0
Simazin (G)	2.0	8.25 ab	8.00 a	8.5
Check		5.25 e	5.50 c	8.5
				NS

1/ 1 - No control, 10 - 100% control

2/ 1 - Plants dead, 10 - Vigorous plants

3/ Figures in a column followed by the same letter are not significantly different.

None of the treatments resulted in reduced vigor of the raspberries. There was moderate foliage burn in the neburon and dinitro plots but resulted in no permanent damages. Simazine and neburon and EPTC resulted in satisfactory weed control for about six weeks.

Experiment 2 - Black Raspberries

The same general procedure was used in this experiment as in the previous one. The only difference being that both granular and spray applications were used. The applications were directed at the base of the raspberry canes. Weed control ratings sere made at three and six weeks after treatment. The data are presented in table 6.

Table 6 - Weed Control - Black Raspberries

Chemical	Rates in pounds per acre	Weeds* June 4	Weeds* June 25
		1/	
Dinitro (G)	12	7.38	6.75 abc
Dinitro (S)	33 cc/1.3 qt. oil, 13 gal H_2O / 100 sq. ft.	8.00	6.50 bc
Sihazin (S)	3	7.75	6.75 abc
Sihazin (G)	3	8.38	8.50 a
Neburon (S)	5	6.38	5.25 cd
Neburon (G)	5	8.00	7.75 ab
EPTC (S)	6	6.63	5.50 c
EPTC (G)	6	6.75	5.25 cd
Check		5.16	3.30 d

* 1 - No control, 10 - 100% control

1/ Figures in a column followed by the same letter are not significantly

There was no apparent damage to the raspberries from any of the treatments. This was probably due to the use of directed applications. All of the chemicals except EPTC resulted in satisfactory weed control for three weeks. After 6 weeks only the simazine and neburon spray treatments were holding the weeds satisfactorily.

Summary

Strawberries

1. One application of neburon on vermiculite at 6 pounds per acre resulted in good weed control for six weeks without causing injury to the plants. The same chemical as a spray was much more injurious.

2. Sesone resulted in no injury but the weed control was poor after three weeks.

Raspberries

1. Simazine and Neburon resulted in the most satisfactory weed control and resulted in no injury to the raspberries.

HERBICIDE TRIALS IN A MATURE VINEYARD

Oscar E. Schubert[1]

It is often difficult, in practice, to make the necessary repeat applications suggested with several of the herbicides used to control or retard weed and grass growth beneath a grape trellis. With this problem in mind, single applications of several herbicides and combinations of herbicides were made.

The herbicides used were:

1. DNBP + Oil + Water (2.5 pints Dow General + 20 gallons kerosene + 80 gallons water)
2. DNBP + Oil + Dalapon (same concentration of DNBP, oil, and water plus enough dalapon to give a 3 pounds per acre rate)
3. DNBP + Oil + ATA (same concentration DNBP, oil, and water plus enough ATA to give a 4 pounds per acre rate)
4. Dalapon (3 pounds/acre)
5. Dalapon (3 pounds/acre) + ATA (4 pounds/acre)
6. ATA at 4 pounds/acre
7. ATA at 8 pounds/acre
8. Check

The sprays were applied with a 50-gallon Myers power sprayer using a three-nozzle boom. Each nozzle delivered a flat fan-type spray pattern. The boom was curved down 90° at the end so the main part of the boom was held horizontal to the ground while the nozzles were perpendicular to the ground.

A working pressure of 70 pounds was used to reduce atomization and spray drift. A strip about 2 feet wide was sprayed along each side of the trellis of the mature Concord grape planting. All new canes were tied up to the two-wire trellis during the two weeks preceding the spray application so as to eliminate direct spraying of the grape foliage. The lower portion of the grape trunk was sprayed the same as the surrounding weeds.

The ATA sprays, at 4 and 8 pounds per acre were applied on June 15, 1958, and the other sprays were applied June 23, 1958. The application rate was 200 gallons per acre. At this time many weeds and grasses had made a substantial amount of growth. The treatments in each of the two replications were selected at random with five grape plants in each plot. The check plots were mowed with a sickle about the time herbicides were applied.

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[1]Associate Horticulturist. West Virginia Agricultural

At the time the applications were made it seemed that an earlier date may have been desirable, but had the sprays been made earlier it is likely that a repeat application would have been necessary for more of the herbicides. By spraying at this time many late-starting weeds were killed or severely injured as well as those weeds which start growth very early in the spring. Most of these weeds and grasses, if not killed, did not have enough time to recover and present a problem by grape harvest time.

A summary of observations from the different treatments is given in Table 1. ATA at the rate of 8 pounds of active material per acre gave the best degree of weed control. ATA at 4 pounds per acre and a combination of dalapon and ATA gave what was considered an entirely acceptable job of weed and grass suppression. DNBP + oil + ATA was not as effective, perhaps due to rapid kill of plant parts from the DNBP and oil, thus decreasing the amount of ATA absorbed. DNBP + oil + dalapon, DNBP + oil, and dalapon alone would have to be repeated to achieve a satisfactory degree of weed and grass suppression. General recommendation for the use of dinitros and dalapon have indicated the need for repeat sprays.

Table 1. Percent of living cover and extent of weed and grass recovery in various grape herbicide plots.

Herbicide[a]	% Living cover[b]	Have weeds recovered?[c]	Have grasses recovered?
ATA 8 pounds/acre	15	No. Weeds killed or stunted	Very slightly
ATA 4 pounds/acre	25	Very slightly	Slightly
Dalapon + ATA	30	Slightly--2-3" additional growth	Slightly
DNBP + Oil + ATA	45	Moderately	Moderately
DNBP + Oil + Dalapon	75	Yes. Moderate reduction in weed growth	Moderately
DNBP + Oil	80	Yes. Moderate reduction in weed growth	Moderately
Dalapon	85	Yes. Slight reduction in weed growth	Moderately
Check	100	Yes. Many 3 to 4' tall	Yes. 8-15" tall

a ATA alone sprays applied June 15, all others applied June 23, 1958

b Check = 100% and complete control of vegetation = 0%

c With the more effective sprays the weeds have made little or no growth after spraying. All observations were made September 4, 1958

Weed Control in Sweet Corn in 1958

E. M. Rahn
University of Delaware

DNBP amine (amine salt of 4,6 dinitro-o-secondary butyl phenol), applied to sweet and field corn while in the "spike" stage, is a widely accepted practice for control of both annual grasses and broadleaf weeds. It was felt that 3-amino-1,2,4-triazole applied similarly at low rates might do equally well possibly at less cost. Therefore this preliminary experiment was run in 1958.

Procedure

Seed of the NK-199 variety was planted May 23, 1958 in a Norfolk loamy sand at the Georgetown Substation. The treatments used (Table 1) were replicated four times in randomized blocks. Plots consisted of three rows 25 feet long. Chemicals were applied in water sprays at a 50 gal./A. rate. Emid (a wettable powder containing 75 per cent 2,4-dichlorophenoxy acetamide) was applied immediately after planting. Three days later 0.95 inches of rain fell. DNBP amine (applied as Premerge) and amino triazole (applied as Weedazol, 50% active) were applied on June 2, ten days after seeding. On this date the corn was about two inches tall and was actually beyond the intended "spike" stage, for the first two or three leaves had unfolded. The hoed check plots were hoed and cultivated as needed throughout the season. All other plots were never hoed, but after taking weed counts on June 11, they too received tractor cultivation as needed. Also on this date, since a heavy seeding rate was used, the plant stand on all plots was reduced to one plant per foot of row.

Crabgrass was the predominant weed. There was a light infestation of lamb's quarters, pigweed, and ragweed. On June 2, when the DNBP amine and amino triazole were applied, many weeds had emerged and were about a half inch high. Yields were taken on the center rows of each plot only.

Results and Discussion

All three herbicides used gave good commercial weed control (Table 1). On June 11, the date weed counts were made and nine days after amino triazole was applied, it was noted that some of the crabgrass was just stunted by amino triazole. Most of this, however, was subsequently killed by tractor cultivation.

Plant stand was not significantly affected by any chemical. All three chemicals, however, produced some temporary visible effect. Emid retarded germination and early growth slightly. DNBP amine caused some yellowing and necrosis on the margins of the first two or three leaves. Yields, however, were not significantly affected by any treatment.

The cost of the DNBP amine treatment would be approximately $5.20 per acre. The cost of the amino triazole treatment would be approximately $3.40 per acre. If only a foot-wide band over the row were sprayed, the cost would be only one-third of the above.

Summary

Amino triazole, 3/4 lb./A., and DNBP amine, 3 lbs./A., applied when sweet corn was about two inches high, gave good commercial control of annual grass and broadleaf weeds, when followed by tractor cultivation, without significant effect on plant stand or yield. Emid, 2 lbs./A., applied just after seeding, gave equally good weed control with no significant effect on plant stand or yield. All chemicals, however, produced slightly temporary stunting or injury which was quickly outgrown.

Table 1. Effect of early post-emergence applications of DNBP amine and amino triazole, and pre-emergence application of Emid, on yields and stand of sweet corn and on weed growth.

Herbicide	Rate, lbs./A., active	Date of application 1/	Marketable yield from 4 plots, lbs.	Stand, plants per 25 ft.	Weight of weeds per 3 sq. ft. on 6/11, gms.	Percent crab-grass on 6/11
DNBP amine	3	6/2	69.8	42	0.3	21
Amino triazole	3/4	6/2	69.8	41	3.1	85
Emid	2	5/23	69.8	43	0.2	40
Hoed check	---	----	68.8	47	0	--
Unhoed check	---	----	60.0	46	18.8	71
L.S.D. 5%	---	----	N.S.	N.S.	7.9	--

1/ Seeding date was May 23, 1958

STUDIES WITH PRE-PLANTING, PRE-EMERGENCE, AND POST-PLANTING APPLICATION OF HERBICIDES ON CERTAIN VEGETABLE CROPS 1/

Fred L. Bower II, and W. E. Chappell 2/
Virginia Agriculture Experiment Station - Blacksburg, Va.

Four field experiments were set up in Blacksburg and a fifth in Grottoes, Virginia to test various chemicals at different levels of concentration on Upland cress (Barbarea vulgaris) and other crops. Cress is normally seeded in this area about August 15 to September 15. Stands are often poor if dry hot weather is encountered.

Experiments I, II, and III were preliminary experiments seeded to cress. The treatments were arranged in a block design and each treatment was replicated four times. The preliminary experiments were designed to determine which chemicals would give the best weed control without inhibiting seed germination or reducing the vigor of the cress.

Experiment IV was a field test of several herbicides as pre-emergence and pre-seeding treatments on several vegetable crops. Experiment V was a field test of pre-seeding and pre-emergence treatments on cress.

Water and vermiculite were used as carriers. All sprays were applied with a knapsack sprayer using two 8004 TeeJet nozzles at a rate of 40 gallons of solution per acre. Vermiculite was used as the carrier in the granular treatments and was applied with a small hand duster.

Experiment I - Pre-seeding and Pre-emergence

Treatments used in pre-seeding and pre-emergence appear in Table 1. .

Treatment I was black polyethylene plastic which was laid down on June 24, two weeks prior to seeding. The plastic covered the entire plot and was secured on all sides by wire wickets. Pre-seeding treatments 2 to 12 were CDEC, and DNOSBP as sprays and CIPC as sprays and on vermiculite applied on the same date.

The plastic was removed immediately prior to seeding. Pre-emergence treatments 3 to 18 using sprays of CIPC, CDEC, and a combination of CIPC and CDEC were applied as soon as seeding was completed on July 3.

Plots were rated for weed control on July 17. Results appear in Table 1.

1/ These studies were supported in part by grants from the Zonolite Company, The Du Pont Company, and The Columbia Southern Chemical Company.

2/ Graduate Research Assistant and Plant Physiologist

TABLE 1

Weed Control Ratings For Experiment I .
Treatments 1-12 Pre-seeding. Applied June 24
Treatments 13-18 Pre-emergence. Applied July 3.

CHEMICAL		RATE IN POUND PER ACRE	RATING FOR JULY 17
1. PLASTIC			8.25 b c *
2. CDEC	(S)	4	8.25 b c
3. CDEC	(S)	6	8.75 a b
4. CDEC	(S)	8	9.50 a b
5. CIPC	(S)	4	6.75 d e
6. CIPC	(S)	6	6.25 d e
7. CIPC	(S)	8	5.75 e
8. DNCSBP	(S)	3	9 a b
9. DNCSBP	(S)	4½	9.25 a b
10. CIPC	(G)	4	9.75 a
11. CIPC	(G)	6	10 a
12. CIPC	(G)	8	9.75 a
13. CIPC	(S)	2	6.75 d e
14. CIPC	(S)	3	5.75 e
15. CIPC	(S)	4	7.25 c d
16. CIPC-CDEC	(S)	2-4	9.25 a b
17. CDEC	(S)	4	8.25 b c
18. CDEC	(S)	6	8.75 a b
19. CHECK			6.25 d e

S - SPRAY
G - GRANULAR
10 - COMPLETE CONTROL
1 - NO CONTROL

* Values in a column followed by the same letter are not significantly different.

RESULTS

The granular treatments tended to produce better weed control than the spray treatments. The 8 pound rate of CDEC, the 4½ pound rate of DNCSBP, and the combination of 2 pounds of CIPC with 4 pounds of CDEC as sprays produced high levels of weed control. The possibility of these higher rates greatly reducing the germination of even the deepest placed seeds should not be discounted. No data was collected on the crop as a heavy rain washed the seed out.

Experiment II - Pre-seeding and Pre-emergence

Experiment I involved the application of CIPC, CDEC, and DNCSBP as sprays and CIPC on vermiculite as pre-seeding treatments. CIPC and CDEC were applied as sprays in the pre-emergence treatments.

These treatments and the rate of active material in pounds per acre appear in Table 2. The pre-seeding treatments were made on August 1, two weeks prior to seeding. The cress was seeded and the pre-emergence treatments were made on August 16

The first weed control rating was made on August 27 and a second rating on October 7. Data are presented in Table 2.

TABLE 2

Weed Control Ratings For Experiment II
Treatments 1-7 Pre-seeding. Applied August 1
Treatments 8-10 Pre-emergence. Applied August 16

	CHEMICAL		RATE IN POUNDS PER ACRE	RATING FOR AUGUST 27	RATING FOR OCTOBER 10
1.	CDEC	(S)	4	7.75 a b c*	2.75 b c
2.	CIPC	(S)	4	5.25 d	1.50 c
3.	CIPC	(S)	6	6.5 c d	1.25 c
4.	DNOSBP	(S)	1½	6.5 c d	2.25 b c
5.	CNOSBP	(S)	3	7.25 a b c	4 b
6.	CIPC	(G)	4	8.25 a b	6.25 a
7.	CIPC	(G)	6	3.5 a	7.5 a
8.	CIPC	(S)	2	7.0 a b c	3 b c
9.	CIPC	(S)	4	6.75 b c d	3 b c
10.	CDEC	(S)	4	7.50 a b c	3 b c
11.	CHECK			6.5 c d	2.75 b c

S - SPRAY
G - GRANULAR
10 - COMPLETE CONTROL
1 - NO CONTROL

*Values in a column followed by the same letter are not significantly different.

RESULTS

Experiment II was rated for weed control, but not for crop vigor or stand. The stand was irregular or non-existant in all plots due to climatic factors.

In Experiment I, CIPC on vermiculite at the 4 pound and 6 pound rates gave the best weed control. Evidence of this weed control was still apparent on October 10, 2½ months later. The equivalent rates of CIPC applied as sprays did not give equal weed control even 26 days after application, and by October 10 the weed control on these plots was less than that of the check plots.

Experiment III - Pre-emergence

Experiment II was similar to Experiment I in that the same chemicals were used, but all treatments were made as pre-emergence applications.

Cress seeding and treatment applications were conducted on August 29. Weed control ratings were made on October 10, but no crop vigor or stand ratings were made. Ratings were not made because of irregular stands or non-exisistence of stands due to climatic factors.

Weed control ratings are presented in Table 3.

TABLE 3

Weed Control Ratings For Experiment III
Treatments Applied Pre-emergence

CHEMICAL	RATE IN POUNDS PER ACRE	RATING FOR OCTOBER 10
1. CDEC (S)	4	7.5 b c *
2. CIPC (S)	4	6.75 c
3. CIPC (S)	6	6.75 c
4. DNOSBP (S)	3	7.25 c
5. DNOSBP (S)	4½	8.75 a
6. CIPC (G)	2	7 b
7. CIPC (G)	4	7.50 b c
8. CIPC (G)	6	8.50 a b
9. CIPC (S)	2	6.75 c
10. CHECK		6.75 c

S - SPRAY
G - GRANULAR
10 - COMPLETE CONTROL
1 - NO CONTROL

*Values in a column followed by the same letter are not significantly different.

RESULTS

The DNOSBP spray at 4½ pounds per acre and the 6 pounds per acre of CIPC on the vermiculite gave the best weed control.

Data concerning this experiment appear in Table 3.

Experiment IV - Pre-seeding and Pre-emergence

Experiment IV consisted of 16 treatments which were arranged in plots 20 feet by 20 feet in size. Each plot was seeded to corn, lima beans, and green beans to which treatments were applied pre-emergent. Kale, spinach, cress, and tomatoes were seeded 2 weeks after the treatments were applied.

In this experiment DNOSBP, EPTC, SIMZAIN, CDEC, and NEBURON on liquid and granular carriers were used. 2,4-D was used on liquid carriers only. CDEC and DIURON were used with attaclay as the granular carrier instead of vermiculite. All treatments were applied on May 30.

The corn, lima beans, and green beans were seeded on May 30 and the cress, kale, spinach, and tomatoes were seeded on June 12.

Data concerning chemicals, rates the weed control ratings for July 1, July 17, and August 27, and the crop vigor rating for July 1 are presented in Table 3.

TABLE 4

Weed Control (1)

CHEMICAL	RATE IN POUNDS PER ACRE	RATING FOR JULY 1	RATING FOR JULY 17	RATING FOR AUGUST 27
1. DNOSBP (S)	6	7 bcd	6 bcd	2.5 de
2. DNOSBP (G)	6	8 abc	7 abc	4 bcde
3. EPTC (S)	6	9 a	8 ab	3 cde
4. EPTC (G)	6	8.5 ab	8 ab	4.5 bcde
5. CIPC (S)	4	5.5 d	2.5 f	2 e
6. CIPC (G)	4	7.5 abc	5 cde	3 cde
7. SIMAZIN(S)	2	9 a	9 a	8 a
8. SIMAZIN(G)	2	9 a	8 ab	6 ab
9. CDEC (S)	6	8.5 ab	7 abc	4 bcde
10. CDEC (G)	6	8.5 ab	7 abc	4 bcde
11. NEBURON(S)	5	9 a	8.5a	6 ab
12. NEBURON(G)	5	8 abc	7 abc	5 bcd
13. DIURON (S)	2	9 a	8.5a	5.5 bc
14. DIURON (G)	2	9 a	8 ab	6 ab
15. 2,4-D (S)	2	6.5 bcd	4 def	2.5 de
16. CHECK		6.5 bcd	3.5 ef	2.5 de

Values in a column followed by the same letter are not significantly different.

PART II

Ratings For July 1 (2)

CHEMICAL		Vigor CN	LB	SB	Stand SP	K	C	T
1. DNOSBP	(S)	9	8	10	5	2	4	4
2. DNOSBP	(G)	9	9	10	3	2	2	2
3. EPTC	(S)	8	6	10	6	2	9	5
4. EPTC	(G)	5	8	9	4	3	8	4
5. CIPC	(S)	7	7	8	8	2	8	4
6. CIPC	(G)	5	7	9	6	2	7	4
7. SIMAZIN	(S)	6	5	4	3	2	2	2
8. SIMAZIN	(G)	5	6	10	7	2	3	2
9. CDEC	(S)	8	6	9	7	2	9	5
10. CDEC	(G)	7	9	10	9	2	7	3
11. NEBURON	(S)	6	6	8	2	2	2	3
12. NEBURON	(G)	5	7	7	4	2	2	3
13. DIURON	(S)	5	5	5	2	2	2	2
14. DIURON	(G)	6	6	4	2	2	2	2
15. 2,4-D	(S)	7	6	6	6	2	3	3
16. CHECK		7	9	10	5	2	3	4

(1) - NO CONTROL, 10 - 100% CONTROL

(2) - 1 - PLANTS DEAD, 10 - EXCELLENT VIGOR

CN - Corn; LB - Lima Beans; SB - Snap Beans; SP - Spinach, K - Kale; c - Cress; T - Tomatoes

RESULTS

Experiment IV pointed up the fact that chemicals applied on vermiculite tend to persist longer than those applied as sprays except in the case of SIMAZIN and NEBURON. DIURON at 2 pounds per acre as a spray, and on vermiculite also produced good weed control over longer periods of time, as indicated by ratings made 8 weeks after treatment.

Experiment V - Pre-seeding and Pre-emergence in Cress

Experiment V was carried out on the farm of one of the larger commercial cress growers near Grottoes, Virginia. The seed and the seeder were supplied by the grower. Seeding was done on August 25.

CDEC, DNOSBP as sprays and CIPC as sprays and on vermiculite were applied as pre-seeding treatments on August 14. CIPC, CDEC, and a combination of CIPC amd CDEC were applied as pre-emergence sprays on August 25.

Data concerning this experiment appear in Table 5 .

TABLE 5

Weed Control and Vigor Ratings for Experiment V
Treatments 1-9 Pre-seeding. Applied August 14
Treatments 10-15 Pre-emergence. Applied Aug. 25

	CHEMICAL	RATE IN POUNDS PER ACRE	WEED CONTROL RATED SEPTEMBER 15		VIGOR RATED SEPTEMBER 15	
1.	CDEC (S)	4	5	c d *	7.50	a b c
2.	CDEC (S)	6	6.75	b	8.50	a b
3.	CIPC (S)	4	4	d e	7.75	a b c
4.	CIPC (S)	6	4.25	d	8.75	a
5.	DNOSBP(S)	1½	5.50	c d	7.75	a b c
6.	DNOSBP(S)	3	7.25	b	4.25	d
7.	DNOSBP(S)	4½	7.50	b	1	e
8.	CIPC (G)	4	8	a b	7	b c d
9.	CIPC (G)	6	9	a	4.25	d
10.	CIPC (S)	2	2	f	8	a b c
11.	CIPC (S)	3	1	f	8	a b c
12.	CIPC (S)	4	2.50	e f	8	a b c
13.	CIPC-CDEC (S)	2 - 4	7	b	5	d e
14.	CDEC (S)	4	7.5	b	6.25	c d
15.	CDEC (S)	6	7.5	b	5.25	d e
16.	CHECK		1	f	8	a b c

S - SPRAY
G - GRANULAR
10 - COMPLETE CONTROL; NO REDUCTION IN VIGOR
1 - NO CONTROL; DEATH

*Values in a column followed by the same letter are not significantly different.

RESULTS

In Experiment V the higher rates of the chemicals, in general, gave the best weed control. Exceptions were the pre-seeding treatments of CIPC as a spray at 6 pounds per acre, and CIPC spray at 4 pounds per acre as pre-emergence treatments.

CIPC at 4 pounds per acre on vermiculite as a pre-seeding treatment, and CDEC spray at 4 pounds per acre as a pre-emergence treatment were the only two treatments that gave acceptable weed control as well as a reasonably acceptable level of crop vigor.

Pre-planting treatments of DNOSBP sprays at the higher rates greatly reduced vigor as did the application of 6 pounds per acre of CIPC on vermiculite. The combination of 2 pounds of CIPC with 4 pounds of CDEC, and the 4 and 6 pounds per acre rates of CDEC as pre-emergence treatments also reduced vigor.

SUMMARY

1. Several herbicides were applied to various crops as sprays and on vermiculite. In general the chemicals applied on vermiculite gave better control of weeds.

2. CIPC at 4 pounds per acre on vermiculite as a pre-seeding treatment, and CDEC at 4 pounds per acre as a spray gave acceptable weed control and good vigor of cress.

3. The 4 and 6 pounds per acre rates of CIPC on vermiculite, SIMAZIN at 2 pounds per acre, NEBURON at 6 pounds per acre, and DIURON at 2 pounds per acre on attaclay and as sprays produced a high level of weed control. Sprays of CDEC at 8 pounds per acre, DNOSBP at 4½ pounds per acre, and a combination of 2 pounds of CIPC per acre and 4 pounds of CDEC per acre produced comparable weed control.

Control of Northern Nutgrass and Other Weeds in Potatoes and Tomatoes in 1958

E. M. Rahn
University of Delaware

In a screening test on strawberries in 1957, EPTC (ethyl N, N-di-n-propyl-thiolcarbarmate) was found very effective in preventing germination of tubers of northern nutgrass (Cyperus esculentus L.) without significant injury to strawberries. In view of the fact that nutgrass has been seriously reducing yield and grade of potatoes for a number of growers, a preliminary experiment involving the use of EPTC on potatoes was run in 1958 on soil heavily infested with nutgrass tubers. Also nearby, EPTC along with a number of other herbicides mostly as granulars, were screened on tomatoes grown on soil heavily infested with nutgrass and crabgrass.

Potato Experiment

Delus potatoes were planted on April 18 on Norfolk loamy sand at the Georgetown Substation. Treatments (Table 1) were replicated four times in randomized blocks. Plots consisted of three rows 3 feet apart and 30 feet long. EPTC, as a 6 lbs./gal. emulsifiable concentrate, was applied in a water spray at 50 gals./A. on two dates. The first date was April 23, five days after planting. On this date the soil was wet and compact, 0.73 inches of rain having fallen the day previous. The second date of application was May 9, twenty-one days after planting and one day after the ridges were "drug off" with a smoothing harrow. On this date nutgrass was emerging profusely. The soil surface, as a result of "dragging off", was relatively dry and loose. All plots received tractor cultivation as needed. The hoed check plots were hoed when needed.

Results and Discussion

EPTC when applied to dry, loose soil on May 9 gave much better control of nutgrass than when applied to wet, compact soil on April 23. This is in agreement with experiments conducted by the manufacturer, which showed that EPTC applied to wet soil is ineffective because of limited penetration of EPTC vapor into the soil. On June 11, a month after application of EPTC, 10 lbs./A., there was 95% control of nutgrass (Table 1). On August 12, three months after the same application, there was 88% control of nutgrass, indicating some regeneration of nutgrass. This was probably due to propagation of the few plants "missed" by EPTC as well as due to germination of nutgrass tubers late in the season whose dormancy was broken by late cultivation. The late growth of nutgrass caused significant injury to potato tubers - the nutgrass stolons grew through the potato tubers. Probably a second application of EPTC just before or after the last cultivation would prevent this late growth of nutgrass. EPTC at 5 lbs./A. was not significantly different from the 10 lbs./A. rate.

As for control of annual broadleaf weeds, the May 9 application was very effective early in the season, but on August 12 there was considerable crabgrass present due to germination after the last cultivation.

Yields and plant growth were not affected by EPTC applied on May 9.

Summary and Conclusions

EPTC, 5 and 10 lbs./A., applied just after "dragging-off" potatoes, followed by tractor cultivation, gave good control of nutgrass and annual grasses and broadleaf weeds up to three weeks after the last cultivation. After this date nutgrass and crabgrass appeared to some extent. Yields and plant growth were not affected by these treatments.

Table 1. Effect of EPTC on yields of potatoes and growth of nutgrass and other weeds1/

Treatment	Yield, U.S.#1, Bu./A.	Dry Matter, %	Weed Control, Percent			
			Nutgrass 6/11	Nutgrass 8/12	Broad-leafs, 8/12	Annual Grasses 8/12
EPTC, 5 lbs./A applied 4/23	343	----	50	35	33	5
EPTC, 10 lbs./A. applied 4/23	356	----	50	40	25	20
EPTC, 5 lbs./A. applied 5/92/	396	16.8	83	78	80	43
EPTC, 10 lbs./A applied 5/9	392	16.3	95	88	88	48
Check, hoed	441	16.1	95	93	90	18
Check, not hoed	323	----	0	0	0	0
L.S.D. - 5%	88	N.S.	29	41	32	30

1/ Potatoes were planted 4/18
2/ EPTC applied just after "dragging-off".

Tomato Experiment

Treatments used are listed in Table 2. They were not replicated. Plots consisted of three rows 5 feet apart and 33 feet long. Vapam was applied on April 25, fifteen days before planting. A furrow three inches deep was made in the row. Then the indicated amount of Vapam was applied in water, 2 gals. per 100 feet of row, using a sprinkling can. The furrow was closed immediately and the soil surface was compacted by rolling to reduce vaporization to the air.

Delaware 13-2 plants were set on May 10. All plots received tractor cultivation throughout the season as needed. The hoed check plots were hoed as needed. All other plots were never hoed. All chemicals except Vapam were applied twice: on June 12, just after cultivation, and on July 2, just after the last cultivation. The granulars were applied over the plants with

Table 2. Screening of certain herbicides, mostly as granular formulations, for full season weed control in tomatoes[1] in 1958 at Georgetown, Delaware.

Chemical[2]	Formulation	Rate, lbs./A. active	Market Yield, Tons/A.	% Weed control on 6/30			% Weed control on 8/12			% Crop Injury on 8/12
				Nut-grass	Ann. Grass	Broad-leafs	Nut-grass	Ann. Grass	Broad-leafs	
EPTC	5% granular	5	22.2	0	0	0	80	90	90	0
EPTC	5% granular	10	20.3	50	50	50	100	100	90	0
Diuron	2% granular	1	18.3	0	50	80	50	60	100	10
Diuron	2% granular	2	10.3	50	90	100	80	100	100	50
Neburon	4% granular	4	16.4	0	40	40	40	50	100	0
Neburon	4% granular	6	14.5	0	80	80	40	60	100	20
Simazine	10% granular	1½	15.2	0	20	20	40	80	100	50
Simazine	10% granular	3	9.3	0	50	50	60	100	100	80
DNBP amine	10% granular	6	13.4	0	60	100	20	20	90	10
DNBP amine	10% granular	9	11.8	20	90	100	10	30	90	40
CDAA	10% granular	6	19.7	0	100	80	80	50	80	0
CDAA+DNBP amine	10% granular	3+3	18.9	30	100	100	20	40	100	0
CDAA+DNBP amine	10% granular	6+6	13.5	30	100	100	30	60	100	60
Alanap-3	20% granular	3	2.8	80	80	80	20	0	80	90
Alanap-3	20% granular	6	1.8	90	90	90	20	0	80	100
ACP-M-460	Spray	4	2.4	0	100	100	0	100	100	100
Vapam	Drench	1 pt./100'	13.4	0	0	0	0	0	60	10
Vapam	Drench	1 qt./100'	13.0	0	0	0	0	0	80	40
Hoed Check	---------	---	19.0	90	90	90	100	100	100	0
Unhoed Check	--------	---	14.9	0	0	0	0	0	0	0

1/ Tomato plants set into field on May 10.
2/ All chemicals except Vapam were applied to freshly cultivated soil on June 12 and July 2. Vapam was applied as a pre-planting in-the-row soil drench on April 25.

a Gandy spreader. ACP-M-460 (2,5-dichloro-3 nitro benzoic acid) was applied in an over-all water spray, 50 gals./A.

The predominant weeds were nutgrass and crabgrass. There were a few annual broadleaf weeds: lamb's quarters, pigweed, and ragweed.

Results and Discussion

The only chemical in this test that gave full season control of nutgrass, as well as annual weeds, without any plant injury and reduction in yield was EPTC (Table 2). On August 12, six weeks after the lay-by application of EPTC, 10 lbs./A., there was 100% control of nutgrass and annual grasses, and 90% control of broadleaf weeds. On the same date, where a 5 lb./A. rate of EPTC was used, there was 80% control of nutgrass, and 90% control of annual grasses and broadleaf weeds.

Summary and Conclusions

Seven herbicides in granular formulations, one herbicide as an over-all spray, and one herbicide as a pre-planting soil drench were screened for full season weed control, in combination with tractor cultivation, where the principal weeds were nutgrass and crabgrass. The only chemical that gave satisfactory weed control without any plant injury and yield reduction was granular EPTC. A rate of 10 lbs./A. active gave nearly perfect weed control, while a 5 lbs./A. rate gave commercial weed control.

HERBICIDES FOR TOMATOES 1.2.

by

R. D. Sweet and Vincent Rubatzky
Cornell Univeristy

Growers of tomatoes in the Northeast are interested in weed control in tomatoes not only because of weed competition but also because a heavy growth of weeds at harvest time greatly interfers with the harvest operations. Also in some instances heavy weed growth may contribute to foliage diseases and fruit rot due to cutting down the circulation of air. Another aspect of chemical weed control is important where field seeding is practiced. In the Northeast there is little commercial field seeding. However, growers are showing interest in this production practice but weed control when the tomatoes are small is very difficult. They are in need of a selective herbicide that will control several broadleaved species.

REVIEW OF LITERATURE

Several research workers have been active in testing chemicals against weeds in the presence of tomatoes. Danielson (1956) in Virginia and the writer and others have been intensively investigating this problem. It has been generally concluded that Chloro IPC in granular form or, perhaps, as a liquid spray can be applied safely to tomatoes. However, high rates are not possible without causing damage and certain weed species such as lambs-quarters are very difficult to control with this chemical.

Natrin (Zedler 1956) has been investigated by several workers. In the majority of cases there has been injury reported. In certain areas, such as in New York State, there is much less injury reported. However, the chemical is not now being manufactured so regardless of its merits a different material must be found. Dalapon has been reported as being good for weed control but in tests by the writer and others there has been serious interference with blossom set and subsequent yields. Monuron has been used as a liquid and granular material with variable success. Frequently reduced yields have been reported. Simazine was used in 1957 by the writers. The excellent weed control warranted further investigations with this chemical in spite of the foliage burn which occurred with the liquid sprays.

EXPERIMENTAL RESULTS

The work reported here is in two main categories. First, the testing of newer chemicals against both the transplanted and seeded tomato crop and secondly, a comparison of liquid and granular formulations of existing chemicals.

TESTS WITH NEWER CHEMICALS

The 1958 investigations with newer chemicals were conducted on a Dunkirk fine, sandy loam. Plants of the Red Jacket Variety were pulled on June

1. Paper No. 436 of the Department of Vegetable Crops.
2. Part of this work was made possible by a grant from the Zonolite Corp.

10th but due to excessive rainfall they were not transplanted until June 18th. During this eight day period the plants were heeled in under field conditions. Although the quality was excellent at the time of pulling the plants deteriorated somewhat during the heeling-in period. Plots consisted of single rows 15 feet long containing seven plants each. There were two replications. July 1st the area was cultivated thoroughly and the chemicals applied in a two foot band directly over the row. Subsequent cultivations were limited to the row middles. In Table 1 are presented the crop responses and weed ratings. From the table it can be seen that at the early dates all of the granular formulations were performing quite well as far as lack of injury to tomatoes is concerned. Liquid sprays of Karmex W, Neburon, Dinoben, and Niagara Experiment No. 4562 were outstanding in their lack of crop damage amongst the liquid formulations.

Weeds consisted primarily of red-root, pigweed and two annual grasses crab-grass and stink-grass (Eragrotis cilianensis). At harvest time weed control was relatively good with a majority of the chemicals. Most of them were commercially acceptable. A notable exception was the Niagara material 4562.

Yield records were taken. However, due to the relative small plant population and the fact that only two replications were used, the yield data are of questionable value and therefore are not reported.

To further evaluate the newer chemicals and their tolerance by tomatoes, a direct-seeded test was started late in the summer. Chemicals from the above test that showed promise both for tomato tolerance and for weed killing ability were included in this test. In this experiment the field was fitted, planted, and treated the same day. Individual plots were two rows, a foot apart, fifteen feet long. This gave a much higher plant population than with the transplanted crop. There were two replications. At this late date there was little weed growth in spite of considerable showery, wet weather. Therefore, only the results on tomato growth are reported. Since granular formulations tended to perform well in the transplant experiment, comparisons were included between liquid and clay formulations in this direct-seeded experiment. In Table 2, the results are reported. Tomatoes show remarkable tolerance to Vegadex and the Niagara Experimental material 4512. There was a marked difference between the liquid and clay formulations of Neburon and Simazine. It is interesting to note that in contrast to the relatively good tolerance of transplanted tomatoes to granular Chloro IPC applications, the direct-seeded crop is practically eliminated by this chemical whether it is applied as a granule or as a liquid.

In view of the lack of foliage damage from the Niagara Experimental 4562 when applied directly on the foliage of tomato and the evidence from other experiments which indicated that this chemical was quite toxic to broadleaf weeds and at high rates to annual grasses. It was decided to expand the work with this chemical. It gave promise of being the first selective post-emergence chemical that would not harm tomato foliage but would be giving herbicidal activity to emerged weeds. Several small tests were put on out in tomato regions of Western New York. In no case was the tomato foliage damaged. In one test there was a moderate stand of lambs-quarters about four to six inches tall. Four pounds of 4512 killed lambs-quarters after about five days.

Small plots of 4512 were sprayed across variety tests of tomatoes. There seemed to be a very wide tolerance by thirty some varieties in the test.

Table 1. Tomato and Weed Response*

Chemical		Lbs.	Tomatoes July 10 1	Tomatoes July 10 2	Tomatoes August 5 1	Tomatoes August 5 2	Weeds August 5 1	Weeds August 5 2
1	Shell 4777	3	5	9	8	8	7	6
2	"	6	9	8	8	7	8	8
3	Simazine	1	4	7	7	8	6	8
4	"	1½	9	7	8	8	8	9
5	Amchem 460	4	6	6	8	6	8	7
6	"	6	6	6	6	6	8	8
7	" 503	4	2	5	2	2	6	6
8	"	6	6	5	2	2	8	8
9	Niagara 4512	4	9	9	8	8	6	7
10	"	6	9	7	8	7	6	5
11	" 4562	4	1	2	3	-	2	3
12	"	6	2	1	4	1	2	3
13	Natrin	3	8	8	7	8	8	8
14	"	6	6	7	7	6	7	8
15	Monuron	1	4	5	5	8	8	7
16	"	1½	2	3	6	7	6	8
17	Neburon	3	6	7	8	8	6	7
18	"	4½	6	6	8	7	8	8
19	Gen. C. 2603	1	5	6	5	7	7	6
20	"	1½	8	9	6	8	6	6
21	" 2996	1	9	7	9	6	6	4
22	"	1½	7	9	8	8	7	7
23	Sim. (Verm)	1	9	9	8	8	7	8
24	"	1½	9	9	8	9	8	8
25	Sim. (Clay)	1	9	9	9	7	8	8
26	"	1½	9	8	5	8	7	7
27	Neb. (Verm)	3	8	8	7	7	7	4
28	"	4½	9	9	9	7	7	7
29	" (Clay)	3	9	9	8	8	8	7
30	"	4½	8	9	6	8	6	6
31	Vegadex	3	9	9	8	7	8	7
32	"	4½	9	9	8	8	7	7
33	Check		9	8	8	7	4	3

*1= All tomato plants killed 7= Commercially acceptable 9= Perfect plants
1= Entire area heavily covered with weeds 7= Commercial control 9= No weeds

Late summer and early fall work in the greenhouse checking on compatibility of 4512 with common insecticides and fungicides indicates that greenhouse grown tomatoes under relatively low light conditions are much more sensitive than were field grown tomatoes of the same variety. Rates of four and six pounds per acre were not toxic under field conditions yet the rate needed to be lowered to about two pounds in order to prevent rather serious foliage scortch. To date the compatibility tests are not sufficiently complete to draw many conclusions. However, there is a marked difference in tomato response when the common materials are combined with 4512. This may be a true chemical problem or it may be a formulation problem. This is an area where more work is needed because in many areas tomatoes are frequently sprayed, particularly with fungicides.

Table 2. Direct-Seeded Tomato Responses

	Chemical	Form.	Lbs.	Growth* 1	Growth* 2
1	Vegadex	Liq.	3	9	9
2	"	"	4½	9	9
3	"	"	6	9	8
4	"	Clay	3	9	8
5	"	"	4½	9	9
6	"	"	6	9	8
7	Neburon	Liq.	2	2	2
8	"	"	3	1	2
9	"	Clay	2	8	9
10	"	"	3	9	8
11	CIPC	Liq.	2	2	2
12	"	"	3	2	1
13	"	Clay	2	1	2
14	"	"	3	1	1
15	Niagara 4512	Liq.	2	9	9
16	" "	"	4	9	9
17	" "	"	6	9	9
18	" "	"	8	9	8
19	Simazine	"	1	1	1
20	"	"	1½	1	1
21	"	Clay	1	9	8
22	"	"	1½	6	5
23	Check			9	8
24	"			9	9

*1=No tomato plants 7=Commercially acceptable 9=Excellent vigorous stand.

GRANULAR VS LIQUID FORMULATIONS

To help evaluate more fully the value of granular versus liquid formulations of chemicals that showed possibilities in previous tests as herbicides for tomatoes, (Danielson 1953), an experiment was set up on a stony, slit loam. The same source of plants was used as described for the transplant experiment with new chemicals. Plots were single rows 25 feet long, containing 12 plants. There were three replications. The dry materials were applied with a small hand positive feed duster. The liquids were applied with a small plot sprayer. In each case the chemical was applied directly over the crop row in a swath approximately three feet wide. As in the other transplant test, the crop was cultivated and then treated immediately. No hand hoeing was done. The row middles were cultivated as required to reduce weed populations later in the season. The first ratings of crop response were made about ten days following treatment. The second crop rating was made three and one-half weeks later. The weed ratings were made at the time of the second crop rating. These results are presented in Table 3.

Table 3. Tomato and Weed Responses to Granular and Liquid Herbicide Applications.

				Tomatoes						Weeds		
				July 10			August 4			August 4		
Chemical			Rep.	1	2	3	1	2	3	1	2	3
1	Natrin	liq.	3	9	6	8	8	7	6	7	8	6
2	"	"	6	8	8	8	9	7	8	8	8	7
3	Simazin	"	1	6	6	7	7	8	7	8	8	8
4	"	"	1½	6	8	6	6	7	8	8	8	7
5	Mon.	"	1	3	2	5	7	6	6	8	8	5
6	"	"	1½	2	2	4	5	5	6	7	8	8
7	Neb.	"	3	3	5	6	5	6	8	7	8	8
8	"	"	4½	3	3	3	6	7	6	8	8	7
9	Sim.	Clay	1	8	8	8	9	7	8	7	7	7
10	"	"	1½	7	6	8	9	7	7	8	8	7
11	"	Verm.	1	7	8	8	7	8	8	8	8	8
12	"	"	1½	8	7	7	8	8	8	8	8	8
13	Mon.	"	1	4	7	7	7	6	7	7	7	7
14	"	"	1½	4	5	6	6	7	8	8	7	8
15	Check			9	8	9	8	9	8	5	5	5
16	Neb.	Clay	3	8	7	9	9	7	8	7	7	6
17	"	"	4½	7	8	8	8	7	8	7	8	7
18	"	Verm.	3	5	6	7	8	8	8	6	8	8
19	"	"	4½	4	5	6	7	8	8	8	8	8
20	Check			9	8	8	9	9	8	4	5	6

By referring to Table 3 one can readily see that the granular formulations were always less harsh than the same rate of chemical applied as a liquid spray. Except for the Neburon material Vermiculite was as satisfactory as clay for a carrier. With Neburon, however, there was less crop damage from the clay formulations. This may be due to the fact that particles of vermiculite are angular and since with the wet season the foliage stayed relatively moist most of the time, considerably more vermiculite than clay remained on the tomato foliage. It should be pointed out, however, that this may not be the fundamental answer to these observations. By referring back to Table 2 one can see that clay formulations of Neburon are much safer on direct-seeded tomatoes than are liquids. This obviously cannot be a foliage absorption phenomena since the materials were put on at planting time. A subsequent test was set up in the laboratory to help check on this point and it will be discussed later in the paper.

In regard to weed control all chemicals except the lowest rate of Natrin gave commercially acceptable weed control. The principal weed was red-root pigweed.

Due to the cold season in 1958 and to the difficulty in getting the crop transplanted promptly, the yields tended to be somewhat low and were several weeks later than normal. Yield results for the first major harvest as of September 9th are reported in Table 4. It is obvious that the foliage damage noted early in the season is reflected markedly in fewer numbers of fruit and a consequent serious reduction in yield. Whether or not the injured plants would have eventually caught up is questionable. In the relatively cool climate of New York almost any factor which interfers with early fruit set usually shows up with later and lower total yields. In areas where the growing season is much longer and where earliness is not a factor, perhaps this lack of early fruit-set might not be quite so serious.

Table 4. Number and Weight of Tomatoes from Plots Receiving Granular and Liquid Forms of Herbicides*

Chemical			Rep.	Number 1	Number 2	Number 3	Pounds 1	Pounds 2	Pounds 3
1	Natrin	liq.	3	45	8	32	17.9	2.5	9.3
2	"	"	6	46	29	43	13.9	9.1	15.7
3	Sim.	"	1	14	13	28	3.9	4.6	8.8
4	"	"	1½	4	20	13	0.6	6.2	3.4
5	Mon.	"	1	0	1	0	0	0.4	0
6	"	"	1½	0	0	0	0	0	0
7	Neb.	"	3	9	4	4	1.7	1.0	1.1
8	"	"	4½	1	1	4	0.5	0.3	0.6
9	Sim.	Clay	1	36	18	21	12.2	6.8	8.3
10	"	"	1½	30	16	18	10.7	5.0	4.7
11	"	Verm	1	19	27	21	6.3	8.6	6.8
12	"	"	1½	36	16	29	12.2	5.0	10.0
13	Mon.	"	1	6	7	3	1.5	2.0	0.9
14	"	"	1½	3	6	1	0.6	1.4	0.4
15	Check			27	16	34	8.8	5.3	11.9
16	Neb.	Clay	3	32	16	18	10.9	4.4	6.5
17	"	"	4½	24	28	25	8.3	8.9	9.2
18	"	Verm	3	28	12	10	8.9	4.3	3.7
19	"	"	4½	3	11	9	0.7	4.3	3.3
20	Check			28	19	20	10.2	6.7	7.2

*Yields to first main harvest.

GREENHOUSE TESTS WITH GRANULARS VERSUS LIQUIDS

From the field tests with both transplants and direct-seeded tomatoes there were marked differences in crop response to granular and liquid formulations. However, two of the most promising materials, Simazine and Neburon, an-to try to determine under somewhat more controlled conditions the reasons for the superiority of the granular formulations and to determine whether or not the lack of damage to the transplants was just due to a form of depth protection. With both Simazine and Neburon the solubility is extremely low. This might mean that with normal rainfall the transplanted crop roots never encountered active chemical and therefore it is just an "escape" that permits the use of these chemicals on tomatoes.

In the greenhouse a factorial experiment was set up in small flats filled with regular greenhouse potting soil to a depth of two inches. Seeded tomatoes were used. The following treatments were included:

1. Two depths of seeding: one-half inch and one and one-half inches.
2. Two methods of applying the chemical: a normal surface application and a thorough mixing in of the chemical.
3. Two formulations: a standard liquid spray and a clay granular carrier.
4. Two methods of watering: regular surface sprinkling and one inch of water applied for three consecutive days, then regular watering.
5. Two chemicals: Simazine and Neburon.

There were four replications with fifty seeds for each treatment.

In Table 5 are presented data on the plant emergence and the plant survival. The data were combined for the shallow and deep plantings because there was no difference in this treatment, thus making 100 plants possible for each observation. As might be expected, the inch of water for three consecutive days had a bad effect on germination regardless of treatment. Generally speaking, the germination for all treatments that got normal watering was fairly good. There was no consistent difference in germination of the crop between Simazine or Neburon, between liquid or granular formulations or whether the chemical had been incorporated in the soil or applied on the surface. However, after a few days the plants began to die in some of the treatments. Final survival counts were made approximately three months following treating. It was felt that after this time in the relatively restricted root area no tomato seeding would have escaped contacting active chemical if it were present. As can be seen in Table 5 there was essentially no survival from the Simazin treatments regardless of the method of applying the chemical or the formulation used. With Neburon it was quite a different story. Generally speaking, the clay formulation tended to be less toxic than did the conventional liquid formulation. However, there was an interaction with the method of watering and the method of incorporation. No satisfactory explanation can be offered by the author for these results, but they do indicate that Neburon in a clay formulation is not behaving the same as is the liquid formulation. On the other hand, Simazine eventually gives the same type of injury to tomatoes whether on clay or as a liquid. When on clay and applied on the surface the reaction to Simazine is delayed. Under field conditions with transplants the tomato may frequently escape damage from Simazine if it is applied as a granular on the soil surface.

The above data reopen the question of whether or not the lack of

TABLE 5.GERMINATION AND SURVIVAL OF TOMATOES IN GREENHOUSE TEST.

Treatment					Rep. 1 Germ.	1 Surv.	2 Germ.	2 Surv.	3 Germ.	3 Surv.	4 Germ.	4 Surv.	Totals Germ.	Totals Surv.
1	Neb.	Inc.	liq.	reg.	95	0	90	0	90	0	95	0	370	0
2	"	"	"	lea.	43	50	63	69	39	60	44	73	189	252
3	"	"	Clay	reg.	95	75	75	60	99	82	51	83	320	300
4	"	"	"	lea.	60	7	52	13	43	3	71	24	226	47
5	"	Surf.	liq.	reg.	86	1	94	0	89	0	88	13	357	14
6	"	"	"	lea.	78	0	61	0	41	0	46	0	226	0
7	"	"	clay	reg.	92	24	93	46	67	24	100	18	352	112
8	"	"	"	lea.	92	8	67	26	30	0	49	10	238	44
9	Sim.	Inc.	liq.	reg.	84	0	90	0	73	0	54	0	301	0
10	"	"	"	lea.	54	0	46	0	50	0	82	0	232	0
11	"	"	clay	reg.	97	0	96	4	92	0	95	0	380	4
12	"	"	"	lea.	55	0	74	1	70	3	58	0	257	4
13	"	Surf.	liq.	reg.	95	0	95	0	91	0	86	0	367	0
14	"	"	"	lea.	63	0	80	0	32	0	72	0	247	0
15	"	"	clay	reg.	93	0	89	0	78	0	98	0	358	0
16	"	"	"	lea	67	0	53	0	28	0	79	1	227	1

*Total plant emergence after two weeks for shallow and deep plantings (50 seeds each) are recorded as "germination". Survival counts were made three months later.

to Vermiculite is really due to difference in foliage absorption. At this point it seems entirely possible that clay granules are also in some way cutting down the chance of root absorption. The above test is inconclusive in this regard and further work needs to be done.

SUMMARY AND CONCLUSIONS

From these tests it appears that of the newer chemicals Niagara Experimental No. 4512 offers promise as a post-emergence spray with excellent activity against emerged broadleaved weeds such as lambs-quarters. Field grown seedlings and transplants showed remarkable tolerance of 4512.

Granular formulations continue to show excellent advantages over conventional liquid sprays in crop safety and ease of application.

Materials such as Neburon, Simazine and Vegadex look promising on transplants as weed preventatives. Vegadex and Neburon granulars look very good on field seeded tomatoes.

More work is needed to determine whether or not clay granules are changing the true activity of Neburon.

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AN EVALUATION OF GRANULAR AND SPRAY APPLICATIONS OF HERBICIDES ON YIELD AND PROCESSING QUALITY OF TOMATOES

William F. Meggitt[1] and Charles Moran[2]

Several herbicides have shown promise for controlling weeds in tomatoes after the last cultivation. Although weeds coming in at this time will not in most cases reduce yields, they are a deterrent factor in harvesting. If harvesting is halted prematurely or delayed because of weeds or if marketable fruits are overlooked, then yields will be reduced.

Some of the herbicides which have shown promise in certain experiments have failed in others due to lack of weed control or injury to tomatoes. It is felt further information is needed on these herbicides to determine their behavior under a range of environmental conditions. Further to be completely satisfactory for use in tomatoes, a herbicide must not only control weeds without injury and subsequent yield reduction, it must not impart undesirable flavor or delay ripening.

The purpose of this study was to evaluate several herbicides applied as aqueous sprays and on granular carriers for controlling weeds in tomatoes, to measure the response of the tomatoes to these herbicides and to determine the effect, if any, on flavor, color, and acidity of the processed tomato products.

PROCEDURE

These studies were conducted in two locations: one at New Brunswick, New Jersey on a Sassafras sandy loam soil and the other in Rancocas (Central Jersey) on a Woodstown sandy loam soil. The Rutgers variety of tomato was grown at New Brunswick and Campbell 146 at Rancocas. Plant spacings were 3 feet by 6 feet and 2 feet by 5 feet respectively. Plot sizes were 4 rows by 10 plants and 4 rows by 12 plants each. The experimental design at both locations was a randomized block with 4 replications.

Plants were transplanted into the field on May 28 and May 17, 1958. Regular fertilization and cultivation practices were made, and all plots were handhoed and weed-free at the time of treatment.

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[1]Assistant Research Specialist in Weed Control, Farm Crops Dept., Rutgers-The State University, New Brunswick, N.J.

At New Brunswick the following herbicides were applied on July 23, 1958:

Ethyl N,N-di-n-propylthiocarbamate (EPTC) 4 and 6 pounds per acre
2-chloro-4,6-bis-(ethylamino)-s-triazine (Simazin) 1½ and 3 pounds per acre
1-n-butyl-3-(3,4-dichlorophenyl)-1-methyl urea (Neburon) 2 and 4 pounds per acre
2,5-dichloro-3-nitrobenzoic acid (Dinoben) 2 and 4 pounds per acre
4,6-dinitro-ortho-secondary butyl phenol (DNBP) 6 pounds per acre
isopropyl-N-(3-chlorophenyl) carbamate (CIPC) 8 pounds per acre

EPTC, simazin, and neburon were applied as a spray in 20 gallons of water per acre and on a granular carrier (attaclay). Dinoben, DNBP and CIPC were applied only on the granular carrier. All spray applications were made with a 3 nozzle boom over the top of the plants. The granular applications were applied as broadcast with no effort being made to keep the herbicides off the tomato plants. The soil was moist at the time of application.

At the Rancocas location six herbicide treatments were made on July 18, 1958. They were EPTC, spray and granular, 5 pounds per acre; neburon spray 3 pounds per acre; simazin spray 2 pounds per acre; CIPC granular 8 pounds per acre; and DNBP granular 6 pounds per acre.

RESULTS AND DISCUSSION

The weed control and tomato yield for both locations is shown in table 1. At New Brunswick the weeds were slow in making regrowth after the last cultivation. However, observations made early in September showed considerable numbers of pigweed, lambsquarter, flower-of-an-hour, crabgrass, carpet weed and purslane. The percent weed control shown in table 1 for New Brunswick is the average of estimates made independently on September 26 by three evaluators. The data for weed control for the Rancocas location are actual weed counts per 15 square foot area. The major species here were crabgrass, pigweed, ragweed, and chickweed.

The weed control obtained from all herbicide treatments was highly satisfactory. EPTC spray at 4 pounds per acre gave a slightly lower percent control on both broadleaf

Table 1. The effect of herbicide applications at layby on weed control and yield of tomatoes.

Herbicide	Rate Lb/A	Method of Application	New Brunswick % Weed Control Broadleaf	New Brunswick % Weed Control Grass	New Brunswick Yield Tons/Acre	Rancocas Weed Count/15 sq. ft. Broadleaf	Rancocas Weed Count/15 sq. ft. Grass	Rancocas Yield Tons/Acre
EPTC	4	Spray	88	87	16.2			
	5		--	--	----	6.2	2.2	24.1
	6		88	96	15.3			
	4	Granular 5%	92	90	16.5			
	5		--	--	----	3.2	2.5	24.0
	6		93	90	17.6			
Neburon	2	Spray	96	87	14.5			
	3		--	--	----	0.0	3.8	21.0
	4		95	83	10.6			
	2	Granular 4%	90	89	16.7			
	4		93	92	18.7			
Simazin	1½	Spray	97	90	15.6			
	2		--	--	----	0.2	2.8	13.0
	3		93	97	12.1			
	1½	Granular 8.5%	85	92	14.8			
	3		90	93	16.1			
CIPC	8	Granular 5%	99	98	15.2	2.2	1.5	24.3
DNBP	6	Granular 6%	99	90	12.7	0.5	3.2	20.5
Dinoben	2	Granular 10%	95	95	15.9			
	4		99	96	16.6			
Handweeded Check					15.4	5.8	14.8	23.3
Nonweeded Check					15.2			
L.S.D. .05			NS	NS	4.0	3.4	3.3	3.1
.01					NS	4.7	4.6	4.2

and grass species than several of the other materials. The high broadleaf count at Rancocas in those plots treated with EPTC spray was due to common chickweed which germinated late in the season.

The yields presented in table 1 show a significant reduction for neburon spray at 4 pounds per acre at New Brunswick and a tendency toward reduction at 3 pounds per acre at Rancocas. The apparent reduction in yield was not evident in treatments made on granular carriers. Simazin spray at 2 pounds per acre at Rancocas produced a highly significant reduction in yield. The reduction for the 3-pound spray treatment of simazin at New Brunswick approached significance at the 5 percent level. DNBP granular showed a tendency to reduce yields at both locations. Although not significantly lower than the handweeded check, yields from DNBP were significantly lower than EPTC at both locations, neburon granular at New Brunswick, and CIPC granular at Rancocas.

Observations 48 hours after treatment showed some foliage injury from all spray applications. The injury from EPTC was manifest as necrotic spots on the leaves but this was quickly outgrown. Injury from neburon and simazin spray was indicated by chlorosis of leaves with subsequent defoliation. The defoliation in the Rancocas test from simazin was quite severe. DNBP granular although applied when plants were dry produced considerable foliar burn. There was no observable injury to foliage from any of the other treatments made on granular carriers. Lack of foliar injury from granular applications of EPTC, neburon, simazin and CIPC indicate they are considerably safer than sprays.

Fruit size was reduced significantly by simazin in the Rancocas test. The apparent reduction by neburon neared significance at the 5 percent level. Using the number of fruit per 35 pounds as a basis, the check had 102, simazin 136, and neburon 112 fruits. All other treatments ranged from 102 to 108 fruits per 35 pounds.

Samples of fruit from all treatments were taken from the 2nd harvest, August 18, at Rancocas for processing and subsequent taste panel tests, color evaluations, and acidity determinations.

The flavor evaluation of the processed puree was a triangular test comparing the check with EPTC and CIPC in separate tests using six judges and six replications. Since this test is quite involved, only EPTC and CIPC were evaluated as they have appeared the most promising in tests in 1957 and 1958. There was no objectionable flavor detected in either EPTC or CIPC treated samples.

The titratable acidity of canned puree from the simazin plot samples of the August 18 harvest was higher than that of other treated samples. A mean of 6.6 milliliters of N/10 sodium hydroxide was required to neutralize 10 cc of filtered puree from the simazin samples. The check sample required 5.8 milliliters and the other samples ranged from 5.8 to 6.2. This increase in acidity for simazin was significant at the 5 percent level and may be attributed to the smaller fruit size.

Color indexes of samples from both EPTC treatments were somewhat lower than those of other samples. Mean Hunter-Color Difference meter indexes of A/2.5B for the various treatments were: neburon, 66.8; simazin, 66.1; CIPC, 67.4; EPTC spray, 61.6; EPTC granular, 62.8; DNBP, 67.3; and check, 64.5. The difference required for significance at the 1 percent level is 3.1. The reason for the apparent color difference is unknown and further evaluations need to be made.

Of the materials evaluated for weed control at layby in tomatoes EPTC and CIPC appear the most promising after two years evaluation. Neburon and simazin granular should be evaluated fruther since these compounds have shown a tendency to produce injury and to reduce yields when applied as sprays. Dinoben after only one year of testing shows extreme promise when applied on a granular carrier.

The effects of these and other chemicals on quality factors should be further compared at all harvest dates.

SUMMARY

1. Six herbicides applied as aqueous sprays and on granular carriers were evaluated for weed control in tomatoes after the last cultivation at two locations in New Jersey. The effects of these herbicides on tomato yield, fruit size, flavor, color and acidity were also determined.

2. Granular formulations of EPTC, CIPC, dinoben, simazin, and neburon and aqueous sprays of EPTC provided satisfactory weed control with no reduction in yield of tomatoes.

3. Simazin spray at 2 and 3 pounds per acre produced a significant reduction in yield and fruit size. Neburon spray at 4 pounds gave a significant reduction in yield, and 3 pounds tended to produce lower yield and smaller fruit.

4. There was no objectionable flavor in the tomato puree from treatments of EPTC and CIPC, the two herbicides evaluated in the taste panel tests.

5. None of the herbicides evaluated except simazin produced any effect on titratable acidity of canned pureee. EPTC tended to produce a lower color index than other herbicide treatments.

6. Weeds coming in after the last cultivation did not reduce yields but were a deterrent factor in harvesting.

7. Granular formulations were much safer than aqueous sprays in that yields were reduced and foliage injured by sprays but not by granular applications.

8. Granular formulations were equal to sprays in weed control and in some instances appeared to produce a longer lasting control.

CHEMICALS FOR WEEDING CARROTS[1]

by
R. D. Sweet, Vincent Rubatzky, R.Romancwski
Cornell University

For approximately twelve years carrot growers have used Stoddard Solvent as a selective post-emergence herbicide. The material is very effective on a wide range of annual weeds, both broadleaves and grasses. A few notable exceptions are ragweed, galensoga and henbit. Carrots are tolerant of widely different dosages. Since this material is used undiluted, a rather high gallonage of liquid must be handled for each acre. This means storage and handling problems of a very practical nature at the farm. Another disadvantage of Stoddard Solvent is that there is always a potential fire hazard from smoking, engine exhaust, etc.

For the above reasons research workers continue to look at new chemicals to see if they have possibilities for use on carrots. Several tests were conducted on a Dunkirk fine sandy loam and on the muck soils of New York during the 1958 growing season. The first test was mineral soil in which the land was fitted, planted and treated June 16, 17, and 18. Plots were two rows 15 feet long. Each treatment was replicated twice. In Table 1 are presented the chemicals, rates and ratings for carrot growth and weed control. It is interesting to note that the great majority of chemicals did not harm the carrots. The Triazine derivatives were a notable exception. Also there was some damage in one replication from 2,4-D butyric. In this test ACP Dinoben (M-460) Stauffer's EPTAM, and the high rate of Chloro-IPC gave outstanding weed control. The predominant species involved were lambs-quarters, crabgrass, red-root and a few plants of nutgrass.

A post-emergence application was made on carrots also planted on June 17th in an adjacent area. In this second test the weeds were two to four inches tall, the carrots had two true leaves and were generally considered to be at the stage the average grower treated his fields. From a research standpoint it was considered a little bit late for best results with Stoddard Solvent. The results are presented in Table 2. Again, the majority of chemicals did not harm the carrots. However, the ACP Dinoben did give significant stunting at the higher rate. It is also interesting to note that this chemical was not so effective on established weeds as when applied pre-emergence. Chloro-IPC, EPTAM, and others also failed to give acceptable weed control. Stoddard Solvent was one of the very best treatments from both the weed control and crop tolerance standpoint. On the other hand, two compounds from Niagara No. 4512 and No. 4562, gave substantially better weed control in this test than they did when applied pre-emergence.

When the carrots from the better weed control plots were approaching marketable condition, they were dug and the roots judged for straightness, size and taste. There seemed to be no bad effects from any of the new compounds as far as carrot root development was concerned. Of course, where the top growth had been stunted by an injurious chemical early in the season there was reduced growth at harvest time.

Table 1. Carrot and Weed Response[1/] to Chemicals Applied at Planting.

Chemical			lbs.	Carrots 1	Carrots 2	Weeds 1	Weeds 2
1	Niagara	4512	2	9	9	5	5
2	"	"	4	9	9	6	6
3	"	"	6	9	9	7	6
4	Niagara	4562	2	9	9	7	6
5	"	"	4	9	9	6	8
6	"	"	6	7	8	9	9
7	Amchem	460	2	9	9	8	9
8	"	"	4	9	8	9	9
9	"	"	6	7	9	9	9
10	Stauffer	16072	2	9	9	7	6
11	"	"	4	9	9	7	9
12	"	"	6	8	9	9	8
13	"	Eptam	4	9	9	7	8
14	"	"	6	8	9	8	8
15	Geigy	30027	1	1	1	9	8
16	"	"	2	1	1	9	9
17	"	"	4	1	1	9	9
18	"	30028	4	2	2	9	9
19	"	"	6	2	1	9	8
20	"	"	8	1	1	9	9
21	Shell	4777	2	8	9	8	6
22	"	"	4	8	8	5	7
23	"	"	6	9	9	6	8
24	M & B	2 4-D-B	1	7	8	8	7
25	"	"	2	5	9	7	7
26	CIPC		2	9	9	6	6
27	"		4	9	9	9	9
28	Stoddard Solvent		75 gal.	9	9	5	5

1/ 1 = 100% heavy weed cover 7 = commercial control 9 = no weeds
1 = Complete crop kill 7 = commercially acceptable 9= perfect growth

Another series of tests on the Dunkirk fine sandy loam was started on July 21st. An area was disked and planted on that date and the treatments were applied July 22nd. This test was an attempt to evaluate further the chemicals that seemed to be best from the earlier tests. A list of chemicals, rates and response of carrots and weeds are presented in Table 3. In this test the 24D-Butyric was extremely harsh on the carrots. Geigy's Triazine derivative also was very harsh. Most of the other chemicals were tolerated fairly well by the carrots. ACP's Dinoben (M-460) was again outstanding in weed control. At the highest rate, six pounds, it seemed to stunt the carrots somewhat. EPTAM was not quite so good in this test as it was in the earlier one. Vegadex was not harmful to the carrots but was only mediocre in weed control. The Niagara Experimentals No. 4512 and No. 4562 were not so effective on crabgrass as they were on lambs-quarters and red-root. No. 4562 caused some stunting of the carrots. CIPC failed to get lambs-quarters at the two pound rate but did control it at four pounds.

Table 2. Carrot and Weed Response to Chemicals Applied Post-emergence.

	Chemical	lbs.	Carrots 1	Carrots 2	Weeds 1	Weeds 2
1	Niagara 4512	4	8	8	8	8
2	" "	6	8	7	8	8
3	" 4562	4	7	7	8	8
4	" "	6	8	7	8	9
5	Amchem 460	4	7	8	3	4
6	" "	6	6	7	6	5
7	Stauffer 1607	4	8	8	7	6
8	" "	6	9	9	3	4
9	" Eptam	4	9	9	5	3
10	" "	6	9	9	6	4
11	CIPC	2	9	9	6	3
12	"	4	9	9	6	6
13	2,4,D-B	1	7	7	7	4
14	Vegadex	2	9	9	2	4
15	"	4	8	9	6	4
16	Stoddard Solvent	75 gal	9	7	8	9
17	Shell 4777	4	7	8	7	3
18	" "	6	9	8	2	3

Table 3. Carrot and Weed Response to Chemicals Applied at Planting (2nd Test)

	Chemical	lbs.	Carrots 1	Carrots 2	Weeds 1	Weeds 2
1	Niagara 4512	2	9	8	6	6
2	" "	4	8	8	7	7
3	" "	6	8	8	8	7
4	" 4562	2	7	8	8	7
5	" "	4	6	6	8	8
6	" "	6	6	6	9	8
7	Amchem 460	2	8	8	8	8
8	" "	4	7	7	9	9
9	" "	6	6	5	8	8
10	Stauffer 1607	2	8	9	6	4
11	" "	4	7	9	7	6
12	" "	6	8	8	8	7
13	Geigy 30028	½	4	4	7	7
14	" "	1	2	3	8	8
15	" "	2	1	2	8	8
16	Stauffer Eptam	4	8	9	7	7
17	" "	6	7	8	8	8
18	CIPC	2	9	9	6	6
19	"	4	8	9	7	7
20	M & B 2,4,D-B	1	2	1	8	8
21	" "	2	1	1	9	8
22	Vegadex	3	9	9	4	5
23	"	4½	9	9	6	5

CHEMICALS ON MUCK-GROWN CARROTS

In the test on muck all plots were one row, 20 feet long with three replications. The field was disked, floated and planted one day and the treatments were applied the next. In Table 4 are recorded crop and weed responses as of July 18th, about two weeks following treating. From the table it can be seen that again ACP-460 performed well. The two Experimental Niagara materials were weak on weed control. The high rate of Vegadex whether liquid or granular tended to be toxic to the carrots. In contrast to results on mineral soils the Chloro-IPC was not particularly effective in weed control, perhaps due to the relatively low rates for muck. Another outstanding differential performance was the Triazine derivative 30028. On muck soils this compound gave excellent control of weeds without damage to the carrots. EPTAM performed well both on muck and on the mineral soil.

Table 4. Carrot and Weed Response to Chemicals Applied at Planting. (Muck Soil)

	Chemical	lbs.	Carrots ave 3 Reps.	Weeds* ave 3 Reps
1	Amchem 460	2	8	7
2	" "	4	8	7
3	" "	6	8	7
4	Niagara 4512	2	8	4
5	" "	4	8	4
6	" "	6	8	4
7	" 4562	2	9	5
8	" "	4	8	5
9	" "	6	8	6
10	Shell 4777	2	8	3
11	" "	4	8	5
12	" "	6	7	5
13	Vegadex	3	8	7
14	"	$4\frac{1}{2}$	8	8
15	"	6	6	8
16	CIPC	2	8	4
17	"	3	8	4
18	"	4	8	4
19	Geigy 30028	1	8	7
20	" "	2	8	7
21	" "	3	8	8
22	Eptam	3	8	7
23	"	$4\frac{1}{2}$	8	7
24	"	6	7	6
25	Stoddard Solvent	75 gal	9	3
26	Check		9	3

*No chemical controlled barnyard grass.

On July 24th approximately three weeks after planting a section of untreated carrots was treated post-emergence with chemicals that had shown promise post-emergence on mineral soils. Here, again, plots were one row, 20 feet long with three replications. In Table 5 one can see that Niagara Experimental 4562 was harsh on the carrots at the higher rates. Also the 2,4,D-Butyric was not safe. In this post-emergence test the EPTAM derivative 1607 and the Chloro IPC were ineffective on the several weeds present. The latter did control purslane, however. The important weeds were red-rrot, pigweed and barnyard grass with some purslane. There was an extremely heavy infestation of barnyard grass. No chemical except Stoddard Solvent controlled barnyard grass. Consequently, from a practical standpoint no material was as satisfactory as Stoddard Solvent post-emergence with the weed population that was present in these plots. If barnyard grass were excluded, however, the higher rates of Niagara No. 4512 and No. 4562 and Geigy 30028 showed good performance. 2,4,D-Butyric did not control purslane.

Table 5. Carrot and Weed Response to Chemicals Applied Post-emergence. (Muck Soil)

	Chemical	lbs.	Carrots ave. 3 Reps.	Weeds ave. 3 Reps.
1	Niagara 4512	2	8	3
2	" "	4	7	6
3	" "	6	7	7
4	" 4562	2	7	6
5	" "	4	7	7
6	" "	6	5	7
7	CIPC	2	9	2
8	"	4	8	2
9	"	6	7	1
10	Geigy 30028	1	9	6
11	" "	2	8	7
12	" "	3	8	7
13	Stoddard Solvent	75 gal	8	7*
14	M & B 2,4,D-B	½	4	3
15	" "	1	4	4
16	Check		8	1

*Barnyard grass controlled. Also early germinating red-root and purslane. However at time of rating new weeds were present and treatment barely considered commercially acceptable.

SUMMARY

From the above tests it appears that for pre-emergence or at planting application, Chloro IPC, Vegadex, EPTAM, and the new ACP 460 Dinoben, show excellent promise. The Triazine derivative 30028 is not safe on mineral soils but seems to be an added possibility for carrots grown on muck. For post-emergence application Niagara No. 4512 and No. 4562 appear to be serious competitors for the place now held by Stoddard Solvent. However, where barnyard grass is a problem these new chemicals are not as effective as Stoddard Solvent.

CHEMICAL WEEDING OF SET AND SEEDED ONIONS GROWN IN MINERAL SOILS[1]

CHARLES J. NOLL[2]

Much of the chemical weed control investigations of onions has been done on muck soils. The information obtained on the much soils can not always be applied to crops grown in mineral soils. Although the acreage of onions grown in mineral soils is limited, enough is grown to warrant chemical weed investigations.

This investigation includes a combination of both pre-emergence and post-emergence application of herbicides on onions grown from sets and from seeds.

PROCEDURE

Sets of the onion variety Ebenezer were planted May 12, 1958. Pre-emergence applications of herbicides, Chloro IPC and Randox were made May 14. An emergence application of KOCN was made May 20th. Post-emergence applications were made May 27 when the onions were 6 inches tall. Individual plots were 20 feet long by 2 feet wide. Treatments were randomised in each of 10 blocks.

In the second experiment seeds of the variety Yellow Sweet Spanish were planted May 12, 1958. Pre-emergence applications of Chloro IPC and Randox were made May 15, KOCN was applied at time of onion emergence on May 26. All post-emergence applications were made July 9 when the onions were 6 inches tall. Individual plots were 23 feet long by 3 feet wide. Treatments were randomized in each of 10 blocks.

The chemicals were applied with a small sprayer over the vegetable row for a width of 12 inches. Although the onions were started late the growing season was favorable with sufficient rain to allow the onions to mature. An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. The onions grown from sets were harvested September 22 and the onions grown from seed October 1.

RESULTS

The results of onions grown from sets and presented in table I. In the pre-emergence treatments weed control was as follows: Randox was better than Chloro IPC and Chloro IPC was better than KOCN and all materials significantly better than the untreated check plot. Post-emergence treatments had little effect in reducing weeds. Randox was the best of materials used in the post-emergence applications.

Onion stand and weight of bulbs was significantly better than the untreated check with all chemical treatments.

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

The results of onions grown from seed is presented in table 2. Weed control was significantly increased by all chemical treatments as compared to the untreated check. In the pre-emergence treatments weed control was best where Randox was used as compared to the other two chemicals. Post-emergence treatment has little effect on weed control.

Oninn stand was significantly better as compared to the untreated check plots where KOCN was used in the pre-emergence application and followed in the post-emergence applications by Chloro IPC at 3, 6 and 9 lbs. and by Chlorazin at 6 lbs. per acre and where Chloro IPC was used in the pre-emergence application and followed by the post-emergence application of Chloro IPC at 9 lbs. and Randox at 8 lbs. per acre.

Weight of bulbs at harvest were significantly increased as compared to the untreated check plot with all pre-emergence treatments of Chloro IPC, emergence treatments of KOCN and one of the eight Randox treatments.

CONCLUSION

Randox in a pre-emergence treatment at the chemical rates used gave better weed control than either Chloro IPC in a pre-emergence treatment or KOCN applied at time of onion emergence. Post-emergence treatment had little effect on weed control. With set onions yields were good with all three pre-emergence chemical treatments. With onion grown from seed Chloro IPC in a pre-emergence treatment and KOCN applied at time of onion emergence were the best treatments.

Table I. Weed control, plant stand and weight of bulbs under chemical herbicide treatment of onions grown from sets.

Emergence & Pre-Emerg.		Post-Emergence		Average per plot at Harvest		
Herbicide	Rate per Acre lbs.	Herbicide	Rate per Acre lbs.	*Weed Control	Onion Stand	Weight Bulbs lbs.
Nothing	--	Nothing	--	10.0	23.4	4.5
KOCN	12	KOCN	18	4.3	32.6	7.5
"	"	Chloro IPC	6	4.3	29.1	6.3
"	"	Randox	8	2.6	30.8	7.2
"	"	Chlorazin	3	3.4	29.1	6.8
Chloro IPC	6	KOCN	18	2.6	37.5	8.7
" "	"	Chloro IPC	6	3.5	33.5	8.7
" "	"	Randox	8	1.9	37.6	8.8
" "	"	Chlorazin	3	2.2	36.4	8.4
Randox	8	KOCN	18	1.8	34.4	7.5
"	"	Chloro IPC	6	1.3	30.3	6.8
"	"	Randox	8	1.1	34.4	8.0
"	"	Chlorazin	3	1.0	36.3	8.9
Least Significant Difference ($P = .05$)				1.2	6.9	1.9
" " " ($P = .01$)				1.5	9.1	2.6

*Weed Control 1-10
1 Perfect Weed Control
10 No Weed Control

Table 2. Weed control, plant stand and weight of bulbs under chemical treatment of onions grown from seed.

Emergence & Pre-Emerg.		Post-Emergence		Average per Plot at Harvest		
Herbicide	Rate per Acre lbs.	Herbicide	Rate per Acre lbs.	*Weed Control	Onion Stand	Weight of Bulbs lbs.
Nothing	--	Nothing	--	9.4	37.0	5.2
KOCN	12	KOCN	18	3.3	51.1	11.7
"	"	Chloro IPC	3	4.7	63.0	13.9
"	"	" "	6	4.2	65.4	17.5
"	"	" "	9	3.9	60.7	14.4
"	"	Randox	8	4.4	49.6	12.3
"	"	Chlorazin	3	4.6	51.8	12.7
"	"	"	6	4.3	60.2	13.2
Chloro IPC	6	KOCN	18	3.0	49.4	13.4
"	"	Chloro IPC	3	5.3	46.5	10.9
"	"	" "	6	4.8	41.5	11.9
"	"	" "	9	3.5	60.9	15.5
"	"	Randox	8	4.1	60.5	15.5
"	"	Chlorazin	3	3.3	51.5	13.9
"	"	"	6	4.7	43.0	12.1
Randox	8	KOCN	18	1.5	33.7	8.1
"	"	Chloro IPC	3	1.3	32.3	9.3
"	"	" "	6	1.2	33.5	11.6
"	"	" "	9	1.2	26.1	9.2
"	"	Randox	8	2.1	31.4	9.1
"	"	Chlorazin	3	1.7	22.4	5.8
"	"	"	6	1.8	30.0	7.8
Least Significant Difference (P= .05)				1.4	16.2	4.6
" " " (P= .01)				1.9	21.3	6.1

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

WEEDING OF BEETS WITH CHEMICAL HERBICIDES[1.]

CHARLES J. NOLL[2.]

About 1000 acres of beets are grown in Pennsylvania each year. Weeding has been a major production problem. The chemical most used for weeding has been salt applied at an acre rate of 400 lbs. in 200 gallons of water at the time beets have 4-5 true leaves. This treatment may not be satisfactory if the weeds are large at time of treatment or if the major weed is purslane. Satisfactory control of weeds with good beet growth has been obtained in past years using other chemicals in a pre-emergence application. This is a continuation of that investigation.

PROCEDURE

Seeds of the beet variety Seneca Detroit were planted May 15, 1958. Pre-emergence applications of herbicides were made May 19. Salt was applied July 2 when the beets had 4-5 true leaves. Individual plots were 23 feet long and 2 feet wide. Treatments were randomized in each of 10 blocks.

The chemicals were applied with a small sprayer over the vegetable row for a width of 12 inches. The growing season was favorable with rain well distributed and averaging about 1/2 inch a month in excess of normal. An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. Beets were harvested August 5, 1958.

RESULTS

The results are presented in table I. All chemicals significantly increased weed control as compared to the untreated check. The number of marketable roots was significantly increased over the untreated check with the Endothal, TCA combination, Endothal alone, Randox at 6 and 9 lbs. per acre and Monuron. The best weight of marketable roots was with 9 lbs. of Endothal + 10 lbs. TCA, 12 lbs. of Endothal + 10 lbs. TCA, 9 lbs. of Endothal, 12 lbs. of Endothal, 9 lbs. of Randox, 1/2 lb. of Monuron and 3/4 lb. of Monuron.

CONCLUSION

Taking into consideration weed control, number and weight of marketable beets the best treatments were Endothal alone at 9 and 12 lbs., Endothal in combination with TCA at 10 lbs., Monuron at 1/2 and 3/4 lbs. and Randox at 9 lbs. per acre.

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

Table I. Weed control, number and weight of marketable beets under chemical herbicide treatments.

Herbicide	Rate per Acre lbs.	When Applied	*Weed Control (Average per plot)	No. Mkt. Roots (Average per plot)	Wt. Mkt. Roots lbs. (Average per plot)
Nothing	--	--	9.5	52.0	5.3
Salt (NACl)	400 lbs.	Post-emerg.	6.7	68.4	8.9
Endothal & TCA	6 + 10	Pre-emerg.	5.1	71.5	9.1
" "	9 + 10	"	3.5	84.1	11.7
" "	12 + 10	"	3.4	79.4	11.2
Endothal	6	"	5.3	71.4	9.5
"	9	"	4.9	80.9	10.5
"	12	"	3.6	100.6	12.6
FW 450	10	"	4.9	51.4	8.0
Randox	6	"	3.2	77.1	9.3
"	9	"	2.1	74.4	10.6
"	12	"	1.5	51.9	8.5
Monuron	1/2	"	4.0	76.4	10.7
"	3/4	"	2.9	81.6	10.6
Chloro IPC	3	"	4.9	53.0	6.1
Vegadex	4	"	5.9	61.2	7.3
"	6	"	4.8	63.5	9.1
"	8	"	3.3	60.4	10.1
EPTAM	4	"	6.7	54.4	6.4
"	6	"	6.2	55.4	6.6
Least Significant Difference (P= .05)			1.5	19.4	2.2
" " " (P= .01)			1.9	25.6	2.9

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

AN EVALUATION OF PRE-EMERGENCE HERBICIDES IN FIELD CORN AND THE REACTION OF SEVERAL INBREDS TO THESE HERBICIDES

William F. Meggitt and John C. Anderson[1]

There has been a continuing search for a pre-emergence herbicide that will control both broadleaf and grass weeds in corn. Various formulations of 2,4-D have been evaluated and used for this purpose for several years. The results and degree of weed control have generally been satisfactory. However, there are all too many cases where due to environmental conditions at or following the time of application, the 2,4-D materials have failed to control weeds or have given some crop injury. Also 2,4-D has found objection in the possibility of injury to nearby susceptible crops. There are several new chemicals which are being evaluated for the purpose of pre-emergence control of weeds in corn. As these new materials are introduced, it is necessary to evaluate them under varying environmental conditions. Further it is necessary to determine the susceptibility of corn varieties and strains to these materials.

The purpose of this study was to evaluate the more promising herbicides either alone or in combination on one of the recently introduced New Jersey hybrid varieties and to determine the most satisfactory rate of application under 1958 growing conditions in order that they might be contrasted with the extremely dry conditions of 1957. A further purpose was to test the susceptibility of the more prominent inbred lines to those herbicides felt to hold extreme promise.

PROCEDURE

On May 28 New Jersey No. 9 field corn was planted in hills 42" by 42" with five seeds per hill on a Sassafras loam. On May 29 plots 4 hills by 11 hills (14 feet x 38.5 feet) were treated with the following pre-emergence herbicides:

- 2 - chloro-4,6-bis(ethylamino)-s triazine (Simazine) 1, 2, and 4 lbs. per acre.
- Ethyl N, N-di-n-propylthiocarbamate (EPTC) 6 lbs./A
- 2,4-dichlorophenoxyacetamide (2,4-D amide) 1.5 and 2 lbs. per acre
- 2,4-dichlorophenoxyacetic acid; low volatile ester (2,4-D LVE) 1.5 lbs. per acre
- 2 chloro-N-N-diethylacetamide (CDAA) 3 and 6 lbs./A
- 2,36-trichlorobenzoic acid (TBA) ½ lb. per acre used in combination with CDAA at 1½ and 3 pounds per acre.

[1]Assistant Research Specialist in Weed Control and Research Specialist in Corn Breeding, Dept. of Farm Crops,

The experimental design was a randomized block with four replications. All herbicides were applied in water at 20 gallons per acre with a bicycle-type plot sprayer as an overall coverage.

Stand counts were made on June 13 and the stand was thinned to 4 plants per hill after counting. An estimate of the percent control of broadleaf and grass weeds was made on July 2 by three evaluators independently. The major weed species in the experimental area were prostrate pigweed (*Amaranthus graecizous*), redroot pigweed (*Amaranthus retroflexus*), barnyard grass (*Echinochloa crusgalli*), crabgrass (*Digitaria* sp.), foxtail (*Setaria* sp.), purslane (*Portulaca oleracea*), and lambsquarter (*Chenopodium album*).

There was no cultivation throughout the growing season except in the handweeded check plots in which two hand hoeings were made.

In the second experiment ten of the more common inbred lines of field corn were planted in plots 2 by 8 hills. The ten inbred lines were Wf9, W22, J47, J48, J48ms (J48 male sterile), A158, C103, J440, 9206, and Hy2. The first seven inbreds were planted three seeds per hill and due to a limited number of seed J440, 9206, and Hy2 were planted two seeds per hill. The experimental design was a split plot latin square with herbicides as whole plots. The herbicide applications were simazine 2 lbs. per acre, 2,4-D amide 1½ lbs. per acre, and CDAA at 3 lbs. per acre plus TBA at ½ lb. per acre. All herbicides were applied the day after planting (May 29) in 20 gallons of water per acre. All plots were cultivated on July 16.

Stand counts were made on June 12 and estimate of percent weed control was made on July 2. Counts of the number of plants surviving at harvest and the number of "off-type" plants were made on October 1. The corn was harvested on October 2.

RESULTS AND DISCUSSION

The results of the first experiment are shown in table 1. Under the conditions of high moisture in 1958, simazine at 2 and 4 pounds provided the most complete control of broadleaf and grass weeds. For control of broadleaf weeds 2,4-D amide and low volatile ester were as effective as simazine but gave slightly poorer grass control at 1½ pounds although grass control from these materials was adequate. EPTC gave nearly complete control

Table 1. The effect of pre-emergence herbicides on weed control and yield of field corn. New Brunswick, New Jersey. 1958.

Herbicide	Rate Lb./A	Percent Weed Control Broad-leaf	Percent Weed Control Grass	Corn Yield Bu./A
Simazine	1	98	65	104.3
	2	100	93	108.3
	4	100	97	99.2
EPTC	6	98	78	100.9
2,4-D LVE	1.5	100	85	98.1
Emid	1.5	100	75	101.2
	2	100	95	97.9
CDAA (solventless)	3	5	40	93.8
	6	54	88	96.9
CDAA (Randox)	3	5	40	86.0
	6	20	80	89.3
CDAA-T	3	68	53	91.1
	6	88	85	98.5
CDAA + TBA	1½ + ½	55	60	104.1
	3 + ½	78	72	99.6
CDAA-T + TBA	3 + ½	88	90	102.3
Handweeded Check				107.9
Check				78.5
L.S.D. .05				10.1
.01				14.6

of broadleaf weeds and adequate grass control. Control from the combination of CDAA and TBA was not as complete as in 1957 but was adequate. CDAA-T alone or in combination with TBA was more effective than CDAA. CDAA with or without a solvent was not effective in control of broadleaf weeds whereas 6 pounds per acre provided good control of grasses. CDAA-T gave much better control of broadleaf weeds. In the experiment on the evaluation of inbreds simazine gave 98 percent control of all weeds, 2,4-D amide 95 percent, and CDAA plus TBA 95 percent.

There were no reductions in stand of field corn from any of the herbicides. EPTC showed some injury to the growing plants. This injury occurred on some plants in a hill while others in the same hill were completely normal. The injury was manifested as stunted plants which were twisted and some failed to unroll from the spike. It was limited to less than 10 percent of the plants and had no effect on yield. The lower yields in table 1 for CDAA, CDAA solventless, and CDAA-T at 3 pounds per acre were due to the competition from weeds which were not controlled. The handweeded check yield was higher than any herbicide treatment, and this was probably due to some cultivation effect from handhoeing. Yields from plots treated with simazine, 2,4-D amide, 2,4-D LVE, EPTC, and CDAA-TBA combination were not significantly lower than the handweeded check.

The data in table 2 on the evaluation of inbred lines show that simazine and the combination of CDAA-TBA had no apparent effect on any of the inbred lines. There was no reduction in stand, surviving plants, yield and no increase in "off-type" plants.

The stands of A158 and C103 were significantly reduced by 2,4-D amide. There appeared to be an increase in off-type plants for 9206 and J48ms in 2,4-D treated plots; however, this difference was not great enough to be significant. Yields for J48, A158, and C103 were significantly reduced by 2,4-D amide when compared to check. The yields for plots of J48ms treated with 2,4-D amide were significantly lower than simazine or CDAA-TBA treated plots in which weed control was more complete than in cultivated check.

SUMMARY

1. Six herbicides alone and in combination were evaluated for weed control in field corn.

2. Simazine, 2,4-D amide, 2,4-D LVE, CDAA plus TBA and CDAA-T provided satisfactory control of grass and broadleaf weeds with no reduction in yield of corn. EPTC provided satisfactory control of weeds with no yield reduction but some injury was noted on the corn shortly after emergence.

Table 2. The effect of three herbicides on stand and yield per plot of ten major field corn inbred lines. New Brunswick, New Jersey. 1958.

Inbred lines	Simazine Stand	Simazine Yield	CDAA + TBA Stand	CDAA + TBA Yield	2,4-D amide Stand	2,4-D amide Yield	Check Stand	Check Yield
	Plants	Lb.	Plants	Lb.	Plants	Lb.	Plants	Lb.
Wf9	44	14.5	41	13.7	41	13.1	43	14.1
W22	40	11.0	38	11.3	36	9.2	40	11.4
J47	28	15.7	32	16.0	28	12.5	26	14.6
J48	40	21.2	40	19.1	43	14.4	42	19.2
J48ms	44	24.3	43	21.9	42	18.3	43	21.4
A158	28	7.6	27	7.6	17	4.2	27	7.4
C103	28	11.1	33	13.1	20	6.4	29	13.5
J440	28	12.2	32	14.3	30	12.8	30	11.1
9206	26	8.6	27	9.5	24	5.6	23	8.4
Hy2	28	9.5	24	6.9	26	6.7	28	6.9

L.S.D. for yield (Herbicides within inbreds) .05 3.6 lb.
.01 5.4 lb.

3. Simazine, 2,4-D amide, and CDAA plus TBA were tested on ten inbred lines for weed control and effect on stand, development and yield of corn.

4. Simazine and CDAA plus TBA had no apparent effect on any of the inbred lines. Yields of J48, J48ms, A158 and C103 were reduced by 2,4-D amide. None of the other inbreds were affected by 2,4-D amide.

THE INFLUENCE OF WEED COMPETITION ON GROWTH AND YIELD OF SPRING OATS AND CORN

Ming-Yu Li, William F. Meggitt and Richard J. Aldrich[1]

Abstract[2]

The presence of weeds have brought tremendous losses to agricultural producers all over the world. For herbicides and cultural practices to be used most effectively in controlling weeds, basic information concerning these losses, and the period in which they occur are most urgently needed.

This study was initiated to obtain information concerning the relationship between stages of crop development and injury by weeds, as well as to evaluate the relative importance of competition for essential elements.

Experiments were conducted in 1956, 1957, and 1958 at the New Jersey Agricultural Experiment Station and Rutgers-The State University, New Brunswick, New Jersey.

Weeds were allowed to grow in competition with crops for pre-determined intervals after emergence of crops and then were carefully removed by hand. In order to insure weed competition, lambsquarters (Chenopodium album) and pigweed (Amaranthus retroflexus) were broadcast in the corn plots, and wild mustard (Brassica spp.) was seeded with the spring oats.

In order to study the extent of weed control needed for row crops, weed-free bands of various widths were left directly over the row. Three different patterns of weed removal were also used.

All crop and weed samples taken at the established dates of weed removal were retained for recording of green and dry weight and chemical analyses.

In 1958 particular interest was placed upon competition at various fertility levels in both crops.

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[1]Research Fellow; Assistant Research Specialist in Weed Control, Farm Crops Dept., Rutgers; and formerly Research Agronomist, ARS, CRD, USDA, New Jersey Agricultural Experiment Station, respectively.

[2]To be submitted to WEEDS for publication.

<u>Spring Oats.</u> Data obtained from the three years showed that spring oats which grew in competition with weeds produced less dry matter, less grain, less tillers, less seeds per panicle and had a lower content of nitrogen than those growing free from weed competition.

Grain yields were reduced when weed competition was longer than one week after emergence of oats in 1956 and 1957, and longer than three weeks in 1958. The unusually cool spring which retarded weed growth during the first two weeks of competition in 1958 probably account for the difference between the 1956-1957 season. Since they were not in any way contradictory to each other they only substantiated the finding that the critical stage of weed competition is during the early stage of crop growth. Weeds capable to making rapid growth during early stage of crop development depress the crop yield to a greater extent than those which develop later in the season.

In 1958 the grain yields in weedy plots receiving 600 pounds of 5-10-10 fertilizer per acre were higher than those in weed-free plots where no fertilizer was applied. This seems to suggest the possibility of counteracting weed competition by simply increasing the rate of fertilization under humid conditions where moisture is not a limiting factor.

<u>Corn.</u> In 1956 allowing weeds to grow for more than two weeks resulted in a persistent loss of yield even though plots were maintained weed-free thereafter. A 12- or 24-inch weed-free band was not sufficient to eliminate weed competition. Further the presence of weeds lowered the nitrogen content of corn.

The abnormally dry season of 1957 greatly affected the results of this experiment. However, it was evident from the data that competition for a period greater than three weeks was critical. The study on patterns of weed removal appeared to emphasize the practices of pre-emergence treatment.

Corn yields in 1958 revealed that there was a persistent loss when the period of competition was greater than two weeks which is in accord with results obtained in 1956. The reduction was much more pronounced under a low fertility level. At that high level of fertilization, corn yields were not reduced even when only a 12-inch weed-free band was maintained for five weeks after emergence of corn. This again suggests the possibility of eliminating weed competition by increasing the rate of fertilization in situations where water is not limiting. Corn yields in 1958 were improved by not allowing weeds to emerge in corn rather than control two to three weeks after emergence of crop.

Pre- and Post-Emergence Weed Control in Field Corn 1/

John A. Meade and Paul W. Santelmann 2/

Field corn was planted on June 5th, and treated either pre- or post-emergence with various herbicides (alone or in mixtures). Millet, pigweed and lambsquarters were seeded to insure an even weed stand. Pre-emergence treatments alone or as mixtures were applied on June 10 just prior to emergence. Post-emergence applications were made at one of 3 stages: A - spike or very early single leaf; B - 3 leaf stage when the corn was 4 to 6 inches tall; or C - 5 to 6 leaf stage, corn 6 to 8 inches tall. A fairly heavy rain fell the evening of June 10, and also after the "A" post-emergence stage.

All treatments were made with a bicycle sprayer in 30 gallons of water per acre. The soil type is a fairly heavy loam, the soil being fairly moist at time of application. Air temperatures were 80° F for the pre-emergence and first stage post-emergence treatments. The second and third stage post-emergence treatments were made when the air temperature was 70° F.

The plots were 3 rows by 20' long and in 3 replications. The center row was harvested for yield determinations which are reported as bushels per acre of #2 corn at 15.5% moisture. Weed ratings on a basis of 0 = no injury, 10 = complete control were made on July 25th in all plots. The plots were not cultivated with the exception of the cultivated checks. In the pre-emergence mixtures experiment there was also an uncultivated check and a hoe-scraped check, in which the soil surface was disturbed as little as possible.

Temperatures during the growing season were moderate and adequate moisture was present all season. By Maryland standards this was a cool, wet year. Weed growth was very good and corn yields were high.

Significance between means was determined by the use of Duncan's multiple range test.

Results and Discussion

The weed ratings and yield of the pre-emergence test are reported in Table 1. None of the treatments caused a significant reduction in yield below the cultivated check. One treatment, EPTC at 6 pounds per acre, had a significantly higher yield than the check. The lack of significance between the treated plots and cultivated check indicates that controlling weeds with chemicals was, in this test, as satisfactory as Mechanical cultivation.

1/ Miscellaneous Publications No. 340, Contribution No. 2976, of the Maryland Agricultural Experiment Station, Department of Agronomy.

2/ Assistant Professors, Department of Agronomy, Maryland Agricultural Experiment Station, College Park, Maryland

Table 2 lists the weed ratings and yield of corn in the pre-emergence test where mixtures were used. The yield of the scraped check was significantly higher than the rest of the plots. None of the chemical treatments produced yields higher than the cultivated check. There were several treatments which had significantly lower yields than the cultivated check. Some of this is undoubtedly due to increased weed competition as indicated by the weed ratings. There were no significant differences between yields of the 2,4-D+ Randox treatments and the individual components, but the weed control of 2,4-D + Randox, 1½ + 2 lbs per acre is better than either one separately.

In Table 3 are listed the results of the post-emergence trial in corn. Although there are no significant differences between check and treated plots, it would seem to appear that some of the treatments caused a reduction in yield. Weed control in general was quite good.

SUMMARY

Various herbicides were used pre- and post-emergence on field corn in 1958. Pre-emergence, only Eptam at 6 pounds per acre was significantly better than the cultivated check. Yields from other plots treated with Simazine, Randox, diuron, ACP 569. Emid, DNBP, 3Y9 and 2,4-D were not significantly different from the cultivated check.

In another pre-emergence experiment in which various herbicides were used alone and in mixtures, plots scraped with a hoe to remove weed growth yielded significantly better than all other treatments. Plots which were neither sprayed nor cultivated yielded significantly less than all other treatments. Corn treated with 2,4-D or Randox alone was found not to be significantly different in yield from that treated with mixtures of the two herbicides. Plots treated with mixtures of dalapon and DNBP or dalapon and 2,4-D yielded better than those treated with dalapon alone. Dalapon alone did not control broadleaved weeds satisfactorily, but the mixtures did. Some corn injury may have resulted from the use of dalapon.

When used post-emergence, 2,4-D, Emid, Simazine, DNBP, DNBP+ dalapon, 3Y9 and ACP 569 satisfactorily controlled broadleaved weeds. Dalapon alone and amitrol did not. Only Simazine, dalapon and ACP 569 satisfactorily controlled grass weeds. With regard to yield, no treatment was significantly better than the cultivated check.

Table 1 Weed Control Ratings on 7/25/58 and yield of Corn From Plots Treated Pre-emergence with various herbicides, 1958. Ratings on a basis of 0 = no control, 10 = complete control. Average of 3 replications.

Treatment	Rate (lbs/A)	7/25/58 Weed Rating Broad-leaved	Grass	Yield Bushels Per Acre
Simazine	1	9	10	121
	2	10	10	108
	3	10	10	136
Randox	4	7	3	136
	6	8	5	120
Randox T	4	8	10	118
	6	10	10	126
Eptam	2	4	4	116
	4	7	3	110
	6	10	9	140
DNBP	3	3	8	117
	4	2	7	104
2,4-D LVE	1	3	8	110
	1½	6	8	106
EMID	2	8	8	123
Diuron	3/4	9	9	131
	1½	10	10	132
3Y9	2	8-	8	111
	4	8	10	110
ACP-569	2	7	2	128
	4	9	5	115
Solventless Randox	2	3	1	123
	4	7	6	113
Check	-	-	-	112

Significance Test

Treatment	Rate	Yield*
Eptam	6	140
Simazine	3	136
Randox	4	135
Diuron	3/4	132
Diuron	1½	131
ACP-569	2	128
Randox	6	126
S. Randox	2	123
Emid	2	123
Simazine	1	121
Randox	6	120
Randox T	4	118
DNBP	3	111
Eptam	2	116
ACP-569	4	115
S. Randox	4	113
Cult. Check	-	112
3Y9	2	111
2,4-D	1	110
Eptam	4	110
3Y9	4	110
Simazine	2	108
2,4-D	1½	106
DNBP	4	104

* Any two means not connected by the same line are significantly different at the .05 level. Any two means connected by the same line are not significantly different.

Table 2 Weed Control Ratings and Yields of Corn Treated Pre-emergence with various herbicides and mixtures herbicides Control given as 0 = no control, 10 = complete control, 1958. Average of 3 replications

Treatment	Rate (lbs/A)	7/2/58 Weed Ratings Broad-leaved	7/2/58 Weed Ratings Grass	7/25/58 Weed Ratings Broad-leaved	7/25/58 Weed Ratings Grass	Yield Bushels Per Acre
DNBP	1½	6	4	0	0	54
	3	6	6	0	1	67
Randox	2	3	3	2	3	81
	4	8	9	5	5	71
Dalapon	1	2	7	2	0	47
	2	3	8	0	0	42
2,4-D LVE	1½	9	8	4	5	87
DN + Dalapon	½+1	4	3	0	0	50
	3+1	8	8	1	1	81
	3+2	10	8	1	6	65
2,4-D+Randox	1½+2	9	10	7	8	78
	1½+4	10	10	8	8	77
2,4-D+Dalapon	1½ +1	7	9	4	4	74
	1½+2	10	10	7	7	73
Cult. Check						87
Uncult. Check						20
Scraped Check						109

Significance Test

Treatment	Rate	Yield*
Scraped Check		109
Cult. Check		87
2,4-D	1½	87
Randox	2	81
DN + Dalapon	3 + 1	81
Randox + 2,4-D	2 + 1½	78
	4+1½	77
Dalapon+2,4-D	1+1½	74
	2+1½	73
Randox	4	71
DNBP	3	67
DN+dal	3+2	65
	1½+2	62
DN	1½	54
DN+dal	1½+1	50
Dalapon	1	47
	2	42
Uncult. Check		20

* Any two means not connected by the same line are significantly different at the .05 level. Any two means connected by the same line are not significantly different.

Table 3 - Weed Control Ratings and Yield of Corn from Plots treated post-emergence with various herbicides at varying stages of growth. Stage A - spike; B - 3 leaf; and C - 6 leaf. Ratings as 0 = no control, 10 = complete control. 3 replications.

			7/25/58 Weed Ratings		Yield	Significant Test			
Treatments	Rate (lbs/A)	Stage	Broad-leaved	Grass	Bushels Per Acre	Treatment	Rate	Stage	Yield*
2,4-D amine	1	C	10	2	101	Simazine	3	C	129
Emid	½	C	10	1	100	DN+Dal	3+1	A	118
	1	C	10	4	99	ACP 569	½	C	117
Simazine	3	C	9	8	129	ATA	3/4	B	116
	6	C	8	9	111	DN+dal	3+1	B	115
DNBP	1½	A	5	2	96	Cult.Check	--	--	112
	3	A	6	4	86	Simazine	6	C	111
	1½	B	7	1	95	DNBP	3	B	109
	3	B	10	8	109	3Y9	4	C	105
Dalapon	1	A	0	9	82	ACP-569	½	B	104
	1	B	1	10	79	2,4-D	1	C	101
DNBP	1½+1	A	5	8	100	3Y9	2	C	100
Dalapon	3+1	A	9	9	118	Emid	½	C	100
	1½+1	B	6	6	96	DN+dal	1½+1	A	100
	3+1	B	10	8	115	ACP-569	3/4	C	100
3Y9	2	C	4	1	100	Emid	1	C	99
	4	C	8	5	105	ACP-569	3/4	B	96
ACP-569	½	B	9	9	103	DN+dal	1½+1	B	96
	3/4	B	6	9	96	DNBP	1½	A	96
	½	C	9	6	117	DNBP	1½	B	95
	3/4	C	8	9	100	DNBP	3	A	86
Amitrol	3/4	B	4	9	116	Dalapon	1	A	86
Check					112	Dalapon	1	B	79

* Any two means not connected by the same line are significantly different at the .05 level. Any two means connected by the same line are not significantly different.

PRE-EMERGENCE WEED CONTROL IN CORN[1/]

Henry W. Indyk[2/]

The value of 2,4-D in combating the weed problem in corn is well recognized. Its herbicidal activity, however, has limitations which does not permit its effective use in every weed situation or under differing environmental conditions. The annual grassy weeds for the most part have been resistant to 2,4-D. The residual effect or period of effectiveness is not as long as would be desired in many cases. Serious injury to corn has often resulted from its use as a pre-emergence treatment on sandy soils. An urgent need exists for an economic and reliable pre-emergence herbicide which can satisfactorily overcome these limitations of 2,4-D.

A summary of two years' results (1957-1958) on the performance of a number of different herbicides evaluated as pre-emergence treatments on corn grown on light textured soil in Delaware is presented in this paper.

Procedure

The herbicides and their respective rates of application indicated in Tables 1 and 2 were evaluated as pre-emergence treatments on corn at Georgetown, Delaware. The soil in the experimental area was a Norfolk loamy sand. Individual plots consisted of 4 rows, each 15 feet long and spaced 3 feet apart. Conn 870 hybrid corn was planted at a depth of 1.5 inches and at a population of approximately 14,000 plants per acre. One day after planting corn, all chemical treatments with the exception of Randox (granular) and ACP-M-518-I were applied with a modified bicycle-type experimental plot sprayer at a pressure of 30 psi. The low concentration of each herbicide was applied in solution at the rate of 20 gal./A. and the double concentration at 40 gal./A. The double concentration was applied by spraying the designated plots twice using the single rate calibration on the sprayer. Randox (granular) and ACP-M-518-I were applied with a lawn spreader as dry materials.

Broadleaf weeds which predominated included pigweed (*Amaranthus retroflexus*), ragweed (*Ambrosia artemisiifolia*), and lamb's quarters (*Chenopodium album*). Crabgrass (*Digitaria sanguinalis*) was the predominant grass with a relatively light but well distributed infestation of nutgrass (*Cyperus esculentus*).

Weed control ratings and corn population count were taken 5 weeks after the application of chemical. During the remainder of the season all plots received one cultivation. The plots were harvested in the fall for yield data.

1/ Miscellaneous Paper No. 322. Delaware Agricultural Experiment Station.

2/ Assistant Professor in Agronomy, University of Delaware, Newark, Delaware.

Results and Discussion

In 1957, soil moisture at the time of planting was adequate for the germination of corn and weeds. Approximately two weeks after planting, soil moisture became deficient and marked the beginning of a prolonged drought period. The corn crop was a complete failure and as a consequence no yield data were obtained. In contrast, soil moisture in the 1958 season was very satisfactory throughout the entire season.

The performance of the herbicides evaluated in 1957 are summarized in Table 1 and for 1958 in Table 2. These data indicate the distinct superiority of Simazin for the control of all weed growth as compared to the various herbicides included in the tests. The most effective rate for weed control was not consistent between the two seasons. The two pound rate during the moist season of 1958 gave perfect weed control whereas during the 1957 season poor results were obtained with this rate of application. Although satisfactory weed control was obtained in 1957 with the four pound rate, it was not as effective as the two pound rate in 1958. In 1958 the two pound rate was equally as effective as the four pound rate.

It was interesting to note the persistance of Simazin throughout the season. Very satisfactory weed control was obtained throughout the entire growing season even at 2 pounds per acre. Barley and ryegrass were seeded in the fall as cover crops. Slight injury to these crops, particularly barley, was evident at the two pound rate and rather serious injury at the four pound rate. Further observation of these plots will be made in the spring. Information is needed on its residual effect of Simazin and its persistance in different soils under various environmental conditions.

Slight stunting of the corn was noted during the early growth stages. Also, tasseling and silking of the corn on the Simazin treated plots were approximately three days later than the check plot. However, the yield data indicate no significant reduction in yield at either the low or high rate of application.

Less effective but satisfactory results were obtained from a number of other chemicals. In the 1957 test, NaPCP at 25 lbs./A. was the only additional chemical which gave good control of weeds. In 1958, Emid at 2 lbs./A. and Premerge at 6 lbs./A. were very satisfactory in controlling both broadleaves and grasses. Eptem at 6 lbs./A. gave very good control of grasses and fair control of broadleaves. Very satisfactory control of grasses was obtained from Randox at 8 lbs./A. but the control of broadleaves was very poor. A new material Randox-T at 6 lbs./A. not only was comparable to Randox in controlling grasses but was much more effective on the broadleaves. The benzoic materials, although very effective in controlling weeds, caused a serious reduction in stand and yield of corn. Benzac 1281 at 2 lbs./A. gave excellent control of both broadleaves and grasses. ACP-M-518-I was effective in controlling only the broadleaves.

Nutgrass is rapidly becoming a serious weed problem in corn fields throughout Delaware. In these tests two materials showed encouraging results with respect to control of this grass. Simazin at 4 lbs./A. in 1957 and at 2 lbs. in

Summary

Various herbicides were evaluated for pre-emergence weed control in corn grown on a Norfolk loamy sand soil in Delaware during 1957 and 1958.

Simazin was outstanding in the control of both broadleaves and grasses throughout the entire growing season. Soil moisture conditions influenced the effective rate of application. A rate of 2 lbs./A. in a moist season was more effective than 4 lbs./A. in a season of less favorable moisture conditions. Information is needed on its relatively long residual effect.

Satisfactory results were obtained with NaPCP at 25 lbs./A., Emid at 2 lbs./A., Eptam at 6 lbs./A., Premerge at 6 lbs./A., and Randox-T at 6 lbs./A. Randox at 8 lbs./A. was effective on grasses but not on broadleaves.

The benzoic materials, Benzac 1281 and ACP-M-518-I, were unsatisfactory from the standpoint of seriously reducing both corn stand and yield.

Simazin and Eptam appear to be promising for the control of nutgrass.

Acknowledgements

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Amchem Products, Inc., Dow Chemical Co., Geigy Chemical Corp., Monsanto Chemical Co., and Stauffer Chemical Co.

Table 1. The effect of pre-emergence herbicides on weed control, corn stand and corn yield at Georgetown, Delaware - 1957

Treatment	Rate Lbs./A.	Weed Control Rating[a/] Broadleaves	Weed Control Rating[a/] Grasses	Corn Stand Reduction %
Randox	4	2.0	5.3	4.9
Randox	8	4.0	7.0	14.7
Vegadex	4	3.7	5.7	7.8
Vegadex	8	7.0	7.7	12.8
Eptam	3	3.0	4.7	1.4
Eptam	6	6.3	7.3	0
NaPCP	12.5	6.3	3.7	2.9
NaPCP	25	8.7	7.3	1.4
Simazin	2	7.0	5.0	4.8
Simazin	4	8.7	8.0	6.4
CP 6936[1/]	3	3.3	6.3	0
CP 6936	6	6.7	8.3	4.9
3,4-DMB[2/]	3	0	2.7	0
3,4-DMB	6	2.0	6.0	2.9
Check[3/]	-	0	0	0
Check[4/]	-	8.0	8.0	4.9

a/ Weed control rating: 0 - no control, 10 - perfect control.
1/ CP 6936 - dithiocarbamate material.
2/ 3,4-DMB - 3,4-dimethylbenzophenone.
3/ Check - cultivation identical to chemically treated plots.
4/ Check - cultivation as needed, commencing at planting time.

Table 2. The effect of pre-emergence herbicides on weed control, corn stand, and corn yield at Georgetown, Delaware - 1958

Treatment	Rate Lbs./A.	Weed Control Rating[a/] Broadleaves	Weed Control Rating[a/] Grasses	Corn Stand Reduction %	Corn Yield Bu./A. at 15.5% Moisture
Randox	4	0	7.6	2.9	119.8
Randox	8	2.3	9.0	5.7	134.6
Randox (granular)	4	0	7.6	2.9	110.9
Randox (granular)	8	0	7.3	2.9	118.1
Randox-T	3	6.0	7.6	2.9	136.2
Randox-T	6	7.7	9.0	5.7	150.3
Vegadex	4	0	7.3	2.9	118.1
Vegadex	8	2.7	8.3	0	129.8
Eptam	3	4.3	8.0	2.9	137.2
Eptam	6	7.0	9.3	0	154.5
Emid	1	6.7	7.3	0	140.0
Emid	2	8.7	8.3	5.7	139.4
Premerge	3	7.0	6.3	2.9	137.6
Premerge	6	8.7	8.3	2.9	147.9
Simazin	2	10.0	10.0	2.9	141.6
Simazin	4	10.0	10.0	2.9	137.0
Benzac 1281[1/]	2	10.0	8.7	11.4	101.6
Benzac 1281	4	10.0	10.0	25.7	59.7
ACP-M-518-I[2/]		8	0	2.9	115.7
ACP-M-518-I		9.7	2.0	11.4	103.7
Check[3/]		0	0	0	108.5
Check[4/]		7.7	8.0	0	142.0
	LSD .05				9.8
	.01				13.2

a/ Weed control rating: 0 - no control, 10 - perfect control.
1/ Benzac 1281 - 2,3,6-trichlorobenzoic acid.
2/ ACP-M-518-I - Polychlorobenzoic acid (on attaclay)
3/ Check - cultivation identical to chemically treated plots.
4/ Check - cultivation as needed, commencing at planting time.

YIELDS OF SILAGE CORN AS RELATED TO THE USE OF SEVERAL HERBICIDES

Robert A. Peters and Warren G. Wells*

INTRODUCTION

Weed control in corn has definitely proven to be economically worthwhile; thus, screening for better herbicide treatments is a continuing process. The advent of simazine and related compounds have further stimulated interest in weed control in corn.

PROCEDURE

The experiment was conducted at the Storrs (Conn.) Agricultural Experiment Station, Storrs, Connecticut on part of a field planted to silage corn on June 6, 1958. The experimental design was a randomized block design replicated three times. Each plot measured 12 by 20 feet in size. Three rows of corn in each plot were sprayed with one row left unsprayed as a buffer row. Applications of chemicals were made at two stages of growth, namely, pre-emergence on June 11, 1958, 5 days after planting and just after emergence on June 18, 12 days after seeding.

The chemicals were applied with a bicycle type compressed air sprayer in 40 gallons of spray solution per acre. Soil moisture in the rooting zone was adequate; however, the soil surface had dried off by the time the spraying was completed. The weeded check plots were hand-hoed on July 2, and July 29, 1958. None of the other plots were cultivated.

The chemical treatments are listed on the opposite page.

All rates are expressed in terms of acid equivalent or active ingredients per acre.

Treatment effects were determined by taking of periodic notes, by measuring height of plants in each plot and by determining dry matter yields of silage corn at the end of the season.

