WEED AND CROP RESPONSES TO HERBICIDES IN CUCUMBERS AND WATERMELONS [1/]

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Herbicides currently being used in Virginia to control weeds in vine crops include 4,6-dinitro-o-sec-butylphenol (DNBP), dimethyl 2,3,5,6-tetrachloroterephthalate (DCPA) and N-1-naphthylphthalamic acid (NPA). None of these chemicals is entirely satisfactory. Most broadleaved weeds can be controlled for 4 to 6 weeks with DNBP but grass control is usually not satisfactory. Control of many broadleaved weeds and grasses can be obtained with NPA but crop injury can result from applications of this herbicide, thus diminishing the desirability of the chemical. Notwithstanding that DCPA can be very effective, applications must be delayed for 4 to 6 weeks after crop emergence. For this reason, control of weeds during the early stages of crop growth cannot be accomplished with DCPA.

The objective of the research reported in this paper was to evaluate the herbicidal effectiveness and margin of crop safety of several chemicals in cucumbers and watermelons.

Materials and Methods

Studies were conducted on a Sassafras sandy loam soil at the Eastern Shore Branch, Virginia Truck Experiment Station, Painter. Separate experiments, designed as randomized complete blocks with four replications, were conducted for each crop. Cucumbers (var. Gemini) and watermelons (var. Charleston Gray) were seeded 1/2 in deep on May 21 and May 24, respectively, and plots 5 ft wide by 20 ft in length were established. Herbicides listed in the Appendix were applied on the dates of planting except where otherwise noted in the tables. All applications were made as water dilutions at a delivery rate of 55 gpa. The source of pressure was propane. Herbicides applied preplant were incorporated with a power driven rototiller. Tines were set to cut 2 in deep in cucumbers and 1 in deep in watermelons.

Precipitation in the amount of 1.2 in was recorded during the three day period of May 27 to May 29. The time elapsed from herbicide application until the first rain was 6 days for cucumbers and 3 days for watermelons.

Weed control ratings on individual species and crop injury ratings were made using the scale 0 to 10 where 0 represents no control or crop injury

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and 10 represents complete reduction in plant stand. Predominant weeds in the research area were carpetweed (Mollugo verticillata L.), lambsquarters (Chenopodium album L.) and large crabgrass (Digitaria sanguinalis (L.) Scop.). After cucumbers were rated for injury, the crop was thinned to the desired population. Cucumbers were harvested four times to permit determination of herbicide and weed effects on yields. Yields were analyzed statistically and plot yields were converted to an acre basis. Watermelons were not harvested.

Results and Discussion

Weed control, crop injury and yield data are presented in Tables 1 through 4. Herbicides applied preplant incorporated will be discussed first.

Control of broadleaved weeds and crabgrass was excellent with nitralin applied preplant incorporated; however, both cucumbers and watermelons proved to be sensitive to nitralin applications as stands of both crops were reduced. It is believed that stand reductions would have been sufficient to significantly reduce crop yields if cucumbers had not been thinned resulting in similar plant populations for all treatments. Bensulide effected good control of crabgrass but control of broadleaved weeds, especially carpetweed, was incomplete. The addition of DNBP as a preemergence treatment to preplant incorporated applications of bensulide resulted in improved control of broadleaved weeds with no crop injury. Another herbicide effecting good control of crabgrass but failing to provide adequate control of broadleaved weeds was M&B 9057. Excellent broad-spectrum control in both cucumbers and watermelons was obtained with the methyl ester formulation of amiben but severe injury resulted to both crops. Weed control was also good with DCPA with only slight crop injury resulting.

Several preemergence herbicide applications provided good control of weeds. Nitralin effected broad-spectrum control in watermelons but failed to control lambsquarters in cucumbers. The shorter interval between herbicide application and initial rainfall in watermelons than in cucumbers may account for the difference in weed control. The methyl ester formulation of amiben provided good weed control but caused some injury to watermelons. Injury from amiben was less extensive than when the herbicide was applied preplant incorporated. The advantages of adding DNBP to preemergence applications of M&B 9057 or bensulide may be more apparent than real. Although initial ratings indicated both combinations produced broad-spectrum control, as the season progressed it was noted that control of crabgrass was less effective than when bensulide or M&B 9057 were incorporated. The combinations of NPA with DNBP resulted in control which was slightly better than NPA alone without causing any increases in crop injury.

Summary

The capacity of several herbicides to provide broad-spectrum control of annual weeds in cucumbers and watermelons was investigated. Nitralin was more effective when applied preplant incorporated than preemergence but

stand of both cucumbers and watermelons was reduced when the herbicide was incorporated. The addition of DNBP to preemergence applications of bensulide or M&B 9057 improved the control of broadleaved weeds provided by the latter two herbicides when incorporated but grass control was less effective.

The methyl ester formulation of amiben controlled broadleaved weeds and crabgrass when applied preplant incorporated or preemergence but caused extensive crop injury preplant incorporated. Combinations of NPA with DNBP were more effective than was NPA alone. Control with DCPA was good with only slight crop injury resulting.

Appendix

Chemical descriptions of herbicides used in cucumber and watermelon studies.