The principal weed problem was a heavy infestation of wild mustard (Brassica) nigra). Also present but not uniformly distributed were foxtail (Setaria lutescens), ragweed (Ambrosia artemisiifolia) and lambsquarter (Chenopodium album). On many plots the dominance of the wild mustard made an appraisal of the control of other species quite difficult.

RESULTS AND DISCUSSIONS

Treatment Effects On Stands

Pre-emergence:

The effect of the applied herbicides on the three most prevalent plant species are given in Table I, as based on visual estimates of stand density.

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* Associate Agronomist and Research Assistant respectively, Storrs (Connecticut) Agricultural Experiment Station, Storrs, Connecticut.

Chemicals Used in Pre-emergence and Emergence Weed Control

Treatment Number					
Pre-emergence	Emergence	Common Name	Rate[1]	Source	Chemical Name
	1	2,4-DA	3/4	Dow	2,4-dichlorophenoxyacetic acid, alkanolamine salt
1	2	2,4-DA	1½	Dow	2,4-dichlorophenoxyacetic acid, alkanolamine salt
2		2,4-DA	3	Dow	2,4-dichlorophenoxyacetic acid, alkanolamine salt
	3	2,4-DE (LV)	3/4	Thompson	2,4-dichlorophenoxyacetic acid, isopropyl ester
3	4	2,4-DE (LV)	1½	Thompson	2,4-dichlorophenoxyacetic acid, isopropyl ester
4		2,4-DE (LV)	3	Thompson	2,4-dichlorophenoxyacetic acid, isopropyl ester
5		CDAA	3	Mansanto	alpha chloro-N, N diallylacetamide
6		CDAA	6	Mansanto	alpha chloro-N, N diallylacetamide
7		Neburon	2	Dupont	1,N-butyl-3-3,4-dichlorophenyl-1-methyl urea
8		Neburon	4	Dupont	1,N-butyl-3-3,4-dichlorophenyl-1-methyl urea
9	5	Diuron	1	Dupont	3-(3,4-dichlorophenyl)-1,-dimethyl urea
10	6	Diuron	2	Dupont	3-(3,4-dichlorophenyl)-1,-dimethyl urea
11		Simazine	1	Geigy	2-chloro-4,6-bis(ethylamino)-s-triazine
12	17	Simazine	2	Geigy	2-chloro-4,6-bis(ethylamino)-s-triazine
13	18	Simazine	3	Geigy	2-chloro-4,6-bis(ethylamino)-s-triazine
14	19	TCB	1½	Dupont	2,3,6 trichlorobenzoic acid
15	20	TCB	3	Dupont	2,3,6 trichlorobenzoic acid
	9	ACP M569	½	Amchem	Not known
	10	ACP M569	3/4	Amchem	Not known
	7	ATA	½	Amchem	Amino triazole
	8	ATA	1	Amchem	Amino triazole
	13	DNBP	3	Dow	Dinitro-o-sec-butylphenol, alkanolamine salt
	14	DNBP	6	Dow	Dinitro-o-sec-butylphenol, alkanolamine salt
	11	Dalapon	1	Dow	Dichloropropionic acid, sodium salt
	12	Dalapon	2	Dow	Dichloropropionic acid, sodium salt
	15	G30031	2	Geigy	Unknown
	16	G30031	4	Geigy	Unknown
16		Eptam	4	Stauffer	Ethyl-di-n-propylthiocarbamate
17		Eptam	8	Stauffer	Ethyl-di-n-propylthiocarbamate

[1] All rates are given in pounds of active ingredients or acid equivalent per acre.

TABLE I. Density Ratings of Weeds 50 Days Following Pre-emergence Applications of Several Herbicides.*

Treatment		Must.	Ragweed	Foxtail	Treatment		Must.	Ragweed	Foxtail
1. 2,4-DA	1½	0.7	3.0	4.7	11. Simazine	1	4.7	6.0	2.7
2. 2,4-DA	3	1.0	2.0	2.7	12. Simazine	2	1.3	2.0	1.0
3. 2,4-DE	1½	3.0	2.8	3.7	13. Simazine	4	1.0	0.0	0.3
4. 2,4-DE	3	1.3	2.3	3.0	14. TCB	1½	6.7	0.7	1.7
5. CDAA	3	7.7	6.7	4.3	15. TCB	3	4.7	0.3	0.7
6. CDAA	6	7.0	6.0	3.0	16. Eptam	4	9.0	6.3	6.3
7. Neburon	2	6.7	5.0	1.0	17. Eptam	8	8.7	6.7	3.3
8. Neburon	4	1.7	6.0	2.7	18. Hand-weeded check		0.0	0.0	0.0
9. Diuron	1	4.7	4.3	4.0					
10. Diuron	2	2.7	3.7	2.7	19. Check-not weeded		10	7.3	2.3

* 0 - No stand; 10 - Complete cover

Emergence:

The treatment effects following application of chemicals at late-emergence are given in Table 2.

TABLE 2. Density Rating of Weeds 43 Days Following Emergence Applications of Several Herbicides.*

Treatment		Must.	Ragweed	Foxtail	Treatment		Must.	Ragweed	Foxtail
1. 2,4-DA	3/4	1.6	3.3	3.0	11. Dalapon + INBP	1 3	0.7	1.0	1.3
2. 2,4-DA	1½	0.3	2.0	6.7					
3. 2,4-DE	3/4	1.0	3.7	8.0	12. Dalapon + DNBP	2 3	0.0	2.0	2.3
4. 2,4-DE	1½	1.0	1.0	3.0					
5. Diuron	1	1.0	4.0	2.3	13. DNBP	3	0.3	2.0	5.3
6. Diuron	2	2.3	2.7	0.7	14. DNBP	6	0.0	0.0	2.0
7. ATA	½	10.0	3.3	2.3	15. G30031	2	0.7	6.0	2.3
8. ATA	1	3.0	2.0	5.0	16. G30031	4	0.7	6.7	1.7
9. ACP M569	½	2.0	4.3	7.0	17. Simazine	2	2.7	2.0	1.0
10. ACP M569	1	6.0	6.3	3.7	18. Simazine	4	1.3	1.0	1.3
					19. TCB	1½	7.3	0.7	3.7
					20. TCB	3	6.0	0.3	0.7

* 0 - No stand; 10 - Complete cover.

Following pre-emergence treatments mustard was controlled by all 2,4-D treatments, by the 2 and 4 rate of simazine, the 2 pound rate of diuron and the 4 pound rate of neburon. The TBA treatments caused marked stunting of mustard and malformation of leaves but did not reduce the stand. CDAA and Eptam in this experiment showed very little activity on mustard.

Control of ragweed was obtained from the high (3 lb.) rate of either 2,4-D formulation, and by the 2 and 4 pound rate of simazine. In contrast to the effect on mustard, good control from TCB was obtained.

The only chemicals giving obvious control of foxtail were the 4 pound rate of simazine and the 3 pound rate of TCB. It should be repeated that the stands of ragweed and foxtail were erratic as compared to the mustard and in some plots obscured by an overgrowth of mustard; thus, the sensitivity of the ratings in these weeds can be questioned.

Following emergence treatments good mustard control was obtained from the following treatments: 2,4-DE and 2,4-DA, DNBP, DNBP + dalapon, G30031, simazine, and diuron. The emergence treatments of simazine were generally less effective in controlling the mustard than the pre-emergence treatments; however, G30031 gave control equal to simazine applied as a pre-emergence spray. Mustard plants treated with the higher rate of ATA or ACP M569 showed typical chlorotic foliage, but kill was not adequate. TCB caused marked stunting of mustard and malformed leaves, but did not give any kill, as was true with the pre-emergence treatments.

Ragweed was controlled by TCB, DNBP, DNBP plus dalapon, simazine, and to a lesser extent by 2,4-DE, 2,4-DA. Annual grass control was difficult to judge, but indications were that TCB 3, simazine and G30031, and diuron 2 gave the best grass control. While no injury to corn was noted from pre-emergence treatments, some injury was noted on the corn following the emergence treatments. The most severe injury occurred with diuron 2, seen as a severe stunting. While the plants outgrew the stunting as shown by the height ratio in Table 4, the injury was reflected in a lower yield shown in Table 4.

Initial stunting and bending of stalks from the high rate of TCB was also reflected in reduced corn yields.

The combination treatment with DNBP, which included the 2 pound rate of dalapon, resulted in typical dalapon symptoms on about 1/3 of the corn plants. This injury was outgrown, however, as evidenced by one of the highest yields.

There was no evident injury to corn from the 4 pound rate of G30031; however, injury was evidenced by a decrease in yield when going from 2 to 4 pounds per acre.

Treatment Effects on Corn Yields

The effects of chemical treatment on the corn are given in Tables 3 and 4, giving the heights and yields respectively. Yields are shown graphically in Figures 1 and 2. The heights are given as a ratio of the average height of treated corn in each plot with that of the untreated row included in each plot. The yield data were based on dry matter determinations of 15 plants from the center row of each treated plot.

Pre-emergence treatments:

Significant increases in yield over the non-weeded check were obtained from the high rate of either 2,4-D formulation, both rates of diuron, the high rate of neburon, all rates of simazine and the hand-weeded check. Two treatments gave yields which were actually greater than the weeded check, namely the simazine 4 and 2,4-DE at 3 pounds per acre. This increase can be explained by the delay and incompleteness of the hand weeding in the check plot. When comparing rates within chemicals significant increases with increasing rates were found with 2,4-DE, and with simazine when going from 1 to 4.

Emergence treatments:

2,4-DA at 3/4 pounds per acre was used as a standard reference treatment in comparing treatments. Treatments giving a significant increase in yields included both rates of DNBP, simazine and DNBP plus dalapon, and the low rate of diuron and G30031. While not significant, TCB 3 and ATA ½ gave distinctly lower yields.

Significant yields over the best 2,4-D treatments (2,4-DE) were obtained from the high rate of DNBP or the DNBP plus dalapon combination.

When comparing rates within chemical, as shown in Figure 2, significant increases are obtained by doubling the rate of ATA or DNBP. In contrast, increasing the rate of TCB, diuron or G30031 caused a reduction in yield. As discussed under Stands, this was traced to direct injury to the corn.

Summary

Since mustard was the predominant weed, the control of mustard obtained largely determined the corn yields. The greater height ratio, as given in Tables 3 and 4, indicates the greater vigor of corn released from the severe weed competition prevailing. Most of the simazine treatments, e.g., were twice as tall as the adjacent check row.

The best treatments in terms of corn yield were the simazine treatments applied either pre-emergence or at emergence, and the DNBP alone or in combination with dalapon applied at emergence. Dalapon injury occurred to the corn only at the 2 pound rate. This injury was not reflected by any decrease in yields. Since DNBP frequently fails to give adequate grassy weed control this combination is of promise where both grasses and broadleaf weeds are present.

TCB did not adequately control mustard, consequently did not perform satisfactorily in this experiment. The standard 2,4-D treatments were quite satisfactory in this experiment where grassy weeds were not frequent.

TABLE 3. Effect of Pre-emergence Applications on the Yields of Silage Corn.

Treatment Number	Treatment	Yield (Dry Matter) in cwt per A.	Plant Hgt. Ratio*	Treatment Number	Treatment	Yield (Dry Matter) in cwt per A.	Plant Hgt. Ratio*
1.	2,4-DA 1½	54	1.3	11.	Simazine 1	76	1.5
2.	2,4-DA 3	71	1.4	12.	Simazine 2	66	1.5
3.	2,4-DE 1½	42	1.4	13.	Simazine 4	93	1.5
4.	2,4-DE 3	95	1.3	14.	TCB 1½	50	1.2
5.	CDAA 3	35	1.1	15.	TCB 3	54	1.5
6.	CDAA 6	48	1.1	16.	Eptam 4	37	1.1
7.	Neburon 2	50	1.1	17.	Eptam 8	48	1.0
8.	Neburon 4	67	1.3	18.	Hand-weeded Ck	63	1.5
9.	Diuron 1	64	1.2	19.	Ck-not weeded	37	---
10.	Diuron 2	68	1.2				
	LSD 5% level	24.0					

* Ratio of average height of treated plants to untreated plants in same plot.

TABLE 4. Effect of Emergence Applications on the Yields of Silage Corn.

Treatment Number	Treatment	Yield (Dry Matter) in cwt per A.	Plant Hgt. Ratio*	Treatment Number	Treatment	Yield (Dry Matter) in cwt per A.	Plant Hgt. Ratio*
1.	2,4-DA 3/4	57	1.2	11.	Dal+DNBP 1+3	90	1.4
2.	2,4-DA 1½	64	1.5	12.	Dal+DNBP 2+3	98	1.4
3.	2,4-DE 3/4	77	1.3	13.	DNBP 3	86	1.3
4.	2,4-DE 1½	70	1.4	14.	DNBP 6	106	1.3
5.	Diuron 1	81	1.2	15.	G30031 2	80	1.4
6.	Diuron 2	66	1.2	16.	G30031 4	70	1.4
7.	ATA ½	40	1.1	17.	Simazine 2	94	1.4
8.	ATA 1	63	1.3	18.	Simazine 4	87	1.6
9.	ACP M569 ½	58	1.2	19.	TCB 1½	57	1.1
10.	ACP M569 3/4	52	1.3	20.	TCB 3	48	1.2
	LSD 5% level	19.6					

* Ratio of average height of treated plants to untreated plants in same plot.

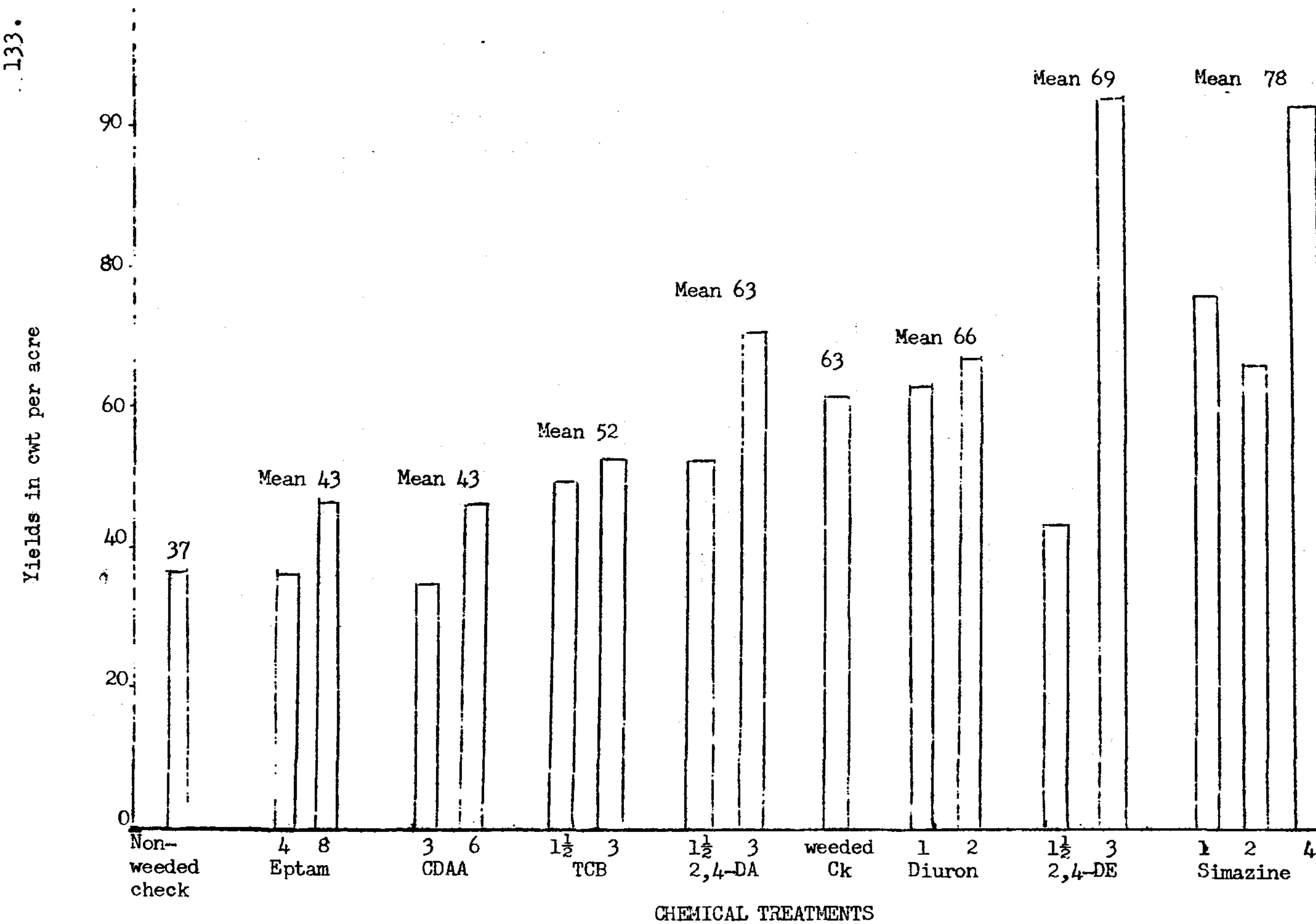

Figure 1. Effect of Pre-emergence Applications of Several Herbicides on Yields of Silage Corn.

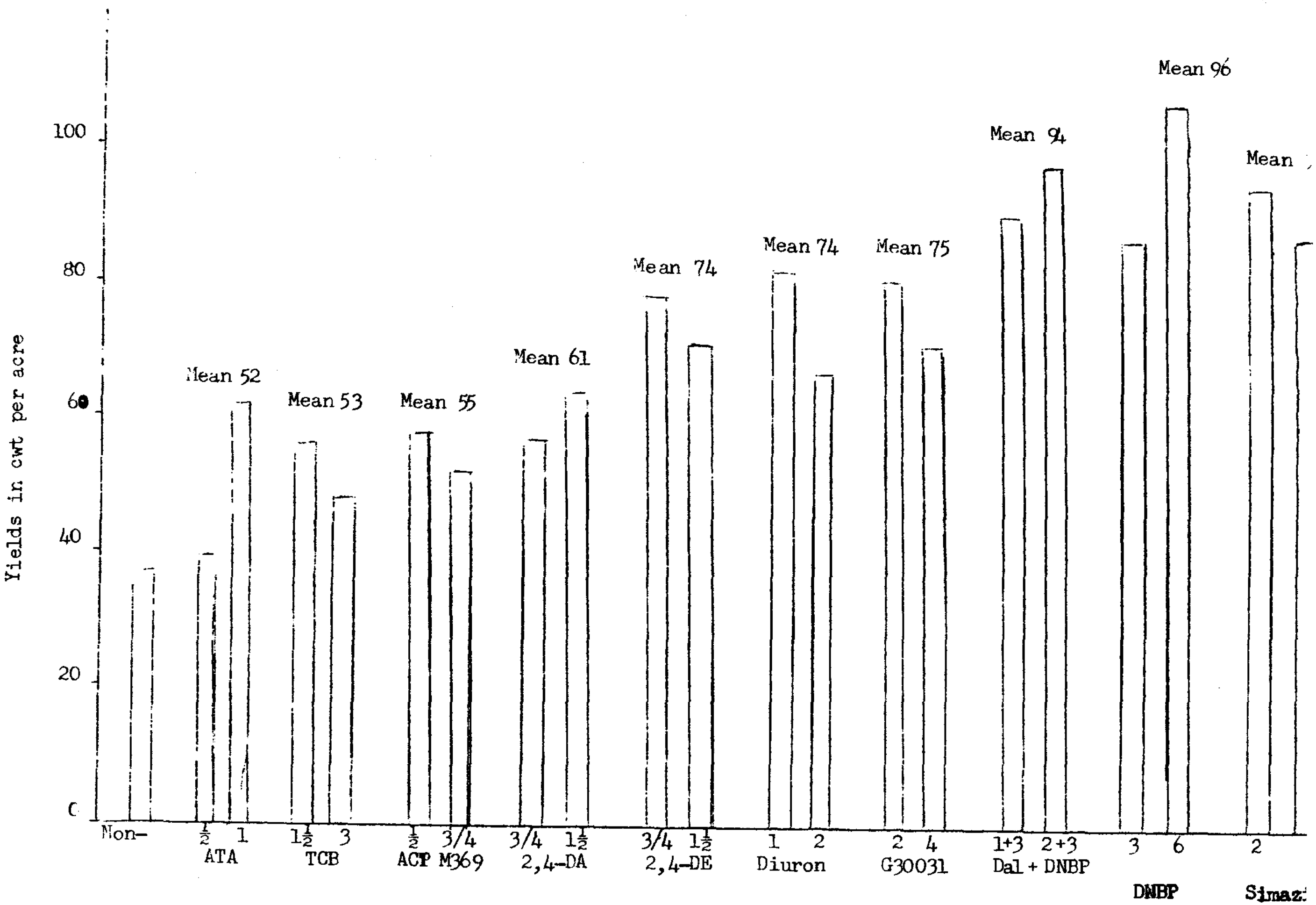

Figure 2. Effect of Emergence Application of Herbicides on Yields of Silage Corn.

WEED COMPETITION AND CORN YIELDS

Collins Veatch [1]

The trials reported in this paper were designed primarily to compare the weed controlling effectiveness of various chemicals when applied as pre-emergence and emergence sprays on corn. The design also permits a study of the relationships between weed index and yield, seasonal rainfall and yield, seasonal rainfall and weed competition as well as time of application and weed control.

Materials and Methods

The corn, U.S. 13, was check planted, 3 kernels per hill, on uniformly fertilized Wheeling sandy loam soil at Point Pleasant, West Virginia. Two row plots 10 hills long were sprayed with a power plot sprayer applying about 45 gallons of spray per acre. Application rates are given in pounds per acre of active chemical. Yield was calculated in bushels per acre at 15.5% moisture, correction being made for single and missing hills. The weed index used was based on a range of 0-9, 0 indicating no weeds present and 9 complete coverage of the plot by weeds. The weed index reported was taken at the time of harvest. The sprayed plots were given a post-emergence spray in 1957 to supplement the pre-emergence application. The check plots in 1957 were not cultivated or sprayed. In 1958 no post-emergence spray was applied but the checks were cultivated.

Diuron treatments at 2 lbs. per acre reduced the stand of corn in 1958 to such an extent that the yields for this treatment were not included in the average or the calculation of the correlation coefficients.

Discussion of Results

A summary of the results of the weed control trials in corn at Point Pleasant in 1957 is given in Table 1. The rainfall during this season was comparatively low as indicated in the accompanying figure. The lack of moisture limited the yield and intensified weed competition as indicated by the average yield of 56.6 bu. per acre and the low yields of the checks where the weeds were not controlled. The correlation coefficient (-.76) between yield and weed index is significant at the 1% level.

The growing season at Point Pleasant in 1958 was quite favorable with an abundance of rain, well distributed, as indicated in the accompanying figure. Some of the chemicals gave satisfactory weed control in spite of the abundant rainfall. Even in the treatments with a high weed index the competition did not limit production as severely as in 1957 when moisture was a limiting factor during the growing season.

1. Associate Agronomist, West Virginia Agricultural Experiment Station, Morgantown, West Virginia.

The 1958 results (Table 2) indicate that the application of a weed spray on corn at emergence, when the corn is in the seedling leaf stage, (early post-emergence) was more effective than when applied pre-emergence. This is indicated by the average yields of 79.7 bu. and 94.13 bu. per acre for the pre-emergence and emergence trials respectively. The weed indexes are, with few exceptions, lower in the emergence than in the pre-emergence trial. Correlation coefficients were negative but very high between yield and weed index -.88 for the pre-emergence and -.97 for the emergence trial. They are both significant at the 1% level.

Summary

Applications of herbicides at emergence gave more effective weed control than pre-emergence applications as indicated by weed indexes, yields and correlation of yield with weed index.

Weed competition was more severe in 1957 than in 1958. Yields were higher in 1958 than in 1957. Abundant well distributed rain in 1958 compared to 1957 made the difference.

Good full season weed control was secured both years by the use of Simazine at the indicated rates.

Figure 1

Rainfall - Point Pleasant, 1957 & 1958

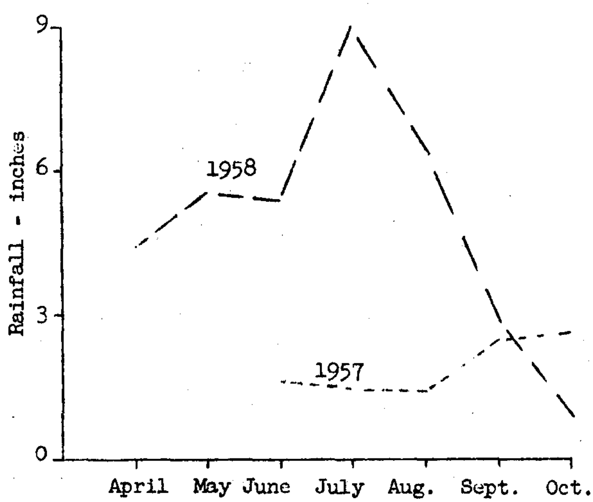

TABLE 1

1957 Yields and Indexes of Weed Control in Corn Plots at Point Pleasant

Chemical	Rate Lbs/A.	Pre-emergence May 15 Yield Bu/A.	Weed Index* 0-9
Check	No Control	14.5	8.25
2,4-D	1	56.5	1.25
DNBP	4	52.5	1.88
EPTC	5	50.5	1.50
Novon	1	56.5	2.88
Novon	2	51.5	1.38
CDAA	4	57.5	2.00
2,4-DB	1	56.5	1.75
Check	No Control	35.0	6.13
Simazine	2	57.5	0.50
Simazine	4	67.0	0.25
G-27901	4	69.0	0.25
Monuron	2	53.0	0.25
Diuron	2	60.5	0.25
Emid	2	53.5	0.75
Amizol	2	48.5	2.25
Check	No Control	12.0	6.88
$L.S.D._{.05}$		16.3	
Average Yield of Treated Plots		56.6	
Correlation coefficient between yield and weed index			-.74

*Weed Index 0 - clean, no weeds
9 - full plot coverage of weeds

TABLE 2

1958 Yields and Indexes of Weed Control in Corn Plots at Point Pleasant.

		Pre-emergence May 19		Emergence May 26	
Chemical	Rate Lbs/A.	Bu/A.	Weed Index* 0-9	Bu/A.	Weed Index* 0-9
Check	Cultivated	98.3	1.75	103.6	3.00
2,4-D	1	64.1	7.25	65.4	2.75
CDAA	4	47.1	8.00	92.8	3.25
DNBP	4	75.4	5.00	108.4	2.50
EPTC	4	77.3	6.00	83.6	4.75
EPTC	6	84.9	4.50	69.7	6.00
2,4-DB	2	52.8	8.00	98.9	3.25
2,4-DB	3	61.9	7.00	93.0	3.00
Amizol	1.5	49.9	7.00	80.3	4.25
Amizol	2	35.1	9.00	79.3	3.25
Check	Cultivated	97.8	1.50	101.0	1.50
Emid	2	59.5	6.00	98.9	2.25
Simazine	0.5	107.4	0.75	107.7	1.25
Simazine	1	111.4	0.75	104.5	0.75
Simazine	2	113.2	0.75	112.8	0.50
Neburon	2	80.5	6.25	98.7	2.75
Neburon	4	99.0	4.75	107.7	2.25
Diuron	1	108.0	0.75	94.6	1.25
**Diuron	2	89.8	1.00	73.3	1.00
Sesone	4	80.5	4.50	103.7	1.50
$L.S.D._{.05}$		26.9		20.9	
Average of all plots		79.70		94.13	
Correlation coefficient between yield and weed index			-.88		-.97

* Weed Index 0 - clean, no weeds
9 - full plot coverage of weeds

** Diuron treated plots reduced the stand so severely that their results were not included in calculating the correlation coefficient.

Acknowledgement

Acknowledgement is made to the following companies who furnished the chemicals used in these trials: American Chemical Paint Company (AMCHEM Products, Inc.), Dow Chemical Company, E. I. du Pont de Nemours and Company, Geigy Chemical Corporation, Monsanto Chemical Company and the Stauffer Chemical Co.

PRE-EMERGENCE WEED CONTROL IN SOYBEANS[1]

Henry W. Indyk[2]

Weed control is a major problem in present-day soybean production practices. Current cultural and mechanical practices are very effective means of combating the weed problem, but they have not been entirely adequate or satisfactory under the various conditions with which a grower may be confronted. Some degree of success has been achieved from research efforts directed toward a reliable and economic means of chemical control but for the most part progress has been comparatively slow. Furthermore, the limited number of recommendations for chemical control of weeds in soybeans are not receiving very rapid acceptance in their respective areas because in many cases of the inconsistant results together with the prohibitive cost of material. Chemical control of undesirable weed growth in soybeans continues to be a weed-crop situation in need of further investigation.

The results of a three-year study conducted in Delaware were reported in 1957 (Proceedings 11th Annual Meeting NEWCC, Jan. 1957). The present report is a summary of the results obtained during the two year period, 1957-58.

Precedure

Various herbicides applied as pre-emergence treatments were evaluated at Georgetown and Newark, Delaware, in 1957 and 1958. The soil type at Georgetown (southern location) was a Norfolk loamy sand and at Newark (northern location) a Sassafras loam. The herbicides and respective rates of application which were included in the tests are indicated in Tables 1 and 2.

The Wabash variety of soybeans was seeded in rows at a depth of 1.5 inches and at the rate of 40 pounds of seed per acre. Individual plots consisted of 4 rows, each row 15 feet long and spaced 3 feet apart. One day after seeding of soybeans, each herbicide was applied at the specified rate with a modified bicycle-type experimental plot sprayer at a pressure of 30 psi. The low concentration of each herbicide was applied in water solution at the rate of 20 gal./A. Plots receiving the double concentration of herbicide were sprayed twice using the single rate calibration on the sprayer.

Broadleaf weeds which predomindated included pigweed (*Amaranthus retroflexus*), ragweed (*Ambrosia artemisiifolia*) and lamb's quarters (*Chenopodium album*). Crabgrass (*Digitaria* spp.) was the predominant grass.

Weed control ratings and soybean stand counts were taken 35 days after the application of chemical treatments. During the remainder of the season all plots were cultivated as needed to control weeds. Generally, this required 1 or 2 cultivations per season. The plots were harvested in the fall for yield data.

1/ Miscellaneous Paper No. 321. Delaware Agricultural Experiment Station.

Results and Discussion

Soil moisture at Georgetown in 1957 at the time of planting, although adequate for germination of soybeans as well as weeds, was slightly deficient and marked the beginning of a prolonged drought period which prevailed throughout most of the season. At Newark slightly better but very similar moisture conditions prevailed. In contrast, the 1958 season at both Georgetown and Newark was characterized by very satisfactory soil moisture throughout the entire season.

The performance of the herbicides evaluated at Georgetown and Newark is summarized for 1957 in Table 1 and for 1958 in Table 2. Weed control ratings and soybean yield data indicate that NaPCP at 25 lbs./A. was very satisfactory in the control of broadleaf weeds at both locations during the two years of this study. The results support the evidence previously reported for the three year period 1954-1956 which indicated the consistant satisfactory performance and superiority of NaPCP for pre-emergence broadleaf weed control in soybeans. Control of grasses was only fair and not entirely satisfactory.

Premerge at 6 lbs./A. also was effective in controlling broadleaf weeds. Previous results with this material have been variable depending upon environmental conditions, particularly temperature and soil moisture.

Emid at 2 lbs./A. has shown considerable promise for the control of both broadleaves and grasses. The stunting and epinasty of the soybean seedlings which was very apparent during the early growth stages was outgrown in later stages of development. The data indicate no significant reduction in yield of soybeans. Further evaluation of this chemical is needed.

In the control of grasses, the carbamate materials were very effective. Considering the two year's results at both locations, Randox was superior to Vegadex in controlling the grasses. Poor control of broadleaves was obtained from both of these herbicides. The results indicate better weed control under the more moist conditions characteristic of the 1958 season as compared to the less favorable soil moisture of the 1957 season. In this respect it is interesting to note the performance of Eptam. This chemical showed better control under the less favorable soil moisture conditions. At 6 lbs./A. Eptam gave better control of grasses than either Randox or Vegadex in 1957 and compared very favorably in 1958. In addition, Eptam was more effective than Randox or Vegadex in controlling the broadleaves. The soybean seedlings were stunted during the early growth stages but this effect was rapidly overcome by new growth. The yield of soybeans was not affected.

In comparing all the herbicides evaluated in these trials the best control of both broadleaves and grasses without any reduction in yield of soybeans was obtained from a mixture of NaPCP at 25 lbs./A. and Randox at 8 lbs./A. However, from a practical standpoint, the cost of this treatment would be prohibitive for use on soybeans.

Summary

Various herbicides were evaluated for pre-emergence weed control in soybeans at Georgetown and Newark, Delaware, during 1957 and 1958.

Excellent control of broadleaves was obtained with NaPCP at 25 lbs./A. Satisfactory results were also obtained with Premerge at 6 lbs./A. Emid at 2 lbs./A. appears to be promising on broadleaves and grasses.

Randox was effective in the control of grasses but the results varied between seasons as a result of soil moisture. This herbicide was more effective under the more favorable soil moisture conditions. In comparison, Eptam was superior to Randox during the dry season and only slightly less effective during the more moist season. Fair control of broadleaves was obtained with Eptam whereas the results were poor with Randox.

The most effective treatment for the control of both broadleaves and grasses was a mixture of NaPCP and Randox.

Acknowledgements

The cooperation of the following companies in providing the chemicals necessary for these trials is gratefully acknowledged:

Amchem Products Inc., Dow Chemical Co., Geigy Chemical Corp., Monsanto Chemical Co., Naugatuck Chemical Co., and Stauffer Chemical Co.

Table 2. The effect of pre-emergence herbicides on weed control, soybean stand, and soybean yield at Georgetown and Newark, Delaware - 1958

Treatment	Rate lbs./A.	Georgetown: Weed Control Rating[a] Broad-leaves	Georgetown: Weed Control Rating[a] Grasses	Georgetown: Soybean Stand Reduction %	Georgetown: Soybean Yield Bu./A.	Newark: Weed Control Rating[a] Broad leaves	Newark: Weed Control Rating[a] Grasses	Newark: Soybean Stand Reduction %	Newark: Soybean Yield Bu./A.
Alanap-3	2	3.0	1.0	0	20.7	2.7	2.7	0	35.5
"	4	6.0	4.3	0	27.5	6.0	4.3	0	39.8
Randox	4	0	7.3	0	27.6	0	5.0	0	35.4
"	8	2.3	9.0	0	29.2	3.0	8.0	0	32.7
Vegadex	4	0	4.7	0	23.4	0	2.0	0	38.1
"	8	1.7	6.7	0	26.8	2.3	6.0	0	32.4
Eptam	3	3.7	6.3	0	29.9	3.0	5.7	0	35.6
"	6	7	8.7	0	29.5	7.0	7.3	0	40.4
NaPCP	12.5	5.3	1.3	0	32.7	5.3	2.7	0	42.0
"	25	8.3	6.3	0	32.8	9.0	6.3	0.8	39.6
NaPCP + Randox	12.5 4	5.7	6.7	0	29.3	7.7	7.3	0	39.9
NaPCP + Randox	25 8	9.3	8.7	0	32.8	9.0	8.7	0	40.3
NaPCP + Vegadex	12.5 4	4.7	6.0	0	30.7	7.3	5.7	0	25.0
NaPCP + Vegadex	25 8	9	7.3	0	29.9	8.7	8.0	0	31.9
Premerge	3	6.3	2.7	0	31.9	7.0	3.0	0	37.3
"	6	8.0	7.3	0	31.6	8.0	7.3	0	40.5
Emid	1	7.0	5.3	0	25.7	8.0	7.3	0	37.4
"	2	9.3	8.0	0	28.0	9.7	8.7	1.5	39.7
Check[1]	-	0	0	0	17.2	0	0	0	36.4
Check[2]	-	7.3	7.3	0	31.1	8.0	8.0	0	41.2
	LSD .05				2.8				NS
	.01				NS				NS

a/ Weed control rating: 0 - no control, 10 - perfect control.
Check[1] - cultivation identical to chemically treated plot. Check[2] - cultivation as needed commencing at time of planting.

Table 1. The effect of pre-emergence herbicides on weed control, soybean stand, and soybean yield at Georgetown and Newark, Delaware - 1957

Treatment	Rate lbs./A.	Georgetown: Weed Control Rating[a/] Broad-leaves	Georgetown: Weed Control Rating[a/] Grasses	Georgetown: Soybean Stand Reduction %	Georgetown: Soybean Yield Bu./A.	Newark: Weed Control Rating[a/] Broad-leaves	Newark: Weed Control Rating[a/] Grasses	Newark: Soybean Stand Reduction %	Newark: Soybean Yield Bu./A.
Alanap-3	2	4.0	4.3	9.6	10.5	7.0	5.3	0	35.1
"	4	6.7	6.0	8.9	10.5	8.3	7.7	0	33.8
Randox	4	0.7	5.0	7.2	6.8	2.0	4.3	0	28.5
"	8	2.3	7.7	14.0	6.2	3.7	6.0	0	26.7
Vegadex	4	2.0	4.7	9.6	5.1	2.7	4.0	0	31.1
"	8	4.3	7.7	14.0	10.2	4.0	6.0	7.8	32.0
Eptam	3	2.3	5.3	0	7.5	7.3	8.7	0	39.6
"	6	6.0	8.3	6.4	10.9	8.7	10.0	0	39.3
NaPCP	12.5	6.0	4.7	0	10.7	7.7	6.0	0	39.4
"	25	8.3	7.0	0.8	17.1	9.0	7.7	14.7	37.9
NaPCP + Randox	12.5 4	5.3	7.7	0	13.4	-	-	-	-
NaPCP + Randox	25 8	8.3	9.3	8.1	15.5	-	-	-	-
NaPCP + Vegadex	12.5 4	3.0	4.7	1.3	9.4	7.7	6.7	0.3	38.5
NaPCP + Vegadex	25 8	8.0	8.3	18.6	11.2	9.0	8.3	15.9	37.9
Premerge	3	6.7	3.7	19.6	11.9	6.3	4.7	0.1	40.2
"	6	8.3	6.7	10.6	16.7	8.3	7.0	0	40.5
CP 6936	3	3.3	5.0	14.5	11.2	3.0	5.0	0	30.6
"	6	6.3	7.3	11.1	15.5	5.3	7.7	0	29.8
G 30031	2	5.3	3.3	8.2	11.5	8.0	7.7	99.4	1.8
"	4	7.7	5.7	5.2	13.8	9.0	9.0	100	0
2,4-D PGBE	0.5	-	-	-	-	6.0	2.3	7.0	37.2
"	1	-	-	-	-	8.3	4.7	18.3	36.0
Check[1/]	-	0	0	0	6.5	0	0	0	28.7
Check[2/]	-	8.0	8.0	0.6	12.9	8.0	8.0	2.1	38.2
LSD	.05				4.6				7.9
	.01				6.2				10.6

a/ Weed control rating: 0 - no control, 10 - perfect control.
Check[1/] - cultivation identical to chemically treated plot. Check[2/] - cultivation as needed commencing at ti of planting.

Effects on Oats of Several Herbicides Applied on Under-seeded Legumes

Robert A. Peters and Warren G. Wells[1]

Since the advent of 4(2,4-DB) there has been a renewed interest in weed control in legume seedings. While the possibility of making forage seedings without a small grain companion crop now seems feasible on many farms seedings will continue to be seeded in grain. In the following experiment, the effect of several herbicides on yields of an oat companion crop were evaluated.

Procedure

The experiment was conducted on the Agronomy Research Farm of the Storrs (Conn) Agricultural Experiment Station. Seedings of legumes were made with a grain drill on May 16, 1958 in a companion crop of Clinton oats seeded at the rate of 1½ bushels per acre.

A randomized block design was used, replicated three times. Individual plot size was 5 by 12 feet. Treatment comparisons were made by use of the Duncan's Multiple Range test. Listed below are the chemical treatments applied on June 13, 1958. The oats averaged six inches in height and were still in the tillering stage.

TABLE 1. Chemicals Used in Experiment

Common Name	Chemical Name	Source
2,4-DA	2,4-dichloro phenoxyacetic acid, amine salt	Dow
MCP	2,chloro-4-methylphenoxyacetic acid, amine salt	Dow
4(2,4-DB)amine	4(2,4-dichlorophenoxy)butyric acid, diethylamine	Amchem
4(2,4-DB)ester	4(2,4-dichlorophenoxy)butyric acid, ester	Amchem
DNBP	dinitro-o-sec-butylphenol, alkanolamine	Dow
Dalapon	2,2-dichloropropionic acid, sodium salt	Dow
Diuron	3(3,4-dichlorophenyl-1,1-dimethylurea	Dupont
Neburon	3-(3,4-dichlorophenyl-1-methyl-1-N-butylurea	Dupont

Chemical treatments were made on June 13, 1958. Applications were made in 40 gallons of solution per acre using a bicycle type sprayer. The oats averaged six inches in height at the time of application and were still in the tillering stage of growth. The predominate weed species were common chickweed (Stellaria media), yellow foxtail (Setaris lutescens), and barnyard grass (Echinochloa crus-galli).

[1]Associate Agronomist and Research Assistant, respectively, University of Connecticut, Storrs, Connecticut.

The oats were harvested on August 12, 1958 when the oats were in the late dough stage. After drying the oats they were threshed in a small power driven threshing machine.

Results and Discussion

Treatment effects became evident quite early in terms of plant stunting and somewhat later as morphogenic responses. Stunting was caused by the 1½ lb. rate of dalapon or any treatment including dalapon. The addition of 2,4-DB amine caused the most severe stunting; up to 50% in some plots.

Morphogenic effects were evident following the use of either rate of 2,4-D or 2,4-DB ester. The activity of the latter was quite markedly greater than the corresponding 2,4-DB amine at comparable rates. Some activity was seen, however, at the 2 pound rate of 2,4-DB amine. The leaf blades of effected plants were narrowed and curled and tended to grow more upright than the normal leaves.

Yields

The yields of threshed oats are given in Table 2. There was a close correlation between injury noted in the field and the oat yields obtained.

TABLE 2. Yields of Oat Grain Following Chemical Treatment

Treatment	Rate	Bu/A[1]	Bu weight	Treatment	Rate	Bu/A[1]	Bu weight
Check		40.1	25.8				
2,4-DA	1/2	35.1	25.6	2,4-DB amine + dalapon	1+1½	24.8	23.8
2,4-DA	1	33.8	24.6	DNBP+Dalapon	1+3/4	44.0	26.6
MCP	1/2	32.6	25.5	DNBP+Dalapon	1+1½	32.6	25.3
MCP	1	42.6	25.8	2,4-D+Dalapon	½+1½	31.6	25.3
2,4-DB amine	1	31.5	26.5	2,4-D+Dalapon	1+1½	31.3	24.2
2,4-DB amine	2	36.5	25.5	Dalapon	3/4	35.5	26.2
2,4-DB ester	1	27.3	24.1	Dalapon	1½	28.2	24.9
2,4-DB ester	2	24.0	23.5	Neburon	3	38.6	25.3
DNBP	1	34.0	26.3	Neburon	6	35.0	25.1
DNBP	2	40.7	26.7	Diuron	3/4	39.6	25.8
2,4-DB amine + dalapon	2+3/4	34.0	26.0	Diuron	1½	36.0	26.2

LSD for yield at 5% level = 10.1   LSD for bushel weight at 5% level - 1.8

[1]Given on basis of 32 lb. oats

The 2,4-DB ester treatments caused a severe reduction in yield at both rates with the yield at the 2 pound level only 70% that of the check. Other treatments causing a significant reduction in yield included the high rate ($1\frac{1}{2}$) of dalapon, alone and in combinations with 2,4-DB and 2,4-D. The DNBP-dalapon $1\frac{1}{2}$ combination, while not significantly lower at the .05 level, was definitely lower. The 2,4-DB amine formulation alone gave some yield reduction but much less than the ester formulation. It is noteworthy that no significant reduction was obtained from a 1 pound rate of 2,4-D which indicates that the oats were not treated at a sensitive stage of growth.

Effects on Bushel Weights

Volume weight determinations were made to determine the influence of treatment upon the endosperm development. Decreased weights relative to amount of glumes as indicated by bushel weights followed the same pattern as the yield reduction with significant reductions over the best yields being obtained from 2,4-DB ester at 3/4 and $1\frac{1}{2}$ pounds and from the combination of dalapon at $1\frac{1}{2}$ pounds per acre with 2,4-DB amine at 2 or with 2,4-D at 1 pound per acre. While dalapon caused stunting, there was little evidence of delayed maturity.

Summary

Reductions in yields of threshed oats and of bushel weight followed the application of 2,4-DB ester at 1 or 2 pounds per acre in the late tillering stage. Much less injury was obtained from 2,4-DB amine. When dalapon at $1\frac{1}{2}$ pounds was used alone or with 2,4-DB amine or 2,4-D, damage was also severe, a direct indication of injury from the higher rate of dalapon.

INFLUENCE OF WINTER AND SPRING APPLICATIONS OF PRE-EMERGENCE HERBICIDES ON CONTROL OF CRABGRASS

R. E. Engel, W. F. Meggitt, and J. R. Fulwider[1]

The development of pre-emergence crabgrass herbicides has raised a question concerning the effect of time interval between application and germination. No research information is available on this question. Three tests were made during the winter of 1957-58 and the spring of 1958 to determine the effect of season of applying chlordane and lead arsenate for crabgrass control.

Procedure

Three pre-emergence crabgrass tests concerning time interval between treatment and germination were established in the winter of 1957-58. Test area I was composed of a mixed turf of Kentucky bluegrass, red fescue, and colonial bentgrass cut to 3/4 inch and seeded with crabgrass in early December 1957. Test II was located on 1/2 inch turf of bentgrass and annual bluegrass that had a natural source of crabgrass seed. Test area III was located on a golf course fairway that had a moderate supply of crabgrass. Treatment dates for the respective tests were: December 24, March 11, and May 14; December 24, April 4, and May 24; and March 13, April 18, and June 2.

The chemical treatments used were chlordane at 40, 60, and 80 pounds per acre on granular attaclay; chlordane at 40 pounds per acre on an organic carrier; chlordane at 60 pounds per acre on vermiculite; lead arsenate at 871 pounds per acre and an arsenical complex* at 1350 pounds per acre.

Plots were 3 x 14, 3 x 12, and 3 x 12 feet for the respective tests. All treatments were replicated three times. Test area I was treated in late May with a complete fertilizer at a rate that supplied one pound of nitrogen per 1000 square feet and mowed at 1/2 inch through the season. Test area II was not fertilized during the fall of 1957 or in the 1958 season, was mowed to 1/4 inch from late spring through the summer, and received supplemental water during July and August. Test area III received standard fairway maintenance. The effect of the treatments on the crabgrass stand was determined by plant counts within a 2 x 10 feet area in the center of each plot on September 29, September 24, and October 25 for the respective tests.

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[1]Associate Research Specialist in Turf Management; Assistant Research Specialist in Weed Control; and Research Assistant, Department of Farm Crops, Rutgers-The State University, New Brunswick, N. J., respectively.

Results

Chlordane gave its best pre-emergence crabgrass control when applied during the period of March 11 to April 18. Chlordane on organic matter (Test I) have the same degree of crabgrass control at all dates of treatment. Lead arsenate gave slightly better performance from the earliest applications. The arsenical complex gave its best performance with the earliest applications.

The 80 pounds per acre application of chlordane gave the best and most consistent crabgrass control. Sixty pounds per acre application of chlordane on granular attaclay gave good control except in Test III when applied during the period of mid-March to mid-April. Chlordane on vermiculite performed similarly to chlordane on granular attaclay. The 40 pounds per acre rate of chlordane gave good crabgrass control on the March 11 treatment of Test I only.

The crabgrass control given by the arsenicals was generally poor. The arsenical complex treatment gave good results on the first two dates of Test III. In part this may have been the result of the nitrogen contained in the treatment, since the test area received no other fertilization during the fall of 1957 or the 1958 season which greatly reduced the density of turf cover. Temporary discoloration resulted from treatment with the arsenical complex preparation.

Summary

Three rates of chlordane on dry carriers, lead arsenate, and an arsenical complex were applied at different seasons to three different turfgrass test areas for pre-emergence crabgrass control. The results were as follows:

1. Chlordane gave best crabgrass control when applied during the period of mid-March to mid-April.

2. The lowering of the rate of chlordane from 80 to 60 and 40 pounds per acre increased the need for specificity in the date of treatment.

3. Chlordane applied at 80 pounds per acre gave the best and most consistent crabgrass control of the test treatments.

4. Chlordane on granular attaclay and vermiculite gave similar results at 60 pounds per acre.

5. The arsenical treatments generally gave their best crabgrass control with winter application. The crabgrass control produced by lead arsenate and the arsenical complex were unsatisfactory except for

New Chemicals For Pre-Emergence Crabgrass Control

John E. Gallagher and Richard J. Otten

Amchem Products, Inc. Ambler, Pa.

Greenhouse and field screening trials in 1957 indicated that DINOBEN (2,5-dichloro-3-nitrobenzoic acid) had the properties of a good pre-emergence crabgrass control chemical. Therefore, an experiment was designed comparing rates of application, number of treatments, and treatment intervals. Standard materials as well as two other new experimental chemicals were included in this test.

The test was located at the Oak Terrace Country Club, Ambler, Pa. The plots were laid out on a site that normally has a high population of crabgrass. The turf was a mixture of broadleaf weeds, Kentucky bluegrass and patches of creeping bent. Plot size was 6' by 10'. Treatments were replicated three times and randomized. Fifteen check plots were included in the plot layout.

Materials	Rate of Active Ingredient
1- DINOBEN (ACP-M-503) 2,5-dichloro-3-nitrobenzoic acid	2,4,6,8,10 lb/A (liquid)
2- DINOBEN (3% on vermiculite)	6,8,10 lb/A (dry)
3- CHLORDANE (76% emulsifiable technical chlordane)	60 lb/A (liquid)
4- CHLORDANE (8% technical chlordane on vermiculite)	60 lb/A (dry)
5- PAX (lead arsenate, arsenous oxide, chlordane)	549 lb/A* (dry) (half recommended rate)
6- 2,4-D/2,4,5-T (esters in 2/1 ratio)	3 lb/A (liquid)
7- ALANAP IF (N-1 naphthyl phthalamic acid plus urea)	720 lb/A* (dry)

Materials	Rate of Active Ingredient
8- ACP XF 707 (2-chloro-4-fluoro phenoxy acetic acid)	1,2,3 lb/A (liquid)
9- FENAC S (ACP-M-673) 2,3,6-Trichlorophenylacetic acid, sodium salt	3,6 lb/A (liquid)
10- FENAC UP (ACP-M-674) 2,3,6-Trichlorophenylacetic acid, amide	3,6 lb/A (liquid)
11- FENAC E (ACP-M-675) 2,3,6-Trichlorophenylacetic acid, ester	3,6 lb/A (liquid)

*Rate of formulation

Materials 1 through 8 were applied on April 3 and at scheduled 3, 4, and 6 week intervals thereafter. Materials 9, 10 and 11 were applied on April 8.

Liquid formulations were applied in 175 gallons of spray per acre using a pressure of 20 psi. A small plot sprayer equipped with a 4 nozzle boom was used. Dry formulations were spread without any additional diluent.

Observations and Results

Although rainfall was adequate, crabgrass did not make up an obvious part of the turf population until late in the summer. The mean crabgrass population in the check plots on July 1 was 3.5 percent, as compared to the August 28 figure of 42.5 percent.

After analyzing the data of the DINOBEN series, comparing rates of application, number of treatments and treatment intervals, 8 and 10 pound per acre appeared necessary, with 2 or 3 treatments at the 4 week interval producing most consistent satisfactory control (above 75 percent). The data also seemed to indicate that liquid treatment series finishing on May 29 and June 26 were more effective, with the dry series finishing on May 29 the most effective.

Of all the treatments applied, FENAC S and FENAC UP were the most promising. Single applications of 3 pounds per acre produced 85% crabgrass control with no turf injury while 6 pounds per acre produced 97% crabgrass control with only slight temporary turf discoloration.

CHLORDANE, at 60 pound per acre was more effective as a dry formulation than as a spray.

PAX was ineffective. This may be explained by the fact that only one-half the recommended rate was applied.

The 2,4-D/2,4,5-T mixture and the XF 707 were ineffective.

Summary

DINOBEN is an effective pre-emergence crabgrass control chemical, but 2 to 3 applications of 8 to 10 pounds per acre are needed to provide satisfactory control.

CHLORDANE results in this test, crabgrass control in the range of 50-75% with a single application of 60 pounds per acre, agreed with test results from other parts of the country. FENAC S and FENAC WP offer considerable promise as pre-emergence crabgrass control materials. Their margin of safety on turfgrass is adequate for general use though not as safe as DINOBEN.

Table I. DINOBEN Series --- Percent Crabgrass Control August 28, 1958.*

Comparison of Rate, Number of Treatments and Treatment Intervals

DINOBEN LIQUID

		Pounds per acre					
No. treatments		2	4	6	8	10	Ave. all rates
3 week intervals							
1	Apr. 3	-29	-29	30	-14	10	-6%
2	Apr. 24	-22	10	78	73	47	37%
3	May 15	-14	91	38	81	22	43%
4 week intervals							
1	Apr. 3	-29	-29	30	-14	10	-6%
2	May 1	38	57	10	87	80	54%
3	May 29	-2	81	49	95	96	64%
6 week intervals							
1	Apr. 3	-29	-29	30	-14	10	-6%
2	May 15	18	-10	49	61	85	40%
3	June 26	30	77	47	83	88	64%

*Control figure is based on the crabgrass cover in the treated plots compared to the crabgrass cover in the check plots. The average crabgrass cover in 15 check plots was 42.5%.

Underscored figures (__) indicates satisfactory control of 75% or better.

Table II - DINOBEN Series --- Percent Crabgrass Control, August 28, 1958.*

Comparison of Rates, Number of Treatments and Treatment Intervals

DINOBEN DRY

3 week intervals No. treatments		Pounds per acre 6	8	10	Average all rates
1	Apr. 3	-18	-7	26	0%
2	Apr. 24	45	33	73	50%
3	May 15	65	65	70	66%
4 week intervals **No. treatments**					
1	Apr. 3	-18	-7	26	0%
2	May 1	45	68	73	61%
3	May 29	64	<u>92</u>	<u>76</u>	<u>77%</u>
6 week intervals **No. treatments**					
1	Apr. 3	-18	-7	26	0%
2	May 15	65	65	70	66%
3	June 26	38	10	68	36%

*Control figure is based on the crabgrass cover in the treated plots, compared to the crabgrass cover in check plots. The average crabgrass coverage in 15 check plots was 42.5%.

Underscored figures (__) indicates satisfactory control of 75% or better.

Table III Additional Chemicals --- Percent Crabgrass Control
August 28, 1958*

Comparison of Commercial Products and Other
Experimental Materials

Material	Rate/acre	Number Treatment	Treatment Interval	Percent Control
CHLORDANE				
liquid	60 lb.	1		56
dry	60 lb.	1		78
PAX (**)	549 lb.	1		2
2,4-D 2,4,5-T	2 lb. 1 lb.	1		-15
ACP XF 707	1 lb.	1		-45
	2 lb.	1		6
	3 lb.	1		-67
Alanap IF	720 lb.	3	4 week	41
FENAC S (ACP-M-673)	3 lb.	1		85
	6 lb.	1		97
FENAC WP (ACP-M-674)	3 lb.	1		86
	6 lb.	1		98
FENAC E (ACP-M-675)	3 lb.	1		45
	6 lb.	1		68
Control	-	-		00

*Percent control figure is based on the crabgrass cover in treated plots compared to the crabgrass cover in check plots. The average crabgrass cover in 15 check plots was 42.5%.

Underscored figures (__) indicates satisfactory control of 75% or better.

Crabgrass Control with Post-Emergence Chemical Treatment[1]

J. R. Kollett and J. A. DeFrance[2]

Rhode Island Agricultural Experiment Station
Kingston, Rhode Island

Previous tests with chemicals such as the mercurials and arsenicals have proven effective for the purpose of post-emergence crabgrass control in lawn turf (1,2,3,4). The object of this investigation was not only to determine the comparative effectiveness of several materials commercially available at present but also to evaluate several newer materials in respect to their possible use for post-emergence crabgrass control.

Materials and Methods

This experiment was conducted during the summer of 1958 on five-year-old lawn turf on the University of Rhode Island campus. The test plots were 50 square feet in area, replicated three times and located on a soil classified as a fine sandy loam of pH 5.9. The turf, composed of Red fescue, Kentucky bluegrass and Colonial bentgrass, was heavily infested with smooth crabgrass (*Digitaria ischaemum*). A one-inch height of cut was maintained and no supplemental water was applied. Precipitation was adequate throughout the entire growing season.

The herbicidal materials used, the percent active ingredient in each compound and the rates of application were as follows:

A. Granular Material A (Mercury - in the form of phenyl mercury salts of acetic, propionic and naphthyl phthalamic as metalic 0.25% N-1 naphthyl phthalamic acid 0.24%) applied with a calibrated spreader at 2.4 and 4.8 pounds per 1000 square feet.
B. Granular Material B (Disodium methyl arsonate hexahydrate 2.5%) applied with a calibrated spreader at the rates of 3.6 and 7.2 pounds per 1000 square feet.
C. Neburon (18.5% 3-(4 dichlorophenyl-2-methyl-1-N-butylurea) at 3 oz. per 1000 square feet.
D. DMA (44% disodium methyl arsonate) at the rates of 1/6 and 1/3 of a pound per 1000 square feet.

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[1]Contribution No. 964 of the Rhode Island Agricultural Experiment Station.

E. Liquid Material AMA (8.0% octyl ammonium methyl arsonate and 8.0% dodecyl ammonium methyl arsonate) at the rates of 1/4 and 1/2 of a pound per 1000 square feet.

F. PMA (10% phenyl mercuric acetate) at the rates of 2.0 and 2.5 oz. per 1000 square feet.

The dry formulations, namely Granular Materials A and B, were applied with a calibrated spreader to ensure correct application and uniform distribution. All other materials were applied in a water solution at the rate of 5 gallons per 1000 square feet with a powerized pressure sprayer.

The first treatment was applied July 24 when the crabgrass plants were in the two and three leaf stage. The second and last application was on August 1st, approximately one week after the first treatment.

The percent crabgrass within the individual plots was taken July 24 just prior to the first application and again on October 17 at the conclusion of the experiment.

Results and Discussion

The results obtained from this study are summarized and the data presented in Table 1. All rates were on the 1000 square foot basis. Granular Material A when applied at double the recommended rate of 4.8 pounds was 97% effective in control and only slight discoloration resulted from the first treatment. This increased to moderate following the second treatment, however, no permanent injury resulted. Seventy-two percent control was obtained with Granular Material A at the rate of 2.4 pounds.

Granular Material B produced 100% control of crabgrass both at the recommended rate of 3.6 pounds and at double the rate of 7.2 pounds. No apparent advantage was noted from the higher rate since both were equally effective. Discoloration was greater at the higher rate although no permanent injury was noted at the conclusion of the experiment.

Neburon at the rate of 3 ounces per 1000 square feet did not reduce the incidence of crabgrass to any significant degree.

DMA at 1/6 and 1/3 of a pound provided 93% and 97% control respectively. The 1/3 pound rate produced moderate discoloration with the first treatment and severe discoloration resulted after the second treatment was applied eight days later. However, discoloration in both cases was only temporary and no permanent injury resulted. The 1/6 pound rate of DMA resulted in only slight discoloration following each of the treatments.

As in previous crabgrass control studies conducted at the Rhode Island Agricultural Experiment Station, PMA at recommended rates of 2 and 2.5 ounces produced 98% and 100% control. The higher rate of 2.5 ounces caused moderate discoloration and the lower rate caused only slight discoloration. In neither case was there any indication of injury at the end of the experimental period.

In 1958, the relatively new ammonium methyl arsonate compounds were available commercially for control of crabgrass. Liquid Material AMA was applied at the rates of 1/4 and 1/2 pound per 1000 square feet. Both rates resulted in 100% control of crabgrass with only slight discoloration resulting after each of the two treatments.

Summary and Conclusions

During the summer of 1958 a post-emergence crabgrass study on lawn turf was conducted at the Rhode Island Agricultural Experiment Station. All materials at the various rates were applied twice. The first application was applied on July 24, when the crabgrass was in the two and three leaf stage and the second on August 1. All rates were on the 1000 square foot basis.

Two treatments of Granular Material A at the rate of 2.4 pounds provided 72% control compared to 97% control at the double rate of 4.8 pounds. Granular Material B at 3.6 pounds and at 7.2 pounds produced 100% control in each case. Greater discoloration resulted from the higher rates however no permanent injury was noted at the conclusion of the experiment.

DMA and Liquid Material AMA both provided exceptionally good control. Only slight discoloration occurred on the Liquid Material AMA plots even at the higher rate whereas moderate to severe discoloration was noted with DMA.

PMA (10%) at the rates of 2 and 2.5 ounces produced 98% and 100% control respectively. No serious discoloration or injury was noted.

Neburon did not provide control at the rates used in this study.

None of the materials showed any severe injury for any length of time at the rates used.

Results indicate that the best time to apply materials for crabgrass control is when the plants are young or in the 2-3 leaf stage and before they begin to spread out over the lawn.

Acknowledgements

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Table 1. Post-emergence control of crabgrass in lawn turf. Rhode Island Agricultural Experiment Station, 1958.

Material	Rate per 1000 sq.ft.	% Crabgrass before Treatment (July 24)	% Crabgrass after Treatment (Oct. 17)	% Control	Discoloration* July 30	Discoloration* Aug. 8	Discoloration* Oct. 17
Granular Material A	2.4 lbs.	32	9	72	1.0	1.0	0.0
Granular Material A	4.8 lbs.	30	1	97	0.7	2.2	0.0
Granular Material B	3.6 lbs.	33	0	100	0.5	T	0.0
Granular Material B	7.2 lbs.	38	0	100	2.3	1.8	0.0
Neburon	3 oz.	29	39	00	0.0	1.7	0.0
DMA	1/3 lbs.	28	2	93	2.5	3.8	0.0
DMA	1/6 lbs.	31	1	97	1.7	1.3	0.0
Liquid Material AMA	1/2 lb.	31	0	100	1.2	1.2	0.0
Liquid Material AMA	1/4 lb.	24	0	100	0.4	T	0.0
PMA	2 oz.	41	1	98	1.0	1.5	0.0
PMA	2.5 oz.	40	0	100	2.3	2.3	0.0
None	---	32	98	00	0.0	0.0	0.0

*Discoloration index: T = trace, 0 = none, 1 = slight, 2 = moderate, 3 = severe, 4 = very severe, 5 = permanent injury.

Treatments were applied July 24 and August 1.

CHICKWEED CONTROL IN LAWNS 1/

By 2/
Paul W. Santelmann

Common chickweed (Stelloria media L.) and henbit (Lamium amplexicaule L.) are becoming major weed problems in Maryland lawns. In the early spring of 1957 and during the winter of 1957-58, various treatments were applied to a Kentucky Bluegrass lawn on the University of Maryland campus in which these weeds were present.

Materials and Methods

One hundred square foot plots were treated on April 3, 1957 (date 1), December 23, 1957 (date 2), and March 3, 1958 (date 3). Where possible, treatments were made at the rates recommended on the container. Silvex (2,4,5 trichloropropionic acid) was used at ½, 1 and 1½ pounds per acre. In the trial on date 3, samples of silvex from the Dow Chemical Company and Amchem Products Inc., were compared. Other herbicides used were: 2,4- dichlorophenoxybutyric acid (2,4-DB) at 1 and 2 pounds per acre; Potassium cyanate (KOCN) at 12 pounds per acre; disodium methyl arsonate (DSMA) as recommended on the container; neburon at 2 pounds per acre; isopropyl-N (3 chlorophenyl) carbamate (CIPC) at 1 and 2 pounds per acre, both in liquid and granular form; and dinitro orthosecondary butyl phenol (DNBP), amine salt, at 1 and 2 pounds per acre, both in liquid and granular form.

The weeds were generally about 2 to 3" tall when treated, and all treatments were in 3 replications. Air temperature varied from 50° to 60° F at the time of treatment. The treatment area was a well established Kentucky bluegrass lawn. In the case of date 3, a light rain began 15 minutes after the plots were treated. The silvex, CIPC and DNBP were applied with a hand sprayer, and the KOCN, neburon, and DSMA with a sprinkling can. The granular materials were mixed with sand and applied by hand.

RESULTS AND DISCUSSION

Table 1 shows the degree of control that resulted from the various treatments. Neburon (2 lbs/A and 2,4-DB (1 & 2 lb/A) did not control the chickweed. The degree of control with the other herbicides varied. The granular materials were relatively ineffective. Uncertain coverage resulted from the hand spreading of the granulars and it is felt that this is part of the cause for their poor showing. KOCN and DSMA caused some injury to the weeds, and silvex, CIPC and DNBP resulted in very good chickweed control. The high rates of silvex and DNBP caused a slight turf burn, and KOCN caused up to a 30% burn. However, the turf appeared to recover from all these treatments. None of the other treatments resulted in turf injury. In the instances where one chemical was used either early or late in the winter the time of treatment appeared

1/ Miscellaneous Publication No. 339, Contribution No. 2975, of the Maryland Agricultural Experiment Station, Department of Agronomy.

2/ Assistant Professor, Department of Agronomy, Maryland Agricultural to have little effect with regard to silvex, CIPC or DNBP. With KOCN and DSMA, better results were obtained with the early winter (December) treatment. Silvex, DNBP and KOCN were most effective for the control of henbit.

SUMMARY

Chickweed and henbit control plots were treated in an established Kentucky bluegrass lawn during the winter and early spring of 1957 and 1958. Treatments used were: Silvex ½, 1 and 1½ pounds per acre; 2,4-DB at 1 and 2 pounds per acre; KOCN at 12 pounds per acre; DSMA as recommended on the container; CIPC, liquid and granular, at 1 and 2 pounds per acre; and DNBP, liquid and granular, at 1 and 2 pounds per acre. Silvex was the most satisfactory herbicide used to control the chickweed but liquid CIPC and DNBP were also satisfactory. The use of KOCN and DSMA was less satisfactory. Granular DNBP, granular CIPC, Neburon and 2,4-DB were relatively unsatisfactory. Henbit was best controlled by silvex, DNBP, and KOCN, respectively.

Table 1 Percent Control of Chickweed and Henbit in an Established Kentucky Bluegrass Lawn with Various Herbicides. Ratings made in May.

Treatment	Rate (lbs/A)	Treated 4/3/57 Chick-Weed	Treated 12/23/57 Chick-Weed	Treated 12/23/57 Henbit	Treated 3/3/58 Chick-Weed	Treated 3/3/58 Henbit
Silvex (Dow)	½	--	90	40	--	--
	1	95	100	100	83	68
	1½	--	--	--	100	100
Silvex (ACP)	1½	--	--	--	100	100
CIPC	1	70	70	20	--	--
	2	--	90	20	--	--
DNBP	1	90	80	0	--	--
	2	--	80	70	--	--
KOCN	12	80	60	60	0	0
DSMA	--	--	50	0	25	0
Gran.DNBP	1	--	10	10	--	--
	2	--	40	10	--	--
Gran.CIPC	1	--	20	0	--	--
Neburon	2	90	30	10	0	0
2,4-DB	1	--	--	--	0	0

Acknowledgement is made to AMCHEM Products, Inc.; The Dow Chemical Company; E.I. Dupont de Nemours and Company; and to the Miller Chemical Company for supplying the chemicals used in these experiments.

Observations on Pre-emergence and Post-emergence Crabgrass Control; on the Control of *Veronica filiformis* with Endothal; and on the Effectiveness of 2,4,5-TP in Controlling a Variety of Turf Weeds

Robert G. Mower and John F. Cornman*

During the 1958 season we have engaged in a number of experiments in selective control of turf weeds. None of the trials on any one phase is comprehensive enough for a separate paper, but the observations on a number of aspects of weed control seem worth recording for the information of other workers in this field of interest.

Observations will be reported on these subjects:

A. Pre-emergence crabgrass control
B. Post-emergence crabgrass control
C. Continuing observations on the control of *Veronica filiformis* with endothal
D. The effectiveness of 2,4,5-TP (Silvex) in the selective control of various turf weeds

The crabgrass trials were at the Cornell Turf Research Plots at the Nassau County Park, East Hempstead, L.I. Here several acres of turf plots have recently been developed and the 1958 season was the first there for turf research work. The 2,4,5-TP trials were at the Cornell Turf Research Plots, Ithaca, and the Veronica observations were on various upstate New York lawns.

A. Pre-emergence Crabgrass Control

One of the newer approaches to one of the most persistent turf weed problems in southeastern New York and on Long Island has been the use of pre-emergence control materials for crabgrass (*Digitaria ischaemum* and *D. sanguinalis*).

A series of demonstration plots was set up at the Cornell Turf Research Plots at Nassau County Park, East Hempstead, L.I., to observe the effectiveness of the several materials now being promoted for pre-emergence crabgrass control.

Two separate areas were used for this test. Area A, selected because of its reliability for crabgrass infestation, consisted primarily of a thin, neglected turf of native bentgrass, red fescue and sheep fescue. Individual plots measured 30 feet by 10 feet and were separated by 2 foot check strips.

Area B consisted of blocks of essentially pure stands of individual grasses of Illahee red fescue, Pennlawn red fescue, Merion Kentucky bluegrass, commercial Kentucky bluegrass, Seaside creeping bent, and Penncross creeping bent. Plots measuring 6 feet wide ran across each of these individual grass plots. Two foot check strips were left between adjacent plots.

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* Turf Research Assistant and Professor of Ornamental Horticulture, respectively, Cornell University, Ithaca, N. Y.

Area A, with the exception of one plot, was treated on April 25, 1958. Treatments were applied to Area B on May 14, 1958, plus an additional one to Area A. Second applications of Alanap 1F and Crag Herbicide were made on June 20, 1958. In each area supplementary fertilizer was added to those plots in which the pre-emergence crabgrass control material did not have fertilizer incorporated. This was applied in an inorganic fertilizer at the rate of 1 pound of nitrogen per 1,000 square feet.

The following pre-emergence crabgrass control materials were used.

Materials

1. "Alanap 1F" - U. S. Rubber Co., Naugatuck Chemical Division Naugatuck, Conn.
2. "Ortho Lawn Pep" - California Spray-Chemical Corp., Lucas and Ortho Way, Richmond, Calif.
3. Chlordane (72% emulsifiable concentrate, 8# a.e./gal.) - Velsicol Chemical Corp., 330 East Grand Avenue, Chicago, Ill.
4. Chlordane (5% granular) - Velsicol Chemical Corp., 330 Grand Avenue, Chicago, Ill.
5. "PAX" - Kelly Western Seed, Division of Coop. Assoc., 580 West 13th South, Salt Lake City, Utah.
6. "Crag Herbicide" - Carbide and Carbon Chemical Co., 30 East 42nd St., New York 17, N. Y.

The materials used, rates of application and the dates on which crabgrass controls estimates and turf injury ratings were made are shown in Table 1.

Under the conditions of our trials none of the pre-emergence control chemicals gave complete control of crabgrass. While a reduction in crabgrass was observed where either chlordane or "PAX" had been used, this reduction (21 to 31%) was not adequate to be considered a satisfactory control. Perhaps time of application has an important bearing on the results obtained with pre-emergence materials, thus accounting for the marked difference between our results and some of those reported elsewhere.

No turf injury was observed on any of the plots with the exception of "Ortho Lawn Pep" where the strip crossed the Illahee and Pennlawn red fescues in Area B. Increased growth, stimulated by the fertilizer material incorporated with the chemical, had increased the susceptibility of these plants to leaf spot (Helminthosporium dictyoides). No injury was visible with the same material on the bluegrass or bent areas. The comparable addition of fertilizer to areas treated with pre-emergence chemicals which did not have fertilizer incorporated in them did not show this type of injury, although severe outbreaks occurred later in the season on all of the fescue blocks.

B. Post-emergence Crabgrass Control

While pre-emergence crabgrass control has been one approach to this important weed problem, the majority of control still centers around the use of post-emergence materials.

A series of plots was set up at the Cornell Turf Research Plots at Nassau County Park, East Hempstead, L.I., to observe the effectiveness of a number of the standard materials and four experimental materials for post-emergence crabgrass control.

The area in which the trials were conducted was seeded to a mixture of 2/3 creeping red fescue and 1/3 Kentucky bluegrass in November 1957. Germination from this dormant seeding was rather poor, and a thin turf existed at the time of crabgrass seed germination this spring. This thin turf permitted a rather heavy crabgrass infestation in the area.

Plots measured 8 by 30 feet with a 4 foot check plot between. Sprays were applied with a small plot sprayer. Pressure was supplied by CO_2 at 30 psi to four fan type Tee Jet nozzles on a hand boom. Each chemical was applied in water at the rate of 100 gallons to the acre except where the manufacturer's recommendations indicated more or less should be used. First applications were made on June 27, 1958 when first crabgrass plants were in a late two-leaved seedling stage. Second and third applications were made on July 7 and July 21, respectively.

The chemicals and formulations used were:

Materials

1. Disodium monomethylarsonate hexahydrate 30% ("Methar 30") - W. A. Cleary Corp., New Brunswick, N. J.
2. Disodium monomethylarsonate pentahydrate 75% ("Methar") - W. A. Cleary Corp., New Brunswick, N. J.
3. Disodium methylarsonate hexahydrate 2.5% (Weedone "Sodar") - American Chemical Paint Co., Ambler, Pa.
4. Octyl ammonium methylarsonate 8% and dodecyl ammonium methylarsonate 8% ("Artox Crabgrass Killer") - Nott Manufacturing Co., Mt. Vernon, N. Y.
5. Potassium cyanate - American Cyanamid Co., New York 16, N. Y.)
6. Phenyl mercuric acetate 2.5% ("PMAS") - W. A. Cleary Corp., New Brunswick, N. J.
7. Darmethene (Experimental) - W. A. Cleary Corp., New Brunswick, N. J.
8. Niagara 4562 (Experimental) - Niagara Chemical Division, Food Machinery and Chemical Corp., Middleport, N. Y.
9. G-106 and G-110 (Experimental) - Gallowhur Chemical Corp., North Water St., Ossining, N. Y.
10. U-9612 and U-9613 (Experimental) - Upjohn Co Research Division, 301 Henrietta St., Kalamazoo, Mich.

As shown in Table 2, satisfactory crabgrass control (90% +) was obtained with a number of the post-emergence chemicals. These included the disodium methylarsonate group, ammonium methylarsonate and phenyl mercuric acetate.

In the disodium methylarsonate group no significant difference in crabgrass control was noted between the liquid and powder formulations. Where the powder formulation was applied at double the recommended rate, excessive turf injury was noted so that after two applications a considerable portion of the desirable turf grasses was killed; on these plots the third application was omitted.

The ammonium methylarsonate gave a significantly greater degree of control following two applications of the chemical than did the disodium methylarsonate but there was a corresponding increase in turf discoloration. Turf recovery from these applications was also quite slow.

Potassium cyanate gave an intermediate degree of control. This is in line with the common opinion that potassium cyanate is more effective on mature crabgrass than on seedlings.

Phenyl mercuric acetate gave good control of crabgrass in the plot area but gave no control over another grassy weed, Panicum dichotomiflorum, present in the test area, so that from superficial observation it appeared that no control of crabgrass had been obtained. The disodium and ammonium methylarsonates controlled both the crabgrass and the Panicum equally well.

Among the experimental materials, only Darmethene and Niagara 4562 at the 8 pounds of active ingredient per acre rate gave any control of crabgrass under the conditions of our trials. The degree of crabgrass control was very small and both produced rather severe turf injury as well.

9. Continuing Observations on the Control of Veronica filiformis with Endothal

In work reported at the 1958 N.E. Weed Control Conference* we indicated that endothal gave good control of Veronica filiformis in experimental plots during one season. Since that time endothal has been marketed in small packages and has been used extensively by home owners where Veronica filiformis was a problem. From replies to a survey questionnaire (sent to about 150 persons who had written to us for identification and control information), it is evident that good Veronica filiformis control has been attained with endothal under a variety of conditions of use in the field.

Typical of the results of endothal treatments are the data presented here in Table 3. Preliminary data from these same plots (after a single treatment) was given in our 1958 paper (op. cit., Table III, p. 146). On the basis of numerous results of this sort and continuing reports and observations of success under field conditions, we have confidence in our current conclusions and recommendations for the control of Veronica filiformis. These are:

a. For Veronica filiformis control, spray with endothal at the rate of 1 pound actual endothal in 100 gallons of water per acre (3 tablespoons of the present commercial formulation in 2½ gallons of water per 1,000 sq. ft.) at any season when grass and weeds are growing normally. A second application, to care for occasional spots missed in the first spraying, is usually needed.

b. Uniform coverage using a pressurized tank and fan-type nozzles is required for good selective control.

c. Best results will be on areas mowed recently to uniform height and free of clippings and debris that might shield the Veronica.

d. In addition to V. filiformis, endothal will control white clover (fall and spring applications only). Incidental observations of other weed species of Veronica indicate that control may also be expected of V. arvensis, V. officinalis, and V. persica. There has been no opportunity to observe effects on V. serpyllifolia.

e. Endothal will not control dandelions, plaintains, etc. The 2,4-D susceptible weeds can be controlled by adding 2,4-D at the usual rates to the endothal without modifying the potency or range of either chemical.

f. At the recommended rate of endothal, bentgrass and Poa trivialis show the most injury, with red fescue next and Kentucky bluegrass least. The bluegrasses and bent recover rapidly from endothal discoloration. Red fescue recovers more slowly, and may suffer some permanent damage.

g. Normal endothal treatments will not interfere with the growth of reseedings with the common northern grasses. Poa trivialis, Kentucky bluegrass, Merion Kentucky bluegrass, creeping red fescue, creeping bent, and domestic ryegrass all germinated normally following surface soil treatments with endothal both just prior to and immediately after seeding.

D. The Effectiveness of 2,4,5-TP in Selective Control of Various Turf Weeds

The herbicide 2,4,5-TP [2(2,4,5-trichlorophenoxy) propionic acid] has been reported by Gallagher and Jack* to be effective against two of the troublesome, low growing, mat-forming turf weeds, common chickweed, Stellaria media, and mouse ear chickweed, Cerastium vulgatum. Its effectiveness against most other turf weeds has not been recorded.

To observe the effectiveness of 2,4,5-TP on a variety of turf weeds, approximately 7500 square feet of turf consisting of a mixture of Kentucky bluegrass, red fescue, and creeping bentgrass infested with a wide variety and number of weeds was treated with 2,4,5-TP in one-half of the area and a mixture of 2,4,5-TP and 2,4-D in the other.

In both cases, the 2,4,5-TP was applied at the rate of $1\frac{1}{2}$ pounds of active ingredient to the acre, while the 2,4-D was applied at the rate of 3/4 pound of active ingredient to the acre. Treatments were made in water at the rate of 50 gallons to the acre on October 3, 1958. The herbicides were applied with an experimental plot sprayer bearing a 9 foot boom supplied with 7 fan-type Tee Jet nozzles. Pressure was supplied by CO_2 at 30 pounds per square inch.

Ten plants each of 16 different weeds were then marked for observation at a later date. For such creeping weeds as clover and chickweed, ten areas of infestation were marked. Because of the retarding effects of cool weather and the late fall application, the degrees of control noted in these early obser-

* Gallagher, J. E. and C. C. Jack. Chickweed control test 1956-57. Proc. N.E. Weed Control Conf. 12: 151-153. 1958.

vations were recorded in three categories: control, in which the treated plants have been killed; promising, in which curling or yellowing have taken place but, at the time this paper was prepared, it was still not definite whether the plants will recover; and no control, where no effects of the herbicide are evident.

A summary of the observations is found in Table 4. Included in this table are a few observations from other trials, each explained in a footnote.

Under the conditions of our trials, mouse ear chickweed, *Cerastium vulgatum*, and common chickweed, *Stellaria media*, were controlled by 2,4,5-TP. A more rapid control was noted for *Stellaria media*, with all plants under observation completely dead two weeks after treatment. Effects on *Cerastium vulgatum* were much slower and not all plants were dead by the end of a four week period. Stitchwort, *Stellaria graminea*, was also controlled. This weed is more common than is generally recognized, especially in golf course fairways, but its fine texture, grass-like color, and apparent lack of interference with play have kept it from being widely recognized as an important turf weed. An increase in inquiries as to its identification and control have been noted in recent seasons.

Observations on yarrow, *Achillea millefolium*, indicate that it, too, can be controlled by the use of 2,4,5-TP. Applications of 2,4,5-TP at the rate of 1.5 pounds of active ingredient to the acre to a yarrow-infested lawn in Glen Cove, Long Island, in the fall of 1957 gave complete control that season and there has been no regrowth since that time. Two separate plots treated on the Cornell Campus in the spring of 1958 gave complete control of yarrow with no evidence of regrowth to date. Yarrow, up to this time, is one of the weeds for which there has been no good control.

Apart from its value for the control of the chickweeds, 2,4,5-TP in our trials shows some possibilities for the control of a number of other turf weeds. This broader range of weed control would be of value in eliminating the need for additional chemicals to kill other turf weeds that might remain after the chickweeds had been removed. Early observations show that 2,4,5-TP may have value for the control of narrow- and broad-leaved plantains, dandelion, ox eye daisy, wild carrot and thistle. No conclusions on these items are justified at the present time, but observations will be continued.

Ground ivy, *Nepeta hederacea*, self heal, *Prunella vulgaris*, and *Veronica filiformis* were not controlled in these trials by either 2,4,5-TP alone or in combination with 2,4-D.

Summary

1. Pre-emergence crabgrass control: under the conditions of these trials, none of the materials used provided adequate crabgrass control. "PAX" gave 31% control and chlordane at 60#/A gave less than 25% control. Alanap 1F, Crag Herbicide #1, and Ortho Lawn Pep were ineffective.

2. Post-emergence crabgrass control: Disodium methylarsonate, ammonium methylarsonate, and PMA gave good crabgrass control (90% +). Potassium cyanate was less effective (65%). Darmethene, Niagara 4562, G106, G110, U-9612, and U-9613 either produced intolerable turf injury or very little crabgrass control. The arsonate compounds also controlled *Panicum dichotomiflorum* and are thus to be preferred to PMA where Panicum is also a problem.

3. For selective control of *Veronica filiformis*, two successive treatments with endothal at the rate of 1# actual endothal in 100 gallons of water continues to give excellent results.

4. 2,4,5-TP at 1½#/A controlled mouse-ear chickweed (*Cerastium vulgatum*), common chickweed (*Stellaria media*), stitchwort (*S. graminea*), and white clover. Apparently 2,4,5-TP was also effective against yarrow (*Achillea*) and yellow rocket (*Barbarea*). Results against a number of other weeds were apparently less satisfactory.

Table 1. Pre-emergence crabgrass control trials

Area A - treated April 25, 1958. Plots 10 x 30 feet, unreplicated.
Area B - treated May 14, 1958. Plots 6 x 90 feet, unreplicated.

Location - Turf Research Plots at Nassau County Park, East Hempstead.

		Area A			Area B		
		% crabgrass control		Turf injury	% crabgrass control		Turf injury
Material	Rate/M*	7/10	8/11	7/10	7/10	8/11	7/10
Alanap 1F	18#	0	0	0	0	0	0
Chlordane 5% granular	30#	38	27	0	29	23	0
Chlordane 72% emul.	24 oz.	31	26	0	26	21	0
Crag Herb. No. 1	10 tbl.	0	0	0	0	0	0
Ortho Lawn Pep	20#	0	0	0	0	0	3.0**
PAX	25#	20	23	0	33	31	0

Turf Injury Ratings: 0 - none; 1 - light; 2 - moderate; 3 - severe; 4 - complete kill.

* Rates are label or manufacturer's recommendations.

** Injury evident only on Illahee and Pennlawn red fescue.

Table 2. Post-emergence crabgrass control

Treated June 27, July 7, and July 21, 1958
Plots 8 x 30 feet, unreplicated.

Material	Rate	Percent crabgrass control 7/3	7/14	8/21	Turf discoloration 7/3	7/14	8/1
1. DSMA - liquid	8 oz/M	28	67	95	1.5	1.5	1.0
2a. DSMA - powder	4 oz/M	30	68	93	1.5	1.5	1.0
2b. DSMA - powder*	8 oz/M	33	76	97	3.0	3.0	3.5
3. DSMA - granular	6#/M	10	36	68	1.0	0.5	1.0
4. AMA - liquid	10 oz/M	37	85	91	2.5	2.0	2.0
5. KOCN	12#/A	12	43	65	3.0	2.0	2.0
6. PMAS	3 oz/M	8	67	97**	1.5	2.0	1.5
7. Dammethene	2 oz/M	33	56	90	2.5	3.0	3.0
8a. Niagara 4562	4#/A	10	18	23	2.0	1.5	1.0
8b. Niagara 4562*	8#/A	18	30	80	2.5	3.5	3.5
9a. G-106	½#/A	0	5	5	0.0	0.5	0.5
9b. G-110	½#/A	0	5	5	0.0	0.5	0.0
10a. U-9612	5 gal. of 6000 ppm/M	12	5	5	1.0	0.5	0.5
10b. U-9613	5 gal. of 6000 ppm/M	10	5	5	0.5	0.5	0.5
% crabgrass in checks		87	85	90			
LSD 5%		9	7	6			
1%		13	10	9			

Turf discoloration ratings: 0 - none; 1 - slight; 2 - moderate; 3 - severe; 4 - complete kill.

Percent crabgrass control calculated on basis of percent crabgrass in checks at the time of estimating.

* Two applications only; turf injury too severe to permit a third application.

** Excellent control of crabgrass but no control of <u>Panicum dichotomiflorum</u> also found in this plot.

Table 3. Veronica filiformis control on lawn turf with endothal.

First application July 10, 1957
Second application September 23, 1957

Plots 4 x 25 feet, complete randomized block in triplicate

Pounds actual endothal/A	Gallons per acre	Per cent Veronica control — Time after first treatment: 5 days	2½ mos.	4½ mos.	11 mos.	15 mos.
½	25	30	43	71	68	71
	50	45	70	83	79	83
	100	75	63	85	83	75
1	25	71	71	79	75	70
	50	68	80	89	88	88
	100	83	85	99	92	93
2	25	58	68	91	89	90
	50	80	78	99	98	98
	100	88	88	99	98	98
LSD 5%		15	12	9	9	7
1%		21	16	13	13	10
% Veronica in check		75	70	72	80	80

% Veronica control calculated on the basis of average amount present in each plot prior to treatment.

Table 4. Observations on weed control in turf using 2,4,5-TP and 2,4,5-TP + 2,4-D combination

Treatments applied October 3, 1958 unless otherwise indicated
Observations on 10 marked plants or areas of infestation made on November 5, 1958

	Number of plants or areas observed					
	2,4,5-TP			2,4,5-TP + 2,4-D		
Weed species	Con.	Pro.	No.	Con.	Pro.	No.
Achillea millefolium Yarrow	3*	-	-	-	-	-
Barbarea vulgaris Yellow Rocket	10	-	-	-	-	-
Cerastium vulgatum Mouse Ear Chickweed	7	3	-	-	-	-
Cirsium sp. Thistle	1	8	1	3	7	-
Chrysanthemum leucanthemum Ox-eye Daisy	-	9	1	-	-	-
Daucus carota Wild Carrot	4	6	-	4	6	-
Dipsacus sylvestris Teasel	1	8	1	5	5	-
Nepeta hederaceae Ground Ivy	-	-	10	-	3	7
Plantago lanceolata Narrow Leaved Plantain	-	8	2	7	3	-
Plantago major Broad Leaved Plantain	1	7	2	8	2	-
Prunella vulgaris Self Heal	-	-	10	-	3	7
Rumex crispus Curly Dock	6	4	-	7	3	-
Stellaria graminea Stitchwort	4**	-	-	-	-	-
Stellaria media Common Chickweed	10	-	-	10	-	-
Taraxacum officinale Dandelion	1	8	1	9	1	1
Trifolium repens White Clover	10	-	-	10	-	-
Veronica arvensis	1	5	4	2	6	2
Veronica filiformis	-	-	3***	-	-	-
Veronica serpyllifolia Thyme-leaved Speedwell	1	4	5	3	4	3

* Achillea millefolium control observed on a Long Island home lawn one year after treatment and on two areas on the Cornell Campus grounds six months after treatment.

** Stellaria graminea control noted in trials on Cornell University Golf

VEGETATIVE CONTROL OF WEEDS ON HIGHWAY SLOPES

Fred V. Grau*

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N.E. Weed Control Conference, New York City

In this paper we make no pretense of presenting research data. Rather we shall make simple statements of accomplished facts in practical usage. The vegetation to which we refer in the title, which is so effective in controlling weeds on highway and other slopes, is Crown Vetch, Coronilla varia. The variety which has been responsible for the accomplishments is PENNGIFT.

All slopes present certain difficulties in maintenance. They are more expensive to maintain than level areas. As runoff increases the slopes become more arid. Fertility, low in slope subsoils at best, rapidly decreases by various well-known means. Most slope mistures require periodic maintenance fertilization to provide continuously-satisfactory cover. Weeds that inevitably occur either must be mowed or sprayed. Either method entails extra cost which depletes maintenance funds. Mowing of slopes may start erosion where vegetation is disturbed by equipment which creates ruts when slipping and sliding. Fatal accidents have occurred when equipment has overturned on steep uneven terrains. Spraying reduces hazards to life and property when equipment is kept on the berm. It, too, costs money for machinery, materials and technical skills which affect maintenance budgets. One of the evils of chemical sprays, to many, is the wholesale and unwarranted destruction of beautiful native wild flowers which add charm and grace to otherwise dreary monotonous expanses of grass.

It has been the privilege of the author to have been intimately associated with crown vetch since 1935. In that year we saw steep slopes (1:1) that had been protected for many years with this spreading perennial legume. These same slopes are still covered today without the expenditure of a penny for maintenance. The high degree of freedom from weeds has been an outstanding characteristic.

Beginning in 1947, when a limited quantity of crown vetch seed was produced in Centre County, Pennsylvania, the Pennsylvania Department of Highways established dozens of demonstration plantings of crown vetch on various soils in different parts of the state. Now, 10 years and more later, with no expenditure for maintenance of any kind, these areas present a solid cover of crown vetch with virtually no weeds. Some of the test sites, to name only a few, may be found on U.S. 22 at intervals between Pittsburgh and Allentown; on U.S. 422 near Butler and Newcastle; on slopes near Wellsboro, Tunkhannock and Factoryville, and in the southeast near Westchester. There are many more.

Experimental work begun in 1947, conducted by the Pennsylvania State University in cooperation with the Pennsylvania Department of Highways, has continued to date and has provided valuable data on establishment and competition. The first set of plots was destroyed in a road widening project. The second set established in 1952 has been reported in Science For the Farmer, Vol. V, No. 4, Spring 1958, and continues to provide useful information. A significant portion of the summary from this report is, "At the end of the sixth season (1957) crown vetch was still providing complete slope protection without additional fertilization or other maintenance treatments". Now it is at the end of the seventh season and the slope still is perfectly covered and almost weed free.

Several state highway departments have recognized the ability of crown vetch to control weeds and to reduce maintenance costs. Accelerated planting programs are under way in Pennsylvania, New Jersey, Indiana, and Kansas, to name only a few. To date there has been no report of crown vetch becoming a nuisance like honeysuckle and kudzu vine.

It seems pertinent to suggest ways in which crown vetch controls weeds. It starts growth very early in the spring thus getting a head start on other vegetation. It has been shown to be highly competitive and able to rise above most other plants. There is green growth even during periods of drought which turns most plants brown and dry. Its ability to grow well in almost any type of soil or subsoil gives it an advantage possessed by few other plants. The extensive fibrous and rhizomatous underground system enables crown vetch to occupy areas continuously and aggressively to the detriment of other vegetation. It is suspected that the nitrogen gathered by the associated bacteria may have an effect on weeds that try to compete. The soil becomes covered with a dense mat of leaves and stems which effectively seem to insulate seeds from the soil and which smothers any seedlings that start. The heavy shade of a dense cover of crown vetch is discouraging to all but the most shade tolerant species.

Regardless of the mechanisms by which weed control is accomplished by crown vetch, it remains a fact that, to our knowledge, every undisturbed planting on slopes has remained weed-free throughout its life thus far, without a cent of cost for maintenance. A Pennsylvania District Roadside Engineer who has used crown vetch on all major slope projects made the statement recently that, "I have never seen a crown vetch planting go backwards".

It would seem folly to expect anything more of a plant that controls erosion, chokes weeds and provides zero maintenance. But the crowning attribute of crown vetch, over and above its Utility value, lies in the Beauty of the rose, pink and white blossoms which occur in great masses over a long period of the growing season. The attractive scene presented to the traveler is sufficiently varied so that the stigma of monotony is avoided.

The Kodachrome slides which are a part of this paper present visual proof that weeds are controlled by a solid cover of crown vetch under a system of zero maintenance. To date there have been no complaints of nuisance from adjoining property owners. Based on data and observations accumulated over a period of nearly 25 years, the conclusion may be drawn that the establishment of crown vetch offers a desirable, economical, low-cost vegetativee method of controlling weeds on highway and other slopes.

Combinations of Chemicals for Weed Control in New Alfalfa Seedings

Robert A. Peters and Albert J. Kerkin[1]

Significant progress has been made of late in obtaining weed control in new seedings of forage legumes. Particular interest has been placed on 4, (2,4-DB) for the control of broadleaf weeds and on dalapon for the control of grassy weeds. A logical sequence has been to combine the two chemicals in one treatment to give control of both types of weeds usually found in new seedings.

Neburon has given good broadleaf weed control in some experiments both as a pre-emergence and post-emergence herbicide (2,3,4). Neburon has generally been more effective on broadleaf weeds than on grassy weeds. Adding an herbicide in mixture which is effective on grassy weeds should be investigated.

Procedure:

The experiment was conducted at the University of Connecticut Agronomy Research Farm, Storrs, Connecticut. The experimental design was a randomized block replicated three times with the individual plots measuring 6 by 12 feet. The seeding was made on May 23, 1958 by banding alfalfa - smooth bromegrass with a grain drill at 12 pounds and 6 pounds per acre, respectively.

The chemicals were applied on June 13, 1958. The prevalent species present at the time of spraying and their stages of growth were as follows:

Alfalfa - 1st true leaf stage, a few in the 2nd true leaf stage.
Bromegrass - emerging.
Mustard - 2-3 inches tall and 3-6 inches in diameter.

Also present were common chickweed (Stellaria media), white cockle (Lychnis alba), yellow foxtail (Setaria lutescens), and lesser amounts of ragweed (Ambrosia artemisifolia), and lambsquarter (Chenipodium album). Rainfall during the entire 1958 growing season was more than ample and weed growth was unusually profuse. Grass growth in particular was unusually heavy.

Chemical Treatments:

All rates are given in terms of pounds acid equivalent or active ingredients per acre:

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[1] Associate Agronomist and former Research Assistant, University of Connecticut, Storrs, Connecticut.

1. No chemical
2. No chemical - Handweeded June 16 and July 11, 1958.
3. Neburon 4 plus Dalapon ½.
4. Neburon 4 plus Dalapon 1.
5. 4(2,4-DB) 2 plus Dalapon 1.
6. 4(2,4-DB) ¼.
7. 4(2,4-DB) ½.

The treatments were applied with a bicycle type compressed air sprayer using 40 gallons of solution per acre.

Results:

The treatment effects were based on yields of hand separated components of the samples cut from each plot on August 13, 1958. The yield data are given in Table I. The bromegrass stand was so weak at the time of harvest that no attempt was made to determine yields.

TABLE I

Yields of Alfalfa and Weed Components of New Seedings Two Months Following Treatment

Treatment	Yields in Pounds Per Acre			
	Alfalfa	Grassy weeds	Broadleaf weeds	White cockle
Check	644	956	2998	402
Handweeded check	2202	272	112	0
Neb 4 + Dal ½	1518	1455	514	0
Neb 4 + Dal 1	2206	476	268	0
2;4-DB 2 + Dal 1	666	1410	1053	260
2;4-D ¼	227	2236	435	372
2,4-D ½	100	1923	324	339

The broadleaf component included considerable common chickweed which was not separated out. It was obvious, however, from notes made during the progress of the experiment that the chickweed was controlled on those plots treated with neburon. The control of white cockle by neburon was also quite evident. It was assumed that the neburon rather than the dalapon component of the chemical mixture was the active agent since neither chickweed or white cockle was controlled by the dalapon - 2,4-DB mixture. This is in contrast to a report by Churchill (1) but the cockle was treated at a much younger stage in this experiment. Excellent control of mustard from neburon as previously found was again evident in this experiment (3). Since neburon in a previous experiment showed limited toxicity on grasses, the adequate grass control obtained in this experiment, when combined with the one pound rate of dalapon, would indicate more than an additive effect.

The weed control obtained from the 2,4-DB - Dalapon combination was not as satisfactory as those reported in a previous experiment and no increase in alfalfa yield was obtained (3). This can be related to poor grass control obtained with the one pound rate of dalapon under the conditions of this experiment. This is attributed in part to the frequency of barnyard grass in the stand which is not controlled by the lower rates of dalapon and in part by the unusually favorable conditions for grass growth during 1958. The low yields of alfalfa following the use of 2,4-D can be explained in part by direct chemical toxicity and in part by the increased competition of the grassy weeds released from the competition of the broadleaf weeds killed by the 2,4-D.

Summary:

The experimental evidence given in this paper indicates that a neburon-dalapon combination is promising for early post-emergence weed control in pure stand alfalfa. This treatment gave both grassy and broadleaf weed control including the control of both common chickweed and white cockle. Both of these species are only slightly effected by 2,4-D or 2,4-DB at rates usually used.

The data given again shows the feasibility of obtaining 1 ton yields of alfalfa within two months of the time of seeding.

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Acknowledgement is made to the following companies for supplying the chemicals used in the above experiment: Dow Chemical Company, American Chemical Paint Company, and E.I. Dupont de Nemours and Company.

A Comparison of Pre- and Post-Emergence Herbicidal Treatments for the Establishment of Legume Seedings[1]

R. J. Hull and R. C. Wakefield[2]

Introduction

The recent development of highly selective herbicides has offered considerable promise in the establishment of forage seedings. Research conducted in the Northeast (3,4,5,8,9) has demonstrated that certain post-emergence chemicals can effectively control the major annual weeds normally encountered in forage seedings, without seriously injuring legumes.

More recent work (3) has shown that certain chemicals applied as a pre-emergence spray can give more immediate weed control with almost no injury to alfalfa or birdsfoot trefoil.

Procedure

To further evaluate the effectiveness of certain post-emergence chemicals and to compare these with pre-emergence treatments a test was established on May 14, 1958 on the Agronomy Research Farm.

A split plot design was used with alfalfa (Narragansett - 10 lbs./A) and birdsfoot trefoil (Viking - 5 lbs./A) as the main plots. Post- and pre-emergence herbicidal treatments were randomized within each main plot. Four replications were used with individual plot size being 6 x 16 feet.

In an effort to reduce variability in the weed population, a mixture of weed seed was sown over the area. Foxtail millet (*Setaria italica*) was used as the annual weedy grass. Also seeded were lambsquarters (*Chenopodium album*), pigweed (*Amaranthus retroflexus*), white cockle (*Lychnis alba*), wild radish (*Raphanus raphanistrum*) smartweed (*Polygonum pennsylvanicum*) and wild mustard (*Brassica kaber* These seeds had been harvested the previous year and treated to break dormancy according to methods described by Steinbauer and Grigsby (7).

These weeds constituted 75% of the resulting weed population according to the following percentages of total number of weed plants present:

Grasses	41.2 percent
Lambsquarters	21.6 "
Pigweed	6.4 "

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[1]Contribution No. 963 R.I. Agricultural Experiment Station, Kings-

Smartweed	3.4 percent
White Cockle	1.4 "
Mustard and Wild Radish	0.5 "
Others	25.5 "

The other weeds were mostly chickweed (<u>Stellaria media</u>), wood sorrel (<u>Oxalis stricta</u>) and purslane (<u>Portulaca</u> sp.).

Chemicals were applied in 30 gallons of water per acre with a sprayer similar to that described by Shaw (6). Chemicals and rates used were as follows:

Pre-emergence:

1. Ethyl n,n-di-n-propylthiolcarbamate (EPTC) 6 lbs. A.E./gal.; 4 and 8 lbs. acid equivalent per acre.

2. 3-(3,4-dichlorophenyl-1-methyl-1-n-butylurea), (Neburon), 18.5% active; 2 and 4 lbs. active material per acre.

Post-emergence:

3. 2,2-dichloropropionic acid, sodium salt 74% A.E. (Dalapon); 2 and 4 lbs. acid equivalent per acre.

4. 4(2,4-dichlorophenoxy) butyric acid, dimethyl-amine salt, 2 lbs. A.E./gal. (2,4-DB); 1½ and 3 lbs. acid equivalent per acre.

5. Dinitro-O-sec-Butyl-phenol, alkanalamine salt, 3 lbs. A.E./gal. (DNBP); 3/4 and 1½ lbs. acid equivalent per acre.

6. 2-methyl-4-chlorophenoxyacetic acid, 4 lbs. A.E./gal. (MCPA); 1/8 and 1/4 lbs. acid equivalent per acre.

The time of application of herbicides and stages of plant development were as follows:

a. Pre-emergence - May 19
   Legume species - non appearing
   Broadleaf weeds - germinating
   Grass - non appearing

b. Post-emergence - June 17
   Legumes species 3-4 true leaf stage
   Weeds 2-3 inches high

c. Post-emergence following pre-emergence - July 1
   Alfalfa - 8-10 inches
   Birdsfoot trefoil - 5-6 inches
   Grass weeds - 10-12 inches
   Broadleaf weeds - variable some flowering

The weather at time of pre-emergence spraying was cloudy, warm and humid. The soil was for the most part moist with some areas being considerably drier.

At the time of post-emergence spraying the weather was cool and clear; the soil being moderately dry. Two days following treatment .27 inches of rain fell. On July 1, the time of the follow-up post emergence treatment, the weather was hot and humid with showers occurring in two days.

In order to evaluate the effect of competing plant populations on legumes and establishment, three handweeded check treatments were maintained in addition to an unweeded check and a plot in which oats had been seeded. These check treatments consisted of (1) broadleaf weeds removed (2) grass weeds removed and (3) all weeds removed. Plots were handweeded at the time of first post-emergence spray applications.

The rainfall over the growing season of April through September was 10.63 inches in excess of the long term average. Much of the excess came during the months of July and August. This abundant moisture may have favored the activity of Neburon by washing it into the root zone thereby giving much longer lasting effectiveness than was noted during the dry 1957 season (2) (3). The extremely moist conditions also tended to favor trefoil growth and development but did not appear to be optimum for alfalfa.

All plots were rated for herbicidal effectiveness and injury to legumes at various intervals throughout the season. Stand counts were made using a 2-square foot quadrat at two locations in each plot two weeks following harvest.

Alfalfa plots were harvested on July 31 and October 9. Birdsfoot trefoil was harvested once on August 12. A 38-inch by 14-foot strip was removed from each plot and the green weight determined. Dry matter samples were taken from each plot. Botanical composition was estimated and checked by occasional hand separations.

Plant samples for crown and root observations were dug from 1-square foot areas in each plot on November 5. Tillers per plant were determined for alfalfa and average dry weight per root (clipped to six inches) was determined for both alfalfa and trefoil.

Results and Discussion

Initial Observations

Pre-emergence:

Observations following pre-emergence treatments indicated no at the 4 or 8 lb. rates. Neburon, which showing no injury to alfalfa, did noticeably stunt birdsfoot trefoil particularly at the 4 lb. rate.

Both chemicals gave good control of grass weeds. EPTC, however, did not give as consistent control of the broadleaved weeds as did Neburon.

Later observations showed that EPTC did not have the residual properties of Neburon with many of the plots becoming heavily infested with broadleaved weeds.

Post-emergence:

Observations on injury made at several dates after spraying showed that no chemical applied singly appeared to cause any serious injury to alfalfa. Alfalfa was retarded by some of the combinations. Dalapon at 4 lbs. per acre with MCPA or 2,4-DB resulted in prolonged injury. Dalapon with DNBP gave only temporary injury of little consequence. Birdsfoot trefoil appeared less seriously injured by the combined treatments than the alfalfa. The combinations of Dalapon and MCPA or 2,4-DB did not injure trefoil to the same extent that it did alfalfa.

DNBP killed mustard plants within 3 days of application. Pigweed and lambsquarters were controlled most effectively by 2,4-DB. Smartweed and white cockle appeared somewhat tolerant of all post-emergence chemicals tested. Although requiring two to three weeks to act, Dalapon at 2 lbs./A effectively controlled all grass species present.

The mixture of Dalapon and 2,4-DB applied following a pre-emergence treatment effectively controlled all remaining weeds present but again showed injury on alfalfa.

Effect on Yields

Yields of alfalfa, birdsfoot trefoil, broadleaved and grass weeds are presented in table I.

Alfalfa:

Over one ton of alfalfa was obtained from those plots receiving the pre-emergence Neburon treatments. This constituted a highly significant increase over both the unweeded and hand-weeded checks. Although this treatment resulted in relatively weed-free alfalfa, a follow-up treatment with Dalapon plus 2,4-DB gave best results. Dalapon at 2 lbs. plus 2,4-DB at 1½ lbs. gave yields of weed free forage in significant excess over the unweeded check.

Birdsfoot trefoil:

Table 1. Yields of legumes and weeds following herbicide treatment.

Treatment	Lbs/A Rate	Yields-Tons Dry Matter Per Acre Alfalfa	Birdsfoot Trefoil	Grass Weeds	Broadleaf Weeds
POST-EMERGENCE					
Dalapon	2	.72	.32	.00*	.59*
Dalapon	4	.57	.30	.00	.51
2,4-DB	1½	.49	.24	.44	.04
2,4-DB	3	.62	.26	.51	.02
DNBP	¾	.70	.25	.58	.17
DNBP	1½	.66	.36	.61	.12
MCPA	1/8	.51	.29	.59	.12
MCPA	1/4	.48	.32	.48	.10
Dal. + 2,4-DB	2+1½	.80	.46	.00	.12
Dal. + 2,4-DB	2+3	.69	.58	.01	.09
Dal. + DNBP	2+¾	.70	.54	.04	.29
Dal. + DNBP	2+1½	.84	.34	.00	.21
Dal. + 2,4-DB	4+1½	.48	.39	.01	.10
Dal. + 2,4-DB	4+3	.55	.48	.00	.09
Dal. + DNBP	4+¾	.72	.62	.00	.24
Dal. + DNBP	4+1½	.74	.38	.00	.15
Dal. + MCPA	4+1/8	.50	.38	.00	.29
Dal. + MCPA	4+¼	.42	.38	.00	.21
PRE-EMERGENCE					
Neburon	2	1.08	.72	.25	.12
Neburon	4	1.13	.82	.07	.05
EPTC	4	.64	.33	.11	.75
EPTC	8	.77	.63	.07	.49
PRE AND POST-EMERGENCE (Dal. 4+2,4-DB 1½, 43 days after pre-em)					
Neburon	2	.84	.71	.04	.01
Neburon	4	1.04	.72	.01	.00
EPTC	4	.42	.52	.00	.14
EPTC	8	.74	.37	.02	.17
CHECK TREATMENTS					
Oats		.46	.22	1.03**	.19
Unweeded		.48	.23	.60	.41
Grass Removed		.62	.28	.04	.74
Broadleaf Weeds Rem.		.51	.31	.67	.01
All Weeds Removed		.80	1.03	.01	.08
LSD (P = .05)		.27	.25	.13	.16

treatment, however, was able to equal the yield obtained from the handweeded check. Dalapon combined with 2,4-DB (at 3 lb.) or DNBP (at 3/4 lb.) resulted in yields significantly greater than the unweeded check.

Yields of grass-type and broadleaf weeds:

As shown in table 1, all treatments involving Dalapon significantly controlled grass weeds. Neburon gave good grass control, particularly at 4 lbs./A. EPTC was effective at both 4 and 8 lbs./A.

The most consistent broadleaf weed control was obtained from 2,4-DB and Neburon although both MCPA and DNBP also significantly reduced weed yields below that of the unweeded check. EPTC proved quite erratic in its effectiveness against broadleaf weeds and resulted in weed yields comparable to those of the check from which all grass had been handweeded. The reduced broadleaf weed yields of both the oats and unweeded checks show the influence of heavy grass stands in suppressing the growth of other weeds. The reduced yields of legume from these plots could be attributed to the same factor of excessive grass competition.

Plant Counts

Data on stand counts, expressed as plants per square foot, will be found in table II.

Alfalfa:

Pre-emergence applications of Neburon with or without a follow-up treatment resulted in a highly significant increase in stand. This was probably due to effective control of weeds at emergence. Seedling weeds although controlled post-emergence by several chemicals apparently resulted in stand suppression. Similarly the check plots, handweeded at time of post-emergence spraying failed to maintain a stand comparable to the Neburon plots. Effective weed control during the first month of legume establishment would seem to be important from the results obtained in this experiment.

Birdsfoot trefoil:

No treatment gave a significant increase in legume stand over the unweeded check. This was undoubtedly due to excellent growing conditions during the 1958 season. As was indicated in the Initial Observations, Neburon, particularly at the 4 lb. rate, significantly reduced trefoil stands below that of the check plots.

Root Data

Root measurements taken from one square foot per plot are

Table 2. Stand counts and root measurements of alfalfa and birdsfoot trefoil following herbicide treatments.

		Alfalfa			Birdsfoot Trefoil	
Treatment	Lbs/A Rate	Plants /sq.ft.	Tillers /Plant	Root Wt. /Plant (gms.)	Plants /sq.ft.	Root Wt. /Plant (gms.)
POST-EMERGENCE						
Dalapon	2	23.0	5.2	.37	17.5	.59
Dalapon	4	22.9	5.3	.40	19.2	.67
2,4-DB	1½	21.2	4.7	.41	17.4	.60
2,4-DB	3	23.6	5.0	.42	20.0	.73
DNBP	¾	26.2	4.9	.38	17.0	.72
DNBP	1½	22.1	5.3	.52	18.6	.73
MCPA	1/8	18.6	4.6	.34	19.7	.65
MCPA	1/4	19.2	4.7	.36	18.4	.63
Dal. + 2,4-DB	2+1½	24.1	4.8	.42	18.0	.84
Dal. + 2,4-DB	2+3	22.8	5.0	.46	19.2	.79
Dal. + DNBP	2+¾	23.1	4.5	.36	19.0	.61
Dal. + DNBP	2+1½	22.2	5.8	.52	17.0	.51
Dal. + 2,4-DB	4+1½	23.2	5.0	.35	18.3	.90
Dal. + 2,4-DB	4+3	21.0	5.3	.43	20.8	.68
Dal. + DNBP	4+¾	23.6	4.7	.38	15.0	.98
Dal. + DNBP	4+1½	24.4	5.3	.40	17.2	.99
Dal. + MCPA	4+1/8	22.7	5.6	.48	17.2	.54
Dal. + MCPA	4+¼	21.4	4.5	.32	16.5	.68
PRE-EMERGENCE						
Neburon	2	26.1	6.1	.59	15.0	1.04
Neburon	4	27.8	5.3	.43	8.6	1.77
EPTC	4	22.8	5.7	.49	19.0	.61
EPTC	8	24.8	5.7	.52	20.0	.73
PRE AND POST-EMERGENCE (Dal. 4+2,4-DB 1½, 43 days after pre-em)						
Neburon	2	27.3	6.9	.59	14.6	.96
Neburon	4	28.6	6.4	.57	8.6	2.30
EPTC	4	22.7	4.1	.28	18.8	.68
EPTC	8	25.2	5.2	.40	19.9	.81
CHECK TREATMENTS						
Oats		22.0	5.2	.35	18.6	.69
Unweeded		21.0	4.0	.28	19.0	.80
Grass Weeds Removed		22.9	4.4	.38	18.3	.59
Broadleaf Weeds Rem.		20.6	5.0	.40	19.9	.68
All Weeds Removed		25.2	4.9	.51	22.2	.72
LSD (P = .05)		4.6	N.S.	.17	3.4	.38

Alfalfa:

Root weight per plant was selected as a measure to compare the relative size of plants resulting from the various treatments. Again the pre-emergence treatments were shown to be generally superior. Neburon particularly with a follow-up post-emergence treatment, resulted in an average root weight per plant which was significantly greater than the unweeded check. EPTC, resulted in a significantly greater root weight per plant when used alone but failed to do so when followed by Dalapon and 2,4-DB. This may be explained in part as a result of the erratic behavior of the chemical. Greater average root weights also resulted from the use of DNBP at 1 1/2 lbs. per acre alone and in combination with Dalapon at 2 lbs. per acre. The latter case at least agrees with the significantly higher yields obtained from the plots.

Although no significance was determined, data on tillers per plant showed close agreement with the figures on root weight per plant.

Birdsfoot Trefoil:

Neburon applied alone and with a follow-up treatment of Dalapon plus 2,4-DB resulted in an average root weight of birdsfoot trefoil far greater than the check plots. This was true in spite of a reduced number of plants per square foot due to this treatment. These results indicate the importance of weed-free conditions for optimum development of birdsfoot trefoil.

The value of a comparatively small number of large, well established plants going into the first winter as compared with a large number of poorly developed plants can be determined only when subsequent years' performance have been determined. It would appear that in the light of greater ability to survive and compete with other plants this small number of sizable plants will have a decided advantage in producing a permanently productive stand.