Herbicide	Chemical description
amiben	3-amino-2,5-dichlorobenzoic acid
bensulide	N-(beta-O, O-diisopropyldithio= phosphonylethyl) benzene sulfonamide
DCPA	dimethyl 2,3,5,6-tetrachloro= terephthalate
DNBP	4,6-dinitro-o-sec-butylphenol
M&B 9057	methyl-(4-amino benzene) sulfonyl carbamate
nitralin	4-(2-methylsulfonyl)-2,6-dinitro-N, N-dipropylaniline
NPA	N-1-naphthylphthalamic acid

Table 1. Weed control and crop responses to herbicides applied preplant incorporated to cucumbers in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 1/ Carpet-weed	Lambs-quarters	Crab-grass	Yields, cwt/A
Nitralin	3/4	2.9	10.0	9.8	9.9	164.8
	1 1/2	4.0	10.0	10.0	10.0	179.3
Bensulide	4	0.2	3.2	5.6	9.6	113.3
	6	0.0	2.1	8.5	9.6	106.0
	8	0.2	1.0	9.4	10.0	157.5
Bensulide + DNBP 2/	4 + 2	0.5	6.9	9.8	9.6	163.4
	6 + 2	0.2	6.9	7.5	9.1	230.9
M&B 9057	2	0.1	4.6	6.7	9.9	209.1
	3	0.0	5.7	9.4	10.0	262.8
	4	0.2	4.5	10.0	10.0	264.3
Amiben (methyl ester)	2	2.4	8.8	10.0	9.2	206.9
	3	3.9	9.2	10.0	9.8	249.0
	4	4.2	9.4	10.0	10.0	240.3
DCPA	6	0.4	9.7	10.0	9.8	225.1
	8	1.0	10.0	9.9	10.0	175.7
Check (cultivated)		0.0	0.0	1.4	0.8	254.1
Check (cultivated)		0.6	0.0	4.2	2.0	268.6
Check		0.2	0.0	2.8	2.5	50.1
LSD 0.05						134.4

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of plant stand.

2/ DNBP applied after planting as a preemergence treatment.

Table 2. Weed control and crop responses to herbicides applied preemergence to cucumbers in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 1/ Carpet-weed	Lambs-quarters	Crab-grass	Yields, cwt/A
Nitralin	3/4	0.2	9.9	6.0	9.4	302.0
	1 1/2	0.8	10.0	6.6	9.8	274.4
Amiben (methyl ester)	2	0.5	9.4	8.5	9.5	288.9
	3	0.2	9.7	9.6	9.9	372.4
	4	1.1	9.8	9.6	9.9	286.8
M&B 9057 + DNBP	3 + 2	0.1	8.4	9.6	9.7	323.1
Bensulide + DNBP	4 + 2	0.1	6.9	6.5	9.3	220.7
	6 + 2	0.4	8.6	8.1	8.9	300.6
NPA	3	1.1	9.8	9.0	8.6	249.0
NPA + DNBP	2 + 1	0.6	9.4	9.6	7.9	212.0
	3 + 1 1/2	0.6	9.8	10.0	9.4	352.8
	4 + 2	1.4	9.7	9.9	9.3	228.7
Check (cultivated)		0.8	0.0	1.5	0.0	175.7
Check (cultivated)		0.1	4.8	3.8	1.8	251.9
Check		0.1	1.0	0.8	1.0	69.7
LSD 0.05						128.9

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of plant stand.

Table 3. Weed control and crop responses to herbicides applied preplant incorporated to watermelons in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 1/		
			Carpet-weed	Lambs-quarters	Crab-grass
Nitralin	3/4	6.0	10.0	10.0	9.9
	1 1/2	7.9	10.0	9.7	10.0
Bensulide	4	1.3	0.0	5.3	9.4
	6	1.6	0.6	7.4	9.7
	8	2.8	2.5	8.5	9.8
Bensulide + DNBP 2/	4 + 2	1.2	6.0	7.2	9.0
	6 + 2	0.5	7.6	8.5	9.7
M&B 9057	2	1.8	1.9	4.1	9.4
	3	1.5	2.3	6.7	9.5
	4	2.1	1.8	9.1	9.9
Amiben (methyl ester)	2	4.1	7.7	9.6	9.3
	3	5.6	9.6	9.9	9.9
	4	8.0	9.8	10.0	9.9
DCPA	6	1.5	10.0	8.8	9.9
	8	3.5	10.0	10.0	9.9
Check		1.1	0.0	1.5	0.0
Check		2.6	0.0	2.0	0.0
Check		2.1	0.0	0.0	0.9

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of plant stand.

2/ DNBP applied after planting as a preemergence treatment.

Table 4. Weed control and crop responses to herbicides applied preemergence to watermelons in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 1/ Carpet-weed	Lambs-quarters	Crab-grass
Nitralin	3/4	1.1	10.0	9.0	9.7
	1 1/2	3.2	10.0	8.9	9.7
Amiben (methyl ester)	2	0.9	9.7	9.6	9.7
	3	2.9	9.8	9.8	9.9
	4	4.8	10.0	9.7	10.0
M&B 9057 + DNBP	3 + 2	0.9	7.2	9.0	9.7
Bensulide + DNBP	4 + 2	0.5	8.0	9.4	9.2
	6 + 2	0.6	9.0	9.6	9.7
NPA	3	2.4	7.0	9.0	8.7
NPA + DNBP 2/	2 + 1	2.1	10.0	9.7	9.8
	3 + 1 1/2	1.3	10.0	10.0	10.0
	4 + 2	1.4	10.0	10.0	10.0
Check		0.6	0.0	0.0	0.0
Check		1.1	0.0	0.0	0.0
Check		1.2	0.0	0.0	0.0

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of plant stand.

2/ NPA + DNBP applied 5 days after planting.

CHEMICAL WEEDING OF CUCUMBERS

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Weed control using herbicides on cucumbers has not been consistently successful. NPA and DNBP are recommended and used but under some conditions give little weed control or injure the cucumber plants. A search for new chemicals or combination of chemicals to use on the crop is reported in the first experiment.

An unpublished report of F. D. Hess and A. R. Putnam describes the successful weeding of cucumbers by delaying the planting and herbicide application following seedbed preparation. The second experiment reported in this paper is based on this technique.

Procedure

The experiments reported here were conducted at the Horticulture farm located 10 miles west of University Park, Pa. The soil was plowed in the fall of 1967. Rainfall was sufficient and no irrigation water applied. Treatments were randomized in each of 6 blocks, each plot 36 feet long. All chemicals were applied in a two foot band. Cultivation controlled the weeds between the rows. A weed rating of 1 to 10 was used, 1 being most desirable and 10 least desirable. Records of weed control, stand of plants, number of fruit and weight of fruits were taken.

In the first experiment the seedbed was prepared, incorporating treatments applied and the cucumbers seeded to variety Fletcher July 2. The soil, a Murrill loam, was fairly free of weeds. Weeds present were yellow foxtail, green foxtail and lambs quarter. Pre-emergence treatments were applied one or 4 days after seeding and post-emergence treatments 10 days after seeding. Weed records were taken August 9 and field harvested September 9 and 27.

In the second experiment the seedbed was prepared July 19, seeding and chemical applications followed, 1, 6, 12 or 16 days after seedbed preparation. The soil, a Hagerstown silt loam, was hard packed by the 12 and 16 day following soil preparation. Seeding was done with a Planet Jr. seeder set at one seeding rate and one depth of seeding. Heavy weed growth occurred where no herbicide was applied with the weeds in greatest numbers being purslane, redroot pigweed, lambs quarter and yellow foxtail. Weed records were taken July 29 and the field harvested September 10.

Results and Conclusion

Results of the first test are shown in table 1. Taking into consideration weed control, stand of plants and yield the best treatments were Bensulide in combination with NPA, CDEC or Amiben; Amiben salt or methyl ester, nitralin or nitralin with NPA in a pre-emergence application, benefin and M & B 9057 in pre-emergence applications.

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Results of the second test are shown in table 2. Weed control with all chemicals improved as time from seedbed preparation to chemical application increased up to 12 days. Stand of plants increased as seeding was delayed up to 16 days. Taking into consideration weed control, stand of plants and yield the best treatments were DNBP and Dynap with a delay in planting from 12 to 16 days.

Table 1. Weed control, stand of plants and yield of cucumbers under chemical herbicide treatments.

Treatment	Active Rate Lbs/A	Application Days from Planting	AVERAGE PER PLOT: Weed Control (1-10)	Stand of Plants	1st Harvest Fruit No.	1st Harvest Fruit Wt. lbs.	Total Harvest Fruit No.	Total Harvest Fruit Wt. lbs.
1. Nothing	---	---	4.0	47.8	36.0	25.1	87.0	41.8
2. Hand Weed (After Weed Rating)	---	---	4.5	48.0	46.5	32.3	120.5	56.8
3. Nitralin (Planavin)	2	Inc -0	2.2	34.0	3.5	2.1	7.7	3.3
4. " + NPA (U1-1008)	1 + 4	"	2.8	45.5	52.8	39.4	100.7	53.0
5. DCPA	10	"	1.0	52.7	33.8	25.0	61.2	33.4
6. Bensulide & NPA	6 & 4	Inc -0 & Pre +1	2.5	64.7	87.5	60.8	150.3	78.6
7. " & CDEC	6 & 2	" & "	2.2	60.3	77.5	54.7	138.7	68.7
8. " & Dynap	6 & 2 + 4	" & "	1.5	23.2	29.2	24.4	74.2	39.1
9. " & Amiben	6 & 4	" & "	1.0	58.2	81.3	47.6	169.7	71.4
10. Sindone & DNBP	4 & 2	Inc -0 & Pre +4	3.0	29.8	42.2	33.9	89.2	50.3
11. Amiben Methyl Ester 65-81-B	4	Pre +1	1.3	42.5	47.8	32.8	122.2	56.7
12. Amiben Salt	4	"	1.2	34.8	33.0	21.6	92.7	39.7
13. Amiben G Methyl Ester 65-45	4	"	1.0	31.5	12.7	8.9	44.3	17.0
14. Amiben G Salt	4	"	1.2	21.3	18.3	9.9	44.3	19.0
15. R 11914	4	"	1.0	37.7	12.0	7.7	29.3	14.1
16. Nitralin	2	"	1.8	48.7	62.7	46.4	119.0	60.7
17. Nitralin + NPA (U1-1008)	1 + 4	"	2.2	52.8	67.8	49.3	134.8	68.7
18. Benefin (Balan)	2	"	2.2	42.8	56.7	41.0	117.3	60.0
19. NPA	6	"	3.2	41.3	54.0	37.8	110.2	57.1
20. DCPA	12	"	1.3	66.2	22.8	14.9	44.8	22.0
21. DNBP + OCS 21693	2 + 4	Pre +4	2.2	39.8	49.0	38.2	108.7	56.3
22. " + Diphenamid	2 + 3	"	1.0	22.3	31.0	23.2	62.5	34.3
23. " + DCPA	2 + 6	"	1.3	37.2	35.0	22.8	82.2	36.2
24. " + NPA (Dynap)	2 + 4	"	1.7	26.5	31.0	24.2	79.7	38.9
25. DNBP	2	"	3.3	38.0	48.3	29.3	102.2	49.8
26. M & B 9057	2	Pre +4	1.7	54.5	65.5	55.3	134.7	78.7
27. CP 49814	3	"	4.5	61.8	80.5	56.9	147.7	74.8
28. "	3	Post +10	1.8	56.3	38.5	19.5	101.8	40.3
Least Significant Difference 5%			1.1	14.1	25.9	18.8	40.2	24.1
" " " 1%			1.3	16.8	31.0	22.5	48.1	28.8

Table 2. Weed control, stand of plants and yield of cucumbers with four chemicals and varying times of planting following seedbed preparation.