Summary

Pre- and post-emergence herbicides applied alone and in combinations were evaluated on spring seedings of alfalfa and birdsfoot trefoil during the 1958 season.

Excellent weed control was obtained with Neburon applied pre-emergence at 2 or 4 lbs./A although 4 lbs. was required for best control of grass-type weeds. Highest yields of usable forage were obtained with Neburon. Alfalfa was particularly responsive to this treatment and yields exceeded those of the handweeded check treatment. Neburon significantly reduced populations of birdsfoot trefoil, particularly at the 4-pound rate. However, surviving plants developed rapidly in the absence of weed competition and yields of forage were significantly greater than the unweeded check treatment. Neburon at the lower rate

(2 lbs./A) followed by a post-emergence application of Dalapon (4 lbs./A) plus 2,4-DB (1 1/2 lbs./A) effectively controlled all weeds.

EPTC controlled grass-type weeds but was inconsistent with broadleaf weeds, results varying from good to poor.

Control of most broadleaf and grass-type weeds was obtained with post-emergence applications of Dalapon at 2 or 4 lbs./A plus 2,4-DB at 1 1/2 or 3 lbs./A but with some injury to alfalfa. Neither chemical was satisfactory when used alone.

DNBP and MCPA applied alone or with Dalapon were not satisfactory because of ineffective broadleaf weed control. MCPA also resulted in some injury to alfalfa.

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Yields of Legume-forage Grass Mixtures as Affected by Several Herbicides Applied Alone and in Combinations During Establishment.

Warren E. Wells and Robert A. Peters[1]

Introduction

Recent investigations have shown some new materials to be selective in pure stands of grasses or legumes (1,2,4). Mixtures of grasses and legumes are more commonly used commercially than are pure stands. The next logical step is the development of herbicide treatments which will selectively remove both broadleaf and grassy weeds from legume and perennial grass mixtures.

Greenhouse Experiment

Materials and Methods

The experiment was conducted during the spring of 1958. A split plot design was used with three replications for each legume-forage grass mixture. Plants were grown in #10 cans in soil which had a uniform high level of fertility.

The legume-forage grass species were:

Vernal alfalfa - Lincoln smooth bromegrass
Viking trefoil - Timothy
Ladino clover - Orchard grass

Rough pigweed (Amaranthus retroflexus) was sown in alfalfa-brome pots to provide a measure of weed control. Stands of all species were thinned to a uniform number after emergence.

Chemical treatments were applied March 1, 1958 by pushing a sprayer similar to that designed by Shaw (3) over the pots. Legumes were in the 2-4 true leaf stage, while the forage grasses were 2" tall. Pigweed was in the 2nd true leaf stage.

The chemicals used in the greenhouse experiment and in a summer seeded field experiment are shown in Table 1. All materials were applied in 40 gallons of water per acre.

Notes on observations were made throughout the experiment. Density of stand ratings were made 1 month after spraying. Yields were taken May 14, 1958 based on hand separations of each species. Duncan's multiple range test was used to compare the treatment averages at the .05 level.

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[1]Research Assistant and Associate Agronomist, respectively, University of Connecticut, Storrs, Connecticut.

TABLE 1. Chemicals Used in Greenhouse and Field Experiments.

Common Name	Chemical Name	Source
Dalapon	2,2-dichloropropionic acid, sodium salt	Dow
4(2,4-DB)	4(2,4-dichlorophenoxybutyric acid) diethylamine form	Amchem
Neburon	3-(3,4 dichlorophenyl-1-methyl-1-N-butylurea)	Dupont
Diuron	3(3,4-dichlorophenyl)-1,1-dimethylurea	Dupont
Simazine	(2-chloro-4-6 bis(ethylamino)-3-triazine)	Geigy
CIPC	isopropyl N-(3-chlorophenyl) carbamate	Amchem

Effects on Yields

Yield data based on hand separations of the species is given in Table 2. In general, yield data agrees with the density ratings as to the trend over the various rates of each chemical.

Alfalfa-Brome

A comparison of all rates of each chemical indicates that Neburon treatments gave greatest yield of both species combined. Alfalfa yields were greater than the check while brome yields were only slightly less than the check. Dalapon, dalapon + 2,4-DB 3/4, dalapon + 2,4-DB 1½, and dalapon + neburon all had fairly good alfalfa yields but poor brome yields. Neburon + 2,4-DB treatments showed a greater than check brome yield, but a much reduced alfalfa yield.

Individual treatments compared at the .05 level indicated significantly higher yields of alfalfa at the 4# rate of neburon, while significantly lower yields of brome occurred at the high rate of dalapon (4#) and the medium and high rates of dalapon + neburon.

Pigweed

Significant reduction in yields of pigweed occurred with all chemicals except the 1 and 2 lb. rates of dalapon, dalapon + 2,4-DB (2+3/4), and the dalapon + 2,4-DB (4+1½). Lack of pigweed control with dalapon alone was expected although the higher rates do exhibit some control of this weed. Some variation in pigweed stands was noticed. Experience has shown that the choice of short day weeds for greenhouse experiments was a poor one due to maturity of the weeds while still very small.

Trefoil-Timothy

Yields of trefoil-timothy were best under dalapon, and dalapon + 2,4-DB 3/4 treatments. As was noted in the density ratings, timothy showed a marked tolerance to dalapon and this is expressed in yields. Birdsfoot trefoil also showed

TABLE 2. Yields of Legume-forage Grass Mixtures and Weeds Following Early Post-emergence Treatment with Herbicides.

Greenhouse Experiment

Yield in grams oven dry per plot

Treatment	Rate	Alfalfa	Brome	Pigweed	BFT	Timothy	Ladino	Orchard
Dalapon	1	4.3	2.3	1.3	3.3	4.3	7.3	3.3
Dalapon	2	4.0	1.6	1.6	2.6	4.3	5.3	4.3
Dalapon	4	5.0	.6*	.6*	4.0	2.6	3.3	2.0
Dalapon+2,4-DB	1+3/4	4.3	1.3*	0*	3.0	4.6	5.0	4.0
Dalapon+2,4-DB	2+3/4	5.0	2.3	1.3	3.3	4.6	6.3	2.6
Dalapon+2,4-DB	4+3/4	4.6	1.6	1.0*	2.3	4.0	3.0	4.6
Dalapon+2,4-DB	1+1½	6.6	2.3	0*	2.0	5.0*	6.0	3.6
Dalapon+2,4-DB	2+1½	3.0	2.6	.3*	1.3	5.0*	3.6	3.6
Dalapon+2,4-DB	4+1½	3.3	2.0	1.3	.6*	5.3*	3.6	3.6
Neburon	2	4.6	2.6	0*	1.6	4.3	6.0	4.3
Neburon	4	8.6*	2.3	.3*	1.6	4.6	4.3	3.3
Neburon	8	5.0	3.6	.3*	2.0	2.6	3.0	1.6
Neburon+2,4-DB	2+3/4	1.3	3.6	0*	0.5*	4.6	4.0	3.6
Neburon+2,4-DB	4+1½	1.1	3.3	0*	0.3*	3.3	1.0*	3.0
Neburon+2,4-DB	8+3	1.6	3.3	0*	0.3*	2.3	0*	5.0
Dalapon+Neburon	2+2	2.3	3.3	0*	0.8	4.6	0*	4.0
Dalapon+Neburon	2+4	5.3	1.3*	0*	0.3*	3.3	0*	3.0
Dalapon+Neburon	2+8	5.0	1.3*	0*	0.0*	3.0	0*	1.1
Diuron	½	5.0	3.0	0*	4.6	1.3*	.6*	0
Diuron	1	3.0	3.3	0*	4.3	0*	0*	0
Diuron	2	3.0	2.6	0*	2.0	0*	0*	0
Check-Normal		4.6	3.0	2.0	2.6	3.3	7.0	2.3
Average of all rates of each chemical								
Dalapon		4.4	1.5	1.2	3.3	3.7	5.3	3.2
Dalapon+2,4-DB 3/4		4.6	1.7	0.8	2.9	4.4	4.8	3.7
Dalapon+2,4-DB 1½		4.3	2.3	0.5	1.3	5.1	4.4	3.9
Neburon		6.1	2.8	0.2	1.7	3.8	4.4	3.1
Neburon+2,4-DB		1.3	3.4	0.0	0.4	3.4	1.6	3.9
Dalapon+Neburon		4.2	2.0	0.0	0.4	3.6	0.0	2.7
Diuron		3.6	3.0	0.0	3.6	0.4	0.2	0.0

* Denotes significance from check at .05 level.

a tolerance to dalapon and to the dalapon + 2,4-DB treatments. Individual treatments showed significantly lower trefoil yields for neburon + 2,4-DB, the medium and high rates of dalapon + neburon and the high rates of dalapon + 2,4-DB 1½. Significantly lower yields of timothy occurred under all diuron treatments. The significantly higher yields of timothy under all rates of dalapon + 2,4-DB 1½ can be explained in part by the reduced stand of trefoil, resulting in less competition to the timothy stands.

Ladino-Orchard

Yields of these species again closely followed the pattern established in the density ratings. Dalapon, dalapon + 2,4-DB 3/4, and dalapon + 2,4-DB 1½, were the best treatments in that order. Significantly lower yields of ladino occurred under the medium and high rates of neburon + 2,4-DB and all rates of dalapon + neburon, and diuron. There were no significant differences in orchard grass yields, although diuron treatments completely eliminated orchard grass stands at all rates.

Field Experiment

Materials and Methods

A field experiment was established August 28, 1957. A randomized block design was used with four replicates for each legume-forage grass mixture. The individual plot size was 6½ x 6½ feet.

The forage species seeded were as follows:

Vernal alfalfa - Lincoln smooth brome
Viking trefoil - Timothy
Ladino clover - Orchard grass

All seedings were broadcast seedings made with a grain drill. No weed species were seeded since a desirable volunteer weed stand was expected. A high uniform level of fertility was established.

The chemicals were applied September 25, 1957, with a sprayer modeled after that designed by Shaw (3). At the time of application of the chemicals, the legumes were in the 2-4 true leaf stage and the forage grasses were 2-3 inches tall. The volunteer weed population consisted primarily of common and mouse-eared chickweed, and scattered lambsquarter and red sorrel plants. Weather at the time of application was clear and cool.

Stand counts were made before and after spraying. Stand counts before spraying were made in check plots in each replication, and these were taken to represent the stand of the entire field. Post spraying stand counts were made October 23, 1958, 28 days after spraying. Density of stand ratings were also made to supplement observation and stand counts. Stand counts were again made May 9, 1958 to give an indication of overwintering.

First cutting yields were obtained June 23, 1958. Plots were harvested by mowing a 39" swath through the center of each plot and yields were based on hand separation of a sub-sample of each plot. A second cutting was made August 18,

1958. Ladino-orchard plots were not harvested since the stand did not overwinter due to insufficient time for establishment between seeding and winter 1957-1958. Treatment averages for stand counts and yields were compared at the .05 level using Duncan's Multiple Range test.

Results and Discussion

Fall Stand Counts

Fall stand counts given in Table 3 did not show appreciable differences in stands for most species. Alfalfa, brome and birdsfoot trefoil stands showed no significant differences from the check. Timothy stands were significantly lower at the 2 and 4 pound rate of simazine, the medium and high rates of dalapon + 2,4-DB, and at the high rate of CIPC. Ladino stands were significantly lower at the 4 pound rate of simazine, the high rate of neburon + 2,4-DB, and the medium and high rates of dalapon + neburon. Orchard stands were significantly lower at all rates of simazine, the high rates of dalapon + 2,4-DB and neburon + 2,4-DB, the low and medium rates of dalapon + neburon, and the medium and high rates (2 and 4 pounds) of CIPC.

A comparison of chemicals (average of all rates) indicates no appreciable difference in stands of alfalfa. Brome stands were somewhat greater under nebu-ron and neburon + 2,4-DB, and clearly lower with dalapon + neburon treatments. Trefoil stands were lower with neburon + 2,4-DB treatments. Timothy stands were sharply reduced by simazine treatments, while some reduction of stand occurred with dalapon + 2,4-DB and CIPC largely attributed to the higher rates. Ladino-orchard stands were greatly reduced with simazine and dalapon + neburon treatments. Dalapon + 2,4-DB, neburon, neburon + 2,4-DB, and CIPC showed the most promise on ladino, while orchard stands generally appeared better with neburon and neburon + 2,4-DB treatments.

Spring Stand Counts

Spring stand counts given in Table 4, were taken to ascertain differences in overwintering as related to establishment. All species showed greater differences smong treatments than was evidenced in the fall counts. Due to slower activity of the herbicides at this time of year, fall counts did not show the eventual effects on establishment. The spring stand counts definitely related establishment to herbicidal treatments.

Alfalfa stands were significantly reduced by Simazine (4 pounds), dalapon + 2,4-DB 1½+2 and 3+2, and CIPC at the 4 pound rate. Simazine and dalapon + 2,4DB at all rates showed step by step decrease in stands with increasing rate, while neburon treatments were all higher than the check but not significantly so.

Brome stands were significantly lower with the 4 pound rate of simazine, dalapon + 2,4-DB 1½+2 and 3+2, all rates of dalapon + neburon, and the 4 pound rate of CIPC. Brome stands were best under neburon and neburon + 2,4-DB treatments.

Weed stands in alfalfa-brome were significantly lower than the check in all treatments except the three rates of dalapon + 2,4-DB, neburon + 2,4-DB, 4+2, and

TABLE 3. Fall Stands of Legume-forage Grass Mixtures Following Early Post-Emergence Treatment with Herbicides.

		Stand Counts Per 2 Sq. Ft. Quadrat					
Treatment	Rate	Alfalfa	Brome	BRT	Timothy	Ladino	Orchard
Simazine	1	38	14	19	29	9	5*
Simazine	2	40	13	15	23*	8	1*
Simazine	4	31	10	22	13*	3*	1*
Dalapon+2,4-DB	3/4+2	34	16	15	38	20	7
Dalapon+2,4-DB	1½+2	31	8	17	27*	12	6
Dalapon+2,4-DB	3+2	31	11	12	15*	12	2*
Neburon	2	34	15	17	39	20	10
Neburon	4	35	15	19	37	19	9
Neburon	8	34	13	18	37	9	6
Neburon+2,4-DB	4+1	29	16	14	36	15	7
Neburon+2,4-DB	4+2	33	13	14	35	9	8
Neburon+2,4-DB	4+4	32	17	12	39	5*	5*
Dalapon+Neburon	1½+2	37	5	16	36	10	4*
Dalapon+Neburon	1½+4	31	9	16	33	4*	4*
Dalapon+Neburon	1½+8	38	7	13	34	3*	6
CIPC	1	31	11	18	29	21	6
CIPC	2	34	11	20	35	15	5*
CIPC	4	30	8	16	24*	18	4*
Check-Normal		35	11	19	38	18	10
Average of all rates of each chemical							
Simazine		36	12	19	22	7	2
Dalapon+2,4-DB		32	12	15	27	15	5
Neburon		34	14	18	38	16	8
Neburon+2,4-DB		31	15	13	37	10	7
Dalapon+Neburon		35	7	15	34	6	5
CIPC		32	10	18	29	18	5

* Denotes significance from check at .05 level.

TABLE 4. Spring Stand of Legume-forage Grass Mixtures Following Early Post-Emergence Treatment with Herbicides.

Stand Counts Per 2 Sq. Ft. Quadrat

Treatment	Rate	Normal + Heaved Alive Alfalfa	Brome	Weeds in Alf-Brome	BFT	Timothy	Weeds in BFT-Tim
Simazine	1	14.25	8.25	0.00*	0.00*	5.75*	0.00*
Simazine	2	9.00	4.75	0.25*	0.00*	0.00*	0.00*
Simazine	4	1.75*	0*	0.25*	0.00*	0.00*	0.00*
Dalapon+2,4-DB	3/4+2	14.75	7.25	3.75	8.25	22.50	2.25
Dalapon+2,4-DB	1½+2	3.25*	.75*	6.00	3.75*	21.75	4.25
Dalapon+2,4-DB	3+2	0.00*	0*	4.25	.25*	19.25	3.50
Neburon	2	19.75	10.50	1.75*	9.75	19.00	.50*
Neburon	4	20.00	12.00	.50*	10.25	18.00	.75*
Neburon	8	18.50	8.25	.75*	1.50*	17.00	.25*
Neburon+2,4-DB	4+1	17.00	11.00	1.25*	2.50*	18.00	1.00
Neburon+2,4-DB	4+2	15.25	9.00	3.00*	4.00*	21.75	.50*
Neburon+2,4-DB	4+4	13.25	13.50	.50*	1.50*	21.50	1.00
Dalapon+Neburon	1½+2	9.50	.50*	.75*	3.00*	20.00	0.00*
Dalapon+Neburon	1½+4	10.75	2.00*	.50*	0.00*	19.00	0.00*
Dalapon+Neburon	1½+8	8.50	0.00*	.50*	1.25*	19.25	0.00*
CIPC	1	15.50	5.25	3.00	1.75*	7.50*	1.25
CIPC	2	19.25	4.25	.50	.25*	2.75*	0.00*
CIPC	4	3.75*	2.00*	0.00*	0.00*	0.00*	0.00*
Check-Normal		14.75	8.75	5.75	10.75	16.75	2.25
Average of all rates of each chemical							
Simazine		8.33	4.33	.17	0.00	1.92	0.00
Dalapon+2,4-DB		6.00	2.66	4.66	4.08	21.17	3.33
Neburon		19.41	10.25	1.00	7.17	18.00	0.50
Neburon+2,4-DB		15.16	11.17	1.58	2.66	20.42	0.83
Dalapon+Neburon		9.58	0.83	0.58	1.42	19.42	0.00
CIPC		12.83	3.83	1.16	0.66	3.42	0.42

* Denotes significance from check at .05 level.

the low rate of CIPC. The high weed population with all rates of dalapon + 2,4-DB is attributed to reduced competition from alfalfa-brome, and to lack of injury from this herbicide combination.

Trefoil stands were significantly lower than the check for all treatments except the low rate of dalapon + 2,4-DB, and the 2 pound and 4 pound rates of neburon. Simazine at all rates was particularly hard on trefoil. Trefoil stands in general appeared to be handicapped by an unfavorable balance with timothy, resulting in excessive competition from the vigorous timothy stands.

Timothy counts were significantly lower with all rates of simazine, and all rates of CIPC. Dalapon + 2,4-DB, neburon, neburon + 2,4-DB, and dalapon + neburon treatments at all rates showed stands slightly greater than the check.

Weed populations in trefoil-timothy stands were very similar to weed populations in alfalfa-brome stands. None of the rates of dalapon + 2,4-DB were significantly lower than the check.

Effects on Yields

Yield data for the first cutting in the year following seeding is presented in Table 5. Alfalfa yields were significantly lower than the check at the 2 and 4 pound rate of simazine, $1\frac{1}{2}$+2 and 3+2 pound rate of dalapon + 2,4-DB, $1\frac{1}{2}$+8 pound rate of dalapon + neburon, and the 4 pound rate of CIPC. All rates of neburon, and the 1 and 2 pound rates of CIPC were higher than the check.

The 2 and 4 pound rates of simazine, $1\frac{1}{2}$+2 and 3+2 pound rate of dalapon + 2,4-DB, all rates of dalapon + neburon and the 2 and 4 pound rate of CIPC reduced yields of brome significantly from the check. Neburon and neburon + 2,4-DB treatments had yields of brome generally higher than the check although not significantly.

Weed yields in all plots for the first cutting were primarily common and mouse-eared chickweed. Lowered weed yields occurred from simazine, neburon, dalapon + neburon, and CIPC treatments. Chickweed appears to be resistant to 2,4-DB as it is to 2,4-D.

Trefoil yields were noticeably low for all treatments, resulting from excessive competition from timothy stands. All treatments except the low and medium rates of dalapon + 2,4-DB, and neburon showed significantly lower yields than the check. Simazine was extremely active on both trefoil and timothy stands, eliminating all vegetation or reducing the stand to only a few stunted plants.

Timothy yields generally followed the pattern of trefoil. The low and medium rates of dalapon + 2,4-DB, neburon, and the medium rate of neburon + 2,4DB were the only treatments not significantly lower than the check. It appears that timothy may have even competed with itself in some cases due to its extremely heavy population.

Second Cutting Yields

Second cutting yields showed less variation between treatments than first

TABLE 5. First Cutting Yields of Late Summer Seeded Legumes-forage Grass Mixtures Following Herbicide Treatments.

Yields - Pounds Oven-dry Per Acre

Treatment	Rate	Alfalfa	Brome	Weeds in Alf-Brome	BFT	Timothy	Weeds in BFT-Tim
Simazine	1	376	1428	103*	0*	0*	0*
Simazine	2	57*	145*	1*	0*	0*	0*
Simazine	4	0*	0*	0*	0*	0*	0*
Dalapon+2;4-DB	3/4+2	505	2634	572*	77	5959	113
Dalapon+2;4-DB	1½+2	103*	150*	567*	60	5274	57*
Dalapon+2,4-DB	3+2	1*	42*	124*	15*	1722*	69*
Neburon	2	1165	2696	144*	62	5743	67*
Neburon	4	1041	2701	207*	72	5701	15*
Neburon	8	959	1603	82*	14*	3598*	5*
Neburon+2;4-DB	4+1	583	2769	452*	19*	4093*	32*
Neburon+2;4-DB	4+2	531	2882	248*	16*	4861	19*
Neburon+2,4-DB	4+4	567	2356	216*	5*	3758*	31*
Dalapon+Neburon	1½+2	485	181*	98*	23*	3925*	4*
Dalapon*Neburon	1½+4	593	129*	407*	8*	3598*	0*
Dalapon+Neburon	1½+8	217*	52*	5*	0*	3098*	0*
CIPC	1	1418	1248	521*	5*	1510*	57*
CIPC	2	1294	521*	86*	37*	278*	12*
CIPC	4	175*	52*	40*	0*	0*	0*
Check-Normal		897	2036	846	124	6454	206
Average of all rates of each chemical							
Simazine		144.33	524.33	34.66	0	0	0
Dalapon+2,4-DB		203.00	942.00	421.00	50.66	4318.33	79.66
Neburon		1055.00	2333.33	144.33	49.33	5014.00	29.00
Neburon+2,4-DB		560.33	2669.00	305.33	13.33	4237.33	27.33
Dalapon+Neburon		431.66	120.66	170.00	10.33	3540.33	1.33
CIPC		962.33	607.00	215.66	42.00	596.00	23.00

* Denotes significance from check at .05 level.

TABLE 6. Second Cutting Yields of Late Summer Seeded Legume-Forage Grass Mixtures Following Herbicide Treatments.

		Yields - Pounds Oven-dry Per Acre					
Treatment	Rate	Alfalfa	Brome	Weeds in Alf-Brome	BFT	Timothy	Weeds in BFT-Tim
Simazine	1	1252	910	117	85*	193*	135
Simazine	2	748	275*	4	0*	0*	0
Simazine	4	109*	6*	39	0*	0*	0
Dalapon+2,4-DB	3/4+2	1320	761	383	411	584	15
Dalapon+2,4-DB	1½+2	208*	123*	1582*	166*	916	32
Dalapon+2,4-DB	3+2	44	7*	1709*	122*	699	112
Neburon	2	1858	630*	214	365	953	13
Neburon	4	1702	761	212	321	698	67
Neburon	8	1443	988	18	33*	861	107
Neburon+2,4-DB	4+1	1617	877	129	39*	700	14
Neburon+2,4-DB	4+2	1196	1188	81	133*	812	81
Neburon+2,4-DB	4+4	1650	761	241	18*	715	36
Dalapon+Neburon	1½+2	1627	134*	652	202*	892	34
Dalapon+Neburon	1½+4	1554	229*	250	47*	772	135
Dalapon+Neburon	1½+8	1586	149*	239	29*	1045	24
CIPC	1	1823	273*	624	118*	642	811*
CIPC	2	2511*	182*	749	104*	735	975*
CIPC	4	1250	82*	1390*	123*	13*	2075*
Check-Normal		1228	1077	206	535	790	134
Average of all rates of each chemical							
Simazine		703.00	397.00	53.33	28.33	64.33	45.00
Dalapon+2,4-DB		524.00	297.00	1224.66	233.00	733.00	53.00
Neburon		1667.66	793.00	148.00	239.66	837.33	62.33
Neburon+2,4-DB		1487.66	942.00	150.33	63.33	742.33	43.66
Dalapon+Neburon		1589.00	170.66	380.33	92.66	903.00	64.33
CIPC		1861.33	179.00	921.00	115.00	463.33	1287.00

* Denotes significance from check at .05 level.

harvest again proved the most promising, while the poorer treatments were generally lowest in yield. These data are given in Table 6.

Alfalfa-brome yields were lowered with increasing rates of both simazine and the dalapon + 2,4-DB combination. Brome yields were significantly lower with all rates of dalapon + neburon, and CIPC. The two pound rate of CIPC gave yields significantly higher than the check which cannot be adequately explained.

Weed yields were significantly higher with the medium and high rates of dalapon + 2,4-DB, and the 4 pound rate of CIPC. All other treatments showed no significant differences in weed yields. Weed yields in trefoil-timothy stands were also significantly higher with all rates of CIPC. Weed yields in these treatments showing significant increase was due to the influx of volunteer witchgrass (Panicum capillare). Lessened competition from the chickweed, legume, or forage grass allowed witchgrass to develop rapidly. Simazine treatments suppressed the encroachment of volunteer weeds due to the residual herbicide in the soil.

Comparison of trefoil-timothy yields showed that all treatments except the low rate of dalapon + 2,4-DB, and the 2 and 4 pound rate of neburon were significantly lower than the check.

Timothy yields were significantly lower for all rates of simazine, and the 4 pound rate of CIPC.

Summary

Alfalfa-Brome

1. Post-emergence neburon treatments gave the highest yield of alfalfa-bromegrass and resulted in a low weed yield in both greenhouse and field experiments. Rates of two and four pounds showed no injury to either species, while the eight pound rate depressed both alfalfa and bromegrass yields slightly.
2. Neburon + 2,4-DB in both experiments proved to be injurious to alfalfa at all rates while showing no tixicity to bromegrass.
3. Dalapon + neburon treatments in the greenhouse test appeared to be non-injurious to alfalfa while lowering bromegrass yields. In contrast, results from the field experiment indicate that the higher rates reduced alfalfa while bromegrass yields were reduced by all rates of this combination.
4. Results of dalapon + 2,4-DB treatments on alfalfa-bromegrass are also contrasting. This combination in the field experiment significantly reduced alfalfa yields but did not in the greenhouse test. Bromegrass yields were reduced in both tests.
5. Simazine, while giving excellent weed control, proved to be severe on both alfalfa and bromegrass.
6. CIPC at 1 and 2 pounds per acre was not injurious to alfalfa. The 4 pound rate reduced yields significantly. Bromegrass yields were reduced with all rates.

Birdsfoot trefoil-Timothy

7. Trefoil-timothy yields show a selectivity to dalapon + 2,4-DB treatments at the low and medium rates. The high rates in both tests significantly reduced

8. Mixtures containing neburon, namely, neburon + 2,4-DB and dalapon + neburon treatments in both tests lowered trefoil yields significantly. Their effect on timothy is conflicting since yields in the field were significantly reduced while yields in the greenhouse were slightly greater than the check.
9. Neburon treatments in the field showed more promise than the results of the greenhouse test indicate. Only at the 8 pound rate were yields of trefoil-timothy reduced significantly from the check.
10. Simazine and CIPC proved too severe for safe use on trefoil-timothy. All plants were killed with the 2 and 4 pound rates of simazine. Only a few escaped complete kill at the 1 pound rate of simazine.
11. Neburon and mixtures containing neburon gave good chickweed control as did CIPC.
12. Fall stand counts did not correlate well with yields the following spring; however, good correlation was noted between spring stand counts (after overwintering) and first cutting yields. Forage species injured from herbicide treatments in the late summer seeding did not have sufficient time to recover before winter dormancy.
13. Mixtures including dalapon, namely dalapon + neburon and dalapon + 2,4-DB combinations were not promising on alfalfa in this summer seeding. Other experiments point out this effect which is in contrast to the results which have been reported on many spring seedings. Alfalfa yields were greatest with neburon treatments, while bromegrass yields were greatest with the neburon + 2,4-DB treatments.
14. The most promising chemicals for trefoil-timothy stands were dalapon + 2,4-DB and neburon. The combination of dalapon + 2,4-DB gave slightly higher yields of trefoil than did neburon, while neburon gave slightly higher yields of timothy in the field experiment.
15. Low rates of dalapon + 2,4-DB appear to offer the most promise for ladino-orchard stands. Diuron was noticeably toxic to ladino clover.
16. Future experimentation with herbicide combinations should probably include lower rates of each component. Possible additive and synergistic effects could thus be more easily recognized.

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LATE SUMMER SPRAYING OF OAK-MAPLE BRUSH

by

R. J. Hutnik and W. R. Byrnes[1]

A spray crew using careful and thorough application can spray woody brush in June and get almost complete kill. The same crew, with the same chemical, on the same type of brush, and using the same method and care of application, may get a very poor kill following spraying in late August. This seasonal variation in effectiveness of chemical spraying is one of the big problems facing men who are charged with maintaining rights-of-way in a brush-free condition.

Among the solutions to this problem that have been suggested are: (1) that the concentration and volume be increased as the growing season progresses, (2) that oil be added to the water carrier during late season spraying, and (3) that the proportion of oil in oil-water emulsions be increased as the season progresses. To partially evaluate these suggestions, a study was set up in Central Pennsylvania in 1957. The specific objective was to compare the effectiveness of five different sprays applied during late summer. Three different chemicals and two different carriers were used in this study.

Procedure

The area chosen for the study was a portion of a 180-foot wide Penelec right-of-way on the south-facing slope of Tussey Mountain in Huntingdon County, Pennsylvania. The right-of-way had been cut through an even-aged mixed oak-maple forest during the winter of 1951-1952. This mixture of species is typical of the ridge and valley section of the oak-chestnut forest type. The dominant species present is chestnut oak in association principally with red oak and red maple, and to a lesser extent with scarlet oak, black oak, white oak, and black gum (Table 1). The ground layer is composed of grasses, woody shrubs, and herbaceous plants with blueberries, huckleberries, and mountain laurel as the major constituents.

Following cutting, the stumps sprouted prolifically. By August, 1957, these sprout clumps had attained an average height of 11 feet with occasional clumps exceeding 20 feet in height. In addition, many seedlings became established during the years following cutting. By 1957, most of these seedlings were still in the ground layer; nevertheless, they constituted a potential brush problem.

Although species composition was relatively uniform over the entire test area (Table 1), brush density did vary. Therefore, the test area was divided

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1/ Members of the staff of the School of Forestry, The Pennsylvania State University, University Park, Pennsylvania.

into two blocks--one in which the brush density averaged about 35 percent and another in which it averaged about 55 percent.

Table 1. Species composition on treatment areas based on sprout clumps of stump origin.

Treatment	Chestnut Oak	Red Oak	Other[1] Oaks	Red Maple	Other[2] Hardwoods	Total	Basis: Total Plants[3] (no.)
	(percent)						
Control	47	23	14	15	1	100	145
D + T esters in water	62	13	8	17	0	100	176
D + T esters in oil-water	68	17	2	12	1	100	139
2,4,5-TP in water	66	16	7	9	2	100	182
2,4,5-TP in oil-water	67	9	7	16	1	100	176
D + T amine in water	60	17	7	11	5	100	131
All treatments	62	15	7	14	2	100	949

1/ Includes scarlet oak, black oak, white oak, and scrub oak.
2/ Includes witch hazel, black gum, hickory, black birch, shadbush, and butternut.
3/ Total of two randomly located 1/2-acre plots.

Each block consisted of 6 plots, 1/2-acre in size. A 100 percent tally was made of the woody brush on each plot. As to be expected, the most serious brush condition was the sprout clumps that originated from stumps. Therefore, a separate tally was made of this class of woody brush. This tally provided the basis for the initial evaluation of the treatments.

The study consisted of six treatments, randomly assigned to the six plots in each block. They are summarized in Table 2. In more detail, they were:

1. An untreated control.

2. D + T esters in water. A half-and-half mixture of butoxy ethanol esters of 2,4-D and 2,4,5-T applied at a concentration of 6 lbs. acid equivalent per 100 gallons of water as a stem-foliage spray.

3. D + T esters in oil-water. A half-and-half mixture of butoxy ethanol esters of 2,4-D and 2,4,5-T applied at a concentration of 6 lbs. acid equivalent per 80 gallons of water and 20 gallons of No. 2 fuel oil as a semi-basal spray.

4. 2,4,5-TP in water. 2-(2,4,5-trichlorophenoxy) propionic acid applied at a concentration of 6 lbs. acid equivalent per 100 gallons of water as a stem-foliage spray.

5. 2,4,5-TP in oil-water. 2-(2,4,5-trichlorophenoxy) propionic acid applied at a concentration of 6 lbs. acid equivalent per 80 gallons of water and 20 gallons of No. 2 fuel oil as a semi-basal spray.

6. D + T amine in water. A half-and-half mixture of amine salts of 2,4-D and 2,4,5-T applied at a concentration of 6 lbs. acid equivalent per 100 gallons of water as a stem-foliage spray.

Table 2. Brief description of the late summer chemical treatments.

Chemical	Concentration	Carrier	Technique
D + T Esters	6 lbs. ahg	water	stem-foliage
D + T Esters	6 lbs. ahg	oil-water	semi-basal
2,4,5-TP	6 lbs. ahg	water	stem-foliage
2,4,5-TP	6 lbs. ahg	oil-water	semi-basal
D + T Amine	6 lbs. ahg	water	stem-foliage

These chemicals were chosen because they have all been widely used with good results on this type of brush, especially during the earlier part of the growing season (2,3). A concentration of 6 lbs. per 100 gallons rather than the more customary 4 lbs. was used to increase the likelihood of obtaining a good kill even in the late summer. For the same reason, the proportion of oil in the oil-water sprays was 20 percent instead of the more customary 10 percent. To insure proper emulsification with this relatively high proportion of oil, the 2,4-D + 2,4,5-T esters and 2,4,5-T propionic formulations used in the oil-water sprays contained slightly more emulsifiers than those used in water. The commercial brushkiller formulations now on the market contain these additional emulsifiers.

The treatments were applied during the period from August 19 to August 23, 1957. Spraying was done with a Bean Royal 7 pump unit and a Bean Spray-Master spray gun. This unit together with a 150-gallon main tank, a 100-gallon reserve tank, and 275 feet of rubber hose was mounted on a Jeep pick-up. A No. 8 nozzle was used and a pressure of 300 lbs. was maintained at the pump during spraying in all the plots.

With water as the carrier, the stem-foliage technique was used. This technique is fully described in the 1958 Report of the Research Coordinating Committee on Woody Plants (2). Briefly, it consists of wetting the foliage with a fine spray to the dripping point and then wetting stems with a coarser spray until rundown occurred to the ground line.

With an oil-water mixture as the carrier, the semi-basal technique was used. This consisted of thoroughly wetting the stems at the base with a coarse spray (narrow cone), then proceeding up the stems with a finer spray until rundown occurred, and then spraying the foliage to the dripping point with a fine spray (broad cone) to a height of about 4/5 of the clump.

Under both techniques, the clumps were sprayed from opposite sides to insure thorough coverage. Also, special care was taken to spray the small tree seedlings almost hidden in the ground cover.

A record was kept of the quantity of spray solution applied on each plot. In general, there was a good relationship between the amount of brush on a plot and the quantity of spray applied. The plots in Block I, which had only about 35 percent brush density, received an average of 117 gallons on a half-acre plot. The plots in Block II, which had about 55 percent brush density, received an average of 176 gallons. Thus, in view of the light brush density, the quantities applied were high--equivalent to over 600 gallons per acre on brush of 100 percent density that ranged up to 20 feet in height.

Results

In August, 1958, another 100 percent tally was taken of all the woody brush on the treated plots. In addition, a more detailed tally was made of the clumps of stump origin. Each of these clumps was placed into one of the following three classes: (1) complete topkill, not resprouting; (2) complete topkill, resprouting; and (3) incomplete topkill. The number of resprouts and the number of original stems still living were also recorded.

Although only one year had elapsed since treatment, the results were so striking that a detailed analysis of the data was warranted. At the same time, it was recognized that the complete story is yet to be unfolded as more of the clumps die and others resprout during the next few years.

The kill ranged from poor to excellent without any clearcut differences between the two blocks or among the three chemicals (Table 3). However, the carrier that was used made a big difference in the results. For example, those plots which received an oil-water spray showed an average of 80 percent complete kill compared to only a 17 percent kill in the plots which received a water spray. These figures are for clumps that were completely killed to the ground line and have not resprouted.

For topkill alone, the difference was even more pronounced. This figure is obtained by combining the data for "complete topkill, not resprouting" and "complete topkill, resprouting" as given in Table 3. There was somewhat more resprouting following spraying with an oil-water carrier than with a water carrier. This is especially apparent with the 2,4-D + 2,4,5-T esters. However, as past experience has shown (1), it is probable that many of these sprouts will die in the ensuing years.

Table 3. Percent kill of sprout clumps of stump origin 1 year following spraying. All species combined.

Treatment	Complete Topkill Not Resprouting Bl. I	Bl. II	Complete Topkill Resprouting Bl. I	Bl. II	Incomplete Topkill Bl. I	Bl. II
D + T esters in water	22	9	1	3	77	88
D + T esters in oil-water	78	79	17	16	5	5
2,4,5-TP in water	24	12	1	0	75	88
2,4,5-TP in oil-water	98	72	0	6	2	22
D + T amine in water	48	4	0	2	52	94

If the 2,4-D + 2,4,5-T amine treatments are eliminated, it is possible to make a detailed statistical analysis of the data. In effect then, this experiment is a factorial design of two blocks, two chemicals, and two carriers. In addition, since both the oaks and red maple are well represented on all plots, the reaction of these two species groups to the treatments can also be evaluated (Table 4).

Table 4. Percent topkill, not resprouting, of oak and red maple sprout clumps of stump origin 1 year following spraying.

Chemical	Carrier	Oaks Block I	Block II	Red Maple Block I	Block II
D + T Esters	Water	20	6	36	14
D + T Esters	Oil-water	73	76	100	100
2,4,5-TP	Water	19	6	55	42
2,4,5-TP	Oil-water	98	67	100	88

This analysis shows that the differences in the kill between carriers and between species were highly significant (Table 5). As mentioned before, the oil-water carrier resulted in better control. Also, red maple was more easily killed than were the oaks. On the other hand, the differences in kill between chemicals and between blocks were not significant; that is, they could easily have been due to chance alone. None of the interactions were significant except the one between species, chemical, and carrier. This means that the difference in kill between species varied with different combinations of carriers and chemicals. This is more clearly seen in Figure 1. With the water carrier, red maple was more easily killed by 2,4,5-T propionic than by the 2,4-D + 2,4,5-T esters. The opposite was true for the oaks. With the oil-water carrier, the results were reversed, red maple being slightly more susceptible to the 2,4-D + 2,4,5-T esters with the oaks slightly more susceptible to 2,4,5-T propionic. The graph further suggests that fair control of red maple might be possible with 2,4,5-T propionic in a water carrier as a late-season spray. This is not true of the oaks or if the 2,4-D +

Table 5. Evaluation of the differences in kill by variables and their interactions. Oak-maple sprout clumps of stump origin 1 year following spraying.

Variable	Evaluation of Differences
Chemical	Not significant
Carrier	Highly significant 1/
Chemical x Carrier Interaction	Not significant
Species	Highly significant 1/
Species x Chemical Interaction	Not significant
Species x Carrier Interaction	Not significant
Species x Chemical x Carrier	Significant 2/

1/ Significant at the 1 percent level.
2/ Significant at the 5 percent level.

The 2,4-D + 2,4,5-T amine treatment was eliminated from the above analysis because it was not represented in an oil-water carrier. Furthermore, the 2,4-D + 2,4,5-T amine treatment gave conflicting results. In Block I, this treatment resulted in almost a 50 percent kill of the sprout clumps that originated from stumps; in Block II, only a 4 percent kill. Within a few minutes after the completion of spraying of the amine plot in Block II, it was drenched by a heavy downpour. This may have been the reason for the poor kill.

The 2,4-D + 2,4,5-T amine treatment in Block I resulted in a 63 percent kill of chestnut oak--considerably higher than that of red maple or of the other oaks. Also, since only one year has elapsed since spraying, this treatment may still possibly prove to be quite effective in late-season spraying of oak brush, especially chestnut oak.

Discussions and Conclusions

The results of this analysis, although based on only one-year's observations definitely show the value of adding oil to the water carrier when spraying woody brush with 2,4-D + 2,4,5-T esters or 2,4,5-T propionic during the late summer. This is especially true where the oaks make up a large proportion of the sprout clumps, since at this time of the year they are more resistant to the chemicals than are the red maple clumps.

It is perhaps misleading to attribute all the difference to the adding of oil since the technique of application also differed. However, the stem-foliage technique is customarily used with a water carrier, and the semi-basal, with an oil-water carrier. As long as this practice is followed, it is not necessary from a practical viewpoint to isolate the exact cause of the better performance.

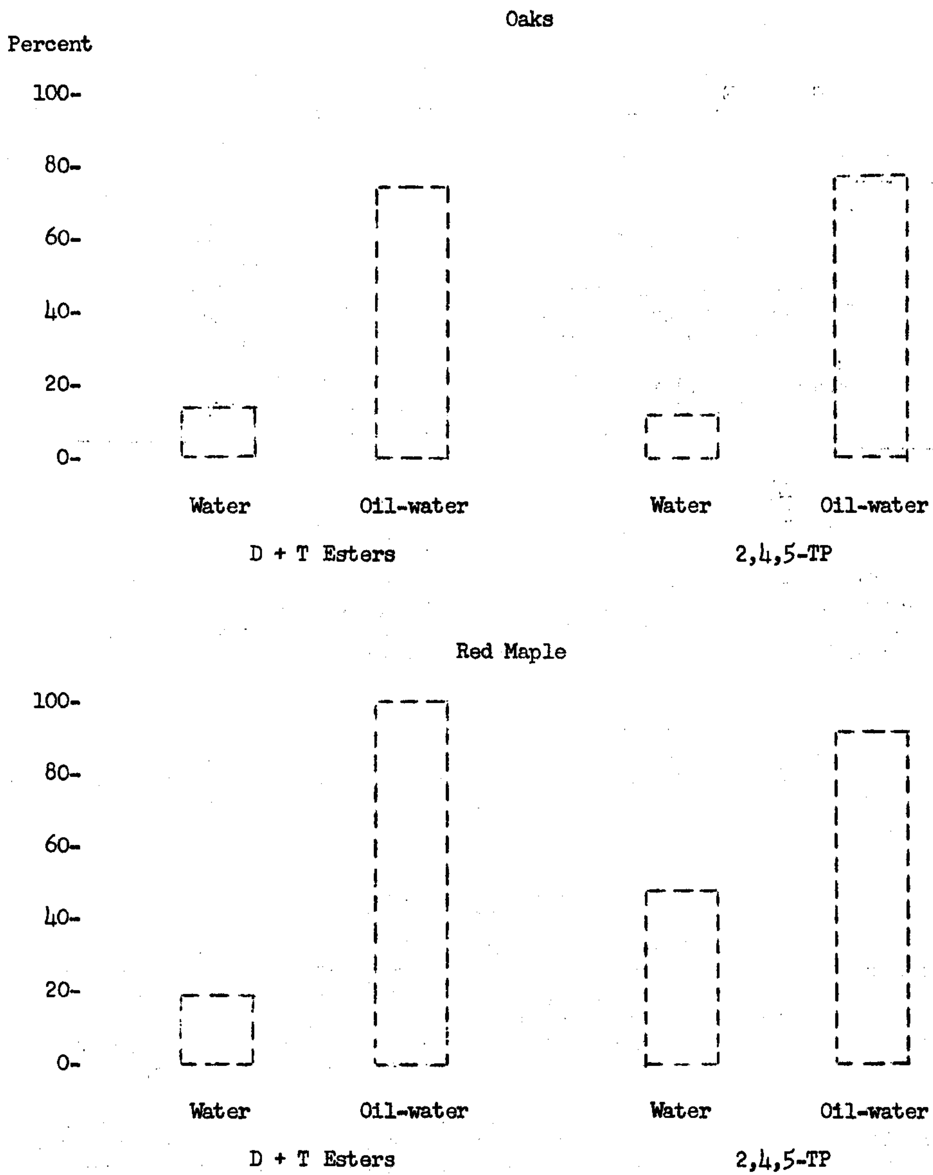

Figure 1. Percent kill by species, carrier, and chemical for sprout clumps of stump origin 1 year following spraying.

There are a number of interesting points outside the scope of this experiment that warrant investigation and discussion. For example, what is the lowest concentration of 2,4-D + 2,4,5-T esters or 2,4,5-T propionic in an oil-water carrier that will consistently give good results? Also, what is the smallest proportion of oil in the oil-water carrier that will still insure good penetration? Should the concentration of chemical and the proportion of oil be varied depending upon how late in the growing season the spraying is being done? Also largely left unanswered in this study is the comparative value of 2,4-D + 2,4,5-T amine as a late-summer spray.

There are, of course, other possible solutions to this problem of seasonal variation in effectiveness of chemical spraying. For example, the use of chemicals in an oil carrier and applied as a basal spray is a proven method of killing trees during all seasons of the year. However, in dense brush conditions, this method is usually too expensive to obtain satisfactory control.

Perhaps the ideal solution would be to develop a chemical that would be effective in a water carrier even late in the growing season. This would eliminate the added expense and inconvenience of using oil. Considerable work has already been done along this line and such chemicals may soon be on the market.

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A NEW APPROACH TO BRUSH CONTROL

P. L. Poulos and W. I. Boyd
Grasselli Chemicals Department
E.I. du Pont de Nemours & Co., Inc.

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Early in our experience with the substituted ureas, it became evident that they might be very effective, in relatively small dosages, for the control of woody plants. Some initial work in the Northeast with monuron, diuron and fenuron for this use was reported by W. I. Boyd at the Northeast Weed Control Conference in 1958. It is the purpose of this paper to report further progress and the present commercial status of formulations and methods of application to control woody plants.

In the spring of 1955, "Telvar" monuron weed killer was registered for chemical control of certain species of trees and brush, in drainage ditches, utility rights-of-way and along railroads. The recommended method of use is to prepare a suspension of one-eighth to one-quarter pound of "Telvar" per gallon of water, and spray this in a circular band about a foot away from the base of each plant.

The next commercial registration, in 1957, was for broadcasting a 25 per cent pelleted formulation of fenuron at the rate of 16 pounds of pellets per acre, to control post oak, blackjack oak, and winged elm on potential grazing lands in Texas. This resulted from several years of cooperative experimental work between the Texas Agricultural Experiment Station and the Du Pont Company.

This registration for fenuron was extended to a larger number of species in northeastern areas largely as a result of the work reported at the Northeast Weed Control Conference last year. Currently as a result of field trials in 14 states, we expect our 1959 recommendations will be for control of 22 species of woody plants.

Test areas established in May, 1956, along lines owned by the Worcester County Electric Company, were rated in July, 1957 and again in 1958. In these plots, where dry mixture and experimental pellet formulations of monuron and fenuron were applied, all of the treated woody plants in the plots showed pronounced to very severe herbicidal effects in 1957. Substantial increases in kill were noted on these plots this year. (Chart I) Species which were distributed uniformly through these plots included oak, maple, birch, wild cherry, pine, poplar, shad, and hazel.

Additional tests at substantially reduced rates were established in 1957. Results were closely related to the amount of chemical applied per brush cluster, regardless of whether a dry mixture, slurry or pellet formulation was used.

Further trials have been conducted to determine practical commercial dosage and timing for spot treatment with both monuron and fenuron wettable powders and fenuron pellets under various common northeastern conditions.

Evaluation of the spot treatment trials established in 1956 and scored in both 1957 and 1958 indicates that results depend almost entirely on getting an adequate amount of chemical concentrated at the base of each cluster. This is one to four grams of active material per cluster. One teaspoon of 25 per cent fenuron pellets provides 1.13 grams of active fenuron, and there are about 100 teaspoons per pound of pellets. Slurry mixtures of the wettable powders seem to offer a good deal of promise, but techniques of applying accurate spot dosages still have to be worked out.

Since fenuron is more soluble than monuron, it is faster acting and is, therefore, preferred for commercial use. Thus, fenuron, rather than monuron, has been marketed in a pellet formulation for control of woody brush. The 25 per cent pellet formulation of fenuron now available as "Dybar" fenuron weed and brush killer is easy to use and has given good results in both spot treatments and broadcast applications. In spot treatment rates as low as one teaspoon per brush cluster have given favorable results.

The label recommendations for use of "Dybar" fenuron pellets are as follows:

For spot treatment in sparse stands of brush, scatter one tablespoonful on the ground to cover an area of one-half to one square foot at the base of each brush cluster.

For spot treatment in dense stands of brush, apply one teaspoonful every three feet in a grid pattern in the brush area.

For broadcast application, apply at rates of 50 to 75 pounds per acre by hand or with mechanical broadcasters.

These applications may be made any time of year, but best results may be expected from late winter or early spring application.

Experimental Data

These recommendations are based on data covering control of fourteen common species of brush obtained in Alabama, Kentucky, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, and Virginia. Early observations in Massachusetts for one and two years (Chart I) after treatment have been confirmed in a considerable number of other trials established last year and this year, and observations will continue. Species which have been successfully controlled in these trials include American chestnut, birch, wild cherry, elm, hazel, hackberry, hickory, locust, maple, oak, pine, poplar, shad, and willow.

In spot treatment, the brush population naturally is the major factor in determining the amount of material required per acre. The brush population in experiments leading to the commercial recommendations for fenuron showed considerable variation, ranging from 1,280 clusters per acre up to 14,360, with an average population between 2,000 and 4,000. (The term cluster is used to designate all stems of a single woody plant.)

Of particular interest are the preliminary results of a Maryland test of "Dybar" fenuron pellets, using a centrifugal grass seeder. (Table I) This test was established on a recently cut-over area of black locust. Three months after treatment, there was no evidence of sprouting where "Dybar" fenuron weed and brush killer was applied at rates of 50, 75, and 100 pounds per acre and there was significant defoliation and reduction in re-sprouting at 25 pounds per acre.

Discussion

Plant response to substituted ureas is dependent upon root absorption, and was usually evident in these trials three to six weeks after application, depending on the time of year and the amount of rainfall. As treated brush died, chlorosis and defoliation occurred.

Susceptible species were killed the year of treatment. Oaks and maples re-sprouted several times but were mostly dead fourteen months after treatment. All terminal growth stopped as soon as first symptoms began to show, usually within a month after treatment. Herbicidal effects on some species were noted as long as 28 months after treatment, especially where low dosages were used.

In treating rights-of-way, treatment may be applied to the edges of the right-of-way where boundaries do not have to be clearly defined. But stems or trees at some distance from the point of chemical application may be killed if their roots extend into the treated area.

As there is no volatility hazard with the substituted ureas, they may be used next to sensitive crop land provided the roots of desirable plants do not extend into the treated area.

The effect on ground cover is limited to the spot actually covered by the chemical. This is usually less than one square foot with spot application.

Summary

Experimental evidence indicates that the pelleted formulation of fenuron meets an important need in industrial brush control in the Northeast. The use of pellets eliminates need for moving heavy spray equipment over difficult terrain, and is suitable for any season of the year, regardless of weather. It is expected that commercial experience with "Dybar" fenuron weed and brush killer may demonstrate effective control in certain situations at somewhat less cost than presently used methods.

TABLE I

FENURON BRUSH CONTROL -- NORTHERN MARYLAND, 1958

Lbs. Pellets Per Acre (a)	Lbs. Active Per Acre	Condition of Black Locust 8-15-58 (b): Height (feet)	Condition of Black Locust 8-15-58 (b): Defoliation
None	None	6	-
25	6.25	3 - 4	Almost Complete
50	12.5	No Re-Sprout	99.5
75	18.75	No Re-Sprout	99.5
100	25	No Re-Sprout	99.5

(a) Broadcast treatments applied May 19, 1958.
(b) Brush cover, predominantly black locust, had recently been cut, and treatments (1000 sq. ft. per plot) were applied over stubble. Plots were bordered by 5 foot buffer strips.

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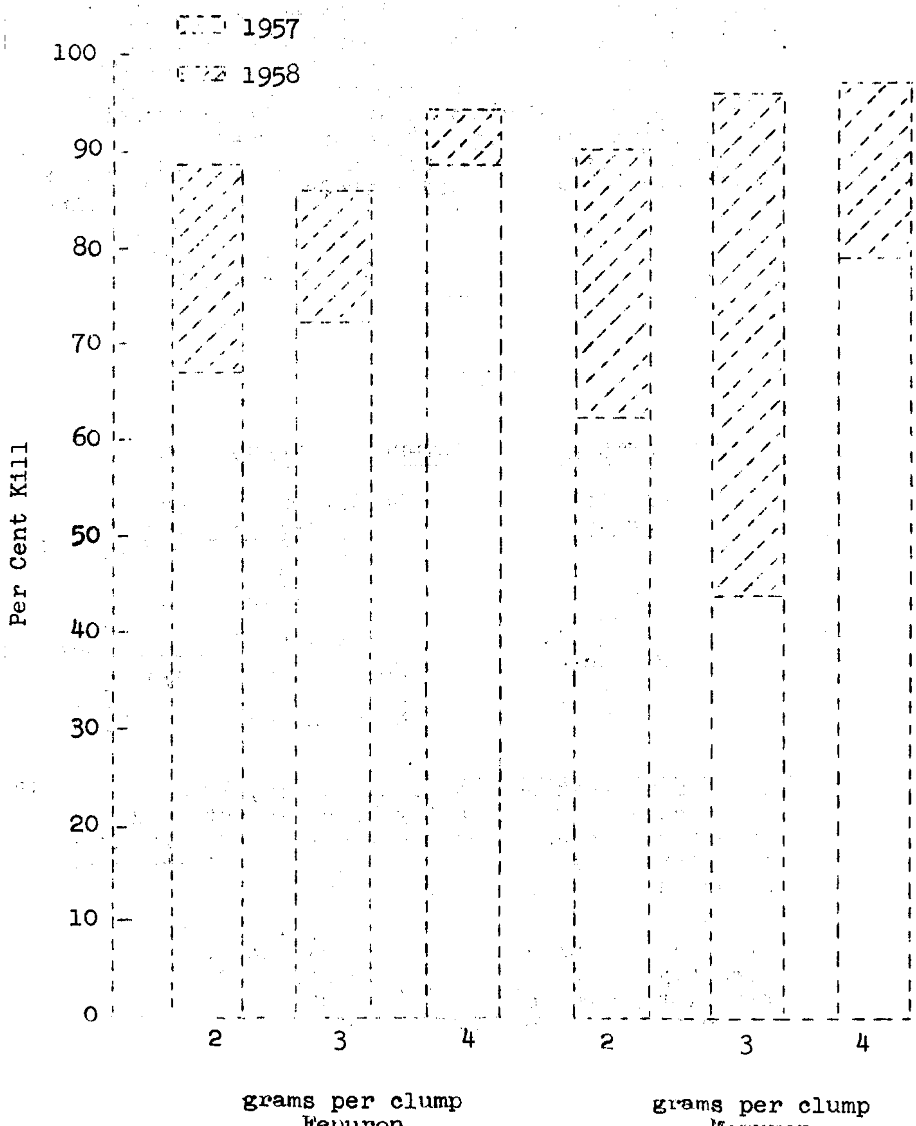
Chart I: Two Years Observation Brush Control
With Dry Mixtures, Fenuron and Monuron,
1957 and 1958



FURTHER STUDIES ON THE USE OF DORMANT TREATMENTS FOR BRUSH CONTROL. 1/

R. E. Sayre and W. E. Chappell 2/
Virginia Agriculture Experiment Station
Blacksburg, Virginia

Present planned programs for many commercial companies applying chemicals to control woody plants are operational only three to four months of the year. By making applications during the season when woody plants are dormant the operational programs could be extended to six or eight months of the year, thereby making more economical use of equipment and personnel. Such applications would eliminate objectional "brown out", which is prevalent when chemicals are applied during the warmer months. These and other advantages suggested that further investigations on the use of dormant season applications were desirable.

In this investigation, experiments were conducted to compare; (1) sprays applied during the dormant season with sprays applied during the growing season; (2) concentrations and formulations of chemicals; (3) technical grade chemicals with formulated chemicals.

PROCEDURE

The experimental areas were located on the power line right-of-ways of the Appalachain Power Company and the Virginian Railroad Company. The elevation of the areas was between approximately 2200 to 2600 ft. The location of the sites was on east, west and south facing slopes. These experiments were selected to better sample the area in which the studies were made. The forest climax on the experimental area was oak-hickory in various stages of ecological succession. The most abundant species present were chestnut oak and red oak. Less abundant species were red maple, black locust, white oak, black gum, hickory, sumac, sassafras and pine.

The plot size was governed by a constant volume of spray material; 25 gallons for dormant applications and 50 gallons for foliage applications. Both volumes covered about the same areas, ranging from one-fourth to one-fifteenth of an acre depending on stem density.

Stem counts of the entire plots were taken at the time of application and again at the end of the next full growing season. The species composition, abundance of species, number of each species, number of stem resprouts, and number of root resprouts were noted and recorded. Spray applications to the aerial portion of the plant is referred to as stem broadcast and spray application to the lower 18 inches of the plant is referred to as broadcast basal.

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2/ Graduate Research Assistant on Educational Lease from the F. A. Bartlett Tree Expert Company and Plant Physiologist.

Top kill in all instances refers to complete killing of all parts of the plant above the ground level. Resprouting refers to the number of sprouts growing from the root system and from the root crown to a point six inches above the ground level.

TABLE I

Fall and Summer Treatments. Top kill of original plants and resprouting from the roots one growing season after treatments. All treatment applications are stem broadcast unless otherwise indicated. Stem counts were taken in October, 1958.

	PERCENT TOP KILL			PERCENT RESPROUTING		
Treatment	Oaks	Locust Sumac Sass.	Others	Oaks	Locust Sumac Sass.	Others
Fall (applied Fall, 1957)						
4# AHG Tech. T. in oil	99.54	98.86	100.00	10.24	98.92	14.61
4# AHG Tech. D&T in oil	98.86	98.25	99.43	10.28	116.49	24.61
6# AHG Tech. T. in oil	97.99	98.28	98.75	8.15	91.79	7.97
6# AHG Tech D&T in oil	99.16	99.77	98.67	11.23	131.20	7.95
6# AHG Formulated T in oil	99.86	99.57	99.97	12.85	147.74	5.76
6# AHG Formulated D&T in oil	99.86	99.78	98.49	11.93	105.92	18.47
8# AHG Tech. T. in oil	99.17	100.00	99.02	9.85	101.80	8.67
Check (cut)				291.79	154.54	165.06
Summer (applied Summer, 1957)						
4# AHG For. D&T water	69.90	85.03	79.84	18.77	158.63	27.15
4# AHG-10 oil-90 water For. D&T	83.87	94.01	93.49	25.33	133.84	27.85
6# AHG For. D&T - water	73.40	94.24	93.17	24.34	147.81	33.09
6# AHG-10 oil-90 water For. D&T	86.56	96.43	95.96	35.05	141.54	34.38
6# Amine T	72.61	94.65	90.55	23.26	91.59	16.44
6# AHG Amine D&T	59.71	95.34	86.74	32.37	191.24	22.87
6# AHG T. Prop.	80.54	91.75	94.32	13.44	161.67	23.59
8# AHG ATA	82.17	93.26	82.32	21.79	80.96	24.01
12# AHG ATA	88.33	94.15	82.85	13.25	73.11	18.95

TABLE II

Winter and Spring Treatments. Top kill of original plants and resprouting from the roots one growing season after treatments. All treatment applications are stem broadcast unless otherwise indicated. Stem counts were taken in October, 1958.

Treatment	Percent Top Kill			Percent Resprouting		
	Oaks	Locust Sumac Sass.	Others	Oaks	Locust Sumac Sass.	Others
Winter (applied Winter 1958)						
4# AHG Tech. T. in oil	97.09	99.85	99.91	20.43	74.16	19.16
4# AHG Tech. D&T in oil	99.73	100.00	99.28	18.71	97.38	25.72
8# AHG Tech. T. in oil	100.00	100.00	99.59	7.61	17.36	9.21
8# AHG Tech. D&T in oil	100.00	100.00	100.00	8.45	42.56	10.83
8# AHG Tech. T. in oil (B)	100.00	100.00	100.00	19.18	34.68	24.04
8# AHG Tech. D&T in oil (B)	100.00	99.48	100.00	6.11	74.50	19.90
Check (Stems Cut)				291.79	154.54	165.06
Spring (applied Spring, 1958)						
4# AHG Tech. T. in oil	99.46	100.00	98.73	66.20	122.88	37.46
4# AHG Tech. D&T in oil	99.81	100.00	99.43	56.78	174.93	50.78
8# AHG Tech. T. in oil	98.77	100.00	99.45	16.11	54.38	15.20
8# AHG Tech. D&T in oil	99.63	100.00	100.00	28.77	187.57	25.32
8# AHG Formulated D&T in oil	100.00	100.00	99.79	22.98	77.67	6.81
8# AHG Tech. T. in oil (B)	98.91	100.00	99.51	13.52	162.01	23.17
8# AHG Tech. D&T in oil (B)	97.11	99.41	96.88	8.18	51.58	17.58
12# AHG Tech. T. in oil (B)	100.00	99.70	98.92	3.67	23.99	16.08
12# AHG For. D&T in oil (B)	97.87	100.00	96.63	9.02	69.67	5.58
Check (Stems Cut)				291.79	154.54	165.06

(B) - BROADCAST BASAL

RESULTS AND DISCUSSION

One season of growth is not enough for conclusive results, but trends may be recognized. Summer and fall treatments were not originally set up to be compared directly, but segments were separated and analyzed by an analysis of variance test at the 5 percent level. The tests were conducted with the assumption that the location of the plots had no influence on the results. Comparisons between treatments and also between seasons resulted in no significant difference. Perusal of the data indicated that the variance of location had a greater influence on the results than the treatment.

Comparative effects of the various concentrations and formulations of sprays during the fall and summer seasons are given in Table I. Top kill of original stems for the summer treatments ranged from 70 to 96 percent for all species, while top kill for the winter treatments ranged from 93 to 100 percent. Resprouting from the roots for summer applications was generally higher than resprouting for the fall applications. Both fall and summer treatments showed a high degree of resprouting in the sassafras, black locust, and sumac group as compared to the oaks and other specie groups. Comparisons of the technical materials during the fall season indicate that 2,4,5-T is superior to a mixture of 2,4-D and 2,4,5-T for controlling resprouting.

Top kill of original stems for winter and spring treatments as given in Table II are comparable to fall treatments. Resprouting in winter treated plots was low in comparision with all other seasons. Inconsistant resprouting between treatments were noted in the spring applications. Technical 2,4,5-T resulted in better control of resprouts than a mixture of 2,4,5-T and 2,4-D in both the winter and spring treatments.

SUMMARY

1. Winter and fall treatments compared favorably with summer treatments.

2. Technical grade 2,4,5-T controlled resprouting better than a technical grade combination of 2,4,5-T and 2,4-D.

3. The percentage of resprouting in the sassafras, black locust, and sumac group was higher than the percentage of resprouting in all other groups.

4. Advantages associated with dormant applications are: (1) the reduction of "brown out", which is prevalent when chemicals are applied as a foliage spray during the warmer months; (2) the present operational program could be extended to 8 or 10 months of the year; (3) cost of application of dormant treatments is about equal to foliage sprays because (a) it requires about half the volume (b) it can be applied in less time (c) and it requires lower pressures and smaller hoses and; (4) the possibility of crop damage is decreased.

FURTHER DEVELOPMENTS IN THE CHEMICAL CONTROL OF CONIFERS

J.M. Bennett[1]

Coniferous species of woody growth have become a maintenance problem on thousands of acres of utility right-of-way in Canada following the selective elimination of deciduous species by 2,4-D and 2,4,5-T herbicides. Preliminary results of an experimental program designed to find a solution to this problem were presented at the 1957 meeting of the NEWCC/1/. The present paper presents further observations on this work, the results of an additional year's extensive plot work and discusses the selection of a suitable treatment for field use.

Methods and Materials

A tagged stem plot technique was used whereby each of the forty trees, which constituted a test plot, was marked with a numbered metal tag. A few plots contained only twenty trees. Treatments were made with a compressed air knapsack sprayer and about two gallons of spray solution were required to spray until run off all stems and foliage in each plot. Applications were made during each of April, late May, July and October 1955 and early May, July and October 1956. These periods of treatment can be placed in four categories, based on stage of growth of the conifers. (1) Prior to bud break when trees were essentially dormant - April 1955 and early May 1956, (2) shortly after bud break when new shoot growth was about three inches long - May 1955, (3) mid summer after shoot elongation virtually completed for the season - July 1955 and July 1956 and (4) fall of the year when trees are almost dormant again - October 1955 and October 1956. Final observations of the results of the treatments were made during October 1958. For summary purposes no rating was given to those stems which were not completely killed, consequently the percentage kills as presented represent a conservative evaluation of the treatments.

The test site was a dense stand of conifers, four to twelve feet in height, on a high tension right-of-way near Haliburton, Ontario. The species were predominately balsam fir, _Abies balsamea_ (L.) Mill., and black spruce, _Picea mariana_ (Mill.) BSP. The site was swampy, verging on a sphagnum bog with a few outcroppings of sand covered rock.

[1]Biologist, Research Division, The Hydro-Electric Power Commission of Ontario. Toronto. Canada.

The following chemicals were tested during both 1955 and 1956.

1. 2,2-dichloropropionic acid, sodium salt, 74 per cent acid equivalent (dalapon).

2. trichloroacetic acid, sodium salt, 79.3 per cent acid equivalent (TCA).

3. 3-(p-chlorophenyl) -1,1-dimethylurea, 80 per cent wettable powder, (monuron).

4. 2-(2,4,5-trichlorophenoxy) propionic acid, propylene glycol butyl ether esters (silvex).

5. 3-amino-1,2,4-triazole, 50 per cent wettable powder, (amitrol).

6. polychlorinated benzoic acids. Seven formulations were tested at one time or another, during the two-year period. All were emulsifiable forms of the free acid. These may be classed in four groups based on isomer content.

   (a) predominately 2,3,6-trichlorobenzoic acid (2,3,6-TBA) (Heyden HC1281WD).

   (b) predominately 2,3,5-trichlorobenzoic acid (2,3,5-TBA). Major isomer constituents 54 per cent, 2,3,5-TBA, 16.2 per cent 2,3,6-TBA, and 12,4 per cent 2,3,5,6-TBA (Hooker X80E0 and ACP-M-177).

   (c) predominately 2,3,5,6-trichlorobenzoic acid, (2,3,5,6-TBA). Major isomer constituents 48 per cent 2,3,5,6-TBA, 25 per cent 2,3,4,5-TBA and 6.5 per cent 2,3,5-TBA (Hooker X42E0).

   (d) mixed polychlorinated benzoic acids. Major isomer constituents 36.4 per cent 2,3,5,6-TBA, 15.3 per cent 2,3,4,5-TBA, 16.3 per cent 2,3,5-TBA and 12.3 per cent 2,5-dichlorobenzoic acid. (Hooker X33E0, ACP-L-970 and ACP-M-103A).

Other chemicals given limited evaluation only in 1956 were:

1. maleic hydrazide, diethanolamine salt (MH).

2. 4-(2,4-dichlorophenoxy) butyric acid, dimethyl amine salt (4-(2,4-DB)).

3. 3-phenyl-1,1-dimethylurea, 80 per cent wettable powder (fenuron).

A number of the less effective chemicals tested during 1955 were not included in 1956 studies and are not discussed in this report.

A surfactant (sodium sulphates of mixed long chain alcohol-fatty acid esters) and a formulation containing a 1-to-1 mixture of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid, isooctyl esters, (2,4-D - 2,4,5-T) were combined with certain of the treatments during 1956.

All rates are given in terms of pounds acid equivalent per 100 imperial gallons (ahg) or active ingredient per 100 imperial gallons (ihg). One imperial gallon is equivalent to about 1.2 American gallons.

Results and Discussion

The results of treatment with TCA are shown in Figure 1A. Applications during the season of active growth gave satisfactory results with about 8 to 14 pound ahg. Concentrations of 7.9 and 13.8 pounds TCA gave 55 and 95 per cent kill, respectively, when applied in late May 1955 and 90 and 100 per cent kill when applied in July 1955. The higher concentrations used gave a correspondingly high degree of kill. In July 1956, applications of 9.9 and 11.9 pounds resulted in 82 and 85 per cent kill. Lower concentrations produced very severe injury and complete kill of some trees but the injured trees recovered and adequate control was not obtained. Treatment before and after the season of active growth generally produced a low level of control. The relatively high concentration of 41.6 pounds applied in April 1955 resulted in only 35 per cent kill and the same rate in October 1955 killed only 32 per cent of the conifers. In May 1956 treatment with 34.6 pounds produced 22 per cent kill. The results of treatment in October 1956, when applications of 23.9 and 41.6 pounds TCA produced kills of 82 and 100 per cent respectively, appear to be at variance with the results obtained with the treatment in October 1955. The explanation for this difference in activity can be attributed to the unseasonably warm weather during and following the 1956 applications when average of the daily maximum temperature for a 10-day period was 62.9F compared with 48.3F for 1955. A consistent high level of control of conifers with TCA was obtained only for applications made during the season of active growth and only when concentrations were about 14 pounds ahg or higher.

The pattern of results with dalapon as shown in Figure 1B is similar to that for TCA (Figure 1A), except that higher rates of dalapon were required to produce the same results. The control with 22.4 pounds of dalapon in late May and July 1955, 95 per cent kill at both times, corresponds to 95 and 100 per cent kill obtained with 13.8 pounds TCA at the same periods. As with TCA, the lower rates of dalapon caused considerable injury and some kill but control was inadequate. Treatments in other than the season of active growth i.e. treatments in April and October 1955 and early May 1956, were relatively ineffective. No treatment with dalapon was made in October 1956.

Figure 1C shows the results obtained with monuron. The initial treatments in 1955 resulted in high levels of kill 65, 80, 100, and 100 per cent at 2.6, 4.6, 8.0 and 13.9 pounds ihg applied in May and 95, 100, 100, and 100 per cent with the same treatments in July. Results in October 1955 were satisfactory only at a concentration of 13.9 pounds. During 1956 lower rates were used and satisfactory control was not obtained. In the limited trial with fenuron during 1956 low rates of application were used and results were not satisfactory. 4.6 pounds ihg in May produced 42 per cent kill and 1.6 pounds ihg in July produced 25 per cent kill. The monuron and fenuron were applied as foliage sprays in the same manner as the other chemicals in this study. Soil applications might be a more satisfactory technique since these materials are known to be readily absorbed from the soil by plants. In the test plots where the trees were small and close together, the kill was highest, probably the action was largely by root absorption and with a dense stand of conifers, a greater amount of chemical was applied per unit area.

The results of the treatment with silvex are in Figure 1D. Concentrations of 3.31, 5.75 and 10.0 pounds produced kills of 0, 12 and 15 per cent when applied in April, 22, 60 and 75 per cent in late May and 77, 97 and 95 per cent kill in July 1955. In October 1955, 5.75, 10.0 and 17.4 pounds ahg resulted in kills of 0, 20 and 50 per cent. During 1956, 5.75 and 10 pounds ahg applied in early May killed 5 and 35 per cent of the conifers while 4 and 5 pounds in July produced kills of 15 and 42 per cent. These results for July are considerably lower than those obtained with comparable concentrations at the same period during 1955. No explanation for this difference is known. The pattern of higher kills with treatments made during the growing season also holds for silvex.

Amitrol produced interesting results but did not give satisfactory control at the rates used. The results are shown in Figure 2. Only in July 1955, when concentrations of 8.7, 15.1 and 26.25 pounds ihg produced kills of 35, 57 and 87 per cent, did control approach an acceptable level. At all rates some effect on the conifers was observed. The terminal growth which developed following treatment was chlorotic on nearly all trees. At the higher concentrations as much as two or three years growth was devoid of chlorophyll and this growth eventually died. All the surviving trees had some apparently healthy foliage and appeared to be on the road to recovery when the final observations were made in October 1958.

The results of the various formulations of polychlorinated benzoic acids are in Table I. Unfortunately all formulations were not tested at the same time, nor were the same rates used with all formulations, consequently a clear picture of the relative value of the various materials was not obtained. 2,3,6-TBA, the first formulation tested, gave outstanding results at the rates tested during the growing season. Concentrations of 5.75, 10.0, 17.4 and 30.2 pounds ahg produced kills of 92, 100, 100, and 100 per cent respectively for a late May treatment and 100 per cent kill at all rates in July. Treatment in October was less effective with kills of 12, 10 and 20 per cent resulting from applications of 3.31, 5.75 and 10.0 pounds ahg. The following year when 2,3,5-TBA was evaluated, lower rates were used and results were not too encouraging with 5 pounds ahg in July resulting in kills of 15 and 35 per cent for two formulations. Ten pounds applied in October 1956 gave a 70 per cent kill. The 2,3,5,6-TBA when applied in July 1956 was more effective than the 2,3,5-TBA with kills of 25, 70 and 70 per cent resulting from treatment with 3,4 and 5 pounds ahg respectively. An October 1955 treatment with 2,3,5,6-TBA at 10 pounds ahg killed 47 per cent of the conifers. The mixed isomers of polychlorinated benzoic acids applied at concentrations of 3,4 and 5 pounds in July 1956 gave kills of 45, 25 and 55 per cent for one formulation and 45, 70 and 90 per cent for another. This difference in results with formulations of the same isomer ratio is as great as the difference between the results with the formulations with different isomer contents or ratios and tends to confuse an already confused picture. However, one formulation of each of 2,3,5-TBA, 2,3,5,6-TBA and mixed isomers from the same source and presumably of the same nature with the exception of the isomers, was evaluated at the same time - during July 1956. On the basis of the results of these tests 2,3,5,6-TBA was the most effective of the three, 2,3,5-TBA was the least effective and the mixed isomer formulation was intermediate between the two in effectiveness.

MH applied at concentrations of 5.75, 9.2 and 17.4 ihg in early May 1956, the only time of treatment, had no toxic effect on conifers. There was some indication that shoot development was delayed and that the terminal growth was reduced, however, no measurements were made.

4-(2,4-DB) at 5 and 10 pounds ahg in July 1956 caused considerable injury but no complete kill. On some trees the top 50 per cent was killed while on others the terminal shoot was simply curled and defoliated. At the final observation period new healthy foliage was present on all trees.

The effect of the addition of a surfactant, at 0.02 per cent by volume, and of 2,4-D - 2,4,5-T at 3 pounds ahg to sprays of TCA is shown in Figure 3A and to sprays of dalapon in Figure 3B. With sprays of TCA the surfactant has enhanced the kill for treatment during both early May and July 1956, but particularly in July when TCA alone at 4 and 6 pounds produced kills of 17 and 30 per cent, whereas with the surfactant kills of 42 and 85 per cent resulted from the same rates. Corresponding figures for the addition of 2,4-D - 2,4,5-T are 74 and 84 per cent kill. Part of this effect of the 2,4-D - 2,4,5-T may be due to the surfactant in the formulation of this herbicide. With dalapon the addition of the surfactant increased the kill obtained for the early May treatment but a lower kill resulted when the surfactant was added in July. The addition of 2,4-D - 2,4,5-T in July also gave conflicting results with a marked increase in activity resulting when added to the 11.1 rate but a decrease in activity when added to 13-pound rate. Perhaps the explanation for these inconsistent results was imcompatability of materials used, and results with other surfactants might be more rewarding.

Summary of Experimental Results

Over a two-year period several chemicals were evaluated in plot trials for control of conifers. The results may be summarized as follows:

Chemical	Range of Concentrations Tested	Control Obtained
TCA	4 to 41.6	Excellent at 8 to 16
Dalapon	4.25 to 38.8	Excellent at 15 to 25
Monuron	0.8 to 13.9	Variable, promising at 3 to 8
Silvex	3.3 to 10	Variable, promising at 4 to 10
Amitrol	2.9 to 26.2	Promising at 26.1
Polychlorinated Benzoic Acids	3 to 30.2	Variable, promising at 4 to 8
Fenuron	0.8 to 4.6	Ineffective at rates tested
MH	5.75 to 17.4	Ineffective at rates tested
4-(2,4-DB)	5 to 10	Ineffective at rates tested

Except at very high concentrations none of these chemicals was effective for control of conifers when applied other than during the growing season.

Field Trials and General Observations

From the results of these experiments it is evident that there are several chemicals which, when applied as aqueous foliage sprays during the season of active growth, are effective for the control of conifers. The choice of a material for extensive use depends on such factors as cost, hazards in use, ease of application, corrosiveness to equipment and effect on other vegetation. Other things being equal, the most important single factor other than effectiveness is cost. Field trials using several of the chemicals tested in plot work, have been conducted to aid in the selection of a material for use in conifer control operations in Ontario Hydro. In these trials TCA has given the most consistent results and has been the most economical material to use. More than 3,000 acres have been successfully treated during the past two years using TCA at concentrations between 10 and 20 pounds ahg. This usage has afforded an opportunity to evaluate some of the characteristics and effects of sprays of TCA as well as some of the factors which influence effectiveness.

TCA is relatively non-toxic to warm blooded animals and presents no hazard from the standpoint of acute toxicity. It is irritating to the skin and eyes if used without caution. The skin on the hands of some spray operators who used TCA for prolonged periods, became red and peeled off. Although this was not painful, it did cause concern, mainly from the standpoint of appearance. The use of gloves can overcome this problem. No fire hazard exists with TCA itself and the dead conifers on the right-of-way are no greater a potential hazard than if they were cut. In any case, the danger is temporary as the needles soon drop and the trees eventually decay. Since TCA is a grass killer there was concern about possible destruction of the grass cover on right-of-ways. However, experience has shown that only temporary and localized injury results from the field use of TCA for conifer control.

The ideal conifer control technique is one which could be used to control deciduous as well as coniferous woody growth. Combinations of TCA with 2,4-D - 2,4,5-T have been applied on a large scale in addition to the small plots. Control of conifers was excellent. Although it has not been too clearly established whether the TCA interferes with the action of 2,4-D - 2,4,5-T on deciduous species, indications from the field work are that with the mixture, satisfactory control can be obtained of the deciduous species usually associated with conifers, namely poplar, birch, willow and tag alder.

Corrosiveness to equipment is a major concern in the extensive use of TCA. In a series of laboratory tests, solutions of TCA attacked magnesium and aluminum severely and steel moderately. The use of protective coatings and frequent washing of the equipment can minimize this hazard. Formulations of TCA containing a corrosion inhibitor may be obtained at a premium price; laboratory tests with such a formulation demonstrated that with the possible exception of magnesium, corrosion was satisfactorily inhibited. No corrosion hazard to conductors and tower steel is anticipated, because of the limited exposure and the washing effect of subsequent rains.

Differences in the susceptibility of various species to control by chemicals became evident in these studies. Spruce is most resistant followed closely by balsam fir. Any treatment which will control these two species appears to be effective for other problem species, e.g., jack pine, white cedar and white pine. For all species the smaller the tree the easier it is to kill. Very thorough coverage of each tree is required to give complete kill. If the lower branches are not well sprayed they may survive and eventually produce a new tree. The weather has considerable influence on the rapidity of action of the chemicals, particularly TCA. On bright, sunny days brown-off of the foliage may occur in a few hours, whereas in cool, dull weather several days may elapse before a noticeable effect has taken place.

Aircraft Application

Application of chemicals from aircraft, including helicopters, has proved to be practical for control of deciduous brush and would be a boon in conifer control operations which, for the most part, are required in remote areas of the north. Limited trials have been conducted with TCA and polychlorinated benzoic acid formulations, but a satisfactory treatment has not yet been evolved. Because of the corrosiveness of TCA to aluminum and magnesium, and the prevalence of these materials in aircraft structures, an inhibited formulation of TCA was used for this work.

Dormant-Season Control

As already mentioned none of the chemicals applied in a water carrier was effective for conifer control except during the growing season. Earlier work indicated that an oil carrier was more effective during the early spring and fall, no doubt due largely to the toxic effect of the oil, and 2,4-D and 2,4,5-T in an oil carrier can be used for conifer at these times. This technique has its limitations, but is quite useful under certain circumstances. In areas where resistant species of hardwoods, especially maple, have survived the standard herbicidal treatment of 2,4-D - 2,4,5-T in a water carrier, a basal spray with an oil carrier is now being used. Conifers growing in the same sections of the right-of-way can be killed by using the same mixture as an over-all spray. Thus, a clean-up of the brush can be accomplished. This work is usually done in the fall of the year, a time when much of the equipment is often idle.

REFERENCE

/1/ Bennett, J.M., Chemical Control of Conifers on Utility Right-of-Way, Proc. 11th Annual NEWCC, p 329-35, January 9, 1957.

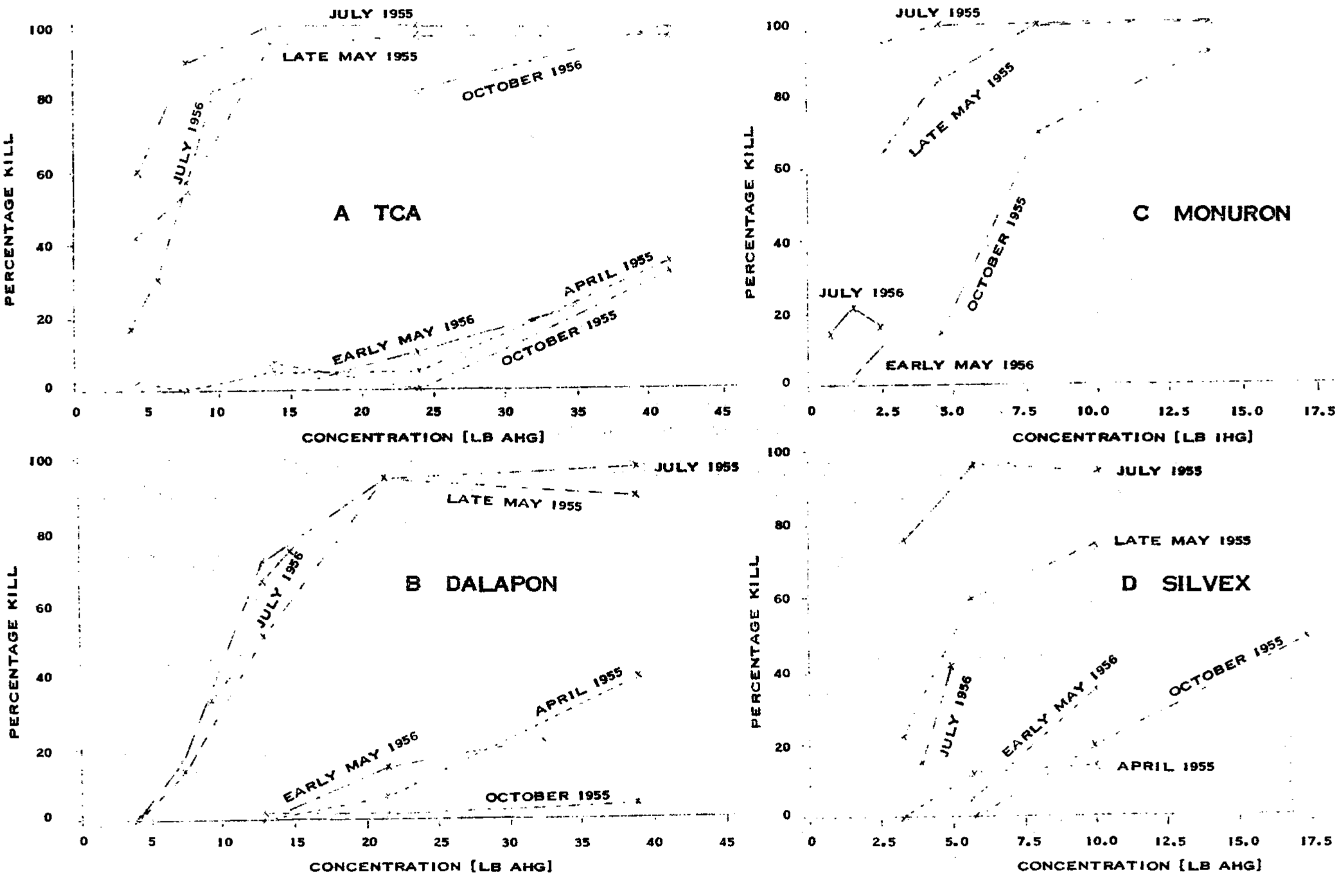


FIGURE I PERCENTAGE KILL OF CONIFERS OBTAINED WITH AQUEOUS FOLIAGE SPRAYS OF VARIOUS CONCENTRATIONS OF TCA, DALAPON, MONURON AND SILVEX AT DIFFERENT PERIODS OF APPLICATION

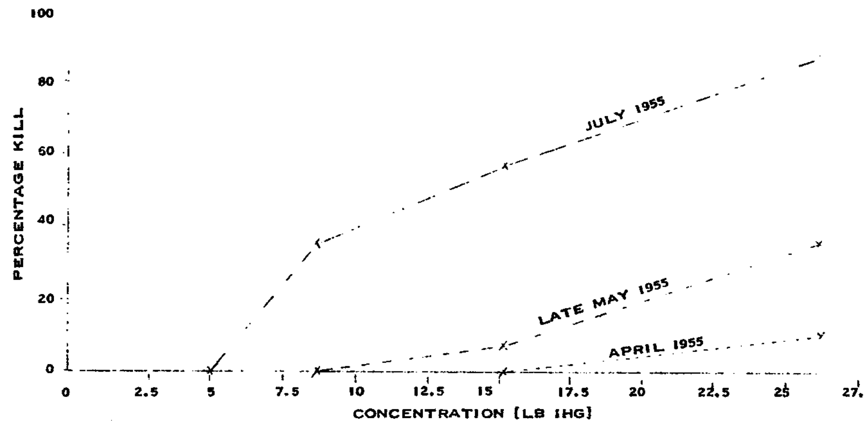


FIGURE 2 PERCENTAGE KILL OF CONIFERS OBTAINED WITH AQUEOUS FOLIAGE SPRAYS OF VARIOUS CONCENTRATIONS OF AMITROL AT DIFFERENT PERIODS OF APPLICATION

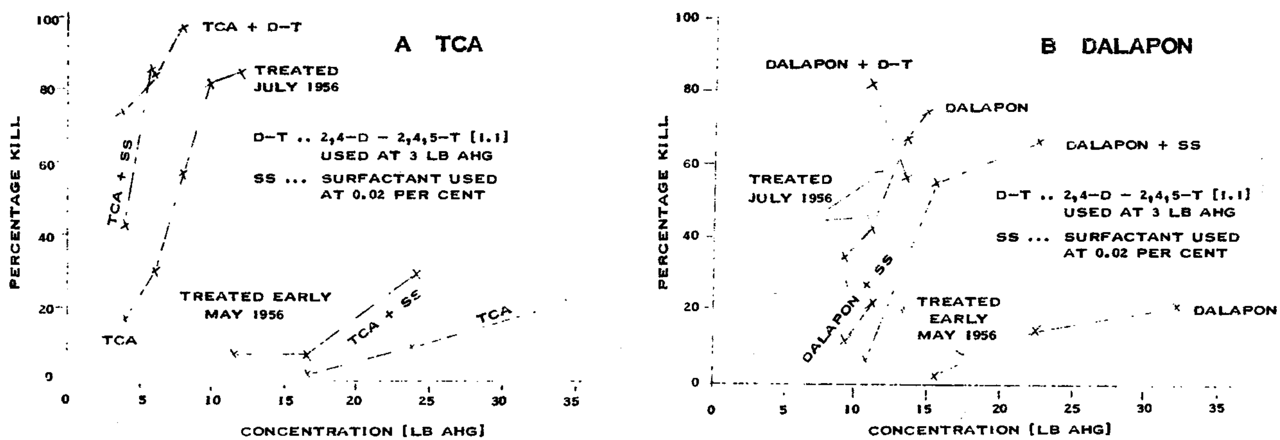


FIGURE 3 PERCENTAGE KILL OF CONIFERS OBTAINED WITH AQUEOUS FOLIAGE SPRAYS OF TCA AND DALAPON, ALONE AND IN COMBINATION WITH A SURFACTANT AND WITH 2,4-D - 2,4,5-T

TABLE I

Per Cent Kill of Conifers with Aqueous Foliage Sprays of Various Concentrations of Seven Formulations of Polychlorinated Benzoic Acids Tested over a Two-Year Period

Isomer	Formulation	Treatment Date	Concentration (lb ahg) 3.0	3.31	4.0	5.0	5.75	10.0	17.4	30.2
2,3,6-TBA	HC1281WD	May, 1955					92	100	100	100
	"	July, 1955					100	100	100	100
	"	Oct., 1955		12			10	20		
2,3,5-TBA	Hooker X80EO	July, 1956	10		20	15				
	ACP-M-177	July, 1956	20		45	35				
	" " "	Oct., 1956						70		
,3,5,6-TBA	Hooker X42EO	Oct., 1955		15			22	47		
	" "	July, 1956	25		70	70				
ixed isomers	Hooker X33EO	July, 1956	45		25	55				
	ACP-L-970	Oct., 1955		2			17	22	52	90
	" " "	May, 1956		5			17	45		
	ACP-M-103A	July, 1956	45		70	90				
	" " "	Oct., 1956						92	100	100

CHEMICAL BRUSH CONTROL ON PUBLIC WATERSHEDS AND SUPPLY LINES

Archie W. Paine
General Superintendent, Sources of Supply
Metropolitan District Water Bureau
Hartford, Connecticut

Public water supply in the Hartford metropolitan area has over 100 years of history behind it -- 103 to be exact -- but at the end of 98 years we were still depending on axes and scythes to clear brush around the shorelines of our reservoirs. At the present time we have two functioning reservoirs and a third one being developed, and our present consuming population is about 350,000 people.

In the watershed area, the district owns approximately 28,000 acres, a great deal of it in woodland. Modern forest conservation methods are used in the care of this timberland, with selective cuttings as trees in a given area reach maturity. Considerable reforestation work has been done adjacent to reservoirs, where we have replaced the natural growth of broadleaved hardwoods with conifers. By surrounding our reservoirs with conifers, we prevent the accumulation of leaves in the water, where they might affect the flavor and color, and could interfere with the operation of valves and pipelines.

Between this conifer screen and the waterline is an area varying from a few feet up to perhaps 150 feet, which we call free board. This is the leeway between the waterline of the full reservoir and the edge of the forest planting. This free-board area gives us a margin for the rise of high water, and also gives us access around the edge of the reservoir when we need it.

We can't let brush grow there because we'd get right into the problem of leaves in the water again.

Then of course we have the usual reasons for clearing brush that are common to any operating area -- whether it's a powerline right-of-way, a timber road, or a gas pipeline. These all add up to providing greater safety and more efficient and economical working conditions for the crews that have to work in the area, and elimination of such hazards as poison ivy.

We have been able to exchange information and recommendations with the people responsible for brush control on the utility rights of-way running through the watersheds or near them, and this has worked out to everyone's advantage. Watershed safety regulations once left them with no choice but hand-cutting in watershed areas. But as chemical methods are approved for our own use, they can use them too.

We are still in the process of developing a program to meet our special requirements. First, to give you an idea of the size of the job -- the total shoreline for one reservoir is 11 miles, while the other reservoir is 30 miles, or a total of 41 miles. The free-board area averages 25 feet in width, so we have about 125 acres of shoreline to keep clear, plus ten miles of pipeline right-of-way averaging 75 feet wide -- or about 90 acres of right-of-way - a total of about 215 acres of land where we have to control brush.

Briefly, here is what we have accomplished so far: Up to 1954, we kept a 10-man crew busy from early spring to late fall, cutting brush along the shorelines and along the pipeline rights-of-way. Now we have one three-man crew doing chemical spraying for a few weeks each year, and we have been able to cut our summertime temporary roll in half. Furthermore, where we have kept comparative cost records, costs of the chemical spraying average less than two-thirds the cost of hand-cutting.

In developing a chemical brush control program for watersheds, we have to consider two basic requirements. First, the chemical has to be approved by the people responsible for the purity of the water. Second, the method of application has to be practical for the terrain. In areas where you have access roads of some kind, of course you can get in with a hydraulic sprayer and use long hoses to reach where the sprayer can't go. But some parts of the shoreline of our reservoirs are wet most of the time, or else they're rugged and rocky. For some of these areas we've tried approaching from the water in a boat, and sending men in with watering cans to treat the brush.

None of these methods of application seemed to promise the savings we thought we had a right to expect from chemical control. So we have taken a leaf out of the fruit-growers' book and we're using a mist blower - not a giant orchard sprayer, but a little knapsack-style blower that straps on a man's back and runs with a gasoline engine. (SHOW SLIDE) This unit weighs about 35 pounds, and holds 2 1/2 to 2-3/4 gallons of spray. For each filling we use eight pounds of a special formulation of "Ammate" weed and brush killer, in two gallons of water with an ounce of spreader-sticker. This special formulation is the same as "Ammate" X without the sodium bichromate.

This is a simple air-blast unit, so there is no appreciable pressure in the tank. The mist is created by blowing air at a velocity of 250 miles an hour through a stream of spray solution. The air orifice is 1-3/4 inches, and the orifice for liquid is 3/32 inches. At full throttle the unit will give good coverage of brush at a distance of 12 to 15 feet from the operator.

This unit gives particularly good coverage of the stems, branches, and foliage -- both the upper sides of the leaves and the under sides.

Since this unit applies a fine mist with little runoff, we are getting effective coverage with 72 pounds of "Ammate" weed and brush killer per acre. This is considered to be less than half the "average" amount needed.

Obviously you have to use a completely nonvolatile herbicide in this type of equipment because of the application technique. Furthermore, you have to use something in watershed areas, anyway, that the laboratory will approve. Our laboratory and sanitary engineers have given this special formulation of "Ammate" a clean bill for our program.

We figure that nine tankfuls with this unit will cover an average acre of our brush. Our average acre is about eight feet high, with an average diameter of one to two inches - the normal regrowth following cutting that you get in four or five years in Connecticut.

Average growth includes all common New England species -- birch, maple, oak, hickory, ash, sumac, sassafras, willow, poison ivy and cherry.

Nine tankfuls is only 72 pounds of "Ammate" to the acre, and some people think this isn't enough to do the job. But this slide (SHOW SLIDE) shows how an area looked after the spray had begun to take effect. And this one (SHOW SLIDE) shows how the same area looked a year later.

We have obviously gotten excellent kill of all the woody brush in this area, using just about half as much "Ammate" weed and brush killer in the mist blower as we think normally would be used in a hydraulic sprayer with spray guns.

A man operating this mist blower can get into areas where it would be just about impossible to drag hoses from a hydraulic sprayer.

The operator refills from 50-gallon drums of pre-mixed spray which are hauled on a trailer pulled by a wheel-tractor as close as possible to the area where he is working. If the mist-blower is operated continuously at full speed, one filling will last 15 to 18 minutes. But it is generally operated at less than full speed, and of course, the spray is not being applied continuously, so one filling may last from 20 minutes to an hour, depending on the size, density and accessibility of the brush.

The success of this method of brush control, like any other in our experience, depends on the spray operator. For this kind of work we try to find men among our regular skilled and semi-skilled crews who seem to have an interest along this line. Then we train them not only in the job to be done, but also give them a chance to see the results. We may go over the sprayed area with them twice during the season of spraying -- once about three weeks after application, and again in another six weeks. Then the following year we take another look to see whether there has been any regrowth, new growth, or skips that will require another treatment.

We still do some cutting ourselves, and we are still experimenting with new ideas and new products. During the past two seasons we have treated the surface of every fresh-cut stump of an inch in diameter or more with a tablespoon of dry "Ammate" weed and brush killer to kill the roots and prevent resprouting. While I know stump treatment is not a new practice in brush control, it's new to us, and we feel we have to try out any practice on a limited scale before we adopt it widely.

I mentioned earlier that we have exchanged information and recommendations with others working in the brush control field. Perhaps our success with the mist blower may offer others the idea of using it. It seems possible that the technique of increasing the chemical concentration and using a mist instead of a spray might be adapted to a degree to hydraulic sprayers, for areas where they can be used. This might be accomplished by simply increasing the pump pressure and using spray guns with smaller orifices. Some of you who have had considerable experience with hydraulic spraying of brush might know of other approaches that could be tried. Just to reiterate the advantages of our application technique you use much less chemical, and you get better foliage coverage without runoff.

In one sense, our present program is only a preview of what's ahead for us because the new reservoir now under development will more than double our watershed area. Meanwhile, if present trends continue, there will be more and more reason to economize on expense and manpower in every kind of maintenance program. In brush control we will be looking for the longest possible control on the lowest possible budget. It looks as though our present program will probably give us acceptable brush control for about four years with one spraying -- and retreatment is generally a much smaller project than the original spraying.

The next thing, of course, will be to work out a schedule for our property so that we can get over the land in one cycle before it is time to spray again. With such a program, we can combine minimum annual budget with maximum labor efficiency in an effective brush control program.

# # # # # #

Effect of Simazine, Related Triazine Compounds, and Various Other Herbicides On Native Weeds and Grasses

James H. Flanagan
Geigy Agricultural Chemicals

Simazine (2-chlor-4,6-bis(ethylamino)-s-triazine) was synthesized by Gysin and Knusli in the laboratories of J. R. Geigy, S. A., Basle, Switzerland. Experiments in this country as well as in Switzerland showed that the compound is an effective herbicide, primarily efficient in a pre-emergence application. Since the chemical is taken up by the roots of germinating or existing plants, adequate moisture is required to carry the Simazine to the root zone. The solubility of Simazine in water is only about 5 ppm so that under conditions of light rainfall, the herbicidal action may be quite slow.

The following experiments were undertaken to study pre- and post-emergence applications of Simazine and several related compounds, alone and combinations of Simazine with commercial herbicides. The plots were laid out in uncultivated areas of Westchester and Rockland Counties, New York, having a good population of native perennial weeds.

The following triazine compounds were included in the tests:

Product		Chemical Name
G-27692	Simazine	2-chloro-4,6-bis(ethylamino-s-triazine
G-30027	Atrazine	2-chloro-4-isopropylamino-6-ethylamino-s-triazine
G-30026	-	2-chloro-4-isopropylamino-6-methylamino-s-triazine
G-31435	Methoxy Propazine	2-methoxy-4,6-bis(isopropylamino)-s-triazine
G-30044	Methoxy Simazine	2-methoxy-4,6-bis(ethylamino)-s-triazine
G-32293	Methoxy Atrazine	2-methoxy-4-isopropylamino-6-ethylamino-s-triazine

The four following methods of application were employed in the experiments: (1) watering can, (2) back-pack sprayer, (3) modified low volume weed sprayer, and (4) Jeep-mounted Chesterford Logarithmic Sprayer.

Test No. 1

Simazine, Atrazine and G-30026 were applied to triplicated 10' x 10' plots on November 10 and 11, 1957 at dosage rates of 5, 10, 20 and 40 pounds active ingredient per acre. The suspensions were applied with a sprinkling can at the rate of about 1-1/2 gallons per plot.

No effects of the treatments were noted until the spring of 1958. During April and May all of the plots were free of weeds; however, many dicotyledonous weeds germinated but failed to survive. By early June, weed growth was noted on all plots receiving the 5 pound per acre treatments. The G-30026 plots were covered with crab grass. Hedge bindweed, horseweed, wild carrot and yellow wood sorrel were evident on the Simazine and Atrazine plots. In July, these weeds appeared on the Simazine plots which received 10 pounds per acre. The Atrazine plots had less of these species; however, all plots contained fall panicum (Panicum dichotomiflorium) seedlings.

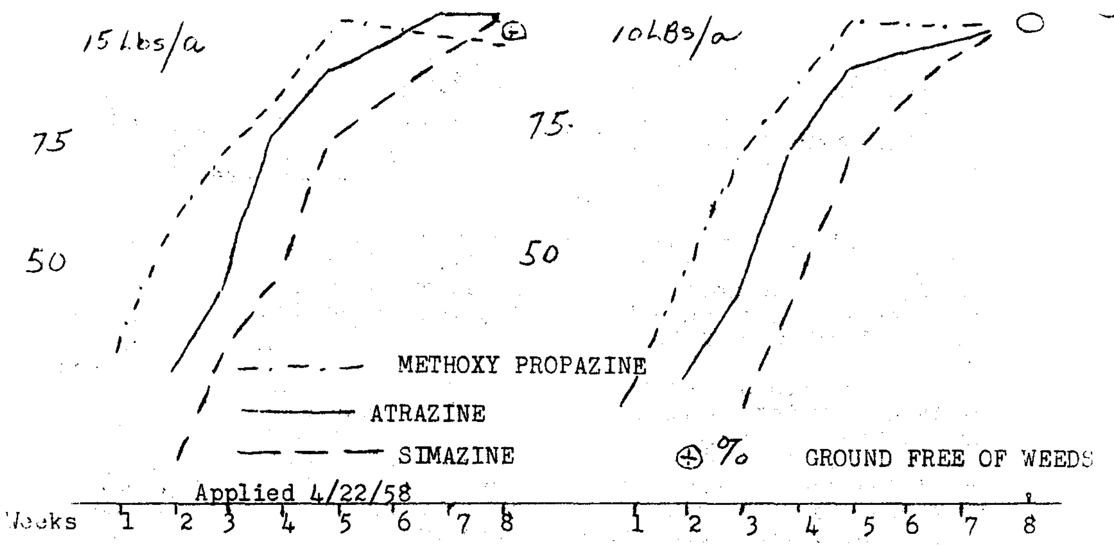
In October 1958 the following conclusions were drawn from the plots:

1. Simazine at 20 and 40 pounds per acre maintained complete weed control for one year following a fall application.
2. At rates of 5 and 10 pounds per acre a supplemental spring application of Simazine would be necessary to keep all weeds controlled.
3. Atrazine gave results comparable to Simazine at all rates, possibly more effective at the 10 pound rate.
4. Annual Panicum species show some tolerance to Atrazine and G-30026 and to a lesser extent to Simazine.
5. Crab grass and Panicum sp. were the only annual weeds to appear in any of the plots.

Test No. 2

On April 22 and 23, 1958, Simazine, Atrazine, Methoxy Propazine and G-30026 were applied at the rates of 5, 10 and 15 pounds per acre to 10' x 10' triplicated plots in Rockland County. The materials were applied with a watering can at the rate of about 1-1/2 gallons per plot. Winter annual, biennial and perennial weeds were present in the plots.

EFFECT ON WEEDS AT WEEKLY RATINGS



Observations of the test during the season led to the following conclusions:

(1) All four of these chemicals produced practical seasonal control at the 10 and 15 pound dosage rates.

(2) Atrazine was faster acting than Simazine or G-30026 and controlled the same weeds as Simazine. The 5 pound rates of Simazine and Atrazine produced satisfactory control, except that perennial panicum grasses were present in the latter.

All dosage rates of Atrazine killed the overwintering stages of perennial panicum species but failed to control the germinating seeds of these species. The only other weeds found to be tolerant to Simazine and Atrazine were two species of St. John's worts, (Hypericum perforatum and H. mutilium). These early applications controlled the perennial bluegrasses (Poa compressa and P. trivialis); control by later applications has been inconclusive.

(3) Methoxy Propazine at 10 and 15 pounds per acre produced rapid knockdown and controlled all of the weeds mentioned in the list of weeds indicated hereafter. Yellow wood sorrel has a considerable tolerance to Methoxy Propazine.

Test No. 3

Simazine and Atrazine at dosage rates of 5 and 10 pounds per acre in combinations with the following herbicides were applied to 100 square foot plots with a low volume and a back-pack sprayer on May 26, 27 and 28, 1958:

Chemical and lbs./acre

Amino Triazole	5
Dalapon	40
Polychlorobenzoic acid	8
TCA	100
MCPA	2
TCA - 2,4-D	100 - 2
Dalapon - MCPA	40 - 2

Two weeks after application the combinations containing TCA produced the fastest knockdown with the Dalapon combinations second. The addition of 2,4-D to TCA and Dalapon combinations did not increase initial knockdown. Amino triazole was somewhat beneficial over Simazine alone at the 5 pound per acre level, but did not produce quick knockdown.

Four weeks after application, Atrazine alone and Atrazine with other indicated compounds were equal to or better than the additives alone or in combination with Simazine.

Combinations of Simazine and Atrazine With Other Herbicides
Test No. 3, Applied May 26-28, 1958
Percent Leaf Burn

	Atrazine		Simazine		Alone	Atrazine		Simazine		Alone	Atrazine		Simazine		Alone
	5	10	5	10	—	5	10	5	10	—	5	10	5	10	—
Amino triazole 5#	35	45	Sym	15	Sym	60	80	15	50	Sym	75	80	60	75	50
Dalapon 40#	60	75	45	60	50	90	90	90	90	85	95	95	90	90	85
2,4-D 2#	45	50	Sym	Sym	Sym	65	80	35	45	30	85	95	70	75	50
Dalapon 40# + 2,4-D 2#	40	60	40	45	45	80	85	75	75	80	90	95	85	85	75
Benzac 8#	30	45	Sym	Sym	Sym	75	80	15	40	20	90	90	50	70	50
Triazine alone	35	50	10	15		80	95	30	40		85	100	40	80	
Triazine alone	30	55	5	15		60	90	25	45		75	100	40	75	
TCA 100#	90	90	85	90	90	100	100	100	100	95	100	100	100	100	100
MCPA 2#	40	45	Sym	Sym	Sym	80	85	30	40	20	90	95	60	75	45
2,4-D 2# + TCA 100#	90	90	90	90	90	100	100	100	100	100	100	100	100	100	100
Dalapon 40# + MCPA 2#	35	50	25	30	40	80	85	55	60	70	95	100	90	95	80
Triazine alone	35	60	10	20		70	95	40	65		80	100	35	70	

(Sym - typical symptoms)

The plots were rated at frequent intervals during the remainder of the season from which the following conclusions can be

(1) Atrazine alone after 4 weeks produced results equal to or better than any of the combinations and maintained 95% to 100% control for the entire season.

(2) Atrazine was superior to Simazine when applied post-emergence.

(3) All combinations increased the knockdown and overall performance of Simazine, particularly at the 5 pound dosage level. The increased performance was more pronounced in combination with TCA. Results of subsequent tests indicated that a dosage rate less than 100 pounds of TCA was adequate in combination with Simazine at a dosage level of 5 pounds.

(5) No annual broadleaf weeds or annual grasses appeared in any of the combination plots or with Simazine or Atrazine alone. Both Simazine and Atrazine controlled seedling wild garlic but not mature bulbs. The only species to make new growth in the fall were perennial blue grasses.

Test No. 4

On June 13, two hundred square foot plots were treated with Atrazine and Simazine at 5, 10, 15 pounds per acre. The chemicals were applied with a back-pack sprayer using approximately 200 gallons per acre to weeds 12 to 24 inches high. Within three weeks, Atrazine caused 100% burn to leaves and 80% burn to stems of all species present in the plots treated with the 15 pound rate; at 10 pounds per acre rate, 70% to 80% of the leaves were burned and severe chlorosis occurred to terminal growth. Corresponding rates of Simazine produced symptoms on most species and leaf burn on certain species, namely; ox-eye daisy, black-eyed susan, red clover and sweet clover. It was confirmed from further observations that the burn produced by Atrazine resulted in complete death of all species, the only variable being the speed of action.

Test No. 5

A test was applied on June 20 using 15 pounds per acre of Atrazine and Simazine on horse tail (Equisetum arvense) with a back-pack sprayer. Within three weeks the horse tail was completely burned in the Atrazine plot; Simazine produced only slight burn. Later observations indicated Atrazine had effected excellent control while only partial control was given by Simazine.

Test No. 6

The following dosage rates of Simazine and Atrazine and Methoxy Propazine were applied with a logarithmic sprayer on July 1 and July 5, 1958:

(1) Simazine 40 lbs./A decreasing
(2) Atrazine 40 lbs./A decreasing
(3) Methoxy Propazine 40 lbs./A decreasing

After two weeks, a comparison between the speed of action of Atrazine at 10 pounds per acre and an application of the same rate made five weeks earlier indicated that the stage of growth is an important factor in the rapidity of knockdown. Early blooming species of weeds were affected to the same degree from either the early or late application, while the late blooming species, such as goldenrod, yellow toad flax and aster, required a higher dosage in the late application to give the same amount of injury. Rates in excess of 12 pounds produced quick knockdown. In these plots, the only weed to survive was dandelion.

The action of Methoxy Propazine did not appear to be affected by the stage of growth at rates in excess of 10 pounds per acre. The only species to survive were yellow wood sorrel and a few wild carrots.

Simazine produced poor results in these late applications. The 40 pounds per acre dosage of Simazine was comparable to 12 pounds per acre of Atrazine.

Test No. 7

During the week of July 22, Simazine and Atrazine were combined with a series of other herbicides in plots sprayed with the logarithmic sprayer.

Simazine and Atrazine were applied at a constant rate of 5 and 10 pounds per acre and were combined with the following materials:

	Chemical	Pounds per Acre, Decreasing
1.	Amino triazole	5
2.	TCA	100
3.	TCA -	100
	2,4-D amine	2
4.	Dalapon	40
5.	Dalapon -	40
	2,4-D amine	2
6.	2,4-D amine	2

In addition, the following materials were applied alone:

1. Methoxy Propazine, 15 pounds per acre, decreasing
2. G-32293, 20 pounds per acre, decreasing.

Before giving conclusions, it should be stated that at the time of application weeds generally were not actively growing or were in the leveling off stage of growth.

This test was conducted on an abandoned farm in Rockland County, New York, which has been out of production for six years. Weed growth consisted of a majority of the weeds mentioned previously with goldenrods (Solidago sp.) predominating. The weeds at the time of application were 15" to 24" high. Very little if any of the spray actually reached the soil during the spray with the TCA combinations and on the Methoxy Propazine plots within two days after the application. Slight burn was noted with Atrazine and G-32293 after four days; no rains occurred during this period. As a supplement to this test, 200 square foot plots were sprayed with Atrazine and Methoxy Propazine with a back pack sprayer using 5, 10, 15 pounds active in 200 gallons of water per acre. The purpose of the test was to compare a back pack sprayer application versus applications with conventional low volume sprays.

Results of the test would indicate the following conclusions:
(1) TCA combinations again proved the quickest acting; between 50 and 60 pounds per acre of TCA appeared to be a satisfactory dosage rate.
(2) The activity of Simazine and Atrazine alone was much slower when compared with earlier applications.
(3) The application of Methoxy Propazine at 15 to 20 pounds per acre active was very effective as a knockdown chemical.
(4) Method of application affected the speed of action on the weeds but not the weed control at the end of the season.

Summary

In summarizing the activity of the triazine compounds in the above tests, the following conclusions may be stated:

(1) For maximum results with Simazine, applications must be made before active growth begins and should be applied before or during the period of maximum rainfall. If for various reasons the time of application is delayed, combinations of various contact herbicides with Simazine will partly overcome the growth factor.
(2) Atrazine is definitely more active on emerged weeds than Simazine and can be applied later in the season to control the same weed species. Rates of 10 pounds per acre were found to be effective for general weed control. At the present time, the exact residual nature of Atrazine is unknown; however, it did produce seasonal control.
(3) Methoxy Propazine and Methoxy Atrazine demonstrated a high degree of foliage toxicity. The minimum dosage rate for Methoxy Propazine alone is 10 pounds per acre. A sharp decrease in activity on perennial weeds occurs below this rate.

Weeds Controlled by Atrazine, Simazine, and Methoxy Propazine

The following is a list of weeds controlled in the experiments conducted in Rockland County, New York. Weeds not controlled are discussed separately in the report of each experiment.

1.	Pasture thistle	Cirsium pumilum
2.	Golden rods Sp.	Soladago Sp.
3.	Ox eye daisy	Chrysanthemum lencanthemum
4.	Black eye susan	Rudbechia hirta
5.	Narrow leaf plantain	Plantago lancealata
6.	Broadleaf plantain	Plantago major
7.	Wild carrot	Daucus carota
8.	Yarrow	Achillea millefolium
9.	Yellow wood sorrel	Oxalis stricta
10.	Curled dock	Rumex crispus
11.	Burdock	Arctium minus
12.	Prickly lettuce	Lactuca scariola
13.	Wild lettuce	Lactuca canadensis var. latifolia
14.	Purple stem aster	Aster puniceus
15.	Spreading cinquefoil	Potentilla reptans
16.	Sulfur cinquefoil	Potentilla recta
17.	Yellow hawk weed	Hieracium pratense
18.	Yellow toad flax	Linaria vulgaris
19.	Common speedwell	Veronica officinalis
20.	Stork bill	Erodium ercutarium
21.	Tall butter cups	Ranunculus acris
22.	Daisy fleabane	Erigeron strigosus
23.	Horse weed	Erigeron canadenis
24.	Horse tail	Equisetum arvense
25.	Will parsnip	Pastinaca sativa
26.	Yellow mustards	Brassica rapa and kaber
27.	Timothy	Phleum pratense
28.	Quack grass	Agropyron repens
29.	Slender rush	Juncus tenuis
30.	Orchard grass	Dactylis glomerata
31.	Nible will	Muhlenbergia schreberi
32.	Oat grass	Anena sativa
33.	Hop sedge	Carex lupulina
34.	Crab grass	Digitaria sanguinalis
35.	Broom sedge	Andropogon virginicus
36.	Yellow rocket	Barbarea vulgaris
37.	Common mullein	Verbascum thapus
38.	Purple meadow rue	Thalictrum revolutum
39.	Evening primrose	Oenothera biennis
40.	Wild strawberry	Fragaria virginiana
41.	Crane bill	Geranium carolinianum
42.	Tall oat grass	Arrhenatherum elatius (L) Mert. Koch.