Treatment	Active Rate Lbs/A	Application and Seeding Days From Seedbed Preparation	AVERAGE PER PLOT Weed Control (1-10)	Stand of Plants	Marketable Yield No.	Wt.
1. Nothing	---	+ 1	10.0	13.2	5.2	1.5
2. OCS 21693 + DNBP	4 + 2	+ 1	9.7	9.3	10.5	6.4
3. DNBP	2	+ 1	5.5	6.7	5.2	2.4
4. Dynap (DNBP + NPA)	2 + 4	+ 1	1.8	7.0	7.8	5.4
5. CP 49814	3	+ 1	10.0	13.5	6.7	2.5
6. Nothing	---	+ 6	10.0	10.2	2.7	1.6
7. OCS 21693 + DNBP	4 + 2	+ 6	2.7	14.0	10.5	7.8
8. DNBP	2	+ 6	6.3	9.8	5.0	3.1
9. Dynap	2 + 4	+ 6	1.2	10.8	9.5	8.1
10. CP 49814	3	+ 6	9.7	10.0	5.2	1.8
11. Nothing	---	+12	10.0	25.0	4.5	1.7
12. OCS 21693 + DNBP	4 + 2	+12	1.0	17.5	11.0	8.1
13. DNBP	2	+12	1.0	20.8	18.2	12.6
14. Dynap	2 + 4	+12	1.0	19.5	12.7	8.3
15. CP 49814		+12	4.5	17.2	14.5	7.9
16. Nothing	---	+16	10.0	33.7	3.3	0.9
17. OCS 21693 + DNBP	4 + 2	+16	1.0	35.7	13.7	5.7
18. DNBP	2	+16	2.7	38.7	15.8	8.0
19. Dynap	2 + 4	+16	1.3	50.0	22.7	12.0
20. CP 49814	3	+16	8.0	35.7	15.8	8.4
Least Significant Difference 5%			1.3	14.8	8.0	5.3
" " " 1%			1.6	18.2	NSD	6.5

WEED CONTROL IN SWEET POTATOES 1/

C. D. Altman and J. D. Long2/

Although many herbicide experiments have been conducted with sweet potatoes, a need still exists for compounds that will give dependable, satisfactory weed control without crop injury. Promising new chemicals and combination treatments to broaden the weed control spectrum need evaluation. A few chemicals have performed well on certain weed species without crop injury. However, a chemical weed control program for sweet potatoes that is adequate in all situations has not been developed.

Materials and Methods

Studies in 1967 and 1968 were conducted at the University of Maryland Vegetable Research Farm, Salisbury, Maryland on a sandy soil low in organic matter. The experimental design was randomized complete blocks with 4 replications. Each plot consisted of 3 rows 25 feet long with rows spaced 3 feet apart. Plants were 1 foot apart in the row. Entire plots were treated but only the center rows were used for records. All herbicides were applied with a tractor-mounted sprayer at the rate of 50 gallons per acre. Incorporation (2-4") of pre-plant treatments was accomplished with a disc harrow. All plots were again disced at a right angle to the first discing and spiked-tooth harrowed before planting. The predominant weeds were lambsquarters, crabgrass, goosegrass, carpet weed and pigweed. The variety Nemagold was tested both years.

1967 Experiment. Pre-plant treatments were applied June 1 and incorporated immediately. Plots were planted June 2. All plots were cultivated and side-dressed June 12. Pre-emergence sprays were applied June 12 to dry soil with a surface temperature of 110°F. Air temperature was 89°F.

1968 Experiment. Pre-plant incorporated treatments were applied May 21 to slightly moist soil. Diphenamid and DCPA applications were sprayed between 6:00 and 8:00 A.M. and incorporated from 8:00 to 8:30 A.M. All other pre-plant treatments were sprayed in alphabetical order and incorporated immediately. Plots were planted May 21. On May 22 pre-emergence sprays were applied to a dry soil surface. All plots were cultivated and side-dressed June 11 and top-dressed July 1. The hand-weeded check was weeded weekly from June 28 until the middle of August. Rainfall was scarce during the major portion of the growing season. Irrigation was not used.

Results and Discussion

1967 Experiment. Table I shows treatments and responses for the 1967 experiment. Combination treatments provided the best season long weed control.

1/ Miscellaneous Publication No. 684 Contribution No. 4115 of the Maryland Agricultural Experiment Station, Department of Horticulture.

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Table 1. Effect of herbicide on weed control, crop injury and marketable yield in sweet potatoes, 1967.

Treatment	Rate lb ai/A	Method 1/	Weed Control 2/ 7/5	8/7	10/2	Crop Injury 3/ 7/5	8/7	Yield 4/ Bu/A
1. Check (single cultivation)		---	.8	0	0	10.0	10.0	169 e
2. CP-50144	1	pre	5.8	3.3	2.5	10.0	10.0	326 abcd
3. CP-50144	2	pre	7.0	4.8	4.8	10.0	10.0	372 abc
4. DCPA	6	ppi	7.5	5.3	4.0	10.0	10.0	307 bcd
5. Diphenamid	4	ppi	9.5	7.5	7.8	10.0	10.0	434 a
6. Diphenamid	2	ppi	9.8	8.5	6.3	10.0	10.0	435 a
+ Amiben	2	pre						
7. Molinate	4	ppi	7.8	6.3	5.3	10.0	10.0	401 ab
8. Vernolate	2	ppi	9.8	8.5	7.5	8.5	9.3	345 abcd
9. Vernolate +	2	ppi	10.0	9.5	9.0	8.0	8.5	333 abcd
Diphenamid	2	pre						
10. Vernolate +	1	ppi	9.5	8.8	8.3	10.0	9.8	396 ab
Diphenamid	2							
11. Vernolate +	2	ppi	9.8	9.3	8.8	8.5	9.5	338 abcd
Diphenamid	1							
12. Vernolate +	2	ppi	10.0	8.5	7.8	8.0	8.8	279 cd
Diphenamid	2							
13. Vernolate +	2	ppi	10.0	9.5	8.8	8.5	8.8	285 bcd
Diphenamid	2	pre						
Amiben	2	pre						
14. UC-22463	4	pre	6.8	3.3	3.0	8.8	10.0	254 de

1/ Treatment pre-plant incorporated (ppi) were applied 6/1/67. Pre-emergence (pre) sprays were applied 6/12/67.

2/ Rated 0 to 10 with 10 representing nearly perfect weed control. Chief weeds were lambsquarters, crabgrass, goosegrass, carpetweed and pigweed.

3/ Rated 0 to 10 with 10 representing no apparent injury.

4/ Total marketable yield. Yields followed by the same letter are not significantly different at the 5% level.

In general, pre-plant incorporated treatments were superior to pre-emergence sprays. Pre-emergence treatments performed poorly unless preceeded by a pre-plant incorporated compound.

CP-50144. Acceptable weed control was not attained with CP-50144 at 1 or 2 pounds. Crop injury was not detected at the rates tested.

DCPA. In general, weed control was poor. This compound did not injure the crop but competition from the weeds reduced the yield. The rate may have been low.

Diphenamid. Weed control was excellent for over 6 weeks. Acceptable weed control was maintained throughout the season without crop injury. Incorporation of this chemical improved its performance. The combination of diphenamid applied pre-plant plus amiben as a pre-emergence spray gave better early weed control than diphenamid alone. Diphenamid alone and in combination with amiben resulted in the highest yields of the experiment.

Molinate. This compound performed about like DCPA. Again, the rate may have been low.

Vernolate. Good weed control was maintained throughout the growing season but crop injury prevailed. Though not significantly different, yields tended to be lower in vernolate-treated plots. Combinations of vernolate pre-plant plus diphenamid either pre-plant or pre-emergence provided good, season-long weed control. However, vernolate above 1 pound resulted in crop injury. Vernolate plus diphenamid plus amiben gave excellent season-long weed control, but again, crop injury was observed and yield was reduced compared to diphenamid alone or diphenamid plus amiben.

UC-22463. Weed control was poor and yield was consequently reduced.

1968 Experiment. Data indicating the responses to various herbicides are recorded in Table 2. Treatments tested in 1967 did not perform as well in 1968.

C-6313. Weed control at 1.5 pounds was not season-long. The 3.0 rate provided satisfactory control for the entire season and resulted in one of the highest yields. However, injury from both rates was noticeable even after 2 months.

CP-50144. Slight early stunting was detectable. Early weed control was adequate. After 1 month, neither 2 or 4 pounds showed acceptable control and weed competition reduced yields drastically.

DCPA. Good weed control was provided for over 2 months but not for the entire season. However, only a fair yield in comparsion to the hand-weeded control was obtained. Pre-plant incorporated treatments of DCPA plus metobromuron gave very good, season-long weed control with little injury. The combination of DCPA and metobromuron at 4 plus 1 pound appears promising and yield was not significantly different from the hand-weeded check.

Diphenamid. Poor results were obtained with diphenamid. This was not

Table 2. Effect of herbicides on weed control, crop injury and marketable yield in sweet potatoes, 1968.

Treatment	Rate lb ai/A	Method[1]	Weed Control[2] 6/28	7/22	9/2	Crop Injury[3] 6/28	7/22	Yield[4] Bu/A
1. Check (single cultivation + hand weeded)		---	3.5	9.5	9.3	10.0	10.0	374 a
2. Check (single cultivation)		---	0.8	0.5	0.3	10.0	10.0	20 i
3. C-6313 50W	1.5	pre	9.1	5.0	4.8	8.4	8.5	134 defgh
4. C-6313 50W	3.0	pre	10.0	8.5	7.4	5.5	8.5	230
5. CP-50144 2E	2.0	ppi	9.0	5.0	4.5	8.9	9.4	110 efghi
6. CP-50144 2E	4.0	ppi	10.0	6.4	4.8	8.5	9.8	73 ghi
7. DCPA 75W	7.5	ppi	8.5	8.0	6.6	9.8	9.5	217 cde
8. DCPA 75W +	4.0	ppi	9.8	9.0	8.4	9.6	9.6	273 bc
Metobromuron 50W	0.75							
9. DCPA 75W +	4.0	ppi	10.0	9.9	9.1	10.0	10.0	322 ab
Metobromuron 50W	1.0							
10. Diphenamid 4D	3.0	ppi	9.3	5.0	3.0	9.5	9.5	158 defgh
11. Diphenamid 4D	1.0	ppi	7.0	4.0	1.8	9.9	10.0	105 fghi
+ Amiben 2E	2.0	pre						
12. Diphenamid 4D	1.0	ppi	9.3	4.8	3.5	9.5	9.5	178 cdefg
+ Amiben 2E	4.0	pre						
13. Diphenamid 4D	2.0	ppi	8.9	4.3	2.8	9.8	10.0	144 defgh
+ Amiben 2E	2.0	pre						
14. Diphenamid 4D	2.0	ppi	9.1	4.5	3.5	9.1	9.6	150 defgh
+ Vernolate 6E	0.5							
15. Diphenamid 4D	2.0	ppi	9.6	5.4	4.3	9.9	9.6	134 cdef
+ Vernolate 6E	0.75							
16. Diphenamid 4D	2.0	ppi	9.9	6.6	5.3	9.6	9.3	201 cdef
+ Vernolate 6E	1.0							
17. Molinate 6E	6.0	ppi	9.5	3.3	1.8	9.0	9.5	112 efghi
18. Molinate 6E	12.0	ppi	9.8	6.1	5.5	9.8	10.0	191 cdef
19. Nitralin 4 WDL	1.0	pre	9.8	8.0	7.5	10.0	10.0	276 bc
20. Nitralin 4 WDL	1.0	pre	10.0	8.8	8.4	9.3	9.9	276 bc
+ Pinolene 8E	1.0							
21. OCS-21693 2E	2.0	ppi	7.0	3.0	0.8	9.9	10.0	53 hi
22. OCS-21693 2E	3.0	pre	8.4	3.0	1.8	8.9	9.8	101 fghi
23. UC-22463 4E	6.0	pre	8.6	3.1	2.5	5.5	8.5	65 hi
24. Vernolate 6E	1.0	ppi	9.5	4.9	4.3	9.8	10.0	135 defgh
25. Vernolate 6E	2.0	ppi	10.0	6.8	5.6	7.5	9.4	167 defg