Scattered species:

Canada wild rye	Elymus canadensis

RESULTS OF FOLIAR AND GRANULAR HERBICIDE APPLICATIONS TO MIXED BRUSH IN 1957 1/

W. E. Chappell and R. E. Sayre 2/
Virginia Agricultural Experiment Station
Blacksburg, Virginia

In 1957 a number of chemicals and mixtures of chemicals were applied to brush growing in power line right of ways. The species of plants involved covered a wide range but the major ones were: chestnut oak, white oak, red oak, sassafras, black locust, red maple, hickory, sumac, yellow poplar and sourwood. The population of these species varied considerably from one individual plot to another. This varibility resulted in most of the lack of significance between treatments in the experiments reported here-in. Examples of the variability of the species and species location to selected treatments are presented in Table 1.

Table 1 - Effect of treatments on various species. Examples of individual stems per plot.

Species	ATA-8		IBK-6-100		IBK-6-10-90	
	Before	After	Before	After	Before	After
Red Oak	18	4	107	55	131	66
Chestnut Oak	31	6	49	29	119	85
Sassafras	28	144	36	59	51	261
Black Locust	86	10	220	269	53	63
Sumac	96	14	—	—	39	9
Maple	—	—	113	56	52	35
Hickory	3	1	68	21	29	16
Black Gum	3	49	—	—	4	1

Species	245T Amine-6-100	
	Before	After
Red Oak	535	91
Chestnut Oak	99	19
Sassafras	95	12
Black Locust	—	—
Sumac	—	—
Maple	—	—
Hickory	22	2
Black Gum	40	0

1/ These studies were supported in part by grants from the Appalachian Power Company, American Cyanamid Company, Amchem Products, Inc., The Bartlett Tree Research Laboratories and The duPont Company.

The foliage treatments were applied with a Bean pump that delivered $7\frac{1}{2}$ gallons per minute at 300 pounds pressure PSI. The nozzle used was a spraying system gunjet with a No. 5 disc. A 50 gallon spray tank with mechanical agitation was used. In spraying an attempt was made to cover the entire plant but stems and basal portions of the plants were primary targets.

The spray mixtures were placed into the tank and allowed to mix thoroughly before spraying any plants. Individual plots were sprayed with the entire 50 gallons at a rate of 200 to 450 gallons per acre, depending upon the plant size. Dividing lines between treatments were clearly marked with yellow paint and tagged with aluminum plant labels.

The monuron was applied as 25% clay pellets or 40% granular on No.2 vermiculite. Application was made by hand to individual clumps of brush or to individual stems.

Initial stem counts of the various species were made and recorded shortly after the plots were sprayed. At the end of the 1958 growing season all green stems and root sprouts over 6" in height were counted and recorded by species for each plot. Calculations were then made for the percentage top kill and sprouts as compared to the original stem counts.

The chemicals used and the results obtained are recorded separately in the text.

Results and Discussion

Experiment I - Amino Trizole - (ATA) - Time of Application

Duplicate plots using 8 and 12 pounds (active) of ATA were treated in May, June and July of 1957. The May treatments had little or no effect on the brush and were not counted. The results are presented in Table 2.

Table 2 - Time of Application of ATA

Treatment	% Top Kill			% Resprouts		
	May	June	July	May	June	July
8 lbs.-100 gal. 500gal/A	10*	72.11	93.95	100	62.13	30.06
12 lb.-100 gal. 500gal/A	10	99.68	96.05	100	20.76	33.67

*Estimated

In that area chosen for this test the brush was 10 - 12 ft. high and was predominately black locust, sumac, sassafras, and oaks. The volume used was very high but not uncommon on brush of this size. A breakdown of the major species in the plots is as follows:

Stems Per Acre - Before and After Treatment

	8# ATA - June		12# ATA - June	
	Before	After	Before	After
Oaks	49	15	93	2
Sassafras	28	144	198	127
Black Gum	3	49	0	0
Black Locust	86	10	254	3
Sumac	96	14	75	0

As can be seen from the data black gum and sassafras were the two most resistant species in this experiment. Sumac and black locust were very susceptible.

Experiment II - Monuron Studies

In an effort to determine the effectiveness of monuron on brush in a dry formulation when applied to mixed brush at different times of the year an experiment in which four application dates and two rates of chemical was designed. The treatments were applied in June, August, October and December. In the June treatments one rate of 5 grams active monuron per clump (1-10 stems) of brush was applied. In the August treatments a slurry consisting of 1 part 80% monuron and 1 part water was used in rates of 5 and 7½ grams per clump. In the October and December treatments 5 and 7½ grams per clump were applied in the granular form. Three replications were made. Plots were 50 x 100 ft. in size. The results are presented in Table 3.

Table 3 - Monuron Applied At Different Dates

Treatment	Date	% Reduction of Stems
1. Pellets 5 gr/clump	6/4/57	79.80
2. Slurry 5 gr slurry/clump	8/5/57	79.25
3. Slurry 7.5 gr/clump	8/5/57	74.86
4. Pellets 5 gr/clump	10/1/57	74.06
5. Pellets 7.5 gr/clump	10/1/57	74.65
6. Pellets 5 gr/clump	12/19/57	72.51
7. Pellets 7.5 gr/clump	12/19/57	73.63

Little or no root sprouting occured in any of the treatments and the data includes both stem counts and root sprouts. Although the percentage top kill does not appear to be very high most of the stems were apparently dying, but many were still green at the time the counts were made.

Notes taken early in the growing season of 1958 showed little effect from the October and December treatments on most plants, but as the season progressed all plants became chloratic, browned out and were defoliated in September when the counts were made.

Some off the right-of-way injury was noted in all plots. Some oak and

Experiment III - "Standard" Mixtures

In this experiment several more or less commonly used chemicals were applied to brush considered to be about optimum size for the most efficient spraying. In the area used the brush ranged from three to five feet in height, included a wide variety of species and was of average density. Six foliar treatments and one granular application were made. Each treatment was replicated at least three times and in some cases six replications were made. All treatments in the main test area were applied in August. In addition to this area some treatments were applied in other areas to check on their performance but they cannot be compared directly. The results are presented in Table 4.

Table 4 - "Standard Treatments"

Treatment (Lb. in 100 gal. solution)	Main Test Area		Other Areas	
	%Top Kill	%Resprouts	%Top Kill	%Resp.
Butoxyethanol esters 24-D-245T 4 lb.	75.54	33.97	—	—
Butoxyethanol esters 24-D-245T 4-10-oil	89.78	32.33	89.08	62.12
Butoxyethanol esters 24-D-245T 6	88.63	15.46	88.65	54.92
" " 6-10-oil	94.00	23.79	87.43	61.38
Amino triazole 8	88.66	30.57	73.79	77.66
Amino triazole 12	77.76	15.93	86.55	40.48
Ammate 40-4(oil)	95.28	85.38	—	—
Check (Hand cut)	0.00	195.79	—	—

Somewhat better results were obtained with all chemicals in the area of the main test than in other locations. This was probably due to smaller brush in that area. In general the top kill was satisfactory but the percentage of resprouts left something to be desired.

The use of 10% oil in the mixtures increased top kill in this experiment by 15% in the 4 lb. and by 7% in the 6 lb. rate of the D&T esters. Ammate resulted in good top kill but the percentage resprouts was very high.

Stem counts will again be made at the end of the 1959 growing season and a final evaluation made at that time.

Experiment IV - Screening Test

Several rates of chemical and various mixtures were applied in July and August of 1957. Fifty gallons of total spray was used except that with monuron 5 grams active was applied as 25% pellets. Each treatment was replicated two or more times. The results of these treatments are presented in Table 5.

Table 5 - Screening Experiment
(lb/100 gal. solution)

		% Top Kill	% Resp.
Butoxyethanol esters 24-D-245T	6-15 (oil)	97.24	45.96
Butoxyethanol esters 24-D-245T	8-20 (oil)	99.17	47.77
Amino trizole ≠ Dalapon	8 ≠ 10	91.88	51.28
Amino trizole - Veon 100	8 ≠ 4	91.70	127.00
Amino trizole - Veon 100	8 ≠ 6	86.30	14.72
Amino trizole - D&T	8 ≠ 6	88.42	15.75
ACP 414 (Invert emulsion)	6 ≠ 15 (oil)	83.31	80.21
ACP M23A (Invert emulsion)	6 ≠ 15 (oil)	87.42	36.43
245T Amine	6	89.66	25.00
24D - 245T Amine	6	82.11	64.21
Veon 100	6	74.08	17.51
Monuron pellets	5 gr (per clump)	94.62	16.00
245T Prop.	4	83.55	17.50
245T Prop.	6	88.66	25.36
24D Acid Paste	6	70.72	28.16

The most promising treatments used in this experiment were 245T Amine, alone and in combination with Amino trizole, and monuron as a granular treatment.

Summary

Field experiments on the performance of several chemicals and combination of chemicals are reported here-in. From these experiments the following general observation can be made:

1. Amino trizole alone and in combination with other chemicals offers some promise for controlling certain hard to kill species such as ash, sumac, and black locust. Conversely it has little effect on black gum and sassafras.

2. The Amine salts of 245T resulted in a generally low percentage of resprouting, although the top kill was not as high as with the esters.

3. Monuron both in granular and in spray form resulted in a low percentage of resprouting and in a high apparent top kill. It's use resulted in some kill of trees off the right-of-way,

THE EMULSIFICATION OF HERBICIDES

by

J. W. Van Valkenburg
J. A. Kelly

Since the introduction of the plant-growth-regulator-type herbicides such as 2,4-D and 2,4,5-T a decade or more ago, contractors have applied millions of gallons of diluted spray to unwanted vegetation. In so doing, much has been learned regarding the necessary and desireable properties for a good herbicide formulation. Thus, any activity in which so many have participated and contributed knowledge rapidly assumes a forbidding technical appearance to the uninitiated. Also, because of the great importance of this work, much highly developed technical research has necessarily been done by countless workers.

Accordingly, the purpose of this paper is to critically review the fundamental aspects of herbicide emulsifiable concentrates in order to develop a clear understanding of the progress made in recent years.

To best accomplish this goal, we propose to discuss, point by point, the parameters directly concerned with the making of a quality herbicide formulation. These include:

1. What's in the can?

2. What is an emulsion?

3. How is an emulsion made?

4. What degree of emulsification is needed for proper brush control?

5. How much agitation is required for the emulsification of herbicide plus oil?

6. Can spray drift be minimized through use of a particular formulation?

7. Can the activity of herbicide be enhanced significantly by the formulation?

1. WHAT'S IN THE CAN?

Obviously, the primary constituent is the herbicide itself in a form that is assimilatable by the plant. The herbicide must be present in the amount and kind guaranteed by the label statement. This requires careful control of the manufacture from start to finish to insure that this will be so. Quality control of the formulation accomplishes this. In general, 2,4-D and 2,4,5-T are sold as esters, and in brush control work, low-volatile esters such as the glycol ether esters are extremely effective and find wide use.

A second important ingredient in the formulation is the solvent. The purpose of the solvent is to act as a carrier for the herbicide and the emulsifier so that proper emulsification or solution is obtained when diluted with water or oil at the time of use. The solvent has a man-sized job to do when one considers that this job must be properly done at the time the package is opened regardless of the previous history of that particular package. For example, a good brush killer must stand extremes of temperature in storage of zero degree Fahrenheit or below without crystallizing and yet be unaffected by summer storage at 125°F. or above and this repeated for several seasons! A solvent capable of doing this is not chosen by whim but only after careful research and evaluation. The physical characteristics of typical 2,4-D and 2,4,5-T ester solvents are shown in Table 1.

Table 1.

PHYSICAL CHARACTERISTICS OF TYPICAL
2,4-D AND 2,4,5-T ESTER SOLVENTS

Mixed aniline point, degree F. ---	52-82
Kauri-butanol value --------------	79-98
Aromatics, % ---------------------	80-100
Sp. Gr. at 68°F. -----------------	0.860-0.895
Flashpoint, °F. (C.C.) -----------	81-164
Boiling range, °F. ---------------	274-386/290-495

The emulsifier is the third important ingredient in the formulation and is put there for the express purpose of dispersing the herbicide-carrying oil in the dilution water so that homogenous emulsions can be formed that adequately distribute the herbicide over the area to be sprayed. In addition to this service, the emulsifier present in the formulation is called upon to emulsify as much as ten gallons of added fuel oil per gallon of herbicide in those situations where oil is a preferred additive. This is not all that is expected of the emulsifier; for when oil is used as the sole diluent, the emulsifier must not precipitate out of solution in the aliphatic diluting oil to gum up equipment and spray nozzles.

The solubility of an emulsifier in oil is quite important to good emulsification. In an article by Gladstone(2) he states that if an emulsifier is not soluble in oil, the solution will tend to be hazy. Upon standing, this haze will gradually settle out to a viscous layer with the net result that the emulsification of the oil is impaired. This is explained by the fact that an emulsifier works best when it has both water and oil solubility.

Such emulsifiers represent much research and development effort on the part of formulators and the specific materials used are reluctantly discussed, if at all. Suffice it to say, that emulsifiers commonly used today consist of various blends of non-ionic surfactants with anionic surfactants. However, those possessing all of the attributes listed here are not readily available.

2. WHAT IS AN EMULSION?

An herbicidal emulsifiable concentrate is essentially an oil mixed with an emulsifying agent. When we pour this oil, or emulsifiable concentrate, into water we have to fight the old adage that oil and water just don't mix. When we mix the oil and water, we want that oil to break up into fine droplets and to be dispersed in the water. When finely divided oil droplets are dispersed (being a discontinuous phase) in the water (a continuous phase), we have what is called an oil in water emulsion. Figure 1 shows a microscopic picture of a brush killer extended with oil and then emulsified in water. Magnification is several hundred fold and you can see that the oil has a random particle size, that is, some droplets are very fine while others are larger.

As the oil droplets become finer, the emulsion assumes a creamier appearance and becomes what we call a tight emulsion. If these oil droplets become too large, they will rise to the surface of a water mixture and form an oily layer (this is of course assuming the oil is lighter than water). If all the droplets are fine enough, the droplets may remain in an emulsified form but they may not stay in the same place. In other words, the emulsion may have a tendency to cream. When an emulsion creams, one can see two phases: A layer containing a high concentration of emulsified oil and a region containing a much lower concentration of emulsified oil. We will have more to say about this later.

One comment is appropriate here as to why emulsions are made. Undiluted, an herbicide would have to be applied at approximately one drop of liquid per square foot. By emulsifying and diluting the herbicide, it is possible to spread more finer droplets uniformly over the same area.

3. HOW IS AN EMULSION MADE?

The hardest system to emulsify is a gallon of herbicide extended with ten gallons of fuel oil and mixed with roughly eighty-nine gallons of water. So, let us use this as an example of "how to make an emulsion." The order of mixing ingredients in such an emulsion is very important. The oil and emulsifiable concentrate should be premixed before the combination is added to water.

It would be ideal if one could mix oil, concentrate and water in any order, so, an actual experiment was devised to test the importance of order of addition.

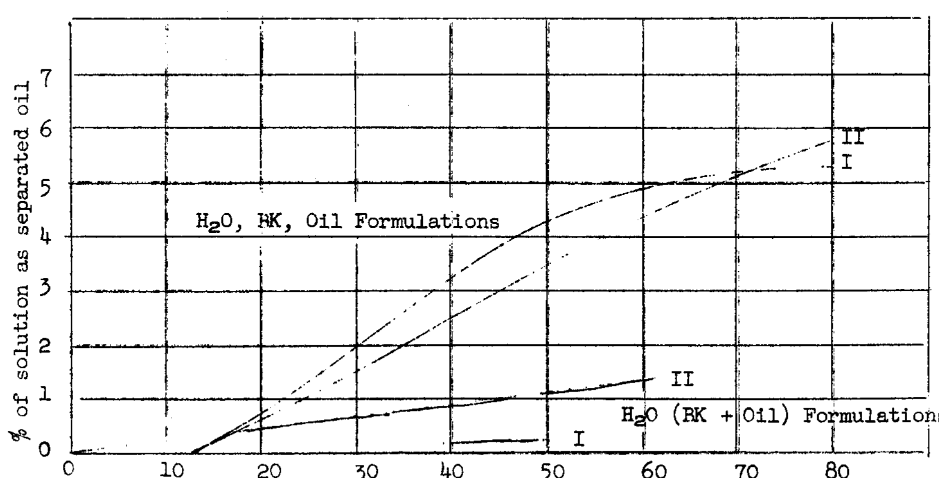
A Hardie Sprayer mounted on a power wagon was secured for this experiment. The sprayer had a one hundred gallon tank which was agitated vigorously with paddle and bypass agitation. One gallon of brush killer was added to eighty-nine gallons of water and then ten gallons of oil were added. The order of addition, then, was: Water, brush killer and then oil, each added separately. The solution received maximum agitation for several minutes after which samples of liquid were taken from the top, middle and bottom of the spray tank. Figure 2 shows the oiling out rate of two prominent brush killer formulations. As you can see, oiling out is greatly increased when the oil is not premixed with the emulsifiable concentrate. This oil that rises to the surface has not had a chance to dissolve any emulsifier, and consequently, just doesn't emulsify. The bottom two lines show how much less oiling out occurs when oil and herbicide are premixed.

Therefore, for any herbicide-oil program, it is recommended that the user mix oil and herbicide first then add this mixture to water. An excellent emulsion can be obtained in the following manner:

Start adding water to the spray tank. Immediately, add premixed oil and herbicide. Continue adding the rest of the water. In cases where bypass agitation alone is used, this procedure will yield excellent emulsions.

Figure 2.

OILING OUT RATES AS A FUNCTION OF ORDER OF ADDITION



4. NOW, WE HAVE AN EMULSION MADE, BUT HOW GOOD AN EMULSION IS REQUIRED FOR GOOD BRUSH CONTROL?

For maximum brush control, we want the largest possible spray deposit on foliage for a given volume of spray. Ben-Amotz and Hoskins[1], way back in 1937, found that maximum oil deposit is obtained with merely a mechanical mixture of oil and water. As more and more wetting agent was added, deposit actually decreased.

These results have been explained by Gladstone[3]. A tight emulsion consists of oil surrounded by water. When water hits the waxy outer layers of a plant, water will tend to ball up and run off and the herbicide is lost. Also, laboratory tests show that if there is a lot of wetting agent present spray deposit is minimized in that run off is reached with less spray. So, a tight emulsion results in less herbicidal spray deposit on a plant.

Conversely, in a relatively loose emulsion, when spray hits foliage, the oily portion of the spray drops out of the mixture and wets foliage with more of the active ingredient. The water can run off leaving an oily layer behind resulting in better brush control.

Accordingly, many herbicide formulations are designed to give only adequate emulsification of the oil solution in water. The emulsions are relatively fast-breaking so that when a spray hits foliage, maximum deposit may be obtained and consequently better brush control may result. The addition of wetting agents in the field may reduce spray deposit though the leaf appears to be wetted better.

5. HOW MUCH AGITATION IS REQUIRED FOR THE EMULSIFICATION OF HERBICIDES PLUS OIL?

Based on what has been related so far, it can be seen that emulsification of oil plus herbicide is a hard job. Therefore, one needs agitation to break up and disperse the oily phase into the aqueous phase. Excellent emulsions can be obtained with either paddle or bypass agitation. Greater precautions must be observed, however, in making up emulsions using bypass agitation alone. The ratio of volume of solution through the bypass to spray tank volume should be high to achieve good dispersions. In other words, a high capacity pump is essential. Sufficient time should be allowed for the complete solution to pass through the bypass system several times--the chemical engineers tell us that six times are required.

The contractor who uses bypass agitation alone is confronted by a problem that the contractor who uses paddle agitation does not have. This problem is the homogeneity of the spray solution at the time of spraying. When the contractor sprays from a rig with bypass agitation alone, the volume of solution returning to the spray tank drops to a minimum. The spray solution is virtually without agitation. Now all emulsions on standing without agitation will separate into two phases--a concentrated and a dilute phase. The rate of separation will depend upon the manner of mixing ingredients, the hardness of the water, water temperature, and the extent of the agitation. This rate of separation will vary a great deal with every spray rig and may cause variations in the concentration of herbicide of from ten to fifty per cent in the first ten minutes after agitation has stopped. Large concentration variations could have serious consequences in producing erratic results. Therefore, the contractor should insure himself that his method of operation results in homogeneous solutions. The contractor can do this very easily by taking samples of spray solutions from various sections of the spray tank at various time intervals. He should then observe the amount of phase separation in each sample to see how much variation he actually is obtaining in his mixing procedure.

It should be recommended that paddle agitation will assure homogeneous spray solutions. The contractor should be very careful in using bypass agitation alone.

6. CAN SPRAY DRIFT BE MINIMIZED THROUGH USE OF A PARTICULAR FORMULATION?

A problem that frequently arises in the use of herbicidal spray solutions is drift. Along highways and railroad right of ways, there are many areas that border highly susceptible crops and one just does not dare spray normal herbicidal spray solutions for fear the wind will carry the herbicide into the susceptible crop area. A recent development of the chemical industry to combat drift is the use of invert emulsions.

Invert emulsions are, as the word indicates, the reverse of normal emulsions. They contain minute droplets of water dispersed in oil and are, therefore, called water in oil emulsions.

A special formulation is required for invert formation. A special emulsifier has to be used which favors the formation of an invert. Then, too, the order of addition of chemicals is different for invert formation. Here one adds the oil and herbicidal concentrate to a spray tank first. Then the water is added to the oil with good agitation. As more and more water is added and the percentage of water in the spray mixture gets higher and higher, the spray solution becomes thicker and thicker. It is possible to add a sufficient amount of water such that a spray solution obtains almost a mayonnaise type consistency. This is obtained when approximately 85% water has been added. This thick emulsion can be sprayed using appropriate nozzles and the high viscosity results in large spray droplets which are relatively unaffected by wind. Merely adding oil to conventional oil-water emulsions does not reduce drift.

Invert emulsions have several plus factors. These are (1) that much larger herbicide deposits can be built up on foliage and (2) that good deposits can be obtained in spite of wet foliage. It is interesting that these invert emulsions can actually be sprayed in the rain and good brush control will result.

Figure 3 shows the type of deposit one can get with invert emulsions.

7. CAN THE ACTIVITY OF AN HERBICIDE BE ENHANCED SIGNIFICANTLY BY THE FORMULATION?

As is well known, the addition of oil to an herbicide has a significant effect on the activity of the herbicide. An oil program results in a faster more uniform brown-out and better control of pine. However, here are several disadvantages to an oil program.

In many out of the way places, it is inconvenient to carry in the extra oil, added oil is harder to emulsify, and a larger percentage of resprouting of brush is likely to occur. Also, oil and the labor of handling it is expensive. It would be ideal if an emulsifiable concentrate could be designed which would be as effective as an herbicide plus oil but without having to add any oil.

"Forron"* promises to fulfill these requirements. It has been under test for the last several years and many of you have had a chance to evaluate it. Brown-out is obtained with "Forron" just as fast as with brush killer plus oil. Brush control is in many cases better than an oil program. No oil needs to be hauled into out of the way places because "Forron" is designed for use without added oil. Homogeneous spray solutions are easily obtained from "Forron" thus reducing the concern a spray operator needs to give to his sprayer agitation requirements.

"Forron" contains an "extender" specially developed by The Dow Chemical Company. This extender causes the herbicide to penetrate foliage and translocate into the stem better than an herbicide plus oil. Brush control results look exceedingly good with "Forron".

Today, we have tried to review some of the fundamentals of the emulsification of herbicides. We have reviewed the components of a formulation and how a formulation is made to emulsify. We have reviewed some of the problems that one encounters in emulsifying added oil to herbicides. We have reviewed how spray drift can virtually be eliminated through the use of invert emulsions. We have mentioned how a specially designed emulsifiable concentrate will have the effect of oil without the use of oil. There is more and more research being done by many companies to make herbicidal emulsions handle and perform more effectively. This is not the end, this is a continued story.

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*Trademark of The Dow Chemical Company

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Survey of Brush on Pole Line Rights-of-Way

C. J. Waldron 1/

The people responsible for pole line right-of-way maintenance are usually required to set up year-to-year schedules so that funds can be budgeted for this purpose. In order to estimate costs and decide on methods to use it is necessary to have details on condition of the unwanted vegetation.

In its contract forms for electric and telephone line construction the Rural Electrification Administration defines right-of-way clearing units as one thousand feet in length, having widths in multiples of ten up to one hundred feet. Width depends on type of line to be constructed. The length to be cleared is measured in a straight line parallel to the line between poles and across the maximum dimension of foliage cleared (not trunk) projected to the ground line. All trees and underbrush across the width of the right-of-way are considered to be grouped together as a single length in measuring the total length of clearing. Spaces along the right-of-way in which no trees are to be removed or trimmed or underbrush cleared are omitted from the total measurement. All lengths thus arrived at, added together and divided by one thousand, give the number of thousand-foot units of clearing.

This clearing unit deals only with length of right-of-way of specified widths for estimating and bidding clearing costs. In itself it requires no data on species, height or density of growth to be cleared. No comparisons of unit costs reflecting the effect of these variables can be made until supplementary data are obtained.

Experience with REA borrowers has shown the advisability of including in the survey of brush on pole line rights-of-way the following data:

1. Location and number of clearing units of specified width.
2. Terrain (grades, natural obstructions, and accessibility).
3. Growth conditions (average height and density).
4. Species present and relative count of those predominating.
5. Available water for foliage spraying.
6. Location of crops grown near rights-of-way that may limit method and time of spraying.

Items 5 and 6 are applicable for consideration of chemical treatment. Item 4 is much more necessary for consideration of chemical treatment than for other methods.

Time spent in the office to plan field work required for the survey will result in greater accuracy of data obtained, as well as the expenditure of a minimum amount of time on the field work. Data that are useful for planning the field work include records of clearing for construction and of reclearing work. System maps should be available, showing location and number of units originally cleared as well as those recleared, and dates when such work was done. Knowledge of rate of growth in representative portions of the system

1/Electrical Engineer, Rural Electrification Administration, Washington, D.C.

will be of value in determining frequency of reclearing, widening or other maintenance work. Supervisory personnel who drive along most of the important lines at least once a year can take data that will prove invaluable in keeping records and maps up to date. Mileage of line requiring maintenance and total line miles traveled can be recorded from the vehicle odometer. Other significant data easily seen can be recorded and later transferred to records and maps in the office. If there are no records of original clearing or of maintenance work previously done, it will be necessary to take observations on a purely sampling basis on five to ten percent of the total system mileage.

In conducting the survey, observations should be made at enough locations to assure that all important conditions have been represented. If conditions are fairly uniform, a relatively few observations will be required. Grouping according to species and age (or time since last right-of-way maintenance was done) will enable the person making the survey to determine where and how many observations he should take.

Species is of great significance when chemical treatment is to be done and should be recorded by name and relative count of those predominating on the section being sampled. Density and height are also recorded on a sampling basis and can most conveniently be indicated by symbols.

Density (crown cover) should be considered as a maximum horizontal dimension of the foliage cleared, projected to ground level. It is expressed as percent of ground area overhung by foliage of the woody growth:

Heavy - over 70 percent cover
Medium - 40 to 70 percent cover
Light - 10 to 39 percent cover

The survey should also include grouping according to average height of the major portion of the growth:

Tall - over 15 feet
Intermediate - 10 to 15 feet
Short - 4 to 9 feet

If desired, a different provision could be made for "tall" growth, classifying by diameter all trees over four inches in diameter near the ground. This procedure would largely eliminate the "tall" classification for brush and would involve a count of individual trees. Growth less than four feet tall would not require immediate clearing and could be recorded as "very short" for future reference.

By classifying all the brush according to density and height a maximum of nine groups would be recorded:

HT--heavy tall	MT--medium tall	LT--light tall
HI--heavy intermediate	MI--medium intermediate	LI--light intermediate
HS--heavy short	MS--medium short	LS--light short

Sufficient records should be kept of right-of-way maintenance work done so that past work can be analyzed in planning future work. These records, together with data acquired from the brush survey, are essential to the planning and execution of an economical and effective long-range right-of-way

The Theory and Practice of Successful Selective Control of "brush" by Chemicals.

William C. Hall[1] and William A. Niering[2]

In "brush" control work weed killers are being used primarily as broadcast or selective sprays. The former involves the application of the chemical to all the brush comprising a mixture of trees and shrubs, and incidentally all herbaceous vegetation as well, whereas the selective technique emphasizes treating only those plants which are undesirable in any given situation and preserving all others. Over the years the broadcast technique has been most widely employed because it is initially inexpensive, simple to apply and requires little or no knowledge of the plants being treated. However, in recent years, at this conference and elsewhere, there has been increased concern among wildlife agencies, conservation groups, some progressive utilities, and private citizens that greater benefits are derived from the selective approach whereby all the facets of the problem are intelligently evaluated.

What is the theory behind the selective approach? In commercial application it usually involves the removal of potentially tall growth, usually trees with a minimum of injury to the low plants including shrubs, broadleafed flowering plants and certain grasses. The presence of this low growth, especially the shrubs, which remains tends to keep out invading forest trees, thereby maintaining the line with a stable low-growth type over the years. This desirable plant cover will directly reflect low maintenance costs on a long-range basis. In addition, conservation benefits specifically result in better wildlife and game habitat as well as in the preservation of the native flowering plants. This ultimately results in an aesthetically desirable picture and therefore good public relations to the company.

Can selective spraying be done by regular spray crews? Yes. There is no problem if this is the aim of the client and contractor. However, the following points should be taken into account:

1. Work crews must understand the objectives to be achieved.
2. The foreman need not necessarily be technically trained. However, both he and the crew must be taught to recognize those plants which are to be saved.
3. At the start of each job, the foreman and crew must be closely supervised.
4. The quality of the job will be directly dependent upon how seriously the men have taken the assignment and how well the foreman has done his job.

[1] Arboreal Associates, Harriman, New York

[2] Associate Professor of Botany, Connecticut College, New London, Conn.

With regard to application several techniques have been successfully used in commercial practice; their effectiveness related to the degree of selectivity desired. Among the most effective is the oil basal technique. However, stem-foliage sprays have also been adopted by the senior author to this approach using Ammate, 2,4,5-T, 2,4-D and 2,4,5-T in combination and amino triozole. Soil treatments with urea compounds show considerable promise for selective work.

As would be expected in comparing the techniques, greater root-kill is attained with the oil basal and least disturbance occurs to the low ground cover. However, with good specifications and careful supervision much of the ground cover can be spared and good control of many woody species can be ascertained with stem-foliage sprays.

What species have been treated, with what effectiveness, and what plant cover has been preserved? In the northeast, the basal treatment using oil and 2,4,5-T has been effective on practically all tree species treated at any time of the year, except root-suckering species which are most easily eliminated by late summer applications. With the stem-foliage sprays good control of red and chestnut oak, sugar and red maple, ash, elm, hickory, black locust, linden, birch and wild cherry has been observed by the senior author. As a result of selective spraying, areas dominated by trees and shrubs have been converted to laurel, huckleberry, blueberry, viburnum, azalea, dogwood, hazel and sweet fern along with the existing broad-leafed flowering plants and grasses.

How does this approach compare with less selective treatments? Initially the cost may be higher. However, since better control of the unwanted plants is attained initially and fewer treatments are needed costs tend to compare favorably when prorated over the years. After more than five years of experience with selective spraying the senior author has found the selective approach competitive with less selective techniques when all benefits are evaluated.

In practice, this approach is applicable to brush control along roadsides where "brush" interferes with visibility. Here, in general, only trees are removed, except on the inner sides of curves where both trees and shrubs might have to be sprayed for good sight line conditions. By following this approach unsightly brown cuts are minimized and the existing native shrubs and wild flowers which are spared serve to enhance the beauty of our roadsides. When this approach is applied on power lines, the trees and other tall undesirable growth directly under the wires are selectively removed. Low shrubby growth is preserved. On the edges beyond the outer lines only the potentially tall growing trees are sprayed since taller growth can be tolerated here. Regardless of the situation the basic idea is to fit the spray technique to the particular "brush" control problem at hand and accomplish it as selectively as possible.

In conclusion it may be stated that this approach is no longer a theory. It has had an adequate test in practice by several commercial companies. The present condition of the lines after more than five years of observations throughout the northeast is adequate proof that this approach not only accomplishes the objectives of the client but benefits the wild life, the hunter and naturalist in addition to providing good public relations to the company The question may yet be asked, how well will the shrubs tend to keep out trees and take over future maintenance? Although many situations could be cited, two areas are of especial interest. After five years on the right-of-way demonstration area at Penn. State the investigators state that the tight low shrub cover resulting from the selective basal treatment has held back the development of seedlings, sprouts, and suckers for at least five years. On a line at Ten Mile River, New York over fifteen years has passed and shrubs are still doing the job. The selective approach has been proven. It merely awaits application by those who are sufficiently progressive to employ it. Again, however, it should be mentioned that to get selective work one must want it and work for it; one must provide good supervision and get his crew foreman saving the right plants at the start of the job. One must check his work if the selectivity is to be achieved for maximum company and public benefit.

PLANS FOR RAGWEED CONTROL PROGRAM IN NEW YORK STATE*

By

Alexander Rihm, Jr.
Executive Secretary
Air Pollution Control Board

Air is a vital, natural resource without which we can live only a few minutes. It also is a commodity which is easily polluted. For example, while you are sitting in this room listening to me talk, while you are merely performing the normal, involuntary function of inhaling and exhaling, you are polluting the atmosphere with carbon dioxide, bacteria, viruses and a number of other things.

Several of you are smoking. You also are polluting the air, the natural resource we all must utilize to stay alive.

These things are pretty obvious to you all, I'm certain. I point them out merely to demonstrate that in our ordinary, everyday experience there really isn't any completely pure air. Go into the wilderness far removed from our fuming, industrialized civilization. Even there the atmosphere is polluted by nature -- with molds, pollens, insect parts, products of vegetable, mineral and animal decomposition, and by spores and dusts of every conceivable kind.

For many years, man has taken limited steps to protect air, our most valuable natural resource. Smoke control ordinances, for instance, have been in effect since the 13th century. More recently, communities have become more concerned with control of some newer contaminants in the atmosphere and ordinances are being passed prohibiting dust emissions, odoriferous compounds, and similar substances. We have become concerned, also, with the so-called natural atmospheric contaminants which I mentioned a moment ago. These are contaminants which become airborne by natural means or as an indirect result of man's activities. Pollen is one of these natural contaminants.

At a recent meeting in Paris‡ of medical scientists from 40 nations it was announced that allergies now rate third, after cancer and heart ailments, on the list of diseases in France and the United States. Furthermore it was reported that allergies are on the increase -- pollens in the United States are the principal cause of allergies.

In New York State alone, somewhere between one and two million people suffer from pollinosis. Of these, gross estimates indicate that about one million or more suffer longer than six weeks each year because of the presence

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* Presented at the Annual Meeting of the Public Health Secetion of the Northeastern Weed Control Conference, Hotel New Yorker, New York City, January 8, 1959.

‡ November, 1958.

of ragweed pollen in the air. If we use nationally accepted figures, 30 per cent of these people eventually develop chronic asthma.

People who react to pollen are affected to various degrees, ranging from minor nose and eye symptoms to complete invalidism. Once a person is sensitized he remains so and will continue to exhibit symptoms each time he is exposed to a sufficient concentration of the sensitizing agent.

Pollen in the atmosphere may come from various sources. Five grasses in New York State - timothy, red-top, sweet-vernal grass, Kentucky blue-grass, orchard grass - cause most grass reactions.

Trees, too, cause pollinosis: oak and birch for instance, and certain fruit trees, cause serious reactions among sensitive people. For obvious reasons, however, there is little that can be done to control grass pollens and tree pollens because these are important economic crops.

Control of ragweed pollen presents an entirely different situation. Here we have a plant which is of only minor economic importance. It is a plant which quickly takes over abused, neglected land from which it extracts nutrients and grows prolifically on seemingly barren soil. It does have one minor economic value, though; it stabilizes the soil and prevents erosion until more permanent grasses can be established.

Because it does take over quickly on abused or neglected land, it thrives along highways, in vacant lots, and on abandoned, poorly cultivated farmlands. Short ragweed flourishes in relatively dry areas while giant ragweed is more commonly found in wetter areas. By far, the largest part of the hay fever problem in New York State can be attributed to short ragweed.

If we could increase the fertility of all abused and neglected land in the United States, establish good grass cover on it and control ragweed in farm crops, we probably could reduce ragweed pollen concentrations to the point where few people would react.

Let's go back for a minute: in 1951 the New York State Joint Legislative Committee on Natural Resources began a study of atmospheric pollution. The committee adopted the idea that pollen because of its air-borne nature and because it causes serious health problems is an atmospheric contaminant with which the State should be concerned.

Pollen generated in one New York State community is readily transported by atmospheric currents to other communities. In fact, pollen can be transported over such long distances that it is really a federal, perhaps even an international, problem. With these considerations in mind, pollen was defined in New York State Air Pollution control legislation as an important contaminant with which the Air Pollution Control Board would be concerned.

Even before the New York State Air Pollution Control Act was passed, laws in force and effect provided municipalities with power to control noxious weeds. Towns, villages, cities and counties all have power to control ragweed, and many municipalities conducted control programs with varying success.

Generally, however, none of these campaigns was successful because a significant reduction in pollen concentration could not be demonstrated. To my knowledge, only one limited epidemiological study was conducted to determine whether ragweed control in a small area could be successful and this study, conducted in a borough of New York City also showed that pollen control on a limited area basis was relatively unsuccessful.

If the cause of disease is known, steps can be taken to prevent it. Therefore we, in New York State, have organized a program which we believe will eventually lead to its control.

In making our plans, we enumerated what we know about ragweed and what else we must know before we can conduct an intelligent control campaign. First of all, what do we know?

1) We know that a number of people are what we might term "allergy-prone". They might react only to ragweed or they might react to a host of allergens. In fact, they may react to other allergens and not to ragweed. As much as ten per cent of our population is allergy-prone.

2) We know that ragweed pollen produces allergic symptoms in a high percentage of allergy-prone individuals.

3) We know that ragweed pollens are readily transported long distances by atmospheric currents. Ragweed pollen, for instance, has been found in Greenland, which has no ragweed plants.

4) We know that, with the exception of two limited areas, ragweed flourishes throughout New York State and produces pollen from about the middle of August until the plant is killed by frost; that the production of ragweed pollen is dependent upon the length of the day and not on the age of the plant, degree of fertility, and other factors.

5) We know that ragweed flourishes on disturbed land of poor fertility, that it will not germinate and flourish on well-established, fertile grassland.

6) We know that individuals vary in their sensitivity to ragweed pollen.

7) We know that most people cannot recognize the ragweed plant.

8) We know many characteristics of the ragweed plant, such as the amount of pollen it produces, the time of day when most of it is produced, how it is produced.

9) We know that ragweed plants can be killed by mowing close to the ground, and by certain chemical sprays.

With all we know about ragweed, how it grows, and what effect it has on our population, it would seem that there is enough information available for us to begin a program to eliminate this source of pollinosis. There are, however, important links missing in our chain of knowledge. What are some of these?

1) We know that ragweed is transported long distances but we need to know whether its ability to sensitize is influenced by weathering, by moisture, high temperatures and sunlight in the atmosphere. It is extremely important to know this because this factor alone governs the size of the area which must be effectively controlled.

2) We need to develop improved techniques for sampling pollen.

3) We need to know more about the mechanisms of sensitization, about how much of a pollen **dose** sensitizes an individual and makes him susceptible to hayfever. We need to know what other factors, such as diet, fatigue, emotions, temperature, and humidity, enter into this dose-response relationship. We need to know if there is a threshold below which ragweed sufferers do not exhibit observable symptoms. We need to know if this threshold varies from individual to individual and if so, what percentage of the population might be expected to react at what concentrations.

4) We also need to know more about the meteorological factors affecting the dispersion of pollen in its broader sense; how daily pollen releases may be related to weather; the effects of solar radiation, air temperature, humidity and wind speed and manner of dispersion once it is airborne.

5) We need to know more about the fate of pollen in the atmosphere, where it goes, and what happens when it settles on soil or water.

Knowing some facts, and what we need to know to fill in the missing links in our chain of information, a long-range program was designed by the Air Pollution Control Board. We believe it will eventually lead to diminution of ragweed pollinosis in New York State.

It is evident that any program such as this will not succeed without public awareness of the problem and of control efforts which are being attempted. With a fully informed public, needed financial support, private and official assistance and cooperation can be obtained. People must recognize what is causing disease, they must know what they as individuals can do, they must be brought in to assist in the program. Only in this way can their support be gained.

Information and education, therefore, is a first step in this program. The New York State Air Pollution Control Board has already embarked on this activity. Last summer, films for television presentation were prepared to assist the public in recognizing and controlling ragweed. A pollen sampling and counting network was set up, and during the ragweed season, with the cooperation of United Press International, local radio and television news services, ragweed counts were made available to all local news services in the state.

Secondly, a research program is being designed to find answers to some of the missing links in our chain of information. The Air Pollution Control Board assist in designing a research program, and funds already have been requested in next year's budget for support of these activities.

Finally, we will conduct scientific programs, in cooperation with local agencies, to demonstrate the types of control efforts which can be exerted on a community basis. We will do extensive sampling of the atmosphere as part of these studies and correlate the results with epidemiological and meteorological data in order to evaluate our efforts to reduce pollinosis. Our work will be guided by our Technical Advisory Council, the membership of which is made up of leaders in several fields which contribute to a knowledge of pollinosis.

Although we need to know a great deal more about ragweed, there is one thing of which we are confident: that if all of us bring our energy to bear on a hay fever relief project, the least we can accomplish is a giant step toward making life more livable for the half-million sufferers in our state.

And, who can say exactly how far this step will take us?

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BOTANICAL RESEARCH ON ATMOSPHERIC POLLUTION

W. H. Wagner, Jr.

The University of Michigan Project on Atmospheric Pollution by Aero-allergens is directed by Dr. John M. Sheldon (Medical School) and Dr. E. Wendell Hewson (College of Engineering) under Public Health Service Research Grant No. E-1379. This is a cooperative enterprise, utilizing the professional viewpoints and techniques of medical, meteorological, public health, and botanical researchers in order to develop a comprehensive program of study of aeroallergen-producing plants and their pollen, of the means by which pollen is dispersed in the atmosphere, and of the nature of the physiological reaction of sensitive individuals. The immediate goal is to better our understanding of fundamental aspects of the problem. The botanical research of the last several year s has focussed on the ragweeds. As background for this work, one of the primary contributions has been "An Annotated Bibliography of Ragweed (Ambrosia)" which is soon to be published. and which brings together the published literature on all aspects of the biology of ragweeds for ready use by members of the different fields. The botanists have also concerned themselves with providing plants for extra-seasonal experiments, with ascertaining the causes of flowering in different areas, the origin and migration of the species of ragweeds, the destruction of pollen in the s oil, the production and discharge of pollen by the flowers, and the biology of the pollen grain, including the growth of the pollen tube.

It is our belief that the life of the ragweed plant needs to be understood in all its phases. A study of the biology of ragweeds may ultimately aid us in devising better methods of control of either the whole plant or of the production of its pollen. Such problems as why some years have apparently heavier pollen loads than others; or why for periods of several days during a given season, the amount of pollen in the air diminishes, are ones we seek to understand. Numerous other botanical questions brought up by our colleagues who are working on other aspects of the aeroallergen problem force us to examine the plant more carefully than ever before.

One of our primary activities has been to prepare plants for pre-seasonal experiments, at a time when only the pollen of artificially grown ragweeds would be in the air. This was necessary since during the regular ragweed period, the plants are scattered over the countryside and we needed a technique to localize the source. A small experiment using only 136 pollen-producing plants in June, 1956, was so encouraging that it was greatly expanded in 1957 and 1958, when over 3000 plants were closely grouped in a circle about 26 ft. in diameter and set out in an open field. The plants for these experiments were grown in greenhouses of the University of Michigan Botanical Gardens from seed planted around April 1st of each year.

If care was not taken, however, the plants would flower too soon and att too small a stature, so the gardeners exposed the seedlings to artificial light during the first month or so of growth, to extend the day length to over 12 hours. This treatment finds its basis in the studies of Garner and Allard (1920) who showed that ragweed would reach the flowering stage in only

27 days under shortened light exposures less than 12 hours, in contrast to 85 days for the full-day control. Thus it was necessary to supplement the shorter days of April and early May with artificial light in order to have plants large enough to produce ample pollen in June. The pre-seasonal experiments were carried out with a pollen source some 60 days before the regular pollen season, and the botanists were able to make a number of careful observations on pollen production during these experiments. The meteorologists and medical workers simultaneously carried out studies on the atmospheric dispersal of pollen and the effects of the pollen source on volunteer sensitive persons.

These experiments were conducted with the "low" or "common ragweed," *Ambrosia artemisiifolia* var. *elatior*. This, and the "giant ragweed," *A. trifida*, are probably the most important causes of ragweed hayfever in northeastern and central United States, but other species and varieties also possess varying degrees of importance in the problem. We have found by bringing together varieties of common ragweed into the greenhouse and growing them under essentially uniform conditions that their behavior in terms of growth period and pollen production differs widely. In 1958, plants were obtained from Nova Scotia and Louisiana to compare with the variety common in southern Michigan. The plants from Nova Scotia and Louisiana were picked as young seedlings and transferred to the University of Michigan Botanical Gardens; the plants from S. Michigan were observed in the field. The following data resulted:

	NOVA SCOTIA	MICHIGAN	LOUISIANA
Approx. time of germination of seeds	June 1	May 1	April 1
Began flowering	July 15	August 15	September 15

This preliminary study emphasizes the genetic diversity that exists in one species, *Ambrosia artemisiifolia* over its wide range, a diversity which is reflected also in the structure of the plants—the plants from the far north tend to be very much smaller than the "giant" plants of the south.

The perennial ragweeds, *Ambrosia coronopifolia* and *A. psilostachya*, are less common than the others except in the west, but they have a special interest in the hayfever problem because of their tendency to produce pollen two or three weeks ahead of the annual species. Because of this fact, and because the perennial ragweeds seemed to be invading Michigan and spreading their ranges eastward, we made a special study of these plants in this state. We discovered the perennial ragweed, *A. coronopifolia*, in 18 new counties, bringing the total to 43. A careful survey of the historical evidence reveals that it was probably wholly introduced from further west where it is native. No collections of this species are known in Michigan prior to 1900, although many botanists explored the state in the last century. It forms large clones by proliferation from roots in disturbed habitats such as roadsides and railways, especially around populated areas, and, unlike the annual species, *A. artemisiifolia*, it can invade grassy fields. The substrate is

A. coronopifolia are smaller than those previously reported in A. psilostachya (20 microns in diameter rather than 23), and the chromosome number is 2n = 72.

An heretofore undescribed perennial ragweed, Ambrosia X intergradiens was discovered that differs from A. coronopifolia in hairiness, color, leaf cutting, petiole length, and fruit structure. Its characteristics are intermediate between the latter and the annual A. artemisiifolia and it is interpreted as their natural hybrid. The new ragweed turned out to be unexpectedly common, and a large number of populations have been observed in 15 counties of Michigan. It will probably be found elsewhere where the two parental ragweeds grow together. It inherits the perennial reproductive ability of A. coronopifolia and is therefore able to form large populations, but these are mainly or wholly sterile, only 16 per cent of the flowers forming normal-appearing fruits, and only 45 per cent of the pollen grains containing living matter. Pollen size of this complex of ragweeds correlates with chromosome number: A. artemisiifolia with 2n = 36 has the smallest; A. coronopifolia with 2n = 72 is next; and A. psilostachya with 2n = ca. 108 is largest. The new hybrid perennial ragweed does not fit into the sequence, but its grains are so variable and its division processes so irregular that this probably affects the size of the pollen. It is our belief that a full understanding of the evolution and migration of ragweeds will have to include studies in warmer regions in southern U. S., Mexico, and elsewhere; they cannot be confined only to peripheral regions like the Great Lakes region and California.

We have been concerned not only with the source, production, and dispersal of ragweed pollens; we have also wondered where all the atmospheric pollen load ultimately goes. What happens to the pollen that falls out of the atmosphere? Mr. Solomon Goldstein, a mycologist, has made preliminary investigations of this problem by collecting not only ragweed pollen, but 32 other species of plants that produce air-borne pollen, and exposing them to conditions that would test whether they are destroyed in the soil or on water surfaces by fungus action. Pollens were gathered by allowing mature anther sacs to open over paper at room temperature. With ragweed, however, the flower parts had to be macerated with mortar and pestle to liberate the grains, for reasons that will be apparent below in the discussion of pollen discharge of ragweed. When not in use the pollen was stored in a deep-freeze in capped bottles. Samples of soil were gathered from the top 2 cm. of the ground and usually within 1½ hours the soil samples were placed in sterile petri dishes and covered with a layer of ca. 0.5 cm. of sterile tap water. The pollen grains were dusted on the surface of the water, one kind to one culture dish, and each day microscope slides were made by touching a slide to the surface of the water, staining the attached material with acid fuchsin and sealing with a cover-slip. The results of 140 cultures, recorded in terms of number of grains infected per 100 grains counted per slide, indicated that fungi certainly must play a role in the destruction of pollen grains in the soil. There was no specificity between any of the pollens employed and any of the fungus attackers encountered in this study, but there is a variation in degree to which the various pollens are susceptible to attack by the two most commonly found chytridiaceous fungi (Rhizophydium and Olpidium). Some pollens never showed more than five infections per 100 grains, while others were attacked totally. In general, whether wind-borne pollen grains land on damp soil or in the water of lakes and ponds, we can expect a high degree of action on them by fungi, action which will vary in terms of the part of the grain affected (i.e., contents, or wall, or both) and intensity of attack (some species being more readily attacked than others).

The production and discharge of pollen grains from ragweed has been a center of botanical attention over the past three years, and in 1958 our group was joined by Messrs. Donald E. Bianchi and Donald J. Schwemmin, plant physiologists, who carried out controlled experiments on some of the processes involved. The staminate or pollen-producing flowers of ragweed are small tubular structures, a few millimeters long. Approximately ten to twenty of these flowers are borne together in green cups or involucres, the latter attached to terminal stems five to twenty millimeters long, fifty to a hundred or more involucres per "spike." The tubular flowers themselves develop in sequence throughout the pollinating period, so that at any one time some of the flowers in an involucre are still embryonic and undeveloped, others are ready to release their pollen, and others have already discharged it. (The female or seed-producing flowers of ragweed are entirely different in appearance, and are located below the terminal "spikes" in the axils of foliage leaves). Our studies of the structural and functional changes that take place in the flowers of ragweed have led to the following outline of important steps:

1. Maturation of flowers.--This involves the biological background of the growth and maturation of the plants themselves and whatever seasonal and meteorological factors govern this.

2. Presentation of Pollen Sacs.--The extension depends on processes within the plant that enlarge the cells of the anther stalks and thus push the pollen sacs out and push open the petal lobes of the flowers. It takes place in early morning prior to dehiscence of the pollen sacs and release of pollen. The mechanism of extension is apparently controlled by cell enlargement, which is, in turn, presumably caused by water uptake and inflation of the cells along a longitudinal axis.

3. Opening (Dehiscence) of Pollen Sacs.--Dehiscence is controlled mainly by the relative humidity and rainfall. The time is usually between 6:30 and 9:30 a.m. It may be an abrupt process, involving all the plants of the population in a period of only 15 minutes; or gradual, extending over several hours. If the relative humidity is very high, the opening of flowers may not occur.

4. Flotation of the Pollen.--This depends on wind. Flotation may be accomplished slowly or fast, at any time during the period following dehiscence and depending on wind factors. The stickiness of the pollen clumps may modify this to the extent that the pollen clumps are held more or less to the foliage surface and (or) to the sides of the pollen sacs.

5. Dispersal of the Pollen.--Once in the atmosphere, the distribution depends on the activities of the air mass. During the course of the travel of the grains, there may be biological changes taking place, such as modifications of the substances on the surface of the grain, or changes in the viability of the pollen.

6. <u>Extension of the Pistillodium</u>.—The pistillodium is a peculiar vestige of the pistil in the otherwise all-male or staminate flower; it has the form of an umbrella and during the primary opening of the pollen sacs it lies concealed deep in the tube of the flower. At a period of several hours after opening of the pollen sacs, however, it extends, probably by the same mechanism as the pushing out of the anthers. The pistillodium seems to function as a "sweeper" of such pollen grains that still remain between the open pollen sacs.

7. <u>Withdrawal of Pollen Sacs and Closing of Flower</u>.—This happens sometime late in the same day that the flower functioned. It is apparently an irreversible process: once a flower has discharged its pollen, it closes, never to open again.

Previous observations had indicated the diurnal periodicity in the release of pollen from ragweed plants. The process of release is more complicated than that in most aeroallergenic plants, and this explains why pollen cannot be collected merely by removing flowers from the plant and laying them on paper, as described above; apparently the processes are quite sensitive and require a fairly complicated series of life reactions before the anther-sacs will extend and open the flower. The purpose of the studies by Bianchi and Schwemmin was (a) to confirm and define our observations; and (b) to investigate the environmental factors which are responsible for the initiation and control of the diurnal release.

Observations during the pre-season experiment of 1958 confirmed the diurnal periodicity of the pollen release and demonstrated that this dehiscence of the pollen sacs occurred generally between 6:30 and 8:00 a.m. During this period in which floral activity occurred there was a marked drop in the relative humidity, a rise in the temperature, and an increase in the solar radiation.

Prior to the actual release of the pollen, the flower proceeds through a developmental sequence which brings about the elevation or presentation of the pollen sacs above the corolla. This appears to be due to the elongation of the stamen-stalks or filaments. The pollen sacs then break apart, exposing the pollen mass. It was possible to demonstrate experimentally that the extension of the pollen sacs could be controlled by varying the temperature. The extension process could be inhibited by incubation of the flowers at reduced temperatures. This inhibition was reversed by exposure to a second elevated temperature.

By regulating the relative humidity and the temperature of the environment, the actual release of pollen from the anther could also be controlled. The dehiscence process is simply a drying and splitting of the pollen sacs. Release of the pollen is thus stimulated by a rapid drop in the relative humidity and an increase in temperature. These experiments for the most part were performed with excised flowers. The application of the conclusions derived from these experiments to the results observed in the pre-seasonal experiments in the field must be made with some reservation. However, it should be pointed out that the field data do indicate that, just prior to the release of pollen, the relative humidity begins to decrease and the temperature throughout the entire period slowly increases from the temperature of the previous night. Continuing work on the production and discharge of ragweed pollen grains is being conducted.

The last of the aspects of our work concerns the biology of the pollen grain. This is a phase that has potential medical significance in regard to the source of the allergenic substances--Is the allergic reaction cause by substance on the wall of the pollen grain, the wall of the grain itself, or by the living contents of the grain? By devising techniques to cause germination of the pollen grain, and separating the living pollen tube from the inert wall materials, it may be possible to obtain some answers to these questions.

However, difficulties have been encountered by pollen workers in their studies of *Ambrosia* pollen because of their inability to germinate this pollen *in vitro.* Mr. Theodore F. Beals, plant cytologist, has attacked this problem in the attempt to find a suitable culture condition for germination and to determine the effects of various factors on the development of the pollen tube. Much time was spent fruitlessly exploring possible culture conditions before the truly limiting factor was discovered, namely that the age of the pollen was extremely critical. It was found that the viability of pollen under culture conditions very rapidly declines after the optimum peak achieved not long after release from the pollen sacs. A curve of percentage germination plotted against the age of the pollen (i.e., the number of hours a fter the pollen was released from the plant) shows typically a large peak at about 1½ hours, followed by a lower plateau continuing until the fourth hour. This is followed by a sharp drop in germination to about 10%, at which point the curve remains fairly level. It is a remarkable fact that this small percentage of germinability is maintained over long periods of time, and even after a year it is possible to obtain a low level of germination. The high peaks obtained on various strains of ragweeds from about 40 to 60 per cent germination, however, are never again obtained, after the critical post-discharge time of 1½ hours. It was also found in this study that normal species and varieties of ragweeds all have a fairly high level of germination, but the hybrid ragweed, *Ambrosia X intergradiens,* produced a mere 2 per cent of pollen tubes.

One of the difficulties present in this research thus far is that it has been impossible to carry the growth of the pollen tubes beyond one-twentieth or one-tenth of a millimeter. In the natural conditions, when the tube grows on the plant, it must grow for as much as one to two millimeters. Thus, it will be necessary in our future experiments to determine means that favor the continued development and expansion of the pollen tube that more nearly approximates the natural condition.

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ADMINISTRATIVE ASPECTS
of a
MUNICIPAL RAGWEED CONTROL PROGRAM

Israel Weinstein, M.D.
Former Commissioner of Health, New York City

Since hay fever is not a reportable disease, the exact number of persons who suffer from it each year is not known. However, the United States Public Health Service estimates that 5% of the inhabitants in the area east of the Rocky Mountains, with the exception of the Northern Great Lakes region, Northern New England and Southern Florida, suffer from hay fever caused by the pollen of ragweed. This means that over 8,000,000 people in the United States east of the Rockies are suffering from a disease that is preventable, and they are clamoring for relief. Moreover, it is generally recognized by allergists that the prevalence of this condition is increasing from year to year. In a report on chronic diseases taken from data collected in the National Health Survey conducted by the U.S. Public Health Service in 1935 and 1936, "hay fever and asthma" stood fourth in prevalence in a list of chronic diseases. Surely this condition merits the serious attention of all officials concerned with public health.

In the New York metropolitan area there are two varieties of ragweed that are commonly found. One is the short, dwarf or common ragweed (Ambrosia artemisiifolia) which reaches a height of 1 to 5 feet. The other is the giant ragweed (Ambrosia trifida) which grows from 5 to more than 15 feet tall. In this area the seeds start germinating about the first week in April. The plants begin to flower and produce pollen during the first or second week of August. This process continues until the seeds are mature, which usually occurs at the end of September or beginning of October. The plants bloom every year at about the same time, regardless of the extent of growth. Whether they are several inches tall or have reached their maximum height seems to be of no importance.

The ragweeds are prolific pollen producers. It has been estimated that each year an acre of ragweed can produce as much as 50 pounds of pollen. The pollen grains are exceedingly small. It would take more than one billion of them to fill a teaspoon. Most currents and may be carried a great distance. However, the concentration of atmospheric pollen drops rapidly as it is carried away from its source. It is not necessary to eliminate all the poller from the air. The majority of hay fever sufferers will get relief from their symptoms if the concentration of the pollen grains in the atmosphere falls below 25 per cubic yard of air.

The ragweeds are wind pollinated annual plants and reproduce only by seeds. Just as soon as the seeds are mature, the life cycle of the plants has been completed, and they die. The seeds fall to the ground and remain there until such time as conditions are favorable for their growth. They are very viable and can remain dormant for as long as 40 years.

Ecologists classify plants into three general categories: pioneer, intermediate and climax vegetation. This natural phenomenon is known as plant succession. The most important pioneer plant is ragweed. Wherever pioneer plants establish themselves they flourish over a period of years until the soil is such that it can support an intermediate group of plants (herbaceous perennials and grasses). This process may take 10 or more years. As the intermediate plants grow the pioneer plants are forced out. The ragweed is not only a pioneer, it is also a non-competitive plant. If undisturbed the intermediate stage gives way to climax vegetation, such as shrubs and trees. According to Dr. Wodehouse, theIndians had no hay fever because they lived in the primeval forest or on the native prairie. In those early days the land was covered with climax vegetation. As the white man built cities and highways and developed farms, climax vegetation was removed and much of the soil was left bare. Hay fever is nature's reply to man's wasteful exploitation of natural resources.

The hay fever sufferer may seek relief in various ways. He may receive a series of injections of specific pollen extracts to build up a resistance against the harmful effect of the pollen, or he may take certain drugs as the antihistamines. These personal measures are not always effective. The individual may protect himself by moving to a pollen-free area during the pollinating season; or he may install an air-conditioning or pollen-filtering unit in his home. Many, if not most, hay fever victims cannot afford these luxuries. A far better way of bringing relief is to treat the environment rather than the patient. With the discovery of the herbicide 2,4-dichloro-new field in public health was opened. It now became possible to eliminate ragweed from vast areas at a reasonable cost; in fact at only a fraction of that required for mosquito control.

2,4-D is a selective herbicide. In a concentration of 0.1 per cent by weight it kills broad leaf plants but does not affect grasses and some other resistant plants. The herbicide is absorbed by the plant, transferred to the lower stem and roots, causing the plant to starve. The spray should be well mixed and applied uniformly in the form of a coarse drenching spray. Care should be exercised not to allow any of the spray to wet adjacent desirable vegetation. The equipment should not be used for any other agricultural pest control work. 2,4-D is non-corrosive to equipment, and non-poisonous to human beings and animals.

In 1946 the New York City Health Department instituted a large scale ragweed control program. A number of other city departments cooperated. The Health Department was the coordinating agency. It assumed responsibility for planning the budget and providing technical and supervisory guidance. It also carried on education and public relations. Several ragweed sufferers' groups assisted in this part of the program.

The Borough Presidents' Offices, that have jurisdiction over the streets in New York City, had charge of the spraying. They engaged the labor and supervised the work.

The Department of Sanitation loaned the street flushers which were converted to provide power units for the spraying operations. The Department of Health and the Borough Presidents' Offices jointly undertook the equipping of the trucks. The Park Department sprayed ragweed growing on the property under its jurisdiction. The Police Department, through its precinct safety inspectors, mapped the city showing the location and quantity of ragweed.

Before the actual start of the program the Health Department in two trial operations found that when the herbicide 2,4-D was applied as a 0.1% solution, wetting about 90% of the plant foliage, it would kill the weeds without injuring the grasses. Approximately 200 gallons were found to be necessary for one acre of ragweed. A crew of 3 men could spray about 2½ acres a day of scattered city lots. One pound of 2,4-D powder was used to make 100 gallons the chemical at that time to approximately $2 an acre.

Critics of municipal spraying programs have maintained that it is a waste of public money for the city departments to do this work. They call attention to laws on the statute books requiring property owners to destroy ragweed on their premises. But attemps to enforce these laws have not only been costly in the time consumed, but in large measure ineffective. Many property owners could not be located. Others, in spite of instructions, destroyed the weeds after the pollen had polluted the atmosphere and seeds had fallen on the ground. Campaigns in the past to eliminate ragweed by cutting and pulling generally were failures. Wherever the soil was disturbed, dormant seeds were given the opportunity to germinate. Thus in a short time new plants appeared which pollinated and produced more seeds. There is no doubt that in any city-wide campaign for the destruction of ragweed the cooperation of the property owners should be sought. Effective help can often be obtained from those who live on their property or are otherwise using it. But the bulk of the ragweed in a large city is on vacant lots, along highways and in alleyways, and this must be destroyed by the municipal authorities.

Many people believe that a program for the elimination of ragweed within a local area is futile unless similar programs are carried out by neighboring communities within a radius of at least 50 miles. This is a mistaken idea. It has been shown by Wodehouse and others that ragweed pollen quickly loses its power to irritate as it travels through the air. In other words the closer the hay fever patient is to the plant the more irritating its pollen. The pollen that is blown for 50 or 100 miles is a negligible factor in bringing on sneezing and the other symptoms of the disease. This explains why there are resorts to which hay fever victims go for relief that are within comparatively short distances from areas where ragweed flourishes. Of course, every effort should be made to induce neighboring communities to eliminate ragweed in their own territory. But the fact that some of these communities might not react favorably to this idea is no excuse for a city to be derelict in its duty to its citizens. May I repeat, it is the local growth that is the important factor in initiating the symptoms of hay fever.

As in the case of any other public health program careful planning and adequate supervision are the factors necessary for success. Each year the accomplishments should be carefully evaluated, and the over-all plan modified in accordance with the lessons learned. If the same care and attention are given to ragweed destruction as are given to other public health campaigns as for example mosquito control, there is no reason why ragweed, and with it hay fever, should not be entirely eliminated from this part of the world.

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What Garden Clubs Can Do

Possibly because the word "garden" is part of the name of our institution, I have been given the topic "What Garden Clubs can do in the matter of weed control." Actually we have no more contact than any other group with the machinery of Garden Club operation. BUT, the fact that there are hundreds of thousands of Garden Club members over the land, and the fact that they have taken up every worth while cause within their reach that would make for better community living, makes it reasonable to assume that Garden Clubs can have an important role in certain phases of the weed control program.

If we reduce the weed control problem to its simplest terms, we can say that for well over a decade we have had knowledge of the technical means of destroying unwanted plants, and a number of communities have implemented programs for noxious weed control. The greatest weakness, as I see it, is that fact that most people have absolutely no idea of the problem, much less its control. If public opinion is to be mobilized against tolerating plants that are detrimental to health, we must do more than release a few newspaper articles. It has to be a grass roots project. To make it so, every community organization might have one or two ten-minute talks as a part of its program each year. The first talk could be devoted to demonstrating the offending plant or plants, explaining how they can be simply eradicated — whether at the volunteer or paid personnel level (depending upon the size of the community). Such instructive talks would require a battery of people to carry out. My recommendation would be for any state where there is to be a serious effort for noxious plant eradication, to enlist the good offices of state Garden Club organizations. They could be asked to contact all their clubs and to set up the machinery for a grass roots educational program. The information put in their hands should be carefully worked out, and Garden Club officers should be asked to limit their requests for speakers to those who can do a convincing job in a brief span of time; ten minutes might be the top limit. There would be little point in talking the situation to death before it starts. If a typical Garden Club could mobilize a half-dozen good speakers, either members or non-members of their respective clubs, they could contact all other civic-minded groups in the community, whether made up of men or women, and ask for a small piece of a program at the appropriate season.

Garden Clubs can provide coverage that can be had in almost no other way — unless at great expense. And I might add that volunteers are often more effective than paid personnel! So, why not invite the Garden Club movement to provide the network for spreading information? This is only one link in the chain, but it is a very important one.

George S. Avery
Brooklyn Botanic Garden

POLLEN POLLUTION OF THE AIR, WHAT CAN BE DONE ABOUT IT?

PUBLIC RELATIONS ASPECTS

By Charles N. Howison, Executive Secretary of the
Air Pollution Control League of Greater Cincinnati

Good public relations are vitally important to the success of any program to prevent and control pollen pollution of the air from ragweed.

Good public relations helps to get needed legislation. Good public relations, and especially effective publicity are needed for a continuing program of education. Weed control is a matter of education of the public, and of children in particular, through illustrated booklets, posters, radio talks, exhibits, special campaigns, etc.

The eradication of weeds is expedited through good public relations. The general methods of control of noxious weeds include eradication by cutting, digging out and mowing, and finally - the best and easiest method - spraying with a herbicide in solution.

In Cincinnati our theme is "Get Ragweed Before It Gets You". Our program is to persuade and motivate people to destroy weeds, particularly ragweed, because the pollen from ragweed is the principal cause of late summer hay fever and asthma.

Through the continued efforts over the years of our active Hay Fever and Weed Control Committee, effective weed control ordinances have been passed by the City of Cincinnati. Our committee insists that these ordinances be enforced.

MUNICIPAL COOPERATION IMPORTANT

A good example set by public officials in the enforcement of weed control ordinances helps the overall program to abate pollen pollution of the air. It is especially important that the municipality wage a continuing battle to destroy weeds growing on city owned property, and along streets and highways. This gives the private property owner a good opinion of city enforcement officials and results in a greater desire on the part of the public to cooperate. Good public relations does not require a million dollar budget. However, it does require an effectively planned enforcement program efficiently carried out.

The Cincinnati Weed Control Ordinance #376-1953 provides for notice or warning to be sent property owners where weeds are growing in violation of the ordinance. This first step is taken by the Police Department. During 1958 warning notices were sent to 1686 property owners involving 2107 locations. Citations were given to three property owners. During the year 1958 the Police Department reported 74 city owned locations to the Public Works Department for the cutting or spraying of weeds. The splendid cooperation of the Cincinnati Police Department in notifying owners of private property where weeds are growing in violation of the ordinance has been most helpful in obtaining citizen cooperation. This program was supplemented with educational leaflets provided by our organization.

During the year 1958 the Cincinnati Department of Public Works had a total expenditure of $37,300, for the killing of weeds along street right-of-ways and on public property. The program required a total of 8700 man hours, which did not include the many man hours of the Work House inmates.

The weed cutting routes were completed four times during the season or the equivalent of approximately 1200 miles of roadway. Weed spraying along the same routes were completed once and repeated where necessary. The control of weeds by spraying required the use of 1780 gallons of Dimethylamine Salts of 2.4D, four lbs. acid per gallon. In addition the Department of Public Works destroyed weeds on ten parcels of private property as provided in the city's anti-weed ordinance. A total of fourteen parcels of private property were referred to Public Works by the Police Division.

I believe it is important that you know of the good example set by the City of Cincinnati itself in our program to reduce pollen pollution of the air. This splendid support is an important factor in obtaining citizen cooperation and helps greatly to reduce the suffering of persons allergic to ragweed pollen.

We work for cooperation of the public through an educational program which makes all possible use of all channels of communication. This includes press, radio and TV, pamphlets, booklets, public talks and appearances, posters and exhibits. The services of all interested groups, including civic clubs, garden clubs and PTA's are solicited in the annual campaign.

PRESS RELATIONS

In building good press relations it is important to become acquainted with members of the working press - managing editors, city editors, columnists, reporters and photographers. A good way to get acquainted is to invite them to see the work you are doing - the before and after effect. They are interested in getting ragweed control news since it is good news for the community.

The editorial good neighbor policy pays dividends. The press is close to public opinion and when trouble is brewing a cooperative press will ask you for an explanation. When they do -

Give them all the information you can consistent with the interests of the principals involved. Newsmen are under pressure to get facts and they appreciate cooperation. Generalities and evasiveness are road blocks to public relations and should be avoided.

PUBLICITY RELEASES

Directed to the right editors, the neater and simpler the news release appears, the more chance it has of being read and put to use. A title gives the editor a clue as to contents, although it probably won't be used. A standard size white sheet $8\frac{1}{2}$" x 11", and double spaced typing helps. Your name and title should be at the top. The date written and day to release is required.

The who, what, when, where, why and how belong in the first paragraph. Details can follow. These "do's" and "don'ts" help.

"Do's"
1. Put in all the pertinent facts. The editor will cut the story.
2. Learn when the paper goes to press and get in story a day or more ahead.
3. Get the names, dates and statistics complete and correct.

"Don'ts"
1. Don't submit a story after the event takes place.
2. Don't ask the editor to print a story as a favor.
3. Don't editorialize or try to give advice to the public.

When submitting photos have them made by professional photojournalists. It is not necessary to wait for perfection to tell the ragweed control story. Progress is good news.

RADIO & TELEVISION

The story of pollen pollution control is as important to radio and television stations as it is to newspapers and magazines. The ability to obtain coverage on local radio and television stations depends on the efforts of the local Ragweed Control Committee. Experience has shown that local stations are interested in the local story and therefore every effort should be made to keep these stations fully informed of local activities.

The first thing for the local committee to do in order to gain time on radio and television is to ascertain the names, addresses, and telephone numbers of the program directors and public service directors of all radio and television stations. This can be done quite easily by a telephone call of inquiry to the stations.

A letter should be sent to each of these directors stating that the local Weed Control Committee is interested in assisting the directors in their efforts to tell their listeners and yours about weed control activities in the area. Insofar as possible, the local committee members should discover what, if any, programs on the local stations are devoted to topics of community interest. It is evident that these are the types of programs on which the Weed Control Committee story should be heard. Once this information is obtained contact can be made by letter directly to the moderators or producers of such programs.

Any news releases which are sent to local newspapers concerning weed control activities should be sent at the same time to all news desks of the radio and television stations in the area. There is no need to change copy for news programs on radio and television.

WHAT TO AVOID

Experience has shown that most radio and television stations prefer "live" to canned programs, that is, programs recorded somewhere outside the community, or scripts designed for use anywhere without a definite local angle. They much prefer an unrehearsed and fairly spontaneous interview type program which is clearly designed for local consumption.

Where a station (and this will usually be radio) has programs of short duration, 15 minutes or less, they may prefer the speaker to deliver a talk without a question period and with only a few introductory remarks and closing remarks by a station announcer. Again it must be stressed that here, too, the local story should be emphasized although there is nothing to prohibit references to what other communities are doing in the field of weed control or pollen pollution control.

SPOT ANNOUNCEMENTS

Much success for local control programs has been found with what are known as "spot announcements." These are usually 15 to 20 seconds in duration and should be designed to tell the local listeners that the committee seeks their help in the fight for weed control. Local radio and television stations usually are capable of giving time for such brief announcements. These should be typed, double spaced and at least two or perhaps three copies of such announcements should be sent to each station. Television stations usually like some sort of art or photographic material with these announcements, but this is not absolutely necessary. It should be made clear that the language may be changed to suit the stations' requirements and that the suggested dates and times of broadcasting are left to the discretion of the station.

ARE THERE ANGELS?

In many areas of the country large corporations of the public service type, such as utilities, have regularly scheduled programs on radio and television. Employees of such corporations may be members of your Weed Control Committee. The commercial time of these programs is, of course, devoted to announcements which have no comparison with a company that produces a product; they have, basically, good-will in mind. There is an excellent possibility that from time-to-time, perhaps while discussing its own efforts in the field of weed control, such a corporation will be willing to devote some commercial time on these programs to public service announcements from the local Weed Control Committee, or enforcement agency. Therefore, close contact should be made and sustained with the director of community relations or public relations of such corporations.

Your committee representative should not expect that the local radio and television stations are waiting with bated breath for his entry into the public relations field. Nevertheless, he will find that if a good story is ready, radio and television, like newspapers and magazines, will want to do something about it. You may believe that you have an excellent story, and at a particular time the program directors may feel otherwise. Since they are doing you what is in essence a favor, you should accept their refusal graciously and keep trying.

The initial contact is often the toughest and what you do today may not bear fruit for some time. But - once the contact is made and once the radio and television stations know that you are available and want to be helpful most of your job will have been accomplished.

In summarizing, these are the steps that must be taken to obtain radio and television time:

1. Accumulate a list of all radio and television stations together with the program directors and public service directors.

2. Determine all public service programs which are on local stations.

3. Contact all program directors, public service directors and moderators or producers of public service programs.

4. Make sure that all radio and television stations receive at the same time whatever material you are sending to newspapers and magazines.

5. Do not offer "canned" material unless the radio and television stations specifically say they will use same.

6. Contact utilities which have radio and television programs.

7. Send spot announcements to all radio and television stations.

8. Do not be discouraged.

SERVICE CLUBS & CIVIC ORGANIZATIONS

Public talks and appearances are important. There are many organizations whose support can be enlisted, depending upon local factors. Often a service club, such as the Kiwanis or Rotary, will adopt an effort of this kind as a part of its program. If the employees of a particular factory are significantly affected by hay fever, it is possible that both management and the union can be interested in efforts to overcome the cause. A good deal of missionary work must be done among the natural leaders of the community. They must be sold on the necessity for a control program if the organizations they lead are to function effectively.

Publicity is the product of action. With guidance you can initiate and encourage the action which produces the publicity. Any action to bring about better community understanding of a problem and to prompt community action to overcome that problem is sound publicity effort in its broadest and best sense. It is information with a mission. It is communication. It is good public relations.

An interested, enthusiastic, dedicated committee will achieve more results than a front page story in the paper every week without such organizational effort. The front page story is read today and forgotten tomorrow or the next day. But the dedicated committee makes its impact felt every day in some way. It gets people to thinking and it gets them to act. It won't allow them to forget. The media of information takes their place as tools to supplement, from an informational standpoint, the organizational work of such groups.

In securing the active participation of groups and media, it is helpful if you can find among them persons who are personally subject to hay fever. It is desirable to identify prominent persons, wherever possible, who are personally affected by hay fever because they are receptive to efforts to eradicate ragweed.

I have found it productive to send news stories directed to the attention of the chief editorial writer of the paper as well as to the city editor. For reasons of space or personal preference, the copy desk may on occasion leave out the paragraphs you would particularly like the editorial writer to see. We have seen helpful editorials result from sending occasional news stories directly to the editorial writer.

PROCLAMATIONS

If the organizational effort has been well planned, it should be followed up with requests for proclamations to mayors and to the governor. All such requests should be submitted at least a month before the period for which they are desired and they should be accompanied by a suggested proclamation. Many such requests are turned down in executive offices because they are received at the last minute and there is not time to consider them in relation to other requests for the same period of time. Governors and mayors receive as many as five different requests to observe the same period for different purposes. Other things being equal, the only fair policy the executive can follow is to consider the meritorious requests on the basis of first come, first served. Be sure your request is submitted well in advance, that its purposes are clearly stated, and, if possible, indicate that a substantial number of citizens is asking for it.

As you know, June is National Ragweed Control Month. This project originated in Cincinnati with the Air Pollution Control League. It is one of the many Special Days, Weeks and Months recognized by the United States Department of Commerce and the United States Chamber of Commerce. Its purpose: "To control the growth of ragweed because the pollen of this weed is the chief cause of late summer hay fever and asthma". In 1958 June was proclaimed as Ragweed Control Month by the governors of twenty-two states and by the mayors of many cities and towns.

Another suggestion is not to ignore community newspapers. In Cincinnati and Hamilton County we have two daily newspapers. We also have 25 community papers published in towns and communities in the area. Circulation ranges from 4,000 to 15,000. These publications can be very helpful. They should receive notices of all meetings which are going to be held in or near their respective communities. They should also receive editorial background material and educational material distributed through the schools and to the homes of citizens.

CONCLUSION

Publicity is not an end in itself. It is an important part of good public relations. It is a means to an end. Its effectiveness can be measured by the contribution it makes to the attainment of overall public relations objectives.

In the objective which we are presently considering - pollen pollution control - publicity will be based on the control effort. If the control effort is sound and sustained, there will be ample opportunity to secure helpful publicity. The degree to which the opportunity is seized and utilized is a measure of the resourcefulness of the informational specialist.

Public understanding of weed control work to reduce pollen pollution of the air is a desirable objective. Public relations consists of, first of all, doing the right thing and letting people know about it. The use of modern good will building methods speeds the process and widens your horizons.

It is imperative for the members of the local committee to be expert in providing accurate and understandable information to the community and the public. To be expert and willing requires action.

Paper presented at the Northeastern Weed Control Conference -
Public Health Section, New York City, January 8, 1959.

PUBLIC HEALTH ASPECTS OF WEED CONTROL

By: Floyd I. Hudson, M.D.
Executive Secretary
Delaware State Board of Health

Presented at the Panel Discussion - "Pollen Pollution Of the Air, What Can Be Done About It" - of the Public Health Section, 13th Annual Meeting of the Northeastern Weed Control Conference, in New York, N. Y., on January 8, 1958

Many of us were fortunate in having the opportunity to attend the National Conference on Air Pollution called by the Surgeon General of the U. S. Public Health Service in Washington in November. Much of what I will tell you today was also discussed at the Washington conference.

The existence of particles in the air, derived from plants and animals, is now generally considered a part of the greater problem of air pollution. We must, therefore, consider the continuing of the attack to remove such harmful particles as ragweed pollen as a part of a total air pollution control program. The efficacy of eliminating these substances from the atmosphere has already been demonstrated by the many programs developed, chiefly in official agencies throughout the country. Organizations such as your own - and national organizations with the same purpose - can also play an important part.

The effects on health by many products of vegetable or animal origin have been known to medical science for many decades. The association of hay fever with ragweed pollen was described more than 85 years ago. There are many things which can be accomplished in the field of weed control, but such accomplishments to be practical and effective must include the efforts of many disciplines outside of health itself.

The great amount of unnecessary illness and suffering from hay fever and contact dermatitis of weed origin has been fully described to you many times at previous meetings of your conference and in the literature. It is not necessary to further elaborate on the actual and estimated statistics of this great public health hazard at this time. To minimize or eliminate injury done by ragweed pollen and poison plants to persons sensitive thereto, public health agencies and the medical profession have tried the following methods:

1. The prevention of these diseases by the elimination of the cause; namely, the removal of pollens or offending substance from the environment. Two means are used to accomplish this: Firstly, the destruction of the weed from which the pollen emanates. This is the practice most commonly put into use by public health and other official organizations. It is applicable to fairly large areas and should be a total community effort. Secondly, mechanical devices are frequently installed in homes or buildings to remove pollen and other particles from the local atmosphere. This often provides relief for individuals suffering from air borne causes of allergy. It is not practical except to control local small areas.

2. The desensitization, with small doses of antigens, of individuals who are susceptible to the particular plant substance which causes the disease. This process is one which requires special medical training and experience. It is dangerous and should be used only on the advice and under the supervision of a qualified medical practitioner. Two types of antigen preparations are currently being used: (a) preparations for hypodermic injection; and (b) preparations for oral administration. Good response to this kind of preventive treatment has been reported, but results show it is far from 100% effective. This method is applicable only to individuals and is not advised as a public health procedure.

3. The treatment with appropriate drugs (antihistamines) of persons who suffer with symptoms caused by a specific pollen or plant material. This is also a medical procedure and should be used only under the supervision of a physician. It is not ordinarily employed as a public health practice.

All of the three methods above mentioned are used with varying d degrees of success; however, I believe that all of us would agree that the elimination of the weed causing the difficulty produces the best and longer lasting results. It has been demonstrated by past experience that the destruction of ragweed and poison ivy by means of chemical sprays is both economical and effective. It is clear, therefore, that a program which determines the where, the what, and the why - as well as the measure of pollen in the air - should be given prime consideration. In geographic areas where air pollution programs are in force, the identifying and measuring of the pollens can be part of the total program of defining and measuring the pollutants in community atmosphere.

Public health persons throughout the country have worked diligently on the elimination of many diseases, utilizing the epidemiological approach, which is also applicable to weed control. This approach is well documented and needs no further explanation at this point. There are many textbooks and papers available on this subject.

In studying the possibilities of alleviating hay fever and contact dermatitis by means of controlling the weeds which are the basic cause thereof, it appears that we are faced with a goal which, though difficult, is indeed attainable. Almost any officially organized political unit should be able to develop a program in this field.

In order to implement a successful weed control program, there must be a coordinated effort on the part of all agencies involved. At the State level this would include the Agriculture Department of the State University, the Highway Department, State Department of Agriculture, State Health Department, and other organizations having to do with conservation and economic development. It is clear that harmful weeds may, from a practical and economical point of view, be eliminated. The benefits to the health of all people will more than repay any community for the effort put into the reduction or elimination of these pollutants. Persons who have suffered from these causes and have been relieved by an effective program will be grateful and supporting friends for life.

I would like to stress at this point that no one agency or person can successfully solve the hay fever problem in any community. The combined efforts of a large number of agencies and persons is essential. Administratively this can be accomplished by the formation of coordinating committees, special councils which include key personnel from all agencies, and other interested groups. Liaison between all groups must be constantly maintained; however, one agency must have the authority to direct the entire operation, following agreement which comes from coordinated planning of all participating groups.

I would also like to emphasize the importance of good public relations and general education as procedures to be used in developing knowledge and understanding which will be beneficial to any program. Public health educators in health departments can assist greatly in the development and operation of weed control programs.

Detailed facets of this problem which touch upon disciplines other than health have not been discussed in this paper, but are well covered in the subject matter of this panel and the conference. I am sure that health departments at the national, state, and local levels are keenly interested and are willing to cooperate in every possible way to do away with the unnecessary scourge of weeds which cause illness and discomfort to so large a proportion of our population.

RAGWEED CONTROL

THOMAS J. MCMAHON

The most important aspect in a ragweed control program is public relations. Good public relations is a forthright, truthful presentation of all the facts relating to a project for the purpose of creating understanding. Failure to respect this requirement in matters dealing with projects affecting large areas of the population exposes the endeavor to the loud voice of the uninformed.

It was Dr. Donald Schallock of Rutgers who pointed out last year when the spraying for the gypsy moth ended in the courts, "It just goes to show that however good a project may be, it must first begin with a campaign to inform the public." The courts upheld the U.S.D.A. men in their project, but it was a costly and injurious action.

Perhaps the most important function the Public Health Section of this Conference has performed has been to afford an opportunity to bring to light and to develop the facts on hay fever. It was here four years ago that F. Wellington Gilcrease, then of the New York State Health Department and now of the University of Florida, raised the question of the value of a pollen count as the index of the severity of a hay fever attack. Concurring with him was another hay fever sufferer, Alfred Fletcher of the New Jersey Health Department. At that time they made two observations:

1- A pollen count does not afford an accurate index of what the reaction of the sufferer has been. They could not explain this inconsistency; they merely affirmed the fact. And

2- A pollen count is not a forecast, but a report on what has happened. It is not like a weather forecast, but rather a report on what has been. It confirms a condition; it suggests no way to avoid the condition.

Two years ago the tests of a Mr. Potts of the U. S. D. A. from New Haven were reported. Mr. Potts had stated at a meeting in Spring Lake, N. J. that he had been unable to produce an allergic reaction in tests on himself using pollen three days old. "Pollen," said Mr. Potts, "exposed to air and sunlight for three days will not produce an allergic reaction."

Dr. P. G. Wodehouse, then of Lederle Laboratories, gave support to Mr. Potts, though he ventured to state that that it is necessary only that pollen be exposed to air. He stated, "Pollen exposed to air overnight will lose half its potency."

Thus came to light a possible answer to the observations of Gilcreas and Fletcher. And the question arose: Does a pollen index consider the age of the pollen counted? If a hay fever sufferer has had a light attack on days when the pollen count was high and, yet, a severe attack on the days when the pollen count was low, the simple explanation lies in the knowledge gained by Potts and Wodehouse. The full answer cannot be written so simply, and it is interesting to note that further research is being made on this subject.

But this simple but important clue merits its place in this business of information, for it has also been stated here that a ragweed control program is useless. "Pollen has been found twenty and thirty miles out to sea," said some. "What good does it do to control ragweed here only to have more pollen carried in on the wind?" There is every indication now that the fresher the pollen, the more allergic severity of the reaction. The nearer the ragweed, the greater the danger. The greatest benefit may be expected from the ragweed control program in one's immediate locality.

It was here, too, that it was estimated that up to 65% of all ragweed grows along the side of the road in the Northeast. It was here that it was agreed that up to 10 per cent of the people suffer from hay fever. (This estimate has been stated from as low as five per cent to as high as fifteen per cent.)

It was here at these meetings that attention was called to the survey of the U. S. Public Health Survey of 1936. It was the Public Health Officer of Binghamton who called attention to this survey. Out of it came these figures:

1- At the end of 25 years, of 100 people having hay fever, 65 will have gone into asthma.

2- Asthma totally incapicitates more people than cancer and other related tumors.

Four years ago Dr. Miriam Sachs presented what is still today a medical doctor's finest analysis of the problem for the public helath officer and the public official. Dr. Sachs went beyond mere statistics and step by step established two main points:

1- Hay fever is a public health problem. And

2- A ragweed control program is the most feasible method we have at this time to attack the problem.

Among other things which have been developed at these meetings which fall into this factual data one needs for a public relations program were:

Ragweed grows only in disturbed or denuded soil. Though, for this reason, ragweed has been called a pioneer plant, there is some reason to belive it would be more aptly called a vandal; for it has been observed that when ragweed is sprayed and killed, other plants quickly grow. A key to observed fact may be found in the discovery of the Swedish botanist, Osvald, who in 1947 proved that the reason the rape seed will not germinate in a stand of red fescue is because the roots of the red fescue exudate a chemical which inhibits the germination of the rape seed. This was the first time in the history of Botany that it was proved that roots do exudate chemicals which are growth inhibitors to other plants. (PLANT GROWTH SUBSTANCES by Dr. L. J. Audus)

One should dwell for a moment on these above points. There is a tendency to look with alarm at any move to treat any plant. It is important that people know all about ragweed and something about the way that the exudations of one plant's roots will inhibit the germination or growth of another seed or plant. Garden clubs particularly are concerned with what happens when one sprays, and they are to be commended for their interest and efforts to protect our flowers. But these members are not opposed to a good program. They are opposed to bad programs. I can state with a certain experience that members of our Garden Clubs welcome complete information on growth. Osvald's discovery opens a new door of scientific knowledge, begins a new chapter in the fascinating story of nature.

You may recall it was Dr. Fogg of Pennsylvania who learned that only 65 per cent of the weeds of the Northeast are native; 35 per cent are foreign, and this percentage is by species. In volumn, the foreign weeds have almost outnumbered the native. To those who were concerned about disturbing our native roadside flowers, Dr. Fogg's studies come as something of a shock. The disturbance is already here, the disturbance of foreign invaders. Our native plants are disappearing.

If now we consider for a moment the implications of Osvald's discovery about root exudations, we will begin to see how important it is to include this information in any weed control program public relations. We begin to see that the vigor of the weeds from Europe, Asia, and elsewhere may be really chemicals from their roots which are inhibiting our native plants.

I remember several years ago visiting at Washington's Crossing in New Jersey an area the New Jersey Garden Clubs had devoted to the preservation of our native flowers. This was before weed sprays. It was an interesting day, and I found myself wondering why it was that these native flowers were disappearing. What could it be? Maybe Mr. Osvald has given us the key. And maybe the hope of the native flower, at least along roadsides, is, to some degree, a weed spray program.

A point to remember in this regard is that roadsides, the roads themselves, constitute only one half of one per cent of the total land area of the United States. What additional percentage of the land is disturbed or denuded? If 65 per centof this ragweed is to be controlled by a spray program covering only one half of one per cent of our land area, it would s em that the remaining disturbed soil areas would be but a small amount to become alarmed about.

It is very important that gaden clubs as well the general public be acquainted with the ecological aspects of weed control work.

Audubon Societies are another problem. So also are Conservation and Sportsmen's Clubs. These people are all fine people and sincere. They want to do the right thing. But the difficulty is that they are all confused with all the chemicals being thrown at them. That indicates further why a public relations program is so important. It is not so much that one wishes to tell somebody something; it is that people want to know, want to be told, want to cooperate in an intelligent way.

These groups are concerned with the effect of growth control programs on wildlife. The most important thing to make clear to them is weed control materials used in selective control are not poisonous. When work was being done in New York State to secure clarification of County Law 224 to permit certain weed spraying, Mr. Zemlansky, Mr. Gorlin, and I appeared before the Legislative Session of the Conservation Clubs of New York State at Albany.

The year before, County Law 224A had been vetoed by the Governor without comment. When a law is vetoed without comment, there is an indication of a controversy which would best be avoided. The governor's wishes are respected and the matter is filed. The difficulty with this type of veto is the supporters of the bill have no way of knowing why the bill was vetoed.

It was necessary, therefore, to patiently go to all departmnts and explain the objectives, the reasonablness, the benefits, and the like, and to answer all objections.

Here, it should be pointed out, is the tremendous problem which was created by not having from the beginning a public relations approach. from the beginning. A controversy had developed through ignorance. I mention controversy, for many people avoid controversy, and basic public relations suggests such a course. But fervent opposition is not always antagonistic, and if it is, one should not avoid facing it if the baisis of this antagonism is misunderstanding. The avoidance of such a problem is not the solution.

We faced the 65 members of the New York State Conservation Clubs at their Legislative Session two years ago and presented the story of weed control, particularly ragweed control.

We related to these men that at the Boyce-Thompson Institute in Yonkers in the early forties, Drs. Zimmerman and Hitchcock were exploring the various fields of chemicals in search of insecticides, miticides, and fungicides. In the course of their tests, they tried 2,4-D. They learned that though 2,4-D would not kill mites, fungi, or insects, the material stimulated the growth of the plants, improved their rooting, and generally affected the growth characteristics. They discovered that 2,4-D possessed all the characteristics of a natural plant auxin. So important did they consider this discovery that they wrote a paper on it. Later it was discovered that used in stronger amounts, 2,4-D killed broadleaf weeds.

We established the fact that the material had been rejected as a miticide, fungicide, and insecticide before it was learned of its use as a growth control chemical. We covered also many of the points which I have mentioned to you here today. Similarly, each point as it met the department's interest, was covered with other departments including the governor's office. Active to a great degreee in this effort was Robert McMahon. So was the Northeastern Weed Control Conference, for the ball which we carried was the one you fashioned. You made it; we bought it and put it in play.

Sometimes we find difficulty in moving that ball. In discussing the matter with some folks with Rutgers, we were told, "The difficulty is the industry has gotten ahead of the text books; and the difficulty with the text books is that this whole field is moving so quickly ahead that one does not know where to begin." It is this difficulty which has contributed so much to the confusion of the press, radio, and television. Even so august a publication as the New York TIMES adds to the confusion.

For example, there recently appeared in the TIMES an article on weed control chemicals by an author who was really mixed up. When one man called the TIMES and asked to talk to the author, he was told the article was by a contributor. When asked how to get in touch with the contributor, the TIMES advised the caller that they never gave out the addresses of their contributors. A letter was, therefore, sent to the author in care of the TIMES. That was in August. There has been no acknowledgement of the letter.

I said to one man, "What do you do about such things."

He laughed to himself and looked at me with the eye of experience. "You know what is said in such cases, don't you?," he asked. And then without waiting for me to reply, he said, "Progress must wait for the death of the incumbents."

He may be right. We may have to wait in many cases for the eventual textbooks, for the new grads of a new era to come forth with the new era. But I hope not. If proper, forthright representation of this program with all it implies is made, then there will follow an understanding; and with understanding will surely come an endosement.

I spat three years calling on the Pennsylvania Turnpike. Finally, I met with Michael Baker, Jr., Consulting Engineer. He had refused,- had thrown this program out of the budget when it appeared it would be adopted. But after 20 minutes of presentation of many of the facts I have covered here today, and with pictures showing the results, Michael Baker Jr., foremost highway consulting engineer in the United States turned and said, "Certainly, such a tool should have a place in every highway program."

On August 15 last, the Turnpike put out a special publicity release telling the motorist to travel the pollen free Pennsylvania Turnpike.

And this year, two counties in New York State as a result of County Law 224A did their complete roads. In Broome County, over 1500 miles of roads were cleared of ragweed and poison ivy. In Cayuga County over 1400 miles of roads were similarly cleared. Every city street between sidewalk and gutter were treated in Binghamton, Endicott, Johnson City, Auburn, and other communities in these counties. The highest pollen count on any day in Broome County was 40; Syarcuse, 75 miles north with no program, had pollen counts as high as 229; and Albany with no program had pollen counts as high as 420.

It is unfortunate that New York City has never seen fit to spend more than $23,000 in any single year for ragweed control; It is unfortunate that the whole city has not been done with experienced pesonnel. with proper equipment in any one year. There has been not more than one third the city treated in any single year. Fortunately, the fate of ragweed control programs does not rest with the experience of New York. Sussex County in New Jersey with an average pollen count of 2, the lowest in New Jersey; and

Broome and Cayuga Counties with significabt low counts in New York State provide examples of what can be done with a properly conducted ragweed control program.

Actually, what should be done is a ragweed control program encompassing the Metropolitan New York area. It could be done for two million dollars. It might be a worthwhile project for one of our Foundations. If Mr. Rockefeller were fully informed of the problem and the facts, he might be persuaded to present the project to the Rockefeller Foundation.

This, however, is another matter. For the purposes of this meeting, let me repeat, the most important thing in a ragweed control program, in any weed control program, is public relations. I have endeavored to cover here with you today some of the aspects of these public relations as we see them, as we use them, in what we consider to be a factual, forthright manner. We cannot wait for the incumbents to die.

The technical and mechanical phases of a ragweed control have been omitted; they are fairly well known. It is assumed that any program will observe the known requirements of planning, timing, experience, equipment, and supervision. The words of the sage of public relations are not forgotten, "Public Relations are ninety percent what we do, 10 per cent what we say." Performance must measure up to publicity.

Tom McMahon

A special tribute is in odder for this group, the Public Health Section, and to the Hay Fever Prevention Society, and to the New York State Public Health Department, and to all those who contributed to the adoption of the new Air Pollution Law in New York State. This law becomes effective this year. Air borne pollens causing allergic reactions are listed as air polluters.

The prompt action taken by Dr. Herman E. Hilleboe, Commissioner of Health for the State of New York, and by Alexander Rihm, Jr., Executive Secretary of the Air Pollution Control Board, will be applauded by all here. Foremost in first steps taken was an educational program throughout the state informing the people on ragweed and what to do about it. In the light of todays subject, it is interesting to note that the first step taken was a public relations one. Our congratulations to New York State.

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RECENT DEVELOPMENTS IN PHRAGMITES CONTROL

by

John H. Steenis
Bureau of Sport Fisheries and Wildlife
U. S. Fish and Wildlife Service
Laurel, Maryland

and

Everett B. Chamberlain and Robert A. Beck
Delaware Board of Game and Fish Commissioners
Dover and Delaware City, Delaware

Common reed or phragmites (Phragmites communis) is one of the most aggressive plants of marshes. For the most part it confines its growth to the higher levels. However, in places that are characterized by changing water levels, it readily grows in lower areas, and when it is once established it can withstand a considerable depth of water. It also is able to spread into drier habitats where farm crops, like corn, can be raised.

In certain situations this plant can be of considerable value. It readily covers dikes and road banks as well as spoils from channel dredging with its rip-rap growth of rootstocks and its dense cover. These reduce wash during times of storm or excessive rain. When interspersed with other vegetation or with water, phragmites has value as cover for both marshland and upland wildlife. However, because of its vigorous growth, phragmites often forms solid stands that greatly reduce its value to wildlife. Furthermore, it is a serious detriment in drainage and irrigation ditches, where it retards water movement. In industrial and urban areas it can be a serious fire hazard. Considerable work has been done in the New York City area on control of phragmites for fire prevention along rights-of-way of power and telephone lines and near installations such as oil-storage areas. In the wildlife field we are concerned with making more effective use of phragmites by creating openings and interspersion of this cover plant with other desirable types of vegetation and with water so that the area will be of more use to waterfowl and other game. For example, along the Chesapeake and Delaware Canal in Delaware (Beck 1957), fire-lane construction and improvement of phragmites for upland game have been done by the U. S. Corps of Engineers and the Delaware Board of Game and Fish Commissioners.

Cooperative studies on control of phragmites have been conducted by the U. S. Fish and Wildlife Service and the Delaware Board of Game and Fish Commissioners since 1949 (Steenis and others 1951, 1954 a and b; Steenis 1955, 1956; Martin and others 1957). In all, more than 500 experimental treatments have been made. Early studies showed that in dry sites dalapon at rates of 30 to 35 lb/A was effective in controlling phragmites. Amitrol, applied at rates as low as 16 lb/A, also controlled this plant. These treatments were not very effective in wet sites, however. Subsequent studies with mixtures of dalapon and amitrol showed promise. This paper summarizes results of recent tests with herbicides used alone and in combination. It also appraises the problems of aerial application.

Field Study Procedure

Most tests on phragmites were made on 1/100-A and 1/40-A units. Later, some treatments that showed promise were replicated by airplane treatments of one-acre strips. As response of phragmites to control was different in non-flooded sites than it was in flooded sites, a series of treatments was made in both types of habitat.

Non-flooded Sites. In dry sites, dalapon was applied at rates of 10, 15 and 20 lb/A during different stages of plant growth. In like manner, 2,2,3-TPA was tested in a smaller series of trials. Amitrol was applied at dosages of 2 and 4 lb/A; some treatments were made with monuron at 6 lb/A. Then mixtures of these herbicides were applied at the rates given above in a series of adjoining plots. In addition, tests were made with erbon at rates of 15 and 25/A, with neburon at 4,8, 16 and 24 lb/A, with the sodium salt of 2,3-dichloroisobutyrate at 35 lb/A, and with simazin and three related formulations at 10 lb/A. The chemicals were applied at different stages of phragmites growth.

Wet Sites. Because results from preliminary studies indicated that treatments that were successful in non-flooded sites were not as effective in wet sites, a different series of tests was made in flooded habitat. In these later tests, treatments were limited to the flowering and early fruiting period when phragmites was known to be most vulnerable to control. Dalapon and 2,2,3-TPA were applied at rates of 25, 35 and 45 lb/A, amitrol at 2, 4 and 8 lb/A and monuron at 6 lb/A. Mixtures of these herbicides also were tested. Additional tests were made with dalapon and amitrol at higher dosages.

Results

Non-flooded Sites. Amitrol-dalapon mixtures yielded effective results in dry sites and were more economical to apply than was either herbicide used alone. For example, control was obtained with amitrol when it was applied at 15 lb/A, at an approximate cost of \$60/A; control also was obtained with dalapon when it was applied at 30 lb/A, at an approximate cost of \$30/A. However, we repeatedly obtained good control with mixtures of dalapon and amitrol at respective rates of 10 and 2 lb/A; the total cost was approximately \$18/A. The period when treatment was effective extended from the time the plants were 30 inches in height to the time of early fruiting. Attempts to obtain control by aerial applications were not successful, for the most part, because the required amount of herbicides was not applied.

Other aspects of treatment with this mixture deserve attention. Amitrol is translocated much more readily than is dalapon. In situations where spray coverage is irregular, a mixture of the two herbicides can result in a more uniform kill than results when dalapon is used alone. Evidence that translocation occurs readily is shown by the phragmites kill in the buffer strips that separated the plots. Repeatedly, most plants in these strips of 15 to 20 feet in width have been controlled by these treatments.

Among the other herbicides tested, erbon is of interest. When this chemical was applied at low dosages, it appeared to cause a limited soil sterilization, which disappeared in a short time. In earlier tests, we found that applications as low as 15 to 25 lb/A could control phragmites. Studies of treatments that were made at different times revealed that phragmites can be controlled at rates of 15 lb/A in non-flooded areas if the treatments were made 3 months or more before the cessation of plant growth due to cool weather. Sterilant-type herbicides that have limited residual effects can be of considerable value in controlling a non-desirable plant without destroying the productivity of the soil. Another interesting feature of the low dosages of erbon was that there was some selectivity. For example, pokeweed (Phytolacca americana) and some other species were not killed by the treatment.

Of the other herbicides that were tested the sodium salt of 2,3-dichloroisobutyrate yielded effective control at 35 lb/A but neburon, simazin and related formulations were not effective. The effectiveness of 2,2,3-TPA cannot be completely evaluated until the 1959 growing season.

Wet Sites. In wet sites, we were unable to control phragmites with dalapon alone, even with applications of more than 100 lb/A. We obtained sporadic control with amitrol during the vulnerable period of flowering and early fruiting. Too much of either dalapon or amitrol appeared to cause a fast contact kill of the leaves and stems that prevented translocation. In the case of dalapon, this occurred at rates of about 70 lb/A, but even at or below this dosage control was ineffective. In the case of amitrol, the amount that was required to control the plant was close to the level that prevented translocation of herbicide. When amitrol was applied at the rate of 24 lb/A, results were erratic. Complete control resulted from amitrol treatments of 20 lb/A. Similar difficulties were encountered when mixtures were used at higher dosages. Uniformly good control resulted from applying a mixture of dalapon at 25 to 30 lb/A with amitrol at 4 to 5 lb/A. In treatments by airplane, control was rated as 90% and sometimes 80%. Under these circumstances it would be advantageous to make clean-up treatments the following year.

Control was only partly effective when dalapon-monuron mixtures were used.

When we compared these results with treatments made in other sections of the country, we found that Dill (1958) controlled phragmites in wet sites in Minnesota by applying amitrol at a rate as low as 8 lb/A. Apparently, where the growing season is shorter and the plant exhibits a less vigorous type of growth, phragmites can be controlled more readily. Likewise, we noticed that effective results were obtained with lesser amounts of herbicide in New York City than were required in Delaware. These variations were to be expected. For this reason, it often would be advantageous to make a series of pilot tests in problem areas to determine the most practical rate of application.

Problems of Application

Ground Equipment. In dry sites, power-spray equipment was operated from a truck. However, it is difficult to move ground equipment over rough terrain through this high jungle-type grass. In flooded areas, it is often impossible to make more than marginal treatment from floating equipment.

Aerial Equipment. In many areas, an airplane is the only means by which a herbicide can be applied. Application by plane, however, presents many difficulties and pitfalls.

One of the first problems we encountered was the reluctance of commercial operators to allow their equipment to be used for herbicidal work. They were afraid of contamination that would damage agricultural fields when the plane was used later for crop treatment.

Equipment must be free of leaks. No airport operator would be happy to have the grass on his parking area and runways subjected to spot application of the chemicals used in this work. This would be true also if a convenient field, rather than an airport, was used as a base of operations. Probably even more important is the fact that it is nearly impossible to load and deliver these chemicals without passing over agricultural land. As many of the areas to be sprayed are adjacent to cropland, equipment must not only be free of leaks but also must have positive and complete cutoff at the nozzles so that no chemicals escape when turns have to be made over growing crops. If cutoffs are made at the tank, extreme care should be taken not to fly over cropland.

Another problem concerns the dosage that is applied. Because of the difficulties of calibrating spraying equipment, it is necessary to see if the actual rate of application is the same as that which the equipment is set to deliver. For example, a sprayer that supposedly delivers 5-7 gallons per acre may actually put out 4 or 8 gallons per acre. In experimental work, it is important to know the exact gallonage that is delivered in order to be sure that the right poundage of chemical is applied. For control of phragmites, a specific poundage of herbicide is required, irrespective of the amount of carrier used.

It is desirable for spraying equipment to be adjustable for different rates of application. This is especially important in experimental work because the various formulations and combinations of chemicals must be tested at different rates in order to determine the most effective and economical treatment. It is also advantageous to have an accurate and a fairly wide range of adjustments, from about 3 gal/A to at least 10 gal/A.

Our experience with commercial aerial operators indicates that some of them are not very critical of the rate of application. It therefore is of the utmost importance that the dosage be accurately determined, not only for the sake of economy but also in order to plan the treatment so that a variation of a gallon per acre either above or below the recommended figure will not seriously affect the results. It sometimes may be advantageous to recommend slightly higher dosages than those that are found to be effective in experimental tests.

Precipitation and wind are the most important weather factors to be considered in making applications of herbicides. Spraying should be done when no rain is expected for at least ½ day after treatment. Treatment also should be made under as nearly a no-wind condition as possible. This usually will limit working time to a period of 2-3 hours immediately after daylight and to approximately the same amount of time in the evening just before it gets too dark to fly. Once a formulation and rate of application have been established, a slight amount of wind can be tolerated, because an experienced pilot can compensate for moderate drift if the area to be treated is large and if there is no agricultural land immediately adjacent.

To achieve maximum economy in aerial application, herbicidal treatment should be completed in a single flight. The loading site should be as close as possible to the area to be treated, and the chemicals should be weighed and mixed ahead of time so that ground time is kept to an absolute minimum after the aircraft starts working.

Acknowledgments

The following chemical companies have been actively interested in these investigations and have furnished materials for testing. Amchem, American Cyanamid, Dow, Du Pont, and Geigy. J. B. Whelan and O. Florschutz, Jr., student assistants, U. S. Fish and Wildlife Service, participated in the field studies.

Summary

Tests of chemical methods for control of phragmites were made in Delaware marshes in the summers of 1955-58. These investigations on control of phragmites revealed that a mixture of dalapon and amitrol was superior to either herbicide used alone. Most effective and least expensive control on dry sites was obtained from an application of mixtures of dalapon at 10 lb/A with amitrol at 2 lb/A. Uniformly good control on wet sites resulted from a mixture of dalapon at 25-30 lb/A with amitrol at 4-5 lb/A which was applied during the flowering and early fruiting period. Effective control of phragmites with lesser amounts of herbicide is possible in other locations where the growth of this grass is less vigorous.

In many areas, aerial application of herbicide is the only way in which phragmites can be controlled. Requirements for airplane application are avoidance of damage to nearby croplands and correct calibration of equipment. To be economical, treatments should be completed in a single flight.

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COMPARATIVE TESTS OF VARIOUS HERBICIDES ON WATERCHESTNUT[1]

by

John R. Greeley, New York State Conservation Department,
Albany, N. Y.
and
John H. Steenis, Bureau of Sport Fisheries and Wildlife,
U. S. Fish and Wildlife Service, Laurel, Md.

INTRODUCTION

Waterchestnut (Trapa natans) was introduced into New York about 1884 and is now established in some areas of Massachusetts, Maryland, Virginia and Vermont. It seriously interferes with fishing, waterfowl hunting, boating, swimming and other use of waters by forming impenetrable mats of vegetation during the summer and early fall. The plant is an annual and decays after frost leaving an abundant crop of its large, thorny seeds. Many of these sprout the next spring, but there is also some delayed germination over a period of several years. Complete eradication has been achieved in a number of areas by destroying the plants prior to seed production for several successive years. The methods generally used in control programs have been spraying with 2,4-D or underwater cutting of heavy infestations and handpulling of light infestations. Control projects are currently in operation in New York, Vermont and Maryland.

Details on earlier control work in New York including tests of methods are given by Smith[2]. In recent years, beginning in 1955, an eradication project has been operated with the aid of

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1/Acknowledgments. This study could not have been made without the active interest and assistance of several chemical companies who provided materials for tests: Amchem, Dow, General, Chipman, Rohm & Haas and DuPont. J. H. Gallagher of Amchem actively participated in field work as did R. H. Smith, New York State Conservation Department; J. B. Whelan, U.S. Fish and Wildlife Service; W. R. Miller, Vermont Fish and Game Service; and G. F. Beaven, Maryland Department of Research and Education.

2/Smith, Ralph H. Experimental Control of Water Chestnut (Trapa natans) in New York State, New York Fish and Game Journal 2:173-193. 1955.

Dingell-Johnson funds and has destroyed or reduced many infestations which threatened to spread into new areas. The large infestations of the lower Mohawk and Hudson Rivers, however, amounting to several thousands of acres, have presented a more difficult problem. The development of improved, low-cost methods might be expected to increase the chances of successfully eradicating these large infestations. There has been an increasing number of requests by property owners and others for information on methods for combatting waterchestnut, and it is expected that the development of improved methods would result in considerable control work by individuals as well as by state agencies.

In planning the present tests, published and unpublished information from several sources was available. Published work by Smith has already been mentioned. Further testing on a field basis was done in the New York control project during 1956 and 1957. In 1956 and 1957, tests were made in Maryland by Steenis.

Any successful method for eradication of waterchestnut must stop seed formation. To be practical for large-scale application it should be rapid, economical and safe with reference to personnel, to adjoining property and to other uses of water. Although a number of methods currently used in control projects meet these requirements reasonably well for certain situations, the testing of new and better methods is considered desirable. It should be emphasized that a number of the tests made were of a preliminary nature, and it is not possible at this time to include a full comparison of relative effectiveness or costs on a field application basis.

NEW YORK 1958 SPRAY

The spray method used by the control project of the New York State Conservation Department during 1958 affords a useful basis for comparing other materials or methods of application and will be discussed first. This emulsion spray was formulated as follows: 2/3 gallon 2,4-D (mixture of isopropanol and di-isopropanol amine at 4 lbs. acid equivalent per gallon), 2 gallons kerosene, 1 pint Igepal CO-530 emulsifier (Antara Chemical Company) and 20 gallons water. This totals slightly over 22-2/3 gallons, but water was not measured with exact precision in field use and, hence, the spray tank load could be considered to be about 23 gallons. The procedure followed in mixing was to put in about 10 gallons of water, to add the 2,4-D and the Igepal dissolved in kerosene, and then to pour in the other 10 gallons of water. This gave a good emulsion.

Spraying was from a specially built 18-foot aluminum boom having 13 jets, mounted on 12-foot aluminum boat powered by a 4 horsepower air-propeller driven outboard motor. The speed was estimated at 3-1/2 miles per hour. The apertures used in most of the spraying were T jet No. 8004. As a hose spray had been used before the spray boom was devised, the pump was of a high-pressure type with a gauge which was not accurate for exact reading at low pressure. It was estimated, however, that pressure was about 30 p.s.i. When allowance is made for factors such as over-lap in spraying and variability in speed, the rate of application was estimated at about 4 pounds per acre.

In most waters where the emulsion spray was used effectively in 1958, it is concluded that both surface and submerged effects were involved. It was particularly evident that "spot spraying" of scattered plants was not so effective as treatment of entire areas of dense growth even though the spray boom wet the leaves equally well under both conditions. In spot spraying, the underwater effect of the spray would be quickly dissipated by diffusion into adjacent untreated waters, whereas in treating larger areas more effective concentrations of 2,4-D are maintained. However, a weakening of the submerged effect by diffusion in deep water occurs and would explain the sprouting of weak, lateral rosettes which was found to occur repeatedly. In some areas one application, properly timed to prevent such lateral rosettes from setting seed, gave successful control. Although early spray applications (mid-June) were successful in greatly decreasing the seed crop, a second spraying to destroy lateral rosettes late in the season would be necessary for complete suppression of seed.

SMALL PLOT TESTS

Two areas of the Mohawk River where waterchestnut growth was dense and where there was little chance of interference with observations over a long period were selected for test plots of 1/100-acre size (21 x 21 feet). These were at Allen's Cove near Crescent, and Wagar's Cove near Vischers Ferry. Numbered stakes were used to mark the plots. A number of chemicals were tested, most of them at several rates of application expressed as pounds of active ingredient or of acid equivalent per acre. The materials used fall into three groups: (1) granular formulations, (2) sprays of solutions or of emulsions, and (3) invert emulsion sprays (herbicide dissolved in water and enclosed in oil droplets).