1/ Pre-plant incorporated (ppi) treatments were applied 5/21/68. Pre-emergence (pre) treatments were applied 5/22/68.

2/ Rated 0 to 10 with 10 representing nearly perfect weed control. Chief weeds were lambsquarters, crabgrass, goosegrass, carpetweed and pigweed.

3/ Rated 0 to 10 with 10 representing no apparent injury.

4/ Total marketable yield. Yields followed by the same letter are not significantly different at the 5% level.

consistent with past results but may be partially explained by the low rates evaluated (1,2). Weed control was not acceptable after 1 month and yield was low. Combinations of diphenamid pre-plant incorporated plus amiben as a pre-emergence spray also provided poor weed control which resulted in very low yields. Pre-plant incorporated treatments of diphenamid plus low rates of vernolate gave good weed control for 1 month with very slight injury. All treatments of diphenamid with or without amiben or vernolate performed poorly after 1 month. The reason for this was uncertain. Indications from 1967 were that these combinations were promising.

Molinate. Weed control after 1 month was very poor even at 12 pounds. Injury was not a problem. Yields were very low.

Nitralin. Acceptable weed control was provided for the entire season. Pinolene improved the season-long performance of nitralin but did not influence yield. Slight injury was prevalent for 2 months with the pinolene combination. The hand-weeded check and DCPA plus metobromuron at 4 plus 1 were the only treatments that gave higher yields than nitralin. Pre-emergence use appeared promising.

OCS-21693. This chemical did not provide acceptable weed control and yield was reduced.

UC-22463. Phytotoxicity was severe early and prevalent after 2 months. Weed control and subsquently yield were poor.

Vernolate. Excellent early weed control was obtained. Injury was evident above 1 pound. Season-long weed control was not obtained. A non-phytotoxic rate of vernolate provided inadequate weed control.

Summary

Pre-plant incorporated and combination treatments show promise for wide spectrum weed control in sweet potatoes. Diphenamid plus vernolate or amiben were promising in 1967 but performed poorly in 1968. Vernolate above 1 pound reduced vine growth both seasons. DCPA plus metobromuron was a promising 1968 combination treatment. Nitralin also performed well in 1968 as a pre-emergence spray. Investigations need to be continued with combination treatments and new chemicals to establish a safe, dependable, wide-spectrum weed control program.

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THE EFFECT OF UC22463, METOBROMURON AND DIPHENAMID-DNBP ON WEED CONTROL IN PEAS, BEANS AND SWEET CORN

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Introduction

The past six or seven years have given the commercial vegetable growers chemical tools to help greatly in the control of weeds. There is still a great need for new herbicides in vegetable crops. Many researchers are investigating herbicide combinations in an effort to improve overall weed control and minimize soil residues. The research reported herein was designed to give some answers as to the length of effectiveness of several herbicides and the crop response to varying application rates.

Procedure

Weed control plots were established for the beans, peas and sweet corn at the University Horticulture Experimental Farm, Durham, New Hampshire. The plots were plowed, harrowed, fertilized, and harrowed again with a drag to level the field and firm up the seed bed. The soil is a sandy clay loam with a five percent humus content.

The pea plots consisted of three rows 95 feet long spaced three feet apart (1/50 acre). The peas were planted by hand, placed two inches apart in the row. Three different herbicides were used in the trials; namely, U22463 (sirmate), Metobromuron (Patoran), and Diphenamid-DNBP (Enide Dinitro). All chemicals were applied with a logarithmic plot sprayer. All treatments were pre-emergence and replicated three times. The application was done uniformly with a compressed air constant pressure logarithmic plot sprayer which had been carefully calibrated at a constant rate of movement over similar terrain. One quart and one pint of spray per 1/50-acre plot was used in every treatment. The pea plots were completely free of any visible live weeds at the time spray was applied immediately after planting on June 13, 1967. No other treatment followed on any of the pea plots. One-half inch of rain fell the day following the herbicide application but no further rain occurred until after peas had emerged. The

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soil was well pulverized, and the moisture was near the level of the seventy-five percent of field capacity.

The bean plots were identical in design as those planted with peas, and the herbicide treatments were the same.

The sweet corn plots also included three rows, spaced three feet apart. Spacing within rows was in 9 inch hills. The corn was planted by hand, one kernel in each hill. The herbicides used were the same as applied to peas and beans. All treatments were pre-emergence and replicated three times.

The results were not summarized until 1968 in order to check the possible residue carry-over with metobromuron (Patoran). It was observed and recorded in 1967 that metobromuron at the four-pound-per-acre rate maintained complete control of all weeds (grasses and broadleaf) for the entire season. The plots were all allowed to winter over until May 25, 1968, at which time they were plowed, harrowed several times, and planted to beans, peas, and sweet corn on June 5, 1968. No herbicide was applied in 1968 but careful observations of the plots were carried on until no further data was considered necessary.

Results and Discussion

UC22463 at 6 and 4 pounds, Metobromuron at 4 and 2 1/2 pounds, and Diphenamid-DNBP at 4 pounds all gave excellent weed control through harvest of the peas, beans and sweet corn. The Metobromuron at 4 pounds killed the peas and beans. It was slightly toxic to the corn but with no delay in harvest or reduction of growth. At 2 1/2 pounds it stunted the peas and beans for a short time, but they outgrew the effects with no apparent effect on production. It did delay the harvest date by four or five days.

The 2-pound rate of UC22463 gave insufficient weed control for the peas and beans. These crops were overgrown by weeds which cut the production one-third. However, there was no decrease in corn yield even though it was weedy at time of harvest.

The Metobromuron at the 1-pound rate controlled weeds for 30 days, but its effectiveness deteriorated quite rapidly after that. The pea and bean production was reduced fifty percent, and the corn production also appeared to be reduced, but no definite percentage could be determined by ear count.

The Diphenamid-DNBP at the 2 1/2-pound rate held the weed growth in check satisfactorily for the corn harvest but was not adequate for peas and beans. The pea harvest was reduced by 33 percent, and the beans by 20 percent. The 1-pound rate proved too low to control weeds. As a result, the peas and beans were lost completely and the sweet corn yield was reduced by 70 percent.

Table 1. Effectiveness of Several Herbicides on the Weed Control in Peas, Beans and Sweet Corn

No.	Treatment & Formulation	Lbs. /A.	Date of Application	6/13	7/15	7/31	8/15	11/15
1	Cultivated Check	--	---	10	9	8	8	0
2	UC22463	6	6/13/67	10	9.5	8	7.5	3
3	UC22463	4	6/13/67	10	8.5	7.5	7	2
4	UC22463	2	6/13/67	10	7.5	5	4	0
5	Metobromuron**	4	6/13/67	10	10	10	10	10
6	Metobromuron***	2.5	6/13/67	10	9	9	9	9
7	Metobromuron****	1	6/13/67	10	8	6	4	2
8	Diphenamid-DNBP	4	6/13/67	10	9	8	7.5	4
9	Diphenamid-DNBP	2.5	6/13/67	10	7	6	5	2
10	Diphenamid-DNBP	1	6/13/67	10	5	4	2	0

* 0 = No weed control; 10 = near perfect; 7.5 = commercial control

** Killed out the peas and beans and slightly toxic to the corn

*** Stunted peas and beans slightly but no loss in germination

**** No injury to peas or beans but weed control not desirable

All percentages were computed by using the cultivated check as the basis for comparison.

In plots treated with Metobromuron in 1967, the peas, beans and corn all germinated and grew normally. Weed growth was delayed three weeks in the areas that had received the 4-pound-application rate. All species of weeds came back in abundance by the fifth week, and cultivation was necessary in order to control them.

Summary

1. It appears that Metobromuron would be effective for sweet corn. It may have a place in weed control where residue is becoming an important factor in our vegetable crop rotations.

2. Diphenamid-DNBP and UC22463 show promise as herbicides for peas, beans and corn. It appeared from the results that the pounds per acre might be increased to give a longer residual against the weed seed germination.

3. The one-half inch of rain following the application of the herbicides applied pre-emergence was ideal for the highest performance of these materials.

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CARROT RESPONSE TO POST-EMERGENCE APPLICATIONS OF LINURON AND STODDARD SOLVENT 1/

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INTRODUCTION

Linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) and Stoddard Solvent have been widely used for weed control in carrots, (Daucus carota, Linn.). The tolerance of carrots to linuron and the excellent control of problem weeds such as ragweed (Ambrosia artemisiifolia) and annual grasses has been pointed out by several researchers (1,2,5). However, injury to carrots by post-emergence applications of linuron have been noted in research tests (1,5) and growers in New York State have obtained injury in fields where linuron was applied post-emergence. They feel this injury is related to carrot variety. Stoddard Solvent has been used extensively for weed control in carrots since the discovery of its selectivity to carrots (3,4,6). However, it often gave poor control of ragweed and in the middle of the growing season late germinating grassy weeds often became a problem.

Growers have tried to eliminate this ragweed and grass problem by two applications of linuron or application of linuron following Stoddard Solvent applied early post-emergence. Injury to the carrots has been observed in some cases where this was done.

The purpose of this research was to determine the response of carrot varieties to linuron when applied post-emergence, either alone or following Stoddard Solvent.

MATERIALS AND METHODS

An experiment was conducted in 1967 to compare the response of six carrot varieties, including four seed lots of one variety, and three of another, to the herbicide treatment of Stoddard Solvent followed in one of two weeks with linuron. The carrots were seeded on silt loam soil June 21 and sprayed 40 days later with Stoddard Solvent at approximately 50 gal./A. Linuron was applied eleven days later at 1 and 2 lbs./A. to designated plots. There were 4 replications. Yields were taken on September 5-7, by harvesting 16 feet of row and recording the weight of all carrots present. This harvest date was approximately two weeks before the optimum date of harvest.