The plots were laid out with intervening buffer zones left untreated. Earlier plots were laid out with 6-foot buffers and later ones with 21-foot buffers. Although the materials were carefully sprayed or scattered in each test plot, there was in some instances interference with interpretations because of subsequent diffusion. Larger buffer areas would have been desirable.

During 1958 tests were made on 71 plots in New York, 12 in Vermont and 3 in Maryland.

GRANULAR FORMULATIONS

2,4-D (Amchem M-518c), butoxyethanol ester without emulsifier on 8-15 mesh attaclay, 10% acid equivalent. At the time of first series of treatments on May 21 some sprouting had taken place but no rosettes had reached the surface. Tests in New York, Maryland and Vermont included rates of 4, 8, 12, 16 and 20 lb./A. Effect ranged from none to a slight reduction. A few thickened leaves indicated some distortion.

A single plot at the 40 lb./A. rate was treated in New York on June 17 when young rosettes were at the surface. Control was excellent. An area at least four times as large as the plot was clear at the first check on July 15 and remained clear.

2,4-D diethanolamine salt (2%), 2,4,5-T triethylamine salt (0.66%) on fine vermiculite. At the time of application on July 15 in New York waterchestnut covered the surface. Rates were 4, 8, 12 and 16 lb./A. Control was excellent. An area of water at least five times as large as the original plots was cleared and remained clear. Rates of application could not be evaluated separately because of the large amount of diffusion.

Monuron-TCA (General Urox Weed Killer), 22% on granular mineral base. Plots at 10, 20 and 40 lb./A. rates were treated on June 17 in New York. There was no control at the first check on July 17. Thereafter, diffusion from nearby applications of 2,4-D and 2,4,5-T on vermiculite made it impossible to differentiate between the treatments. A delayed effect might have been responsible for some of the later, good control in the Urox plots.

Monuron, 25% on pellets. Plots at 10, 20 and 40 lb./A. rates were treated June 17 in New York with no control.

Silvex, 10% on 8-15 mesh attaclay. Plots at 2, 4, 8, 12, 16 and 20 lb./A. rates were treated on May 22 and at a 40 lb./A. rate on June 17 in New York. There was only a slight reduction in density of plants at the 20 and 40 lb./A. rates.

CBMM (Chipman Chlorea) in granular form. Plots at 50, 100 and 150 lb./A. rates were treated on June 17 in New York with no effect.

TBA (Amchem Benzac 103, polychlorobenzoic acids), 25% on 15-30 mesh attaclay. Plots at 3, 6 and 12 lb./A. rates were treated on May 21 with no effect.

SPRAYS IN WATER, KEROSENE-EMULSION OR KEROSENE

2,4-D amine salt, kerosene, and Igepal CO-530 in water (New York formulation as previously described except a greater dilution of water was used). Plots were treated on July 15 and checked on September 12. Most rosettes were killed or effectively stunted, but a few seeds of possible viability were still attached. Weak lateral rosettes were observed. Results were best in the 8 lb./A. plot and slightly poorer in the 4 and 2 lb./A. plots.

2,4-D butoxyethanol ester in water. Plots were treated on July 15. When checked on September 12, rosettes were mostly killed or disintegrating, but some seeds of possible viability were still attached. These plots were in a zone of diffusion from the plots treated with 2,4-D and 2,4,5-T on vermiculite and could not be evaluated precisely. The 8 lb./A. plot had a few seeds, but the 4 lb. and 2 lb./A. plots nearer the plots of 2,4-D and 2,4,5-T on vermiculite were clear of plants. Applications made in Maryland on June 4, 1956 at 4 and 8 lb./A. rates gave complete control at the higher rate and nearly equal control at the lower rate. A preliminary trial at a 4 lb./A. rate in which triethanalomine was added to 10 ratio gave complete control.

2,4-D butoxyethanol ester in kerosene. Applications were made on July 15 and checked on September 12. Most rosettes were killed or very weak, but some seeds of possible viability were still attached. The 8 lb./A. rate was much better than the 4 lb./A. rate which, in turn, was much better than the 2 lb./A. rate.

2,4-dichlorophenoxy acetamide (Amchem Emid, wettable powder). Applications were made on July 15 and checked on September 12. Most rosettes were killed, but some plants showed continued growth and formed weak lateral rosettes. Some seeds of possible viability were still attached. The 8 lb./A. rate was slightly better than the 4 lb./A. rate which in turn was slightly better than the 2 lb./A. rate.

MCPA in water. Applications were made on July 15 and checked on September 12. Many plants had disintegrated, but some seeds of possible viability were attached and some rosettes were recovering. The 8 lb./A. rate was definitely best with the 4 lb./A.

Dalapon (soluble powder). An application at a rate of 6 lb./A. was made on July 16 and checked on September 12. This treatment was ineffective.

Amitrol (soluble powder and liquid). Applications were made at a rate of 2 lb/A. on July 16 and checked on September 12. These treatments were ineffective.

TCA (wettable powder). Applications at a rate of 5 lb./A. were made on July 16 and checked on September 12. These treatments were ineffective although rosettes showed some damage.

Sodium salt of 2,4-dichloroisobutyric acid (Rohm & Haas FW-450, wettable powder). Applications at a rate of 10 lb./A. were made on July 16 and checked on September 12. These treatments were ineffective since rosettes showed only slight damage.

INVERT EMULSION SPRAYS

Invert 2,4,5-T technical (Dow Inverton 245). Applications were made on July 16. Treatments at rates of 1/2, 1, 2 and 4 lb./A. resulted in partial control. Many rosettes were recovering, and some seeds of possible viability were still attached on September 12.

Invert 2,4-D butoxyethanol ester. (Amchem). Applications were made on July 16. Treatments at rates of 1, 2, 4 and 8 lb./A. resulted in partial control. Most of the rosettes were killed but some were recovering and some seeds of possible viability were still attached on September 12.

DISCUSSION AND CONCLUSIONS

In evaluating results and drawing conclusions it is important to bear in mind that the trials on a small plot basis were for the most part exploratory and that close standardization of conditions was not always possible because of variable weather and other uncontrollable factors. The timing of treatment with reference to the growth stage of waterchestnut was one important variable.

Interpretation of data from 1/100 acre plots is not considered directly applicable to large-scale treatment since experience has indicated that large areas generally show a better response. If a chemical does show good control at a given rate in a small plot or even reaches beyond the boundaries of a plot, it would probably give better control on a large application at a reduced rate per acre where diffusion into adjoining untreated areas of water is not possible.

With limitations of the above mentioned types in mind we can summarize conclusions:

(1) Of all the chemicals tested, 2,4-D gave the best results. Although some formulations also contained 2,4,5-T, this compound has not shown any advantages over 2,4-D on the basis of previous study.

(2) Only 2,4-D in formulations of attaclay and vermiculite granules gave a complete kill characterized by no regrowth. However, early treatment with a relatively insoluble formulation of 2,4-D on attaclay failed to give control even though it might have been expected to remain active for a long period. On the basis of the one later application in June at a heavy rate (40 lb./A.) it is clear that 2,4-D pellet treatments have good possibilities. Vermiculite impregnated with soluble 2,4-D was tried only in July on dense stands but gave excellent results.

These results with vermiculite containing a soluble form of 2,4-D (amine salt) suggest that perhaps attaclay pellets impregnated with more soluble or emulsifiable forms than those tested constitute a promising field for further experimentation.

(3) Conventional sprays of 2,4-D in water, kerosene-water emulsion or kerosene gave effective results although generally did not stop all regrowth. The sprouting of lateral rosettes is an important factor to be considered, but proper timing of sprays can avoid any setting of seed by these before killing of the plants by frost.

(4) Invert emulsion sprays of 2,4-D destroyed or damaged rosettes of water chestnut but did not stop regrowth and are considered only partially effective. Where wave action might wash off the usual types of sprays, invert emulsion sprays may have good possibilities for application on a repeated basis.

When all field data are considered together, it seems clear that any surface treatment of only the rosettes of water chestnut does not reach the entire plant. Some of the sprays do, however, penetrate under water to a material extent. Absorption from pellets at lower parts of a plant is considered likely to result in upward translocation of the herbicide and this would explain the complete kill. Vermiculite, which gradually sinks, affects both top and underwater parts of the plant and gives a complete kill. Improvement in surface sprays might be expected through changes in specific gravity to provide a slow sinking material. One test in this direction involving the addition of triethanolamine

A PROGRESS REPORT ON SIMAZINE FOR AQUATIC WEEDS

By
Edwin O. Schneider (1

Simazine (2-chloro-4,6-bis(ethylamino)-s-triazine was introduced experimentally to experiment station and other workers in 1956. Outstanding performance as a pre-emergence weed control chemical was reported in corn and in several agronomic crops in 1956 and again in 1957. Weed control in woody species and aquatics were investigated during the same period. Walker (2) in 1957 reported a 10% active ingredient pellet showed promise as a herbicide for controlling aquatic species of weeds without injury to several species of fish or fish food organisms at soil sterilization concentrations.

This paper will discuss Simazine as an aquatic herbicide. A paper in the Wildlife Management and Forestry Section discusses in more detail the physical properties and mode of action of Simazine.

TOXICOLOGICAL PROPERTIES

The acute oral toxicity of Simazine has been determined in both rats and mice and was found to have an LD_{50} in excess of 5g/Kg. Walker (2) reported analysis of the bottom fauna in ponds show no indications of deleterious effects of the herbicide or no visible toxicity to fish in enclosures treated for one year at 10 lbs. active ingredient per acre. Data from other workers on toxicity to fish will be available in the near future.

CHEMICAL PROPERTIES

Simazine is a white, crystalline substance which has a solubility of 5 ppm in water.

TOLERANCE TO PLANTS

Tests have demonstrated that corn will tolerate rates of Simazine much in excess of those necessary for the control of annual broadleaf weeds in grasses. Application either before the corn emerges, or application to the emerging or growing plant, has resulted in no injury to the corn plant. Tests by

(1 Geigy Agricultural Chemicals, Div. of Geigy Chemical Corp.

experiment station workers on many species of ornamentals and forest conifers have found no injury at the suggested rates and only minor symptoms when rates were increased several times in nearly pure sand culture in pots in the greenhouse.

It has been determined that corn is able to decompose Simazine within the plant probably by enzyme action shortly after being taken from the soil by the roots. While on the other hand, susceptible plants either cannot decompose the absorbed chemical, or do so at a rate so slow that death of the plant occurs before decomposition.

Apparently rooted aquatic weeds take the Simazine up through the roots whereas the unattached aquatics have the ability to pick up the chemical from the water.

MODE OF ACTION

Experiments have demonstrated that Simazine is taken up by the roots of plants and translocated upwards to the leaves. Seeds in treated soil germinate normally and the seedling is killed at, or soon after, emergence. Rooted aquatics apparently absorb the chemical from the soil.

The first plant symptoms appear as chlorosis at the leaf tip and margins. The symptoms continue to progress and necrosis follows. The indications are the chemical interferes with the Hill reaction or the ability of the chloroplasts to break down water to hydrogen and oxygen in the presence of light and iron. The chemical apparently does not penetrate the unbroken cuticle of the leaf, but must enter through the root.

The mode of action in algae has not been determined but it is thought to be by absorption. The solubility of Simazine in water can be in excess of the lethal concentration found to be effective on algae.

PERFORMANCE

Simazine has been evaluated by experiment station workers, state fish biologists and others for toxicity to fish and for the herbicidal performance on rooted and free floating aquatics. Walker (2) worked in small enclosures in a pond made by using two stakes at the outer edge of the plot, and suspending the plastic sheet from styrofoam floats. In these enclosures a single species, or several species of weeds could be treated with a chemical at varying rates and in the presence of fish and fish food organisms. Rates used were up to soil sterilization concentrations or 10 lbs. per acre. The major aquatic pest of Missouri represented in the tests were adequately controlled for a full year. An 8% granular and the 50% wettable powder was used in these tests.

In Ohio an application of 20 lbs. actual as a wettable powder was made on August 28, 1958, to a one acre lake with an average depth of 4 ft. The lake was severely infested with Potomageton spp. and filamentous algae. The species of fish were not determined but trout is known to be in the lake. Run-off at the time of treatment and following was at a minimum. Browning of the vegetation started in 7 days and progressed until complete kill was noted during the third week. Regrowth has not occurred to date. Injury to fish and the surrounding trees was not observed.

A half-acre area in a 1½ acre lake in southeastern Ohio was treated on May 2, 1958, using 60 lbs. 50% wettable Simazine per acre. The control was similar to that reported above. The run-off was moderate and movement of the chemical was noted from the head water area treated to the out-let and to other parts of the lake. Control was rated as excellent in September.

Work in Kentucky in ponds indicated the granular Simazine has possibilities of controlling patches of weeds by spot application. Potomageton spp. was controlled at 4 to 8 lbs. per acre with isolated plants showin regrowth at the lower rates after 5 months. Observation will be made next year to determine the length of kill.

Jansen, etal (1) indicated the s-triazines tested had considerable algicidal potential in their culture tests when compared to the standard treatment. Other workers have noted the elimination of surface growing organisms in soil and in storage water bottles when treated with 2 to 4 ppm. Studies in tank cultures of rooted aquatics have demonstrated the effectiveness of Simazine as an algaecide when compared to the untreated tank. In a closed recirculating system Simazine at 3 ppm kept slime and algae practically eliminated for the summer. The water was exposed to contamination and was recirculated only for cleaning.

Simazine has been used with excellent success for the control of annual weeds and grasses that grow at the water line of ponds, lakes, irrigation ditches and fish rearing ponds. Rates of 10 lbs. per acre have given up to 18 months control when applied pre-emerge to the weeds.

Simazine has given control of many troublesome rooted and floating aquatics. Some of the species reported to be controlled are pondweed (Potamogeton spp.), muskgrass (Chara), Milfoil (Myriophyllum speccatum), fanwort (Cabomba caroliniana), horned pond weed (Zannaichellia palustris), and numerous species of filamentous algae. The chemical has been found to be most effective in closed areas with a minimum run-off and when the entire area is treated at one time. The wettable powder appears most effective on algae, whereas the granular material gave the best control of rooted aquatics.

SUMMARY

Simazine appears promising as a herbicide for the control of many aquatic species without injury to fish or fish food organisms at rates as high as 10 lbs. active per acre.

The most successful treatments have been in areas of little or no run-off and where the entire area could be treated at one time. Spot treatments with granules appeared promising in limited tests in large ponds.

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Further Study of the Effect of the Weedicide Kuron upon the Flora and Fauna of Long Pond, Dutchess County, New York.

Madelene E. Pierce, Vassar College, Poughkeepsie, N. Y.

The purpose of this paper was to repeat on a larger scale the pilot experiment carried out on Long Pond in the summer of 1957.* An attempt was made to determine the effect of Kuron upon the plankton and benthic organisms, as well as upon the weeds, when a limited area of a pond is sprayed. The dates during which the study was made were June 11 - September 26, 1958.

I wish to thank Mr. John Gould of the New York State Department of Conservation for his continued encouragement and help. Thanks are due also to Mr. John Grimm of Rhinebeck, New York, who gave a day of his service to spray the area professionally. To Mr. Otto Johnson, I am indebted for constant use of his shore line as my base of activity, and his boat for sampling. Dow Chemical Company provided the Kuron and Vassar College gave a small grant to defray cash expenses incurred.

Long Pond, previously described in detail (Pierce, 1958) is a very shallow pond, 1 - 6 feet in depth, with a broad border of aquatic weeds. These include submerged, floating, and emergent types. Even the so-called channel, 5-6 feet in depth, has a dense carpet of submerged weeds which are mostly Potamogetons.

Two acres of the pond were staked out on June 10, 1958. This area was located off shore, included the channel, but did not include any part of last summer's experimental plots. The depth varied from 1-2 feet along the shoreward boundary, up to 6 feet along the inner boundary and also in the northeast corner of the area.

On June 11, the first sampling was done. This set the pattern for the following ones which were carried out on June 21, immediately after the spraying, July 7, July 25, and Sept. 20. Since the experimental plot was 400 feet in length, stakes were placed at 100 foot intervals. Two sampling stations were selected at the 100, 200, and 300 foot intervals. One station was designated as the west station, the other as the east. The same simple routine of study was used as in the previous summer. At each station the bottom temperature was recorded, a water sample from the bottom was obtained, and two dredges for benthic forms were made with an Eckman dredge. One plankton haul for the entire area was standardized as much as possible by rowing on the same route for the same duration of time. In the field the contents of the dredgings were sieved, identified, and counted. In the laboratory, the plankton was studied and identified and the determinations of pH and O_2 in ppm were made by use of the Hellige

*Pierce, Proc. 12th Annual Meet. Northeast. Weed Control Conf. Jan. 1958. New York

Testing Apparatus.

The control area was selected at a point south of the treated area, and far enough removed to be unaffected by diffusion of the Kuron.

The application of Kuron was made by a professional on June 20. The Kuron was sprayed from four jets at the stern of a boat. The concentration used was 2 ppm in the pond.

Before the spraying a careful map of the pond weeds was made. The species found were the same as the previous summer (Pierce, 1958). Near the shore the common submerged plants were *Utricularia*, *Chara*, and *Potamogeton amplifolius*; *Nymphaea odorata* was the common floating type. In the deeper areas, the common submerged plants were *P. amplifolius*, *P. crispus* and *P. natans*; the common floating types were *Nymphaea odorata* and *Nuphar advena*.

The most spectacular and immediate results of the treatment by Kuron were observed on *Nymphaea*, the white water lily. Within 24 hours, the leaves showed the typical brown spots, the stems were lengthening and beginning to curl. After 3 days, the typical reaction was evident; the stems were increased in length by several inches; many were coiling like corkscrews; some were arching above the surface, and as a result many leaves were overturned. The tangled red stems and red undersurface of leaves gave a rosy hue to the entire area. This effect of accelerated growth became even more noticeable up to the 7th or 8th day. After about 2 weeks, the broken blossoms and leaves presented a tangled, unpleasant mass of dead and dying plants, which gradually decomposed, dropped to the bottom, or were removed by the wind. By 4 weeks, on July 20, the 2-acre plot stood out distinctly as a surface clear of lily pads, when contrasted with the surrounding water of the pond. Probably this condition could be hastened by mechanical removal, such as raking or dragging, of the dead weeds. For the rest of the summer and fall the surface remained clear with minor exceptions. In early September, a few small red shoots, new growth of the white water lily, appeared, but these were practically negligible. In the deeper portion, several patches of *P. natans* appeared, but again these were relatively few in number and small in size.

In summary it can be said that Kuron at a concentration of 2 ppm was successful in clearing the surface of forms such as *Nymphaea*, *Nuphar*, *Brasenia* and *Pontederia*. The control area presented throughout the season a uniform lush green growth dotted with hundreds of blossoms.

The effect of Kuron upon the submerged plants was not as spectacular. It was much more difficult to observe, to interpret, and to evaluate the conditions even with the help of the map. Certainly no judgments can be made within a few days or even a week. After a

Chara, and P. amplifolius were very much reduced; and later in the summer, two of the weeds Utricularia and P. amplifolius were, for all practical purposes, cleared out completely, leaving a bare substrate. Chara was never completely cleared out, but was much reduced. When compared with the control area, which contained a "dense forest" of submerged plants, the nearly bare substrate of the treated area was marked indeed.

The effect of Kuron upon the submerged plants in the deeper areas was not so successful. After a month, the thick carpet of Potamogetons did not appear to be decreased. Even by September these weeds appeared to maintain their abundant numbers. Comparison with the control area showed little difference or contrast. It is suggested that perhaps a higher concentration of Kuron might prove more effective in these particularly dense areas of growth.

The summer of 1958 was relatively cool and rainy as compared to the exceedingly hot, dry summer of 1957. During the period of June 11-September 23, the bottom temperatures varied only from 67 - 78°F. The pH remained, as before, remarkably constant, 7.2-7.4. The dissolved oxygen content also varied little, ranging from 6.5 - 7.5 ppm. Neither the pH or dissolved oxygen content showed any change immediately after the application of Kuron. Any variations in the conditions were comparable to the control area.

The benthic organisms identified in 1958 comprised the same large groups as those found in 1957; Annelida, Mollusca, Crustacea, and Insecta. The individual species were also the same. At no time in the treated area did any one group drop out or show a significant decrease in numbers of individuals which was different from the pattern of the control area.

Exact counts were not made on the large aquatic vertebrates such as fish, frogs, and turtles. However, all three groups were abundant in both treated and control areas throughout the season. Adult pickerel, perch, and sunfish were often seen as well as myriads of young fish. It is obvious that the Kuron had no harmful effect upon the vertebrates. In fact, the local residents never recounted a story of hundreds of dead fish along the shore, and even admitted the fishing was at least as good as usual.

The plankton identified in the 1958 season was similar to that of the previous summer. (Pierce, 1958) This proved to be the only group of organisms which did suffer at least a temporary harmful effect from the Kuron. On the first day after spraying there appeared to be a decrease in abundance of the haul, and many dead organisms were present. Of the older forms, many were abnormal in shape and the population as a whole looked "sick". However, there were still living a fair number of small, young crustacean forms. A second sample was taken after 7 days, and still a third after 11 days. On the seventh day after spraying, the general picture was one of improvement. Within the Crustacea there was a thriving population of tiny individuals. By the eleventh day, the general picture was nearly normal, so that one might resonably say that within a two week period the plankton population would have returned to its original health and abundance. One month later, when the routine sampling for the pond was carried out, no difference between treated and control area was observed.

Mention should be made of a plot treated in 1957 with Kuron at a concentration of 1.3 ppm. The effect of the Kuron for that season has already been reported (Pierce, 1958). In the spring of 1958, when compared to its control, there was a definite decrease in the number of lily pads upon the surface. However, it was obvious that although the surface had been entirely cleared of lily pads in 1957, in 1958 a substantial number were appearing. In fact by June 20, the numbers had increased so that there was little difference between experimental and control areas. As a favor to the landowners, an unmeasured but heavy dose of Kuron was applied, with the expected results of complete clearance within a month. It will be interesting to note the conditions of this area in the Spring of 1959.

Summary

1. Long Pond, a shallow pond, is rapidly filling in with a dense population of emergent, floating, and submerged aquatic weeds.
2. An experimental area of two acres was selected in June 1958 for study during the season June 11 - September 26, 1958. This area did not include plots which were treated in the summer of 1957.
3. Preliminary study of the following conditions was made on June 11: temperature, pH, dissolved oxygen content, plankton, benthic organisms, large aquatic vertebrates, and aquatic plants. This routine study was repeated at intervals on June 21, July 7, July 25, and September 20.
4. The experimental area was sprayed once with Kuron on June 20. The concentration used was 2 ppm.
5. The effect of the Kuron upon the Nymphaea was to accelerate the growth within a few days, the stems and leaves then broke off, decomposed, and the surface of the treated area was entirely cleared of lily pads in a few weeks. Pontederia and Nuphar also succumbed to treatment but were slower in reacting. The treated area remained clear for the season.
6. The submerged weeds of shallow areas, such as, Utricularia, Chara, and Potamogeton amplifolius were definitely decreased after one month, and in some areas completely eradicated. In the deeper area, where several species of Potamogeton were extremely dense, little if any decrease in abundance was observed.
7. In September, 10 weeks after spraying, a few new shoots of Nymphaea appeared in shallow areas, and several patches of P. natans appeared in deeper areas.

8. The temperature of the bottom water varied between 67-78°F.
9. The pH varied only 7.2-7.4.
10. The dissolved oxygen content varied only from 6.5 - 7.5 ppm.
11. Plankton was continuously represented by the same forms as in the preceding summer. For a week after spraying the population appeared reduced in numbers, and individuals looked abnormal, but by the end of the second week the population exhibited a normal condition.
12. Benthic forms were continuously represented by the same groups as in the preceding summer. Their numbers and vigor were not effected by Kuron, but paralleled the conditions in the control area.
13. Large aquatic vertebrates, like fish, frogs and turtles maintained numbers and vigor similar to the control area.
14. Except for a temporary setback to some plankters, Kuron applied in the concentration of 2 ppm appears to have no harmful effect upon the fauna of this pond.
15. The experimental plot, completely cleared of lily pads of *Nymphaea* in the summer of 1957, showed in 1958 a growth nearly equal to that of the control.

FIELD TESTING OF KURON AS AN AQUATIC HERBICIDE IN MASSACHUSETTS

By
Mario M. Boschetti
Sanitary Biologist
Massachusetts Department of Public Health

Introduction

Under a special study authorized by the Massachusetts Legislature, the Departments of Public Health, Natural Resources, and Public Works have been conducting a research study on the chemical control of nuisance aquatic vegetation in Massachusetts. The study has been in progress since 1953. The field testing of Kuron was initiated in 1957, and the data in this paper will include results obtained during the period extending from June, 1957 to November, 1958. A major portion of the Kuron used during this research was received gratis from the Dow Chemical Company. The author wishes to extend thanks to Mr. Mark Wiltse and Mr. Robert Roy of the Dow Chemical Company.

Summary and Results

1. A total of ten treatments were made with Kuron during the time of the study.

2. The treatments were applied under varying conditions of weed species and population, of water chemistry and hydrography.

3. The concentrations of Kuron employed varied from 0.5 to 2.0 parts per million. In one instance Kuron was used against water lilies on a one-gallon per acre basis, and against certain of the emergents a 3% solution was employed.

4. At a concentration of 0.5 parts per million, Kuron was effective against *Myriophyllum* in 100' x 100' plot treatment, and against *Nymphaea* in whole small pond treatment.

5. At concentrations of one part per million Kuron was effective against *Ceratophyllum* and *Elodea* in whole small pond treatment.

6. At concentrations of 2 parts per million, Kuron was effective against *Myriophyllum*, *Nymphaea*, *Brasenia*, *Utricularia*, *Pontedaria*, and *Sagittaria*. In the case of the latter two genera, topical application of a 3% solution of Kuron (Silvex) also proved effective.

7. Concentrations of Kuron ranging from 0.2 to 2 parts per million were ineffective against various species of *Potamogeton*

and *Sparganium*. In the case of *Sparganium*, topical application of the 3% solution also proved ineffective.

8. It was found that generally the effects of Kuron could be seen during the first and second week after treatment. In some instances this interval was less and in others more. During the study, temperature did not appear to be a governing factor; perhaps water chemistry may be the important factor here.

Field Methods

A John Bean 44-K pumping unit was employed almost exclusively for the application of Kuron. Generally the Kuron was sprayed on the water surface. In several instances where the aquatic weed growth was below the surface, close to the bottom, the chemical was applied by submerging the spray gun to a depth of about 3 feet. In the small shallow areas where it was not feasible to use a power sprayer, a knapsack sprayer was used. It is the author's opinion that good coverage of all areas sprayed was obtained. Samples of water were collected for chemical and microscopic examination before and after each treatment. The temperature of the water was also recorded. In several instances bottom samples were collected before and after treatment and examined for bottom organisms. Aquatic plants were collected before and after treatment for identification and examination in the laboratory.

Observations were made of the treated areas at semi-weekly intervals whenever possible. In one instance a daily check was made on a treated area and samples of the plants were collected for cytological examination at the laboratory.

Laboratory Methods

In the laboratories of the Lawrence Experiment Station the examination of water, bottom and plant samples were completed with no delay, whenever necessary. The biological studies were conducted in aquaria, and observations and results recorded at daily intervals, or sooner when necessary. Plants removed from treated areas 2 to 3 days after treatment were placed in aquaria with water from the treated pond. Plants were periodically removed from the aquaria and examined microscopically to determine which parts of the plant were affected by Kuron.

Field Observations

Generally, the effect of Kuron on submersed aquatics can be observed during the first week following treatment. On superficial examination, the plants appear healthy and normal. Closer observation, however, shows that the plants have diminished in vitality and elasticity. When the plants are removed from the water they appear limp and are somewhat soft to the touch. The leaves may be easily stripped from the plants with little effort. During the third to fourth weeks after treatment, the plants begin to settle to the bottom, and the water surface appears clear of weeds. Most of the plants have lost their leaves, and bare stems can sometimes be seen uprooted and floating or still attached to the bottom. After one month, most of the plants have undergone decomposition and only little evidence of their presence is generally found.

In the case of attached flaating vegetation, e.g., water lily and water shield, superficial effects of Kuron treatment are visible within hours after treatment. The pads of these species are covered with brown spots where the droplets of chemical have come in contact with them. Further signs become evident within a week after treatment. The pads then begin to shrivel and to lose their natural deep coloration. The stems become flaccid and lose much of their tension. They appear to have become elongated and swollen somewhat and are rather easily pulled apart. Within three weeks, the pads have submerged and the water appears free of vegetation. During the first and second month following treatment decomposition occurs and proceeds quite rapidly. Also during this time a great many of the underground stems have dislodged and can be seen free-floating on the surface. Complete eradication is usually assured when this occurs.

It was found that Kuron at 1 part per million was not effective against water lilies when applied during the fall (October). The author reasons that treatment this late in the growing season fails because of the physiological condition of the lily pads during this time of the year. Being deciduous by nature, all vital functions have probably been arrested by this time and consequently the uptake of chemical does not occur. This is in contrast to the species of submerged plants such as *Myriophyllum*, which lie dormant during the colder weather but are still physiologically active although at a decreased rate.

Kuron proved to be ineffective against various species of *Potamogeton* at concentrations varying from 0.5 to 2 parts per million. A 1% Kuron spray was ineffective against *Lemna* (duckweed). No outward signs of susceptibility were noted during the post-treatment examinations of these species.

In treated areas of large ponds from which *Myriophyllum* and *Utricularia* were eradicated, floating, healthy pieces of *Utricularia* from adjacent control areas were noted in the area. However, the *Utricularia* did not take root, and the areas have remained relatively free of vegetation for 1½ growing seasons. During the study no effect of Kuron was apparent on bordering shoreline trees and ornamental plants.

A summary of Kuron treatments is shown in Table I.

Table I - Summary of Kuron Treatments - 1957-58

Kuron (Silvex) PPM	Aquatic Weed	Area Treated	Pre-Treatment Growth	Treatment Date	% Kill	% Regrowth	Remarks
1957							
2	Myriophyllum	100'x 100' (.25 Acres)	Dense	8/13/57	100	0 thru 1958	A sharp line growth eviden outside area.
1	"	5 Acres	Dense	10/24/57	100	"	
2	Potamogeton	0.3 Acres	Dense	8/28/57	0	-	Treatment Ineffective
1958							
2	Myriophyllum	4 Acre Cove	Dense	9/2/58	100	To be determined	Exam. of 9/15, showed no evidence of live plants.
"	"	3 Acre Cove	Dense	"	"	"	"
1.5	"	4 Acres (Whole Pond)	Dense	10/11/58	"	"	Treated by ha at 3-day intervals.
2	"	200'x 50' (shoreline area)	Dense	9/2/58	90	"	Spray gun submerged below surface.
2	Nymphaea	1 Acre	Dense	9/2/58	100	To be determined	
"	"	3.5 Acres (Whole Pond)	Dense	6/28/58	"	0 thru 1958	

Table I (continued)

Kuron Silvex) PPM	Aquatic Weed	Area Treated	Pre-Treatment Growth	Treatment Date	% Kill	% Regrowth	Remarks
% Soln.	Lemna (duckweed)	2 Acres (Whole Pond)	Dense (on lee shores)	8/28/58	0	-	
1	Ceratophyllum	2 Acres (Whole Pond)	Moderate	8/28/58	100	To be determined	
"	Elodea	"	"	"	100	"	
1.5	Utricularia	Scattered Growths	Moderate	9/2/58	90	To be determined	
1.5	Brasenia	"	"	"	100	"	
1.5	Nymphaea	"	"	"	100	"	
0.5	Nymphaea	2 Acres (Whole Pond)	Dense	8/13/58	95	To be determined	Kuron applied on a 1 gallon per acre basis.
0.5	Myriophyllum	100'x 100' plot	Dense	8/14/58	100	To be determined	
% Soln.	Sparganium	200' shoreline treatment	Dense	9/2/58	0	-	Slight browning, but plants appeared healthy on 9/15/58.
% Soln.	Pontedaria	Small	Dense Clumps	9/2/58	100	To be determined	Plants brown 1 week post-treatment.

Laboratory Observations

Specimens of Myriophyllum collected after Kuron treatment were examined microscopically to determine the areas and extent of tissue damage. It was found that the root, stem and leaf tissues were all involved. The epidermal (outer) layer of cells of the root system was spotted with dead cells-evidenced by browning and loss of cellular integrity. The stem tissues showed similar changes. The leaf tissue showed more marked changes. The brown spotting was more extensive and penetrated the parenchymal (deeper) tissue cells to a greater extent. Under oil emersion (960 X magnification), some of the leaf cells were observed to contain large "brown" masses within the cytoplasm proper, in others the "brown" discoloration was restricted to the cell membranes. It is conjectured that the "brown" formations were a product of cellular coagulation. No attempt has been made to determine the significance of these findings, since the author feels that more detailed research at the cellular level is necessary before conclusions can be reached relative to the mode and site of action of Kuron on aquatics. If funds are made available to continue the present research, it is planned to undertake similar studies during 1959.

The aquatic studies conducted on the chemically treated plants showed that under laboratory conditions the plants succumbed to the effects of Kuron at a much faster rate than did the plants which were left in the treated area under natural conditions.

Microscopic examinations of water samples collected before and after Kuron treatment indicate that except for a moderate initial decrease in the plankton forms, the plankton population was not adversely affected by the Kuron treatments. Essentially, the same was true of the bottom organisms. Here again, more detailed study is indicated and necessary before any definite statements can be made relative to the effect of Kuron on fish food organisms. The fact that eradication of aquatic weeds in fish culture ponds is fast becoming a practice, and that scientific knowledge in this area of weed control is lacking, the author feels that this would be an excellent field for research by interested individuals.

Conclusions

1. Kuron (Silvex) 2 (2,4,5-Trichlorophenoxy) Propionic Acid shows great promise as an aquatic herbicide and is effective against most species of aquatic plants at contact concentrations of 2 parts per million. The notable exceptions to this appear to be the genus Potamogeton among the submerged aquatics, and the genus Sparganium among the emergents.

2. Kuron, apparently, is not a "contact" "poison", but

must be absorbed by the plants in order to exert its toxic effects. In view of this, Kuron may properly be termed an "internal" poison.

3. From the observations made of the reaction of the water lily to Kuron treatments - the resulting elongation of the stems - one is led to conclude that Kuron acts as a growth stimulating substance, and is properly classed as a plant growth regulant along with 2,4-D and 2,4,5-T.

4. Since areas which have been cleared of aquatic weeds with Kuron remain weed free for more than one growing season, it is concluded that Kuron is capable of residual control.

5. Kuron properly used against aquatics does not adversely affect land plants which border the treated areas.

PROGRESS REPORT ON THE USE OF KURON, 2,4-D and 2,4,5 TP GRANULES AS AQUATIC HERBICIDES

by

Roy R. Younger 1/
Assistant Fisheries Biologist
N. J. Division of Fish and Game

The purpose of this report is to summarize the results of three year's experimentation using Kuron, and one year's progress in using 2,4-D and 2,4-5 TP granules as aquatic herbicides.

Kuron

The first experimental work with Kuron was conducted at Ramapo Lake, Passaic County in 1956. 2/ The following year thirteen lakes and ponds were treated. The results of these experiments have been presented in a previous paper. 3/

At Ramapo Lake, the herbicide was applied at a concentration of 2.5 p.p.m. to control water milfoil, *Myriophyllum heterophyllum*; fanwort, *Cabomba caroliniana*; and white water lily, *Numphaea odorata*. No further treatment was necessary in 1957, however, in 1958 the treated areas were completely reinfested with the same noxious weeds.

Good control of the most predominant species - water milfoil, *Myriophyllum* sp., yellow water lily, *Nuphar* sp., and white water lily, *Nymphaea* sp., was obtained in five ponds receiving total applications of Kuron in 1957 at concentrations ranging from 0.5 to 2.5 p.p.m. In 1958 these ponds needed no further treatment because the water milfoil had not reappeared and the water lily stands were greatly reduced. Considering the size and extent of the lily root systems it is not difficult to understand why total control in one application is not possible.

Plant reinfestation seems most likely to occur, at least in New Jersey, from seeds and plant fragments entering from untreated lakes upstream, rather than from the germination of seeds after the application of Kuron. There is some evidence

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1/ The author is now employed as a technical representative of Halco Chemical Company, Kenilworth, N. J.
2/ Huckins, Robert K. 1956. Job completion report, Project F-1-R, Aquatic Weed Control, unpublished.
3/ Younger, Roy R. 1957. Preliminary studies using Kuron as an aquatic Weed Control Conference, New York, January, 1958.
All this work has been conducted under federal aid in Fish & Wildlife Restoration Acts, New Jersey project numbers F-10-R

that new plant species, normally shaded out by dense stands of predominant plants, will start to appear once the dominant vegetation has been removed. For example, water starwort, Callitriche sp., started to appear in isolated clumps along the shoreline in ponds where other species had been controlled the previous season. It is doubted that this species will successfully infest the pond since it will be crowded or shaded out by a more prolific and faster-growing species.

Plants which were successfully controlled by Kuron applications are:- water milfoil, Myriophyllum sp., fanwort, Cabomba sp., yellow water lily, Nuphar sp., white water lily, Nymphaea sp., water shield, Brasenia sp., rush, Juncus sp., water celery, Vallisneria sp., water weed, Anacharis sp., cattail, Typha sp., water starwort, Callitriche sp.

Plants on which limited control was obtained using Kuron are:- bladderwort, Utricularia sp. and pond weed, Potamogeton sp. 4/

The factors which seem to affect the successful control of aquatic vegetation when using Kuron are:-

1. Water temperature

Cold water applications produced little, if any, control. Since aquatic plant growth is at least partly associated with water temperature, it is speculated that the cold water reduced the plant's vulnerability to Kuron. For this reason it is recommended that treatment with Kuron should begin when the water temperatures are in the 60's, around May 15th in New Jersey. Spraying programs can be continued until the flowers are present. It is doubted that spraying after the seeds are found will provide adequate control on them since Kuron is not a chemical sterilant or a pre-emergent type herbicide. However, the mature plant will be controlled.

2. Contact time

The contact time necessary for Kuron to produce plant destruction has never been determined. It has been observed that in those lakes where water levels were

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4/ Results in other states have indicated that Potamogeton sp., can be controlled, however, this species was never controlled in experiments conducted in New Jersey.

reduced prior to treatment greater plant destruction was achieved. Therefore, it is recommended that lakes and ponds receive total treatment and that the lake volume be reduced to insure sufficient contact time.

The concentration recommended to obtain adequate control with Kuron is 2.0 to 2.5 p.p.m. The Dow Chemical Toxicological Laboratory has determined the L.D. 50 for the emerald shiner, Notropis atherinoides, is 7.0 p.p.m. The recommended concentration is far below the toxic level and fishkills should not occur, providing other chemicals are not used before or after treatment. Furthermore, damage to shoreline vegetation should be negligible at this concentration. 5/

3. Bottom application

Spraying the exposed bottom with Kuron at the rate of 4 gallons per acre has proven successful in one instance. It might be worthwhile to more fully explore this technique, thereby reducing the cost and making it possible to spray at an earlier period in the spring.

Conclusions

The results of three years of experimentation would seem to indicate that longer periods of control are obtained with Kuron than with other herbicides.

2,4-D and 2,4,5 TP granules

As a result of Dr. Grigsby's 6/ work in Michigan, the New Jersey Division of Fish and Game became interested in further field testing of 2,4-D and 2,4,5 TP granules. Thirty-six plots containing 2,500 square feet (.057 acres) were laid out to evaluate the effectiveness of 2,4-D and 2,4,5 TP granules of either 15/30 or 8/15 mesh size. The "TP" granules were tested in three plots and the "D" in thirty-three plots.

5/ There have been some fishkills in the past. In one instance the fishkill was caused by the addition of copper sulfate for algae control prior to treatment with Kuron. Another fishkill in a farm pond was attributed to the rinsing of spray equipment previously used to apply Malathion. A third fishkill has never been explained due to so many extraneous factors which occurred either prior to or immediately following application.

6/ Grigsby, B. H. and R. H. Hamilton, 1958. New techniques in the application of herbicides for control of aquatic plants. Presented at the 1958 meeting of the Weed Society of America, Memphis, Tenn. January, 1958.

The "TP" was evaluated at 5, 10 and 15 pounds per acre and the "D" from 10 to 60 pounds per acre. The plants in these plots were water milfoil, Myriophyllum sp., water celery, Vallisneria sp., and pond weed, Potamogeton sp. (Table I) For the most part the granules were distributed by a cyclone spreader.

The results of these experiments were very erratic and discouraging. Water milfoil and white and yellow lilies were the only species controlled. In the areas where control was obtained the plot was quickly reinfested by plant fragments drifting in from untreated areas. These fragments would settle to the bottom and develop adventitious roots. The water lilies soon developed new leaf and stem systems. This reinfestation did not affect the lake's usage since the plants did not grow rapidly. There were no fishkills and in one instance sunfish were observed making a nest in an area which had just been "sowed" with "D" granules.

The concentration producing the greatest degree of control were the higher ones of 20 to 60 pounds per acre for "D" and 15 pounds per acre for TP. There is evidence that even at these rates treatment will be necessary the following year.

The disadvantages of the granules are:-

(1) The granule size. The 15/30 size mesh attaclay produced the greatest problem since they could not break through the surface tension of the water because of their lightness. A granule of 8/15 size mesh readily breaks through the surface tension of the water and becomes distributed on the leaves and stems of the plant.

(2) Granular hardness. The hardness of the material used for granules ranged from hard to very soft. The soft granules produced a threefold problem. First, clouds of dust were given off as these granules were being distributed, resulting in some damage to trees along the shoreline. Secondly, this dust was inhaled and drowsiness resulted to project personnel. Whether this drowsiness is associated with the 2,4-D or the attaclay dust has yet to be determined. Thirdly, an oil slick appeared on the surface of the water immediately following application of the softer-type granules. Some tests have revealed that the oil slick is 2,4-D, thereby possibly reducing the effectiveness of the material.

(3) The time required to bring about plant destruction is approximately six weeks. Early spring and winter applications have not been made to determine the effectiveness

Conclusions:

The advantage of using granules is ease of distribution since no cumbersome spray equipment is required. This makes it possible for lake front property owners to treat their portion of the lake.

If the mechanics of the granules can be improved, and if the rates of application can be determined, they will definitely have a place in aquatic weed control.

Table I.

SUMMARY OF 2,4-D and 2,4,5 TP EXPERIMENTS IN NEW JERSEY FOR 1958

Area treated	Date treated	Water temp.	D.O.	pH	No. plots and amt. active 2,4-D/acre	No. plots and amt. active 2,4,5 TP/acre
Applegate's Pond Monmouth County	4/29/58	62	10.4	6.8		3 plots 5 lbs/acre 10 lbs/acre 15 lbs/acre
Medford Lakes Camden County	4/30/58	65	7.4	5.4	3 plots 10 lbs/acre 20 lbs/acre 30 lbs/acre	3 plots 5 lbs/acre 10 lbs/acre 15 lbs/acre
Musconetcong Lake Morris County	5/9/58	63	9.2	6.6	3 plots 10 lbs/acre 20 lbs/acre 30 lbs/acre	3 plots 5 lbs/acre 10 lbs/acre 15 lbs/acre
Hopatcong Sussex County	6/12/58	76	7.8	7.6	10 plots 2 - 10 lbs/acre 2 - 20 lbs/acre 2 - 30 lbs/acre 2 - 40 lbs/acre 2 - 60 lbs/acre	
Grovers Mills Mercer County	7/10/58	78	6.8	6.6	3 plots 15 lbs/acre 20 lbs/acre 25 lbs/acre	
Esteville Lake Atlantic County	8/7/58	76	6.6	5.2	3 plots 15 lbs/acre 20 lbs/acre 25 lbs/acre	
Saxtons Falls Warren County	8/5/58	72	8.0	7.5	3 plots 15 lbs/acre 20 lbs/acre 25 lbs/acre	

Table I Contd.

SUMMARY OF 2,4-D and 2,4,5 TP EXPERIMENTS IN NEW JERSEY FOR 1958

Area treated	Type of vegetation	Control
Applegate's Pond Monmouth County	Fanwort, *Cabomba* sp. Spatterdock, *Nuphar* sp.	None
Medford Lakes Camden County	Water milfoil, *Myriophyllum* sp. White water lily *Nymphaea* sp.	None
Musconetcong Lake Morris County	Water milfoil, *Myriophyllum* sp.	2,4-D control only with 12 and 18 lbs/acre. 2,4,5 TP control with 9 lbs/acre 1/
Hopatcong Sussex County	Water milfoil, *Myriophyllum* sp. Spatterdock, *Nuphar* sp. Pond weed *Potmegeton* sp.	Good control at all rates 2/
Grovers Mills Mercer County	Fanwort, *Cabomba* sp.	None 3/
Esteville Lake Atlantic County	Bladderwort *Utricularia* sp.	None 3/
Saxtons Falls Warren County	Water milvoil *Myriophyllum* sp.	None 3/

1/ At time of application no *Vallisneria* was observed. After treatment and destruction of *Myriophyllum*, the *Vallisneria* took over the treated area.

2/ Regardless of rates of application, good control was had for a short period of time since weed fragments from untreated areas settled to the bottom, putting out advantitious roots, thus reinfesting the treated area.

3/ In these plots the 2,4-D was sprayed on soft attaclay which broke down immediately upon contact with water.

A PRELIMINARY REPORT ON THE USE OF CHEMICAL HERBICIDES TO CONTROL PURPLE LOOSESTRIFE (LYTHRUM SALICARIA) ON A SMALL MARSH

W. H. McKeon, New York Conservation Department, Poughkeepsie

In the Lower Hudson Game Management District, 23 wildlife marshes have been constructed under the Pittman-Robertson program since 1951. These marshes generally back up water averaging two and one-half feet in depth over areas ranging from three to seventeen acres. The chief purpose of these marshes is to provide nesting and breeding areas for wild waterfowl. In order to make this possible, a variety of food and cover plants are essential. However, a large percentage of marshes in the district have an almost pure stand of Purple Loosestrife (Lythrum salicaria) which provides little food but does give some cover.

The marsh chosen for this study is the Traver Marsh located in Pleasant Valley, Dutchess County, New York. It was constructed in 1952 and floods approximately twelve acres. The central portion is almost completely dominated by Purple Loosestrife with a few sedges interspersed.

In an effort to find some means of controlling this plant so that it might be replaced by more desirable food and cover plants, several types of treatment were used.

Manipulation of water levels was first attempted. This was completely unsuccessful. Burning of the marsh in the winter was next tried. This too failed as Loosestrife has a deep root system and does not burn readily. Surface and subsurface cutting was next attempted. This had no effect. Our next attempt was with chemical control. We set up several study plots of various sizes and used a number of different preparations.

During 1955-58 several chemical concerns donated their products for experimental use on the Traver Marsh in an attempt to control this weed. Among the products used in 1955 and 1956 were Weedazol, Karmex 40, 2-4D, 4-5T and 2-4 Dow. In 1958 we obtained sufficient quantities of Kuron to treat several one acre study plots.

All the spray work completed in 1955 and 1956 was hand applied on quarter acre study plots. The locations of all plots are indicated on the accompanying map.

In order to facilitate the spraying process on the two one-acre plots which were to be sprayed with Kuron during 1958, they were cleared to ice level by mowing during the winter. This gave us more maneuverability and visibility for spraying since Loosestrife has a dense vegetational habit. The dead canes from the previous two or three seasons which remain erect form a substantial barrier to a man wading with a hand sprayer on his back. Further the root-stocks form a bog like structure which also causes difficulity in wading. This clearing operation was completed in March of 1958.

Spraying activities were completed on Plot F on June 6, 1958. In this application we used Kuron at the rate of 6# acid equivalent per acre.

Spraying was completed on Plot G using a 12# acid equivalent per acre of Kuron on June 12, 1958.

On July 18, 1958 Plot F was resprayed using 6# acid equivalent per acre of Kuron. All applications were made in a mist form with no perceptible drift.

All applications that were made during the entire period are tabulated below in Chart I.

CHART I

Plot	Size	Date	Temp.	Wind	Cloud	Cover % kill*	Dosage**	Precip.
A	1/4 acre	5/9/55	40°	14 NW	90%	--	4# per acre (Weedazol)	None
	" "	7/12/55	85°	4 S	0%	85%	8# per acre (Weedazol)	None
B	" "	5/20/55	70°	4 NW	0%	100%	4# per acre (2-4 Dow)	None
C	" "	5/6/55	75°	12 SW	25%	25%	4# per acre (Weedazol)	None
D	" "	6/6/55	80°	4 N	0%	80%	4# per acre (2-4D, 4-5T)	None
E	" "	6/8/55	65°	10 SW	100%	50%	15# per acre (Karmex 40)	None
F	1 acre	6/6/58	70°	10 W	0%	--	6# per acre (Kuron)	None
		7/18/58	80°	10 S	0%	100%	6# per acre (Kuron)	None
G	1 acre	6/12/58	75°	5 W	0%	100%	12# per acre (Kuron)	None

* % of kill at end of growing season

The spray work that was done during 1955 was further evaluated in the growing season of 1956. It was found that regeneration had taken place so that all plots except Plot A were still 75% covered with Loosestrife.

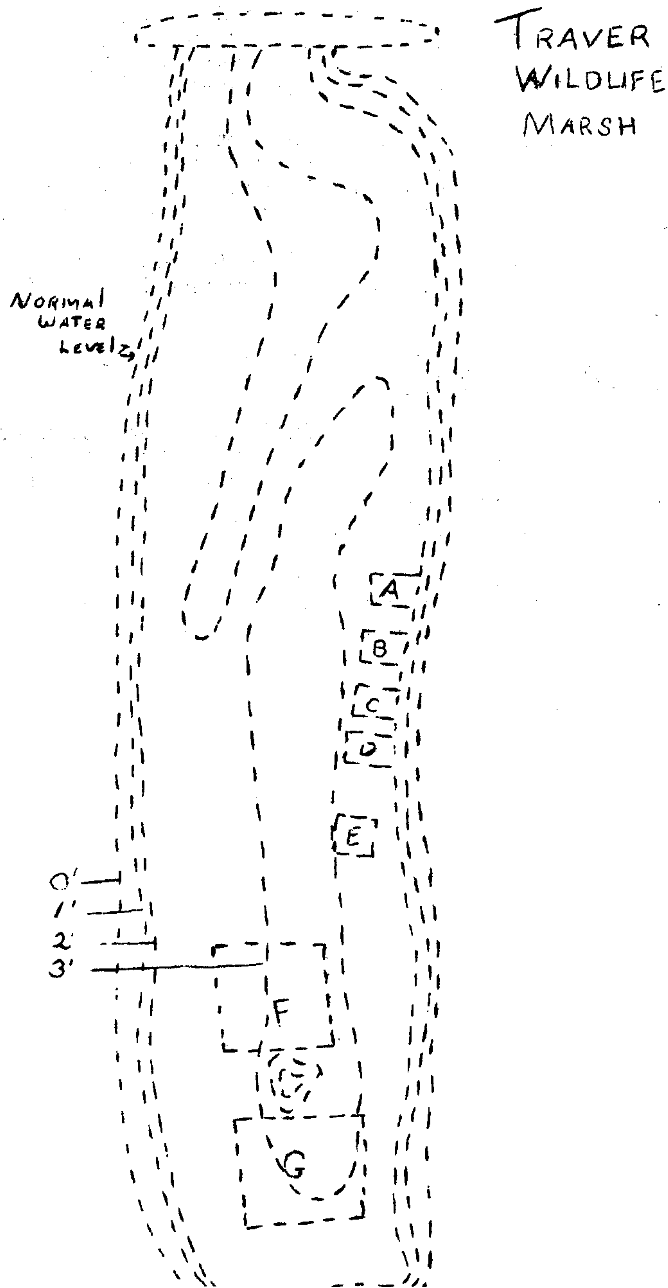
Further sprayings on Plot A during 1956 using Weedazol kept this plot open. However, with the amount of spraying that is necessary District-wide, it would not be economically feasible to attempt control with this formulation.

The 2-4 Dow and 2-4D, 4-5T compounds were not sufficiently effectibe to be used for the degree of control we need.

Karmex 40 was not effective at all in the strength used.

We do not have sufficient information as yet on the plot sprayed with Kuron to determine its value in control. We will have to wait until next year's growing season to determine its effectiveness even though it gave a total kill in the year of application.

At this time further studies are needed since none of the chemical compounds which were used gave us the degree of control desired at a feasible cost.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SOME EXPERIENCES WITH CONTROL OF PURPLE LOOSESTRIFE AT THE MONTEZUMA NATIONAL WILDLIFE REFUGE

Lawrence S. Smith[1]

The importance of purple loosestrife, Lythrum salicaria, as a weed threat in areas managed for waterfowl first came to this author's attention in the period 1954 through 1956 in connection with pool management on the Montezuma National Wildlife Refuge.

Purple loosestrife has been noted to be a common species on wetland areas of Central New York (Wiegand and Eames, 1925), particularly so along the New York State Barge Canal in the vicinity of Montezuma and Port Byron, New York, and on and near the New York State Howland's Island Game Management area. This species is common along the watershed of the Oak Orchard Creek in western New York--on the present State Game Management Area and on the area being acquired as the Oak Orchard National Wildlife Refuge.

Through 1955, purple loosestrife was noted as occurring outside of, but adjacent to, impoundment areas at the Montezuma Refuge. A maximum drainage of refuge impoundments was made during the summers of 1954 and 1955 for the purpose of solving a carp problem. At that time purple loosestrife encroached into the pool areas. While the preponderance of growth appeared near the established stands of loosestrife growing at the foot of dike slopes and along the Barge Canal, individual plants were found widely scattered throughout the pool area a half-mile and more from any previously known stands of loosestrife.

From my acquaintance with Dr. Arthur Cook of the New York State Conservation Department, I had learned of the problems the state had encountered with this species. Dr. Cook pointed out the young plants of purple loosestrife within the Main Pool area at Montezuma and briefed us on his failures as of that date to control the plant with herbicides where it grew in standing water. Once established, loosestrife continues to grow from the same root and eventually forms a stump of sorts at the water line. With a little age the species takes on the appearance of brush. Its only value to waterfowl is cover, which could be better provided by several other emergent aquatics. Where loosestrife grows in dense stands, it makes an area impenetrable to access by boats and precludes the growth of aquatics of more worth to waterfowl. One redeeming feature of this plant in the deeper water portions of impoundments for waterfowl may be its ability to survive both deeper water and muskrat activity, thereby providing cover where other species cannot exist. The success of this species in extending itself throughout wetland areas may well be explained by the fact that it is an introduced plant of European origin.

From my discussions with Dr. Cook, it became apparent that while we had the beginning of a problem on our hands, this period of initial encroachment

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1. Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service

was going to be the most opportune time to control the species, if possible. During the early summer of 1956 we had equipment set up for application of AMS (Ammonium sulfamate, commercially Ammate) on brush. While the use of this herbicide on loosestrife had not been reported to me, we applied AMS to loosestrife on shoreline areas by truck mounted brodjet aprayer. The more dense stands of loosestrife within the Main Pool area were sprayed by mounting our spray equipment within a skiff. Where loosestrife had encroached in more widely scattered situations, considerable effort was put forth to hand pull the individual plants. This was done by a laborer in hip boots pushing a canoe along for removal of the plant from the water. Evidence was that the plant would re-establish itself if left to lie in the water.

Within ten days of the application of AMS, the loosestrife receiving this spray appeared quite dead in appearance; and we were encouraged to continue with the application of this herbicide to an estimated six acres of loosestrife during the summer of 1956. No exact and controlled applications were made. The AMS was mixed as per manufacturers recommendations for use on brush, and a wetting agent added. The spray tank was filled at the rate of 60pounds of active AMS (75 pounds commercial Ammate) and six ounces of wetting agent per 100 gallons of water. The objective in spraying was to completely spray the loosestrife to the exclusion of other emergent aquatics. The nature of the growth of loosestrife that we sprayed makes it difficult to assess the amount of herbicide utilized on an acre basis. Our records indicate that it fluctuated between 32 and 40 pounds of active ingredient per acre (Smith, 1956).

Prior to killing frosts in 1956, a new shoot was noted on several of the loosestrife plants which had been sprayed and otherwise appeared quite dead. This shoot came up from the root adjacent to the original stem and reached a height of 10 inches above the water. Because of this evidence, there was considerable doubt about the eventual success of our initial spraying with AMS. However, we were surprised to find during 1957 a 100% kill of the loosestrife that had received a complete coverage of spray. Any living plants within the area sprayed could be attributed by location to incomplete spraying (Bauman,1947).

With this evidence of success, we continued application of AMS during the summer of 1957 both during pre-flowering and flowering stages of growth in the months of July and August. A total of 7.5 acres was treated. The bulk of this application was on loosestrife at locations outside the impoundments for the purpose of eliminating the source of seed. The commercial Ammate X was used during 1957 at a mixture of 57 pounds of active AMS (60 pounds of Ammate X) and six ounces of wetting agent to 100 gallans of water. Our records indicate the same application per acre of 32 to 40 pounds of active AMS(Smith and Morse, 1957). Results from the 1957 applications with Ammate X were as successful as those with Ammate in 1956. A further favorable aspect of the use of AMS on loosestrife is the fact that AMS is effective throughout the growing season. In the pre-flowering stage, purple loosestrife is difficult to identify where individual plants are growing amidst other vegetation. The most practicable period to have a spray crew in the field is during the flowering period when any laborer can identify the plant. The flowering period is in the mid-summer season after the period of most rapid growth when certain other herbicides have a maximum effectiveness.

Our biggest problem as of the 1958 season has been in getting the herbicide to the plant. Purple loosestrife has gained considerably the last three years along roadsides, along canal banks, and in dry marsh situations--areas adjacent to the managed impoundments. This increase is in the nature of many individual plants scattered throughout other growth rather than solid stands that can be efficiently treated with herbicide. The location of most of these plants precludes the use of power equipment in applying herbicides. In some instances hand pulling seemed more practicable than spraying which necessitated covering the ground on foot with the added encumberance of a back pack pump. Upon attempting hand pulling we learned that plants on dry ground situations would break off at the ground leaving the root to re-establish the plant.

The status of purple loosestrife today at the Montezuma Refuge poses a considerable problem to the further management of impoundments on the drawdown principle. Drainage for purposes of control of carp has hitherto been carried out during the summer months so that a crop of millet and smartweed could be produced for waterfowl foods. It appears likely that a drawdown now with the pool areas surrounded with this species would result in an invasion of loosestrife with which we could not cope. Drainage at another season would necessitate foregoing a type of management most productive in terms of waterfowl food production.

Another avenue of approach to the control of emergent aquatics is the possibility of drowning the plant out. I have no observations to indicate to what depth the loosestrife plant would have to be flooded to secure a kill. The fact that loosestrife thrives in water depths of 24 inches and possibly greater indicates that this practice would not be feasible on the bulk of our areas managed for waterfowl.

In summary, our experiences at the Montezuma Refuge indicate AMS to be a satisfactory herbicide for elimination of purple loosestrife, both in aquatic and terrestrial situations. Hand pulling of loosestrife proved to be a satisfactory means of eliminating individual young plants growing in water as long as the plant was removed from the water. Hand pulling on terrestrial situations was not practicable due to breaking of the stem.

Loosestrife has continued to increase its foothold on the refuge on all areas not covered by permanent water. This poses a considerable weed threat to impoundment areas during any future drainage operations. Elimination of purple loosestrife as of this date would be most difficult, if not impossible, due to its widespread occurrence over areas difficult of access.

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Techniques Involved in the Use of Chemicals for Establishing Wildlife Clearings/1

H. A. Trumbo and W. E. Chappell/2

Wildlife clearings and/or food patches are essential management tools for a number of game birds and animals. Such areas are valuable from several standpoints, i.e., attractiveness, simply as an open area or "playground", to provide more "edge" or shruby growth, and those planted to agricultural crops as a source of supplementary foods. A combination of these uses is most desirable.

Bulldozing and hand labor are the foremost methods of establishing and maintaining such wildlife clearing areas. Although these methods have been quite successful, they are also costly; the two main categories of cost are labor and equipment, with a number of factors contributing to each one.

After preliminary experiments at this station in 1956 and 1957 the possibility of establishing wildlife clearings by use of herbicidal treatments appeared to be economically feasible. Monuron pellets applied in June or October resulted in good control of woody plants (Table 1). Earlier work by Darrow/3 showed that large trees could be killed by as low as 10 lbs. (active) Monuron per acre. Monuron treatment applied at a rate of 5 gms. per clump of brush in December, 1957, indicated that this method might be worthy of further trial. The results are presented in Table 2.

Table 1. Stem counts showing per cent of top-kill on plots treated with Monuron

	June treatment Plot 1; 3 Reps. (Av.)			October treatment Plot 5; 3 Reps. (Av.)		
	Before	After Total sprouting	% kill	Before	After Total sprouting	% kill
Red oak	308	65	79	280	49	82
White oak	73		100	46	3	93
Chestnut oak	183	55	70	209	73	65
Black gum	69	25	64	77	55	29
Red maple	98	8	92	137	7	95
Sourwood	261	119	54	278	220	21
Pine	7	3	57	9	5	45
Others	819	70	91	799	133	83
Total	1818	345	81	1835	545	70

/1 These studies were supported in part by grants from the duPont Company and American Chemical Products, Inc.

/2 Graduate Research Assistant and Plant Physiologist.

/3 Darrow, Robert A. and Wayne G. McCully. Proceedings of the Tenth Annual

Table 2. Stem counts on 1/100-acre sample of wildlife clearing treated with Monuron and Tech T

	Control	Monuron 5 gms./clump Hand application			Tech T 6#-100 oil Stem-broadcast		
		Stems dead	Stems green no resprouting	Roots resprouting	Stems dead	Stems resprouting	Roots resprouting
Red oak	21	30	28	0	68	0	0
White oak	37	47	28	0	55	0	0
Sassafras	3	7	0	0	31	0	0
Red maple	5	0	0	0	34	0	0

PROCEDURE:

Two field experiments were set-up on U.S. Forest Service and Virginia Forest Service lands to make the following evaluations:

1. The effectiveness of herbicidal treatments as a method of establishing wildlife clearings.
2. Comparison of cost of this herbicidal method to that of bull-dozing and manual labor.
3. The utilization of these clearings by game species.

Craig County Experiment

The area selected was one of approximately 2,000 acres adjoining a series of four (4) study areas equally as large and of approximately the same ecological composition. These areas or compartments were designed to study the response of game species to various methods of habitat manipulation such as agricultural food plots and timber management practices. Clearings had been established in two of these compartments by bulldozer and were planted to various agricultural crops such as clovers, grasses and small grains.

The topography of the experimental area varies from relatively level areas to those that are quite steep; bounded on the southeast by a very prominent mountain range. Predominant tree species are red oak, white oak, chestnut oak, red maple, sourwood, table mt. pine, and black gum. The chestnut oaks and pines occur on the higher and drier slopes along with several shrub species, i.e., mountain laurel, blueberries and huckleberries. Stem sizes vary from seedlings to trees with a d.b.h. of 18 inches.

Ten approximately one-acre areas were selected with the same criteria used in selecting the sites in the adjoining compartments. Plot boundaries were established and each clearing was divided into quarters (Table 4). Each quarter of each clearing was treated with a separate herbicide. The selection of quarters to receive a particular treatment was randomized. The four herbicides chosen were: (1) Monuron on a vermiculite carrier, (2) Fenuron clay pellets, (3) Ammate X, and (4) 2,4,5-T. Control areas one-chain square are to be established at each clearing.

Table 4. Design of wildlife clearings, Broad Run Project

2	3
1	4

Four chemicals were used in treating each clearing. Each quarter to receive a particular treatment was selected at random.

All chemicals were applied at a high enough concentration to remove all woody vegetation on the clearings because this vegetation is normally removed by other methods (bulldozing and manual) employed in creating wildlife clearings.

Monuron and Fenuron were applied in June (first application June 5) to two quarters of each clearing at the rate of 5 to 10 gms./stem. Stems 5 in. d.b.h. and under were treated with 5 gms. and those above 5 in. were treated with 10 gms. Applications were fairly evenly distributed around the base of each stem at a distance of several inches from the stem.

Ammate X and 2,4,5-T were used in frill treatments which began August 4, 1958, and were completed that month. In the use of Ammate, overlapping ax cuts were made at waist height around all tree species 1 in. d.b.h. and above (shrubs and tree species under 1 in. d.b.h. were not treated). A solution of 7 lbs. per 2 gal. water was applied to these cuts by Knap Sack sprayers and other type hand sprayers.

It was decided to vary the frill somewhat with the use of 2,4,5-T from the one used in the Ammate treatment. Ax cuts were made at approximately 4 in. intervals on stems 4 in. d.b.h. and above. Those from 1 to 4 in. d.b.h. were cut on two sides. All frills were made at approximately waist height. Tree species under 1 in. d.b.h. were stem-foliage sprayed. 2,4,5-T at a rate of 12 lbs. per 100 gal. oil (#2 fuel oil) was applied with the same sprayers used in the Ammate treatment (Table 5).

Table 5. Wildlife clearings, Broad Run Area, acreage/clearing, amount herbicide/quarter clearing

Clearing	Acreage	Acreage per quarter	Total amount herbicide/quarter 2,4,5-T 12#/100	Ammate 3.5/gal.	Fenuron 25%	Monuron 40%
2	.6	.16	2 gal.	2.5 gal.	12 lbs.	3.5 lbs.
4	1.6	.40	7	4	36	13.5
5	1.0	.25	3.5	3	20	12
6	.6	.16	4	3	12	7
7	.3	.07	1	1	10	3.5
8	1.0	.25	2	1.5		21.5
9	.9	.23	2.5	2	40	24
10	1.0	.25	6	4	24	12
11	1.0	.25	12	10	15	7
12	1.5	.38	16.5	14	36	16

Observations

On June 27 it was observed that an over-all "brown-out" had developed on the quarter sections treated with Fenuron and by August all species were completely defoliated and dead in appearance.

On the Monuron treated sections a browning effect was noted July 30 and by September 17 a majority of the species were defoliated and the remainder was brown.

All species on the Ammate treated sections showed some browning effect but few of the leaves were shed prematurely.

There was no sign of effective treatment on sections treated with 2,4,5-T except for the smaller stems which were foliage sprayed; these appeared to have been killed. Apparently the spaced ax cuts were the limiting factors in this treatment. A spring check will be more conclusive.

Stem counts were made and recorded on all sections. A second count will be made in the spring in an attempt to determine the effectiveness of each chemical.

Roanoke County Experiment

An additional field experiment was set-up on a tract of State forest land on Fort Lewis Mountain, Roanoke County, Virginia, to evaluate different levels of concentration (1, 2, and 4 gms./clump) of Fenuron. Two replications of each concentration were made on areas approximately 1-chain square. Treatments were made July 24 and 25, 1958, (Table 6).

Table 6. Six 1/10 acre plots, 2 replications, treated with 1, 2, and 4 gms./ stem of Fenuron*

Treatment**	Range in No. stems	Average No. stems/acre
1 gm.	1006-1008	10,070
2 gms.	1002-1312	11,570
4 gms.	816-1087	9,520

* Commercial form clay carrier with 25% active Fenuron.
** Active ingredient.

Part of this area was heavily burned in October, 1953. Although there are a number of stems on each plot ranging in size from 4 to 18 in. d.b.h., a majority is a low growth 5 years old. Except for buffalo nut (Pyrularia pubera), which is parasitic, the variation in species is slight from those on the Broad Run Project Area.

Observations

By October 4, 1958, all species except table mt. pine (*Pinus pungens*) had been defoliated. Although the pines had not shed their needles they were completely brown. The plots treated with 1 gm. contained a large number of buffalo nut which had been defoliated but showed a rebudding tendency.

Stem counts were made and recorded on each plot and a second count will be made in the spring.

A number of factors must be considered in selecting a herbicide(s) for establishing clearings.

1. Accessibility of areas.
2. Density and size of vegetation.
3. Species present.
4. Equipment used in application.
5. Cost of herbicide.*

SUMMARY

From observing the results of the four herbicides used in the outlined experiments, it appears that Fenuron and Monuron could be the most successfully used in establishing wildlife clearings; quicker results being obtained from Fenuron (this is probably due to the soluability of the carrier). Both of these appear to be very effective and can be transported to inaccessible areas quite easily in a knap sack. No equipment is necessary for the application of these herbicides and with some practice approximately the proper amount can be determined and applied by hand (without the use of a measure).

It appears that the rates of Monuron and Fenuron in the Craig County experiment were in excess of what was actually needed. Rates of as low as 1 gm. per stem seemed to give results comparable to the 5 to 10 gms. rate used in the earlier experiment.

*The cost of the herbicide to be used will be determined by several of the other factors, i.e., accessibility of area, equipment used in application and the density and size of vegetation.

Progress Report #5. Effects of Chemical Brush Control Upon Game Food and Cover

W. R. Byrnes and R. J. Hutnik1/

This is the fifth in a series of 5 progress reports depicting the effect of chemical sprays on control of woody brush and the ultimate development of vegetation on a power line right-of-way. The major objectives of the investigation were (1) to determine the effects of chemical spraying on game food and cover plants, (2) to study game usage of the various treatment areas, and (3) to study the effectiveness of thorough chemical applications in controlling woody brush. The purpose of this report is to summarize the observations made in the course of the study, relating them to these stated objectives.

The experimental area for this series of tests is located on a 3-mile section of the new Pennsylvania Electric Company right-of-way extending through state gamelands 33 on the Allegheny Plateau in Centre County, Pennsylvania. Forest cover on the test area, consisting of mixed oak and associated species, was cut during the winter of 1951-52 to form a clear right-of-way 180 feet wide. In June 1953, before chemical treatment, the regrowth of tree species had attained a height of approximately 2 to 6 feet and consisted primarily of compact well-distributed sprout clumps.

During the 5 years following spraying there has been a continual change in species composition of the lesser vegetation. Within the first 3 years, this change was very pronounced. It is still continuing but at a much slower pace. In order to determine the ultimate composition of the ground layer vegetation and the long term control of woody brush, the scope of the study has been extended for a second 5-year period. Minor changes will be observed annually, with a more complete evaluation at the end of the 10-year period.

PROCEDURE

Design:

The field design of this study consisted essentially of six treatments applied in a randomized block design, with 4 replications. Each treatment area, which covered from 1.9 to 3.9 acres, was large enough to permit the use of commercial equipment and crews for spray application. The entire test involved approximately 60 acres of the 180-foot wide right-of-way.

To obtain quantitative data, sampling plots were established within each treatment area. The main sample plot consisted of a randomly located strip transect, 33 feet wide, extending across the width of the right-of-way. Also, five 100-foot line transects were mechanically spaced in each treatment area to provide permanent sampling points for additional quantitative data. General condition of the vegetation and game usage observations were studied on entire treatment areas. Observations were made before treatment in 1953 and in late summer for the following 5 years.

1/ Members of the staff, School of Forestry, The Pennsylvania State University. University Park, Pennsylvania

Vegetation on the right-of-way was separated into two layers for analysis. A shrub layer was recognized that included all woody vegetation over 3 feet in height which makes up the so-called "woody brush" to be eliminated from the right-of-way. A second layer, the ground layer, was recognized that included all vegetation under 3 feet in height. This layer is made up mostly of grasses, herbs, and woody shrubs, but may also contain tree seedlings and sprouts under 3 feet.

Treatments and Application:

The six treatments initially applied to the original brush on the right-of-way, which have been fully described in a previous publication (1), may be briefly characterized as follows:

A - Unsprayed control to serve as a comparison with chemical treatments. Hand cut in April 1958, six growing seasons after the initial capital clearance, by a commercial crew using brush saws and axes.

B - Broadcast foliage spray of 2,4-D plus 2,4,5-T butoxy ethanol esters, half and half, at a concentration of 4 pounds combined acid equivalent per 100 gallons of water. Applied June 1953.

C - Oil water, semi-basal spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half; 3 gallons of spray material to make a concentration of 6 pounds of combined acid equivalent per 100 gallons spray in an oil-water carrier consisting of 10 gallons of No. 2 fuel oil in 87 gallons of water. Applied June 1953.

D - General summer basal spray of emulsifiable acids of 2,4-D plus 2,4,5-T, half and half, at a concentration of 12 pounds of combined acid equivalent per 100 gallons of spray, No. 2 fuel oil being used as a carrier. Applied June 1953.

E - Selective winter basal spray of 2,4,5-T butoxy ethanol esters at a concentration of 12 pounds of acid equivalent per 100 gallons of spray, No. 2 fuel oil being used as a carrier. Applied February 1954.

F - Broadcast spray of Ammate at a concentration of 3/4 pound per gallon of water; 4 ounces of DuPont sticker-spreader were added per 100 gallons of spray. Applied June 1953.

To insure a maximum control of woody brush by each of the treatment techniques used, thorough and careful applications were made. High volumes of spray solution as shown in table 1 were applied to obtain complete coverage of the brush. Results of this study and other investigations (2) have shown that these high volumes are necessary in the initial application for effective long term control with the least amount of respraying.

Within 2 growing seasons after application, resurge of varying magnitude was apparent on all plots. Much of this consisted of seedlings that were missed, despite the thorough and careful applications of the sprays, and young sprouts that were developing on topkilled plants. To determine the value of a

Table 1. Summary of initial treatments and follow-up sprays applied on the power line right-of-way.

	Treatment	Number Replications	Total Acreage Treated	Average gallons per acre	Average man hours per acre	Average brush saw hours per acre	Average truck hours per acre
A	Unsprayed (handcut)	4	8.60	----	39.45	9.39	8.40
B	Broadcast (D + T)	4	8.43	460	7.23	--	2.41
BD	Summer basal follow-up	4	3.48	48	5.20	--	1.30
C	Semi-basal	4	10.08	345	7.11	--	2.37
CD	Summer basal follow-up	4	4.06	20	3.26	--	.81
D	Summer basal	4	9.82	140	11.61	--	3.87
DD	Summer basal follow-up	4	4.15	21	3.13	--	.78
E	Winter basal	4	10.05	137	16.90	--	3.30
ED	Summer basal follow-up	4	4.47	138	19.91	--	4.75
F	Broadcast (ammate)	4	12.65	415	7.05	--	2.35
FD	Summer basal follow-up	4	4.25	40	4.33	--	1.08

quick "follow-up" spray under such conditions, each treated area was subdivided into two parts. To one part in each area a summer basal follow-up spray (D) was applied 2 seasons after initial treatment. The chemical used was ACP formula 1054-E. It contained 2 pounds of 2,4-D and 2 pounds of 2,4,5-T per gallon and was diluted at the rate of 4 gallons in 96 gallons of No. 2 fuel oil.

The areas receiving these follow-up treatments are designated as B-D, C-D, E-D, and F-D. This follow-up spray was applied in July, 1954 except for E-D which was applied in June, 1956.

Unsprayed control plots (Treatment A) were incorporated in the study to serve as a conparison with the chemically treated areas in vegetation development for game food and cover. By August, 1957 the undisturbed woody brush on these plots, which had attained a height ranging from 6 to 15 feet, constituted a hazard to power line operation. In accord with original recommendations to remove this brush when it threatened to interfere with line maintenance, all brush on the control plots was handcut. All stems were severed to within 3 inches of the ground and the resultant slash piled and burned.

A summary of treatment application including acreage treated, volume of spray solution applied, man hours, truck hours, and brush saw hours for initial treatments and follow-up sprays is given for comparative purposes in table 1.

Control of Woody Brush

Comparisons of chemical techniques in controlling woody brush was not the primary objective of this study. However, it was important to determine the relative effectiveness of the treatments applied on the woody brush before a proper evaluation could be made of the vegetation remaining in the ground layer. With this in mind, data taken for two years following spraying were concerned with topkill, or death of plants to the ground line. In this respect, a progressive dying of original stems was observed for all treatments during the two-year period following initial chemical treatment (Table 2). Topkill was most gradual following the broadcast foliage (B), oil-water semibasal (C), and Ammate (F) treatments. By the end of the second season after spraying, highly satisfactory topkill results, ranging from 94.1 to 99.7 percent, were obtained for all treatments.

Table 2. Topkill of original stems for all species combined, one and two growing seasons after initial chemical treatment.

Treatment	Topkill first season after initial spray	Topkill second season after initial spray
	%	%
B Broadcast (D + T)	45.5	94.1
C Semi-basal	53.8	99.0
D Summer basal	90.7	98.9
E Winter basal	94.0	98.3
F Broadcast (Ammate)	33.4	99.7

Resurge, sprouts and suckers from original stems that have been topkilled and seedlings or seedling sprouts, was studied for five years following spraying. For analytical purposes the data have been divided into 2 groups: (1) resurge over 3 feet in height, and (2) resurge under 3 feet. The first group will soon constitute a control problem. Many of the seedlings and sprouts in the second group will probably be destroyed by plant competition, animal activity and extremes of temperature. Although it is problematical how many of them will emerge from the ground layer, they are still a potential source of brush on the right-of-way.

A comparison of the status of living plants over 3 feet in height on the various treatment areas in August, 1957 is given in table 3. It should be noted that it has been necessary to segregate sassafras, which, owing to its gregarious root suckering habit, may increase so abundantly on the right-of-way as to obscure the effects of chemicals on other species. When sassafras is segregated in the data, all treatments are shown to have given adequate control with a resurge of only 26 to 42 plants per acre as compared to 980 for control areas. When sassafras is included, the winter basal spray without a follow-up shows up as an inferior method for control of that species. The broadcast sprays and the semi-basal, on the other hand, when applied in high volumes as used in these tests, gave an adequate control of sassafras even without a follow-up spray. All treatments when followed by a follow-up basal gave adequate control of all species including sassafras.

Table 3. Status of living plants over 3 feet in height on the test areas in August, 1957.

	Species						
Treatment	Bear Oak	Other Oaks	Red Maple	Misc. Hardwoods	Sassafras	Total	Total Minus Sassafras
	Number						
Single Sprays							
A Unsprayed	126	408	158	288	1,282	2,262	980
B Broadcast (D + T)	24	14	0	2	4	44	40
C Semi-basal	2	2	8	14	2	28	26
D Summer basal	14	4	8	8	124	158	34
E Winter basal	8	28	2	4	1,182	1,224	42
F Broadcast (Ammate)	2	0	10	16	0	28	28
Sprays with Follow-up Basals							
BD Broadcast (D + T)	0	0	0	2	0	2	2
CD Semi-basal	0	0	0	12	0	12	12
DD Summer basal	0	0	0	26	4	30	26
ED Winter basal	0	2	0	4	2	8	6
FD Broadcast (Ammate)	0	0	0	2	2	4	2

Variation in Ground Layer Vegetation

Following clearance of the right-of-way in 1951-52, the sparse vegetation existing on the forest floor, stimulated probably by full sunlight and reduced competition for moisture and nutrients, increased in abundance by 1953 to form a dense layer covering 73 to 87 percent of the ground surface (Table 4). The species composition of this ground layer was predominantly bracken fern, vernal sedge, mixed woodland herbs and grasses, and the common shrubs blueberry, huckleberry, and deerberry (Table 5).

By August, 1953, three months after the initial spraying an early evaluation of the effect of the various treatments on the ground layer was possible. Observations at this time were limited largely to an estimation of the cover value of the surviving plants (Table 4). It was readily evident that the broadcast foliage sprays of 2,4-D + 2,4,5-T and Ammate had caused a major disturbance to the ground layer vegetation, with only enough plants surviving to cover 10 percent of the ground surface. The semi-basal spray was less severe in this respect, leaving a sufficient number of living plants to cover 25 percent of the surface. In direct contrast, the basal applications caused only a slight change in cover value, affecting only those plants growing immediately adjacent to sprayed sprout clumps and seedlings. With invasion of the bare areas by other plants--mostly fireweed, loosestrife, and grasses--plants of the ground layer nearly regained their former abundance within two growing seasons after spraying. In 1957, five years after initial treatment, this vegetation has spread to cover 95 to 98 percent of the ground surface on all chemically treated areas.

Table 4. Progressive changes in area covered by the ground layer before spraying and for 5 years following spraying in June, 1953.

	Treatment	May 1953	August 1953	August 1954	August 1955	August 1956	August 1957
		Percent					
	Unsprayed	87	79	96	84	80	89
B	Broadcast (D + T)	73	10	79	88	96	98
C	Semi-basal	81	25	95	96	98	98
D	Summer basal	81	75	95	96	98	98
E	Winter basal	83	75	95	95	97	98
F	Broadcast (Ammate)	80	10	71	84	85	95

Species composition of the ground layer was radically changed following certain chemical treatments (Table 5). The most notable of these was the broadcast Ammate area which developed an almost pure fireweed community the first year following spraying. In subsequent years, other plants, especially sedges, bracken, and sweetfern gradually increased at the expense of the fireweed, until by the fifth year, fireweed occupied only a minor position in the ground layer. Other important changes were the more gradual development of a sedge-grass community following the broadcast spraying of 2,4-D + 2,4,5-T and the temporary, less pronounced dominance of fireweed in the year following the semi-basal spray. Since the basal sprays were highly selective in their application, they caused only slight disturbance to the original plant composition.

Table 5. Dominant plants in the ground layer, before spraying in May, 1953 and after spraying in August 1954 and August, 1957.

Treatment in June 1953	May 1953	A.S.1/	Aug. 1954	A.S.	Aug. 1957	A.S.
A Unsprayed	Bracken	2.3	Bracken	3.3	Bracken	3.3
	Sedge	2.3	Sedge	2.3	Sedge	2.3
	Mixed Herb	1.1	Mixed Herb	1.1	Loosestrife	1.2
	Blueberry	2.2	Blueberry	2.2	Blueberry	1.3
B Broadcast (D+T)	Bracken	2.3	Sedge	2.3	Bracken	2.3
	Sedge	2.3	Grass	1.3	Sedge	2.4
	Mixed Herb	+.1	Mixed Herb	1.1	Grass	1.3
	Blueberry	1.2	Bracken	1.1	Loosestrife	1.1
			Blueberry	++.1	Blueberry	+.2
C Semi-basal	Bracken	2.3	Fireweed	2.2	Bracken	3.4
	Sedge	2.3	Bracken	1.2	Sedge	3.4
	Mixed Herb	+.1	Grass	1.2	Loosestrife	1.1
	Blueberry	1.2	Sedge	1.3	Blueberry	+.2
			Blueberry	++.1		
D Summer basal	Bracken	2.3	Bracken	3.4	Bracken	3.3
	Sedge	2.3	Sedge	1.3	Sedge	2.3
	Mixed Herb	+.1	Mixed Herb	1.2	Loosestrife	2.3
	Blueberry	1.2	Blueberry	1.2	Blueberry	2.3
E Winter basal	Bracken	1.3	Bracken	2.3	Bracken	3.4
	Sedge	2.3	Sedge	1.3	Sedge	2.3
	Mixed Herb	+.1	Mixed Herb	1.1	Loosestrife	2.3
	Blueberry	1.2	Blueberry	1.2	Blueberry	1.3
F Broadcast (Ammate)	Bracken	3.3	Fireweed	5.5	Bracken	2.3
	Sedge	2.3	Sedge	1.3	Sedge	3.4
	Mixed Herb	+.1	Grass	1.2	Loosestrife	2.4
	Blueberry	1.2	Bracken	+.1	Fireweed	1.2
			Blueberry	++.1	Sweetfern	1.2
					Blueberry	++.2

1/ A = Abundance and cover expressed in symbols: ++ = Occasional; + = Sparse, cover very small; 1 = Plentiful, but of small cover value; 2 = Covering 1/20 to 1/4 of the area; 3 = Covering 1/4 to 1/2 of the area; 4 = Covering 1/2 to 3/4 of the area; 5 = Covering more than 3/4 of the area.

S = Grouping (sociability) expressed in symbols: 1 = Growing singly; 2 = Grouped or tufted; 3 = small patches (less than 1 milacre); 4 = Extensive patches or carpets; 5 = Pure population.

The long-time trend on all plots has been toward the development of a plant community similar to the one existing before spraying. The outstanding exception was the practical elimination of blueberry and huckleberry on the broadcast and semi-basal areas. In addition, the herbaceous plant loosestrife had increased in abundance by 1957 to dominate the mixed herb category in all treatment areas including the unsprayed control.

Utilization of Ground Layer Plants by Game Animals

As pointed out in the previous section, several important changes occurred in species composition of the ground layer following certain chemical treatments. In three treatment areas (B, C, and F) temporary plant communities with one or more dominant plant species developed and remained prominent for 1 to 4 years; while on other areas (A, D, and E) the original composition of bracken, sedge, mixed herb, and blueberry remained essentially unchanged. To fulfill the second major objective of this study it was necessary to determine the value of these plant communities for game food and cover. This was accomplished by reviewing published reports and making direct observations in the course of this study. Utilization of the common plants found on the right-of-way is summarized in table 6.

It is readily evident that the plants most frequently used by the four animals listed - deer, rabbit, grouse, and turkey - are the woody shrubs, blueberry, huckleberry, and blackberry; the sedges and grasses; and the herb sheep sorrel. All parts of these plants are reputedly eaten during some season of the year, with deer and rabbits feeding mostly on leaves and stems while grouse and turkey feed heavily on buds and fruit.

Bracken fern which has become the major ground layer plant on all treatment areas (Table 5) has a relatively low food value with practically no usage in the winter, high usage by grouse in the fall, and low usage by deer in the spring and summer when the fronds are tender. Fireweed which dominated the broadcast Ammate areas for 3 years and the semi-basal areas for 1 year has little known food value, except for occasional browsing of young plants by deer in early spring. The herb loosestrife, most abundant in the mixed herb category in 1957, also has low utilization in the spring and summer and virtually no value in the fall and winter. Other plants listed in table 6 are intermediate, showing high utilization in at least one season of the year.

The most important comparison between dominant plants present in 1957 (Table 5) and utilization of plants by game animals (Table 6) is the relatively high usage of blueberry and its very low abundance on the semi-basal and broadcast spray areas. In contrast to this, blueberry has retained its former abundance on the unsprayed control and basal spray plots. In addition, on the unsprayed areas of treatment A the woody brush of the shrub layer supplies a surplus of browse for deer and rabbits.

Table 6. Common plants occurring in the ground layer on the power line right-of-way and their utilization for food by the game animals, deer, rabbit, grouse and turkey.

Common Plant	Utilization1/ by Seasons			
	Spring	Summer	Fall	Winter
Grasses and Sedges				
Vernal Sedge	H	H	L	H
Panic Grass	L	L	H	L
Other Grasses	H	H	H	H
Ferns				
Bracken	L	L	H	-
Herbs				
Loosestrife	L	L	-	-
Fireweed	L	-	-	-
Sheep Sorrel	H	H	H	L
Cinquefoil	H	H	L	L
Violets	-	H	L	H
Herbaceous Smilax	H	L	H	L
Shrubs				
Blueberry	H	H	H	H
Huckleberry	L	H	H	H
Teaberry	L	L	H	L
Sweetfern	L	-	L	H
Blackberry	H	H	H	H
Witch-hazel	L	L	H	H

1/ H = high utilization.
L = low utilization.

Wildlife Observations on The Right-of-Way

To complete the picture it is necessary to know what wildlife animals were present and with what frequency they visited the right-of-way. This was accomplished in two ways; first, by direct observations of the animals themselves; and secondly, an indirect determination of their presence as shown by pellets, tracks and evidence of feeding.

An intensive study of wildlife on the right-of-way was made during the first year after spraying by a wildlife specialist. At this time, concentrated observations were made on all treatment areas during both day and night periods. Additional data were recorded in subsequent years during special surveys of the entire right-of-way test area in the winter months at various intervals after snowfall. This information was further supplemented by observations made during the course of other work on the right-of-way. The more important wildlife species or signs observed on the right-of-way during the 5-year period of this investigation are given in table 7. It should be pointed out that other animals; such as, fox, racoon, woodchuck, opossum, skunk, and the like were also evident on the right-of-way. However, since these are not important upland game animals they were not included in the analysis.

A number of important trends of wildlife distribution by treatment areas are apparent from the recorded data. To begin with, it was immediately evident that deer, rabbit, grouse, and squirrel visited all treatments and that turkeys were observed on all but the unsprayed control plots. Deer and rabbits used the control areas of treatment A more heavily than the chemically treated areas, probably because of the availability of woody browse and diversified cover conditions. Numerous deer beds were observed under the protection of dense sprout clumps in these areas. In general, the population of deer and rabbits progressively increased on the right-of-way in all treatment areas during the period of this study.

Grouse observations were fairly uniform on all areas with no special pattern developed. In most instances when grouse were observed, they occurred along the edges or in the forest immediately adjacent to the right-of-way. Turkeys were most frequently observed on the broadcast spray areas of treatment B and F where grasses and herbs dominated the vegetation. Insects commonly associated with such grassy openings apparently attract the young turkeys.

Table 7. Common wildlife species or signs observed on treatment areas from 1953 through 1957.

	Treatment	Deer	Rabbit	Grouse	Turkey	Squirrel
		Number				
A	Unsprayed	83	51	12	0	6
B	Broadcast (D+T)	45	8	8	31	2
C	Semi-basal	62	3	7	1	6
D	Summer basal	53	12	5	1	8
E	Winter basal	59	25	8	1	11
F	Broadcast (Ammate)	69	7	8	15	18
	Total	371	106	48	49	51

The use of pellet counts as an indication of the degree of usage of the right-of-way by wildlife was initiated in 1954. All pellets on 20 transects, 3 feet wide by 100 feet long, for each treatment area were counted and removed in March or April of each year. Correlations of number of pellets with animal populations have not yet been made. In general, however, the numbers of pellets recorded agree very closely with the direct observations on animal usage as given in table 7. Although there were considerable numbers of deer and rabbit pellets on all areas, the counts were highest on the control areas.

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Cook's TRICKLER - How to Make and Use It.

David B. Cook, Supervising Forester
Conservation Department, Albany, New York.

We forest and gameland managers are always in search of better and cheaper tools for applying new and improved technologies to our work. This is especially true in the field of chemicals, where the old equipment often fails to do the job efficiently. And, whether it be from private funds or public budget, money to invest in expensive equipment is always hard to come by.

At Cooxrox Forest, my special problem is the complete deadening of weed hardwoods, not only in conifer plantations but also in natural woodlands. Some of these are seedlings, some are sprouts or root suckers of varying age, size and generation; all will resprout vigorously if cut. To abate sprouting and to get rid of these weeds, root and branch, I have used a wide variety of chemicals but principally sodium arsenite and the plant hormones applied as "basal spray". This last is, I think, a poor title as I contend that "spray", which implies application under considerable pressure, is the wrong approach. Nevertheless, the term is well established and we will probably continue to use it.

Cook's TRICKLER was developed after a good deal of unsatisfactory trial-&-error use of standard spray apparatus. It can be built by anyone who is handy with tools, from low-cost, standard parts; it is foolproof in operation and requires a minimum of maintainence; replacement of deteriorated parts can be made easily. And the TRICKLER does a better job - in terms of time, energy and chemicals used and trees completely deadened - than does any other rig that I know about.

The TRICKLER was first described by me in DOWN TO EARTH in 1953. Even wider notice was achieved by its being figured in E.I.Roe's "Forest Plantation Release", Miscellaneous Report No. 33 of the Lake State Forest Experiment Station, 1955. Unfortunately, descriptions of parts and their assembly were inadequate and some of those who tried to build TRICKLERS ran into difficulty. This present report brings developments up to date, indicates the remedy for some previous troubles, the exact description and source of supply of some critical items and the operational advantages of this effective little gadget. I hope it will be specific enough so that anyone who has the urge can make one for himself.

Basically, the TRICKLER is a 2-gallon can carried on a man's back, from which chemical flows by gravity thru a flexible tube to a light wand, the discharge being controlled by a cheap, easily-operated and leak-proof valve. Pressure of discharge is low. The rig is light in weight ($3\frac{1}{2}$ pounds vs 7+ pounds for a 2-gallon pressure sprayer), and cheap. It has no moving parts to get out of order and it is liquid-tight, minimizing the chance for dripping, which is always a problem with pressure sprayers. The wide backboard is much easier to carry than flexible spout on top prevents slopping as the worker moves about but admits air as the liquid is withdrawn from the tank. The tube connecting tank to wand is of plastic, and kerosene-proof. However, it is much too stiff to work easily in the valve, so a short length of pure latex tubing - flexible but not proof against kerosene - is inserted. When this "weak link" deteriorates it can be replaced in a matter of minutes. The cost of parts is nominal; some are readily-obtained salvage material, others can be bought for a dime or a half dollar. It can be assembled in an hour or so with simple hand tools and maintained with a pair of pliers and a pocket knife. There are no parts to get lost and the TRICKLER is practically indestructable.

The Specification Sheet indicates how the TRICKLER is assembled and where and for how much the parts can be obtained. After cutting and/or boring the pieces, the nipple is inserted in the can, the can and clothes-pin attached to the backboard and the harness strung. The valve is attached to the handle, the wand inserted and the tubing assenbled. The ferrule of the plastic tube is fitted over the nipple on the tank and clinched with a twist of soft iron wire. Screw the flexible spout on the top of the tank and the TRICKLER is ready for use.

The basal spray formulation that I have used with great success contains 5 fluid ounces of Esteron 245, a level teaspoonful of either Red-O Oil Dye or Sudan Orange as an indicator, and enough kerosene to make two gallons - essentially a 2 percent solution. This is transported to the site of operations in 2-gallon oil cans, which weigh only 1¼ pound - light, tight and relatively unbreakable. To fill the TRICKLER the valve is snapped shut and the wand clipped into the clothes-pin holder, the flexible spout is unscrewed and put on a stock can, whose contents can then be entirely poured into the tank. Put the spout back on the tank and the rig is ready.

To operate, the tip of the wand is placed against the base of the stem to be treated, the valve is unlatched and thumb pressure released to give the desired rate of discharge. A slight squeeze shuts off the flow, while a little additional pressure will latch the valve shut.

Maintenance is very low. The latex tubing link at the valve will ultimately absorb, swell up and come loose from the aluminum tubes. At the first sign of swelling, it should be replaced. The aluminum wand will eventually accumulate a coating of dried-on chemical; this can be cleaned out with a ramrod made from a wire clothes hanger.

Basal spray is not well suited to the killing of conifers. Apparently, there is so much cork tissue in the bark that excessive amounts of chemical are required to saturate it before the cambium can be effected. Among our Northeastern evergreens, only pitch pine will sprout; the rest can be easily and completely deadened by the application of sodium arsenite. On hardwoods, basal spray is a slow but certain method for achieving total death. Where the requirement

It is well known that plant hormones such as 245T are effective only at the point of application and that they are not translocated very far. Death of the tissue actually treated results in a girdling, which causes the death of the parts above it. A stem girdle WILL NOT cause the death of the stump and its associated root-collar buds, if such be present. The trick, then, is to flood the base of the stem with enough chemical so that it thoroughly wets the above-ground bark and flows down onto the thinner bark underground. Only enough of the base of the stem need be treated to show what trees have been worked on; six inches is quite sufficient. The TRICKLER does this much better than does any sort of pressure sprayer because it quickly applies a relatively large volume of liquid, so that the rundown and lateral spread is complete. The result is to effectively deaden the root crown and to separate the roots from the stem and from one another. The tree is killed, root and branch, and there will be no sprouting. By treating the base of each stem and all the exposed roots, it is even possible to kill most of a patch of beech root-suckers, so that a second application can complete the job.

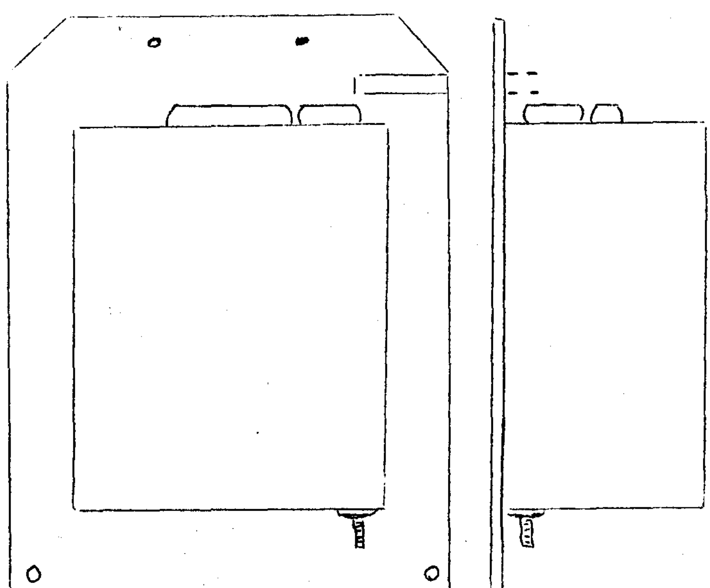
The TRICKLER is a simple, rugged, cheaply constructed and easily operated gadget with which to apply basal spray. When correctly used, it will achieve a very nearly complete kill of susceptible hardwoods, within the limit of efficient use for plant hormones.

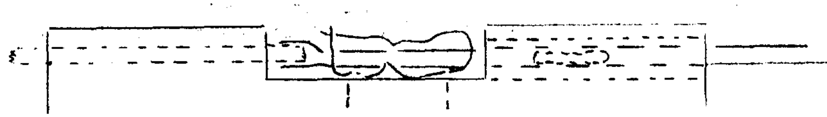
Bill of Materials.

1	Backboard, ¼" plywood, 12" x 16", bored as per sketch	$.24
2	Clothesline, 8'	No cost
3	Flexible spout, to fit 2-gallon can (Auto Supply)	$.29
4	Spring-type clothespin	$.02
5	Sheet metal screws (6)	No cost
6	Lubricating oil can, undented.	Salvage
7	Nipple, 1/8", with 2 nuts and 2 steel washers. (Electrical Supply)	$.10
8	Toothpaste tube, empty	Salvage
9	Zoller Harris Flush Tube #Z-700 (plastic) (Zoller Chemical Co., Los Angeles or Surgical Supply)	$.50
10	Pure latex tubing, ¼" scant inside diameter, 1 yard, used for handling blood. (Surgical Supply)	$.50
11	Clip valve, to fit latex tubing. (Surgical Supply)	$.15
12	Handle, 1" x 2" x 9", softwood	Salvage
13	Aluminum tubing, ¼" o.d., 24" (Auto Supply) (Cut off 1" for tubing link)	$.50
14	Box nails, 1½" cut to 3/4" (2)	No cost
15	Stovepipe wire, 2"	No cost
		$2.30

Instructions for Assembling TRICKLER

Cut and bore backboard (1) and handle (12). Bore clothespin (4). Bore lubricating oil can (6), being sure to file off burr on inside of hole. Assemble nipple (7): nut, steel washer, lead washer cut from four thicknesses of toothpaste tube (8); drop thru from inside, put on steel washer and nut, draw up TIGHT. Thread clothesline harness(2) thru holes in backboard (1), knot ends. Attach lubricating oil can assembly (6+7+8) to backboard (1) with 4 sheet metal screws (5), catching the flanges of the can, top and bottom, under the screw heads. Place clip valve (11) in place on handle (12), attach the box nails (14) at either end, catching clip under nail heads. Insert aluminum tubing wand (13) in handle, so that it sticks thru 1" toward clip valve. Cut plastic tube (9) to 36", insert 1" aluminum tubing link cut from (13), insert other end of link in 4" piece of latex tubing (10), thread free end of latex tubing thru back of handle and thru clip valve, slip over end of aluminum tube. Slip ferrule of plastic tube (9) over nipple (7) on can, clinch with a twist of stovepipe wire (15). Remove cap from can (6), replace with flexible spout (3). Adjust fit of TRICKLER to worker with clothesline harness (2) and by shortening plastic tube (9) if necessary.





Chemi-Thinning Hardwoods in the Dormant Season

by
Robert R. Morrow
Department of Conservation, Cornell University

The several herbicide concentrates of 2,4-D and 2,4,5-T offer new tools for chemi-thinning or TSI work in forest stands. While slower in action and more expensive than sodium arsenite, these hormone compounds are still relatively cheap and effective if properly used. In addition they are very low in toxicity and effective when applied in the dormant season.

Basal spraying of trees with low volatile esters of 2,4,5-T in oil is now accepted practice for small stems, particularly where sprouting from the root collar is a problem. Results vary according to how well the root collar is soaked with spray. However, large stems require more chemical per inch of diameter than small stems; also, white ash, basswood, and sometimes black birch are notably resistant (5). It is generally conceded that frill treatments for deadening tree tops are cheaper than basal sprays when tree diameter exceeds 4-5 inches.

Frilling

Considerable research in dormant frilling of hardwoods, especially beech, has been done since 1950 on several hundred trees at Cornell's Arnot Forest in southern New York. Some of the results have been published elsewhere (5). In all cases, "frilling" means a series of single light cuts through the bark made by a light axe. The outstanding result is that top kill of most trees was assured only with a complete frill, irrespective of the chemical used. Such top kill apparently resulted from a chemical girdle caused by deadening of the wood immediately above and below the frill. Where seams, fire scars, or other deformities prevented a complete frill in beech, the tops remained alive for years; in vigorous trees, new callous tissue sometimes bridged the girdled region and the trees recovered.

The particular chemical used, while apparently having little effect on eventual kill, does influence the amount of deadening around the frill and may be important in preventing bridging of dead wood by particularly vigorous trees. The chemical also affects the time required for top kill to become complete. A test made in October 1953 on beech on a good site is illustrative. Where 20# ahg (acid equivalent per one hundred gallons of diluent) 2,4,5-T ester in kerosene was applied at a rate of 2-3 ml. per inch of diameter (a small volume compared to that used in most tests reported in the literature), a girdle of dead wood was formed which extended at least two feet both above and below the frill. Five years after treatment, ten of eleven trees (4-13" d.b.h.) were top-killed. Of six trees of similar size treated with either kerosene or gasoline only at a rate of 3 ml. per inch of diameter, the girdle of dead wood rarely extended over one inch above and four inches below the frill. After five years, half of these trees were top-killed, and the other half nearly so. Treatment with 80# ahg 2,4-D ester in kerosene at a rate of 3-4 ml. per inch of diameter gave only little better results than oil alone. Trees with nothing added to the frill quickly calloused over and exhibited no necrosis.

In all of the above treatments, the frills completely encircled the tree. Except where nothing was added to the frill, there is a girdle of dead wood and eventual top kill is assured. The results indicate that 2,4,5-T in oil added to frills in the dormant season will usually cause complete top kill in three to six years. Probably an average of two more years are required where 2,4-D in oil or oil alone is used. Usually, but not always, the bigger and more dominant trees hang on longer. In some cases it is possible that root grafts prolong the life of the tree. On the other hand, extreme drought conditions may contribute to complete top kill within two or three years, even where oil alone is used in the frill. Such appeared to be the case where the above treatments were replicated in November 1956 on a droughty site in a region where severe droughts were common from 1954-1957.

Further frilling tests at the Arnot indicated that most hardwoods can be deadened by frills more quickly than beech. An October treatment of 40# ahg 2,4,5-T ester in kerosene at a rate of 3-4 ml. per inch of diameter was made on trees ranging from 4 to 13 inches d.b.h. on a fairly good site. For most trees the number of years for complete top kill to take place were as follows:

Sugar maple	(30 trees)	- 3-4 years
Black birch	(15 trees)	- 1-3 years
Basswood	(15 trees)	- 2-4 years
White ash	(3 trees)	- 2-3 years

Other tests have shown that these too are top-killed by frills with oil alone.

There appears to be little difference in frilling results from one part of the dormant season to another. Results from treatments on beech in every month from October through March were similar. Maples probably should not be treated in late winter when there is a possibility of sap flow which might flush the chemical out of the frill.

McQuilken (4) has recently reported on results of frill treatments made in the growing season in Pennsylvania. In general his treatments consisted of lower concentrations, but bigger dosages, than were used in the Arnot work. Even though McQuilken's results are not final (they included results of only three full growing seasons after treatment), it is interesting to note several similarities between growing season and dormant season frilling. The kind of chemical and the concentration used were not overwhelmingly decisive in determining results as far as tested. Species sensitivity was similar; i.e., black birch was most quickly deadened while beech and sugar maple were more resistant. Also the bigger and more dominant trees were more resistant. McQuilken obtained at least 80 percent kill in beech, red maple, and sugar maple in three years; thus, summer treatments appear to be somewhat faster acting than dormant treatments.

The cost of chemi-thinning with frills is mostly labor. In the work at the Arnot, where tree diameters ranged from 4 to 15 inches, chemi-thinning was done at the rate of 1,000 diameter inches in four man-hours, exclusive of tree marking time or time for travel to and from the job. This agrees substantially with time reported by Lotti (3) for similar work at the Southeastern Forest Experiment Station where an average of 77 trees per acre (average 9" d.b.h.) were treated on 13 acres in 37 man-hours. One gallon of chemical is sufficient to treat 1,000 diameter inches and, for 20# ahg 2,4,5-T in kerosene, the cost is about 80 cents. Thus, if labor is \$1.50 per hour, it would cost about \$6.80 per 1,000 diameter inches or about seven cents to eliminate a 10 inch tree. McQuilken (4) reviewed several reports giving cost of frill treatments, and these in general agree with the Arnot results. The use of oil only in the frill would reduce the total cost by only about ten percent; therefore it may be wiser to use 2,4,5-T to both assure and speed up the release of crop trees.

Spaced Cuts

There have been some attempts to lower the labor cost of chemi-thinning by applying the chemical in wounds or cuts spaced evenly around the tree, leaving from one to four inches of live wood between cuts. Rushmore (6) recently reported this as a successful technique with sodium arsenite. There have been differing reports from southern United States, but under some circumstances there has been success in applying high concentrations of 2,4,5-T in wounds made by tree injectors. Gleason and Loomis (1) and Westing (7) in the Midwest, and Leonard (2) in California, have also reported some success using undiluted 2,4-D amine in spaced cuts. In most cases, successful treatments were made at times when the trees were not completely dormant. Several oaks, which apparently are relatively susceptible to hormones in cuts or frills, have been the trees most commonly killed by this method. Leonard, Gleason and Loomis, and Westing all reported that 2,4-D amine was superior both to 2,4,5-T amine and the esters of these chemicals.

At the Arnot, undiluted 2,4-D amine was used in axe cuts, each separated by a space of about two inches, at the rate of 2-3 ml. per cut or 1-2 ml. per inch of diameter (comparable to amounts used by the above-named workers) on many hardwoods during the dormant season. A band of wood was killed vertically up and down from each axe cut, but a band of live wood remained between each cut. The bands of dead wood usually became more narrow above the cut and gradually merged into all live wood. A few overtopped or intermediate trees were killed, and some crown damage occurred in more vigorous trees. In general, however, average crown reduction was only about 30 to 40 percent for most hardwoods. An exception is aspen (both trembling and big-tooth), which was top-killed within a year by this treatment. For most northern hardwood species, this demonstrates once again the necessity of making a complete frill to obtain good top kill by dormant treatments.

Summary

Dormant frill treatments on hardwoods were successful where the frill was complete and chemical was added to cause a girdled area of dead wood. The chemical used was of secondary importance, but 2,4,5-T caused a wider girdle of dead wood and quicker top kill than oil alone. Tree vigor, root grafts, or poor growth conditions may also considerably affect the time required for complete top kill. Dormant frilling was slower in action than summer frilling; spring frilling may give poor results because of excessive sap flow. Aspen is an exception and can be top-killed by 2,4-D amine in spaced cuts.

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A PROGRESS REPORT ON TESTS OF CONTROLLING JAPANESE HONEYSUCKLE

S. Little[1]

Summary.--Japanese honeysuckle deters forest management in some parts of Maryland, Delaware, New Jersey, and Pennsylvania. Grazing and burning are not effective in controlling this vine. Herbicides (ACP-977, Amitrol, and 2,4-D) tested as foliage sprays kill it back but do not eliminate it--even after 2 or 3 treatments. Foresters have yet to find a practical treatment for eliminating honeysuckle.

Control of Japanese honeysuckle (*Lonicera japonica*) is a growing problem in forest management in eastern Maryland, Delaware, southern New Jersey, and southeastern Pennsylvania. Honeysuckle may form a dense cover on the ground; it may wrap around and climb trees and shrubs, often bending down and deforming sapling trees. Its growth is particularly luxuriant in openings, where it usually prevents reproduction of other vegetation. Foresters often hesitate to harvest trees on sites where it occurs, because of fear that honeysuckle will prevent reproducing a forest stand.

Although found in some pine stands, honeysuckle is most troublesome on the best hardwood sites, those that should be growing yellow-poplar and sweetgum. Maryland foresters found it on 8 percent of the sites examined in their upper Coastal Plain and Piedmont (2). Honeysuckle probably occupies similar proportions of the forest land in northern Delaware, the Delaware Valley section of New Jersey, and southeastern Pennsylvania.

Consequently, in 1957 and 1958 certain materials that have been recommended for controlling honeysuckle were tested by the Northeastern Forest Experiment Station in cooperation with the Maryland Department of Forests & Parks and the New Jersey Department of Conservation.

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[1] Northeastern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, New Lisbon, N. J.

The Athens-Macon Research Center of the Southeastern Forest Experiment Station has screened many chemicals for their effectiveness on honeysuckle. That Center has recommended two: ACP-977 and Amitrol (1, 3). The former is a 2:1 mixture of the butoxy ethanol esters of 2,4-D and 2,4,5-T; the latter contains 50 percent of the 3-amino-1,2,4-triazole wettable powder. Some other investigators, such as Walker (4), have recommended 2,4-D.

All three chemicals were tried in our tests. The amounts of ACP-977 and Amitrol followed the first Southeastern Station recommendations (3); the amount of 2,4-D acid was equivalent to the acid content of ACP-977. Water was usually used as a carrier for the sprays. Two amounts, 125 and 250 gallons per acre, were tried because the first Southeastern Station recommendations called for 250 gallons in using ACP-977, 125 gallons in applying Amitrol.

While principal emphasis was placed on testing prior recommendations, a few modifications were also tried in both years--primarily on an exploratory basis.

LOCATION AND TREATMENTS

1957 PLOTS

1957 Work

Seventy-two 1/40-acre plots were established in 1957--24 near Green Bank, N. J., 24 on the City of Baltimore's Lock Raven Watershed, 16 on Contee Farms property near Edgewater, Md., and 8 near Havre de Grace, Md. These plots sampled conditions that varied appreciably, as follows:

1. Green Bank plots in a loblolly pine plantation:
   a. One series in a light cover of honeysuckle.
   b. One series in a medium cover of honeysuckle. Each series included some plots that were burned by a light controlled fire on March 13, 1957.

2. Lock Raven plots in three blocks, one each in:
   a. A very heavy cover (waist high) of honeysuckle under silver maple and boxelder.
   b. A lighter cover of honeysuckle in a stand of planted red pine, redcedar, and dogwood.
   c. A cover formerly similar to b, but burned by a very hot wildfire on April 28, 1957.

3. Contee Farms plots in two blocks with relatively light covers of honeysuckle under a yellow-poplar stand:
   a. One block in an area not previously grazed.
   b. One block in an area grazed by cattle, but from which cattle were excluded after the initial spraying.

4. Havre de Grace plots: a light cover of honeysuckle in a yellow-poplar stand.

Each Maryland block was composed of 8 plots, 6 treated and 2 controls. Spray treatments in June on 1/40-acre plots were (1) 1/5 pound acid of ACP-977 in 12.5 quarts of water, (2) 1/5 pound acid of 2,4-D in 12.5 quarts of water, (3) 1/4 pound of the commercial Amitrol in 12.5 quarts of water, and (4-6) same amount of ACP-977, 2,4-D, or Amitrol in 25 quarts of water. In June the full amount of spray was used in each plot, but in August the same mixtures were applied only in amounts sufficient for thorough wetting of living foliage. Maryland plots were treated on June 17-20, and again on August 26-27.

New Jersey plots received similar treatments, except that in the burned blocks no mixtures involving 25 quarts of water per plot were used. Spraying there was done on June 25 or 27, and again on August 20.

1958 Work

Because of the regrowth of honeysuckle, three of the 1957 blocks were set up for re-treatment in June 1958 and in June of the following years until all honeysuckle had died. These three blocks were the two unburned blocks in New Jersey and the block of silver maple and box-elder at Loch Raven. Spray mixtures used were the same as in the original treatments, and amounts used were sufficient for thorough wetting of living honeysuckle foliage. However, because the effect of 1957 Amitrol treatments seemed to be continuing, the Amitrol plots in these blocks were not re-treated in 1958.

Again because of regrowth, some additional data to determine its importance seemed desirable. Thus, 15 shoots were selected in June 1958, and staked for growth measurements. All 15 shoots were in plots not scheduled for subsequent re-treatments.

1958 PLOTS

Additional plots were established in 1958, for two reasons. First, the 1957 drought might have affected results in that year. Second, June and June treatments, a year apart, might be more effective than June and August treatments in the same year.

The 1958 plots included 4 blocks of 8 plots. These plots too were 1/40 acre in size. Each block included the same number of controls, and the same spray mixtures on treated plots, as in the 1957 8-plot blocks. Two blocks were in the Belleplain State Forest, N.J.; one was in a light cover of honeysuckle, one in a medium cover. The other two blocks were in Maryland's Loch Raven Watershed; one had a heavy cover of honeysuckle in the stand of silver maple and boxelder

On 1/160-acre plots in the Belleplain stand, the use of kerosene as a carrier for 2,4-D and ACP-977 was also tried. Treatments here involved (1) only kerosene, (2) ACP-977 in kerosene (125 gallons per acre), (3) 2,4-D in kerosene, and (4 and 5) ACP-977 or 2,4-D in a carrier composed in half of water and in half of kerosene.

RESULTS AND DISCUSSION

BURNING AND GRAZING

A light fire, as used at Green Bank, had relatively little effect on light and medium covers of honeysuckle. Because the Green Bank fire burned only deep enough to consume the L-layer and part of the F-layer of the forest floor, the honeysuckle sprouted vigorously. In late June 1957, less than 4 months after the burn, the unsprayed burned plot that had a light cover before burning was rated the same. The unsprayed plot that had a medium cover before burning took longer to regain this cover--to the end of the second or 1958 growing season.

An intense, relatively deep-burning wildfire, such as occurred on the Loch Raven Watershed in 1957, is more effective in eliminating honeysuckle than a prescribed burn. However, since it kills overstory vegetation, the honeysuckle that survives is very vigorous. By the end of the second growing season, surviving shoots in unsprayed plots of the Loch Raven burn had built up a cover similar to that present before the fire.

Grazing also reduces the honeysuckle cover, but apparently neither this nor fire is of much value in eliminating the honeysuckle problem.

SPRAYING

Effect of Cover Density

The cover in honeysuckle-infested spots varies greatly in density, but the author doubts that variations between light and very dense covers have much effect on the amount of spray necessary. Even in very dense covers most of the honeysuckle foliage is near the surface and is readily covered.

The spray treatments tried to date have had similar effects in waist-high growth as in somewhat scattered vines that formed light or very light covers. Since foliage sprays are used, and in practice might be applied by machine sprayers, nearly all densities of cover may need nearly the same amount of material. Hence, prior treatments, such as burning or grazing, seem to have little value in reducing the amount of spray necessary.

However, severing of high-climbing vines may usually be necessary before spraying.

Timing

Recommendations by Brender and Hodges (3) on the timing of repeat treatments do not seem to fit Northeastern conditions. They recommend second treatments of ACP-977 later in the same summer, of Amitrol later in the summer or in the following spring. Under our growing conditions these seem too soon, since areas treated with ACP-977 may by then have had little regrowth, and the full effect of the initial Amitrol treatment may not have developed. So for Northeastern conditions a second treatment with ACP-977 should probably be made a year after the first one; with Amitrol, 1 or 2 years after the first one.

Type of Carrier

Water seems preferable to oil as a carrier. At least there is no indication to date that the use of oil, either alone or in mixture with water, is a more effective carrier than water.

Amount of Carrier

Desirable amounts of carrier seem to vary, although the differences are relatively slight and do not agree with recommendations by Southeastern Station personnel. Though they have recommended about 250 gallons per acre as the carrier for ACP-977 (1, 3), our results show consistently that the same amount of ACP-977 is slightly more effective when applied in 125 gallons of water per acre.

In contrast, there is no consistent relationship between the amount of carrier and the effectiveness of Amitrol: in some blocks the more dilute spray is slightly more effective, in others the more concentrated spray. However, in the case of 2,4-D the differences, while slight, indicate that 250 gallons of carrier per acre is more effective than 125 gallons.

Effect of Active Chemicals

The three chemicals differ in their effect, Amitrol being much slower acting than the other two. In both years the initial effectiveness of 2,4-D or ACP-977 was much more striking than that of Amitrol when the plots were rated 2 months after treatment. At that time plots treated with 2,4-D or ACP-977 had a brown appearance: all or nearly all of the old honeysuckle foliage had been killed, and little new growth had started. In contrast, in the same period Amitrol had usually killed only some of the old foliage, although some of the surviving growth would have whitish or chlorotic leaves.

By the following spring the picture changed in the 1957 plots. Then the Amitrol treatments appeared most effective becasue there more of the old foliage had died, leaving relatively few shoots of honeysuckle. In contrast, in the other treatments there was an appreciable amount of new growth.

This new growth spread so rapidly that its cover in August 1958 approached original conditions, particularly where the original cover had been light. Where it had been medium or where the area had been burned, another growing season will usually be needed to permit the cover to reach its original density in the ACP-977 and 2,4-D plots.

Of course, where a third treatment with these chemicals was made in June 1958, there is as yet little new growth. On first glance, these plots appear almost devoid of honeysuckle. However, close inspection shows a few living sprigs, usually 3 to 15 per plot, although in one plot none were noted. Just how important these will be, and how many treatments will be necessary to eliminate honeysuckle with these chemicals, are still unanswered question.

Amitrol plots that were scheduled for another treatment were not given it in June 1958 because there was little living growth--and most of that was chlorotic. Whether the delayed effects of Amitrol will be sufficient to eliminate honeysuckle without additional treatment is very questionable. In September 1958 new honeysuckle shoots with normal foliage were seen developing in these plots.

AMOUNT OF CONTROL NECESSARY

The failure to date of any treatment to eliminate honeysuckle brings up the question: How much control is necessary? Do occasional springs, 10 or 20 on a 1/40-acre plot, form a sufficient nuisance so that they should be eliminated?

Partly to answer that question, observations and measurements were made on scattered shoots of honeysuckle in 1958. These were located in plots treated with 2,4-D or ACP-977 in 1957, and not scheduled for additional treatments.

Between June and late August or early September 1958, most of these shoots grew little if at all. For example, only one of the five New Jersey shoots added any to its own length, and that by only 0.4 foot, during the period.

However, laterals developing leaf axils of the original shoots expanded greatly during that short period. For example, five New Jersey shoots had a total length of 4.1 feet in June, of 23.8 feet by early September, chiefly because of the growth of laterals and sublaterals. One of the Maryland laterals grew 3.7 feet in that period; a New Jersey one, 5.8 feet. However, most of the laterals grew less than one foot, many only 0.1 to 0.3 foot.

On the basis of their growth, and of the recovery of honeysuckle cover in plots treated with ACP-977 or 2,4-D only in 1957, the logical objective in preparing sites for tree reproduction would be elimination of honeysuckle, not partial control. The author estimates that tree reproduction may need a 10-year period for establishment and growth before it is beyond appreciable damage by this vine. If so, the scattered springs still living in the best of our treated

COSTS

Since none of the treatments have been effective as yet, their costs are rather immaterial. However, none of the treatments tried has been cheap. For example, chemicals used in the 1957 treatments would cost $10 to $14 an acre for 2,4-D, $24 to $40 for ACP-977, and $24 to $34 for Amitrol

Perhaps one saving feature is that costs per tract would usually be far less, because in most sections honeysuckle occurs in spots, not throughout whole tracts.

CONCLUSIONS

The three principal chemicals tried in our tests--Amitrol, 2,4-D, and the combination of 2,4-D and 2,4,5-T known as ACP-977--all greatly reduce the honeysuckle cover, but the reductions tend to be temporary. On none of the plots, even those treated 2 or 3 times, have we as yet eliminated honeysuckle.

Foresters need a treatment that, applied preferably only once, will eliminate honeysuckle vines at a reasonable cost, say $25 or less per acre. On that basis none of our trials can as yet be called successful. We will welcome any suggestions on materials or techniques that offer possibilities of meeting that goal.

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A PROGRESS REPORT ON SIMAZINE FOR CONTROLLING WEEDS IN FOREST & NURSERY PLANTINGS

By
Edwin O. Schneider (1

Simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) was introduced experimentally to experiment station and other workers in 1956. Outstanding performance as a pre-emergence weed control chemical in corn was reported in 1956 and again in 1957. Weed control in other agronomic and horticulture crops appear promising. Besides the agronomic crops, weed control in woody species and aquatics were investigated. Ries and Watson (4) reported 2 and 4 lbs. per acre effectively controlled weeds for the entire season without causing any injury to Taxus media hicksi, Cotoneaster acutifolia, Taxus cuspidata and Syringa rothinagensis. Herron (3) applied a 2 ft. band of Simazine at 4 and 8 lbs. per acre to newly transplanted 3 year old sugar maple liners for weed control on March 12, 1957. Weed control was excellent with no injury for the season. Walker (5) in 1957 reported a 10% active ingredient pellet showed promise as a herbicide for controlling aquatic species of weeds without injury to several species of fish or fish food organisms at soil sterilization concentrations. Following the label acceptance for corn by the United States Department of Agriculture on April 19, 1958, another label was accepted for weed control in specific ornamentals.

This paper will deal with weed control in forest and ornamental tree plantings and in other conservation uses of Simazine.

TOXICOLOGICAL PROPERTIES

The acute oral toxicity of Simazine has been determined in both rats and mice and was found to have an LD_{50} in excess of 5g/Kg. No irritation to skin, eyes or mucous membranes has been reported in over two years of field and laboratory testing.

CHEMICAL PROPERTIES

Simazine is a white, crystalline substance which has a solubility of 5 ppm in water, 400 ppm in methyl alcohol, 2.0 ppm in petroleum ether and 900 ppm in chloroform. The pure chemical has a melting point of 225° C. The 50% commercial wettable powder is whitish in color, virtually ordorless and has extremely low toxicity to man and animal.

(1 Geigy Agricultural Chemicals, Division of Geigy Chemical Corp.

TOLERANCE OF CROPS

Tests have demonstrated that corn will tolerate rates of Simazine much in excess of those necessary for the control of annual broadleaf weeds and grasses. Applications either before the corn emerges, or application to the emerging or growing plant, has resulted in no injury to the corn plant. Tests by experiment station workers on yews (Taxus spp.), Juniper (Juniperus spp.), apples (Malus spp.), Scotch Pine (Pinus sylvestris), Arbor vitae (Thuja spp.), and many more species have resulted in no injury at the suggested rates and only minor symptoms when rates were increased several times in nearly pure sand culture in pots in the greenhouse. Most all woody species of plants demonstrate resistance but some of the broadleaf evergreen species are more susceptible than the narrow leaf evergreens.

It has been demonstrated that corn is able to decompose Simazine within the plant probably by enzyme action shortly after being taken from the soil by the roots. While on the other hand, susceptible plants either cannot decompose the absorbed chemical, or do so at a rate so slow that death of the plant occurs before decomposition. Recent experimentations by analytical methods sensitive to 0.1 ppm and by labeled C_{14} Simazine has confirmed that breakdown occurs in corn.

MODE OF ACTION

Experiments have demonstrated that Simazine is taken up by the roots of plants and translocated upwards to the leaves. Seeds in treated soil germinate normally and the seedlings may penetrate the surface of the soil before being killed. Young seedling plants are more easily and faster killed with lower rates than older more mature plants. Older plants usually require higher rates for control. Since the chemical is taken up by the roots, moisture must be present in ample amount to carry the chemical to the root zone. The first plant symptoms appear as chlorosis at the leaf tip and margins. The symptoms continue to progress and necrosis follows. The indications are the chemical interferes with the Hill reaction or the ability of the chloroplasts to break down water to hydrogen and oxygen in the presence of light and iron. The chemical apparently is not able to penetrate the unbroken cuticle of the leaf but must enter through the root. This property is valuable because spraying can be done pre-emergence to the weeds and over small woody plants without absorption by the foliage. Drift to adjoining foliage will not result in injury unless large quantities are eventually washed from the foliage and into the root zone by rain on species of plants subject to injury.

PERFORMANCE

Simazine has been used in many tests by experiment station research workers and conservation personnel for control of weeds in corn (conservation use) and in forest and ornamental tree plantings. Due to the many factors involved, each of the above uses will be discussed individually.

Conservation use in growing corn - Corn for use as wild life food patches usually is planted in inaccessible areas, areas where cultivation is difficult or areas where the weed population is very high. Bayer and Buchholtz (1) found Simazine effective for quackgrass and annual weed control when applications were made 3 weeks prior to planting corn in sod culture. They reported very slow quackgrass control which caused stunting of the corn from competition before the quackgrass was killed. The corn made a good recovery and produced a moderate yield. The annual weeds were controlled for the season. Rates used were 4 and 8 lbs. active per acre as an overall application.

Areas tilled prior to planting rather than planting in sod usually requires less of the chemical for weed control. Other tests on area infested with annual weeds were effectively controlled at 3 to 4 lbs. active per acre. It is suggested that applications be made from 3 to 6 weeks prior to spring planting, or in the fall. In areas infested with quackgrass early treatments are important because of the slow response of the chemical.

Forest and Ornamental Tree Plantings - Several papers are in the process or have just been published on the use of Simazine for weed control in nursery or tree plantings. Workers have had excellent success if applications were confined to trees one year old or older, and not for seed bed weed control with applications made at seeding or in the seed bed before the trees have been established. At the present time it is suggested applications be confined to Apple (non-bearing), Balsam Fir, Barberry, Boxwood, Cotoneaster, Douglas Fir, Fraser Fir, Juniper, Norway Spruce, Privet, Red Pine, Red Spruce, Rose, Scotch Pine, White Pine, Yew (Taxus) and White Spruce. Additional species will be added as data is received on the tolerance.

In one nursery 2 to 4 year old Juniper (Juniperus spp.), Yew (Taxus spp.), and Arborvitae (Thura spp.) in liner beds were treated overall at 2 lbs. active per treatment in the fall of 1957 and again in the spring of 1958 for weed control. The winter weeds were chickweed (Stellaria media), henbit (Lamium amplexicaule), and downy brome (Bromus tectorum), while the summer weeds were similar to those found in a mid-west corn field.

The application gave excellent control of these weeds where the normal cost of hand weeding was from $200 to $300 per acre. Cultivation was used prior to application to relieve soil compaction.

DenUyl (2) used 2 and 4 lbs. Simazine in a 2 ft. band over newly planted 1X Scotch Pine trees in an abandoned field. The trees were planted in April when the grasses were just starting to emerge. The application controlled the vegetation that would compete for moisture or would smother the small tree during the winter when snow packs the dead vegetation down.

Applications of Simazine at 2, 4 and 6 lbs. per acre on newly planted Scotch Pine in the spring of 1958 in Missouri gave fair control at 2 lbs. per acre and excellent control of annual weeds and grasses at the 6 lb. per acre rate. These treatments allowed other low growing woody species to afford shade and protection during the summer. Scotch Pine and other narrow leaf ornamentals in a nursery for replanting on Ohio roads were kept free of interfering weeds when application at 3 lbs. per acre was made in a 2 ft. band over the row in early May. Reduction of competition from weeds resulted in additional growth of the trees. Simazine at 3 lbs. per acre applied on april 28, 1958, in a wood infested area improved the survival of the White Pines in a very dry year by eliminating competition. None of the trees survived in the untreated area whereas 55% were living on September 17, 1958, in the treated area.

SUMMARY

Simazine has been used for the control of annual weeds and grasses in corn planted in sod culture or with minimum tillage in remote locations for bird food. In quackgrass infested areas, the rate must be increased from 3 lbs. to 5 to 6 lbs. per acre for control.

Most woody species of plants show resistance to Simazine when used for weed control either as a directed or overall spray for pre-emergence weed control. Many species show tolerance. However, only Apple (non-bearing), Balsam Fir, Barberry, Boxwood, Cotoneaster, Douglas Fir, Fraser Fir, Juniper, Norway Spruce, Privet, Red Pine, Red Spruce, Rose, Scotch Pine, White Pine, Yew (Taxus) and White Spruce are cleared for use.at the present time. Additional species of forest trees and nursery planting will be added as data is received on tolerance.

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"The Use of Herbicides in Nature Sanctuary Management"

by

Eugene Decker, Resident Director
Westmoreland Sanctuary
Mount Kisco, New York

As our urban areas with their sprawling suburbs continue to grow with our exploding population, the necessity of setting aside natural tracts within them is becoming more evident and popular. A discussion of the need for and purposes of these natural areas has been the subject of many publications, and I am sure that all of us are sympathetic with the movement. These "open spaces" within the populated sections may take the form of parks, sanctuaries, nature preserves, wildlife refuges, or other similar operations.

The term "nature Sanctuary" as used in this paper refers to those tracts which are retained in a natural state and are also utilized for nature study and conservation education activities. These activities generally consist of tours along trails which lead through the various communities where the relationships of the plant and animal life are explained by guides, signs, or guide books.

The purpose of this paper is to describe the usefulness of chemical herbicides as tools in the management of nature sanctuaries.

NEED AND REQUIREMENTS OF HERBICIDES.

Since the operation of a nature sanctuary is centered around its use by the public, the maintenance of the trails within the area is a major concern. These paths wind through various communities and should be kept as natural looking as possible to be effective. A trail, just kept comfortably passable by the usage of persons or animals, appears to be popular and pleasing to most persons. The picturesque "deer trail" or "Indian path" of popular fiction probably conveys the idea of what is to be desired.

On some of our very high public-use sanctuaries, the paths are kept bare by constant usage; on others, several problems are encountered in the maintenance of trails, where the activities are more restricted and seasonal. These are concerned with the control of woody vegetation on paths in the woodland communities, the control of grasses and weeds in the open and old field sections, and the eradication of poisonous plants adjacent to the trails.

The repeated cutting of the vegetation with hand tools, or by mechanical means where applicable, has been the accepted method involves many manhours of labor and upkeep of equipment during a period of increased activity on the sanctuary. The resulting trails often tend to be artificial in appearance with the fresh cut stumps and sprouts.

The development of chemical herbicides has provided promising tools for the management of these trails. The simplicity of the equipment involved and the labor-saving factors of their use are both favorable considerations for their adoption. The herbicides also appear useful in other sanctuary management operations such as the elimination of grass from parking areas and drives, and the initial clearance of new trails.

The requirements of herbicides for use in nature sanctuary management are probably more restrictive than those for other operations. First, the materials must be non-toxic not only to the public but also to any wildlife which may come in contact with the treated vegetation. The volatility of the herbicide must be low in order to safeguard desirable growth near the sprayed sections. Other considerations are the selectivity of the herbicide to species involved in the various operations, and the ease of application.

HERBICIDES USED.

Chemical herbicides were tested on Westmoreland Sanctuary, Westchester County, New York, during the spring and summer of 1958. This project was conducted with the cooperation of the Agricultural Chemicals Division of The Dow Chemical Company, which supplied the chemicals tested.

Four materials commonly referred to as systemic hormone type herbicides were used. They are various formulations of 2,4-D, 2,4,5-T, and similar materials. The commercial formulations used are known as Veon 245, Garlon, Kuron, and Baron.

Trade Name and (Common Name)	Active Ingredients
Veon 245 (Amine salt of 2,4,5-T)	Triethylamine salt of 2,4,5-trichlorophenoxyactic acid, minimum------------------56.7%
Garlon (Dalapon ester plus low volatile ester of silvex)	Diethylene glycol bis, 2,2-dichloropropricnate, minimum---------------------------50.8% 2-(2,4,5-trichlorophenoxy)propionic acid, propylene glycol(C_3H_6O to $C_9H_{18}O_3$) butyl ether esters, minimum---------------------- 7.7%
Kuron (Low volatile ester of silvex)	2-(2,4,5-trichlorophenoxy)propionic acid, propylene glycol(C_3H_6O to $C_9H_{18}O_3$) butyl ether esters, minimum-----------------64.5% 2-(2,4,5-trichlorophenoxy)propionic acid, equivalent, minimum-------------------------35.5%
Baron (erbon)	2-(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate---------------------------30.5% Related compounds---------------------------10.8%

Recommended Mixtures Used:

Veon 245 - 1 part Veon 245 to 100 parts water.
Garlon - 1 part Garlon to 30 parts water.
Kuron - 1 part Kuron to 100 parts water.
Baron - 1 part Baron to 6 parts water.

These materials were chosen as they have been proven non-toxic to man and animals in the dosages recommended for application. The toxicity of the materials involved have been adequately tested and discussed by Grigsby and Farwell[1], Willard[2], Fertig[3], and Rowe and Hymas[4]. The Westmoreland Sanctuary has a high population of wild birds, mammals, and reptiles, and no evidence of any adverse effects on any form was noticed even though the treated areas were found on all communities.

These sprays were also selected because of their low volatility and no damage to adjacent vegetation was observed after their use. The danger of wind drift was eliminated by controlling the droplet size of spray by adjusting the nozzle.

The materials chosen all form mixtures readily with water which greatly facilitates their use in the field. A three-gallon booster tank and pump with a back sling was used for all spraying treatments and proved to be quite efficient.

Figures for the amount of spray needed for a definite length of trail to be treated are difficult to calculate as the application varies according to the density of the species sprayed in the various communities.

MAINTENANCE OF TRAILS.

A. Wooded Communities. Woody vegetation in the paths can be adequately controlled with the application of a suitable herbicide in late spring. Maple-leaf viburnum was a major problem in these trails and it was easily controlled by application of Veon 245 spray. Other growth in the paths killed by this spray were spice bush, red maple, flowering dogwood, white oak, chestnut oak, and Virginia creeper. White ash was found to be particularly resistant to this spray. The vegetation in the paths is especially vigorous and persistent as it was mostly sprout growth resulting from the initial clearance by cutting. One spraying was successful in eliminating the woody growth and only a follow-up of spot spraying for later growth was necessary. The killed vegetation dried out rapidly, was easily knocked down, and the resulting path was quite natural looking.

Poison ivy was completely eradicated along the edge of the trails with Veon spray. This spray was applied so as to provide a lane through the large patches so that users of the trails would not come in contact with it. No attempt was made to completely eradicate these communities as they have a definite influence on keeping the sanctuary visitors from wandering away from the trails. Also, the poison ivy fruits produced in these patches are widely used for food by wild birds.

B. Open Communities. Grasses and broad-leafed weeds present problems in the trails through the old fields and through openings in the woodlands. The application of Garlon spray to these trails provided cessation of growth and an open clear trail.

C. Initial Clearance of Trails. The development of a nature sanctuary necessitates the location and clearance of trails. Once the heavy material has been removed, the spraying of a brush killer on the remaining growth greatly facilitates the final removal of this growth. A definite lane is marked for the trail and the dead vegetation is easily knocked down or removed. The resulting path is pleasant to view and maintenance problems will be limited to spot spraying of new growth. Kuron spray was used for this operation and most of the growth in these lanes was killed.

The elimination of grass and weeds in roadways and parking areas was easily accomplished by applying Baron, a non-selective herbicide which has a high degree of persistence in the soils.

To obtain maximum effectiveness of the materials in a spray, the operation should be conducted during a period of low wind velocities and when the opportunity for rain is unlikely. Thorough wetting of the vegetation is necessary for effective killing, and the spray particles' size should be regulated so that they are large enough to prevent drifting.

CONCLUSION.

The occurrence of unfortunate incidents involving the unwise choice of materials and the incorrect application of herbicides has caused many persons to regard the use of any chemical herbicide as a hazardous and unthinkable operation. Nevertheless, herbicides of the systemic hormone type have provided safe, efficient and economical tools for use in the management of a nature study sanctuary type operation.

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WEED CONTROL ON GLADIOLUS, 1958 RESULTS

Arthur Bing

Cornell Ornamentals Research Laboratory

Introduction

Studies on weed control for gladiolus cormel plantings have been carried on at the Cornell Ornamentals Research Laboratory on Long Island for several years (1) and on flowering stock at other stations (2,3). This report covers the 1958 results on Long Island.

Procedure

The cormels were planted on May 20. There were 11 rows and each row contained 20 lots of 1000 cormels, 10 lots of the variety Friendship alternating with 10 lots of the variety June Bells. Each lot of 1000 was planted 2 inches deep in a space 5 inches x 4 feet with 1 foot of blank row between varieties and 2 feet between treatments. The rows were 36 inches apart center to center. A treatment consisted of one lot of each of the two varieties. There were 22 treatments replicated five times with the first two treatments in each row block A, the second Block B, etc. All treatments were replicated once in each block. Cormels were covered with a hill of soil which was raked level on June 3. The field was irrigated June 5. Granular treatments with Simazin, Diuron, and Chloro IPC were applied with a fertilizer spreader on June 6. Intermittent showers held up further applications until June 11 when the remaining treatments were applied.

Results and Discussion

Weed growth in the plots was rated on July 11 by two observers. Results are shown in Table I. Nutgrass was quite prevalent in most plots and as no materials showed control it is not included in the ratings. After rating all plots were weeded. Values in the the table were on the basis of 0 for no weed growth to 5 for full of weeds. The best weed control was from 4% CIPC-4% SES granular 50#/A, Diuron granular 2# active/A, Neburon 6#/A, Karmex DW 1 1/2#/A, and Karmex W 1 1/2#/A with CIPC 6%-SES 4% 150#/A, and Simazin liquid 2#/A very close. Also giving good control were CIPC 8# liquid/A, Diuron granular 1#/A, Simazin 1# liquid/A, CIPC 6%-SES 4% 100# granular/A, CIPC 4%-SES 4% 100 #/granular/A, Sesone 4#/A, and G30031 2#/A. The other treatments did not give adequate control although any average weed growth of less than 3 showed significant control.

Corms were dug in late September, washed and cured. No effort was made to retain cormels other than those that remained attached to the corms during digging. After curing, corms were cleaned, cured for 1-2 weeks and then weighed at the end of October. Variety June Bells germinated poorly and grew sparsely. Corm yields were poor and analyses of yields showed no significant differences between treatments. Variety Friendship grew well and Table II shows the yield data. All treated plots had an average yield higher than all the untreated except G30031 which was also very low yielding in variety June Balls. No treatments were significantly harmful to the yield of variety Friendship. Actually several treatments yielded significantly higher than the untreated. The lower yield of untreated plots is due to the weed competition before rating and subsequent weeding of the weedy plots. Later regrowth of weeds after the weeding was probably not so serious to the crop.

On the basis of crop yield, the best treatments would be rated roughly in the following order. Karmex W 1 1/2#, Neburon 6#, CIPC 8#, CIPC 6%-SES 4% 100#, CIPC 4%-SES 4% at 150#, Karmex DW 1 1/2#, Simazin 2# granular, Diuron 2# granular, followed by most of the other treatments. Good weed control makes it much easier to dig the young corms. Crabgrass is the most difficult to contend with when digging.

Summary

Many treatments gave good weed control and produced crop yields greater than from the untreated plots. On the basis of crop yield and weed control the following treatments performed best: Karmex W 1 1/2#, Neburon 6#, Karmex DW 1 1/2#, CIPC 4%-SES 4% at 150 lbs granular, CIPC 8# liquid, CIPC 6%-SES 4% 100 lbs granular and Diuron 2% granular at 100 lbs.

Acknowledgment

Cormels for this experiment were supplied by "The House of Spic and Span", Newfield, New Jersey.

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Table I

Weed Growth

*(Scale 0-5)

Treatment June 6 or 11	Weed Growth July 11					
	Block					
	A	B	C	D	E	Average
Untreated #1	5	5	5	5	5	5
Untreated #2	1.5	5	5	4.5	5	4.2
Untreated #3	5	5	5	5	5	5
Simazin 1# Gran	4	5	4.5	4	4.5	4.4
Simazin 2# Gran	3	3	2	1.5	3	2.5
Simazin 3# Gran	4	3	2.5	2.5	2	2.8
Simazin 1# Liq	1	0	2	1.5	2.5	1.4
Simazin 2# Liq	1	0	0.5	1	1	0.7
Karmex DW 1 1/2# Liq	0	1	0.5	0	1	0.5
Karmex W 1 1/2 # Liq	1	1	0	0.5	0	0.5
Karmex Diuron 1# Gran	1	2.5	1	0	1.5	1.2
Karmex Diuron 2# Gran	1	0	0.5	0	1	0.5
Neburon 6# Liq	1	0	1	0	0.5	0.5
CIPC 8# Gran	3	5	1.5	1.5	3	2.8
CIPC 8# Liq	0	1	1	1.5	2.5	1.2
G30031 2# Liq	2.5	1	2	1.5	2.5	1.9
Sesone 4# Liq	1.5	1	2	2	3	1.9
** C_6S_4 50# Gran	3	2	4	2	2.5	2.7
** C_6S_4 100 # Gran	1	2	1	1.5	2	1.5
** C_6S_4 150 # Gran	1	1	1	0	0	0.6
*** C_4S_4 100 # Gran	5	1	1.5	1	0	1.7
*** C_4S_4 150 # Gran	0	0	1	1	0	0.4

Required Significant Difference between averages 1.1

* Scale	0	No weeds	3	Some weeds
	1	Very few weeds	4	Many weeds
	2	Few weeds	5	Very weedy

** Chloro IPC 6%-Sesone 4% granular at 50#/Acre
*** Chloro IPC 4%-Sesone 4% granular 100#/Acre

Table II

Gladiolus Corm Yield Variety Friendship

(From 1000 cormels)

Treatment June 6 or 11						Yields in Grams
	A	B	C	D	E	Average
Untreated #1	720	680	1130	680	730	798
Untreated #2	930	490	890	690	1130	826
Untreated #3	980	700	1700	650	1180	1042
Simazin 1" Gran	860	810	930	1050	710	872
Simazin 2 # Gran	980	1290	1650	1430	1030	1276
Simazin 3 # Gran	990	850	1340	1350	1230	1152
Simazin 1 # Liq	1050	1320	730	1130	1240	1094
Simazin 2 # Liq	880	1150	1040	1030	1510	1122
Karmex DW 1 1/2 # Liq	1210	1220	1750	1330	880	1278
Karmex W 1 1/2 # Liq	1090	1010	1540	1610	1350	1320
Karmex Diuron 1 # Gran	1020	840	1110	1200	1120	1058
Karmex Diuron 2 # Gran	1310	980	1430	1510	1100	1266
Neburon 6 # Liq	860	1290	1300	1490	1560	1300
CIPC 8# Gran	1040	730	1300	1490	1430	1198
CIPC 8 # Liq	1070	1400	1340	1630	1000	1288
G 30021 2 # Liq	980	1170	870	700	910	926
Sesone 4 # Liq	830	1160	1280	920	920	1022
** C_6S_4 50 # Gran	930	1400	1000	1440	930	1140
** C_6S_4 100 # Gran	1290	950	1430	1530	1220	1284
** C_6S_4 150 # Gran	1010	910	1060	1690	1350	1186
*** C_4S_4 100 # Gran	730	1180	1160	1300	1510	1176
*** C_4S_4 150 # Gran	1360	1000	1300	1420	1260	1288

Required Significant Difference between averages 222

** Chloro IPC 6%-Sesone 4% granular at 50#/Acre
*** Chloro IPC 4% Sesone 4% granular 100 #/Acre

Evaluation of DNBP and Sesone for Control of Weeds in Gladiolus

L. L. Danielson and Neil W. Stuart [1/]

Abstract [2/]

Weed control investigations in gladiolus under field conditions were initiated in 1957 and continued through 1958 to obtain data on the effect of DNBP (4,6-dinitro ortho secondary butylphenol) and sesone (sodium 2,4-dichlorophenoxyethyl sulfate) on yield and quality of flowers and corms of gladiolus and on date of flowering.

Pre-emergence applications of 6 pounds of DNBP per acre were used alone and in combination with pre- and post-flowering applications of 3, 4, and 5 pounds of sesone per acre. Plots were irrigated before each application.

Corms were weighed and counted at planting and digging time. Corms treated in 1957 were stored and planted again in 1958 to study the possibility of carry-over of herbicidal effects from season-to-season in the corms. Total length of each flower stalk and the length of its flowering portion were measured. Numbers of flower stalks, florets per stalk, side shoots per stalk and date of opening of first floret on each stalk were recorded. Treated plots were compared with hand-weeded plots.

Annual grasses and broadleaved weeds were controlled for the entire growing period with a pre-emergence application of DNBP followed by pre- and post-flowering applications of 3 pounds of sesone per acre.

None of the treatments had any effects on flowering or corm production, and there was no evidence of carry-over effect, when using single applications. There were indications of injury from double applications of sesone at the higher rates.

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

2/ Paper to be offered for publication in the Journal of the Weed Society of America.

WEED CONTROL FOR PEONY PLANTINGS

Arthur Bing
Cornell Ornamentals Research Laboratory

Introduction

Weed control in perennial crops is quite difficult because perennial weeds soon get established where it is impossible to cultivate. Peonies are propagated by division and when planted usually remain in the same place for five years. The crowns are near the soil surface so cultivation during the dormant season cannot root our perennial weeds. The plants spread out and form flower buds soon after emerging early in the spring making it difficult to cultivate then also. They flower in the end of May on Long Island.

Considering some of the newer herbicides used on nursery stock at the laboratory, it appeared as if there should be a chemical suitable for treating peonies during the dormant season. In September the tops are normally all cut off flush with the soil surface and removed for disease control, thus making it easy to come in with machinery and treat the soil over the dormant plants.

Procedure

A field of peonies at the State University of New York, Agricultural and Technical Institute at Farmingdale was available in the fall of 1957. The tops were removed and the field rototilled between rows in late October. Each herbicide was used on two adjacent rows with rates varying along the rows where different concentrations were used. There were several varieties involved in the test with no effort made to differentiate between them because it was necessary to work with an established field. The field was observed continuously during the growing period. Treatments and duration of weed control are shown in Table I. Treatments were made December 22.

Results and Discussion

From Table I it can be readily observed that Karmex diuron liquid or granular at 4 lbs actual per acre, Simazin at 10 lbs actual per acre, and Neburon at 8 lbs actual per acre gave very effective weed control over the entire growing season. Lower rates of these materials gave effective control until time of cutting. Plots rated clean were practically if not entirely free of all weeds. Crabgrass was the most prominent weed invading areas that remained weed free only until shortly after time of flower cutting. The other herbicides were not effective. Where weed control was best, plants looked greener probably because of less competition from weeds for nutrients. There were no adverse effects on the cut flowers. Moisture shortage because of weeds was not a factor this past season, the wettest in many a year.

Table I

Weed Control on Peonies

Material	Rate (actual/A)	Duration of Control
Karmex DW	2#/100 gal	Clean until time of flower cutting
Karmex DW	4#/100 gal	Clean until autumn
Karmex Diuron	2% granular 2#	Clean until time of flowering
Karmex Diuron	2% granular 4#	Clean until autumn
CIPC	8#/100 gal	Poor control by spring
CIPC	5% granular 8#	Poor control by spring
Untreated		Weedy in early spring
Neburon	4#/100 gal	Poor control
Neburon	6#/100 gal	Some control at time of flowering
Neburon	8#/100 gal	Clean until late summer
Simazin	2 1/2#/100 gal	Poor control by spring
Simazin	5#/100 gal	Clean at time of cutting
Simazin	10#/100 gal	Clean until fall
Dinitro	4% granular 4#	Weedy in early spring no control
4% CIPC-4% SES	4# each	Poor control
4% CIPC-4% SES	8# each	Poor control

Granular Mylone -- A Preplanting Measure for Control of Perennial Weeds of Nursery and Ornamental Plantings

A. M. S. Pridham, Cornell University

Screening tests to determine the effectiveness of granular Mylone formulations at several rates and temperatures was done in the greenhouse. Unsterilized soil units of 1 pound at approximately 30% moisture (dry weight basis) served as test units to which weed seed or root pieces of Artemisia vulgaris, Agropyron repens, Amaranthus retroflexus and Digitaria sanguinalis were used as test weeds.

Thirty pounds of soil were spread on polyethylene sheeting and the appropriate amounts of Mylone added. It is assumed that soil a furrow slice deep will weigh 2 million pounds per acre. Mylone was used at 300 pounds of active ingredient per acre. After table mixing, the sample was placed in a Leverpak drum and rolled for 5 minutes to complete the mixing of the Mylone with the soil.

Culture samples of 1 pound were weighed out into polyethylene bags. Weed samples were added and the bags closed, labeled and stored for a week at selected controlled temperatures of 35°, 40°, 45°, 50° and 60°F.

Treated soils were then removed from storage and transferred to flower pack paper containers. Soil was firmed, moistened and the surface sown to redtop, Agrostis alba, grass seed carrying yarrow, Achillea millefolium, as an impurity. Soil samples were placed in a greenhouse at 50°F night temperature and 50-55° day temperature. Germination of seed and growth of root parts was noted at intervals and records concluded after 6 weeks.

The formaldehyde-like odor of Mylone was present in the storage chambers and faintly so in the greenhouse where the cultures were placed. Germination was normal in rate and amount in control cultures from all temperatures from 35° to 60°F. Mylone treatments of 300 pounds of active ingredient per acre were not detrimental to germination or growth of redtop, Agrostis alba, when treatment temperatures were 50°F or more. Germination was usually slower where treatments were made at 35°F or where amounts of Mylone exceeded 300 pounds of active ingredient per acre. The weed count includes those weed seed added to the soil as well as those present in composted soil but excludes yarrow. Weed counts are given in Table 1.

Under the conditions of this test, weeds were controlled as seed or seedlings when Mylone was used at 150 to 300 pounds of active Mylone per acre and where soil temperatures of 45°F or higher prevailed for 7 days following application of the Mylone.

Artemisia vulgaris and quackgrass, Agropyron repens, failed to grow vigorously in the controls and did not appear in any of the treatments. These weeds were gathered from below frost line in frozen soil. A second series was set up later and treatment confined to the 30°F soil temperature.

Table 1. The effect of Mylone on germination of weed seed sown in soil prior to treatment with Mylone. Total number of seedlings - 5 reps. All seedling weeds after 5 weeks.

Temperature maintained during 7 day treatment of soil sample	Untreated control	Pounds of active Mylone applied per acre					
		50% bran formula			25% bran formula		
		300	150	75	300	150	75
35°F	91	4	10	54	2	5	21
40	104	0	10	50	3	19	51
45	112	2	2	35	0	4	7
50	174	0	8	64	3	3	3
60	76	5	5	32	0	0	0
	557	11	35	235	8	31	82

Table 2. Number of shoots of Artemisia vulgaris from 20 stolons, 5 each in 4 replicates following treatment with Mylone at 30°F, 7 days.

Formulation	Pounds of active Mylone/Acre				
	0	38	75	150	300
Mylone 25% bran	8	9	6	0	0
Mylone 10% vermiculite	-	11	5½	4½	0

These results confirm earlier ones of 1957 under field conditions with sandy loam at 40-45°F and where wettable powder formulation of Mylone was compared with Vapam for elimination of Artemisia vulgaris. Present tests suggest that early spring treatments could be made successfully.

In April 1958 treatments were made as soon as the soil was dry enough to rototill. Soil temperatures ranged from 40 to 42°F at 4" depth. 25% bran formulation and year old 10% vermiculite formulations were used. Half of each plot was covered by plastic; half remained open. No heavy rains fell during the period of a week after treating. When the plastic cover was removed, test plantings were made. Pachysandra terminalis and Vinca minor were planted and redtop grass seed was sown on the soil surface.

Random samples of soil (1 square foot) were taken in November and the roots of Artemisia sorted out, washed free of soil and air dried, then weighed. The results are given in Table 3.

Table 3. Effectiveness of soil sterilization treatments with Mylone and with Vapam for control of Artemisia vulgaris in sandy loam during early spring prior to planting out bare root nursery stock. Results in terms of grams of green weight of surviving stolons in 1 square foot soil samples taken at random in duplicate. Fall 1958, 6 months after treatment.

Treatment and rate	Date of treatment April 29	June 3
Undisturbed soil	82 grams	--
Rototilled - untreated	63	98 grams
Rototilled Mylone 25% bran		
300 pounds Active/acre	0	0
150 " "	17	-
300 lbs. Active/A, Vermiculite	5	-
Rototilled Vapam	5	1.0

Mylone and Vapam used at manufacturer's recommended rates drastically reduced the stand of Artemisia vulgaris in sandy loams.

Plant survival in the potted ground cover materials Vinca minor and Pachysandra is reduced if planting is done 7 days after treatment but established Forsythia plants adjacent to treated plots did not show injury from treatment.

Table 4. Survival of Pachysandra terminalis and of Vinca minor set as bare root plants in sandy soil 7 days after soil treatments were made. Soil 40-42°F.

	Plot covered			No cover
Soil treated with	7 days Pachysandra	14 days Pachysandra	7 days Vinca	7 days Pachysandra
Mylone 25% bran				
300 lbs. Active/A	100%	100%	100%	30%
150 lbs. Active/A	80	100	100	70
Mylone 10% vermiculite				
300 lbs. Active/A	80	100	100	70
Vapam pt/100 sq. ft.	0	100	100	40
Untreated - rototilled	70	100	100	100

Effectiveness of granular Mylone treatment of silty clay during early spring

Treatments were begun on May 12 as soon as the soil had dried sufficiently to permit rototilling. In the first soil test, temperatures were 43-45°F, plots were 100 sq. ft. in size and bordered on two sides by established plants of *Forsythia intermedia* variety Spring Glory. Plots extended between the rows of Forsythia. One series was covered by black mulching polyethylene and another left uncovered. No heavy rains followed during the week. On May 19 the series was repeated but both replicates were covered. Heavy rains occurred. Tables 5 and 6 indicate the rates and treatments as well as the survival of test crops.

Table 5. Survival of *Vinca minor* planted at the conclusion of a 7 day treatment with Mylone - no period for aeration.

Date of treatment and formulation	Mylone 300# ae/A B.R.	Mylone 300# ae/A Pot	Mylone 150# ae/A B.R.	Mylone 150# ae/A Pot	Mylone 75# ae/A B.R.	Mylone 75# ae/A Pot	Untreated B.R.	Untreated Pot	Vapam B.R.	Vapam Pot
May 12										
25% bran - open	4	4	4	4	4	4	4	4	-	-
- covered	2	4	4	4	4	4	4	4	4	4
May 19										
covered										
10% vermiculite	3	2	4	4	-	-	3	4	-	-
	3	-	4	-	-	-	-	-	-	-
25% bran	1	4	4	4	-	-	-	-	-	-
	0	-	4	-	-	-	-	-	-	-
	13/24	14/16	24/24	16/16	8/8	8/8	11/12	12/12	4/4	4/4

Table 6. Survival of *Pachysandra terminalis* planted at the conclusion of a 7 day soil treatment with Mylone - no period for aeration.

Date of treatment and formulation	Mylone 300# ae/A B.R.	Mylone 300# ae/A Pot	Mylone 150# ae/A B.R.	Mylone 150# ae/A Pot	Mylone 75# ae/A B.R.	Mylone 75# ae/A Pot	Untreated B.R.	Untreated Pot	Vapam B.R.	Vapam Pot
May 12										
25% bran - open	1	4	3	4	4	4	4	4	-	-
- covered	2	4	3	4	4	4	4	4	4	4
May 19										
covered										
10% vermiculite	4	2	3	4	-	-	4	4	-	-
	1	3	4	4	-	-	-	-	-	-
25% bran	0	1	2	2	-	-	-	-	-	-
	1	0	4	3	-	-	-	-	-	-
	9/24	13/24	19/24	21/24	8/8	8/8	12/12	12/12	4/4	4/4

Other test plants

Plant	Survival	Control
Euonymus fortunei coloratus	B.R. - 50%	100%
Chrysanthemum morifolium vars.	Pot - 80%	100%
Rose Better Times	B.R. - 12%	100%

Other treatments

Granular Nemagon applied May 26 resulted in no mortality in Pachysandra, Rose Better Times, Chrysanthemum, *Vinca minor*, or Caryopteris.

Mylone used at manufacturer's recommended rates resulted in reduced stand of bare rooted nursery stock set out in treated soil 7 days after treatment. Pachysandra, Euonymus and Rose were more susceptible to injury than was *Vinca minor*. Potted plants set out without disturbing the root ball survived better than bare rooted plants of the same age and species.

Re-establishment of weeds in sterilized plots

Following treatment of soil with Mylone, the plastic cover was removed and soil walked on in the process of planting. This occurred twice -- once at the time of taking off the cover and the second time a week later. No hand weeding, hoeing or chemical weeding was done during the summer.

In October weeds were cut off at the soil surface, sorted and weighed. Count was made of large weeds beyond seedling stage. The number of large weeds reflects the relative amount of hand weeding needed to keep the plots clean through the summer till early fall growth of seedling weeds.

Untreated plots had Canada thistle, *Cirsium arvense*, *Malva rotundifolia* and *Sonchus arvensis* as common perennial weeds. Plots were free of *Agropyron repens* and *Artemisia vulgaris*. Pigweed, *Amaranthus retroflexus*, and lambs quarters, *Chenopodium album*, were common as was groundsel, *Senecio vulgaris*.

Weeds of treated plots were mainly pigweed and some Canada thistle and later groundsel in quantity.

Tables 7 and 8 indicate weed populations of treated plots in comparison to the untreated control in terms of number of large weeds and total gram weight of weeds per plot.

The use of a plastic cover in these tests leads to more effective weed control in terms of reduced number of weeds growing during early to mid-summer. This is especially true where manufacturer's rates were used though some reduction in weed population also occurred at lower rates. Reduction in total weight of weeds leads to similar observation and reaffirms the value of using adequate amounts of material as well as a plastic cover.

Table 7. Re-establishment of weeds following soil treatment with Mylone -- number of large weeds beyond seedling stage by October from treatment in May.

Treatment and formulation	Rate of application of active Mylone 300# ae/A	150# ae/A	75# ae/A	Untreated	Vapam 1 pt/ 100 sq.ft.
Bran 25%					
Open	23	17	38	71	-
Covered	4	10	27	39	6
Covered	7	5	--	56	-
Vermiculite 10%					
Covered	8	16	--	--	-

Table 8. Re-establishment of weeds following soil treatment with Mylone. Total weight of weeds produced from May to October - green weight in grams

Treatment and formulation	Rate of application of active Mylone 300# ae/A	150# ae/A	75# ae/A	Untreated	Vapam 1 pt/ 100 sq.ft.
Bran 25%					
Open	4279	4962	3653	5145	----
Covered	405	3118	4053	4832	2425
Covered	1517	1570	----	4037	----
Vermiculite 10%					
Covered	1272	2432	----	----	----

Summary

Mylone used at manufacturer's recommendation of soil temperature 50°F or more, Mylone used at 300 pounds of active ingredient per acre, and the application sealed with a cover leads to most effective results. Control of Artemisia vulgaris and other perennial weeds can be accomplished in early spring where granular or spray formulations are rototilled into the soil. Treatments lasting a week prior to planting were adequate to control perennial weeds. Bare root plants of Vinca minor, Pachysandra terminalis and roses are likely to be injured or killed if set in freshly treated soil. A two week period from date of treatment appears to be a safe interval between treating and planting if during one week of the two the soil is exposed to air and not subject to heavy rain or watering. Potted plants appear in these tests to be suitable for planting and rapid establishment in Mylone treated soil.

The fact that grass seed sown at the conclusion of the treatment period grows normally suggests practical application in this area of horticulture. The control of Artemisia with relatively low rates of Mylone has practical significance in the cultivation of nursery stock.

Acknowledgment is hereby given Carbon and Carbide Co. of New York City for Mylone wettable powder and to the Miller Chemical and Fertilizer Corp. of Baltimore, and the Vermiculite Corp. for formulations; also to the Stauffer Chemical Co., Chauncey, N. Y. for Vapam used. Data taken by Douglas Bean

PRE- AND POST-PLANTING TREATMENTS FOR WEED CONTROL IN NURSERY LINING OUT STOCK[1]

By
R. L. Ticknor, J. R. Havis, P. F. Bobula
University of Massachusetts, Waltham

One of the most expensive weed control jobs in the nursery is in beds where plants are grown until large enough to be planted in the field. Because of the close spacing of the plants hand labor must be used to control weeds.

A major hope to alleviate this situation is by the use of pre-planting herbicides. These materials usually control soil diseases and soil insects as well as weeds.

Previously we have reported on use of five materials as pre-planting treatments. The three most effective materials,- methyl bromide, DMTT, and SMDC - were used in the trials this year. In addition, pilot work was started this year with another material, EPTC.

Since none of the plots remained free in previous years, post-planting treatments were added to suppress weed growth. Mulches of bark[2] and sugar cane[3] and granular CIPC were applied after the stock was planted.

METHODS

Each pre-planting treatment, applied on June 6th, was replicated three times in 5' x 20' beds. Soil temperature was 66°F. at treatment time. Methyl bromide was applied under a plastic cover at a rate of one pound per 100 square feet. DMTT 90 percent in pelleted form was applied at 3/4 pound per 100 square feet and rotary tilled to a depth of five inches. SMDC was applied with a "hozon" proportioner at one quart per 100 square feet and thoroughly watered into the soil. EPTC was applied to the dry soil surface at a rate of 10 and 20 pounds per acre on a granular carrier and was rotary tilled to a depth of five inches. Check beds were left untreated at this time.

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[1]Contribution Number 1178, Massachusetts Agricultural Experiment Station.

[2]Screened bark from the paper industry.

[3]Sugar cane bagasse sold in bales for poultry litter.

Post-planting treatments were applied on June 17th, the day after setting the plants. Each 5' x 20' bed was divided into four 5' x 5' areas. The first was left untreated, the second was covered with two inches of bark, the third was covered with two inches of sugar cane, and the fourth was treated with 5 percent granular CIPC at a rate of 8 pounds per acre.

Plants used in this experiment were growing in two inch bands prior to planting in the beds. Five plants each of the following varieties were set in each 5' x 5' area of the beds: Euonymus patens, Rhododendron yedoense poukhanense, Taxus media browni, Thuja occidentalis, and Viburnum juddi. An exception to this was EPTC plots where a few plants of each variety except Viburnum juddi were used.

RESULTS

Survival of plants was markedly influenced by the chemical used as a pre-planting treatment. The effect of post-planting treatments generally did not produce as marked an effect. Total plant survival in the Methyl Bromide treated plots, 293 out of 300 plants, was greater than the check, 274 of 300 plants. Casualties were greatest in the DMTT plots where only 96 of 300 plants lived. SMDC also had losses greater than the check as 243 of 300 plants survived. In the DMTT plots, more Euonymus and Taxus survived when mulched than not mulched. More even soil moisture conditions under the mulches probably enabled these plants to survive with damaged root systems until an adequate system was regenerated.

Ten days did not prove to be sufficient time for the DMTT to dissipate, as evidenced by the plant loss. Survival results with SMDC possibly also would have been better had a longer time elapsed between treating the soil and setting out the plants.

The vigor of growth parallelled the number of plants which survived. Thus, generally better growth occurred in the Methyl Bromide and check plots than in the DMTT and SMDC plots. Again, this was probably due to the damage to the root system at the time of setting by the herbicidal residue.

Growth of plants on plots treated with EPTC at a rate of 10 pounds per acre was equivalent to the check. The 20 pound rate caused inhibition of growth but did not cause any casualties.

Weed control effectiveness is given in Tables 2, 3, and 4. Readings were taken at approximately monthly intervals, July 10, August 8, and September 15, after treating on June 6. The check plots were weeded on July 11, and all plots except EPTC were weeded on August 11.

During the first month little weed growth took place except on the check plots. Sugar cane mulch proved to be the most effective secondary treatment on these plots followed by CIPC and bark mulch.

By the second month the check areas of all plots except those treated with EPTC needed hand weeding. The EPTC plots were completely clean at this time. Sugar cane mulch continued to be the most effective post-planting treatment. On a rating scale of area covered by weeds CIPC looks superior to the bark mulch. Actually, fewer large weeds covered the surface in the bark mulch while many smaller weeds grow in the CIPC areas. It is easier to eliminate a few large weeds than it is many small ones.

The third reading was taken on September 15, approximately one month after all plots except EPTC had been weeded. At this time, the EPTC plots were still weed free. The small amount of weed growth that occurred on the mulched plots following weeding is the most notable feature of the results of this date. Any residual effect of CIPC appears to have disappeared by this time.

During October some henbit and chickweed began to develop on the EPTC treated plots; however, the growth still was not as heavy as on plots treated with other materials.

CONCLUSIONS

EPTC appears to be a very promising pre-planting herbicidal material when applied to dry soil. A pilot study set up August 5 indicated that this chemical in liquid and granular form was less effective on moist soil.

Methyl Bromide continues to be somewhat superior in herbicidal effectiveness to DMTT and SMDC. Better growth also resulted where it was used, possibly due to its shorter residual life in the soil.

Sugar cane mulch proved to be the most effective of the post-planting treatments.

REFERENCES

1. Ticknor, R. L., and E. C. Gasiorkiewicz (1958). Pre-planting Treatments for Weed Control in Nursery and Herbaceous Ornamentals. Proc. NEWCC 12:114-8.

Acknowledgment is made to the Stauffer Chemical Company for financial aid and chemicals; to Dow Chemical Company and Union Carbide and Carbon Corporation for chemicals; to Brown Paper Company for bark,

TABLE 1

Average Plant Survival in Pre-Planting Treatments. Treatments Applied June 6, 1958.
Plants Set Out June 16, 1958. Record Taken September 15, 1958.

	CHECK					BARK					CANE					CIPC					Total Number of Plants
	E	R	TA	TH	V	E	R	TA	TH	V	E	R	TA	TH	V	E	R	TA	TH	V	
Methyl Bromide	5	4.6	5	5	4.6	5	4.6	4.6	5	5	5	4.3	5	4.3	5	5	5	5	5	5	293
DMTT	2.3	0.3	1	0.3	0	3.6	0.3	3.3	2.3	0	4	0.3	3.3	2.0	1	3.6	0	1.3	2.3	0.3	96
SMDC	4	3.6	4.6	4	3	4.3	4.3	4.6	4	2	4	3.3	4.6	3.6	3.6	4.6	4	5	4.6	4.6	243
CHECK	5	4.3	4.6	4.6	4	4.3	4.6	5	4.6	4.3	5	4.3	4.6	4.3	4.6	4.6	3.3	5	5	4.6	274
Total Number of Plants			211					229					230					235			

E - *Euonymus patens*

R - *Rhododendron yedoense poukhanense*

TA - *Taxus media browni*

TH - *Thuja occidentalis*

V - *Viburnum juddi*

Table 2. Results of Pre-Planting Treatments.
Treatments Applied June 6. Results July 10.

		Check	Bark	Cane	CIPC
Methyl Bromide	Rep 1	2	0	0	0
	Rep 2	0	0	0	0
	Rep 3	0	0	0	0
DMTT	Rep 1	0	0	0	0
	Rep 2	1	0	0	0
	Rep 3	0	0	0	0
SMDC	Rep 1	2	0	0	0
	Rep 2	0	0	0	0
	Rep 3	0	0	0	0
EPTC	10 lbs. clay	0	0	0	0
	10 lbs. verm.	0	0	0	0
	20 lbs. verm.	0	0	0	0
Check	Rep 1	8	4	1	3
	Rep 2	6	4	1	3
	Rep 3	10	5	2	3

Checks weeded July 11.

The ratings are based on a scale of:

0 - less than 4 weeds per square foot
1 - 10 percent of the soil surface covered by weeds
2 - 20 " " " " " " " "
3 - 30 " " " " " " " "
4 - 40 " " " " " " " "
5 - 50 " " " " " " " "
6 - 60 " " " " " " " "
7 - 70 " " " " " " " "
8 - 80 " " " " " " " "
9 - 90 " " " " " " " "
10 - 100 " " " " " " " "

Table 3. Results of Pre-Planting Treatments.
Treatments Applied June 6, Results August 8.

		Check	Bark	Cane	CIPC
Methyl Bromide	Rep 1	9	8	0	3
	Rep 2	5	1	0	0
	Rep 3	8	4	3	0
DMTT	Rep 1	8	9	0	7
	Rep 2	10	4	4	2
	Rep 3	3	4	3	0
SMDC	Rep 1	10	4	3	2
	Rep 2	6	7	4	4
	Rep 3	9	2	3	3
EPTC	10 lbs. clay	0	0	0	0
	10 lbs. verm.	0	0	0	0
	20 lbs. verm.	0	0	0	0
Check	Rep 1	10	4	3	4
	Rep 2	7	3	5	6
	Rep 3	7	4	6	6

Plots weeded on August 11.

The ratings are based on a scale of:

0 - less than 4 weeds per square foot
1 - 10 percent of the soil surface covered by weeds
2 - 20 " " " " " " " "
3 - 30 " " " " " " " "
4 - 40 " " " " " " " "
5 - 50 " " " " " " " "
6 - 60 " " " " " " " "
7 - 70 " " " " " " " "
8 - 80 " " " " " " " "
9 - 90 " " " " " " " "
10 - 100 " " " " " " " "

Table 4. Results of Pre-Planting Treatments
Treatments Applied June 6, Results September 15,1958.

		Check	Bark	Cane	CIPC
Methyl Bromide	Rep 1	3	2	0	4
	Rep 2	3	0	0	3
	Rep 3	0	1	0	0
DMTT	Rep 1	5	2	1	9
	Rep 2	7	2	1	7
	Rep 3	10	4	2	10
SMDC	Rep 1	8	2	0	8
	Rep 2	6	2	0	7
	Rep 3	8	0	1	6
EPTC	10 lbs. clay	0	0	0	0
	10 lbs. verm.	0	0	0	0
	20 lbs. verm.	0	0	0	0
Check	Rep 1	10	2	2	10
	Rep 2	5	1	1	6
	Rep 3	10	3	3	10

The ratings are based on a scale of:

0 - less than 4 weeds per square foot
1 - 10 percent of the soil surface covered by weeds
2 - 20 " " " " " " " "
3 - 30 " " " " " " " "
4 - 40 " " " " " " " "
5 - 50 " " " " " " " "
6 - 60 " " " " " " " "
7 - 70 " " " " " " " "
8 - 80 " " " " " " " "
9 - 90 " " " " " " " "
10 - 100 " " " " " " " "

CHEMICAL WEED CONTROL IN EVERGREEN NURSERIES

John F. Ahrens

The Connecticut Agricultural Experiment Station, New Haven, Conn.

Increasing labor costs make it imperative for commercial nurserymen to adopt newer methods of controlling weeds. Elimination of hand hoeing is desirable from the standpoint of plant injury as well as the labor cost consideration.

Two preliminary experiments were conducted in 1958 to evaluate the effects of several herbicides in certain evergreen shrubs. In one trial the herbicides were applied to 3-yr. old Taxus liners which had been field grown for 1 year. In another, the herbicides were applied to 2-yr. liners of Taxus, Tsuga and Pieris one week after transplanting to the field.

Liquid formulations were applied overhead in 84 gal. of solution per acre with a knapsack sprayer. Granulars were applied with a 24" Lawn Beauty fertilizer spreader. Treatments were replicated 3 times with 4 control plots per replication.

The first experiment was conducted on Hartford sandy loam soil using Hicks, Hatfield and compacta yews as the test plants. Plots were 15' (6 plants) long and 54" (4 plants) wide. The area between the 2 center rows was evaluated. Applications of treatments shown in Table I were made on April 19 and again on June 4 after clean cultivation and hoeing each time. About ½" water was applied with irrigation immediately following application. Dominant weeds during early spring were chickweed and pineapple weed and during the summer were crab-grass, annual bluegrass, smartweed, lambs quarters, amaranthus species, pineapple weed, chickweed and wild carrot. Evaluations of plant injury showed the following:

1. DNBP liquid at 12 lb./A applied to dormant yews in April resulted in some leaf burn. Growth in September was normal even after an additional treatment was made with a granular formulation of DNBP.

2. Neburon at 8 lb./A caused some leaf injury and stunting in Hatfield yews after 2 applications.

3. Two applications of Natrin at 6 lb./A caused definite stunting in all yews.

4. Alanap-3 liquid caused stunting in Hatfield and compacta yews while Alanap 20-Gr. did not.

5. Two 4 lb. applications of Simazin caused slight stunting in Hicks yews.

6. No stunting or other injury was observed with CIPC, Sesone, CIPC plus

Sesone, CDAA and CDEC at the rates shown in Table I.

The second experiment was conducted on Merrimac sandy loam. Plots consisted of 3 plants each of Pieris japonica, Tsuga canadensis, Taxus capitata and Taxus cuspidata. The 2-yr. old plants were lined out at 18" on May 8 and the treatments shown in Table II were applied on May 15. Dominant weeds were lambs quarters, pigweed, oxalis, crab-grass, purslane and carpet-weed.

Injury evaluation on June 24 showed:

1. No injury was obtained in the T. cuspidata or Pieris with any chemical treatment.

2. T. capitata was injured by all chemicals except CDEC, CDAA and Alanap. Inconsistent response of injury to rates of Simazin and Neburon indicate possible interaction of transplanting injury with herbicide rate.

3. Hemlock (Tsuga) seedlings were injured by CIPC, Sesone, CIPC plus Sesone, EPTC, Simazin, and CDAA at the rates applied.

Weed control obtained with the herbicide treatments used in the two experiments can be summarized as follows:

1. In early spring DNBP, Simazin, Neburon, Alanap and CIPC plus Sesone gave fairly good control of chickweed and pineapple.

2. When applied again on June 4, good to excellent control of broadleafed weeds and grasses was obtained with all chemicals except Sesone, Alanap and CDAA. When applied on May 15 in a similar soil, however, single treatments of Sesone, 6 lb./A and Alanap, 4 lb./A, gavegood weed control for 4-5 weeks.

3. EPTC, CDAA and CDEC were more effective after June application than after April or May application, but this may have been due in part to residual activity from the April treatment. Rainfall in the 2-week period following the May treatment was 1.6" compared to about 1.2" following June treatment, including the 0.5" of irrigation water applied.

4. Simazin, neburon and natrin gave longest residual weed control.

5. The 10% granular CIPC was more effective than the 5% formulation.

6. CIPC, 4 lb./A, plus Sesone, 4 lb./A was more effective than CIPC, 8 lb./A or Sesone, 6 lb./A.

TABLE I. PRE-EMERGENCE WEED CONTROL IN ESTABLISHED TAXUS LINERS
TREATED APRIL 19 AND JUNE 4 (a)

Treatment	active rate lb./A	May 28	July 7 Bdlf	July 7 Grass	July 24	July 30	Comparative growth (b) Sept. 5
Control		1.4	1.3	1.1	1.1	1.0	normal
5%Gr.CIPC	8	4.7	6.7	7.0	3.0	-	"
	12	7.0	8.8	8.7	6.0	-	"
10%Gr.CIPC	8	6.3	8.5	8.2	5.0	-	"
5%Gr.CIPC ≠ liq.Sesone	4 4	8.3	8.0	7.3	4.0	-	"
Sesone	3	5.3	2.7	3.3	1.7	-	"
	4	4.7	4.0	3.0	2.0	-	"
	6	5.0	5.3	4.3	1.7	-	"
Neburon	4	8.3	9.8	9.3	9.1	8.3	"
	8	-	9.7	9.7	9.1	8.7	sl.stunting Hatfield
Alanap-3	4	6.7	2.3	1.3	1.0	-	sl.stunting Hatfield and compacta
Alanap 20-Gr.	4	8.7	1.3	1.7	1.0	-	normal
Gr.EPTC	4	6.7	9.0	10.0	8.3	7.5	sl.stunting Hicks
	8	6.0	9.5	10.0	9.3	9.0	" " "
Natrin	3	4.3	8.7	9.2	7.8	6.8	sl.stunting Hatfield
	6	7.7	9.8	10.0	9.3	8.4	stunting-all varieties
Gr.Simazin	2	7.7	9.7	8.0	6.7	-	normal
	4	8.7	10.0	9.5	9.3	8.9	sl.stunting Hicks
DNBP liq.	6	7.7	9.3	7.7	4.5	-	normal
then Gr.(c)	12	9.3	10.0	9.2	8.8	7.9	"
Gr.CDEC	8	6.0	8.3	7.7	3.7	-	"
Gr.CDAA	8	3.7	6.7	7.7	3.3	-	"

(a) 1 is no weed control, 10 is complete weed control.

(b) Taxus hatfieldi, T. hicksi and T. compacta included.

(c) liquid DNBP first treatment, 10% granular second treatment.

TABLE II. PRE-EMERGENCE WEED CONTROL IN 2-YEAR LINERS OF TAXUS, PIERIS AND TSUGA, TRANSPLANTED MAY 8 AND TREATED MAY 15.

Treatment	active rate lb./A	Weed Control (a) June 23 30 days	July 9 46 days	July 16 53 days	Injury June 24 (b) Taxus capitata	Taxus cuspidata	Tsuga	Pieris
Control		1.5	1.2	1.0	1.3	1.1	1.3	1.2
5%Gr.CIPC	4	4.2	3.0	1.3	1.6	1.0	1.8*	1.4
	8	7.4	6.0	5.3	1.8*	1.1	2.1*	1.2
	12	9.7	8.0	7.3	1.7	1.1	1.8*	1.2
10%Gr.CIPC	8	8.2	7.5	7.3	2.3*	1.2	1.3	1.2
(12% Gr.CIPC plus Sesone)	4 4	9.7	8.5	7.8	2.0*	1.3	2.0*	1.1
Sesone	3	6.5	4.7	3.0	1.3	1.1	1.7	1.3
	6	9.3	7.2	6.0	2.0*	1.4	1.8*	1.2
Neburon	2	9.0	8.0	7.5	1.8*	1.0	1.2	1.0
	4	9.9	9.7	9.5	1.3	1.0	1.4	1.3
Alanap-3	4	8.9	5.3	3.3	1.6	1.0	1.2	1.2
Alanap 20G	4	7.5	4.8	3.3	1.4	1.2	1.3	1.1
Gr.EPTC	4	5.4	3.2	1.3	1.3	1.0	1.2	1.1
	8	5.9	4.7	3.3	2.3*	1.2	1.8*	1.2
Natrin	3	8.0	7.5	7.1	1.6	1.1	1.2	1.6
	6	9.0	8.8	8.9	2.0*	1.2	1.6	1.2
Gr. Simazin	2	7.7	5.3	3.3	2.3*	1.0	1.3	1.0
	4	9.2	8.5	8.0	2.2*	1.2	1.9*	1.3
	6	9.9	9.2	8.7	1.7	1.0	1.6	1.2
Gr.CDEC	6	5.7	3.3	1.3	1.3	1.0	1.1	1.2
Gr.CDAA	6	5.2	3.7	2.3	1.2	1.1	2.2*	1.4

(a) 1 is no weed control, 10 is complete weed control.

(b) 1 is no injury, 4 is dead plant

*-Denotes injury significant from controls at 5% probability level.

TWO YEAR TESTS WITH DIURON AND CHLORO IPC ON NURSERY STOCK

Arthur Bing

Cornell Ornamentals Research Laboratory

Introduction

Several herbicides have been found to be quite useful in nursery weed control and have been reported at previous meetings of the Northeastern Weed Control Conference (1,2,3,4,5). Some herbicides are now used by commercial nurserymen. The purpose of these experiments is to test several of the older chemicals for both crop tolerance and weed control. The experiments extend over a period of several years to study possible cummulative effects of the herbicides.

Methods and Results

In the first series of tests, fifty foot rows of nursery plants were divided into four treatment areas across the rows. Treatments were Karmex DW at 1 1/2 pounds in 100 gallons of water per acre in 1957 and an equivalent amount of Diuron granular in 1958, Chloro IPC emulsifiable 8 pounds in 100 gallons per acre, twice each year, Chloro IPC 5% granular at 8 pounds actual per acre twice a year, and an untreated lot. Weed and crop growth were periodically observed. After two growing seasons the plants are removed as in regular nursery practice. The treated areas are replanted the following spring a nd the treatments continued.

Plants tested for two years and showing no injury from Chloro IPC were Rhododendrom carolinianum, Rhododendron catawbiense, Taxus cuspidata capitata, Leucothoe catesbaei, and Azalea kaempferi. Plants tested for one year showing no injury were Ilex crenata convexa, Enkianthus campanulatus, Buxus semperviens, and Rhododendron catawbiense. Azalea Hindogeri grown in Chloro IPC treated soil were much smaller than the controls. Galinsoga parviflora which was not controlled by Chloro IPC has become more of a problem each year in the Chloro IPC plots. Erigeron also was not controlled. There was good control of most other weeds especially purslane, chickweed, and seedling grasses. Untreated plots were overrun with Galinsoga, purslane, henbit, chickweed, and Erigiron unless frequently cultivated.

The Karmex plots were weed free the first season except for an occasional plant of Barnyard grass. In the second season the Karmex plots were essentially weed free. The following crops were uninjured after two seasons: Rhododendron carolinianum, Rhododendron catawbiense, Azalea kaempferi, Azalea Hinodegiri, and Leucothoe catesbaei. Taxus capitata showed injury on some plants. After one season, Ilex crenata convexa showed some yellow leaves but Enkianthus, Buxus, sempervirens, and Rhododendron catawbiense showed no injury and grew normally.

In the second series two rows of established Taxus cuspidata were treated one row with Chloro IPC at 12 pounds per acre and the other at 16 pounds per acre. Treatments were made twice a year for three years using liquid applications the first year and granular the second and third years. There was no crop injury but Galinsoga became a real problem.

Every other Taxus was removed in the late spring of 1957 and planted in two new rows. One row was treated on May 27 with 2 pounds of Karmex DW per acre the other at 4 pounds per acre. Applications were repeated on June 3, 1958. There was severe injury at the 4 pound rate the first season but there was only slight injury on some plants the second season. Injury from the 2 pound rate was only slight the first year, none the second season. The injury was a severe chlorosis and about 5% of the plants were killed from the 4 pound per acre application.

Discussion and Summary

Karmex diuron granular shows great promise as a herbicide for nursery stock but may be harmful to Ilex crenata convexa and newly planted yews. Chloro IPC injured Azalea Hinodegiri but none of the other plants tested. Galinsoga becomes quite a problem in Chloro IPC plots. The colored slides show the effectiveness of Chloro IPC in a commercial nursery.

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Evaluation of Simazin in the Control of Seedling and Established Perennial Weeds in Nursery and Ornamental Plantings

A. M. S. Pridham, Cornell University

Field tests with Simazin in 1956 and 1957 demonstrated consistent and prolonged residual control of seedling weeds following application of spray or granular formulations of Simazin.

A test was run under the controlled environment of a greenhouse. Simazin granular formulation on attaclay was used to control the germination of redtop, Agrostis alba. Watering was done through time clock controlled misting system equipped with Florida nozzles. Under the favorable conditions maintained for germination, 1 pound of active Simazin per acre prevented emergence and growth of redtop seedlings. A second test was run in August 1958 with similar results. In both tests CIPC prevented germination at $\frac{1}{2}$ to $\frac{1}{4}$ pound per acre active. Diuron and Fenuron were also effective at $\frac{1}{2}$ pound active per acre levels, Neburon at 4 lbs. active per acre.

Field tests were made during 1957 and 1958 at selected intervals when the following situations prevailed.

1. Environment favorable for weed germination: - this often follows cultivation, either to prepare soil for planting or to remove existing weed growth by rototilling and/or hoeing. It is preferable that crop plants be dormant or have mainly mature tissue in stems and foliage.

2. Weed seedlings small growing rapidly, with little or no mature tissue in stem leaf or bud. Crop plants preferably dormant or have mature tissue in stems and foliage.

3. Perennial weed, Agropyron repens, in first flush of regrowth in spring or following later cutting or cultivation. Crop plants should not be in their main growth period, May 1 to June 15.

4. Weeds of all types at summer maturity, e.g. late July and early August. Crop plants also at summer maturity. Sprays used directionally for "in row" treatment.

Control as used in this report means that on a rating basis by 2 or more observers, a plot remained free of all weed growth for a period of at least 3 months after initial action following treatment. When 20 or more individual small weeds (to 6") survive in a plot of 100 square feet, then control has not been reached or has been lost. Untreated or check plots typically contained more than five individual weeds per square foot and average from 500 to 2,000 grams of green weight of weeds in 3 months.

Weed populations in plots treated with Simazin (Major)

Fall	Spring
Chickweed, Stellaria media	Lambs quarters, Chenopodium album
Annual bluegrass, Poa annua	Pigweed, Amaranthus retroflexus
Groundsel, Senecio vulgaris	Purslane, Portulaca oleracea

Others frequent but not predominant
Yellow rocket, Barbarea vulgaris
Quackgrass, Agropyron repens
Dandelion, Taraxicum officinale
Plantain, Plantago major

Herbicides Used in Addition to Simazin

Herbicide	Form	Rate of active ingredient per acre
Amino triazole	granular	5
Atrazine	spray	4 - 6 - 8
CIPC	granular	4 - 8 - 12
"	spray	4 - 8 - 12
CIPC-SES	granular	4 - 8 - 12
Diuron	"	2 - 4
DN	"	4
Endothal	"	2 - 4
Garlon	spray	4 - 6 - 8
Neburon	granular	4 - 6 - 8
"	spray	4 - 6 - 8
Propazine	"	4 - 6 - 8
Simazin	granular	1 - 2 - 4 - 6 - 8 - 10 - 12
	spray	6 - 8 - 10 - 12
Trietazine	"	4 - 6 - 8
Zytron	"	4 - 6 - 8

Situation 1. Weed seed germination in clean soil

Treat-ment dates	Ornamental plant	Soil type	Control by Herbi-cide	Control by Formu-lation	Rate lbs. ae/A	# plots control	# plots treated
7/57-11/58	ground covers: Euonymus fortunei Hedera helix (inj.) Iberis sempervirens Juniperus horizontalis Pachysandra terminalis (yellowed-discolored) Vinca minor	silty clay loam	Simazin	granule	12	4	4
9/57-11/58	ground covers: as above	silty	Simazin	granule	12	4	4
	1 series hoed clean	clay l.	Diuron	"	4	1	2
7/57-11/58	Rose Better Times	loam	Simazin	"	12	7	7
"	" " "	"	"	"	10	1	1
8/58-11/58	Rose Fashionette " Arlene Francis	gravelly loam	Simazin	spray	8	2	2
7/57-11/58	Taxus cuspidata " media hicksi	sandy loam	Simazin	granule	8	1*	1
8/58-11/58	Taxus cuspidata	"	Simazine	"	4	1	2
	" media hicksi		Neburon	spray	8	1	1

* 12' x 100'

Situation 2. Small weed seedlings to 3-6 inches in height

Treatment dates	Ornamental plant	Soil type	Control by Herbicide	Control by Formulation	Rate lbs. ae/A	# plots control	# plots treated
9/57-11/58	ground covers & liners: Euonymus fortunei	silty clay loam	Simazin	spray	4	1	1
	Hedera helix		Diuron	granular	4	1	1
	Iberis sempervirens						
	Juniperus horizontalis						
	Pachysandra terminalis						
	Vinca minor						
	Buxus sempervirens (inj.)						
	Taxus cuspidata						
	Thuja occidentalis (inj.)						
9/57-7/58	Taxus cuspidata (Senecio vulgaris major weed)	silty loam	Simazin	granular	4	3	3
			Diuron	"	4	4	2
9/58-11/58	Taxus cuspidata	"	Simazin	spray	4-8	1	1
			"	granular	8	6	2
			"	"	8	2	2
			Neburon	spray	8	1	1

Situation 3. Regrowth of Agropyron repens

Treatment dates	Ornamental plant	Soil type	Herbicide	Formulation	Rate lbs. ae/A	# plots control	# plots treated
Fall 1956-6/57	None	silty clay loam	Simazin	spray	8	1	1
					12	1	1
9/57-11/58	Thuja occidentalis Liners	"	Simazin	"	5	1	1
					10	1	1
4/58-11/58	Rose climbers	gravelly loam	"	"	12	1*	1

* 3' x 100'

Situation 4. Mature Agropyron repens and others

Treatment dates	Ornamental plant	Soil type	Herbicide	Formulation	Rate lbs. ae/A	# plots control	# plots treated
8/6/58 11/20/58	Rose species	silty loam	Simazin 30027	spray	8	1	1
			Atrazine	"	8	1	1
8/6-11/20/58	Rose Better Times	"	Simazin 30027	"	8	1	1
			Atrazine	"	8	1	1
			Propazine	"	8	1	1
8/6-11/20/58	Juniperus horizontalis " virginiana	silty clay loam	Simazin 30027	"	8	1	2
			Atrazine	"	8	1	2
8/6-11/58	Peony hybrids	gravelly loam	Simazin	"	8	1	1

Summation

Situation 1, germination weeds. Twenty-two plots of Simazin were in this group. One hundred per cent control was present in all but 1 case -- granular Simazin at 4 pounds or more of active per acre.

Situation 2, Weed seedlings young and active. There are 12 plots in this group. Ten are classed as satisfactory control. All plots at the 8 pound level resulted in control but granular formulations were only partly effective at the 4 pound level.

Situation 3, Young growth in Agropyron repens. Five plots were in this category and all received Simazin as a spray formulation. Treatments were made in cool weather, spring or fall, at 5 to 12 pound levels of active ingredient per acre. Three successful treatments were made at 10 pounds or more active Simazin per acre.

Situation 4, Agropyron repens mature in mid-summer, 1958. Ten plots were treated in August. Spray formulation only was used. Weed tops were killed back and no seedlings have developed to date in rates of 8 pounds of active per acre. Lower rates do not appear to be effective. Tests included both 6 and 4 pound rates. Simazin relatives Atrazine and Propazine also appear effective.

The interest of the nurserymen in Simazin and its relatives lies in the ability of these compounds to control many annual weeds at germination or young growth stage in fall with adequate residual effect to reduce populations of spring and summer weeds. Control of quackgrass among woody plants such as narrowleaf evergreens, roses and other plants is also of major interest.

These results seem from these tests to be obtainable with 4 pounds of active ingredient as a granular formulation for seedling weeds and for 8 pounds or higher levels as spray for quackgrass in young regrowth stage.

Herbicides used in these tests were supplied by the following: Dow Chemical Company of Midland, Michigan, Geigy Chemicals of Ardsley, N. Y., Anchem, Ambler, Pa., Penn Salt of Philadelphia, Pa., and Niagara Chemical Division of Food Machinery and Chemical Company, Middleport, N. Y.

AFFECTS OF SOME HERBICIDES ON NURSERY STOCK

Arthur Bing

Cornell Ornamentals Research Laboratory

Introduction

The experiment reported in this paper is a continuation of the work reported in t he previous paper: "Two Years Tests with Diuron and Chloro IPC on Nursery Stock." This series was started in the spring of 1958 to study crop tolerance and weed control in areas treated with some older and some experimental herbicides at several concentrations. Seventeen rows of nursery stock were planted in late May. In thirteen rows 100 plants were set out at two foot intervals. In 4 rows, plants of smaller ultimate size were set out 200 per row alternating two varieties. The rows were three feet apart center to center. Individual treatments were made across the rows covering one plant each of 21 varieties except gladiolus which were planted 6 corms for each treatment. Materials and rates are shown in Table I. The field was raked June 3, irrigated June 5, and granular Simazin, Diuron, and Chloro IPC applied on June 6. Rain held up other treatments until June 11 when the remaining treatments were applied.

In late August the plants were rated for injury by two obwervers. In table IIa and IIb are shown the minimum rate of each herbicide that caused serious injury to the crop. A dash (-) indicates no apparent injury at that time. In cases where there was injury at a lower rate of a herbicide but not at higher rates no injury is shown in Table II. There is a very much greater tolerance of many plants to granular Karmex diuron than to the liquid applications. The Simazin granular was not harmful to the plants but also did not kill the weeds so the results probably were due to a poor formulation. Enkianthus was injured by rates as low as 2 pounds per acre of liquid Simazin or liquid Diuron. Armeria was adversely affected by most herbicides at low rates of applications. Pieris, Privet, Taxus, Forsythia, Rhododendron, and Leucothoe were rather tolerant to most herbicides except Karmex DW liquid.

On July 15, a nurseryman, a county agricultural agent, and the author rated all the plots for weed control. The field had a good native stand of nutgrass, (Cyperus esculentus), red root (Amaranthus retroflexus), lambs quarter (Chenepodium album) mustard, and ragweed (Ambrosia artemisiifolia) Table III shows the minimum rate of each herbicide that produced satisfactory control of the major weeds. The outstanding result was the control of nutgrass by Geigy 30027. At two pounds per aere there was partial control (2P) while at the 4 and 8 pound rates there was very good control. Nutgrass in the higher rate Karmex DW plots was partially controlled as evidenced by reduced growth later flowering, and considerable root injury which made it easy to pull the grass.

In late July all weeds in al l plots were pulled and the space between rows lightly rototilled. On August 19, all granular treatments were repeated. In addition three plots across the rows were treated with granular Mylone at 64, 128, and 192, pounds per acre. In November the Karmex diuron granular plots were all clean and practically all plants in good condition. Mylone granular at all rates killed all the weeds many of which were up 3-4 inches but there was crop injury at the higher rates to all crops but *Leucothoe*. Other granulars were not too effective. The plots that received only the original higher liquid applications of Karmex DW and Simazin were still weed free in November in spite of the rototilling in July.

Discussion and Summary

Karmex diuron granular shows great promise as a herbicide on nursery stock while the liquid is quite harmful. Karmex granular may not be safe on *Ilex crenata convexa*. Simazin and Karmex have a long lasting effect in the soil at sufficient rates and should require only one application during one growing season. Geigy 30027 shows promise for nut-grass control even though it is harmful to some ornamentals. This series is only intended as a quide to further studies on weed control of ornamentals. The present study is being continued.

Acknowledgments

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Table I

Herbicides Used in Nursery Tolerance Study

Material	Rates used in lbs actual/A
Simazin 8.5% granular	1, 2, 3, 4, 6, 8
Karmex Diuron granular	1, 2, 3, 4, 6, 8
Simazin 50% WP	1, 2, 3, 4, 6
Karmex DW 80% WP	1, 2, 3, 4, 6
Geigy 30026 WP	2, 4, 8
Geigy 27901 WP	2, 4, 8
Geigy 30028 WP	2, 4, 8
Geigy 30031 emulsifiable	2, 4, 8
Geigy 31435 emulsifiable	2, 4, 8
Geigy 30027 WP	2, 4, 8
Sesone 90% soluble powder	3, 6, 9
CIPC emulsifiable	6, 8, 16, 24
CIPC 5% granular	8, 16, 24, 32
CIPC 6%-Sesone 4% granular	3+2, 6+4, 9+6, 12+8
CIPC 4%-Sesone 4% granular	2+2, 4+4, 6+6, 8+8
Neburon 18.5% WP	2, 3, 6, 8, 12
EPTC 5% granular	3, 6

Table IIa

Crop Tolerance to Herbicides

Minimum rate in pounds per acre crop does not tolerate (See Table I for rates used)

	SIM Gran	Karmex Diuron Gran.	Simazin Liq.	Karmex DW	Geigy 30026	Geigy 27901	Geigy 30028	Geig 3003
Gladiolus var. Snow Princess	-	-	6	6	-	-	-	-
Enkianthus campanulatus	*	-	2	2	8	-	2	-
Tsuga canadensis	-	-	-	1	8	-	-	-
Pieris japonica	-	-	-	-	-	-	-	-
Ligustrum ovalifolium	-	-	-	-	8?	-	-	4
Ilex crenata convexa	-	-	3	1	-	8	-	8
Taxus cuspidata capitata	-	-	-	4	-	-	-	-
Taxus media Hicksii	-	-	-	3	-	-	-	-
Forsythia intermedia	-	-	-	3	-	-	4?	-
Rhododendron catawbiense	-	-	-	4	-	-	-	-
Leucothoe catesbaei	-	-	-	6	-	-	-	-
Delphinium Hybrids	-	-	1	2	4	-	2	2
Philadelphus coronarius	-	-	-	4	8	-	4	-
Azalea Hinodegiri	-	-	2	1	2	8?	2	2
Azalea Coral Bells	-	-	2	1	2	8?	4	2
Sedum spectabile	-	2	-	1	4	-	8	8
Hedera helix	-	3	-	1	8	-	-	4
Sedum sp.	-	2	-	1	-	-	8	8
Sedum sp.	-	2	2	2	2	-	4	2
Armeria laucheana	3	4	1	2	2	8	2	2
Iberis sempervirens	3	1	2	-	-	-	-	2

* No serious crop injury at any of the rates used is shown by a dash

Table IIb

Crop Tolerance to Herbicides

Minimum rate in pounds per acre crop does not tolerate (See table I for rates used)

	Geigy 31435	Geigy 30027	Sesone	CIPC Liq	CIPC Gran	CIPC 6% Sesone 4% Gran	CIPC 4%- Sesone 4% Gran	Neburon
Gladiolus var. Snow Princess	2	*-	-	24	-	-	-	-
Enkianthus campanulatus	8	-	-	-	-	-	-	-
Tsuga canadensis	-	-	-	8	-	-	-	-
Pieris japonica	8	-	-	-	-	-	-	6
Ligustrum ovalifolium	4?	4	-	-	-	-	-	-
Ilex crenata convexa	-	-	-	-	-	-	-	6
Taxus cuspidata capitata	-	-	-	-	-	-	-	-
Taxus media Hicksii	-	-	-	-	-	-	-	-
Forsythia intermedia	-	4	-	-	-	-	-	-
Rhododendron catawbiense	-	-	-	-	-	150	-	-
Leucothoe catesbaei	-	-	-	-	-	-	-	-
Delphinium Hybrids	?	4	-	6	-	-	50	-
Philadelphus coronarius	-	-	-	-	-	-	-	-
Azalea Hinodegiri	4	4	-	16	-	-	?	-
Azalea Coral Bells	4	4	-	16	-	-	?	-
Sedum spectabile	-	4	-	-	-	-	-	2
Hedera helix	-	4	9	-	-	-	-	-
Sedum sp.	4	-	9	16	-	-	-	2
Sedum sp.	4	?	9	16	-	-	-	8
Armeria laucheana	-	-	-	-	-	-	-	6
Iberis sempervirens	4	-	-	-	-	-	-	2

* No serious crop injury at any of the rates used is shown by a dash.

Table III

Herbicidal Action on Weeds

Minimum rate in pounds actual that produced satisfactory weed control in troublesome weeds.

Material	Nut Grass	Red Root	Lambs Quarter	Rag Weed	Crab Grass	Mustard
Simazin 8.5% gran	*NC	NC	NC	NC	NC	NC
Karmex diuron 2% gran	NC	1.	2	1	1	1
Simazin 50% WP	8P	1	1	1	2	1
Karmex DW 80% WP	4P	1	1	1	2	1
Geigy 30026 WP	8	2	2	2	8	2
Geigy 27901 WP	N C	2	2	2	8	2
Geigy 30028 WP	***	2	2	2	NC	2
Geigy 30031 emul. liq.	NC	2	2	2	8	2
G eigy 31435 emul. liq.	8P	-	-	-	-	-
Geigy 30027 WP	2P	2	2	2	4	2
Sesone 90% soluble powder	NC	9	9	9	9P	6
CIPC emul. liq.	NC	16	6	16P	16	8
CIPC Gran	NC	8	8	NC	24	8
CIPC 6%-Sesone 4% Gran	NC	12+ 8	12 + 8	NC	12+8	3+ 2
CIPC 4%-Sesone 4% Gran	NC	4+4	4+4	6+6	6 + 6	4+ 4
Neburon 18.5% Gran	NC	2	2	2	8	2
EPTC 5% gran	3	NC	NC	3	3	-

* No control at rates used. For rates see table I.
** 8P particle control at 8 pounds.
*** Insufficient weed population or other reason for not rating.

CHEMICAL WEED CONTROL IN MAPLE SHADE NURSERIES

John F. Ahrens

The Connecticut Agricultural Experiment Station
New Haven, Connecticut

The successful control of weeds in orchards has indicated that hand labor may be virtually eliminated in deciduous nurseries as well. This report is of a preliminary experiment in which several herbicide treatments were evaluated for their effects on weed control and tree growth.

The trees used were Crimson King maples ranging from 1/2 to 3/4" in diameter (at 3' from soil) and grown in a Hartford sandy loam soil. Plots consisted of 6 trees and were 18' long. Treatments were replicated three times and two controls were included per replication.

The post-emergence treatments were first applied on May 19 to existing stands of broadleafed weeds and grasses which included chickweed, pineapple weed, downy brome-grass, curled dock, and annual bluegrass. Sprays were directed in an 18" band over the row with a knapsack sprayer. The lower branches of the trees were pruned so that no foliage was hit. Two rates of amino triazole and two DNBP plus Dalapon combinations were applied as contact sprays in 84 gal. per treated acre.

Table I indicates the percentage weed kill observed 2 weeks after treatment (June 3). A second treatment was applied at that time. Excellent kill of all grasses and broadleafed weeds was obtained with the two applications of either 2.5 or 5 lb./A of amino triazole. Annual bluegrass persisted, although stunted, in the DNBP plus Dalapon plots. Tree growth, as measured by average increase in diameter, was not affected by the treatments and no foliage injury was observed.

The pre-emergence treatments were applied in 18-20" bands over the row on May 19 after hoeing. A rainstorm occurred shortly after application, and 1.8" of rain fell in the following 2 weeks.

Weed growth following initial hoeing was slow even in control plots. Best residual weed control was obtained with diuron at 3 or 6 lb./A or Simazin at 4 lb./A, as shown in Table II.

Summary

grass weeds was obtained with 2.5 or 5 lb./A of amino triazole. Annual bluegrass appeared somewhat resistant to DNBP plus Dalapon.

2. No growth inhibition or foliage injury of trees was obtained with any of the herbicides tested.

3. Diuron and simazin were very effective for long time weed control following hoeing.

4. Great possibilities exist for the use of combinations of amino triazole or dalapon with residual herbicides to eliminate hoeing.

Table I. Effects of Contact Treatments on Weed Control and Growth in Crimson King Maples
Chemicals applied May 19 and June 3 in 18-20" band

Treatment	active rate lbs./A (a)	Weed Control Percentage Kill June 3 Grass	June 3 Bdlf	June 23 Grass	June 23 Bdlf	Tree Growth diameter increase (mm)
weedy control		0	0	0	0	8.1
Amino triazole	2.5	70-80	80-90	95-100	95-100	7.7
	5.0	75-85	85-95	95-100	95-100	8.9
DNBP plus Dalapon	3.0plus 4.0	40-50	60-70	70-80	95-100	6.8
	3.0plus 8.0	45-55	70-80	80-85	95-100	8.1

(a) On treated band.

Table II. Effects of Pre-emergence Herbicides on Weed Control and Growth in Crimson King Maples
Chemicals applied May 19 in 18-20" band after clean cultivation and hoeing

Treatment (a)	Active (b) rate lbs./A	Weed control July 21	Weed control Sept.22	Tree Growth diameter increase (mm)
Control		1.8	1.5	6.5
Diuron	3	9.2	8.7	7.6
	6	9.5	9.7	8.0
Gr.Simazin	4	7.4	7.0	6.5
Sesone	4	4.7	1.0	5.5
Gr.CIPC	8	6.0	1.0	5.0
Sesone	4 plus 4	6.3	1.0	8.1
plus Gr.CIPC	4 plus 8	6.0	3.0	8.1

(a) Treatments not mentioned as granular (Gr.) were applied as sprays.

(b) On treated band.

(c) 1 is no weed control, 10 is complete control.

A DISCUSSION OF THE MODE OF ACTION, TOLERANCE AND SOIL TYPE EFFECTS OF THE TRIAZINES

By
Edwin O. Schneider (1

Simazine (2-chloro-4,6-bis-(ethylamino)-s-triazine) was synthesized by Gysin and Knusli in the laboratories of J. R. Geigy, Basle, Switzerland. Simazine was released for herbicidal evaluation to experiment station and other workers in this country in 1956. Outstanding results, particularly in controlling weeds in corn with pre-emergence applications, led to an expansion of research activities in the control of weeds in corn as well as in many other agronomic and horticultural crops. Other triazine herbicides closely related to Simazine were introduced in the following years for evaluation on agronomic and horticultural crops. The general herbicidal activity of Simazine, when applied at rates substantially higher than for selective control of weeds in crops, led to its commercial sale for this purpose in 1957. Label acceptance for the use of Simazine for weed control in corn was granted by the United States Department of Agriculture on April 19, 1958. Claims for weed control in ornamentals were subsequently accepted.

This paper will discuss phases of the mode of action, crop tolerance and soil type effects of the triazines.

THE TRIAZINES

A group of triazine compounds related to Simazine have been released to numerous research workers and other workers in this country for study of the herbicidal properties. These chemicals have been evaluated on many crops and aquatic weeds. Table I presents the chemical structure of the compound along with the names and the solubility in water.

STRUCTURE AND WATER SOLUBILITY OF SIMAZINE AND THE RELATED COMPOUNDS

Common name or number	Proposed trade name	X	Y	Solubility in water 20-22°C
Simazine	Simazine	NHC_2H_5	NHC_2H_5	5.0
G-30027	Atrazine	NHC_2H_5	$NHiC_3H_7$	70.0
G-30028	Propazine	$NHiC_3H_7$	$NHiC_3H_7$	8.6
G-27901	Trietazine	NHC_2H_5	$N(C_2H_5)_2$	20.0
G-30031		$NHiC_3H_7$	$N(C_2H_5)_2$	40.0

(1- Geigy Agricultural Chemicals, Division of Geigy Chemical Corporation

TOXICOLOGICAL PROPERTIES

The acute oral toxicities of the triazine compounds in Table I have been determined on both rats and mice. The LD_{50} for Simazine against both test animals is in excess of 5,000 mg/Kg. The other compounds are in the same range of toxicity although the LD_{50} are somewhat lower than for Simazine.

TOLERANCE OF CROPS

Tests have demonstrated that corn will tolerate rates of Simazine much in excess of those necessary for the control of annual broadleaf weeds and grasses. Applications either before the corn appears or application to the emerged plant has resulted in no injury to young corn plants. Roth (1) working on the metabolism of Simazine in corn found that the enzyme peroxydase probably catalyzes the hydrolysis of Simazine within the plant shortly after absorption from the soil. Plants mentioned below in Table II and many woody species of plants have demonstrated tolerance to Simazine. Probably these plants are able to decompose Simazine in the same manner as corn.

Apparently susceptible plants cannot decompose the absorbed chemical or do so at a rate so slow that death of the plant occurs before decomposition of the chemical occurs. Tests have demonstrated that corn, wheat and *Coleus blumei* take up Simazine in about equal amounts but the latter two will die when approximately 5 PPM on a green weight basis has been absorbed from nutrient solutions. Studies using radio active C^{14} Simazine have confirmed that the uptake in susceptible and resistant plants is very rapid and in about the same amount.

Recent experiments indicate Atrazine is decomposed in corn plants in the same manner as Simazine. Corn can tolerate all of the chloro-triazines listed in Table I.

Table II lists the crops that demonstrate tolerance to the chloro-triazines. These crops in general do not show as high a tolerance to the chloro-triazines as does corn to Simazine. All of these compounds have sufficient herbicidal activity to be of interest.

TABLE II

Triazine	Crops showing tolerance
Simazine	Corn, grapes, asparagus, strawberries, pineapple, sugar cane, brambles
G-30027	Corn
G-30028	Celery, carrots, sorghum
G-27901	Potatoes, peas, tobacco, some varieties of strawberries, lima beans
G-30031	carrots, cotton

PLANT SYMPTOMS

The typical symptoms of Simazine toxicity is the chlorosis which starts at the leaf tip and progresses along the margins to the base of the leaf. Necrosis of the tissue occurs in the chlorotic area. Chlorosis spreads rapidly to the entire leaf surface followed by death of the leaf and eventually the entire plant.

Older plants must be treated with rates large enough to penetrate to the root zone for kill. Chlorosis appears on the older leaves and progresses upwards to the growing point. Eventual death of the entire plant will result if enough moisture is present to leach the chemical into the soil to root depth.

Atrazine and the other triazines exhibit a similar chlorotic pattern described for Simazine. The symptoms expressed by Atrazine appear faster than for Simazine probably due to the higher solubility of the chemical.

MODE OF ACTION

Simazine is taken up by the roots of plants and translocated upwards to the leaves. Seeds normally germinate and penetrate the surface of the soil before being killed. The roots of germinating seeds and seedling weeds in the treated soil zone take up the Simazine that has been carried into the root zone by moisture. The chemical has been found to inhibit the Hill reaction, the ability of the chloroplasts to break down water to hydrogen and oxygen in the presence of light and iron. Simazine apparently is not able to penetrate the unbroken cuticle of the leaf but must enter through the root.

The mode of action of the other triazines mentioned in Table I demonstrates root absorption from the soil with a very closely related chlorosis pattern to Simazine. Several of the triazines can be absorbed from the foliage by contact action.

The most outstanding one is Atrazine which is equal to Simazine as a pre-emerge chemical in corn yet demonstrates excellent contact kill of small seedling emerged weeds. Several of the other triazines are leaf absorbed to varying degrees but do not exhibit the speed and thoroughness of kill as does Atrazine.

Atrazine has demonstrated complete kill of the common annual broadleaf weeds and grasses in corn when applications at 2 and 4 lbs. actual were made to corn 4 inches tall with weeds ½ to 1 inch in height. In another test, corn 12 inches tall was treated at 1½ and 2 lbs. actual with weeds and grasses from 2 to 6 inches in height. The smaller weeds were controlled at both rates, however, velvet leaf (Abutilon theophrasti) was not controlled when 3 inches high or taller. Grasses under 2 inches were controlled while the taller foxtail (Setaria spp.) and barn yard (Echinochloa crusgalli) escaped with only stunting. No injury was noted on any of the corn.

FACTORS EFFECTING THE HERBICIDAL ACTION OF THE TRIAZINES

Pre-emerge applications of Simazine and the other triazines are effective through the roots, therefore moisture must be present in sufficient amount in one or more rains to carry the herbicide to the root zone of the weeds. To obtain the best results moisture should be present in the soil before and at the time of application as well as following the treatment. Rain or overhead irrigation must occur to remove the chemical from the dry surface soil and leach it down into the root zone. Usually ½ inch of rain is required in one shower to move the Simazine downward, although the rapidity of evaporation at the surface and the amount of soil moisture at the time of the rain may affect the requirement. Atrazine being more soluble than Simazine in the soil, may require less moisture for movement into the root zone. Moisture for these chemicals which are leaf absorbed is not critical.

Studies underway on the effect of soil temperature and fixation by the clay and organic matter of the soil are not conclusive at the present time. Observations on the growth of plants indicate a rapidly growing plant under ideal conditions is killed more rapidly than one growing under low temperature or drought stressed. Apparently the plant is able to absorb more chemical as the root system will spread rapidly in the treated zone and accumulate the Simazine at a much faster rate.

Soils having a high organic matter or high clay content require rates of the chemical in excess of the requirement for sandy soils. In sand the low affinity of the sand for the chemical allows movement of Simazine into the root zone more easily. In heavier soils, the clay adsorption makes a higher rate necessary in order for an ample amount to penetrate to the germinating zone.

RESIDUAL ACTIVITY

Simazine is a very stable chemical, practically insoluble in water and apparently not affected by soil organism. The herbicidal activity in the soil is generally reduced by adsorption on soil colloids, slow leaching, and cultural practices. Pre-emergence application at the normal recommended rate of 2 to 4 lbs. per acre generally affords the control of many annual weeds for the entire growing season. Crops planted in the soil the following spring after normal plowing and cultivation are not generally affected. Most of the other triazine herbicides under test have somewhat less residual action.

SUMMARY

Corn shows a definite tolerance to all of the chloro-triazines while other horticultural and agronomic crops show varying degrees of tolerance. All of the triazines are taken up by the roots of plants while several can be absorbed by the foliage. Chlorosis starts at the leaf tip and margins and progresses rapidly to cover the entire leaf. Necrosis follows in the chlorotic areas and kills the leaf and subsequently the plant. The triazines apparently inhibit the Hill reaction in the area of the leaf where chlorosis occurs.

For best results, the soil moisture should be optimum before and at the time of application. Rain or overhead irrigation is necessary to move the chemical into the weed germinating zone. The rate for weed control depends on the colloidal absorption of the soil, organic matter and texture of the soil. In general 2 lbs. actual Simazine is needed for sandy loams, 3 lbs. for the rich, black clay loam, and 4 lbs. for muck.

(1) Roth, W. J. R. Geigy, S.A. Personnel Communication

SOIL INCORPORATION OF SELECTIVE HERBICIDES

By:
Antognini, J., D. F. Dye, G. F. Probandt & R. Curtis*

The use of selective herbicides applied prior to weed emergence, in the past, has been limited primarily to soil surface sprays. Recent experimental and commercial results have shown EPTC (Eptam[TM]) and certain other selective herbicides to have increased activity and certain other chemicals to have decreased activity when incorporated into the soil.

Research workers as well as growers are well aware of the variability in results obtained with soil surface applications of herbicides. This variability has led to the necessity of making recommendations on the basis of specific climatic factors and farming practices.

It has been shown by experimental and commercial applications that soil incorporation of herbicides offers the following advantages over surface applications.

Increases Activity:

It has been determined that the activity of EPTC is much greater when it is incorporated into the soil than when it is merely applied to the soil surface. This may also be the case with some of the presently known herbicides as well as with some of the herbicides of the future.

Greatly Minimizes Variability Due to Soil Moisture, Tilth, & Type:

Satisfactory weed control with surface application of herbicides is dependent on a specific combination of the above factors. The specific combination required varies according to the type of herbicide and the weeds and crops involved.

Reduces Influence of Subsequent Rainfall and Type of Irrigation:

With surface applications the degree of herbicidal activity, in many cases, is influenced by the interval to and quantity of moisture. Activity can also be influenced by the type of irrigation, i.e., sprinkler vs. furrow irrigation when surface applications are used. Soil incorporation minimizes this influence.

* Stauffer Chemical Co., Res. & Devel. Dept.

TM - Eptam is Stauffer Chemical Company's trade-mark for ethyl-di-n-propylthiolcarbamate.

With Soil Incorporation Time of Application is Not Dependent Upon Planting Schedules:

By incorporating EPTC into the soil seasonal weed control is obtained. Whether or not seeding is done immediately following application control is obtained for the growing season.

Soil Incorporation Minimizes the Need for Special Cultivation Practices:

When the entire soil area is treated with a soil incorporation technique untreated soil is not moved into the crop row during normal cultivation practices.

Seedling Weed Growth is Eliminated During Soil Incorporation Applications:

Certain selective herbicides are effective only prior to weed emergence necessitating that seedlings present at time of application be destroyed by some means other than the chemical being applied. With incorporation of the herbicide these weed seedlings are automatically eliminated.

Soil Incorporation Offers Possibilities of Combining Herbicides with Insecticides and/or Fertilizers Normally Applied Prior to Seeding:

At the present time many fertilizers and soil insecticides are applied to the soil surface and worked in prior to seeding. By combining an herbicide with these materials simplicity and economy of farming operations may be obtained.

Soil incorporation techniques which have been used successfully with EPTC in field applications and which can probably be used with other herbicides are:

Preplant Soil Incorporation:

A.) Incorporation immediately prior to seeding of tolerant crops has been accomplished by use of discs, spike tooth harrows, and rototillers.

B.) Incorporation with delayed seeding of susceptible crops. Fall applications followed by spring seeding of susceptible crops have given weed control during the crop growing season.

Pre-emergence Soil Incorporation:

This method has been used on deep seeded (2-3") tolerant crops. With this method, application is made immediately following seeding by incorporating to a depth of $1\frac{1}{2}$" by discing, spike tooth harrowing, or rotary hoeing in the direction of planting.

Post-emergence Soil Incorporation

DEVELOPMENT OF FOUR NEW HERBICIDES

A. J. Tafuro[1]

In 1958, following extensive greenhouse trials, four new chemicals were given preliminary field tests to further evaluate their effectiveness and potentialities as selective or non-selective herbicides. These materials were sent to weed workers throughout the country, and were also tested on the Amchem Research Farm, Ambler, Pa.

Two new benzoic acid derivatives -- 2,5-dichloro-3-nitrobenzoic acid (ACP M-460 or Dinoben) and 2,5-dichloro-3-aminobenzoic acid (ACP M-629 or Amoben) -- show promise for pre-emergence control of weeds in various vegetable and field crops and crabgrass in turf. Amoben is of particular interest for soybeans.

In first-year tests, a new liquid formulation of 3-amino-1,2,4-triazole (amitrol) has appeared superior to other formulations of amitrol now on the market for quackgrass control.

Formulations of 2,3,6-trichlorophenylacetic acid as the water-soluble sodium salt (Fenac-S) or as a wettable powder of the amide (Fenac-WP) have produced outstanding pre-emergence control of crabgrass in turf and look promising for controlling bindweed and quackgrass, and for soil sterilization. This material was discovered by Hooker Chemical Corporation research workers, and is being developed cooperatively by Hooker and Amchem Products, Inc.

Dinoben and Amoben

These materials were applied to a variety of vegetables and field crops as an aqueous spray and in granular form for pre-emergence and post-emergence weed control. Pre-emergence application of Dinoben at 4 and 6 pounds per acre to field and sweet corn produced good commercial weed control with no apparent permanent injury to corn. Amoben showed more selectivity on soybeans and better weed control than Dinoben.

TABLE I

Response of soybeans and weeds 6-8 weeks after pre-emergence treatment

Chemical	Rate (lb/A)	Weed Control	Crop Injury
Amoben	2	Good	None
Amoben	4	Good	None
Amoben	8	Excellent	None
Amoben	12	Excellent	None
Dinoben	2	Fair	None
Dinoben	4	Good	Slight
Dinoben	6	Good	Moderate

Weeds present - Barnyard grass (Echinochloa crusgalli), pigweed (Amaranthus retroflexus), lambsquarters (Chenopodium album), foxtail (Setaria lutescens and faberii), Johnson grass seedlings (Sorgum halespensis)

[1] Research Specialist, Agr. Chem. Div., Amchem Products, Inc., Ambler, Pa.

Table I gives observations of three field tests at rates of 2 to 6 pounds per acre and a logarithmic application of 12 pounds per acre downward. At 4 pounds per acre, good commercial weed control was observed with no injury to the soybean crop. Amoben produced no apparent injury at rates up to 12 pounds per acre, whereas Dinoben produced slight injury at 4 pounds per acre and moderate injury at 6 pounds per acre.

Dinoben was the first chemical tested in the greenhouse and was initially field tested on sandy soil in South Carolina and on muck soil in Florida. Later in the summer, it was tested in New York, Pennsylvania, Indiana and California. These initial tests with water as the carrier were applied immediately after planting. Test results indicated that with overhead irrigation weed control was good in dry areas, but in California, where furrow irrigation is practiced, Dinoben was not effective. Carrots and peas seem to be the vegetable crops most tolerant of Dinoben applied pre-emergence. Other seeded crops which showed tolerance of pre-emergence Dinoben application were butternut squash and parsnips.

TABLE II

Response of crops and weeds 6-8 weeks after pre-emergence aqueous spray treatment with Dinoben

Crop (Seeded)	Rate (lb/A)	Weed Control	Crop Injury: Upland Soil	Crop Injury: Muck
Carrot	2,4,6	Good kill	None	None
Tomato	2,4,6	Good kill	Severe @ 4 & 6 lb/A	Slight @ 4 lb/A Severe @ 6 lb/A
Lettuce	2,4,6	Good kill	Severe @ 4 & 6 lb/A	Slight @ 4 lb/A Severe @ 6 lb/A
Cabbage	2,4,6	Good kill	Severe @ 4 & 6 lb/A	-----
Cucumber	2,4,6	Good kill	Severe	Slight @ 6 & 4 lb/A
Peas	2,4,6	Good kill	None	-----
Red Beet	2,4,6	Good kill	Plant killed	-----

Weeds: Pigweed (Amaranthus retroflexus and A. spinosus), lambsquarters, foxtail (Setaria spp.), and crabgrass (Digitaria sanguinalis)

These data indicate that crops seeded and grown on muck soil were more tolerant of a pre-emergence application of Dinoben than were crops on upland soil. Although some of these crops showed severe hormone injury early, the plants seemed to outgrow the symptoms.

In mid-summer of 1958, Amoben was made and tested with Dinoben. Initial tests showed this material to have similar herbicidal activity to Dinoben, but indicated a longer residual control. Amoben also gave fair weed control when applied post-emergence, whereas Dinoben was ineffective at comparable rates. Since aqueous sprays of both materials showed similar activity, 10% granular formulations of Dinoben and Amoben on 24-48 mesh attaclay were made. Pre- and post-emergence weed control tests were applied to both seeded and transplanted vegetable crops. These data are given in Table III.

TABLE III

Response of vegetable crops on two soils to pre- and post-emergence granular application of Amoben and Dinoben

Crop	Rate (lb/A)	Weed Control	Crop Injury Upland Soil	Crop Injury Muck
Tomato (Seeded)	2,4,6 (Pre) 2,4,6 (Post)	Good	Slight @ 4 lb/A Moderate @ 6 lb/A	----
Tomato (Trans.)	2,4,6 (Post)	Good	Slight @ 6 lb/A	----
Lettuce (Seeded)	2,4,6 (Pre) 2,4,6 (Post)	Good	Slight stunting	Slight stunting
Lettuce (Trans.)	2,4,6 (Post)	Good	Slight stunting	Slight stunting
Cabbage (Trans.)	2,4,6 (Post)	Good	No injury	----
Cauliflower (Trans.)	2,4,6 (Post)	Good	Slight @ 6 lb/A	----

Weeds: Crabgrass, pigweed, lambsquarters and foxtail

Results similar to those stated in Table III were observed on transplants such as pepper, Brussels sprouts, eggplant and broccoli. (All applications were made post-emergence to the crop and pre-emergence to the weeds.) Dinoben and Amoben showed similar action when applied in granular form. Little or no crop injury was observed; probably foliage absorption is not a factor with granular formulations as it is with sprays.

Preliminary greenhouse and field tests with Amoben indicate it to be a promising herbicide for soybeans. Dinoben and Amoben are promising herbicides for post-emergence application in granular form to some transplanted vegetable crops. Dinoben looks promising for pre-emergence application to seeded crops such as carrots, peas, butternut squash, and parsnip.

The performance of Dinoben for crabgrass control in turf is being reported to this conference in another paper. Test data comparing rates of application, number of treatments and treatment intervals indicate that two or three treatments of 8 to 10 pounds per acre at 4-week intervals gave consistently satisfactory control (above 75 per cent).

<u>Liquid Formulation of Amitrol</u>

The new liquid formulation of amitrol was given extensive trials for control of quackgrass (<u>Agropyron repens</u>). In three spring tests, quackgrass 6 to 8 inches tall was treated, plowed under, and the area planted to field corn. A logarithmic test was applied in early summer to regrowth of quackgrass that had been plowed in the spring.

Results showed that liquid amitrol was at least twice as active on quackgrass as the present formulation, and as safe to use when plowing and planting corn followed two weeks after application. Four pounds of liquid amitrol was equivalent in control of quackgrass to 8 pounds active of dalapon or 16 pounds of Weedazol (8 pounds amitrol). In no case was corn injured when planted two weeks after an application of liquid amitrol, whereas dalapon did produce moderate injury to corn planted two weeks after application.

TABLE IV

Chemical	Rate	Quackgrass Control	Corn Injury
Liquid amitrol	2	60%	None
	4	90+	None
Weedazol	4	65-70	None
(50% dry amitrol)	8	85-90	None
Dalapon	8	80-85	Slight to Moderate

Initial tests in California and the East indicate liquid amitrol to be twice as effective as Weedazol on stoloniferous grasses such as quackgrass, Bermuda grass, and seaside bentgrass. Work is now in progress to discover whether or not this activity holds true on perennial weeds such as Canada thistle (Cirsium arvense), whitetop (Cardaria draba), cattails (Typha latifolia), tules (Scirpus acutus), etc. Plots were sprayed in the summer of 1958. Initial observations indicated liquid amitrol gave a quicker topkill of these perennial weeds than Weedazol did. Final evaluations on regrowth will be made in 1959.

Fenac

Fenac is very promising for pre-emergence crabgrass control in established turf, for quackgrass and bindweed control, for pre-emergence control of annual grasses and broadleaf weeds in corn, and for soil sterilization.

Extensive tests involving replicated application of eleven crabgrass killer formulations at different rates and time intervals to over 350 plots were carried out from April 3, to June 26, 1958. Final observations on August 28 showed that Fenac-S and Fenac-WP were the most promising. Single applications of 3 pounds per acre produced 85 per cent crabgrass control with no turf injury. Six pounds per acre produced 97 per cent crabgrass control with only slight temporary turf discoloration.

Quackgrass control tests with Fenac were applied in Niagara County, New York, and at State College, Pennsylvania. In one trial in Niagara County, a dense quackgrass sod was treated July 2, 1957, at rates of 1, 2, 4 and 8 pounds per acre. On July 7, 1957, the plots were plowed and disced. Field and sweet corn were planted the next day. When the plots were inspected September 10, 1957, the 2, 4, and 8 pounds rates showed good quackgrass control, along with good control of annual grasses and broadleaf weeds. The 1 pound rate gave only partial quackgrass control. Although no yield study was made, neither the field nor sweet corn showed apparent injury at the 2 pound rate. The 4 pound rate produced some corn injury, and the 8 pound rate produced severe injury.

In the spring of 1958, half of each plot was plowed, disced and planted to sweet corn. The other half of each plot was undisturbed. The 8 pound rate, both plowed and undisturbed, continued to give complete control of quackgrass. There was no visible damage to the corn at maturity. At the 4 pound rate, only partial control of quackgrass was observed during the second season.

At State College, Pennsylvania, a logarithmic sprayer application of Fenac was made to quackgrass. This was a cooperative experiment between Dr. S. M. Raleigh, Amchem Products, Inc., and Hooker Chemical Corporation. Chemicals were applied to 12-foot-wide plots in 25 gallons of solution per acre. Two weeks after the April 30, 1958 treatment, the area was plowed and planted to corn. The half-dosage distance was calculated at 21.6 feet. Quackgrass shoot counts were made on October 31, 1958, following periodic observations during the growing season. The counts were made at the half-dosage distance and the rates recorded are therefore approximate. Each treatment was replicated three times. The degree of quackgrass control is given in Table V.

TABLE V

Quackgrass Control

			Approximate Rate			
Treatment	16 lb/A	8 lb/A	4 lb/A	2 lb/A	1 lb/A	0.5 lb/A
Fenac-S	----	96.7%	95.3%	86.4%	84.5%	82.2%
Benzac 354 *	----	49.0	68.0	35.8	13.9	8.6
Dalapon	60.0%	71.9	40.2	42.5	0.0	

* Amine salt formulation of polychlorinated benzoic acid

Fenac-S injured corn at a rate between 8 and 4 pounds per acre, although the 4 pound rate injury did not appear to reduce yields. No corn injury was observed below 4 pounds per acre, and the persistent nature of the compound resulted in excellent control of annual weeds down to 2 pounds per acre. Below 2 pounds per acre, there was a marked suppression of size and number of annual weeds. The 2 pounds per acre zone showed annual weed control similar to that obtained with 2 pounds per acre of simazin in other areas. The quackgrass plants counted in the Fenac-S plots were stunted and malformed. No corn injury was observed in the Benzac 354 plots. (In 1957, however, corn was damaged by Benzac 354 treatments.) Because of the short time interval between treatment and planting, dalapon caused marked injury in the 16, 8 and 4 pounds per acre zones.

These data indicate that quackgrass may be controlled by spring applications of 1 to 4 pounds of Fenac-S. Safe planting of corn at various time intervals after treatment seems possible. Response of quackgrass to fall application of Fenac-S, with or without plowing, has not been determined, nor has the persistence of low rates of Fenac-S and its likelihood of damaging crops following corn in the rotation.

In one test of 2 pounds per acre, Fenac-S was applied pre-emergence to field corn. Application was made immediately after planting. Weed control in this plot was excellent and comparable to 2 pounds per acre of simazin. There was no apparent injury to the corn throughout the season and although yields were not taken, no apparent injury to the ears of corn was noticed. This treatment controlled both annual grasses and broadleaf weeds for a period of at least 8 weeks.

Although Fenac-S appears to be considerably more effective in eradicating bindweed* than polychlorobenzoic acid or 2,3,6-trichlorobenzoic acid (2,3,6-TBA) are, its action is considerably slower. Preliminary tests indicate that fall applications of 5 to 10 pounds of Fenac-S per acre can prevent emergence of bindweed the following spring, whereas spring applications of as much as 20 pounds per acre have sometimes failed to give complete eradication by fall. The rate of action appears to be related to the amount of rainfall. Where heavy rainfall occurred immediately after spring application, Fenac-S produced 90 to 100% topkill within two weeks when applied at 8 pounds per acre. Under dryer conditions, rates as high as 10 and 20 pounds per acre gave only 25% control after a month, and only 90% control after five months.

Fenac-WP appears to be slower acting than Fenac-S. Even though moisture is sufficient, Fenac-WP will take from three to six months after application to produce satisfactory control.

Promising results were observed when Fenac was used in combination with 2,4-D and related compounds. In two trials conducted during the 1958 season, under wet soil conditions, 1 pound of 2,4-D per acre gave rapid topkill of bindweed in June, but heavy regrowth was observed by October. An application of 5 pounds of Fenac-S plus 1 pound of 2,4-D gave equally rapid topkill but there was no regrowth in October. The use of combinations under different climatic and soil conditions, particularly in early spring and mid-summer applications has not yet been investigated.

Preliminary trials of Fenac-S and Fenac-WP for complete vegetation control were also carried out. In the southern part of the United States, rates of 1, 2, 4, 8, and 16 pounds per acre were applied in May 1958, to heavy vegetation consisting of annual broadleaf and grass species, ferns, perennial grasses, honeysuckle (Lonicera japonica), locust (Robinia pseudoacacia), sumac (Rhus spp.), sassafras (Sassafras albidum), etc. These plots were observed and data taken in August, 1958. One pound per acre of Fenac was too low, and did not give good weed control. At the 2 pound rate, good control of broadleaf weeds and annual grasses and severe injury to the ferns and sedge-grass (Andropogon virginicus) was observed. At the 4 pound rate, there was good control of sedge-grass, annual grasses and broadleaf weeds, and severe inhibition of locust, sumac, and sassafras; honeysuckle was killed. At rates of 8 pounds per acre, all vegetation was killed, except for some brush species, which were injured. To date, no live vegetation has appeared in the 16 pound area. Combination of 4 pounds of Fenac-S and 200 pounds of sodium chlorate per acre gave good general vegetation control and appears to be as effective as 16 pounds of Fenac-S alone.

* (Convolvulus arvensis)

Testing for long-term soil sterilization, the Fenac herbicides were applied in December 1956, in the northeastern United States to a heavy clay soil. Vegetation consisted of annual grasses and broadleaf weeds, wild carrot (Daucus carota) and wild strawberry (Fragaria virginiana). Little difference in results was observed throughout 1957, as well as throughout the 1958 growing season. Fenac-WP at 8 pounds per acre gave substantially 100% control with about 95% control of wild carrot. Fenac-S gave poor control at 8 pounds, but was effective at the 16 pound level. The least favorable results observed to date on long-term soil sterilization were obtained on a heavy clay soil which was plowed and disced before mid-summer 1957 application. Inspections one year later showed the following rates of Fenac herbicides necessary for complete control.

Fenac-S

(1) Annual broadleaf weeds - 2½ to 3 pounds
(2) Perennial broadleaf weeds and perennial grasses - 10 to 20 pounds
(3) Perennial bluegrass - 20 to 40 pounds

Fenac-WP

(1) Annual broadleaf weeds - under 2 pounds
(2) Perennial broadleaf weeds and grasses - 3 to 40 pounds
(3) Perennial bluegrass - 20 to 40 pounds.

At the other extreme, Fenac-WP was applied at 6 pounds per acre in September 1957, on a sandy area containing annual grasses and broadleaf weeds and perennials including wild carrot. The treated area remained completely bare of vegetation throughout 1958 with sharp boundary lines along adjacent heavily infested control plots.

These four new materials are promising herbicides and will be evaluated further in 1959. The data indicate new tools for quackgrass control, weed control in corn, soybean, vegetable crops and a new material for total vegetation control. Liberal supplies of these chemicals will be available for extensive trials in 1959.

STATUS OF SPRAYING

A Summary of Six Years of Spraying for Weed and Insect Control in Vermont

T. R. Flanagan[1]

The extent of weed and crop-insect control in Vermont by spraying has been determined yearly. The County Agricultural Agents have reported during the last six years, figures for acreages and crops sprayed, equipment and operators, chemicals and techniques. Acreage information and tractor-owner statistics are taken from the 1954 Agricultural Census Reports.

Vermont's agricultural acreage is indicated in Figure 1. More than three million acres (3,317,737) are involved one way or another, as Vermont land in farms. A good part of it is in woodland, almost half of which is pastured. This woodland conceivably could be treated with silvicides or insecticides to some extent. Proceeding clockwise on Figure 1, "Other Pasture" with its low dollar per acre value could be sprayed for pasture brush and weed control, and probably some renovated with chemicals. Any treatment should improve the value.

The section extending from 5 o'clock to 9 o'clock in Figure 1 represents the bulk of the really usuable farm land. Together with the few acres of idle cropland this represents about one million acres. This is the land which is and can be used most intensively, land which produces the most economic gain for Vermont agriculture. These are the acres which have received the greatest proportions of spray treatment for weed and insect pest control. This too is the area in which future spraying will be of most benefit to the farmer.

Let us examine this hay, pasture, and cropland in greater detail. This farm land is called "cropland harvested, cropland pastured, and cropland idle" by the census report. For the state, about 6 percent of this 1,062,000 acres is in corn, 4 percent in small grains, 20 percent in improved or pastured cropland. Orchards and horticultural crops (including beans and potatoes) account for only 0.5 percent each. Legume seed crops use 0.05 percent of this cropland. The bulk of the area consists of hayland, almost 70 percent of the farm land acreage. The rest is idle land. Exactly how this good farm land is used in each county is shown in Table 1.

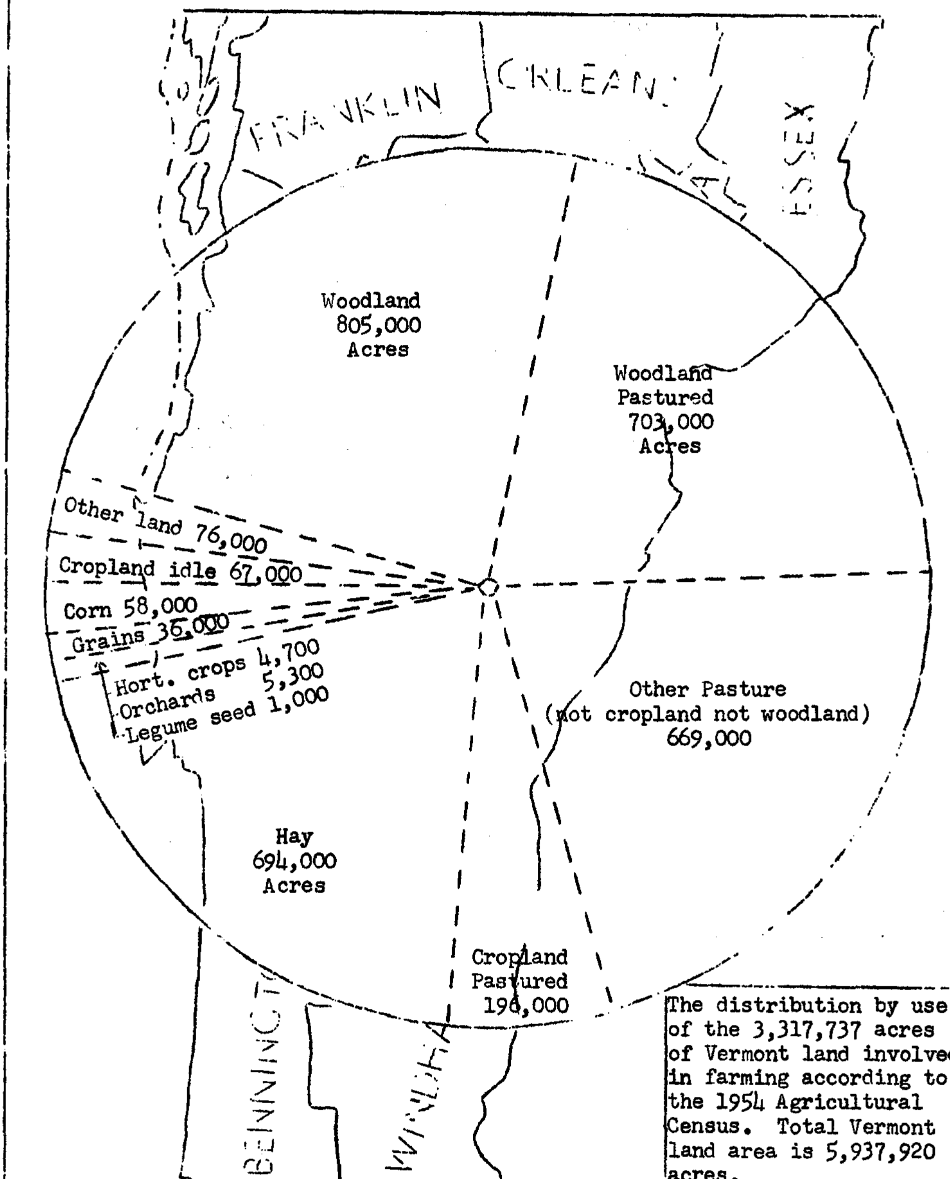
SPRAYING

From 1953 through 1958, we kept track of the acreage of the various crops sprayed and the numbers of low-pressure, low-volume sprayers in use. Figure 2 shows how the use of spraying has increased each year. No record exists of farmer use of 2,4-D in the state before the early 1950's, however, it was used experimentally in 1945. We can estimate that less than 1,000 acres of crops were sprayed with any chemicals before 1952.

[1]Assistant Agronomist, University of Vermont, Burlington, Vermont

FIGURE 1

VERMONT LAND IN FARMS



The distribution by use of the 3,317,737 acres of Vermont land involved in farming according to the 1954 Agricultural Census. Total Vermont land area is 5,937,920 acres.

TABLE 1 - PERCENT OF VERMONT FARM LAND USED FOR CROPS

County	Total cropland harvested and pastured. Acres	Percent of this land in use for: Corn	Grains	Cropland pastured	Other crops*
Addison	140,665	7.4	5.0	17	0.1
Bennington	32,730	7.9	4.8	24	0.4
Caledonia	72,826	3.7	2.7	21	0.5
Chittenden	88,162	8.6	4.3	19	0.9
Essex	20,414	1.8	2.5	27	1.2
Franklin	122,383	5.8	5.7	15	0.2
Grand Isle	26,049	9.0	6.3	27	0.2
Lamoille	40,053	5.5	2.0	21	1.3
Orange	72,540	4.6	2.5	23	0.6
Orleans	107,650	3.4	4.0	20	0.4
Rutland	93,673	6.5	2.6	16	0.4
Washington	63,751	4.2	2.0	21	0.6
Windham	40,002	6.9	1.4	23	1.1
Windsor	74,514	4.6	1.5	23	0.3
State total	995,410	5.8	3.7	20	0.5

*Beans, potatoes, other horticultural crops combined.

Most of the spraying in 1953 was for cornfield weeds with a little on underseeded oats, a few pasture weeds, and some brush. The following year, 1954, saw invasions of forest and field insects, hence a tremendous increase in spraying. The corn acreage sprayed almost doubled; more than twice the cropland acreage was sprayed for weeds than the year before. It was estimated, but unreported, that over 10,000 acres of forest land were sprayed by air for forest tent caterpillars and gypsy moths. For the first time ground "weed sprayers" were also being used to combat insects. Some 450 acres were sprayed with tractor mounted equipment for armyworm control, and several acres of forage crops for spittlebug and leafhopper.

The year 1955 saw a steady increase in acreages sprayed and the advent of airplane spraying of cropland for insect control. In 1956, over 9,000 acres were sprayed, one way or another. Some 200 acres[1] were sprayed with insecticides, about half of which were airplane sprayed.

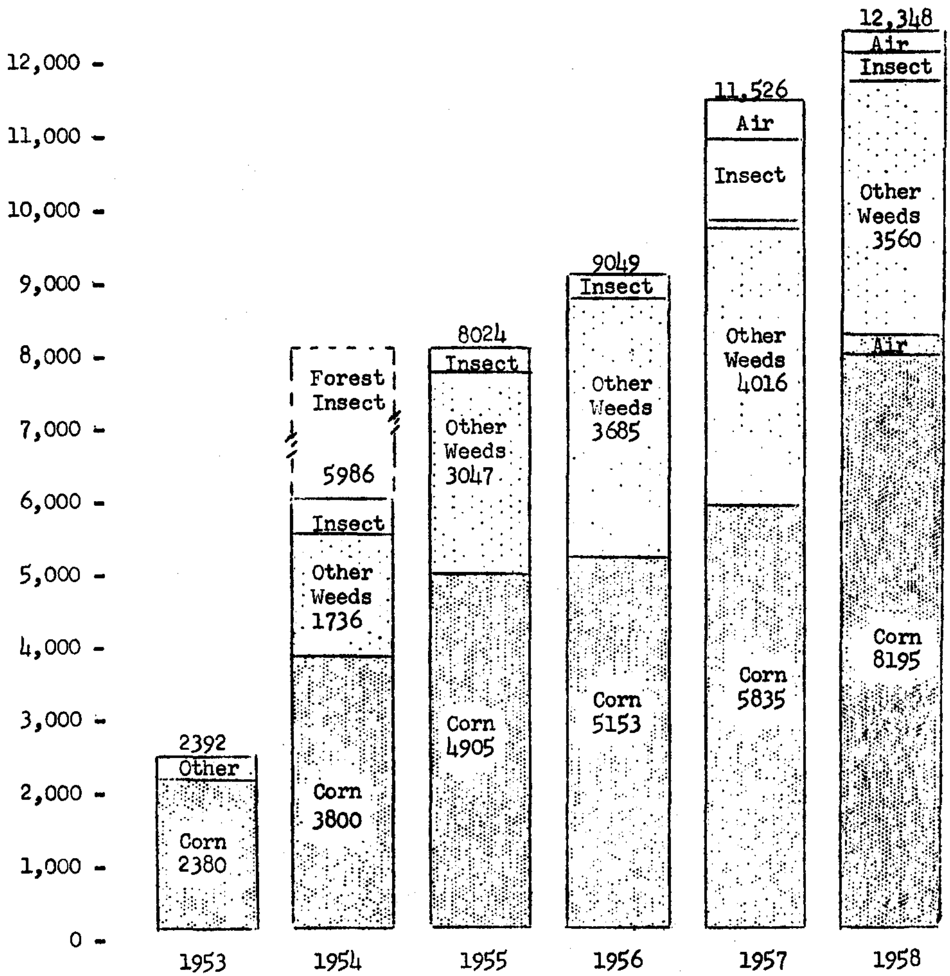
The fifth year of the survey (1957) again saw an increase in the amount of spraying done. Almost 6,000 acres of corn were sprayed, over 2,500 acres of small grains, mostly underseeded to legumes, and more than 200 acres of pastures. In addition, over 600 acres of potatoes, beans, and other horticultural crops were sprayed for weed control. Almost the entire potato acreage (some 2,500 acres) was sprayed for disease and insect control, as usual, but increased use of low-pressure, low-volume equipment was noted.

[1]The 5,000 or so acres of orchards are excluded from this report.

FIGURE 2

USE OF SPRAYING IN VERMONT

1953 - 1958



Annual total acreage sprayed for weed and insect control by low-pressure, low-volume ground sprayers, and by air. Orchards, and high-pressure, high-volume potato spraying excluded.

Over 1,600 acres of cropland were sprayed for insect control in 1957, about half by air and more than half by tractor-mounted sprayers. A few acres of corn were also weed-sprayed by airplane. This last year saw increases again for all weed spraying. The use of insecticides decreased slightly.

The total acreage sprayed in Vermont climbed in just six years from less than 1,000 to over 12,000 acres. The figures for cropland sprayed each year in each county are listed in Table 2. Not shown are the numbers of lawns treated for weed control, an item which has been increasing each year, but difficult to obtain accurate figures for, nor the amount of poison ivy sprayed, nor brushland, fencerows, and roadsides sprayed by the farmer.

TABLE 2 - ANNUAL SUMMARY OF SPRAYING IN VERMONT 1953 - 1958

County	Total acres sprayed each year*					
	1953	1954	1955	1956	1957	1958
Addison	40	611	337#	520#	1,291#	522#
Bennington	500	805	700	600	740	673
Caledonia	300	330	570	1,190	1,180	900
Chittenden	150	326	1,300	1,300	1,400	800
Essex	100	430	850	660	740	478
Franklin	100	75#	500	550	550	782
Grand Isle	22	64	328	323	292	452
Lamoille	76	580	275	300	1,150	819
Orange	300	1,000	875	665	565	1,320
Orleans	75	300	325	330	730	735
Rutland	100	250	800	1,001	870	1,415
Washington	29	200	314	475	660	2,144
Windham	250	500	350	610	530	400
Windsor	350	515	500	525	810	908
State total	2,392	5,986	8,024	9,049	11,526	12,348

*All weed and insect spraying on crops, oats, pasture, potatoes, beans, sweet corn, and other horticultural crops except orchards.
#Includes both ground and air applications.

PERCENTAGE OF LAND SPRAYED

The above figures, although showing yearly gains in total acreages sprayed and also for the various crops treated, must be compared with the actual acreages of these croplands that are being farmed in Vermont.

Table 3 shows the actual acres sprayed as percentage of total acres county by county, and for the state as a whole, at the beginning of the survey for the best year and for last year. The acres sprayed have been compared with the cropland acres listed in Table 1, and the percent of the acreage actually sprayed calculated. Percentages are used to place counties on a fair basis for comparison. The acreages sprayed have increased tremendously in the last six years, but the percentages could be much greater.

TABLE 3 - PERCENT OF TOTAL CROP ACREAGE SPRAYED FOR WEEDS AND INSECTS*

County	1953	1958	Best percentage accomplishment of ideal goal.
Addison	0.03	0.37	4
Bennington	1.60	2.05	10
Caledonia	0.41	1.23	7
Chittenden	0.17	0.90	6
Essex	0.48	2.34	25
Franklin	0.08	0.64	3
Grand Isle	0.08	1.73	7
Lamoille	0.18	2.04	12
Orange	0.41	1.81	7
Orleans	0.07	0.68	3
Rutland	0.11	1.51	6
Washington	0.04	3.36	13
Windham	0.62	1.00	6
Windsor	0.46	1.22	5
State total	0.24	1.24	5

*Percentages based on acreages in Table 1, and acres sprayed, Table 2.

To make the picture realistic, we have suggested a "goal of optimum spraying", or "ideal goal". This, for total farm land, is equivalent to one-fourth of the total acreage of all crops. The maximum area of land we expect to be sprayed annually for weeds and insects would be 250,000 acres of hay, pasture, and cropland. Another way one could look at this is a goal where every acre gets treated once in some way every four years on the average, or, when one out of four acres is being sprayed.

Comparing the actual acreage sprayed against this one-quarter "ideal goal" we find that the state average is just 5 percent of completion.

5%	GOAL: 250,000 ACRES

CORN SPRAYING

Let us look at Vermont's principal cultivated crop, corn. In Table 4 census figure acres are again compared with reported data for weed spraying, county by county, yearly since 1953. The acreages sprayed have gradually increased in most counties, and the state totals show a gradual but steady increase in corn weed control for each year.

TABLE 4 - WEED CONTROL IN CORN*

County	Total Acres Corn#	Acres Sprayed 1953	1954	1955	1956	1957	1958	Best percentage accomplishment of ideal ½ goal
Addison	10,905	35	140	130	180	95	125	3
Bennington	2,589	500	600	600	500	600	600	46
Caledonia	2,715	300	200	400	500	550	570	42
Chittenden	7,555	150	225	300	300	400	550	15
Essex	364	100	95	200	250	200	75	41
Franklin	7,163	100	50	500	450	450	670	19
Grand Isle	2,345	22	40	175	73	40	150	13
Lamoille	2,210	76	300	200	250	500	755	68
Orange	3,329	300	800	600	500	400	550	33
Orleans	3,653	75	200	250	250	250	350	19
Rutland	6,132	100	250	500	650	700	1,200	39
Washington	2,667	17	100	200	350	500	1,400	100
Windham	2,777	250	300	350	400	400	300	22
Windsor	3,449	350	500	500	500	750	900	52
State total	57,853	2,380	3,800	4,905	5,153	5,835	8,195	28

*Includes silage corn, grain corn, grazed corn.
#Census of 1954.

Over 8,000 acres were sprayed in 1958. However, this is only 14 percent of the total corn acreage. Fully half of the 57,000 acres of corn grown annually in Vermont are weedy, some only moderately so. Unfortunately many fields are almost too weedy to be harvested. Let us establish a goal for corn where all of the weedy fields are sprayed. Thus, there are 25,000 to 30,000 acres of corn which could and should benefit from chemical weed control. How well we have done to date is shown below.

28%	GOAL: 28,500 ACRES

As we can see, 14 percent of the total corn acreage, or 28 percent of this separate goal for corn weed spraying has been accomplished. Spraying corn should and can be the most probable weed control effort that will show immediate economic gains for the Vermont farmer. Weeds in the cornfield cost money.

SMALL GRAIN SPRAYING

Table 5 gives a picture of the weed spraying work done on oats and other small grains. It is a picture somewhat different from that for corn. Acreages sprayed have increased over the five-year period of the survey but not consistently. Possibly more acres are sprayed than reported.

TABLE 5 - WEED CONTROL IN SMALL GRAINS*

County	Total acres grain#	Acres Sprayed 1953	1954	1955	1956	1957	1958
Addison	7,437	+	45	35	55	-	5
Bennington	1,572	+	100	100	100	50	50
Caledonia	1,996	+	90	150	160	100	120
Chittenden	3,835	-	100	1,000	1,000	1,000	85
Essex	513	+	122	400	300	400	200
Franklin	7,072	+	25	0	100	100	110
Grand Isle	1,654	+	20	150	250	250	275
Lamoille	786	+	50	50	50	75	60
Orange	1,789	+	200	125	75	125	120
Orleans	4,292	+	75	75	75	90	100
Rutland	2,482	+	-	300	350	150	200
Washington	1,316	12	75	100	100	100	700
Windham	546	+	100	300	200	100	0
Windsor	1,086	+	15	0	25	25	0
State total	36,376	132	1,017	2,785	2,840	2,565	2,025

*Includes grain grown together and threshed as a mixture, oats threshed or combined, other grain threshed or combined, and small grains cut for hay. #Census of 1954 +Approximately 10 acres -no report

About half of the small grain fields concerned are underseeded to grass-legume mixtures resulting in hay or improved pasture lands of several years' duration. These should be economically important to the farmer, and be treated for weed control. However, with presently available spray materials such acreages will probably be sprayed, on the average, one year out of four. On the other hand, good hayland can be profitably treated for insect control, which could conceivably be on an annual basis.

A goal of one-fourth the small grain acreage to be sprayed is then not too far out of line. About 22 percent of such a goal was averaged last year.

22%	GOAL: 9,000 ACRES

Such a goal is not too much to expect for the future. With the anticipated advent of safer chemicals and those more efficient for direct use on seedings, better legume and grass stands can be established than ever before.

HAY AND PASTURE

Accurate figures for hayland and pasture land sprayed for weed or insect control do not exist. Since such lands are involved in the large blocks of relatively extensively farmed hay and pastured cropland (Figure 1) it might be well to assume such fields would be treated, on the average, no more often than one year out of four. Hence they would become part of the over-all goal of 25

Hay and pasture spraying can take many forms, from insecticides, general broadleaf weed control, spot spraying of thistles and milkweed, brush patch eradication, to land renovation, quackgrass control for pre-crop planting, and even the possibility of fungicides and hay preservatives. Such will be contributions to the over-all goal of 250,000 acres treated annually for weeds, insects, and disease.

USE OF SPRAYERS

The numbers of low-pressure low-volume sprayers were counted annually. The numbers of such spray rigs in use in 1958 are listed in Table 6. From only a handful (less than 30 in 1952), these have increased in number to over 200. Last year 212 sprayers were in operation. This figure includes all types from boomless to tractor-mounted boom-type rigs. In addition, about 13 commercial outfits are being operated. Also not counted in this total is a half dozen airplanes and helicopters spraying brush and forage insect control by contract. Over 70 of the farmers owning weed sprayers did some custom work.

TABLE 6 - PERCENT OF FARMERS OWNING TRACTORS THAT HAVE SPRAY RIGS

County	Number of tractor owners*	Number of sprayers 1953	Number of sprayers 1958	Percent of tractor owners having sprayers
Addison	1,118	2	12	1.1
Bennington	484	4	10	2.1
Caledonia	701	2	13	1.8
Chittenden	882	2	25	2.8
Essex	166	3	4	2.4
Franklin	1,158	2	9	0.8
Grand Isle	245	1	10	4.1
Lamoille	515	1	11	2.1
Orange	949	0	25	2.6
Orleans	1,037	4	20	1.9
Rutland	963	3	20	2.1
Washington	648	3	25	3.8
Windham	650	6	10	1.5
Windsor	1,089	6	18	1.6
State total	10,120	39	212	2.1

*1954 Agricultural Census data for farmers owning one or more tractors.

Here also a similar situation exists, akin to the corn spray picture. Over 10,000 farmers in Vermont own one or more tractors. Only a little more than 2 percent of these tractor owners have sprayers. Many more could and should be so equipped at a likely profit to themselves and a gain in weed control efforts for the state.

ACRES SPRAYED PER RIG

It might be conceivable that with the steady increase in numbers of sprayers that the use of each sprayer would diminish. However, the reports are to the contrary. In 1953, about 39 acres were sprayed by each operator. In 1958, the state average increased to 58 acres of weed and insect control per spray rig (Table 7). Many counties did better than this.

TABLE 7 - ACRES OF CROPLAND SPRAYED PER RIG

County	Acres 1953	Acres 1958	Possible net profits per rig at $1.50 net/A 1958	Possible net per rig with goal*
Addison	13	36	$ 54.00	$189
Bennington	71	67	100.50	102
Caledonia	50	69	103.50	156
Chittenden	33	32	48.00	150
Essex	33	119	178.50	186
Franklin	11	87	130.50	159
Grand Isle	76	45	67.50	160
Lamoille	300	74	111.00	117
Orange	75	53	79.50	116
Orleans	25	37	55.50	156
Rutland	33	71	106.50	146
Washington	10	86	129.00	147
Windham	36	40	60.00	93
Windsor	50	50	75.00	102
State total	39	58	$ 87.00	$147

*Goal: ¼ of tractor-owner farmers having sprayers and spraying ¼ of total farm land acreage (Table 1).

It is interesting to note that at an estimated net profit for custom work of $1.50 per acre, the average gain to the owner of a sprayer in 1958 was $87.00 (Table 7). Many operators, judging by the county figures, did better than this.

If we set up a goal of one-fourth of the farmers spraying one-fourth of the cropland acreage, the average net profit per spray rig could be almost $150 per year. These net gains were calculated over and above all costs of operation, labor, materials, and depreciation over a 10 year period. Ignoring depreciation it would conceivably be possible to buy a $300 low-pressure, low-volume sprayer and pay for it by two years of custom operation.

INFORMATION

To provide impetus to Vermont's spray program considerable use has been made of farmer meetings and of the newspaper, radio, and television. Brieflets, pamphlets, a periodic weed spray bulletin to county agents - "Spray Tips", and annual Weed Control Recommendation Charts have been widely distributed. Local herbicide dealers have also contributed to the increasing success of weed and

TEMPERATURE, LIGHT, AND SEED SIZE AND THEIR EFFECTS ON GERMINATION OF DOG FENNEL

R. D. Ilnicki[1] and M. W. Johnson[2]

ABSTRACT

Dog fennel (Anthemis cotula), is classified as a winter annual and sometimes as an annual. This weed causes serious losses in small grain production and is also a pest in other crops and pastures in the Northeastern States. Dog fennel seeds apparently germinate throughout most of the growing season. These extensive germination periods increase the difficulty of developing control practices. In order to obtain good control of this species by the proper timing of herbicidal chemicals, it is imperative to know when dog fennel seeds germinate and what factors enhance germination.

Seeds of dog fennel were introduced into thermostatically controlled dark germinators operated at 50°, 59°, 68°, 77°, 86°, 95°, and 104°F. in order to determine what temperature regimes were most favorable for germination. Temperatures of 50° and 68° were most favorable for germination, however, many seeds failed to germinate.

Greater numbers of seeds germinated when they were introduced into an alternating dark-daylight germinator operated at 68° in the dark and 86° F. in daylight. At this point in the study it was observed that only small seeds germinated.

The relation of seed size to germination was studied. Two sizes were made by screening seed through a 6 x 24 mesh screen. Seed that passed through were called small; the ones retained were called large. These two sizes of seed were introduced into dark-daylight germinators. Many more small seeds than large ones germinated. Large seeds germinated when their seedcoats were removed. This behavior is contrary to the late germinating small, hard seeds of legumes.

The first seed supply was made on the College Farm Campus. An additional seed harvest was made near Jamesburg, N. J. in order to determine whether this peculiar characteristic of seed size was typical of all dog fennel seed. Similar data were obtained with the new seed harvest.

Additional seedings made in pots, in the greenhouse and out-of-doors, and in field plots indicated that the marked difference in germination percentages of large and small seeds is a characteristic of this species.

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[1]Research Agronomist, Crops Research Division, ARS, USDA, in cooperation with the New Jersey Agricultural Experiment Station, Rutgers-the State University, New Brunswick, N. J.

[2]Seed Analyst, New Jersey Agricultural Experiment Station, Rutgers-the State University, New Brunswick, N. J.

Quackgrass Control*

S. M. Raleigh
Penn State University

It is relatively easy to control 85-95% of the quackgrass by chemicals when compared with non-treated checks. Some of the 5-15% of the plants which were not controlled, come from seed. The control of quackgrass is influenced by cultural methods. We achieved better control on the lower slopes of a field where the plow turned the furrow down the hill, than where the furrow was turned up the hill. Control was poorest where the soil was hard to plow and cultivate.

Since Dalapon must be handled in a different manner than amino triazole, two experiments were set up for dalapon, and two tests handled for the benefit of amino triazole.

The first dalapon plots were 6 rows wide and 150 feet long. They were sprayed April 14. The second plots were sprayed April 23, and the last on April 30. The plots were all plowed May 1st and 2nd and planted May 23 to corn. The best control was obtained with April 23 spray date. The results were: 3.3#, 80%; 6.6#, 89%; 11.1#, 95% and 22.2#, 94%.

The control of quackgrass on the first and last dates was about 5 to 10% poorer than on the April 23 date. There was some injury to the corn crop on all treated plots with this 21-day interval between plowing and planting.

The second dalapon experiment was sprayed by hand using 10, 20 and 40 gallons of water per acre, each with 3.3, 6.6 and 11.1 pounds of dalapon. The plots were sprayed May 12 when the quackgrass was about 6-8 inches tall. There were 3 replications. There was no visible difference in control with the different water rates. The 10-gallon of water per acre plots were somewhat browner than the 20 or 40 gallon per acre plots when the sod was plowed. The control for each rate was; for 3.3#-67%, for 6.6#-83%; and for 11.1#-91%. There was some injury to the corn on all treatments early in the season. The corn plants on the check plots was taller than on the dalapon plots for about 3 weeks; later, when competition with quackgrass became severe the corn on the check plots were smaller than the treated plots.

Greenhouse tests by Amchem Products, Inc. last winter indicated that amino triazole activity could be increased by combinations of 2 or more herbicides so 69 plots were sprayed in the field with a "log" sprayer in the spring of 1958. The applications were made April 28-30 when the quackgrass was 4-6 inches tall, plowed May 15 and planted May 16. The treatments were 1, 2 and 4# amino triazole respectively, with 12# ACP 604 (PCPE), 12# ACP 605 (PCNA) and 12# ACP 655; 2# amino triazole with 12# Ammate, 12# thiourea, 12# ACP 354 (PCB) and 4# dinitro, respectively. In each case, the last material was "logged". 8# fenac (2,36 trichlorophenylacetic, Na salt) 16# dalapon and 4# dalapon with 8# ACP 569 logged.

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The addition of compounds 604, 605 and 655 increased the activity of amino triazole at the lower rates (1-2 pounds); but at the 12# of these compounds rates there was no benefit. The addition of ammate, thiourea and dinitro had no beneficial effect on action of amino triazole at any of the rates tried. Liquid amino triazole controlled quackgrass at rates down to 2 pounds per acre.

Fenac is an efficient compound, when applied to quackgrass 4-6 inches tall, treated areas allowed to stand 2 weeks, then plowed and planted. All growth including corn, was killed by this material at the rate of 8 lbs.

There was little injury to corn at the 4# rate and lower levels. Quackgrass was controlled at 1½ or 2 pounds per acre.

In another experiment, (table 1) twenty-one treatments with 4 replications each were applied May 8 to quackgrass 5-7 inches tall. The plots were plowed and planted May 27. Four plots in each replication had been treated with 50# of N April 17. There were 5 plots in the second replication where the control was rated rather low, (70% control); there were 6.6# of dalapon and 4# ACP 354 with and without nitrogen, and ACP 569. The average control is given in table 1.

Areas where 2, 4 and 8 pounds of amino triazole was applied to quackgrass were treated with 1 and 2 pounds of Simazin and 2,4D ester at planting and at emergence. In no case was there injury to the corn and in no case was there any improvement in quackgrass control over that achieved with amino triazole alone.

<u>In summary</u>, it is necessary to wait 4 weeks after plowing before planting corn where dalapon has been applied.

Cultivation of corn is helpful and desirable where quackgrass control has been applied. It is essential with spring applications of amino triazole.

Where amino triazole is used, after waiting 2 weeks after herbicide is applied it is desirable to plow, prepare the seedbed and plant corn the day of plowing.

Table 1. Percentage Quackgrass Control in Relation to Cultivated Check.

Rate in pounds per acre	Treatment	% Control
2	Amino triazole	92
4	" "	94
4	" " ≁ 50# Nitrogen	88
8	" "	91
2	" " ≁ 1# ACP 604	94
2	" " ≁ 2# ACP 604	93
2	" " ≁ 1# ACP 605	94
2	" " ≁ 1# ACP 655	97
1	Liquid amino triazole ACP 569	84
2	" " " ACP 569	94
6.6	Dalapon	85
6.6	" ≁ 50# Nitrogen	84
11.1	"	89
4	Simazin	87
4	" ≁ 50# Nitrogen	85
8	"	94
4	ACP 354	86
4	ACP 354 ≁ 50# Nitrogen	88
8	ACP 354	96
4	Fenac	89
8	"	96

Effect of Soil Reaction, Moisture, and Fertility on the Response of Northern Nutgrass to Monuron[1]

R. S. Bell, E. J. Bannister, Jr. and T. Tisdell[2]

When the northeastern regional weed control project to study the influence of environmental factors on the effectiveness of herbicides was activated, a greenhouse study with monuron, (3-(p-chlorophenyl)-1, 1-dimethylurea) and northern nutgrass (Cyperus esculentus L.) was begun at the Rhode Island Agricultural Experiment Station, supported in part by the regional project, N.E. 12. The purpose of this investigation was to determine whether variations in soil moisture, soil acidity, and fertility affected the herbicidal and residual toxicity of this herbicide.

Hill and his co-workers (2) published an extensive report on the fate of substituted urea herbicides in soil. They found that the toxicity of 1 to 2 pounds of chemical per acre disappeared in 4 to 8 months. Loss by leaching was not a major factor under field conditions. Some decomposition by light was possible where the material remained on dry soil. They concluded that the loss of substituted ureas was principally due to microbial activity.

Loustalot and co-workers (3) showed that high temperatures and moisture facilitated the loss of monuron. Rahn (4) found less monuron with an oat bioassay test than by chemical tests, which suggested that non-toxic degradation products were present.

Sherburne, Freed and Fang (5) determined that the leaching of monuron increased with increasing water percolation. Leaching was greater from a sandy than from a clay loam soil.

Field tests in Rhode Island (1) showed that 10 pounds per acre of monuron reduced markedly the numbers of nutgrass plants but its residual toxicity lasted for several months.

Upchurch (6) working with diuron found that this material produced plants having nearly equal amounts of growth under all soil moisture levels. This indicated that moisture had no absolute effect but a large relative effect on the phytotoxic properties of diuron.

Materials and Methods

The investigation was conducted in a greenhouse during the winter of 1955-56 and 1956-57. Soil having pH levels of 5, 6, and 7 was prepared. The original pH of the Bridgehampton silt loam

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[1]Contribution No. 961 of the R. I. Agr. Expt. Station.
[2]Associate Professor and former graduate assistants at Rhode

was 5. Calcium hydroxide was used to produce pH 6 and 7. The fertility was supplied with a soluble fertilizer with a 19-28-14 guaranteed analysis applied at rates of 250 and 500 pounds per acre for each pH level.

The source of monuron was Karmex W (80% active). The rates of Karmex W used were: none, 2½, and 5 pounds per acre, respectively. The herbicide was suspended in water and applied to the soil surface.

Sufficient numbers of pots were used so that the effect of monuron, pH, and fertility could be tested at 2 moisture levels, 35-50%, and 80-100% available. The soil was placed in 6-inch pots. Six 6-inch clay pots were used for each treatment.

Nutlets gathered from a nearby potato field in October were started in flats of soil in a warm greenhouse. When 2 inches high, three uniform plants were transplanted into each pot. Incandescent lights were used from transplanting until January 1 to afford a 16 hour day, which favored top growth. They were grown with normal daylight during January to promote nutlet formation. Yields were taken in early February, after which oats were planted from time to time in these pots to test for the residual toxicity of monuron. Harvesting of the nutlets brought about a mixing of the herbicide through the soil.

Results and Discussion

Several visual toxicity symptoms appeared on the nutgrass 10 days to 2 weeks after the application of monuron. There was a yellowing or browning of the leaf tips, a collapse of the leaf sheath sufficient to allow the blades to droop, and some sticking together of the tips of new blades. A small amount of pitting was found along the veins.

Dry weight of tops.

The average oven dry weights of nutgrass tops in grams per pot are shown in table 1. The total average yields for the 0, 2½, and 5 pounds per acre of Karmex W were 1.06, 0.73, and 0.55 grams in 1956, and 1.87, 0.97, 0.71, respectively, for 1957. This amounts to an average decrease in yields of 22 and 49 percent in 1956 and 49 and 63 percent respectively, in 1957. These data show that the toxicity of the monuron in Karmex W is of such magnitude that the effects of soil reaction, soil moisture and fertility are of little consequence.

In 1956 no differences in yields of tops were attributable to pH variations. In 1957, as is fairly common in plant tests where complete control of environmental factors is not attained, the yields of tops from the check plots were somewhat greater at pH 5. Again, however, at 2½ and 5 pound per acre, respectively, no significant difference in yields were found for the three pH levels.

Table 1. Average dry weight of nutgrass tops in grams per pot 1956 and 1957.

Karmex W Lbs/A	pH Levels 5	6	7	Moisture Low	High	Fertilizer Lbs/A	Lbs/A	Karmex W Av.	Average Percent Reducti
					1956				
0	1.04	1.08	1.08	0.96	1.17	0.96	1.17	1.06	
2½	0.77	0.76	0.66	0.71	0.74	0.74	0.73	0.73	22
5	0.54	0.54	0.58	0.55	0.54	0.61	0.49	0.55	49
Av.	0.78	0.79	0.77	0.73	0.82	0.77	0.79		
					1957				
0	2.06	1.90	1.63	1.53	2.21	1.66	2.10	1.87	
2½	1.02	0.97	0.91	1.03	0.91	0.96	0.98	0.97	49
5	0.73	0.71	0.70	0.83	0.60	0.68	0.74	0.71	63
Av.	1.27	1.19	1.08	1.12	1.24	1.10	1.27		

L.S.D. at 5 percent levels.

	1956	1957
Karmex W	0.12	0.13
pH	NS	0.11
Moisture	0.07	0.10
Fertility	NS	0.09
Karmex W x pH	NS	0.18
Karmex W x Moisture	0.12	0.15
Karmex W x Fertility	0.12	0.15

Each year both high fertility and moisture promoted significant increases in yields of nutgrass tops from the untreated soil. The yields were significantly reduced in direct proportion to the amount of monuron added. In 1956 in the presence of monuron the yields of nutgrass were similar at both low and high moisture levels. However, in 1957, a significantly lower yield was obtained from the interaction of 5 pounds of Karmex W and high moisture. Monuron nullified the favorable effect of adequate fertility and moisture.

Green weight of nutlets.

The total average green weights of nutlets in grams per pot are shown in table 2. They were 4.04, 0.89, 0.08 grams for 1956, and 5.01, 0.85, and 0.24 in 1957 for 0, 2½, and 5 pounds of Karmex W per acre. This amounts to an average decrease in yield of 78 and 98 percent in 1956 and 83 and 94 percent in 1957. Monuron caused a greater percentage reduction in nutlet production than in top growth.

Yields of nutlets from the check plots were significantly greater at high moisture and fertility. The soil reaction made no significant difference to the check in 1956 but in 1957 yields of nutlets were higher at pH 6. A study of the interactions shows a direct depression of the growth by increasing amounts of Karmex W. Variations of interactions of this herbicide with pH, moisture, or fertility for the 2-year period showed that these variables were of little consequence compared to the effect of monuron. At the 2½ pound per acre rate of Karmex W, the yield of nutlets was significantly higher at the higher moisture content in 1956 but significantly lower in 1957. Since less top growth was produced in 1957 by the high moisture + Karmex W combinations, it is likely that the lowered yield of nutlets is also related to the reduced growth of nutgrass tops.

Residual toxicity.

In the residual toxicity tests oats grew better at pH 6 or 7 than at 5. The monuron toxicity was first shown by whitening of the tops of the lowest leaves, followed by reduced growth or death of the plant. In 1956 the toxicity of monuron was reduced more quickly in the pots of soil at pH 6 or 7 and high moisture content. In the dry soil these differences did not occur. In 1957 low acidity and high moisture did not produce this effect. One possible explanation is that in 1956 a microbial population may have developed in the less acid, moist soil which favored a more rapid degradation of the monuron. New soil was brought in for the 1957 tests so there was no microbial carry-over from the previous year. Hill and co-workers (2) have found that microbes play a definite role in the decomposition of substituted ureas. In the winter of 1958 soil formerly treated with Karmex W and adjusted to 3 pH levels was placed in plastic bags. Fresh soil was similarly treated. Small amounts of monuron were mixed into

Table 2. Average green weight of nutlets in grams per pot 1956 and 1957.

Karmex W Lbs/A	pH Level 5	pH Level 6	pH Level 7	Moisture Low	Moisture High	Fertilizer Lbs/A	Fertilizer Lbs/A	Karmex W Av.	Average Percent Reduct.
				1956					
0	4.14	4.13	3.85	3.32	4.76	3.76	4.31	4.04	
2½	0.92	0.75	0.99	0.65	1.13	0.76	1.02	0.89	78
5	0.05	0.07	0.11	0.13	0.03	0.08	0.08	0.08	98
Av.	1.70	1.65	1.65	1.36	1.97	1.53	1.80		
				1957					
0	4.99	5.49	4.54	3.42	6.59	4.29	5.72	5.01	
2½	1.22	0.78	0.57	1.11	0.60	0.83	0.88	0.85	83
5	0.23	0.20	0.29	0.40	0.07	0.22	0.26	0.24	94
Av.	2.14	2.15	1.79	1.64	2.44	1.78	2.28		

L.S.D. at 5 percent level.

	1956	1957
Karmex W	0.25	0.41
pH	NS	0.24
Moisture	0.20	0.33
Fertility	0.18	0.23
Karmex W x pH	NS	0.40
Karmex W x Moisture	0.31	0.36
Karmex W x Fertility	0.31	0.36

samples of these soils during the spring and summer gave no indication that either pH or former applications of monuron was effecting the disappearance of monuron.

Conclusions

The initial toxicity of monuron is such that soil reaction, fertility, and moisture have no practical effect on it. Karmex at 5 pounds to the acre reduced top growth of nutgrass by as much as 63 percent and nutlet production by 98 percent. Undoubtedly under field conditions the disappearance of monuron from the topsoil is due to combinations of microbial decomposition and leaching.

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SPECIFICATION OF HERBICIDE MATERIALS FOR PUBLIC AGENCIES

JACK DREESSEN*

ADEQUATE SPECIFICATIONS FOR PURCHASING VARIOUS HERBICIDE MATERIALS HAVE NOT BEEN DEVELOPED FOR MOST HERBICIDES COMMONLY USED TODAY. THIS LACK OF SPECIFICATIONS HAS CREATED PROBLEMS FOR THOSE WHO SELL THESE MATERIALS AS WELL AS THOSE PERSONS WHO ARE RESPONSIBLE FOR BUYING THESE MATERIALS FOR USE BY PUBLIC AGENCIES.

THE FEDERAL GOVERNMENT, RECOGNIZING THE NEED FOR PURCHASE SPECIFICATIONS, HAS ADOPTED AN INTERIM FEDERAL SPECIFICATION FOR USE BY FEDERAL AGENCIES IN PROCURING 2,4-D FORMULATIONS. THIS SPECIFICATION WAS REVIEWED BY SEVERAL MEMBERS OF THE AGRICULTURAL CHEMICALS INDUSTRY AND MANY SUGGESTIONS OFFERED BY MEMBERS OF THE INDUSTRY ARE INCORPORATED IN THE SPECIFICATION.

THE INTERIM FEDERAL SPECIFICATION FOR HERBICIDE 2,4-D IS PRESENTED HERE IN FULL IN THE HOPES THAT IT WILL SERVE AS A GUIDE FOR OTHER PUBLIC AGENCIES. SOME CHEMISTS HAVE RESERVATIONS AS TO THE ADEQUACY OF METHODS OF ANALYSIS SET FORTH IN THE SPECIFICATIONS, BUT AS OF THIS TIME THIS SPECIFICATION FOR 2,4-D IS THE BEST THAT HAS BEEN DEVELOPED.

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*NATIONAL AGRICULTURAL CHEMICALS ASSOCIATION,

O-H-00200 (AGR-ARS)
AUGUST 6, 1956

INTERIM FEDERAL SPECIFICATION

HERBICIDE, 2, 4- DICHLOROPHENOXYACETIC ACID (SALTS AND ESTERS)

THIS INTERIM FEDERAL SPECIFICATION WAS DEVELOPED BY THE AGRICULTURE RESEARCH SERVICE, DEPARTMENT OF AGRICULTURE, BASED UPON CURRENTLY AVAILABLE TECHNICAL INFORMATION. IT IS RECOMMENDED THAT FEDERAL AGENCIES USE IT IN PROCUREMENT AND FORWARD RECOMMENDATIONS FOR CHANGES TO THE PREPARING ACTIVITY AT THE ADDRESS SHOWN ABOVE.

1. SCOPE AND CLASSIFICATION

1.1 SCOPE.- 2,4-DICHLOROPHENOXYACETIC ACID (2,4-D) IS AN ORGANIC ACID RELATIVELY INSOLUBLE IN WATER OR OIL. IT IS NORMALLY COMPOUNDED BEFORE BEING USED AS AN HERBICIDE. 2,4-D IS A SELECTIVE HERBICIDE. WHEN APPLIED AS A POST-EMERGENCE SPRAY IT WILL KILL MANY BROADLEAVED WEEDS AND WOODY PLANTS, WITH LITTLE OR NO INJURY TO MANY GRASSES, SEDGES, AND OTHER MONOCOTYLEDONOUS PLANTS. HOWEVER, WHEN USED AS A PRE-EMERGENCE SPRAY OR AS A FOLIAGE SPRAY ON SEEDLINGS 2,4-D CAN ALSO BE USED TO CONTROL MANY ANNUAL GRASSES. THIS SPECIFICATION COVERS THREE GENERAL TYPES OF 2,4-D.

1.2 CLASSIFICATION.- FORMULATIONS OF 2,4-D COVERED BY THIS SPECIFICATION SHALL BE OF THREE GENERAL TYPES AS SPECIFIED:

TYPE I - DRY POWDER, SODIUM SALT, FORMS WHICH ARE THE LEAST TOXIC TO PLANTS PER POUND OF 2,4-D ACID EQUIVALENT.

TYPE II - LIQUID AMINE SALT FORMS WHICH ARE INTERMEDIATE IN TOXICITY TO PLANTS PER POUND OF 2,4-D ACID EQUIVALENT.

TYPE III - LIQUID ESTER FORMS WHICH ARE THE MOST TOXIC FORMS OF 2,4-D TO PLANTS PER POUND OF 2,4-D ACID EQUIVALENT.

CLASS 1.- VOLATILE ALKYL ESTER OF 2,4-D.

CLASS 2.- LOW VOLATILE ESTERS.

2. APPLICABLE SPECIFICATIONS, STANDARDS, AND OTHER PUBLICATIONS

2.1 THE FOLLOWING SPECIFICATIONS AND STANDARDS, OF THE ISSUES IN EFFECT ON DATE OF INVITATION FOR BIDS, FORM A PART OF THIS SPECIFICATION:

<u>FEDERAL SPECIFICATIONS:</u>

PPP-C-96 -CANS, METAL 28 GAGE AND LIGHTER
PPP-D-723 -DRUMS. FIBER.

PPP-D-729 -DRUMS: METAL, 55-GALLON
(FOR SHIPMENT OF NON-CORROSIVE MATERIALS).
PPP-D-760 -DRUMS AND PAILS, METAL (5 AND 16.64 GALLON).
PPP-P-31 -PRESERVATION, PACKAGING, PACKING, AND MARKING OF MATERIAL, AND SHIPPING INSTRUCTIONS (DOMESTIC SHIPMENT AND STORAGE).

FEDERAL STANDARD:

FED-STD No. 102 - PRESERVATION, PACKAGING, AND PACKING LEVELS.

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MIL-STD-105 - SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY ATTRIBUTES.

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2.2 OTHER PUBLICATIONS - THE FOLLOWING PUBLICATIONS, OF THE ISSUE IN EFFECT ON DATE OF INVITATION FOR BIDS, FORMS A PART OF THIS SPECIFICATION:

GOVERNMENTAL:

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT.

(COPIES OF THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT MAY BE OBTAINED FROM THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON 25, D. C. PRICES MAY BE OBTAINED FROM THE SUPERINTENDENT OF DOCUMENTS.)

3. REQUIREMENTS

3.1 TYPE I.- THE DRY POWDER FORM SHALL CONSIST OF THE SODIUM SALT OF 2,4-DICHLOROPHENOXYACETIC ACID MONOHYDRATE AND SUCH MODIFYING AND CONDITION-

80 PERCENT 2,4-DICHLOROPHENOXYACETIC ACID AS DETERMINED IN 4.4.1. THE PRODUCT SHALL BE SOLUBLE IN SOFT OR HARD WATER (600 PPM. CALCIUM CARBONATE) AT THE CONCENTRATIONS SPECIFIED IN THE DIRECTIONS FOR USE, NON-FOAMING, AND CONTAIN NO INGREDIENTS WHICH WILL INHIBIT THE APPLICATION OF THE MATERIAL AT THE CONCENTRATIONS NORMALLY USED FOR WEED CONTROL.

3.2 TYPE II.- THE LIQUID AMINE SALT FORM OF 2,4-DICHLOROPHENOXYACETIC ACID SHALL CONTAIN A MINIMUM OF FOUR POUNDS OF 2,4-D ACID PER GALLON OF FORMULATION AT 68^{O}F., AS DETERMINED IN 4.4.2 THE AMINE IN THE FORMULATION SHALL BE EITHER THE ALKYL OR ALKANOLAMINE OR MIXTURES OF THESE TYPES. THE PRODUCT SHALL BE SOLUBLE IN HARD OR SOFT WATER AT THE CONCENTRATIONS SPECIFIED IN THE DIRECTIONS FOR USE, NON-FOAMING, DISPERSE EASILY, MAKING A SOLUTION THAT CONTAINS NO INGREDIENTS WHICH WILL INHIBIT THE APPLICATION OF THE MATERIAL AT THE CONCENTRATIONS NORMALLY USED FOR WEED CONTROL. THE PRODUCT SHALL CONTAIN NO INGREDIENTS WHICH WILL COAGULATE WITH WATER. THE MATERIAL SHALL CONTAIN SEQUESTERING AGENTS WHICH FACILITATE ITS APPLICATION IN HARD OR SOFT WATER.

3.3 TYPE III.- THE LIQUID ESTER FORMS OF 2,4-DICHLOROPHENOXYACETIC ACID.

3.3.1 <u>CLASS 1.- THE VOLATILE ESTERS OF 2,4-DICHLOROPHENOXYACETIC ACID</u>. THE ALKYL LIQUID ESTERS OF 2,4-D SHALL CONTAIN A MINIMUM OF TWO POUNDS OF 2,4-D ACID PER GALLON OF FORMULATION AS DETERMINED IN 4.4.3. THE ESTERS IN THIS CLASS SHALL BELONG TO THE ALKYL GROUP SUCH AS METHYL, ETHYL, PROPYL, ISOPROPYL, BUTYL, AMYL, AND PENTYL, OR MIXTURES OF THESE ALKYL ESTERS. THE FORMULATION SHALL BE A CLEAR SOLUTION READILY MISCIBLE WITH OIL AND EMULSIFIABLE WHEN MIXED WITH WATER. IT SHALL CONTAIN THE NECESSARY SOLVENTS, CARRYING AND EMULSIFYING AGENTS, SUCH THAT THE EMULSION FORMED REQUIRES A MINIMUM OF AGITATION TO MAINTAIN INTIMATE MIXTURE WITH THE DILUENT DURING THE MIXING AND APPLICATION PERIOD. THE OIL CARRIER FOR THE FORMULATION SHALL BE OF SUCH GRAVITY AND VISCOSITY, NOT DETRACTING FROM THE KILLING POWER OF THE ACTIVE INGREDIENTS, TO OFFER MAXIMUM PENETRATION AND SPREAD OF THE SPRAY SOLUTION.

3.3.2 <u>CLASS 2.- THE LOW VOLATILE ESTERS</u>. THESE INCLUDE THE GLYCOL, POLYGLYCOL AND THEIR ETHER ESTER DERIVATIVES OF 2,4-D, AS WELL AS OTHER HEAVY MOLECULAR WEIGHT ESTERS OF 2,4-D THAT ARE KNOWN TO BE LOW VOLATILE. THE LOW VOLATILE ESTERS OF 2,4-D SHALL CONTAIN A MINIMUM OF FOUR POUNDS OF 2,4-D ACID PER GALLON OF FORMULATION AT 68^{O} F., AS DETERMINED IN 4.2.3. THIS CLASS SHALL NOT INCLUDE ESTERS OF THE LOWER ALKYL GROUP SUCH AS METHYL, ETHYL, PROPYL, ISOPROPYL, BUTYL, AMYL, AND PENTYL, OR MIXTURES OF THESE ALKYL ESTERS. THE FORMULATION SHALL BE READILY MISCIBLE WITH OIL AND EMULSIFIABLE WITH WATER. THE PRODUCT SHALL BE A CLEAR SOLUTION, AND SHALL INCLUDE THE NECESSARY SOLVENTS, CARRYING AND EMULSIFYING AGENTS, SUCH THAT THE EMULSION FORMED REQUIRES A MINIMUM OF AGITATION TO MAINTAIN INTIMATE MIXTURE WITH THE DILUENT DURING THE MIXING AND APPLICATION PERIOD. THE OIL CARRIER FOR THE FORMULATION SHALL BE OF SUCH GRAVITY AND VISCOSITY, NOT DETRACTING FROM THE KILLING POWER OF THE ACTIVE INGREDIENTS, TO OFFER MAXIMUM PENETRATION AND SPREAD OF THE SPRAY SOLUTION. WHEN TESTED FOR VOLATILITY AS DESCRIBED IN 4.4.4. THE PRODUCT SHALL HAVE AN AVERAGE RESPONSE OF LESS THAN 4.0.

3.4 WORKMANSHIP.- THE FINISHED PRODUCTS SHALL BE CLEAN AND UNIFORM, AND FREE FROM ANY DEFECTS WHICH MIGHT IMPAIR THEIR UTILITY.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 SAMPLING FOR LOT ACCEPTANCE.

4.1.1 INSPECTION LOT.- FOR PURPOSES OF SAMPLING, A LOT SHALL CONSIST OF ALL MATERIAL OFFERED FOR INSPECTION AT ONE TIME. IN CASE MATERIAL IS PRODUCED BY A CONTINUOUS-RUN PROCESS THE LOT SHALL CONTAIN MATERIAL FROM ONLY ONE CONTINUOUS RUN. MATERIAL IN THE INSPECTION LOT SHALL BE IDENTIFIED BY ORDER OF PRODUCTION (IN CASE OF A CONTINUOUS-RUN PROCESS) OR BY BATCH NUMBER (IN CASE OF BATCH PROCESS) UNTIL ULTIMATE ACTION IS TAKEN BY THE GOVERNMENT INSPECTOR AS TO THE ACCEPTANCE OR REJECTION OF THE LOT.

4.1.2 SAMPLING FOR INSPECTION OF FILLED CONTAINERS.- A RANDOM SAMPLE OF FILLED CONTAINERS SHALL BE TAKEN FROM EACH LOT BY THE GOVERNMENT INSPECTOR, IN ACCORDANCE WITH MIL-STD-105 AT INSPECTION LEVEL I, AND ACCEPTABLE QUALITY LEVEL (A.Q.L.) = 2.5 PERCENT DEFECTIVE TO VERIFY COMPLIANCE WITH ALL STIPULATIONS OF THIS SPECIFICATION REGARDING FILL, CLOSURE, MARKING, AND OTHER REQUIREMENTS NOT INVOLVING TESTS.

4.1.3 SAMPLING FOR TESTS.- FROM EACH INSPECTION LOT THE GOVERNMENT INSPECTOR SHALL TAKE THREE SEPARATE 1-POUND OR 1-GALLON SAMPLES. IN CASE THE MATERIAL IS PRODUCED BY A BATCH PROCESS, AND THE INSPECTION LOT CONTAINS MORE THAN 2 BATCHES, THE THREE SAMPLES SHALL NORMALLY BE TAKEN FROM DIFFERENT BATCHES, FROM TIME TO TIME; HOWEVER, AT THE DISCRETION OF THE INSPECTOR, TWO OR THREE OF THE SAMPLES SHALL BE TAKEN FROM THE SAME BATCH, IN WHICH CASE THE SAMPLES SHALL BE OBTAINED IN A MANNER CALCULATED TO DISCLOSE ANY NON-UNIFORMITY OF THE MATERIAL WITHIN THE BATCH. WHERE MATERIAL IS PRODUCED BY A CONTINUOUS-RUN PROCESS THE THREE SAMPLES SHALL BE TAKEN SO AS TO REPRESENT RESPECTIVELY, THE FIRST PART, THE MIDDLE PART, AND THE LAST PART OF THE RUN WHICH PRODUCED THE INSPECTION LOT. EACH SAMPLE SHALL BE THOROUGHLY MIXED AND DIVIDED INTO THREE EQUAL PORTIONS. THE PORTIONS SHALL BE PLACED IN SEPARATE, CLEAN, DRY, METAL OR GLASS CONTAINERS, WHICH SHALL BE SEALED AND CAREFULLY MARKED. ONE OF THE PORTIONS OF EACH SAMPLE SHALL BE FORWARDED TO A GOVERNMENT LABORATORY DESIGNATED BY THE BUREAU OR AGENCY CONCERNED, ONE SHALL BE DELIVERED TO THE CONTRACTOR, AND ONE HELD BY THE GOVERNMENT INSPECTOR TO BE USED FOR RETESTS IN CASE OF DISPUTE.

4.2 INSPECTION

4.2.1 INSPECTION OF FILLED CONTAINERS.- EACH SAMPLE FILLED CONTAINER SELECTED IN ACCORDANCE WITH 4.1.2 SHALL BE EXAMINED BY THE GOVERNMENT INSPECTOR FOR DEFECTS OF THE CONTAINER AND THE CLOSURE, FOR EVIDENCE OF LEAKAGE, AND FOR UNSATISFACTORY MARKINGS. EACH SAMPLE FILLED CONTAINER SHALL ALSO BE WEIGHED TO DETERMINE THE AMOUNT OF THE CONTENTS. ANY CONTAINER IN THE SAMPLE HAVING ONE OR MORE DEFECTS, OR UNDER REQUIRED FILL, SHALL BE REJECTED, AND IF THE NUMBER OF DEFECTIVE CONTAINERS IN ANY SAMPLE EXCEEDS THE ACCEPTANCE NUMBER FOR THE APPROPRIATE SAMPLING PLAN OF MIL-STD-105 THE LOT REPRESENTED BY THE SAMPLE SHALL BE REJECTED. REJECTED LOTS MAY BE RESUBMITTED FOR ACCEPTANCE TESTS PROVIDED THAT THE CONTRACTOR HAS REMOVED OR REPAIRED ALL NONCONFORMING CONTAINERS.

4.3 LOT ACCEPTANCE TESTS.- THE SAMPLE SPECIMENS SELECTED IN ACCORDANCE WITH 4.1.3 SHALL BE SUBJECTED SEPARATELY TO THE TESTS SPECIFIED IN 4.4 IF EITHER SPECIMEN FAILS IN ONE OR MORE OF THE TESTS THE LOT SHALL BE REJECTED. REJECTED LOTS MAY BE RESUBMITTED FOR ACCEPTANCE TEST PROVIDED THE CONTRACTOR

4.4 TEST PROCEDURES

4.4.1 2,4-DICHLOROPHENOXYACETIC ACID CONTENT IN SODIUM SALT OF 2,4-DICHLOROPHENOXYACETIC ACID MONOHYDRATE. DISSOLVE A SAMPLE EQUIVALENT TO ABOUT 1 G. OF 2,4-D ACID OR 1.20 - 1.25 G OF THE SODIUM SALT IN 50 ML. OF WATER, TRANSFER TO 250 ML. SEPARATORY FUNNEL. NEUTRALIZE IF NECESSARY WITH 10% H_2SO_4, AND ADD 10 ML. IN EXCESS. EXTRACT THE AQUEOUS PHASE TWICE WITH 75 ML. PORTIONS OF ETHER. WASH THE COMBINED ETHER EXTRACTS FREE FROM MINERAL ACID WITH 3 PORTIONS OF WATER EXACTLY 10 ML. EACH. AVOID SLIGHT EMULSIFICATION BY EXCESSIVE SHAKING. FILTER THE ETHER SOLUTION THROUGH A FUNNEL CONTAINING A SMALL PIECE OF COTTON PREVIOUSLY SATURATED WITH ETHER INTO A 400 ML. BEAKER, RINSING THE SEPARATORY FUNNEL WITH ETHER. ADD 25 ML. OF WATER, A FEW BOILING CHIPS, AND EVAPORATE OFF THE ETHER LAYER ON A STEAM BATH UNTIL APPROXIMATELY 25 ML. OF ETHER REMAINS. REMOVE THE BEAKER FROM THE STEAM BATH AND EVAPORATE OFF THE REMAINING PORTION OF ETHER AT ROOM TEMPERATURE BY MEANS OF A CURRENT OF AIR. DISSOLVE THE AQUEOUS MIXTURE IN 100 ML. OF NEUTRAL ETHYL ALCOHOL AND TITRATE WITH 0.1 N NAOH USING 1 ML. OF INDICATORS* (LG IN 100 ML. OF ALCOHOL).

*EITHER PHENOLPHTHALEIN OR THYMOLPHTHALEIN MAY BE USED IN THE TITRATION PROVIDED THE ONE SELECTED IS USED IN STANDARDIZATION OF THE SODIUM HYDROXIDE.

EACH ML. OF 0.1 N NAOH IS EQUIVALENT TO 0.02210 G OF 2,4-DICHLOROPHENOXYACETIC ACID OR 0.02610 G OF SODIUM DICHLOROPHENOXYACETATE. REFERENCE: METHODS OF ANALYSIS, ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, 8TH ED., PAR. 5.133 (c), PAGE 75.

4.4.2 2,4-DICHLOROPHENOXYACETIC ACID CONTENT IN AMINE SALTS OF 2,4-DICHLOROPHENOXYACETIC ACID. TRANSFER A SAMPLE EQUIVALENT (OR A SUITABLE ALIQUOT OF A SAMPLE DILUTED WITH WATER) TO ABOUT 1 G OF 2,4-D ACID TO A 250 ML SEPARATORY FUNNEL. DILUTE TO 50 ML. OF WATER AND PROCEED AS DIRECTED IN 4.4.1. CALCULATE THE PERCENT 2,4-D ACID FOUND TO THE SPECIFIC AMINE PRESENT IN THE SAMPLE.

4.4.3 ESTERS OF 2,4-DICHLOROPHENOXYACETIC ACID BY DETERMINATION OF TOTAL CHLORINE. WEIGH AND MIX 1.5 G OF BORIC ANHYDRIDE (EASTMAN KODAK CO., CAT. #2685 OR EQUIVALENT), 1.0 G FINELY POWDERED POTASSIUM NITRATE, AND 0.4 G FINELY POWDERED SUCROSE. TRANSFER APPROXIMATELY ONE-FOURTH OF THIS MIXTURE TO A 42 ML. PARR BOMB ELECTRIC IGNITION TYPE, AND ADD FROM A SMALL WEIGHING BURET ABOUT 0.25 - 0.30 G OF SAMPLE CONTAINING FROM 0.030 - 0.034 G CHLORINE, (WHEN A SAMPLE LARGER THAN 0.30 G IS REQUIRED, 2.5 G OF BORIC ANHYDRIDE SHOULD BE USED. IN NO CASES SHOULD A SAMPLE LARGER THAN 0.6 G BE TAKEN.) MIX WELL WITH A THIN STIRRING ROD. ADD THE REMAINDER OF THE BORIC ANHYDRIDE, POTASSIUM NITRATE AND SUCROSE MIXTURE IN SMALL PORTIONS AND THOROUGHLY MIX AFTER EACH ADDITION. MEASURE 15 G OF CALORIMETRIC GRADE SODIUM PEROXIDE IN A STANDARD MEASURING DIPPER, ADD A SMALL PORTION TO THE CONTENTS OF THE BOMB, AND STIR. ADD THE BALANCE OF SODIUM PEROXIDE AND THOROUGHLY MIX BY STIRRING WITH THE ROD. WITHDRAW THE ROD AND BRUSH FREE OF ADHERING PARTICLES. QUICKLY CUT OR BREAK OFF THE LOWER $1\frac{1}{2}$ INCHES OF THE STIRRING ROD AND IMBED IT IN THE FUSION MIXTURE. SPRINKLE ON THE TOP OF THE FUSION MIXTURE A SMALL QUANTITY OF FINELY GROUND SUCROSE. PREPARE THE HEAD BY HEATING THE FUSE WIRE MOMENTARILY IN A FLAME AND IMMERSING IT INTO A SMALL QUANTITY OF SUCROSE. ONE MILLIGRAM OF THE SUBSTANCE IS SUFFICIENT TO START THE COMBUSTION. ASSEMBLE THE BOMB AND IGNITE IN THE USUAL MANNER WITH A SATISFACTORY SHIELD BETWEEN THE OPERATOR AND APPARATUS.

PLACE ABOUT 100 ML. OF DISTILLED WATER IN 600 ML. BEAKER AND HEAT NEARLY TO BOILING. AFTER COOLING OF THE BOMB, DISMANTLE IT AND DIP THE COVER IN THE HOT WATER TO DISSOLVE ANY OF THE FUSION WHICH MAY BE ADHERING TO ITS UNDER SIDE. WASH COVER WITH A FINE JET OF DISTILLED WATER CATCHING THE WASHINGS IN THE BEAKER. WITH A PAIR OF TONGS LAY THE FUSION CUP ON ITS SIDE IN THE SAME BEAKER OF HOT WATER, COVERING IT IMMEDIATELY WITH A WATCH GLASS. AFTER THE FUSED MATERIAL HAS BEEN DISSOLVED, REMOVE THE CUP AND RINSE WITH HOT WATER, COOL THE SOLUTION, ADD SEVERAL DROPS OF PHENOLPHTHALEIN INDICATOR, NEUTRALIZE WITH CONCENTRATED NITRIC ACID AND ADD 5 ML. IN EXCESS. FROM THIS POINT, THE CHLORINE MAY BE DETERMINED BY ELECTROMETRIC TITRATION OR BY THE VOLHARD PROCEDURE AS DIRECTED IN THE METHODS OF ANALYSIS, ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS, 8TH ED., PAGE 80, PAR. 5.153 (A) (C).

NOTE 1.- THE COMBINATION OF MATERIALS USED IN A SODIUM PEROXIDE BOMB HAS EXPLOSIVE PROPERTIES IF WRONGLY HANDLED, AND THE OPERATOR SHOULD REMAIN FULLY AWARE AT ALL TIMES OF THE PRECAUTIONS THAT MUST BE OBSERVED AND THE STEPS WHICH MUST BE TAKEN TO AVOID DAMAGE TO THE APPARATUS AND POSSIBLY PERSONAL INJURY. IT IS SUGGESTED THAT THE INSTRUCTIONS AND PRECAUTIONS GIVEN IN THE "PARR MANUAL NUMBER 121 - PERIOXIDE BOMB APPARATUS AND METHODS," PARR INSTRUMENT COMPANY, MOLINE, ILLINOIS, BE OBSERVED.

NOTE 2.- A FLAME FIRED BOMB MAY BE USED IN PLACE OF THE ELECTRIC IGNITION TYPE, BUT IN CASE OF DISPUTE THE ELECTRIC IGNITION TYPE WILL GOVERN.

4.4.4 <u>VOLATILITY TEST - RELATIVE VAPOR ACTIVITY</u>.- THE VAPOR ACTIVITY TEST IS CONDUCTED WITH GASTIGHT CELLOPHANE CASES APPROXIMATELY 3½ X 3½ X 16 INCHES IN SIZE. YOUNG RAPIDLY GROWING PINTO BEAN PLANTS ABOUT 4 INCHES IN HEIGHT ARE USED AS TEST PLANTS. A SINGLE BEAN PLANT GROWING IN A 3 INCH POT IS PLACED IN EACH CELLOPHANE CASE JUST PRIOR TO TESTING THE ESTER.

4.4.4.1.- TWO MILLIGRAMS OF ACID EQUIVALENT AS THE ESTER IS DISSOLVED IN 10 MILLILITERS OF 95% ETHYL ALCOHOL AND A WHATMAN NO. 1 FILTER PAPER (9 CM. DIAMETER) IS THOROUGHLY MOISTENED BY DIPPING IN THE SOLUTION. (DO NOT REUSE THE CONTAINER USED IN THIS IMPREGNATION.) THE ALCOHOL IS THEN ALLOWED TO EVAPORATE AND THE FILTER PAPER IMPREGNATED WITH THE ESTER IS INSERTED INTO THE CELLOPHANE CASE CONTAINING THE BEAN PLANT AND FASTENED TO THE INSIDE OF THE CASE 6 INCHES ABOVE THE LEAVES OF THE TEST PLANT. THE OPEN END OF THE CASE IS THEN SEALED.

4.4.4.2.- THE CASE CONTAINING THE TEST PLANT AND TREATED FILTER PAPER IS THEN PLACED IN A DARK ROOM FOR A PERIOD OF 24 HOURS. THE TEMPERATURE RANGE OF THE ROOM SHOULD BE 80° TO 90°F. CONTROL PLANTS ARE ALSO SEALED IN SEPARATE CASES. THE EXPERIMENTAL DESIGN IS A RANDOMIZED BLOCK WITH THREE REPLICATIONS AND EACH TEST IS REPEATED THREE TIMES. THE EVALUATIONS SHALL BE MADE FOLLOWING AN EXPOSURE PERIOD OF 24 HOURS.

4.4.4.3.- OBSERVATIONS OF EFFECT OF THE VAPORS ON TEST PLANTS SHOULD TAKE INTO CONSIDERATION WHETHER OR NOT THE PLANT IS SLIGHTLY, MODERATELY OR SEVERLY INJURED, INCLUDING SUCH SYMPTOMS AS DEGREE OF STEM CURVATURE, TERMINAL BUD INHIBITION AND DEGREE OF LEAF CURL. THE RELATIVE VAPOR ACTIVITY OF AN ESTER CAN BE NUMERICALLY DESIGNATED AS FOLLOWS: 0 - NO VISIBLE EFFECT; 1, 2, 3 - SLIGHT INJURY - PLANT USUALLY RECOVERED WITH LITTLE OR NO REDUCTION IN GROWTH, SLIGHT EPINASTY PRESENT, STEM CURVATURE SLIGHT; 4, 5, 6 - MODERATE INJURY - PLANT

MODERATE STEM CURVATURE PRESENT; 7, 8, 9 - SEVERE INJURY - PLANT USUALLY DOES NOT RECOVER, PRONOUNCED EPINASTY, TOGETHER WITH PRONOUNCED STEM CURVATURE; 10 - PLANT KILLED.

4.4.4.4- CHEMICALLY PURE 2,4-D ACID AND THE BUTYL ESTER OF 2,4-D ARE USED AS STANDARDS. THE 2,4-D ACID UNDER MOST CONDITIONS IS RATED 0 (ZERO) WHILE THE BUTYL ESTER HAS A HIGH VAPOR ACTIVITY WITH A RATING OF 9.0 ESTERS RECEIVING THE FOLLOWING RATINGS WOULD BE CLASSED AS FOLLOWS:

0	NO VAPOR ACTIVITY
1,2,3	VERY LOW VAPOR ACTIVITY
4,5,6	LOW TO MODERATE VAPOR ACTIVITY
7,8,9	HIGH VAPOR ACTIVITY
10	VERY HIGH VAPOR ACTIVITY

ESTERS MUST RECEIVE A VAPOR ACTIVITY RATING OF LESS THAN 4 TO BE DESIGNATED LOW VOLATILE.

5. PREPARATION FOR DELIVERY (FOR DEFINITIONS AND LEVELS SEE 6.1)

5.1 PRESERVATION AND PACKAGING LEVELS.

5.1.1 LEVEL A.- TO BE INSERTED BY THE DEPARTMENT OF DEFENSE.

5.1.2 LEVEL B

5.1.2.1 TYPE I - TYPE I SHALL BE PACKAGED IN 50-POUND FIBER DRUMS. DRUMS SHALL CONFORM TO FEDERAL SPECIFICATION PPP-D-723.

5.1.2.2 TYPES II AND TYPES III

5.1.2.2.1 UNIT CONTAINERS.- THE MATERIAL SHALL BE PACKAGED IN 1-GALLON METAL CANS, WHICH SHALL BE OBLONG, CONFORMING TO TYPE V OF FEDERAL SPECIFICATION PPP-C-96. CANS MAY HAVE EITHER A CLASS 4 SCREW CAP OR CLASS 5 SNAP-ON CAP. THE CONTAINERS SHALL CAUSE NO DELETERIOUS EFFECT UPON THE PRODUCT.

5.1.2.2.2 BULK CONTAINERS.- THE MATERIAL SHALL BE PACKAGED IN 5-GALLON OR 55-GALLON CONTAINERS, AS SPECIFIED IN THE CONTRACT OR ORDER. FIVE GALLON METAL CONTAINERS SHALL CONFORM TO TYPE I, CLASS 1 OR 2, OF FEDERAL SPECIFICATION PPP-D-760. FIFTY-FIVE GALLON DRUMS SHALL CONFORM TO EITHER TYPE II OR TYPE IV OF FEDERAL SPECIFICATION PPP-D-729. THE CONTAINERS SHALL CAUSE NO DELETERIOUS EFFECT ON THE PRODUCT.

5.1.3 LEVEL C.- THE PRODUCT SHALL BE PACKAGED IN ACCORDANCE WITH COMMERCIAL PRACTICE.

5.2 PACKING.

5.2.1 LEVEL A.- TO BE INSERTED BY THE DEPARTMENT OF DEFENSE, IF REQUIRED.

5.2.2 LEVEL B.-

5.2.2.1 TYPE I.- FIFTY-POUND FIBER DRUMS WILL REQUIRE NO OVERPACKING.

5.2.2.2 TYPES II AND III

5.2.2.2.1 UNIT CONTAINERS.- ONE-GALLON CANS SHALL BE PACKED FOR SHIPMENT IN ACCORDANCE WITH THE APPENDIX OF FEDERAL SPECIFICATION PPP-C-96.

5.2.2.2.2 BULK CONTAINERS.- FIVE-GALLON AND FIFTY-FIVE GALLON DRUMS WILL REQUIRE NO OVERPACKING.

5.2.3 LEVEL C.- THE PRODUCT SHALL BE PACKED IN CONTAINERS WHICH ARE ACCEPTABLE BY COMMON OR OTHER CARRIERS FOR SAFE TRANSPORTATION TO POINT OF DESTINATION SPECIFIED IN SHIPPING INSTRUCTIONS AT THE LOWEST TRANSPORTATION RATE FOR SUCH SUPPLIES.

5.2.4 LEVEL D.- TO BE INSERTED BY THE DEPARTMENT OF DEFENSE IF REQUIRED.

5.3 MARKING.

5.3.1 CIVILIAN AGENCIES.- IN ADDITION TO ANY SPECIAL MARKING REQUIRED BY THE CONTRACT OR ORDER, MARKING FOR SHIPMENT SHALL BE IN ACCORDANCE WITH FEDERAL SPECIFICATION PPP-P-31.

5.3.1.1 LABELING.- UNLESS OTHERWISE SPECIFIED, EACH CONTAINER OF 2,4-D FORMULATION SHALL BE LABELED WITH INSTRUCTIONS FOR USE AND MARKED IN COMPLIANCE WITH THE FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT AND OTHER APPLICABLE EXISTING FEDERAL LAWS. DATE OF PACK AND LOT NUMBER SHALL APPEAR ON THE LABEL. IN ADDITION, THE COVER SHALL HAVE THE STOCK NUMBER AND ITEM NOMENCLATURE SHALL BE EMBOSSED ON A METAL PLATE AND WIRED SECURELY TO THE INDIVIDUAL CONTAINER.

6. NOTES

6.1 FEDERAL STANDARD 102 SHOULD BE REFERRED TO FOR DEFINITIONS AND APPLICATIONS OF THE VARIOUS LEVEL OF PACKAGING PROTECTION FOR SUPPLIES AND EQUIPMENT.

6.2 INTENDED USE.

6.2.1 TYPE I.- THE MONOHYDRATE SODIUM SALT DRY POWDER FORM OF 2,4-D IS SPARINGLY WATER SOLUBLE. IT IS ESPECIALLY ADAPTED FOR LAWNS, CEMETERIES AND IN OTHER AREAS WHERE DESIRABLE VEGETATION SUCH AS FLOWERS AND ORNAMENTALS ARE LIKELY TO BE INJURED BY SPRAY DRIFT OR VAPORS. THE DRY POWDER SODIUM SALT FORM IN WATER SOLUTION IS USEFUL ON EASY-TO-KILL WEEDS. THE MAIN DISADVANTAGE OF THE POWDER FORM OF 2,4-D IS THAT IT IS NOT AS EFFECTIVE AS EITHER THE AMINE SALTS OR ESTERS OF 2,4-D ON HARD-TO-KILL WEEDS OR OLDER WEEDS. SOME NOZZLE CLOGGING AND OTHER APPLICATION DIFFICULTIES ARE LIKELY TO RESULT DUE TO INCOMPLETE SOLUTION OF THE SODIUM SALT WHEN THE DRY POWDER FORM IS APPLIED AT HIGH RATES WITH LOW GALLONAGE SPRAYERS. THE EFFECTIVENESS OF THE SODIUM SALT OF 2,4-D IS REDUCED WHEN RAINS OCCUR IMMEDIATELY FOLLOWING APPLICATION. THE SODIUM SALT OF 2,4-D IS THE LEAST TOXIC FORM PER POUND OF 2,4-D ACID TO PLANTS AS SPECIFIED IN TYPES I, II, OR III.

6.2.2 TYPE II.- THE LIQUID AMINE FORMS OF 2,4-D ARE HIGHLY SOLUBLE IN WATER, MAKING A RELATIVELY CLEAR SOLUTION. THEY ARE QUITE STABLE AND ARE EFFECTIVE FOR EASY-TO-KILL OR MODERATELY EASY-TO-KILL WEEDS. THE AMINE SALTS OF 2,4-D ARE MUCH LESS VOLATILE THAN THE ESTER FORMS OF 2,4-D AND ARE SOMEWHAT

BETTER ADAPTED FOR SPRAYING FOR WEED CONTROL NEAR PLANTS SENSITIVE TO 2,4-D. THE LIQUID AMINE SALT FORMS OF 2,4-D ARE WELL ADAPTED FOR SPRAYING IN LAWNS, TURFED AREAS, AND IN TOLERANT FIELD AND HORTICULTURAL CROPS FOR WEED CONTROL. THE AMINE SALTS OF 2,4-D ARE NOT QUITE AS EFFECTIVE ON OLD, SEMI-RESISTANT WEEDS AND WOODY SPECIES AS ARE THE ESTERS. THE AMINE SALTS OF 2,4-D ARE MORE TOXIC TO PLANTS THAN THE SODIUM SALT OF 2,4-D, BUT LESS TOXIC TO PLANTS THAN THE ESTERS OF 2,4-D PER POUND OF 2,4-D ACID.

6.2.3 TYPE III.- THE LIQUID ESTER FORMS OF 2,4-DICHLOROPHENOXYACETIC ACID.

6.2.4 CLASS I.- THE LOWER ALKYL ESTERS OF 2,4-DICHLOROPHENOXYACETIC ACID ARE COMPARATIVELY VOLATILE. WHEN THE LOWER ALKYL ESTERS OF 2,4-D ARE USED FOR WEED CONTROL IN TOLERANT FIELD AND HORTICULTURAL CROPS THEY SHOULD BE USED AT LOWER ACID EQUIVALENT RATES THAN EITHER THE SODIUM OR AMINE SALTS OF 2,4-D. THE LOWER ALKYL ESTERS OF 2,4-D ARE BETTER ADAPTED FOR THE CONTROL OF DEEP ROOTED PERENNIAL WEEDS, HARDER-TO-KILL WEEDS, OLDER SEMI-RESISTANT WEEDS AND WOODY SPECIES THAN THE SODIUM OR AMINE SALTS OF 2,4-D. THE LOWER ALKYL ESTERS OF 2,4-D SHOULD NOT BE USED IN AREAS NEAR SENSITIVE CROPS SUCH AS COTTON, GRAPES, TOMATOES, TOBACCO, AND OTHER SENSITIVE CROPS.

6.2.5 CLASS 2.- THE LOW VOLATILE ESTERS OF 2,4-D HAVE THE SAME INTENDED USE AS THE ESTER FORMS SPECIFIED IN CLASS 1. HOWEVER, IN AREAS WHERE SENSITIVE CROPS ARE GROWN SUCH AS COTTON, ETC., IF AN ESTER FORM OF 2,4-D IS NECESSARY, THE ESTERS SPECIFIED IN CLASS 2 SHOULD BE USED TO REDUCE THE HAZARD OF VOLATILITY.

6.3 ORDERING DATA - PURCHASERS SHOULD EXERCISE ANY DESIRED OPTIONS OFFERED HEREIN (SEE 1.2, 5.1, 5.2, 5.3) (ALSO SEE 6.4 FOR BASIS OF AWARD).

6.4 BASIS OF AWARD

6.4.1 TYPE I.- BIDS SHOULD BE EVALUATED AND THE AWARD MADE ON THE BASIS OF COMPUTING THE PRICE PER POUND OF 2,4-D ACID EQUIVALENT CONTAINED PER POUND OF BULK. (SUPPLIER SHOULD BE REQUESTED TO FURNISH 2,4-D ACID EQUIVALENT DATA).

6.4.2 TYPE II AND III (CLASSES 1 AND 2).- BIDS SHOULD BE EVALUATED AND THE AWARD MADE ON THE BASIS OF COMPUTING THE PRICE PER POUND OF 2,4-D ACID EQUIVALENT CONTAINED IN EACH GALLON OF PREPARATION OR CONCENTRATE (SUPPLIER SHOULD BE REQUESTED TO FURNISH 2,4-D ACID EQUIVALENT DATA).

PATENT NOTICE.- WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS, OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE UNITED STATES GOVERNMENT THEREBY INCURS NO RESPONSIBILITY NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA, IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE, OR SELL ANY PATENTED INVENTION THAT MAY IN WAY BE RELATED THERETO.

PROGRESS REPORT ON HIGHWAY GUARDRAIL VEGETATION CONTROL

R. R. Johnson[1], J.E. Gallagher[1], E.W. Muller[2]

Introduction:

Chemical treatment of highway guardrail areas to control weed growth and reduce mowing costs has become an accepted practice in many areas. Numerous materials of various types have been employed with varying degrees of success. The purpose of this project was to compare several of the standard guardrail treatments and to determine whether new chemicals or chemical combinations would be more effective than treatments now in common use.

In this test twenty-four different treatments were applied to guardrail vegetation in southwestern New York state in early May. Similar treatments were applied in central Ohio and central Connecticut in late July.[3]

Methods and Materials

Herbicide applications were made at 30 gallons per acre with a Dragon backpack sprayer supplying two teejet 8002 nozzles which stradled the guardrail and support posts. An area three feet wide was treated in New York and Connecticut, and an 18 inch strip was treated in Ohio. Plots were 330 feet long and were replicated three times.

The New York test was applied to guardrails along a secondary road that had received periodic broadleaf weed control treatments for several years. Predominate weed species were quackgrass, orchard grass, Kentucky bluegrass, and assorted biennial and perennial broadleaf weeds, including a heavy stand of bouncing Bet.

In Connecticut the weed problem was similar to that in the New York test, but included a moderate population of brambles and blackberries.

The Ohio test was applied to guardrails along a heavily traveled dual trunk highway. Vegetation consisted of a dense stand of tall fescue, red fescue and Kentucky bluegrass. There was a uniform light infestation of wild carrot, chickory and white clover.

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[1]Research Department, AMCHEM PRODUCTS, INC., Ambler, Pennsylvania.
[2]Landscape Architect, New York State Department of Public Works, Hornell, New York.
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An inventory of the plant species present in each plot was taken before treatment and at each evaluation. Because of space limitations, only the vegetation data from the New York tests is included in this paper. It will be noted that in many treatments the same species appear after as well as before treatment. In most such cases the stand of that weed had been reduced considerably. A species was listed in the "after" treatment evaluation if more than two individual plants occurred on the plot.

The following materials were used in these tests:

1. Dalapon - 2,2-dichloropropionic acid, sodium salt.
2. 2,4-D - 2,4-dichlorophenoxyacetic acid, butoxy ethanol ester.
3. Silvex - 2(2,4,5-trichlorophenoxy) propionic acid.
4. Monuron - 3(p-chlorophenyl)-1,1-dimethylurea.
5. Simazin - 2-chloro-4,6-bis(ethylamine)-s-triazine.
6. Amitrol - 3-amino-1,2,4-triazole.
7. Erbon - 2(2,4,5-trichlorophenoxy) ethyl 2,2-dichloropropionate.
8. Diethylene glycol bis 2,2-dichloropropionate.
9. ACP-M-569 - liquid amitrol.
10. ACP-M-617 - 1:3 mixture of amitrol and pentachlorophenol.
11. ACP-M-659 - 1:3 mixture of amitrol and 2,2,3-trichloropropionic acid, sodium salt.
12. ACP-M-660 - 1:3 mixture of amitrol and 2,2,3-trichloropropionic acid, sodium salt.
13. ACP-M-673 - 2,3,6-trichlorophenylacetic acid, sodium salt.
14. ACP-M-674 - 2,3,6-trichlorophenylacetic acid, amide.

In the following tables, the rate is given in pounds of active ingredient per acre. In Table III the following abbreviations are used:

G = Grass control rating.
BL = Broadleaf weed control rating.
AV = Average control rating, $\frac{G + BL}{2}$

Application dates:

New York Test - May 8, 1958
Connecticut Test - July 24, 1958
Ohio Test - July 30, 1958

Table I.

LATE SPRING APPLICATION OF GUARDRAIL VEGETATION CONTROL PLOTS IN NEW YORK STATE

Treatment	lb/A	Grass Rating 6/6	Grass Rating 7/23	Grass Rating 10/3	Broadleaf Weed Rating 6/5	Broadleaf Weed Rating 7/23	Broadleaf Weed Rating 10/3	Average Seasonal Control
1. Dalapon + 2,4-D	21.3 +2	7.0	7.0	5.0	7.7	6.6	6.3	6.6
2. Dalapon + 2,4-D + Monuron	21.3 +2 +8	8.7	8.5	6.7	7.3	8.0	7.7	7.8
3. Dalapon + 2,4-D + Monuron	14.2 +2 +8	9.3	8.3	5.0	8.2	8.6	6.8	7.7
4. Dalapon + 2,4-D + Simazin	21.3 +2 +5	8.8	7.0	7.3	7.7	7.8	6.7	7.6
5. Dalapon + 2,4-D + Simazin	14.2 +2 +5	8.3	6.6	7.3	7.7	7.3	5.3	7.1
6. ACP-M-542	5.6	8.3	8.3	7.7	7.0	9.0	8.3	8.1
7. ACP-M-542	11.2	9.5	9.1	9.0	7.3	9.1	9.0	8.8
8. ACP-M-542	22.4	9.8	10.0	9.7	8.7	9.0	9.0	9.4
9. ACP-M-543	8.1	9.3	5.3	6.0	7.7	5.0	6.3	6.6
10. ACP-M-543	16.2	9.8	7.3	6.0	9.2	8.1	8.0	8.1
11. ACP-M-543	32.4	10.0	9.6	9.0	8.7	9.5	8.6	9.3
12. Monuron	8	8.3	6.8	5.3	7.0	7.8	5.0	6.7
13. Monuron	16	7.7	8.6	7.0	8.0	9.1	7.0	7.9
14. Monuron	32	7.3	9.3	8.3	8.0	9.5	8.7	8.5
15. Simazin	5	2.0	3.1	6.0	1.0	9.5	7.0	4.8
16. Simazin	10	4.8	7.0	8.3	4.3	8.0	8.0	6.7
17. Simazin	20	5.5	8.3	9.5	5.5	9.6	9.3	7.9
18. ACP-M-569	10	6.5	5.7	3.0	7.0	8.8	9.5	6.8
19. ACP-M-569	20	6.7	5.0	3.0	7.3	8.6	9.3	6.7
20. Amitrol	20	6.7	6.0	3.0	7.3	8.1	9.0	6.7
21. ACP-M-617	9	7.5	1.8	4.7	6.0	4.3	9.3	5.6
22. ACP-M-617 + Simazin	9 +2.5	9.0	6.3	4.7	8.0	6.3	8.3	7.1
23. Check		0.0	0.0	0.0	0.0	0.0	0.0	0.0
24. Baron + Dalapon	20 +21.3	7.8	8.3	5.3	5.7	8.5	6.7	7.1

0 - no control
10 - complete kill

Test applied 8 May 1958

Table II.

NEW YORK STATE

GUARDRAIL VEGETATION CONTROL TEST

POPULATION DATA

	Before Treatment - May 8, 1958		After Treatment - October 3, 1958	
Tmt.#	Grass	Broadleaf	Grass	Broadleaf
1.*	orchard, quack, Kentucky blue, timothy, rye, tall fescue	dandelion, carrot, aster, bedstraw, mullein, dock, butter & eggs	orchard, quack, foxtail	bedstraw, milkweed, butter & eggs, bouncing Bet
2.	quack, orchard, Kentucky blue, timothy, rye, tall fescue	dandelion, carrot, aster, bedstraw, mullein, dock, butter & eggs, bouncing Bet	quack, orchard, foxtail, barnyard,	milkweed, butter & eggs, ash seedling, bouncing Bet
3.	quack, orchard, Canada blue, Kentucky blue, tall fescue	geranium, dock, bouncing Bet, dandelion butter & eggs	quack, orchard, foxtail	bouncing Bet, milkweed
4.	quack, orchard, rye, Kentucky blue	dandelion, dock, bedstraw, hardrock, chickweed, carrot, parsnip, clover, bouncing Bet, butter & eggs, yellow rocket	quack, orchard, water foxtail barnyard	dock, milkweed, pigweed, bouncing Bet
5.	quack, orchard, Kentucky blue, tall fescue	dandelion, bedstraw, bouncing Bet	foxtail, barnyard, water	bouncing Bet, milkweed, dock,
6.	quack, orchard, rye, Kentucky blue	dandelion, bouncing Bet,	orchard, quack, foxtail, Canada blue,	bouncing Bet, milkweed,
7.	quack, orchard, Kentucky blue, rye	dandelion, geranium, bouncing Bet, dock, sorrel	foxtail quack	bouncing Bet,
8.	quack, orchard Kentucky blue, Canada blue, rye	dandelion, dock, carrot, yarrow, bouncing Bet sorrel	quack	pigweed, milkweed,

*Treatment numbers refer to treatment list in table I.

Table II.
(cont.)

	Before Treatment - May 8, 1958		After Treatment - October 3, 1958	
Tmt.#	Grass	Broadleaf	Grass	Broadleaf
9.	quack, orchard, rye, timothy Kentucky blue, Canada blue,	dandelion, sorrel, chickweed, dock, burdock, henbit, bedstraw, thistle, yellow rocket, plantain	orchard, quack, foxtail Canada blue, Muhlenbergia	ragweed, pigweed, bouncing Bet, dandelion, burdock, thistle
10.	orchard, quack, Kentucky blue, timothy, Canada blue,	dandelion, bouncing Bet, bedstraw, dock, butter & eggs yarrow, wild geranium	orchard, quack, foxtail, barnyard	milkweed, bramble, sheep sorrel,
11.	orchard, quack, Kentucky blue, rye, timothy, tall fescue, Canada blue	dandelion, carrot, bouncing Bet, dock, sheep sorrel butter & eggs bedstraw, yarrow, chickory, burdock, wild geranium	foxtail, quack,	pigweed, bramble, milkweed, bouncing Bet,
12.	quack, orchard, rye, timothy, Kentucky blue, tall fescue, Canada blue	bedstraw, mint, geranium, yarrow, dandelion, dock, sorrel, bouncing Bet, butter & eggs	foxtail, quack, orchard, barnyard, Canada blue	butter & eggs, bouncing Bet, milkweed,
13.	quack, orchard, Kentucky blue, tall fescue,	dandelion, dock, mallow, oxalis, wild geranium, bouncing Bet, butter & eggs	quack, orchard, water, foxtail, barnyard,	bouncing Bet, milkweed, dock, thistle, sheep sorrel,
14.	quack, orchard, rye, Kentucky blue, tall fescue	dandelion, dock, carrot, bouncing Bet	quack	dandelion, bouncing Bet
15.	quack, orchard, Kentucky blue, tall fescue	dandelion, dock, carrot, yarrow, bouncing Bet,	quack, orchard, Kentucky blue, Canada blue, Muhlenbergia foxtail	thistle, wild geranium, milkweed, sheep sorrel, bouncing Bet

Table II.
(cont.)

	Before Treatment - May 8, 1958		After Treatment - October 3, 1958	
Tmt.#	Grass	Broadleaf	Grass	Broadleaf
16.	quack, orchard, Kentucky blue, Canada blue, tall fescue	dandelion, dock, aster, bouncing Bet	quack, orchard, Kentucky blue, Canada blue,	thistle, bouncing Bet, milkweed
17.	quack, orchard, Kentucky blue, Canada blue, rye	horsetail, bouncing Bet	quack, Muhlenbergia	milkweed, horsetail, bouncing Bet
18.	orchard, rye, quack, tall fescue, Kentucky blue, Canada blue	mullein, yarrow, butter & eggs, dandelion, dock, wild geranium, bouncing Bet	orchard, foxtail, Muhlenbergia	milkweed
19.	orchard, quack, Kentucky blue, tall fescue, rye	yarrow, dock, bedstraw, dandelion, carrot, butter & eggs, wild geranium, bouncing Bet	foxtail, panic,	yellow rocket,
20.	orchard, quack, Kentucky blue, tall fescue, Canada blue	yarrow, dock, bedstraw, dandelion, carrot, burdock, yellow rocket, butter & eggs, sorrel, bouncing Bet	foxtail, orchard, love	dock, prickly lettuce
21.	quack, orchard, Canada blue, tall fescue	bouncing Bet, dandelion, dock,	foxtail, quack, orchard	bouncing Bet,
22.	quack, orchard, Kentucky blue, Canada blue	bouncing Bet, dock, yarrow, butter & eggs, wild geranium	foxtail, orchard, quack	milkweed, bouncing Bet

Table II.
(cont.)

	Before Treatment - May 8, 1958		After Treatment - October 3, 1958	
Tmt.#	Grass	Broadleaf	Grass	Broadleaf
check 23.	quack, timothy, tall fescue, orchard, rye, Kentucky blue, Canada blue,	dandelion, carrot, wild geranium, bedstraw, dock, chickory,aster, butter & eggs, sheep sorrel, bouncing Bet, yarrow, burdock, horsetail	orchard, quack, foxtail, crab, panic, rye, tall fescue, Kentucky blue, Canada blue, Muhlenbergia	milkweed, dock, bouncing Bet,
24.	quack, orchard, tall fescue, Kentucky blue, Canada blue,	Bouncing Bet dandelion, dock, yarrow, wild geranium, butter & eggs	quack, orchard, foxtail, barnyard,	milkweed, sheep sorrel, butter & eggs, bouncing Bet,

Weed species as recorded in this paper:

1. quack - Agropyron repens
2. orchard - Dactylis glomerata
3. tall fescue - Festuca arundinacea
4. Canada bluegrass - Poa compressa
5. Kentucky bluegrass - Poa pratensis
6. Rye - Lolium perenne
7. Timothy - Phleum pratense
8. Dandelion - Taraxacum officinale
9. Wild carrot - Daucus carota
10. Sorrel - Rumex acetosella
11. Bouncing Bet - Saponaria officinalis
12. Dock - Rumex crispus
13. Bedstraw - Galium spp.
14. Chickweed - Cerastium vulgatum
15. Wild geranium - Geranium nolle
16. Mullein - Verbascum thapsus
17. Wild parsnip - Pastinaca sativa
18. Burdock - Arctium lappa
19. Henbit - Lamium amplexicaule
20. Thistle - Circium arvense
21. Plantain - Plantago spp.
22. Chickory - Chichorium intybus
23. Butter & eggs - Linaria vulgaris
24. Mint - Mentha spp.
25. Mallow - Malva neglecta
26. Horsetail rush - Equisetum arvense
27. Yarrow - Achillea millefolium
28. Clover - Trifolium spp.
29. Poison ivy - Rhus radicans
30. Oxalis - Oxalis stricta
31. Wild aster - Aster spp.
32. Bramble - Rubus spp.
33. Foxtail - Setaria spp.
34. Milkweed - Asclepias syriaca

Table III.

LATE SUMMER APPLICATION OF GUARDRAIL TEST

Treatment	lb/A	Connecticut 1 month AV	Connecticut 3 months G	Connecticut 3 months BL	Connecticut 3 months AV	Ohio 2 months G	Ohio 2 months BL	Ohio 2 months AV	Ohio 3 months G	Ohio 3 months BL	Ohio 3 months AV
1. Dalapon + 2,4-D*	21.3+2	7.0	7.5	6.5	7.0	6.0	7.0	6.5	4.3	1	2.6
2. Dalapon + 2,4-D* + Simazin	21.3+2 +5	5.5	8.0	8.0	8.0	8.3	8.0	8.2	8.6	5.0	6.3
3. ACP-M-542	2.8	2.5	2.5	5.5	4.0	3.3	4.3	3.8	2.2	5.0	3.6
4. ACP-M-542	5.6	3.0	4.0	5.5	4.8	6.6	8.6	7.6	6.8	6.0	6.4
5. ACP-M-543	4.05					4.0	4.3	4.2	1.6	4.0	2.8
6. ACP-M-543	8.1					6.3	7.0	6.6	4.3	3.0	3.7
7. ACP-M-569	5	3.0	3.0	7.0	5.0	3.5	7.5	5.5	2.0	5.0	3.5
8. ACP-M-569	10	3.5	5.5	8.3	6.9	7.0	8.5	7.7	3.6	3.0	3.0
9. Amitrol	10	2.5	3.5	8.0	5.8	3.5	8.0	5.8	2.8	3.0	2.9
10. ACP-M-673	5	4.5	4.8	8.0	6.4	0	0	0	0	3.0	1.5
11. ACP-M-673	10	1.5	2.0	5.5	3.8	1.0	1.0	1.0	0	4.0	2.0
12. ACP-M-673	20	1.5	3.5	6.0	4.8	1.5	1.0	1.2	0	4.0	2.0
13. ACP-M-674	5	0.5	0	0	0	0	1.0	0.5	0	4.0	2.0
14. ACP-M-674	10	0	0	4.0	2.0	1.0	3.0	2.0	0	3.0	1.5
15. ACP-M-674	20	7.0	2.0	5.0	3.5						
16. M-673 + M-569	10+5	8.0	4.0	7.0	5.5	3.5	5.0	4.8	2.0	2.0	2.0
17. M-674 + M-569	10+5	9.0	6.0	8.0	7.0	4.0	7.5	5.7	1.0	4.0	2.5
18. ACP-M-659	19.2	5.5	7.0	8.0	7.5	5.5	7.0	6.2	2.3	3.0	2.7
19. ACP-M-660	21.7	6.5	8.0	8.0	8.0	8.5	5.5	7.0	3.0	2.5	2.8
20. M-659 + M-673	19.2+5	4.5	3.0	7.5	5.8	6.5	7.0	6.8	1.0	3.0	2.0
21. M-659 + M-674	19.2+5	4.0	2.0	4.0	3.0	7.5	6.0	6.7	3.0	1.0	2.0
22. M-673 + L-638	10 +2	1.5	3.0	7.0	5.0	0	2.0	1.0	0	1.0	0.5
23. M-674 + L-638	10 +2	1.0	2.0	6.0	4.0	0.5	2.5	1.5	0	2.0	1.0
24. Dalapon ester + Silvex	23 +3					7.0	7.0	7.0	6.5	4.0	5.2

*Dalapon 14.2 + 2,4-D 2 Ohio

Discussion and Conclusions:

Dalapon combinations:

In New York dalapon gave good to excellent initial control of grasses, with control declining through the summer. The addition of 2,4-D gave good control of annual weeds, but did not control milkweed or bouncing Bet. The addition of monuron or simazin to dalapon-2,4-D mixtures improved the control of grasses and broadleaf weeds. By October, grass regrowth covered 50% of the dalapon-2,4-D plots.

In Connecticut, late summer applications of dalapon-2,4-D gave good grass and fair broadleaf weed control for three months. In Ohio, weed control was fair to good after two months and fair to poor after three months. The addition of simazin gave good weed control for a longer period.

In Ohio, a mixture of silvex and diethylene glycol bis 2,2-dichloropropionate gave good control of grass and broadleaf weeds after two months and fair control after three months. Control of tall fescue was superior to the control of blue grass and red fescue. Moderate to severe damage resulted from the treatment's washing onto untreated areas.

Amitrol combinations:

ACP-M-542, a 1:3 combination of amitrol and simazin, gave good to excellent control of grass and broadleaf weeds throughout the summer in New York. A rate equivalent to 1.4 lb/A amitrol and 4.2 lb/A simazin gave an average of 80% control throughout the growing season. This treatment gave acceptable control within the first month and maintained this control throughout the season. Higher rates gave control approaching complete eradication of plant growth. The 11.2 and 22.4 lb/A rates gave excellent control of bouncing Bet with zero to 5% regrowth. The control of bouncing Bet was superior to that acheived with 20 lb/A of amitrol or 20 lb/A of actual simazin alone.

Plots treated with similar amounts of simazin alone gave approximately equal vegetation control by October, but initial control during the first two months was less effective. Plots treated with ACP-M-542 also had more effective control of quackgrass, Canada thistle, milkweed, bouncing Bet and curly dock than did plots treated with simazin alone. Late summer application of ACP-M-542 in Connecticut and Ohio was less effective than early summer application in New York State. In Connecticut 5.6 lb/A of ACP-M-542 gave only fair control of grass and broadleaf weeds after three months, and in Ohio gave good control of grass and broadleaf weeds after three months.

In New York, ACP-M-543, a 1:4 combination of amitrol and monuron gave excellent initial control of all vegetation at rates of 8.1, 16.2 and 32.4 lb/A. Weed control one month after application was superior to a similar rate of monuron, but at 2½ months, weed control with monuron and ACP-M-543 was approximately equal. In Ohio, ACP-M-543 gave good general weed control after two months with fair to poor control after three months. Monuron alone gave good initial weed control which improved to excellent weed control after 2½ months in New York, with a slight decline in degree of weed control after 5 months.

ACP-M-617, a 1:3 combination of amitrol and sodium pentachlorophenate gave good initial weed control which deteriorated after several months. Broadleaf weed control was fair to good, becoming excellent in October. The addition of simazin to this mixture gave increased initial grass control but did not significantly affect the vegetation control later in the season.

Amitrol alone at rates of 10 and 20 lb/A gave good initial grass control and good to excellent initial broadleaf weed control in New York. At the treatment rates, all perennial grasses were controlled, but late summer germination permitted foxtail to invade the plots in September and October. Broadleaf weed control was excellent after five months. There were several stunted milkweeds in the 10 lb/A plot of ACP-M-569, the liquid amitrol formulation; some newly germinated yellow rocket in the rosette stage in the 20 lb/A ACP-M-569 plots and several dock and prickly lettuce plants in the rosette stage in the 20 lb/A amitrol treatment. Rates of five and ten lb/A of amitrol gave good broadleaf weed control in Connecticut after three months but only fair to poor grass control. In Ohio, equal rates of amitrol gave similar results.

Fenac

Applications of the sodium salt and amide formulations of 2,3,6-trichlorophenylacetic acid (Fenac) indicate that initial results with these materials are very slow to appear and that as other research has indicated, three to four months are necessary for these materials to give weed control when applied during the growing season. Five pounds of the sodium salt of fenac gave good broadleaf weed control in guardrail tests in Connecticut, but poor to fair grass control. After three months, the 10 and 20 lb/A rates were not more effective than the 5 lb/A rate. Results on this test would indicate that the amide formulation is slower in reaching its peak activity than the sodium salt formulation. In Connecticut, combinations of fenac with the sodium salt of 2,2,3-trichloropropionic acid and amitrol showed fair to good initial activity with decreasing grass control as the season progressed.

Time of application:

Based on the results of this test, it would appear that late spring or early summer is a more satisfactory time of application for guardrail weed control materials, since early application of most materials in New York State gave better weed control than late summer application of the same materials in Connecticut and Ohio.

Second year evaluation:

Each of the treatments applied in this test will be evaluated in late spring of 1959 to determine the amount of carry-over of chemical activity in the second season. Also, an effort will be made to find treatments and rates which will maintain the treated areas in a vegetation free condition at low cost following initial control with high rates of residual materials.

General observations:

It appears that treatment of highway guardrail vegetation created several problems. First, there is the danger that weed control materials may be washed down the side of fill sections, thus damaging vegetation and possibly creating an erosion problem. When the difficulties of establishing a grass cover are considered, it is questionable whether providing vegetation control under guardrails justifies the possibility of injuring the cover. Also, certain treatments control the perennial population but allow the treated area to be invaded by large unsightly annual grasses and broadleaf weeds such as foxtail, barnyard grass, lambsquarters, pigweed, ragweed or kochia. Many treatments do not control deep-rooted perennial weeds such as milkweed, Canada thistle, horsetail rush or bouncing Bet. Because no one chemical appears to have a sufficiently broad spectrum to control all weed species at economic rates, a mixture of chemicals is usually most suitable.

For example, in this test the combination of a translocated herbicide, amitrol, with a residual herbicide, simazin, appeared to utilize the advantages of each material. Amitrol produced an early knockdown of plant growth and controlled such perennial weeds as milkweed and Canada thistle, while simazin prevented the germination of new weeds. Because amitrol gave initial knockdown and control of problem weeds, less simazin was necessary for seasonal weed control. Aside from the lower cost, the reduced amount of simazin made erosion damage less likely on cut and fill sections.

WEED CONTROL AND OUR PROBLEMS IN VIRGINIA

E. W. Turner, Associate Landscape Engineer

When Mr. Iurka requested that I take part in the program, I, having very little experience with weed control, was naturally hesitant in agreeing to do so. However, in talking of the problems that we have we may receive answers that will be of help to others.

To begin with, a number of years ago we met with representatives of public utility companies, tree trimming companies, chemical companies, and others in order to see if we could not arrive at a mutually satisfactory working agreement. As a result it was agreed, in the hope of minimizing complaints from the public, that spraying would be limited to the selective spraying of material not over three feet - or one season's growth - in height.

Even this brought complaints. Soon we were receiving letters and telephone calls regarding "browning" as a result of spraying. In most instances the spraying was not within our right of way, but, even then, it served to show that we could expect complaints whenever we did spray on our own right of way.

This resulted in our Commissioner issuing instructions on August 25, 1954 to the effect that:

1. A dormant spray for woody plants is not to be used on any vegetation over three feet in height.

2. Foliage spray is not to be used at all except with written permission of the Chief Engineer, after approval by the Commission.

3. Weeds could be sprayed only when less than three feet in height.

4. Any trees, etc. over three feet in height must be cut down to below three feet in height before spraying with any herbicide.

This was again brought up when shortly after one of our men, who was promoted to Resident Engineer, sprayed all brush along the roadsides in his area. The owner of a considerable amount of land in this area was most vigorous in his complaint.

That is one problem. Another, and one usually prevalent in highway departments, is that of financing a program of spraying -

New funds become available in Virginia on the first of July of each year. That is probably rather late to start a program and, in addition, those in charge of funds - and any spraying done would be paid for from regular maintenance funds - are afraid that we will have another bad winter. Every spring - regardless of the type of winter - there is always a lack of funds.

In some instances, we are receiving help from County Boards of Supervisors that request that we use chemical weed and brush control. In such cases, the Resident Engineer will usually go along with a program of spraying - at least to a limited extent.

So, the second problem is one of economics. If we can find a way to eliminate complaints, how can we convince those that control the funds that it is economically feasible to institute a program of spraying?

Twenty years ago, it was a very rare thing to find a paved ditch along our roadsides. We, in the Landscape Division, realized that we would never secure satisfactory control of roadside erosion unless highly erodable ditches were paved. In order to prove the value of such ditches, we began to use a small amount of the very limited landscape funds to pave some of the worse ditches. This convinced our Maintenance Engineer and he gave us a few thousand dollars a year to expand our program. Now it is standard practice for all ditches that may be susceptable to serious erosion to be paved during construction. We have been working on demonstration areas and hope to convince our Resident Engineers of the value of chemical weed control.

It has been claimed, and rightly so, that the proper use of weed control chemicals can not only produce a better appearing turf, but it will also reduce the cost of mowing. This is particularly true of the southeastern part of the State where wild onions spring up at the least sign of warmth. It would also be true in the areas where we have a nearly pure stand of bluegrass. However, the main grass that we use now is Kentucky 31 Fescue. This, as you know, is a tall growing fescue and develops so rapidly that, if you have a good stand, it outgrows the weeds. Saving mowing costs as an argument for weed control would not help much in such instances.

One source of weed infestation is from the topsoil applied to roadside areas. Frequently, this soil is full of weed seed which establishes weed growth before the turf can get a good start. On occasions we have been glad to have even this - but not very often. We would like to know of a practical way to prevent this weed growth. Should we treat the topsoil before it is taken up to be stockpiled? Is there some way that we can treat the topsoil after it has been applied to the roadsides and not delay the seeding operations?

We, of course, agree that many weeds spread to adjoining farmland from the roadsides. I would like to hear of your experience with weed spreading to the roadsides from adjoining fields.

Some of the chief causes of excessive weed growth in turf are:

1. Improper number and time of mowings.

2. Impoverishment of the soil.

3. Deficiency of available water

4. Wet, impermeable, or acid soil

5. Grass varieties not well adapted to environmental conditions.

Some of these, such as a lack of water, we cannot control. However, would it not be possible to try to correct some of the other conditions that promote weed growth? In many of the bluegrass pastures of Virginia the presence of broom sedge is evidence of depletion of soil fertility. Experiments conducted some years ago showed that an application of 200 to 300 pounds of acid phosphate every five or six years kept this weed in check.

In summation, we admit that we have not made much progress in weed control. We need help in finding ways to sell a complete spraying program; we need help in mapping out just what should be included in such a program and, with the increasing demands from public utilities, we need to work out a policy toward utility line spraying that would be most satisfactory to all concerned.

REDUCING STATE HIGHWAY MOWING COSTS WITH CHEMICALS IN MASSACHUSETTS

Joseph L. Beasley
Highway Landscape Supervisor
Massachusetts Department of Public Works

Northeast Weed Control Conference
January 7-9, 1959, New York, N. Y.

Weed control is important in all categories of Roadside Maintenance. Along a secondary highway, or "country road," we generally like to keep the roadside as close to its natural state as possible, consistent with safety and efficient maintenance. In direct contrast is the industrial or commercial highway where beauty competes with utility and efficiency. The state highways of Massachusetts fall in between these two extremes. The people of Massachusetts insist on well-groomed highways, in keeping with the three-century tradition of having a village green in the middle of every town. But at the same time, their Yankee thrift demands that this scenic beauty be achieved at the lowest possible cost.

As a result, the State Department of Public Works has 16,000 acres of roadside grass to mow every year along our present 2,250 miles of state highway. The 90 miles presently under construction will add another 1,800 acres of roadsides. In 1958, the bill for mowing the 16,000 acres was $700,000, an average of $44 per acre--and this was the lowest mowing cost for any year to date, even with continually increasing road mileage and continually rising wage rates.

Since 1951, Massachusetts has been using and experimenting with chemical weed killers in an effort to reduce mowing and maintenance costs. We have used 2,4-D, 2,4-D+2,4,5-T, Maleic Hydrazide, Telvar D. W., Diuron and Ureabor. All have been used with varying degrees of success. We have learned that each has its place in maintenance as a useful tool. Herbicides in themselves are not a "cure-all" for roadside maintenance problems. When properly used, however, in combination with other roadside operations, the result is a more pleasing roadside appearance at a considerable saving financially.

Massachusetts is a pioneer in the field of mowing grass by contract. After a number of trials and revisions, we now feel that we have the best contract mowing specifications in the country. It is this combination of mowing by contract and the spraying of herbicides that has effected our greatest reduction in mowing costs. Therefore, in order to properly and economically maintain the grassed areas of the future 450 miles of interstate highway along with a large portion of the 2250 miles of our State highway system, it will profit us to concentrate even further on our herbicide program.

These mowing contracts call for a maximum of eleven (11) cuttings on certain grassed areas and a minimum of one (1) on other grassed areas.

Item One (1)--Lawn Type Mowing--Eleven Cuts (11) per season--includes:

Median Strips, Bowl Areas, Dividing Strips at Ramps, Traffic Islands and Rotaries.

On the above areas the total width, or on wide median strips and bowl areas, a maximum width of 30 feet from all roadways is mowed under this item.

Item Two (2)--Roadside Hay Mowing--Five (5) cuts per season--includes:

A minimum width of 15 feet of grassed area on the roadside <u>and</u> not <u>over</u> 5 feet but <u>always</u> including this 5 feet on cut slopes and the portion remaining uncut from Item 1 in all areas outlined from Item 1 mowing.

Grass directly in front and in back of guard rail is mowed so that the guard rail is clearly outlined.

Item Three (3)--Hay Mowing--One cut per season--includes:

All grassed areas not covered under Items 1 and 2.

Contracts for certain secondary routes call for Items 2 and 3 only.

<u>Note:</u> I have a copy of a current Contract Mowing Proposal with me that is available for your inspection.

Our first use of chemicals along our roadsides was directed against poison ivy, at the time an extremely serious problem. Through the use of 2,4-D and 2,4,5-T, this problem has been practically eliminated. This fact not only has been reassuring to the 3,000,000 people who enjoyed our 300 roadside rest areas last season, but greatly reduced the lost "man hours" of our department employees who are engaged in roadside work.

The Massachusetts Department of Public Works has been making valuable contributions to highway safety with the aid of chemicals, (2,4-D and 2,4,5-T, 50-50 concentrates combination low volatile esters) by making a concerted effort to increase sight distance on our highways. These herbicides also assist in controlling brush at our roadside rest areas and vistas, behind guard rails and in our selective clearing program.

Not only has the general appearance of our roadsides been greatly improved but we feel that clean roadsides are a major factor in highway safety.

Then we began the selective control of other weeds and have experimented with 2,4-D and M-H-40 in our constant effort to reduce the number of annual mowings. Unfortunately, we haven't found any chemical lawn mowers as yet. But we have found that some weeds grow a good deal faster than grass, particularly in dry years.

We must then control these weeds and insure a uniform growth of grass, which, even though above normal in height, will still present a satisfactory appearance.

We have temporarily discontinued the use of M-H-40 until further technical information is available. However, through a combination of applying 2,4-D to eliminate dandelions, ragweed, and other succulent weed growth on our median strips, and by revising our specifications for contract mowing, we have been able to reduce the number of mowings on Item 1 from 15 cuttings per year to 11.

Reducing the amount of hand work necessary in roadside mowing has resulted in more efficient use of mechanical mowers. In 1958, we had 25 mowing contracts for 500 miles of highway, involving 7,000 acres of roadside. In 1959, we expect to expand this program. It was a great day when we were able to write into these mowing contracts: "This contract does not require trimming at guard rail locations, since those areas will be treated with chemicals...eliminating all vegetative growth..."

It is the intention of the Department to treat all roadside, median strip, ramp road and traffic island grassed areas, subject to contract mowing, with weed control chemicals for the elimination of such weed growth. Two applications of chemicals are planned for the season. As these areas may not be mowed for 72 hours before treatment or 48 hours after treatment, it becomes necessary to coordinate these two operations so as to insure the least inconvenience to all parties concerned and produce the most profitable results.

Our state highway system has approximately 900 miles of guard rail. One hand trimming along a mile of guard rail may take eight man hours, and the job may have to be done five times per season. With this chemical program, we can go along the guard rail with a power sprayer covering a band two feet wide at a rate of one and one-half to two miles per hour. A two-foot band a mile long is about a quarter of an acre, so four miles of guard rail means an acre of spraying. In other words, one hour of soil sterilant spraying, at two miles per hour, eliminates eighty hours of hand trimming. And the job is done once for the whole season. Our present program calls for treating a two-foot stip along all our guard rails in this way, with a follow-up treatment where needed a year or two after the first application.

We now have had five years' experience with this specialized use of chemicals--beginning with a small trial in 1953 along guard rails and in the joint at curb facings. The curb treatment remained effective for one year, and the guard rail treatment for over three years. By 1957, we had treated about 420 miles of guard rail--or over 100 acres, and in 1958, we have done 745 miles, or about 185 acres. We also followed up some of the earlier treatments with "Ureabor" for hard-to-reach locations, and places we had missed entirely. We have learned that soil sterilants of the granular type play an important role in the roadside development program.

The soil sterilant program has been so successful on guard rails that we are adopting the same kind of treatment to eliminate hand trimming around poles, ledges, delineators, curbing, piers, abutments and other structures. We are also trying this approach for weed control in waterways, drainage ditches, gravel sidewalks, and along fences.

In other words, this program is being carried on wherever chemical control can be employed without hazard to trees or desirable plantings.

I mentioned the possible hazards involved in the use of chemical weed killers. We have to remember that these compounds are intended to kill plant life, and that we must observe the proper precautions to be sure that we kill only the plant life of which we want to be rid. In treating nearly 900 miles of guard rail in Massachusetts with soil-sterilant type herbicides, I am happy to say that we have had no mishaps when the material was properly applied.

We have had a few instances of damage to turf outside the treated area, and **all** of these have been traced to faulty application. In some cases the operator turned the spray into areas that should not have been sprayed. In other situations we have found evidence of run-off, and this hazard deserves special attention in highway weed control. The absence of curbing, gutters and culverts may direct drainage and run-off in such a way as to create problems. Established cover of grass and weeds in and around the treated area is an important factor in holding the chemical where it is sprayed. Pavement close to the treated area presents a special problem. For example, if you accidentally spray your weed killer mixture on pavement, there is no soil to hold it and the chemical merely dries on the surface. Then the first good rainstorm can wash it over to an area not intended for treatment.

We have confidence in chemical weed killers, and it is to their credit that they are so effective. However, we must be careful with them.

We have held many meetings in our various districts to instruct engineers and foremen in the proper use of these materials, and to exercise proper precautions in applying them. We want them to accept chemical weed killers as a tool for them to use in its proper place in highway maintenance--just as they use sand, salt, patching materials, or snow plows for their proper purpose.

The variety of chemicals available, and the specialized jobs of each, have placed a premium on expert knowledge in selecting and applying them. In general, it appears that contractors and owners of spraying equipment should see to it that their personnel become more familiar with the various herbicides, as they relate to highway and roadside maintenance work. We are trying to train our local foremen so that they can do many of the little jobs with chemical weed killers. The soil-sterilant work, for example, can be done almost any time of year, with available manpower--so it provides fill-in work for a small crew instead of seasonal work for large crews. If applications are made before growth starts in the spring, then summer work on the treated area is eliminated entirely. In other words, you can kill weeds before they start to grow.

Looking ahead a little bit, we expect to continue and intensify our present program, with the cost of mowing as our primary financial yardstick. We want grass along our roadsides. But we are compelled to admit that we can't afford the luxury of having grass adjacent to the base of guard rail posts, signposts, etc., where hand cutting is required. We have a long way to go before we shall make the best use of the combination of chemicals and mechanical maintenance which are now available to us, and we have a long way to go in training our own people who actually have to get the work done. It has taken seven years to arrive at our present program but further innovations will come more quickly. We think our plan is basically correct, as the intent is to maintain roadsides as our citizens want them; we hope to make this basic plan more effective, by keeping informed on new developments and new ways of doing things.

We welcome the interest and technical help of commercial companies, and we feel sure that as the public understands what this kind of program means to them, we can count on their acceptance and support of what we are doing.

CURRENT HERBICIDE WORK IN NEW YORK STATE

BY

Andrew M. Ditton
Senior Landscape Architect
New York State - Department of Public Works

New York State has completed its second year in a herbicide program on the state highways. This program consists of (1) broadleaf weed control to reduce the number of machine mowings required; (2) chemical mowing of guide rail, posts and signs to eliminate all mowing from these areas where hand mowing has been required; (3) brush control to eliminate undesirable brush growth from the highway right of way; and (4) poison ivy control to eradicate poison ivy from the right of way.

Herbicides have been tested and used to a limited extent along New York State highways for ten or twelve years. This program is on a larger scale than formerly. Because the requirements of roadside maintenance with herbicides are unique, the chemicals and the application techniques are being modified as experience is gained.

Highway maintenance engineers are generally enthusiastic with the results obtained to date and the future use of herbicides as a roadside maintenance tool appears to be assured.

Following is a brief description of the work accomplished in 1958 and a description of the recent experimental work. Costs include materials, labor and equipment at established rental rates.

Broadleaf Weed Control

Chemicals - Low volatile ester of 2, 4-D containing 4 lbs. acid equivalent per gallon.

Standard treatment - ½ gal. 2, 4-D in a minimum of 50 gal. of water per acre applied at any time throughout the growing season to varying widths at right of way.

Amount treated - 5346 acres on 1645 miles of highway.

Average cost - $4.00 per acre

Results - At least one machine mowing eliminated and appearances improved.

Observations - In general only one treatment at any time during the growing season was attempted. The results point out that one treatment a year will eliminate a large percentage of the weeds that are a mowing problem.

Chemical Mowing of Guide Rail, Posts and Signs

Chemicals - Radapon plus low volatile ester of 2, 4-D containing 4 lbs. acid equivalent per gallon.

Standard treatment - 30 lbs. Radapon plus ½ gal. 2, 4-D in a minimum of 30 gal. of water per acre applied in the spring before growth reaches 9 inches in height. A three foot wide strip was treated in the guide rail line as well as the area immediately surrounding individual posts and signs.

Amount treated - 1768 miles of guide rail, posts and signs on 4956 miles of highway.

Average cost - $20.50 per treated mile.

Results - At least one and in some cases all, hand mowings were eliminated.

Observations - The chemicals used did an excellent job of removing all vegetation growing at time of treatment but left the treated area open for mid-summer growth of annual weeds and grasses. This was especially noticeable this past summer. The growth of annual weeds and grasses as well as the regrowth of some perennial grasses such as orchard and quack grass was so strong that in many areas mowing was required by late summer.

Brush Control

Foliage Treatment

Chemicals - Low volatile esters of 2, 4-D and 2,4,5-T containing 4 lbs. acid equivalent per gallon.

Standard treatment - ½ gal. 2, 4-D and ½ gal. 2, 4, 5-T in 100 gal. of water applied at 100 to 200 gal. per acre.

Amount treated - 337 acres.

Average cost - $15.80 per acre.

Results - Cannot be determined until 1959.

Observations - This work generally limited to regrowth of cut brush or other brush growth where the height or location of the brush is such that leaf discoloration would not be considered objectionable.

Combination Foliage Treatment & Weed Control

Chemicals - Same as for foliage treatment.

Standard Treatment - Varying amounts of 2, 4-D and 2,4,5-T with total of about 2 lbs. acid in a minimum of 50 gal. of water per acre.

Amounts treated - 308 acres

Average cost - $6.15 per acre

Results - Good weed control and defoliation of brush.

Observations - This type of treatment apparently holds brush in check with a minimum of brown-out with the possibility of a yearly treatment eliminating all but the resistant species.

Stump and Stubble Treatment

Chemicals - Same as for foliage treatment.

Standard treatment - 2 gal. 2, 4-D and 2 gal. 2, 4, 5-T in a minimum of 50 gal. of oil per acre.

Amounts treated - 19 acres.

Average cost - $104.00 per acre.

Results - Cannot be determined until 1959.

Observations - The accepted method of treatment with hand guns is costly in time and labor and often difficult on the cut and fill slopes found on the roadsides.

Poison Ivy Control

Chemicals - Amino Triazole

Standard treatment - 4 lbs. Amino Triazole in 100 gal. of water applied at approximately 100 gals. of water per acre.

Amounts treated - Spot treatment on 2200 miles of highway.

Average Cost - $20 to $25 per acre in Babylon District.

Results - Excellent top kill but final results cannot be determined until 1959. Results of 1957 work in one district indicate 99% kill.

Experimental Work

Chemical Mowing in Guide Rail

Material	Rate	District	Date of Applic.	Date of Rating	*Rating
Telvar "W"	40 lbs./A.	Hornell	4/58	9/58	Satisfactory
Telvar "DW"	40 lbs./A.	Hornell	4/58	9/58	Satisfactory
Simazine 50W	40 lbs./A	Babylon	4/58	9/58	Satisfactory
Simazine 50W	40 lbs./A	Hornell	5/58	9/58	Satisfactory
Telvar "DW"	30 lbs./A	Babylon	4/58	9/58	Satisfactory
Telvar "DW"	20 lbs./A	Babylon	4/58	9/58	Satisfactory
Simazine 50W	22.5 lbs./A	Babylon	4/58	9/58	Satisfactory
Simazine 50W	20 lbs./A	Hornell	4/58	9/58	Satisfactory
Simazine 50W	20 lbs./A	Utica	4/58	9/58	Satisfactory
Simazine 50W	11 lbs./A	Babylon	4/58	9/58	Unsatisfactory
Simazine 50W	10 lbs./A	Hornell	4/58	9/58	Unsatisfactory
Baron + 2, 4-D	5 gal./A 2 lbs.acid/A	Hornell	4/58	9/58	Unsatisfactory
Telvar "W" + Radapon + 2, 4-D	5 lbs./A 30 lbs./A 2 lbs.acid/A	Hornell	5/58	9/58	Satisfactory
Telvar "W" + Radapon + 2, 4-D	5 lbs./A 30 lbs./A 2 lbs.acid/A	Babylon	4/58	9/58	Unsatisfactory
Simazine 50W + Radapon + 2, 4-D	5 lbs./A 30 lbs./A 2 lbs.acid/A	Hornell	5/58	9/58	Satisfactory
Simazine 50W + Radapon + 2, 4-D	5 lbs./A 30 lbs./A 2 lbs.acid/A	Babylon	4/58	9/58	Unsatisfactory

* Satisfactory - Sufficient vegetative control to require no mowing for one season.
Unsatisfactory- Vegetative growth requiring mowing.

Broadleaf Weed Control

Low volatile ester of 2, 4-D at the rate of 2 lbs. acid in both 30 gal. water per acre and 50 gal. water per acre was applied on 10 miles of highway in Hornell District in August, 1958. The 30 gal. rate was slower acting but final results were rated as equal to the 50 gal. rate. Rainfall was unusually high throughout the summer of 1958.

Brush Control

Karmex F. P. (Fenuron)

Applied as a foliage spray on ¼ acre of brush in late September, 1958 in Hornell District. Leaf discoloration began to show at the same time as fall color. Results cannot be determined until 1959.

Pellatized Karmex F. P. applied by sand blast gun on May 6, 1958 to a test area in Babylon District containing a moderately heavy stand of pine, oak, cherry and sassafras. One test plot treated at the rate of about 50 lbs. per acre and a second test plot at about 25 lbs. per acre. Excellent top kill was observed on both plots in September, 1958. Grass and woody ground cover injured much more severly by the higher rates. Final results cannot be determined until 1959.

Veon

Applied in Hornell District as a foliage spray in July,1958 to evaluate delayed brown-out action as compared with the standard low volatile esters. No difference in reaction time was observed.

Applied in Babylon District as a foliage spray for the same purpose as stated above. No difference in reaction time was observed.

Ammate

A test plot in the Babylon District was foliage sprayed in June, 1957 with 60 lbs. of Ammate X with 4 oz. of DuPont Spreader-Sticker in 100 gal. of water. A second test plot was treated with 40 lbs. of Ammate X with 40 gal. of No.2 fuel oil and 2/3 pint of emulsifier in 96 gal. of water. Results were judged as satisfactory in September, 1958. Cherry and sassafrass were completely killed. Some regrowth of oak and resprouting of sumac and locust was observed.

Amino Triazole

Applied as a foliage spray on 100 acres of predominant oak vegetation in Babylon District. Treated in June and July, 1957 at a rate of 8 lbs. in 100 gal. of water to brush 3 feet high or smaller. About 90% kill was obtained.

A mixture of 8 lbs. Amino Triazole, ½ gal. 2, 4-D and ½ gal. 2, 4, 5-T in 100 gal. of water was sprayed on a small test area in Babylon District in July, 1957. About 80% kill of all species, (pine, oak, cherry, locust and sassafras) was obtained.

Experminetal use of Herbicides for reducing Road Maintenance Costs on New Jersey State Highways

Robert S. Green, N. J. State Highway Department

The New Jersey State Highway Department began experimental use of herbicides in the spring of 1956 when the Department contracted for a trial weed control spraying program on 26 miles of the dualized U.S. Route 1, from Trenton thru New Brunswick to the Garden State Parkway overpass. The contract called for three applications each year over a three year period , spraying with 2, 4-D and 2, 4, 5T along each roadside and on the 12 foot grass median.

In 1957 an additional 35 miles were added on U.S. 130 from the Hightstown By-pass to Milltown Circle on U.S. 1 and on Rt. 23 from Stockholm to Colesville. These locations were selected in order to show contrast with non treated adjacent roads and where little roadside maintenance occurred.

In the spring of 1958, 96 miles of additional State Highway routes were added, covering other parts of the State. At this time, with the third year of our first contract on the 26 mile stretch being reached, we were able to determine the advisability of continuing the project.

The use of herbicides showed partial control of annual and broad leaf weeds the first year in many locations. Noticeable improvement in turf growth followed and adjacent unsprayed private lands showed marked contrast even after the second year.

On account of the varying weather conditions during the same season from year to year it was difficult to determine the number of mowings saved but we believe that an addition to the better stand of grass, prsctically free of weeds, we could count on a saving of two mowings per season. However, a definite and highly pleasing result was shown on the side areas, where little maintenance is done by hand methods, this due mainly on account of the call for more important maintenance construction jobs. Here, weeds were disappearing and a lush growth of grasses, which, if only cut once a year, would present good roadside appearance.

Since we maintain excellent lawn areas on median strips,multple intersections, traffic circles and roadside improvement areas, we feel that weed control spraying can produce better results if applied to the lesser mowed roadsides and difficult to maintain guard rail locations.

In our past contracts of a trial and experimental nature only, we have been charged $ 50.00 per mile for the three applications per year for both sides of a highway,dual roads require one or two extra runs depending on the width of the median thereby increasing the cost to $ 75.00 or $100.00 per mile.

The use of 2, 4-D and 2, 4-5-T, must be used so as not to damage grasses but shall control noxious growth, including the more common Dnadelion, plantain and ragweed, and the more difficult to eliminate Poison Ivy, poison oak and wild cherry.

Safety of application by means of low pressure with heavy droplet will defeat drift of material to areas beyond states right of way. Safety to working personnel, to the motorist and to the pedestrian must be considered at all times during each application, even tho the materials as mixed are non-toxic to human and animal life and non-injurious to any of the several desireable species of grasses growing on the roadsides.

New Jersey has done very little in the use of chemical spraying about guard rails and sign posts. In 1957 and 1958 a single application was made on 18 miles of guard rail areas bordering the roadsides on Route 23 in Sussex County. The object to deremine the effectiveness of various types of chemicals such as Atlacide, Chlorea, Dalapon, Radipon and Simazin. These were applied at various rates per acre. Up to this time we have not determined which was superior. Further studies will be made along these lines during 1959.

The 1958 test applications applied in August have shown varying degrees of effectiveness, but have had little time to determine if any particular herbicide is better than another. Nor have we been able to figure costs. We do know that all types used did some good in weed elimination. Also that complete eradication of weeds and grass would in some instances cause runoff and thus result in serious erosion problems.

Our latest test on guard rail treatment was conducted on 15 miles of roadside between Somerville and Belle Mead, application being made on 16,000 lineal feet of rail for a width of 2 feet. Radapon was used in a mixture of 2, 4-D and 2,4,5-T and water. The 400 gallon mixture turned out to be sufficient for the 16,000 feet on the 2 foot width at an estimated cost of one and one half cents per square foot.

While late Spetember was not the best time to treat the area which had not been mowed this year, results were remarkably good and gave reason to believe a late spring treatment would eliminate mowing or only require one mowing thus making the guard rails cleaner and the roadside more attractive.

Still another experiment was conducted on a ten mile length of median on U.S. Route 1 from Trenton to Princeton. An application of Dolge S.S. Weed Killer was sprayed at the joint between the pavement and the concrete curbing bordering the grass median at the rate of 40 to one. Unsightly weed growth has always been abundant and hand methods of removal consumed much time and at large costs. A short time later a stiff bustle mechanized broom removed all trace of dead weeds. This was a landscape maintenance operation which we hope to expand on during 1959. This will be in conjunction with the use of an application of 20 to one Dolge on Poison Ivy areas adjacent to homes and schools and pedestrian traffic.

In conclusion we believe it is only a matter of time before most states will be compelled to adopt a major program of weed control by spraying. The ever-increasing road mileage of each individual State will demand maintenance expenditures far beyond reasonable budgets. This has already been approached in our state.

Adoption of a statewide weed control program, let out under contract, to eliminate unsightly growth about guard rails, signposts and intersections, will release highway personnel for more important road maintenance, reduce mowing costs and the need of additional landscape forces each year. We will have well kept roadsides throuout the state equal in appearance to our more important arteries which now receive a greater amount of landscape maintenance.

New Jersey State Highway Commissioner Dwight R. G. Palmer in his 1959 - 1960 budget requests, seeks additional moneys to conduct more extensive weed and brush control spraying. We then will be able, during 1959, to extend our program in this field.

WEEDING OF SWEET CORN WITH CHEMICAL HERBICIDES[1.]

CHARLES J. NOLL[2.]

Thirty thousand acres of sweet corn are grown each year in Pennsylvania. Chemical weeding practices have been used over a good part of that acreage. This experiment was designed to determine the best herbicides available, and is a continuation of investigations started a number of years ago.

PROCEDURE

The variety Iochief sweet corn was seeded June 3, 1958. Pre-emergence application of herbicides were made June 5, emergence treatments June 12, and the post-emergence treatment June 30 at the time the corn had 4-5 true leaves. Individual plots were 70 feet long and 3 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 12 inches. The growing season was favorable with rain well distributed and averaging 1/2 inch a month in excess of normal. An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. Corn was harvested September 10th and 11.

RESULTS

The results are presented in table I. All chemicals gave significantly increased weed control as compared to the untreated check. The best weed control was obtained with Simazin at 2 and 3 lbs. per acre, Emid at 3 lbs. per acre applied in a pre-emergence application, G27901 at 4 and 8 lbs. per acre, Diuron at 3 lbs. per acre and Emid at 1/2 lb. per acre applied at time of corn emergence.

Corn stand was significantly reduced as compared to the untreated check by Emid at 3 lbs. per acre applied in a pre-emergence application, Monuron at 3 lbs. per acre and Diuron at 3 lbs. per acre.

The number of marketable ears was reduced as compared to the untreated check by Emid at 3 lbs. per acre applied in a pre-emergence application, by Monuron at 1 1/2 and 3 lbs. per acre, by Diuron at 3 lbs. per acre, and by Neburon at 3 lbs. per acre.

The weight of marketable ears was reduced as compared to the untreated check by Emid at 1 1/2 and 3 lbs. applied pre-emergence, by Monuron at both 1 1/2 lbs. and 3 lbs. per acre, by Diuron at 3 lbs. per acre and by Neburon at 4 1/2 lbs. per acre.

There was no significant difference among treatments in average ear weight but the following treatments reduced the number of ears per plant as compared to the untreated check plot: Emid at 3 lbs. in the pre-emergence application, Monuron at 3 lbs. per acre and Neburon at 3 lbs. per acre.

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

CONCLUSION

No chemical treatment resulted in an increase in yield as compared to the untreated check where some weeds were 3 feet tall at time of harvest. Under more normal weather conditions where water was not well distributed or nearer normal for the growing season it is possible that a number of herbicidal treatments would have resulted in increased yields.

The best treatments taking into consideration weed control, corn stand, and number and weight of marketable ears were Simazin at 2 and 3 lbs. per acre, G27901 at 4 and 8 lbs. per acre and Benzac at 3 lbs. per acre.

I. Weed control, plant stand, number and weight of ears, average ear weight and number of ears per plant of sweet corn under chemical herbicide treatments.

icide	Rate per Acre lbs.	When Applied	AVERAGE PER PLOT: *Weed Control	AVERAGE PER PLOT: Corn Stand	AVERAGE PER PLOT: Marketable Ears Number	AVERAGE PER PLOT: Marketable Ears Weight lbs.	Average Ear Weight lbs.	No. ears per Plant
ing	--	--	9.50	97.0	93.2	53.1	.58	.97
:in	2 lbs.	Pre-emergence	1.17	97.3	93.2	58.1	.63	.96
	3 lbs.	"	1.00	93.3	88.7	55.3	.62	.96
	1 1/2 lbs.	"	2.33	92.3	82.7	48.4	.59	.90
	3 lbs.	"	1.33	73.3	47.0	26.8	.57	.64
l1	4 lbs.	"	1.17	91.7	90.8	56.5	.63	1.00
	8 lbs.	"	1.33	98.0	89.5	55.5	.62	.92
azin	6 lbs.	"	2.33	97.2	88.3	54.5	.62	.91
	12 lbs.	"	1.67	99.8	92.5	56.8	.62	.93
ex	6 lbs.	"	3.33	98.3	93.0	58.1	.63	.95
	9 lbs.	"	2.83	97.3	90.3	57.5	.64	.93
c 103A	1 1/2 lbs.	"	2.00	98.2	88.7	58.6	.66	.91
"	3 lbs.	"	1.33	96.7	96.5	56.5	.59	1.00
on	1 1/2 lbs.	"	1.33	90.0	78.8	45.4	.58	.87
	3 lbs.	"	1.00	60.8	42.8	24.4	.59	.64
n	1 1/2 lbs.	"	2.00	93.7	87.8	54.4	.62	.94
	3 lbs.	"	1.17	86.7	73.5	44.3	.60	.85
	1/2 lb.	Emergence	1.50	101.5	92.5	58.1	.63	.92
	3/4 lb.	"	2.33	97.0	92.2	57.0	.62	.95
Amine	1/2 lb.	"	2.50	97.0	87.9	57.1	.65	.91
"	3/4 lb.	"	2.00	97.5	86.8	52.2	.60	.90
rge	2 lbs.	"	1.67	92.2	83.0	51.1	.62	.90
	3 lbs.	"	1.67	95.3	82.8	51.5	.62	.87
on	3 lbs.	4-5 true leaves	3.67	93.3	77.7	50.0	.64	.84
	4 1/2 lbs.	"	2.50	92.7	86.7	49.3	.57	.94
Significant Difference		($P = .05$)	.55	10.3	13.5	8.7	NSD	.13
"	"	($P = .01$)	.75	14.0	18.3	11.8	NSD	.18

Control 1-10
1 Perfect Weed Control
0 Full Weed Growth

CHEMICAL WEED CONTROL OF LIMA BEANS[1.]

CHARLES J. NOLL[2.]

Over 5000 acres of lima beans are grown annually in Pennsylvania. Much of this acreage could be weeded with presently recommended herbicides. Each year new, and possibly better, herbicides are available. This investigation was designed to further test newer chemicals now available against chemicals now recommended. This is a continuation of an investigation started a number of years ago.

PROCEDURE

Seeds of the lima bean variety Fordhook 242 were planted June 3, 1958. Herbicides were applied June 6 prior to the emergence of the beans. Individual plots were 20 feet long by 3 feet wide. Treatments were randomized in each of 10 blocks.

The chemicals were applied with a small sprayer over the row for a width of 12 inches. The growing season was good with sufficient rainfall well distributed over the growing season. An estimate of weed control was made prior to harvest on a basis of 1 to 10, 1 being most desirable and 10 being least desirable. The plants were pulled and marketable beans harvested September 25, 1958.

RESULTS

The results are presented in table I. All chemicals gave a significantly increased weed control as compared to the untreated check. The stand of plants was reduced as compared to the untreated check with Niagara 5521 at 2 1/4 gal. per acre, ACP M118 at 3 and 4 1/2 lbs. per acre and ACP M119 at 3 lbs. per acre. Yields were significantly increased as compared to the untreated check with Dinitro at 4 and 6 lbs. per acre, Chlorazin at 4 and 6 lbs. per acre, ACP M119 at 3 lbs. per acre, Neburon at 6 and 9 lbs. per acre and G27901 at 4 lbs. per acre. There was no significant difference between these better treatments in regards to yield of beans in the pods.

SUMMARY

Among the best of the treatments was Dinitro, the material now recommended for the weeding of this crop. Other chemicals that look promising and are worthy of further investigation are Chlorazin and Neburon.

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1. Authorization for publication Nov. 19, 1958 as Paper No. 2316 in the Journal Series of The Pennsylvania Agricultural Experiment Station.

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

Table I. Weed control, stand of plants, and weight of lima beans in pods under chemical herbicide treatments.

Herbicide	Rate per Acre lbs.	*Weed Control	Stand of Plants	Wt. Beans in Pod lbs.
Nothing	--	7.7	24.0	7.4
Dinitro	4	3.5	24.4	10.7
"	6	2.3	22.5	10.5
Chloro IPC	6	4.4	19.0	8.7
" "	9	3.5	18.6	9.3
Chlorazin	4	3.3	21.7	10.1
"	6	3.1	25.1	10.4
Niagara 5521	2 1/4 gal.	5.3	17.1	7.2
" "	3 3/8 gal.	3.4	19.6	9.5
ACP M118	3	2.1	14.1	8.9
" "	4 1/2	2.4	13.3	8.1
ACP M119	2	3.0	21.3	9.4
" "	3	1.9	18.1	10.1
Neburon	6	2.7	22.1	11.5
"	9	2.1	25.4	12.0
G-27901	4	1.8	19.9	9.9
"	8	1.3	18.8	8.3
"	12	1.2	20.9	8.8
Least Significant Difference($P = .05$)		1.5	5.5	2.4
" " " ($P = .01$)		2.0	7.3	3.2

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

A NOTE OF THE CONTROL OF NORTHERN NUTGRASS IN SNAP BEANS

M.F. Trevett and Edward Austin[1]

Ethyl di-n-propylthiolcarbamate (EPTC) applied preplanting in 1957 at the rate of four and six pounds active ingredient per acre did not result in satisfactory control of northern nutgrass, (*Cyperus esculentus* L.). Records of nutgrass emergence indicated that the low order of control obtained was the consequence of a comparatively long incubation period of the herbicide before nut grass sprouted. It appeared a reasonable assumption, therefore, that percent nutgrass control could be increased if application of EPTC was deferred until nutlets had sprouted and were making active growth. Such a practice would insure a high concentration of herbicide in the soil during a period of active absorption.

Procedure

A field with a soil of sandy loam texture, that had been plowed in October, 1957 was disk harrowed to a depth of four inches July 8, 1958. At the time of disking, nutgrass was three to six inches tall. Soil moisture was eighty percent of field capacity.

EPTC, applied in a randomized block, at the rate of six pounds active ingredient per acre was immediately disked in. Snap beans, variety Long Tendergreeen, were planted July 9, 1958.

All plots were rototilled five times during the growing season. Treatments are given in Table 1. Beans were harvested September 9.

Results

Weed control ratings and bean yields are given in Table 1.

Nutgrass control averaged 94.7 percent nine weeks after application of six pounds per acre of EPTC. EPTC did not control *Brassica nigra*.

Yield of EPTC plots that were hand-hoed twice was significantly higher at the five percent level than plots that were hoed but not treated with EPTC, but did not differ significantly from EPTC plots that were either hoed or hoed only once.

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1 Associate Agronomist and Technical Assistant, Department of Agronomy, University of Maine.

Conclusions

Control of northern nutgrass in snap beans with EPTC can be increased if preplanting treatments are deferred until nutgrass has sprouted and is making active growth. EPTC should be worked into the soil following prior harrowing of the sprouted nutlets.

Pre-emergence application of other herbicides may be required for complete weed control, particularly if species of Brassica are present.

Table 1. Yield of snap beans and percent broadleaf weeds and northern nutgrass control following application of 6 pounds EPTC per acre.

Treatment 1/	Yield Pounds Snap Beans Per Acre	Percent Weed Control 9 Sept. '58 Nutgrass	Broadleaf weeds 2/
EPTC, hoed 22 July + 4 Aug.	6747	95	93
EPTC, hoed 4 August	6457	95	83
EPTC, hoed 22 July	6187	97	60
EPTC only	5046	92	30
Hoed only 22 July + 4 Aug.	4253	10	83
Hoed only 22 July	3944	0	0
Hoed only 4 August	3731	5	33
Check	1624	0	0
L.S.D. 5%	2477		

1/ All plots were rototilled five times during season. EPTC was applied at 6 pound active ingredient per acre.

2/ Principal broadleaf was *Brassica nigra* L.

CONTROL OF ANNUAL WEEDS IN SWEET CORN WITH MIXTURES OF DNBP, AND DIURON, SIMAZIN, OR ATRAZINE

M.F. Trevett and Edward Austin[1]

Introduction

This paper is a report of a comparison of the effectiveness of mixtures of certain herbicides on the control of annual broadleaf weeds and annual grasses in sweet corn. The herbicides used were: 4,6-dinitro ortho secondary butylphenol (DNBP); 3(3,4-dichlorophenyl)-1,1-dimethylurea (Diuron); 2-chloro-4,6-bis-(ethylamino)-s-triazine (Simàzin); and 2-chloro-4 ethylamino-6-isopropylamino-s-triazine (Atrazine).

Procedure

Variety Marcross 13.6 sweet corn was planted June 9, 1958, one to two inches deep in a sandy loam soil. Treatments were replicated seven times in a randomized block in which single-row treated plots were 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. All plots were cultivated throughout the season, but during cultivation the soil was not disturbed six inches on either side of the crop row. Corn was harvested at the soft dough stage of maturity.

Planting (PL) applications were made June 9, emergence (EM) applications were made June 17. Counts of annual grass were made August 21 (8.5 weeks after planting), counts of annual broadleaf weeds were made August 4 (seven weeks after planting).

The principal broadleaf weeds were Black mustard (*Brassica nigra* Koch.), Red-root pigweed (*Amaranthus retroflexus* L.), and Lambs-quarters (*Chenopodium album* L.). The annual grasses present were Barnyard grass (*Echinochloa crusgalli* Beauv.),and Foxtail (*Setaria viridis* L., Beauv.).

Rain fall data are found in Table 1.

Results

Yields of snapped ears are found in Table 2, percent broadleaf weed control in Table 3, and percent annual grass control in Table 4.

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1 Associate Agronomist and Technical Assistant, respectively, Department of Agronomy, University of Maine.

On the basis of Duncan's Multiple Range Test, a mixture of 0.5 pounds of Atrazine and 3 pounds of DNBP, applied at emergence (Treatment No. 1, Table 2), was the only treatment giving significantly higher yields than the standard treatment of 4.5 pounds of DNBP applied at emergence (Treatment No. 12, Table 2). The only treatment resulting in significantly lower yields than standard was 1.2 pounds Diuron applied at planting (Treatment No. 17, Table 2).

Treatments resulting in higher percent control of both annual broadleaf weeds and annual grasses are conveniently presented as follows:

TREATMENTS RESULTING IN SIGNIFICANTLY HIGHER WEED CONTROL THAN 4.5# DNBP APPLIED AT EMERGENCE[1]

	Annual Broadleaf Weeds	Annual Grasses
No. 2[2]	1.0# Simazin EM[1] + 4.5# DNBP EM[3]	1.0# Simazin EM + 4.5# DNBP EM
" 9	2.0# Atrazine PL[2]	
" 5	0.8# Diuron EM + 4.5# DNBP EM	0.8# Diuron EM + 4.5# DNBP EM
" 8	0.8# Diuron EM + 3.0# DNBP EM	
" 3	Hand hoed only	Hand hoed only
" 1	0.5# Atrazine EM + 3.0# DNBP EM	
" 7	0.5# Atrazine EM + 4.5# DNBP EM	
" 14	0.5# Simazin EM + 4.5# DNBP EM	0.5# Simazin EM + 4.5# DNBP EM
" 11	1.0# Simazin EM + 4.5# DNBP EM	
" 10	0.4# Diuron EM + 3.0# DNBP EM	0.4# Diuron EM + 3.0# DNBP EM
" 6	0.4# Diuron EM + 4.5# DNBP EM	0.4# Diuron EM + 4.5# DNBP EM
" 16	2.0# Simazin PL	
" 13	0.5# Simazin EM + 3.0# DNBP EM	
" 17		1.2# Diuron PL

1/ Duncan's Multiple Range Test.
2/ No. refers to treatment number, Tables 2, 3, and 4.
3/ EM = applied at emergence PL = applied at planting.

Treatments significantly lower than all others in broadleaf weed control were the standard emergence application of 4.5 pound DNBP (Treatment 12, Table 3) and planting applications of 1 pound Atrazine (Treatment 4, Table 3), 1.2 pounds Diuron (Treatment 17, Table 3), and 1 pound Simazin (Treatment 15, Table 3). Treatments that did not differ significantly from standard in annual grass control included planting applications of 2 pounds Atrazine (Treatment 9, Table 4), 2 pounds Simazin (Treatment 16, Table 4), 1 pound Atrazine (Treatment 4, Table 4), 1 pound Simazin (Treatment 15, Table 4) and the emergence application of a mixture of 0.5 pounds Atrazine and 3 pounds DNBP (Treatment 1, Table 4).

Although five chemical treatments gave significantly higher control of both annual broadleaf weeds and annual grasses than 4.5 pounds DNBP applied at emergence, only one treatment resulted in significantly higher yields (Treatment 1). This anomaly can perhaps be explained by the assumption that the level of weed control obtained with 4.5 pounds of DNBP was sufficiently high to permit near miximum yields for the magnitude of weed population and environmental and cultural conditions prevailing.

The yield depression following planting application of either 1.2 pound Diuron or 2 pounds of Simazin (Treatments 16 and 17 respectively, Table 2), appeared to be due to herbicide injury to the corn.

One pound Atrazine and one pound of Simazin applied at planting are phytotoxically equal to 4.5 pounds of DNBP applied at emergence.

Conclusions

Significantly better annual broadleaf weed and annual grass control than resulted from an application of 4.5 pounds DNBP at emergence in sweet corn was obtained by emergence applications of the following mixtures: 1 pound Simazin and 4.5 pounds DNBP; 0.8 pounds Diuron and 4.5 pounds DNBP; 0.5 pounds Simazin and 4.5 pounds DNBP; 0.4 pounds Diuron and 3.0 pounds DNBP; and 0.4 pounds Diuron and 4.5 pounds DNBP. Approximately the same relationship applies to planting applications of either one pound of Simazin or one pound of Atrazine, since these rates of Simazin and Atrazine are phytotoxically equivalent to emergence applications of 4.5 pounds DNBP. Planting applications of 2 pounds of either Simazin or Atrazine resulted in significantly better annual broadleaf weed control than 4.5 pounds DNBP, but did not differ significantly from DNBP in annual grass control.

Mixtures of herbicides, or rates of individual herbicides, resulting in significantly better overall weed control than standard (4.5 pounds DNBP) should not be unrestrictedly suggested for general commercial use, since enhanced weed control may not be accompanied by either higher yields per se, or by higher yields economically obtained. In the present test, although the standard treatment was excelled by five mixtures for total annual weed control, and by twelve treatments for annual broadleaf weed control alone, and by six treatments for annual grass control alone, only one treatment produced significantly higher yields than standard. Thus, while data such as obtained in the present test may be of limited usefulness they do indicate possible solutions to unusual and specific annual weed problems.

TABLE 1. RAINFALL JUNE - JULY 1958. MONMOUTH, MAINE

Date	Inches	Date	Inches
June 1	.37	July 11	.05
" 2	.50	" 15	.43
" 11	.05	" 18	.33
" 20	.70	" 19	.02
" 24	.01	" 21	.35
" 25	.29	" 22	.01
" 30	.52	" 24	.12
		" 25	.39
July 2	.18	" 26	.35
" 4	.01	" 27	.35
" 6	.01	" 28	.35
" 7	.93	" 29	.45
" 10	.66		

TABLE 2. EFFECT OF MIXTURES OF DNBP WITH DIURON, SIMAZIN OR ATRAZINE ON YIELD OF SWEET CO

No.	Treatment 1/ Simazin Diuron or Atrazine + DNBP	Yield Tons Snapped Ears Per Acre 5/	Rank 2/ Yield	Rank 2/ Annual Grass 3/	Rank 2/ Broadleaf Weeds 4/
1.	0.5# Atrazine EM + 3.0# DNBP EM	8.38	1	12	6
2.	1.0# Simazin EM + 4.5# DNBP EM	8.27	2	3	1
3.	Hand hoed only	8.24	3	1	5
4.	1.0# Atrazine PL	8.16	4	13	14
5.	0.8# Diuron EM + 4.5# DNBP EM	8.09	5	4	13
6.	0.4# Diuron EM + 4.5# DNBP EM	7.93	6	2	11
7.	0.5# Atrazine EM + 4.5# DNBP EM	7.92	7	15	7
8.	0.8# Diuron EM + 3.0# DNBP EM	7.82	8	8	4
9.	2.0# Atrazine PL	7.56	9	9	2
10.	0.4# Diuron EM + 3.0# DNBP EM	7.53	10	7	10
11.	1.0# Simazin EM + 3.0# DNBP EM	7.50	11	10	9
12.	4.5# DNBP EM	7.49	12	16	17
13.	0.5# Simazin EM + 3.0# DNBP EM	7.30	13	14	13
14.	0.5# Simazin EM + 4.5# DNBP EM	7.19	14	6	8
15.	1.0# Simazin PL	7.13	15	17	16
16.	2.0# Simazin PL	6.92	16	11	12
17.	1.2# Diuron PL	5.79	17	5	15
	L.S.D. 5%	1.22			
	1%	1.48			

1/ PL = herbicide applied at planting, 9 June '58. EM = herbicide applied at emergence, 17 June '58. Herbicides given as pounds per acre of active ingredient.
2/ 1 - highest yield etc., 19 - lowest yield etc.
3/ Barnyard grass - Echinochloa crusgalli L.
4/ Amaranthus retroflexus L; Chenopodium album L.
5/ Means included within brackets are not significantly different at 5% level. (Duncan's Multiple Range Test).

TABLE 3. EFFECT OF MIXTURES OF DNBP WITH DIURON, SIMAZIN, OR ATRAZINE ON BROADLEAF WEED CONTROL IN SWEET CORN

No.	Treatment 1/ Diuron Simazin or Atrazine + DNBP	Broadleaf Weed Control 2/ 4 August '58 Percent 5/	Angles	Rank 3/ Broadleaf Control	Yield	Annual Grass Control
2.	1.0# Simazin EM + 4.5# DNBP EM	100.0	90.00	1	2	3
9.	2.0# Atrazine PL	100.0	90.00	2	[illegible]	[illegible]
5.	0.8# Diuron EM + 4.5# DNBP EM	99.8	87.36	3	5	4
8.	0.8# Diuron EM + 3.0# DNBP EM	99.8	87.36	4	3	8
3.	Hand hoed only	99.8	87.36	5	3	1
1.	0.5# Atrazine EM + 3.0# DNBP EM	99.2	84.73	6	1	12
7.	0.5# Atrazine EM + 4.5# DNBP EM	99.2	84.73	7	7	15
14.	0.5# Simazin EM + 4.5# DNBP EM	99.2	84.73	8	14	6
11.	1.0# Simazin EM + 3.0# DNBP EM	99.2	84.73	9	11	10
10.	0.4# Diuron EM + 3.0# DNBP EM	98.7	83.57	10	10	7
6.	0.4# Diuron EM + 4.5# DNBP EM	97.8	81.46	11	6	2
16.	2.0# Simazin PL	97.0	79.99	12	16	11
13.	0.5# Simazin EM + 3.0# DNBP EM	96.0	79.13	13	13	14
4.	1.0# Atrazine PL	92.0	73.52	14	4	13
17.	1.2# Diuron PL	88.9	70.59	15	17	5
15.	1.0# Simazin PL	80.5	63.82	16	15	17
12.	4.5# DNBP EM	79.6	63.12	17	12	16
		L.S.D. 5% 12.77				

1/ PL = herbicide applied at planting, 9 June '58. EM = herbicide applied at emergence, 17 June '58. Herbicides given as pounds per acre of active ingredient.
2/ *Amaranthus retroflexus* L; *Chenopodium album* L. Percent was converted to angles for statistical analysis.
3/ Rank: 1- highest yield, grass control etc., 19 - lowest yield etc.
4/ Barnyard grass - *Echinochloa crusgalli* L.
5/ Means included within brackets are not significantly different at 5% level. (Duncan's Multiple Range Test).

TABLE 4. EFFECT OF MIXTURES OF DNBP WITH DIURON, SIMAZIN OR ATRAZINE ON ANNUAL GRASS CONTROL IN SWEET CORN.

No.	Treatment 1/ Diuron Simazin or Atrazine + DNBP	Annual Grass Control 21 August '58 2/ Percent	Annual Grass Control 21 August '58 2/ Angles	Rank 3/ Grass Control	Rank 3/ Yield	Rank 3/ Broad leaf Weed Control 4/
3.	Hand hoed only	100.0 5/	90.00	1	3	5
6.	0.4# Diuron EM + 4.5# DNBP EM	99.5	86.08	2	6	11
2.	1.0# Simazin EM + 4.5# DNBP EM	98.5	82.96	3	2	1
5.	0.8# Diuron EM + 4.5# DNBP EM	97.5	80.82	4	5	3
17.	1.2# Diuron PL	96.7	79.57	5	17	15
14.	0.5# Simazin EM + 4.5# DNBP EM	96.3	78.98	6	14	8
10.	0.4# Diuron EM + 3.0# DNBP EM	92.4	73.97	7	10	10
8.	0.8# Diuron EM + 3.0# DNBP EM	91.6	73.13	8	8	4
9.	2.0# Atrazine PL	90.0	71.51	9	9	2
11.	1.0# Simazin EM + 3.0# DNBP EM	85.9	67.98	10	11	9
16.	2.0# Simazin PL	85.7	67.81	11	16	12
1.	0.5# Atrazine EM + 3.0# DNBP EM	85.5	67.59	12	1	6
4.	1.0# Atrazine PL	85.0	67.25	13	4	14
13.	0.5# Simazin EM + 3.0# DNBP EM	79.6	63.16	14	13	13
7.	0.5# Simazin EM + 3.0# DNBP EM	77.2	61.48	15	7	7
12.	4.5# DNBP EM	74.7	59.78	16	12	17
15.	1.0# Simazin PL	74.6	59.74	17	15	16

L.S.D. 5% 14.46

1/ PL = herbicide applied at planting, 9 June '58. EM = herbicide applied at emergence, 17 June '58. Herbicides given as pounds per acre of active ingredient.

2/ Barnyard grass - Echinochloa crusgalli L. Percent was converted to angles for statistical analysis

3/ Rank: 1 - highest yield, grass control etc., 19 - lowest yield etc.

4/ Amaranthus retroflexus L. Chenopodium album L. Percent was converted to angles for statistical analysis.

5/ Means included within brackets are not significantly different at 5% level. (Duncan's Multiple Range Test).

CONTROL OF ANNUAL WEEDS IN SNAPBEANS WITH MIXTURES OF DNBP, CDEC OR EPTC

M.F. Trevett and Edward Austin[1]

Introduction

This paper is a report of a comparison of the effectiveness of mixtures or combinations of currently approved herbicides for snap beans with the same herbicides applied singly. The herbicides used were 4,6-dinitro ortho secondary butylphenol (DNBP); 2-chloroallyl diethyldithiocarbamate (CDEC); and ethyl di-n-propyl thiolcarbamate (EPTC). It appeared desirable to test combinations of these herbicides since individually they do not control both annual grasses and annual broadleaf weeds equally well. DNBP, for example, is considerably more effective on broadleaf weeds than on annual grasses. CDEC and EPTC, on the other hand, are essentially graminicides.

Procedure

Snap beans, variety Long Tendergreen, were planted June 16, 1958, one to two inches deep in a sandy loam soil. Treatments were replicated four times in a randomized block. Each treated plot was paired with an untreated plot.

Only the inter-row area was cultivated throughout the season, the soil six inches on either side of the crop row was not disturbed. The principal broadleaf weeds were _Chenopodium album_ L. and _Amaranthus retroflexus_ L. The principal grass was _Echinoloa crusgalli_ Beauv.

Herbicides were applied with a small plot sprayer at 40 pounds pressure and 50 gallons per acre volume.

Rainfall data for June and July 1958 are found in Table 1.

Weed counts were made August 19 (eight and one-half weeks after planting) for broadleaf weeds, and August 4 (seven weeks after planting) for annual grass.

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1 Associate Agronomist and Technical Assistant, respectively, Department of Agronomy, University of Maine.

Beans were harvested August 19.

The combinations of herbicides tested and acre rates of application of active ingredient are found in Table 2. Various combinations of "at planting" (Pl) applications with "emergence" (EM) applications were compared. Comparisons of date of application appeared to be of potential consequence because DNBP has been found most effective when applied as weeds are emerging (generally coinciding with crop emergence), while CDEC and EPTC generally have been found most effective when applied prior to weed seed germination. Early application of CDEC and EPTC insures ample time for penetration to the depth at which weed seeds germinate. Thus, it was assumed that a combination of 6# of CDEC applied at planting plus 4.5# DNBP applied at emergence (Treatment No. 14, Table 4) would result in a higher percent annual grass control than if both 6# CDEC and 4.5# DNBP were applied at emergence (Treatment No. 3, Table 4).

Results

Table 2 contains acre yields of snap beans, Table 3 percent control of annual broadleaf weeds, and Table 4 percent control of annual grasses. The rank assigned to treatments are identical in all tables.

On the basis of Duncan's Multiple Range Test, 6# CDEC applied in combination with 3# DNBP at emergence (Treatment No. 1, Table 2) gave significantly higher yields than the following treatments: 4# CDEC plus 4.5# DNBP applied at emergence (Treatment 15); 4# CDEC plus 4.5# DNBP applied at planting (Treatment 16); 4.5# DNBP applied at emergence (Treatment 17); 6# EPTC plus 4.5# DNBP applied at planting (Treatment 18); and 3# EPTC applied at planting (Treatment 19). Six pounds CDEC plus 3# DNBP applied at emergence (Treatment No. 1), did not differ significantly in effect on yields from the remaining treatments.

The high degree of variation in this test precludes any precise measure of treatment effect on bean yields. However, the distribution of Treatment-rank for yield in Table 4 indicates a trend for low yields to be associated with either treatments giving low percent grass control or treatments giving the highest percent grass control. Thus, treatments ranked 1, 2, 3 for annual grass control (Treatments No. 10, 18, 14, Table 4) are ranked 10, 18, 14 respectively for yield. Treatments ranked 16, 17, 18, 19 for grass control are ranked 17, 12, 16, 19 respectively for yield. From these relationships it appears that six pounds of either CDEC or EPTC applied at planting in combination with 4.5# DNBP applied either at planting or emergence is associated with a trend towards low yields compared to emergence applications of CDEC and EPTC in combination with DNBP, Table 2.

Six pounds of EPTC applied at planting in combination with 4.5 pounds DNBP applied at either planting or emergence, and 6 pounds CDEC applied at planting plus 4.5 pounds DNBP applied at emergence (Treatments 10, 14, 18 respectively) resulted in annual grass control significantly higher than for any of the other treatments.

The following treatments resulted in significantly lower broadleaf weed control than all other treatments: 4# CDEC at planting plus 4.5# DNBP at planting (Treatment 16), 6# EPTC at planting (Treatment 12), 6# CDEC at planting (Treatment 4), 4# CDEC at planting (Treatment 13), 4.5# DNBP at emergence (Treatment 17), and 3# EPTC at planting (Treatment 9).

Although 4.5# DNBP was considerably less effective in 1958 than in previous years, 6# CDEC applied pre-emergence either alone or in combination with either 3# or 4.5# of DNBP followed the usual weed control pattern. The four year average (1955 to 1958 inclusive) for pre-emergence applications follows:

	Percent Weed Control	
	Broadleaf	Annual Grass
4.5# DNBP	72	38
6.0# CDEC	45	82
3.0# DNBP plus 6.0# CDEC	88	71
4.5# DNBP plus 6.0# CDEC	82	81

Conclusions

Mixtures of DNBP and CDEC or of DNBP and EPTC control both annual broadleaf weeds and annual grasses more effectively than either DNBP, or CDEC, or EPTC applied alone.

Although the difference is not significant, there is a perceptible trend for planting applications of either CDEC or EPTC when followed by DNBP to reduce yields compared to mixtures of either CDEC or EPTC and DNBP applied at emergence.

Disregarding the economics of the situation, if in previous years DNBP, CDEC, or EPTC have not given satisfactory overall weed control in snap beans, percent control of both annual broadleaf weeds and annual grasses can be increased by emergence applications of either a mixture of 6# CDEC and 3.0# or 4.5# of DNBP or a mixture of 6# of EPTC and 4.5# of DNBP.

TABLE 1. RAINFALL JUNE - JULY 1958. MONMOUTH, MAINE

Date	Inches	Date	Inches
June 1	.37	July 11	.05
" 2	.50	" 15	.43
" 11	.05	" 18	.33
" 20	.70	" 19	.02
" 24	.01	" 21	.35
" 25	.29	" 22	.01
" 30	.52	" 24	.12
		" 25	.39
July 2	.18	" 26	.35
" 4	.01	" 27	.35
" 6	.01	" 28	.65
" 7	.93	" 29	.45
" 10	.66		

TABLE 2. EFFECT OF MIXTURES OF DNBP WITH EPTC OR CDEC ON YIELD OF SNAP BEANS

No.	Treatment1/ CDEC or EPTC + DNBP	Yield Snap Beans2/ Lbs. Per Acre 6/	Rank3/ Yield	Rank3/ Grass Control4/	Rank3/ Broadleaf5/ Control
1.	6# CDEC EM + 3.0# DNBP EM	5514	1	9	1
2.	6# EPTC EM + 4.5# DNBP EM	4757	2	7	5
3.	6# CDEC EM + 4.5# DNBP EM	4479	3	4	2
4.	6# CDEC PL	4472	4	5	16
5.	3# EPTC EM + 4.5# DNBP EM	4426	5	14	11
6.	4# CDEC PL + 4.5# DNBP EM	4220	6	8	9
7.	6# CDEC PL + 3.0# DNBP PL	4172	7	12	10
8.	6# CDEC PL + 4.5# DNBP PL	4145	8	10	8
9.	3# EPTC PL + 4.5# DNBP PL	4100	9	11	3
10.	6# EPTC PL + 4.5# DNBP EM	4057	10	1	4
11.	6.0# DNBP EM	4004	11	13	12
12.	6# EPTC PL	3963	12	17	15
13.	4# CDEC PL	3902	13	15	17
14.	6# CDEC PL + 4.5# DNBP EM	3849	14	3	6
15.	4# CDEC EM + 4.5# DNBP EM	3720	15	6	13
16.	4# CDEC PL + 4.5# DNBP PL	3565	16	18	14
17.	4.5# DNBP EM	3542	17	16	18
18.	6# EPTC PL + 4.5# DNBP PL	3425	18	2	7
19.	3# EPTC PL	3287	19	19	19
	L.S.D. 5%	1401.7			

1/ PL = herbicide applied at planting - 16 June '58. EM = herbicide applied - 23 June - two days before emergence. Herbicides given as pounds of active ingredient per acre.
2/ Beans picked 19 August '58.
3/ Rank: 1 - highest yield, grass control etc., 19 - lowest yield etc.
4/ Barnyard grass: Echinochloa crusgalli L.
5/ Principal broadleaf weeds were: Amaranthus retroflexus L; Chenopodium album L.
6/ Means included within brackets are not significantly different at 5% level (Duncan's Multiple Range Test).

TABLE 3. EFFECT OF MIXTURES OF DNBP WITH EPTC OR CDEC ON BROADLEAF WEED CONTROL IN SNAP BE

No.	Treatment[1/] EPTC or CDEC + DNBP	Broadleaf Weed Control[2/] 19 August 1958 Percent	Angles	Rank[3/] Broadleaf Control	Yield	Grass[4/] Control
1.	6# CDEC EM + 3.0# DNBP EM	83.9[5/]	66.36	1	1	9
3.	6# CDEC EM + 4.5# DNBP EM	73.7	59.14	2	3	4
9.	3# EPTC PL + 4.5# DNBP PL	73.2	58.83	3	9	11
10.	6# EPTC PL + 4.5# DNBP EM	71.8	57.91	4	10	1
2.	6# EPTC EM + 4.5# DNBP EM	71.1	57.47	5	2	7
14.	6# CDEC PL + 4.5# DNBP EM	70.0	56.79	6	14	3
18.	6# EPTC PL + 4.5# DNBP PL	65.8	54.22	7	18	2
8.	6# CDEC PL + 4.5# DNBP PL	63.0	52.56	8	8	10
6.	4# CDEC PL + 4.5# DNBP EM	62.6	52.28	9	6	8
7.	6# CDEC PL + 3.0# DNBP PL	61.4	51.58	10	7	12
5.	3# EPTC EM + 4.5# DNBP EM	57.5	49.33	11	5	14
11.	6.0# DNBP EM	50.0	45.00	12	11	13
15.	4# CDEC EM + 4.5# DNBP EM	50.0	45.00	13	15	6
16.	4# CDEC PL + 4.5# DNBP PL	34.9	36.22	14	16	18
12.	6# EPTC PL	23.0	28.62	15	12	17
4.	6# CDEC PL	21.9	27.72	16	4	5
13.	4# CDEC PL	16.1	23.64	17	13	15
17.	4.5# DNBP EM	12.9	21.06	18	17	16
19.	3# EPTC PL	5.7	13.83	19	19	19
	L.S.D. 5%		20.35			

1/ PL = herbicide applied at planting - 16 June '58. EM = herbicide applied June 23, two days before emergence. Herbicides given as pounds of active ingredient per acre.

2/ Principal broadleaf weeds were : *Amaranthus retroflexus* L; *Chenopodium album* L. Percent was converted to angles for statistical analysis.

3/ Rank: 1 - highest yield, grass control etc., 19 - lowest yield etc.

4/ Barnyard grass: *Echinochloa crusgalli* L.

5/ Means included within brackets are not significantly different at 5% level (Duncan's Multiple Range Test).

TABLE 4. EFFECT OF MIXTURES OF DNBP WITH EPTC OR CDEC ON ANNUAL GRASS CONTROL IN SNAP BEANS

No.	Treatment[1/] EPTC or CDEC + DNBP	Annual Grass Control[2/] 4 August 1958 Percent	Annual Grass Control[2/] 4 August 1958 Angles	Rank[3/] Annual Grass Control	Rank[3/] Yield	Rank[3/] Broadleaf Weed Control
10.	6# EPTC PL + 4.5# DNBP EM	91.3[4/]	72.32	1	10	4
18.	6# EPTC PL + 4.5# DNBP PL	89.5	71.14	2	18	7
14.	6# CDEC PL + 4.5# DNBP EM	83.9	70.50	3	14	6
3.	6# CDEC EM + 4.5# DNBP EM	82.2	65.00	4	3	2
4.	6# CDEC PL	82.0	64.92	5	4	16
15.	4# CDEC EM + 4.5# DNBP EM	80.1	63.53	6	15	13
2.	6# EPTC EM + 4.5# DNBP EM	78.2	62.18	7	2	5
6.	4# CDEC PL + 4.5# DNBP EM	77.8	61.91	8	6	9
1.	6# CDEC EM + 3.0# DNBP EM	76.4	60.92	9	1	1
8.	6# CDEC PL + 4.5# DNBP PL	72.8	58.60	10	8	8
9.	3# EPTC PL + 4.5# DNBP PL	71.8	57.91	11	9	3
7.	6# CDEC PL + 3.0# DNBP PL	71.8	57.90	12	7	10
11.	6.0# DNBP EM	67.0	54.92	13	11	12
5.	3# EPTC EM + 4.5# DNBP EM	51.8	46.01	14	5	11
13.	4# CDEC PL	29.5	32.88	15	13	17
17.	4.5# DNBP EM	28.7	32.88	16	17	18
12.	6# EPTC PL	26.2	30.79	17	12	15
16.	4# CDEC PL + 4.5# DNBP PL	13.5	21.56	18	16	14
19.	3# EPTC PL	11.3	19.62	19	19	19
	L.S.D. 5%		20.03			

1/ PL = herbicide applied at planting - 16 June '58. EM = herbicide applied - 23 June '58, two days before emergence. Herbicides given as pounds of active ingredient per acre.

2/ Barnyard grass: Echinochloa crusgalli L.

3/ Rank: 1 - highest yield, grass control etc., 19 - lowest yield, etc.

4/ Means included within brackets are not significantly different at 5% level (Duncan's Multiple Range Test). Percent was converted to angles for statistical analysis.

PRE- AND POST-EMERGENCE WEED CONTROL IN LEAF CROPS USING HERBICIDE COMBINATIONS[1/]

C. D. Price, Plant Physiologist
Virginia Truck Experiment Station
Norfolk

Pre-emergence Trials

The two standard pre-emergence herbicides for leaf crops in Eastern Virginia are CDEC and CIPC. Each of the two herbicides has its advantages and disadvantages. CIPC is the cheaper of the two and is effective in controlling chickweed (*Stellaria media*). CIPC cannot be used safely on mustard greens and it does not effectively control henbit (*Lamium amplexicaule*). CDEC has been found to be superior to CIPC in that it causes less crop stunting, can be used on a wider range of crops and will control henbit (1). CDEC is not as effective in controlling chickweed as CIPC. Both materials will control crabgrass (*Digitaria sanguinalis*), purslane (*Portulaca oleracea*) and goosegrass (*Eleusine indica*).

In recent research trials with leaf crops at the Virginia Truck Experiment Station, an effort has been made to combine some of the advantages of CDEC and CIPC by using various combinations of the two herbicides. The results of two such pre-emergence experiments are reported here. Crops included in trial No.1 were mustard greens and turnip greens. Spinach was the test crop in trial No.2.

Trial No. 1: Pre-emergence herbicide sprays on mustard greens and turnip greens.
Experimental information
Crop varieties: Mustard greens - Giant Southern Curled.
Turnip greens - Pomeranian White Globe.

Date planted: 8/27/57. Date treated: 8/28/57. Soil moisture: medium. Soil type: sandy clay loam. Exp. design: rand. block with 4 reps. Cultivation: none. Date of harvest: 11/8/57. Area harvested: 10 ft. of row from 3 rows each. Herbicide treatments: see Table 1. Spray per acre: 25 gallons at 30 PSI.

Rainfall record in inches for 1 wk. prior to and 3 wk. period following treatments: 1 wk. prior 0.18, 1st wk. after 0.0, 2nd wk. after 1.77, 3rd wk. after 2.66, 4 wk. total 4.61.

Temperature record for 3 wk. period following treatments in degree hrs. above 0°F: 1st wk. 12,417, 2nd wk. 12,430, 3rd wk. 13,063, 3 wk. total 37,910.

[1/] Contribution from the Plant Physiology Department, Virginia Truck Experiment Station, Norfolk. Paper No. 129, Journal Series. Approved for publication November 25, 1958.

Table 1. Treatments and results of pre-emergence sprays on mustard and turnip greens.

		Mustard Greens			Turnip Greens			
Herbicide	Rate/A.	Lbs. per 30 ft.	Plants per 30 ft.	Lbs. per 100 Plants	Lbs. per 30 ft.	Plants per 30 ft.	Lbs. per 100 Plants	Weed Control*
CIPC	2	6.1	469	1.30	11.78	220	5.24	6.25
CDEC	4	10.98	493	2.33	16.80	254	6.71	9.0
CDEC	2	7.35	399	1.87	11.98	208	5.90	8.5
CIPC	1/2							
CDEC	2	9.12	587	1.54	13.05	256	5.12	7.75
CIPC	1/4							
CDEC	2	9.15	548	1.75	11.92	190	6.44	7.50
CIPC	1/8							
CDEC	1	9.92	536	1.94	14.62	237	6.32	5.0
CIPC	1/2							
CDEC	1	10.52	503	2.17	13.78	215	6.52	6.25
CIPC	1/4							
CDEC	1	10.58	527	2.02	14.38	242	6.17	5.50
CIPC	1/8							
Check	0	9.18	609	1.54	13.38	242	5.54	2.0
L.S.D. (5%)		N.S.	134	0.72	N.S.	N.S.	N.S.	1.76
L.S.D. (1%)		N.S.	182	N.S.	N.S.	N.S.	N.S.	2.38

* Weed problem: crabgrass (*Digitaria sanguinalis*)
1 = no weed control
10 = perfect weed control

Results and Observations

Yield, stand and weed control results are shown in Table 1. CIPC at 2 lbs. per acre measurably reduced the stand of mustard greens and gave some retardation of plants that did germinate. Turnip greens were retarded slightly and weed control was not satisfactory. CDEC at 4 lbs. reduced mustard green stand slightly but not significantly but did not retard growth of plants. Turnip greens were not injured by the 4 lb. rate of CDEC and weed control was very satisfactory.

All combinations of CDEC at 2 lbs. plus 1/2, 1/4 and 1/8 lbs. of CIPC gave commercially acceptable weed control. The mustard green stand was greatly reduced with the 2 and 1/2 lb. combination but the resulting plants grew normally and resulted in only a slight yield reduction. The stand and yields of mustard or turnip were not affected by the 2 plus 1/4 lb. and 2 plus 1/8 lb. combinations. CDEC at 1 lb. in combination with CIPC at 1/2, 1/4 and 1/8 lbs. did not injure the crops but did not give satisfactory weed control.

Trial No. 2: Pre-emergence control of weeds in spinach using CDEC, CIPC and EPTC herbicides.

Experimental information

Spinach variety: Old Dominion. Date planted: 9/17/57.

Herbicide treatments: See Table 2. Dates treated: Treat. No. 1 applied 9/17/57 which was followed immediately by a 2.46 rain. Remaining treatments applied on 9/20/57 while soil was very moist. Spray per acre: 50 gallons at 30 PSI. Exp. design: Rand. block with 4 reps. Cultivation: none. Date harvested: 1/3/58. Area harvested: One 3.5' bed, 30' long and 3 rows per bed per plot.

Rainfall and temperature record:

Period from Treatment	Inches of Rainfall		Temperature (Degree hrs. above 0°F.)	
	Treat. #1	Treats. #2-6	Treat. #1	Treats. #2-6
1 wk. prior	.77	2.46	-	-
1st wk. after	2.46	0.0	12,374	12,046
2nd wk. after	2.58	3.08	10,899	10,467
3rd wk. after	2.62	2.12	10,436	10,449
Total	8.43	7.66	33,709	32,962

Results and observations

CDEC at 2 lbs./A. in combination with 1/4 lb./A. CIPC applied just prior to a 2.46 inch rain gave 100% control of weeds for 5 weeks and was controlling common chickweed 3½ months later at harvest (Table 2). The spinach plants were noticeably stunted after 5 weeks and had not completely grown out of it at harvest although yields were not reduced significantly. The same treatment applied following the 2.46 rain as soon as field conditions permitted gave acceptable but not complete weed control for 5 weeks and very little control of winter weeds. Spinach was not affected by this treatment. The combination of CDEC at 2 lbs. with CIPC at 1/4 lb. gave comparable weed control results with 3 lbs. of CDEC alone.

EPTC at 8 lbs. gave a little better weed control for 5 weeks than did 4 lbs. and neither rate reduced spinach yields. However, these results of no spinach damage do not agree with some later results at the Norfolk Station where EPTC at 4 and 8 lbs. applied to a dry soil severely damaged the spinach stand and growth. The combination of CDEC and EPTC at 1 lb. each gave very satisfactory results in this experiment.

Table 2. Treatments and results for pre-emergence sprays on spinach.

Treat. No.	Chemical and Rate/A in Lbs.		Av. Yield in Lbs. per 30 ft. bed	Weed Control* 10/22/57	1/3/58
1	CDEC-2 (Before 2.46" rain) CIPC-¼		10.75	10.0	8.25
2	CDEC-1 (After 2.46" rain) EPTC-1		14.70	8.0	4.75
3	EPTC-4	"	13.25	8.25	6.25
4	EPTC-8	"	12.68	9.0	5.0
5	CDEC-3	"	11.52	8.75	6.0
6	CDEC-2** CIPC-¼	"	14.25	8.5	5.5
7	Check		12.50	1.0	1.0
L.S.D.'s			N.S.		

* 1 = no control, 10 = perfect control, 8 = considered acceptable.
** Treat. No. 6 altered from 1/8 lb. CIPC to 1/4 lb. CIPC so as to compare treats. 1 and 6 on the basis of the effect of rainfall before and after treatment.
* Weeds controlled: 10/22/57 - crabgrass, no control of pigweed except No. 1
1/3/58 - chickweed in treat. No. 1, henbit not a problem

Summary and conclusions for pre-emergence trials

1. CDEC and CIPC were sprayed alone and in combinations as pre-emergence herbicides to mustard greens, turnip greens and spinach. EPTC was included in the spinach trial.

2. Results indicate that combination sprays of CDEC, CIPC and EPTC have very good possibilities for leaf crops. Rates of 2 lbs. CDEC in combination with 1/4 to 1/8 lb. of CIPC were tolerated by mustard greens, turnip greens and spinach with satisfactory early weed control. The combination of CDEC and EPTC at 1 lb. each looked promising on spinach.

3. Results show that rainfall either just prior to or just after applying treatments can greatly affect the results of pre-emergence treatments.

Post-emergence Trials

With the advent of successful pre-emergence weed control in leaf crops, the next obvious need for leaf crop growers is a herbicide that can be safely used as a post-emergence treatment. The residual from the pre-emergence treatment normally lasts from 3 to 6 weeks. Most leaf crops are then normally at the thinning stage or large enough for a light cultivation where thinning is not practiced. This would be the ideal stage of growth to apply an additional herbicide application for control of germinating weeds. Leaf crops that are fall planted and spring harvested are in particular need of such a treatment. A herbicidal application at late fall thinning that would keep the crop free of winter weeds would be most helpful. Spinach was selected as the test crop for testing the possibilities of such a weed control program.

Methods and Materials

Old Dominion spinach was planted in two locations on October 16, 1957. Both locations received a pre-emergence herbicide of 2 lbs. per acre CDEC in combination with 1/8 lb. per acre of CIPC. This treatment kept spinach weed free for 5 weeks with no damage to the spinach. On December 3, or 7 weeks after pre-emergence treatments, the experimental post-emergence treatments were applied. This was done immediately following a hand thinning and weeding in location No. 1. In location No. 2 henbit had begun to germinate and this was pulled by hand with no thinning or cultivation. The size of the spinach in each case was 2-3 inches in diameter with 4-6 true leaves. Herbicidal treatments used and results for location No. 1 are shown in Table 3 and the same is shown for location No. 2 in Table 4. Herbicides used included spray and granular CDEC, CIPC and EPTC. Location No. 1 was hand harvested on April 17, 1958 and weed control ratings made at that time. Location No. 2 was hand harvested on April 9, 1958 and weeds per 20 sq. ft. were pulled and weighed for each plot.

Results and Discussion

No herbicide, either spray or granular, applied post-emergence to the spinach in either location significantly affected the final spinach yield. Each location provided a contrast as to the weed problem. In location No. 1 chickweed was the major problem weed while in location No. 2 henbit was the problem weed.

The best treatment in location No. 1 where chickweed was a problem was a combination of CDEC at 1 lb. per acre with CIPC at 1/4 lb. per acre applied either as a spray or in granular form. CDEC at 2 lbs. gave satisfactory weed control to harvest but did not completely control chickweed. EPTC at 5 lbs. did not give as good weed control as the other treatments but did not damage the spinach. The granular material with each treatment was slightly superior in weed control over the comparable spray treatment.

In location No. 2 where henbit was the main problem weed, treatments 1 and 3 containing 2 lbs. per acre of CDEC gave very satisfactory weed control from time of application in December to harvest in April. The addition of 1/8 lb. CIPC to the 2 lbs. of CDEC did not appreciably improve the weed control here. The absence of an appreciable amount of chickweed in the experimental area is probably the reason weed control was not improved with the addition of CIPC. All treatments containing less than 2 lbs. of CDEC were not considered as giving acceptable weed control. This would suggest that at least 2 lbs. per acre of CDEC are needed for effective henbit control through the winter.

Table 3. Treatments and results of post-emergence trials in spinach location No. 1.

Treat. No.	Chemical and Rate/A in Lbs.	Carrier	Yield in Lbs. per 30 ft. of bed 1/	Weed Control Rating at Harvest 2/
1	CDEC-2	Water	75.4	7.5
2	CDEC-2	Attaclay (10%)	73.7	8.8
3	EPTC-5	Water	83.8	6.8
4	EPTC-5	Attaclay (5%)	76.2	7.2
5	CDEC-1 CIPC-½	Water	76.7	9.0
6	CDEC-1 CIPC-½	Attaclay (2%) Attaclay (½%)	66.6	9.5
7	Check		73.8	5.0
L.S.D. (5%)			N.S.	1.96
L.S.D. (1%)			N.S.	2.69

1/ 2 rows per bed

2/ 1 = complete ground cover of weeds
10 = no weeds
Weed problem = chickweed (*Stellaria media*)

Table 4. Treatments and results of post-emergence trials in spinach location No. 2.

Treat. No.	Chemical and Rate/A in Lbs.	Carrier	Yield in Lbs. per 20 sq. ft.	Wt. of Weeds in Grams per 20 sq. ft. 1/
1	CDEC-2	Water	29.0	22.5
2	CDEC-1	Water	28.5	111.5
3	CDEC-2 CIPC-1/8	Water	32.8	20.0
4	CDEC-1 CIPC-1/4	Water	32.8	75.2
5	CDEC-1 CIPC-1/8	Water	30.7	78.5
6	CDEC-1.5 CIPC-1/8	Water	26.5	67.0
7	Check		32.2	191.0
L.S.D. (5%)			N.S.	105.0
L.S.D. (1%)			N.S.	143.9

1/ Predominantly henbit (*Lamium amplexicaule*)

Rainfall record in inches for 1 wk. prior to and 3 wk. period following post-emergence treatments at location No. 1 and No. 2: 1 wk. prior 0.83, 1st wk. after 1.75, 2nd wk. after 1.40, 3rd wk. after 0.36, 4 wk. total 4.34.

Summary and conclusions for post-emergence trials

1. Old Dominion spinach was planted in the fall at two locations, treated with one pre-emergence herbicide treatment, thinned or weeded 7 weeks later and given post-emergence treatments of CDEC, CIPC and EPTC. Spinach had 4-6 true leaves at treatment. Granular and spray formulations were compared at one location. Spinach was harvested the following spring. Yield and weed control records were taken.

2. The results indicate the very good possibility of using the pre-emergence herbicides CDEC, CIPC and EPTC as post-emergence herbicides to over-wintering spinach at thinning or when the effects of the pre-emergence treatment is gone. The herbicide or rate to use would depend in part on the weed problem. At least 2 lbs. per acre of CDEC was needed for henbit control in this experiment while 1/4 lb. of CIPC was sufficient for chickweed control in combination with 1 lb. CDEC.

3. Granular formulations appear to have more possibilities for this use. In addition to some better weed control would be the probability of less residues to the crop with the granulars.

4. It is possible that other leaf crops would also show a tolerance of these herbicides at some post-emergence stage of growth.

5. It is suggested that work should be initiated toward the possibility of obtaining residue tolerances from Food and Drug for post-emergence use of CDEC, CIPC and EPTC on certain leaf crops.

Literature Cited

(1) DANIELSON, L. L. Evaluation of pre-emergence spray and granular applications of CDEC on vegetable leaf and cole crops. Proc. of NEWCC 1958: 17-22. 1958.

CONTROL OF WEEDS IN TOMATOES AND SWEET CORN [1/]

C. D. Price, Plant Physiologist
Virginia Truck Experiment Station
Norfolk

This paper presents the results of one experiment each on tomatoes and sweet corn. Both experiments were conducted on the grounds of the Virginia Truck Experiment Station Eastern Shore Substation at Painter during the summer of 1958.

Tomatoes

Over 15,000 acres of tomatoes were grown commercially in 1957 in the two county area comprising the Eastern Shore of Virginia. Most tomato fields developed a rather severe weed problem between the last cultivation and harvest. And although badly needed, no herbicide is presently recommended for use on tomatoes during this period. The purpose of this experiment was to add to the research information available concerning weed control in tomatoes in the hope of soon having a herbicide recommendation for tomatoes.

Experimental Information

Tomato variety: Rutgers. Fertilization: 500 lbs. 10-10-10 at transplanting and again after lay-by. Cultivation: All plots kept weed-free by regular cultivation to lay-by. Date of lay-by: June 17. Date of herbicide treatments: June 19. Temp. at treatment: 75°F. Soil moisture at treatment: moist. Plot size: one 6 ft. row with 12 plants spaced 3 ft. apart. Herbicide treatments: See Table 1. Area harvested: 10 plants per plot. Experimental design: Rand. block with 5 reps. Methods of application: Sprays applied in 23 gals. water per acre as a directed spray with 49 x 49 non-clog 120° nozzles at 30 PSI. Granulars applied over top of plants with a tractor drawn applicator carrying 6 ft. cut.

Temperature record for 3 week period following treatments in degree hours above 0°F: 1st wk. 10,908, 2nd wk. 11,994, 3rd wk. 12,657, 3 wk. total 35,559.

Rainfall record in inches for 1 wk. prior and 3 wks. after treatments: 1 wk. prior 1.44, 1st wk. after 1.14, 2nd wk. after 0.64, 3rd wk. after 0.18, 4 wk. total 3.40.

[1/] Contribution from the Plant Physiology Department, Virginia Truck Experiment Station, Norfolk. Paper No. 128, Journal Series. Approved for publication November 24, 1958.

Results and Observations

In Table 1 are shown the yield totals and weed control ratings for each herbicide treatment. All treatments were applied at lay-by and none of the treatments significantly affected the yield of No. 1 tomatoes or the total yield of all sound tomatoes. The major weed problem in this experiment was crabgrass (*Digitaria sanguinalis*). A weed control rating of 7.0 or above was considered as being commercially acceptable. All treatments gave acceptable weed control. EPTC at 6 lbs. per acre applied in granular form was the only treatment to give 100% weed control in all plots.

CIPC at rates of 2 and 4 lbs. and CDEC at the 4 lb. rate were compared as a directed spray and in granular form applied overall. In each case where granulars and sprays were compared at the same rate, the granular treated plots tended to outyield the spray plots. The weed control was also a little better in each case on the granular treated plots. These results agree closely with the findings of Meggett[1].

Since granular CIPC up to 4 lbs. has received approval from Food and Drug (2) for use on tomatoes at lay-by, emphasis for the present should be placed on the results of the granular CIPC treatments. The 4 lbs. per acre treatment did tend, although not significantly, to reduce tomato yields. The 2 lbs. treatment gave negligible yield reduction with satisfactory grass control. It would appear that the 2 lb. rate of granular CIPC is the treatment that would have possibilities for use by the tomato grower at the present time.

Table 1. Lay-by herbicide treatments to tomatoes and results.

Chemical & Active Rate/A.	Formulation	Carrier	Yield of No. 1 Tomatoes in Lbs./10 Plants 1/	Total Yield of Tomatoes in Lbs/10 Plants 2/	Weed Ratings 3/
CIPC-2	Gran. (5%)	Attaclay	66.58	89.80	8.8
CIPC-4	Gran. (5%)	Attaclay	58.08	81.88	9.2
CIPC-2	Spray	Water	59.18	84.38	8.2
CIPC-4	Spray	Water	55.20	77.78	9.0
CDEC-4	Gran. (10%)	Attaclay	69.38	92.18	9.4
CDEC-4	Spray	Water	65.26	87.40	8.4
Neburon-4	Spray	Water	63.82	87.96	9.8
EPTC-6	Gran. (10%)	Attaclay	62.06	83.98	10.0
G 27901-1	Spray	Water	66.36	88.16	8.8
Check	-	-	70.40	92.92	2.6
L.S.D. (5%)			N.S.	N.S.	

1/ All sound tomatoes that were approximately 2 inches in diameter or over.

2/ All sound tomatoes.

3/ 0 = complete ground cover of weeds.
10 = no weeds.

Summary and Conclusions

1. Rutgers tomatoes were treated at lay-by with spray and granular applications of CIPC and CDEC, with sprays of Neburon and G-27901 and with granular EPTC.

2. No herbicide treatment significantly reduced yields and all treatments gave satisfactory weed control, predominantly crabgrass. EPTC at 6 lbs. gave 100% weed control on all plots to harvest.

3. The most promising treatment for grower use at the present time is 2 lbs. per acre of granular CIPC.

4. CDEC, Neburon, EPTC and G-27901 look promising for weed control in tomatoes at lay-by and research should be continued using these herbicides.

5. Granular formulations of CIPC and CDEC gave slightly superior results in terms of yield and weed control over comparable rates of sprays.

Sweet Corn

In the 1958 sweet corn variety trials conducted at the Painter substation, 17 different herbicides, herbicide combinations and herbicide rates were tested. The variety trials consisted of three row plots and the third row of each plot was treated with a pre-emergence herbicide leaving two rows for a cultivated check. Eight variety plots were treated with each herbicide treatment. A particular sweet corn variety may or may not (usually not) have been duplicated within each treatment and may or may not have been duplicated between treatments. The purpose of this experiment was to get leads on any new herbicide or any herbicide combinations in terms of degree and length of weed control and its effect on as many sweet corn varieties as possible. The results obtained were for the most part observational and no statistical analysis was run.

The results obtained with one of the treatments at two rates was considered of enough interest to report here. The 1 and 2 lbs. per acre rates of Simazine are the only two treatments that will be specifically referred to in this paper.

Results and Observations

Early in the sweet corn's growth it was evident that certain varieties were much greener and more vigorous in growth where treated with pre-emergence applications of 1 and 2 lb. rates of Simazine as contrasted with the cultivated rows. This green color and stimulated growth continued through to maturity and was particularly striking on varieties Crookham 615-12 and Carmelcross. In addition, of the 17 treatments applied, the Simazine treated plots were the only plots that gave acceptable weed control past the second cultivation through to harvest.

The contrast in growth rates was so striking between the Simazine treated rows and the cultivated check for certain varieties that yield records and certain measurements were taken on these varieties. Eleven sets of data were kept for four varieties treated with the 1 lb. rate and two varieties treated with the 1 lb. rate. The results in terms of increased husked ear weight per acre and increased dozen ears per acre over and above the cultivated check are shown in Table 2.

The results shown in Table 2 confirm the observation that varieties Crookham 615-22 and Carmelcross were possibly stimulated by a 1 lb./A. pre-emergence treatment of Simazine. Each variety showed an increase of 415 dozen ears/A. of marketable corn over its cultivated check row. The only variety that could be compared with both the 1 and 2 lb. rates was Aristogold and both plots showed identical increases of 207 dozen ears/A. over its cultivated check. However, the 1 lb. rate increased the ear weights by 1,792 pounds/A. as compared to an increase of 896 pounds for the 2 lb. rate.

At best these results can only be considered as an indication of stimulation since in most instances only one replication of each variety was available for yield results. However, it is believed that the indications of stimulation from these pre-emergence treatments of Simazine are strong enough to suggest that they may be real.

Table 2. Sweet corn per acre yield increases on Simazine treated plots over and above the cultivated check.

Variety	Simazine 1 Lb./A. Weight of Husked Ears in Lbs./A.	Simazine 1 Lb./A. Dozen Ears/A.	Simazine 2 Lbs./A. Weight of Husked Ears in Lbs./A.	Simazine 2 Lbs./A. Dozen Ears/A.
Crookham 615-22	2,937	415		
Carmelcross	4,381	415		
Iochief	1,543	166		
Aristogold	1,792	207	896	207
Golden Hybrid G 101			1,643	249

Summary and Conclusions

1. Simazine at 1 lb. per acre applied pre-emergence to several varieties of sweet corn gave perfect weed control up to harvest with no injury to any variety tested. The 2 lb. rate gave perfect weed control through harvest with no varietal damage.
2. Certain sweet corn varieties appeared to be stimulated by the Simazine treatments.
3. Data are presented which suggest that some stimulation did occur. Further experiments will be necessary to conclusively relate this stimulation in certain sweet corn varieties to Simazine.

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EVALUATION OF CERTAIN GRANULAR HERBICIDES ON INJURY AND WEED CONTROL IN TOMATOES[1]

BARRY K. HUGHES, C. J. NOLL, AND M. L. ODLAND[2]

One of the main factors in the high cost of growing tomatoes is the expense of manual labor in controlling weeds. The development of a chemical which will successfully control weeds without injury to the tomato plant would do much to lower labor costs.

The greatest drawback has been that herbicides in liquid form injure the sensitive tomato plant too much to be of any use. When rates are lowered to reduce plant injury, herbicidal value tends to decrease. Work done previously by Danielson (1,2,3,4,5), and Sweet (6) showed that plant injury could be decreased by the use of granular rather than liquid formulations of the various herbicides.

This investigation was made to determine the effect of several herbicides in granular form on weed control and plant injury in tomatoes.

PROCEDURE

Plants of the variety Rutgers were set in the field on May 29, 1958. The herbicides were applied on July 3, using a lawn seed and fertilizer spreader. The planting was laid out in a randomized block design, using eight replications. Individual plots were 24 feet long by 6 feet wide, with a 2 foot wide treated area over the row.

On July 25 a weed control rating was made of all plots on a basis of 0-10, 0 being no weed control and 10 being perfect weed control (7). Yield records on marketable fruit were taken on September 12 and 24. Plant injury caused by the herbicides was measured in terms of yield, number of fruit and weight per fruit.

RESULTS AND CONCLUSIONS

All chemicals gave significantly better weed control than the check. Neburon was significantly poorer than any of the other chemicals tested, while ACP-M622 was given the highest weed control index rating. CIPC at 6.5 lbs, Randox at 5 and 8 lbs., Vegadex at 8 lbs., and Dinitro at 10 lbs., also gave good weed control. Neburon at 7 lbs., Randox at 5 and 8 lbs., and the check gave the highest number of fruit produced. Difference in yield were not significant.

It should be noticed that among several of the chemicals, especially ACP-M622, there was little or no difference in weed control between the high and low rates. This would seem to indicate that the point of diminishing returns had been reached as far as weed control was concerned and that a lower rate of the chemical might be used without affecting weed control very greatly. Randox, Vegadex, and ACP-M622 show promise when used in granular form.

1. Authorized for publication on November 24, 1958 as Paper No. 2320 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

2. Graduate Assistant, Assistant Professor of Olericulture, and Professor of

TABLE I

Effect of certain granular herbicides upon weed control, yield, number of fruit, and weight per fruit in tomatoes.

Treatment	Rate per acre in lbs. (active)	Weed Control	Yield lbs.	No. Fruit	Wt./Fruit lbs.
1. CIPC	3	6.9	120.41	325	.37
2. "	6.5	8.9	100.70	316	.32
3. Neburon	4	3.1	117.28	357	.33
4. "	7	4.8	131.16	416	.32
5. Randox	5	8.5	146.28	445	.33
6. "	8	8.4	135.08	437	.31
7. Vegadex	5	8.0	134.55	358	.38
8. "	8	8.6	142.40	401	.36
9. Dinitro	5.5	8.1	115.44	358	.32
10. "	10	8.6	122.24	354	.35
11. Check	---	---	138.95	437	.32
12. ACP-M622	6	9.6	135.67	406	.33
13. "	10.5	9.4	121.49	369	.33
L.S.D.	5% level	1.7	N.S.	60	N.S.
" " "	1% level	2.2	N.S.	80	N.S.

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Progress Report on Lay-by Weed Control of Potatoes[1]

R. L. Sawyer, G. H. Collin and W. H. Thorne[2]

The work covered in this report is a continuation of the lay-by investigations, reported in previous proceedings. The main interest is in potato tolerance to materials which have a proven history of weed control.

Materials and Methods

Katahdin tubers were planted April 14 and given normal culture until lay-by herbicides were applied on July 2, 1958. There had been three weedings and three cultivations at this time.

Plots were three rows wide and 30 feet long with four replications of each chemical treatment in a randomized block design. There were check plots beside each chemical treatment. Plots were harvested on September 22.

Storage results are given for the lay-by weed work reported in the 1958 proceedings. Black spot index was obtained by bruising tuber and peeling after 48 hours. This index runs 0 to 90, taking into consideration both the severity of the black spot and the per cent of tubers showing the blackening. The chipping index was obtained by frying cured samples and rating the color of the chips 1 through 9. One indicated very dark chips and 9 very light chips with 5 considered the darkest level for commercial acceptability.

Results and Discussion

None of the materials statistically affected the yield. Dalapon, however, gave indications that even with the granular application there was some yield depression as found in previous years with the overall sprays. There was insufficient weed problem in these plots to take weed data. The yield results are given in Table 1.

The storage results given in Table 2 are for those materials reported on in the 1958 proceedings. None of the materials had any effect on black spot or chipping color. As the dosage of diuron increased, shrinkage in storage tended to increase. There was no statistical significance among the various treatments on sprouting, however, natrin plots were the lowest as they have been for several years.

1 Paper No. 426, Department of Vegetable Crops, Cornell University, Ithaca, N.Y.

2 Long Island Vegetable Research Farm, Cornell University, Riverhead, N.Y.

Table 1. Effect of several lay-by hervicides on yield of Katahdin potatoes.

Materials		Dosage lbs./A.	Bu./A. No. #1	Bu./A 2-3½"
Alanap 2	Spray	4	544	467
Alanap 3	Granular	4	559	477
Diuron	Granular	3/4	505	442
3Y9	Spray	4	569	508
3Y9	Granular	4	601	512
EPTC	Spray	5	558	454
EPTC	Granular	5	583	501
EPTC	Spray	10	569	492
EPTC	Granular	10	560	467
Simazin	Spray	1½	574	469
Simazin	Granular	1½	557	470
Dalapon	Granular	4	494	439
Check			530	400

Table 2. Lay-by weed control (storage results)

Treatments			Per cent shrinkage	Sprouting	Black spot	Chipping color
Material	lbs/A	Spray or Granular				
Alanap 2	4	S	6.2	14.6	40.9	5.5
Alanap 2	6	S	5.9	13.7	35.2	6.0
Alanap 3	4	G	6.8	12.4	30.8	5.8
Alanap 3	6	G	6.5	12.4	30.8	6.3
Natrin	4	S	6.0	12.8	35.2	5.0
Natrin	8	S	5.6	11.2	24.8	5.3
Diuron	½	S	6.2	14.3	42.1	5.5
Diuron	3/4	S	7.2	14.3	39.4	5.5
Diuron	½	G	6.2	13.8	35.8	6.5
Diuron	3/4	G.	6.3	15.4	32.2	4.5
Diuron	1	G	7.0	14.1	36.9	6.3
3Y9	3	S	6.7	14.2	34.6	5.3
3Y9	6	S	7.3	15.0	31.0	6.5
Vegedex	6	S	6.9	15.7	32.7	5.8
Vegedex	9	S	7.1	14.2	35.6	6.3
EPTC	4	S	5.3	14.3	24.9	6.8
EPTC	8	S	6.3	14.7	45.6	6.0
Check			6.3	14.3	38.7	5.5

525 - lost

52~~[illegible]~~6 - lost

A Report on the Use of Atrazine (Geigy 30027) Applied Pre and Post-Emergence in Sweet Corn

*By Norman J. Smith

Problem

An effective herbicide which could safely be applied pre and post-emergence on sweet corn is warranted.

Growers, due to wet soils or other delays occasionally miss the opportune time for pre-emergence applications.

The readily available 2,4-D materials cause injury on many sweet corn varieties grown on light soils and do not control grasses. The Dimtro materials are effective when applied pre-emergence for many broad leaf weeds but the poor grass control is disappointing to growers.

Materials and Methods

The sweet corn variety Iochief was planted July 1. Pre-emergence sprays were applied July 2. Post-emergence sprays were applied July 18. On July 18 the corn was 6 to 8 inches tall with broad leaved weeds and grasses up to 2 inches in height.

The Atrazine (G-30027) was applied in an 18 inch band over 34 inch rows using a 4 nozzle low pressure boom sprayer with one nozzle over each row.

Rates of Atrazine (G-30027) applied were 1¼, 2½ and 5 pounds actual per net acre. Net acre is that soil which was actually sprayed.

The corn was thinned to an 18 inch spacing in the row when it was 10 inches tall.

Weeds present were:

Broad leaf	Grasses
Red root pigweed (Amaranthus retroflexus)	Crab grass (Digitaria sanguinalis)
Lambs-quarters (Chenopodium album)	Green foxtail (Setaria viridis)
Ragweed (Ambrosia elatior)	Barnyard grass (Echinochloa crusgalli)
Purslane (Portulaca oleracea)	Nut grass (Cyperus esculentus)
Common chickweed (Stellaria media)	

*Assoc. County Agric. Agent, Nassau County, N.Y.

Plots were 4 (34 inch) rows wide and 50 feet long. The front 25 feet of each plot received the pre-emergence treatments. The back 25 feet of each plot received the post emergence treatments. Plots were replicated four times. Four check plots included were each 50 feet long and 4 (34 inch) rows wide.

Growing conditions were good with ample rainfall through the complete season. Soil was a sandy loam.

None of the sprayed or check plots were cultivated for the complete growing period.

Results

July 18 observations showed complete control of all broad leaves in the pre-emergence July 2 treatments. Annual grass control was complete except in the $1\frac{1}{4}$ pounds plots.

July 21 observations showed a complete burn on all of the broad leaf weeds in the post emergence July 18 plots. The Atrazine effect was very similar to a contact spray, such as Stoddard Solvent.

The annual grasses showed a slight tip burn.

The corn did not show any effect from the pre or post emergence sprays by July 21 or thereafter.

When the corn in the check plots was 12 inches tall it began to show yellowing and tip burn on the lower leaves caused by weed competition.

Weed population in the untreated areas averaged 50 broad leaves and 10 annual grass plants per square foot. An occasional nut grass plant was found.

Rating of Atrazine Weed Control in the 18 Inch Row

Sprayed Area - At Harvest Time

	Pre-emergence			Post-emergence		
Pounds Actual	$1\frac{1}{4}$	$2\frac{1}{2}$	5	$1\frac{1}{4}$	$2\frac{1}{2}$	5
Broad Leaf Control	10*	10	10	10	10	10
Annual Grass Control	10	10	10	3	7	8
Nut Grass	1	1	3	1	1	3

*Rating numbers are 1 through 10. Ten is complete control and 1 no control.

Rating of Atrazine Weed Control in the UNSPRAYED

Area Between the Rows - At Harvest Time

Pounds Actual	Pre-emergence $1\frac{1}{4}$	Pre-emergence $2\frac{1}{2}$	Pre-emergence 5	Post-emergence $1\frac{1}{4}$	Post-emergence $2\frac{1}{2}$	Post-emergence 5
Broad Leaf Control	1*	8	8	1	8	8
Annual Grass Control	2	6	6	2	6	6
Nut Grass	1	1	1	1	1	1

*Rating numbers are 1 through 10. Ten is complete control and 1 no control.

The results indicated in the above chart are usually unique.

It indicates an apparent lateral movement of the Atrazine

Sweet Corn Yields and Response

The yield of sweet corn in the pre and post emergence $1\frac{1}{4}$, $2\frac{1}{2}$ and 5 pound plots was one marketable ear per plant.

Yield of sweet corn in the untreated areas was zero. No ears could be found which were satisfactory for market. Most ears were less than 5 inches long and 3/4 inches in diameter.

At no time was any adverse affect noted in the sweet corn which was treated pre or post emergence.

Conclusions

Yields of marketable sweet corn, one ear per plant, were obtained during Atrazine (G-30027) pre and post emergence without cultivation. The pre-emergence treatments were most effective for grass control. Pre and post emergence treatments were equally effective for annual broad leaf weed control.

Some degree of weed control was obtained in the unsprayed areas adjacent to the sprayed areas.

Summary

Atrazine looks promising as an effective herbicide for use in corn. The $1\frac{1}{4}$ lb. rate controlled all broad leaf weeds and annual grasses when applied pre-emergence.

The $1\frac{1}{4}$ lb. rate controlled all broad leaf weeds when applied post emergence when corn was 6 inches tall. The 5 lb. rate applied post emergence gave considerable control of annual grasses.

THE MANAGEMENT OF THE ROADSIDE BY SELECTIVE HERBICIDE TECHNIQUES

Richard H. Goodwin[1]
William A. Niering[2]

This paper deals with problems resulting from the improper application of weed killers on our roadsides and recommends ecologically and economically sound management techniques. The recommendations are generally applicable to all types of roadsides, but are especially directed toward two-lane town, county, or state roads. These recommendations do not apply to the maintenance of the grassy turf or to areas under the guard rails.

What is the Crisis?

1. Needless destruction of attractive roadside ornamental shrubs*, wild flowers and other herbaceous flowering plants frequently referred to as "noxious weeds", which, if spared, would enhance the beauty of the roadside.

2. Inadequate root-kill of the sprayed trees and shrubs (brush) on initial application so that repeated treatments are required.

3. The spraying of ragweed, a technique biologically unsound as a method of eradication and with unfortunate side effects listed under item one above.

4. The creation of continuous unsightly brown swaths along roadsides, which result from broadcast spray techniques.

5. Attractive low price-per-mile bids offered by persons careless of desirable plant types being sprayed.

Roadside Needs.

1. Adequate visibility and good sight line conditions, which necessitate removal of certain woody growth along the roadsides.

2. The eradication of poison ivy.

3. A roadside attractive to the motorist, whether he be on vacation or merely commuting to and from work.

1 Professor of Botany and Director of the Connecticut Arboretum.
2 Associate Professor of Botany and Assistant to the Director of the Connecticut Arboretum.

* Azaleas, mountain laurel, blueberries, dogwoods, viburnums, bayberry, winterberry and others.

4. The accomplishment of the foregoing objectives at a minimum cost.

A Selective yet Economical Approach to the Problem.

THE SELECTIVE APPROACH implies removing only those woody plants which either (a) interfere with sight line conditions or (b) are otherwise undesirable (e.g. poison ivy). This involves treating the undesirable woody plants selectively rather than by non-selective broadcast or blanket spray techniques now commonly employed.

A. Management of Roadside "Brush".

Along most roadsides there is a mowed strip of varying width and/or a brushy margin dominated by a mixture of trees and shrubs. The former is often narrow along town roads with the "brush" (trees and shrubs) encroaching right to the edge of the road. Since tree sprouts which occur as clumps, resulting from previous cutting, often obscure visibility and their branches tend to grow out into or lean over the road, it is a common practice to eliminate such tree growth. However, the associated shrubs need not be eliminated unless they interfere with sight line conditions by their occurrence in the mowed strip immediately next to the road or on the inner sides of curves.

By employing this selective approach, many attractive broad-leaf flowering plants frequently referred to as "noxious weeds", such as Queen Anne's Lace, Chicory, Joe Pye Weed, Milkweed, Asters, Goldenrod, etc. are preserved to enhance the beauty of the roadside. Ferns and woodland wild flowers would also be in this category. Obviously, in agricultural regions those plants which actually are noxious weeds may be sprayed or controlled by other appropriate techniques. In other areas, this is not only unnecessary but often undesirable.

Recommended Management Techniques.

1.) DO NOT USE BROADCAST OR BLANKET SPRAYS.

2.) SELECTIVELY SPRAY UNDESIRABLE WOODY STEMS. An effective formulation comprises a mixture of 25 parts of fuel oil to 1 part of 2,4,5-T herbicide* (16 lbs. per 100 gals.). Cut and spray stubs with this mixture at any time of the year, except for root suckering species such as tree of heaven, locust, aspen, sassafras and sumac, which are best treated in late summer. Selective stem-foliage sprays during late summer, if done under extremely careful supervision, show promise for one-year sprouts following winter clearing.

3.) DO NOT SPRAY SHRUBS UNLESS THEY INTERFERE WITH VISIBILITY.**

* Sold commercially under such trade names as Brush Killer, Weedone, etc.

** Under certain circumstances, there may be shrubs with undesirable characteristics which should be sprayed.

B. Poison Ivy Treatment.

Poison ivy can be specifically sprayed during the summer with amino-triozole or 2,4,5-T, following the directions prescribed on the label or treated during the winter by a bark spray using the 2,4,5-T formulation given above.

C. Ragweed Eradication.--Ragweed, being an annual plant, requires open soil for its seeds to become established each year. Therefore, by creating a dense continuous cover of other species (perennial grasses and broad-leaf flowering plants), ragweed is permanently eliminated. At the edge of the pavement there may be an area receiving such serious disturbance as to prevent the establishment of continuous cover. Whenever mowing can not be sufficiently frequent, a light foliage spray <u>confined to this narrow strip</u> may, under certain circumstances, be useful as an annual procedure in controlling ragweed.

Recommended Management Techniques.

1.) ENCOURAGE DENSE COVER whenever possible of perennial grasses and broad-leafed flowering plants in the mowed strip.

2.) MOWING, especially during late summer prior to the flowering of ragweed, is recommended. This will prevent pollen formation of any ragweed which may still be present in the mowed area.

3.) DO NOT USE FOLIAGE SPRAYS any further back from the margin of the pavement than necessary. Such a spray kills the ragweed that particular year, but the soil is opened up and exposed for ragweed seed to grow there in subsequent seasons. It may even be more abundant following treatment, since the broad-leafed perennials are very sensitive to the spray and will be eliminated, thus exposing more soil for ragweed.

4.) THE CHEAPEST WAY TO ERADICATE RAGWEED IS TO ENCOURAGE OTHER PLANTS TO CROWD IT OUT.

<u>The Accomplishments of these Techniques</u>.

1. Only the undesirable woody species are removed.

2. Ragweed is eradicated.

3. Attractive native plants are preserved to enhance the roadsides.

4. Unsightly brown swaths are minimized or eliminated.

5. Fewer treatments will be needed to accomplish the objectives, since better root-kill is obtained. The initial cost of the selective treatment will be higher than that for

WEED CONTROL IN CARROTS - 1958

W. H. Lachman and L. F. Michelson*

Massachusetts Agricultural Experiment Station
Amherst, Massachusetts

The use of Stoddard Solvent for killing weeds in carrots has been a standard practice for about twelve years. Recently a few weed killers have been developed that offer promise of killing weeds in carrots (1). Accordingly tests were made using these products and this paper reports some of the results of the trials.

Materials and Methods

The plots were located on a Scarborough fine sandy loam soil which was well prepared and seeded to Chantenay carrots on June 23, 1958. The soil was relatively moist at the time of planting and later frequent rains maintained ideal conditions for the development of the crop.

Twelve treatments and a check were included in the tests and each of the treatments were replicated four times. The three treatments involving G-30028 were applied pre-emergence immediately after planting. The other nine treatments involving the materials G-30031, N-4562 and Sovasol No. 5 (Stoddard Solvent) were applied post emergence on July 10, 1958, seventeen days after planting when the weeds were approaching two inches tall. All of the materials except Sovasol No. 5 were diluted with water and sprayed on the plots at the rate of 50 gallons per acre; the Sovasol No. 5 at 100 gallons per acre.

The weed population consisted of purslane, smartweed, lamb's quarters, galinsoga, pigweed and crabgrass. Shepherd's purse and ragweed were not present. The readings on weed control, height, crop stand and vigor were made on July 28, 1958. All of the plots were cultivated on August 5 and again on August 15. The carrots were harvested and weighed on October 17, 1958.

Results

The results of the tests are presented in Table I where highly significant differences are displayed among many of the treatments for weed control, stand, vigor and yield of the crop.

*Thanks are due to the Geigy Chemical Corp. and the Niagara Chem. Div. of Food Machinery and Chem. Corp. who supplied the weed killers.
Contribution No. 1180 of the University of Massachusetts, College of Agriculture, Experiment Station, Amherst, Massachusetts.

Table I. Effect of Chemicals on Weed Control Growth and Yield of Carrots
(Figures are the means of 4 replications)
Planted June 23, 1958 - Recorded July 28, 1958

Plot	Treatment	Rate per A. Lbs. Active	Weed Control 1 Poor to 9 Excellent	Tallest Weed Height Inches	Carrot Stand 1 Poor to 9 Excellent	Carrot Vigor 1 Poor to 9 Excellent	Yield Lbs.
1	G-30028	1.0	3.5	8.8	6.3	7.3	86.9
2	G-30028	2.0	7.8	3.5	5.0	5.3	87.5
3	G-30028	4.0	7.8	2.5	1.5	1.8	38.9
4	G-30031	0.5	5.3	5.0	5.8	8.0	99.6
5	G-30031	1.0	6.8	4.8	7.3	7.8	104.9
6	G-30031	1.5	7.0	4.3	6.3	6.8	98.6
7	G-30031	2.0	8.5	1.8	6.5	6.0	95.7
8	N-4562	1.0	6.5	4.5	7.5	8.0	117.1
9	N-4562	2.0	6.5	4.5	7.0	7.5	112.7
10	N-4562	4.0	6.8	2.8	6.3	5.8	107.4
11	N-4562	8.0	7.8	1.5	3.3	3.8	79.4
12	Sovasol No. 5	100 gals.	7.5	1.3	7.3	8.0	107.2
13	Check	---	1.0	13.8	9.0	9.0	89.9
L.S.D. @ .05			1.2	1.6	1.5	1.2	14.7
L.S.D. @ .01			1.6	2.2	2.0	1.5	19.8

It was apparent that 4.0 pounds of G-30028 and 8.0 pounds of N-4562 were toxic to carrot growth and vigor. These two treatments resulted in the lowest crop production in the test. Treatment 12, ie. 100 gallons of Sovasol, No. 5, resulted in good control of weeds with production not significantly different from the best yields. The two materials, G-30031 and N-4562 appear to offer excellent promise as herbicides for carrots. In these tests 1-2 pounds of G-30031 and 1-4 pounds of N-4562 controlled weeds very well without significant effect on crop yield. The treatments did not appear to affect the quality or appearance of either the tops or roots of the crop. The effects of various climatic influences and the uniformity of behavior of these chemicals should be assessed in more widespread and repeated tests.

Summary

Good control of many annual weeds resulted from post emergence sprays of G-30031 and N-4562 on plots of carrots. Further work will be necessary with these chemicals before definite recommendations can be made.

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WEED CONTROL IN SWEET CORN - 1958

W. H. Lachman and L. F. Michelson*

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION
Amherst, Massachusetts

Test on the effectiveness of herbicides in sweet corn have been conducted at this station for many years. These tests have included cooperation in country-wide test programs and evaluation of many chemicals as weed killers when made available by the chemical industry. By bracketing the rates as suggested by the manufacturer, we have also been able to ascertain the best rates to use for killing weeds under the conditions prevailing at Amherst, Massachusetts. This paper presents the results of testing some of the newer chemicals during 1958.

Materials and Methods

Twenty treatments involving seven chemicals were applied to plots of Seneca Beauty sweet corn; the treatments were replicated four times. Each plot consisted of four 18-foot rows. The seed was planted by hand, with the rows spaced 3 feet apart and the hills 3 feet apart in the row. The soil, a Scarborough very fine, sandy loam, was prepared in the usual manner, and a 8-16-16 fertilizer was broadcast at the rate of one ton per acre. The corn was planted on June 17 in rather dry soil. The soil remained dry until June 24 when there was 0.13 inch of precipitation and again on July 5 when 0.34 inch fell. Precipitation during June was less than half that normally expected, during July and August 25 per cent more than normal, and in September 8 per cent greater than that normally expected.

All of the chemicals were applied pre-emergence on June 19, two days after planting. The various chemicals with their respective per-acre rates of application are listed in columns 2 and 3 of Table I. The weed killers were diluted with water and applied at the rate of 50 gallons per acre. The sprays were applied with a Brown Open-Hed No. 4 hand-pressure sprayer fitted with a No. 8004 Spraying Systems Tee Jet, fan type nozzle.

The weed population consisted largely of red root pigweed but also with some mixture of purslane, smartweed, lamb's quarters, galinsoga and crabgrass. The readings on weed control and weed height were made on July 21 and then the plots were side dressed with 400 pounds of 10-10-10 fertilizer and cultivated twice prior to lay-by. The stand of corn was quite variable but growth and appearance of the crop was good.

Results

The results of the tests are presented in Table I. Highly significant differences are displayed among the treatments for weed control and weed height while no significance can be ascribed to differences occurring among the plots for number of marketable ears or plot yields.

*Thanks are due to the American Chemical Co., Dow Chemical Co., Geigy Chemical Corp., and the Monsanto Chemical Co., who kindly supplied the various weed killers.
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TABLE I. Effect of Chemical on Weed Control and Yield of Seneca Beauty Sweet Corn

Planted June 17, 1958 - Treated June 19, 1958 - Recorded July 21, 1958

Plot	Treatment	Rate per acre Lbs. active	Weed Control 1 Poor to 9 Excellent	Tallest Weed Height Inches	Marketable Ears per Plot	Plot Yield Lbs.
1	Simazine	1.0	4.5	8.0	53	37.4
2	Simazine	1.5	5.8	6.8	46	31.6
3	Simazine	2.0	7.0	4.1	46	33.5
4	G-27901	1.0	4.8	6.8	49	34.0
5	G-27901	2.0	7.0	5.4	51	35.6
6	G-27901	4.0	9.0	0.5	50	35.2
7	G-30027	1.0	6.5	6.5	50	36.6
8	G-30027	1.5	8.5	1.8	47	33.0
9	G-30027	2.0	9.0	0.5	48	34.4
10	Vegedex	6.0	7.0	3.8	49	33.7
11	Vegedex	9.0	8.8	0.8	50	35.0
12	Randox	6.0	4.5	6.3	51	35.3
13	Randox	9.0	5.8	5.5	45	31.0
14	DN(Premerge)	6.0	4.3	9.0	47	32.4
15	CDAA-T	2.0	5.5	7.0	45	31.8
16	CDAA-T	4.0	6.3	4.0	49	32.6
17	CDAA-T	8.0	8.5	1.3	47	32.2
18	ACP M-503	4.0	2.5	11.3	42	27.0
19	ACP M-503	8.0	2.5	10.0	40	25.9
20	Check	---	1.0	13.8	46	30.7
L.S.D. @ .05			1.7	2.7	N.S.	N.S.
L.S.D. @ .01			2.3	3.7	N.S.	N.S.

It is very readily apparent that the "Triazine" compounds and CDAA-T (Randox formulation T) were especially effective in preventing weed growth. Plots which were treated with four pounds of G-27901 and two pounds of G-30027 were practically free from all weed growth five weeks after treatment. Under similar conditions Simazine did not perform quite as well nor was its performance as noteworthy as in 1957 (1), a year when soil moisture conditions were more favorable at the time of application.

It was clear that pound for pound Vegedex was markedly more effective than Randox, but as indicated above, Randox - T (CDAA-T) at 8 pounds per acre was one of the outstanding treatments in the test.

The results from the DN(Premerge) treatment were not particularly noteworthy and treatments using ACP M-503 were not significantly better than the check. Yields from the 8 pound treatment with ACP M-503 were the lowest of any treatment but none of the differences among the treatments should be considered as significant.

Summary

Certain Triazine compounds (G-27901 and G-30027) and Randox formulation T were especially noteworthy in their ability to prevent weed growth in plots of sweet corn without affecting the yield of the crop. This was in a year when soil moisture conditions were not optimum for best results with the standard pre-emergence herbicides for corn.

Literature Cited

1. Lachman, W. H. and Michelson, L. F. Weed Control in Sweet Corn - 1957. Proc. N. E. W.C.C. 12:383-385. 1958.