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In 1968 two carrot varieties were selected from the 1967 trial. The varieties Danvers 126 and Waltham Hicolor were selected because the former appeared tolerant and the latter appeared intermediate in response to linuron applied post-emergence. Carrots were seeded June 4 on a silt loam soil in plots 6 ft. x 25 ft. in size. Two rows of each variety were seeded per plot. There were four replications. The early post-emergence treatments were applied July 8 when the carrots had 4-6 leaves and were 2-4 inches tall. The late post-emergence application was applied July 25 when the carrots had 6-8 leaves and were 7-9 inches tall. All plots were rated August 13. An early and late yield was taken on September 5-11 and October 16-29 respectively. The front or back half of the plot was randomly selected, 10 feet of the two rows harvested, and the weight of all roots present recorded at both harvests.

One check treatment was double weeded by hand on July 2 and 29 and the other weeded on July 29 for the once weeded check.

RESULTS AND DISCUSSION

As can be easily seen from the 1967 results presented in Table I there were differences in carrot variety and seed lots in response to linuron applied post-emergence after Stoddard Solvent. In comparison to the check, Danvers 126 and Long Imperator 58 Lot B seemed quite tolerant to linuron, whereas Gold Pak Lots B and D, Royal Chantenay and Scarlet Nantes were very susceptible at 1 lb./A. The remaining varieties and seed lots were intermediate in their response. At the higher rate of 2 lb./A. of linuron all varieties showed a reduction in yield. However, the same ranking as to tolerance and susceptibility of varieties and seed lots seen at 1 lb./A. held at the higher rate of application. Injury to carrot foliage by linuron at 2 lb./A. post-emergence has been reported by other workers (1) and is further substantiated in this test.

The crop ratings of the 1968 test are given in Table II and it can be seen that Waltham Hicolor is much more susceptible to linuron than is Danvers 126. The Danvers 126 suffered very little foliage injury whereas the Waltham Hicolor foliage showed severe burn, necrosis and yellowing with a single application of 2 lb./A. early post-emergence and greater injury with the double early and late application of 2 lb./A. post-emergence. Although there was some injury with the treatments of linuron post-emergence at 1 and 2 lb./A. applied after Stoddard Solvent it does not appear foliar injury due to linuron is increased by prior application of Stoddard Solvent. In all treatments where foliar injury was observed the plants recovered and except for reduced growth appeared normal two weeks later.

The yield data of Table III indicates both varieties suffered a reduction in yield even at the late harvest from the double application of 2 lb./A. of linuron. The Danvers 126 was less susceptible however, and showed much less yield reduction. The low yield of the Danvers 126

Table I. Fresh Weight (Cwt./A.) of Roots of Carrot Varieties and Seed Lots Exposed to Linuron Applied Post-Emergence After Stoddard Solvent.

Variety and Seed Lot	Treatment Linuron 1 lb/A	Treatment Linuron 2 lb/A	No Linuron Control
Danvers 126	598.4	476.0	610.1
Gold Pak Lot A	304.1	229.3	362.6
Gold Pak Lot B	223.8	213.5	368.4
Gold Pak Lot C	334.0	224.4	391.1
Gold Pak Lot D	213.5	129.2	263.8
Long Imperator 58 Lot A	291.0	298.6	321.8
Long Imperator 58 Lot B	407.5	314.2	381.6
Long Imperator 58 Lot C	284.2	261.1	359.8
Royal Chantenay	327.7	285.1	481.4
Scarlet Nantes	320.9	269.3	429.2
Waltham Hicolor	301.4	249.7	375.4
LSD .05	74.8	71.5	82.1

Table II. Visual Rating of Carrot Varieties Exposed to Various Linuron and Stoddard Solvent Treatments.

Treatment	Crop Rating 1/ Variety Danvers 126	Crop Rating 1/ Variety Waltham Hicolor
1 Linuron 1 early post	9.00	8.00
2 Linuron 2 early post	8.75	6.25
3a Linuron 1 early post	8.50	7.00
b Linuron 1 late post		
4a Linuron 2 early post	8.25	5.25
b Linuron 2 late post		
5 Stoddard Solvent 75 gal/A early post	9.00	9.00
6a Stoddard Solvent 75 gal/A early post	9.00	7.75
b Linuron 1 late post		
7a Stoddard Solvent 75 gal/A early post	9.00	7.00
b Linuron 2 late post		
8 Twice weeded check	9.00	8.25
9 Once weeded check	8.75	8.00

1/ Rating of 9=perfect crop; 7=slightly injured but acceptable crop; and 1=complete kill of crop.

Table III. Fresh Weight (Cwt./A.) of Roots of Carrots Treated With Linuron and Stoddard Solvent in Various Combinations.

			Variety			
			Danvers 126		Waltham Hicolor	
			Harvest and Yield			
Treatment		Rate	Early	Late	Early	Late
1	Linuron early post	1 lb/A	490.9	606.8	285.2	381.5
2	Linuron early post	2 lb/A	518.9	570.7	226.6	372.1
3a	Linuron early post	1 lb/A	493.1	609.0	226.6	400.2
b	Linuron late post	1 lb/A				
4a	Linuron early post	2 lb/A	380.9	552.6	193.9	332.9
b	Linuron late post	2 lb/A				
5	Stoddard Solvent early post	75 gal/A	525.8	638.0	374.0	463.8
6a	Stoddard Solvent early post	75 gal/A	416.1	568.8	264.0	413.3
b	Linuron late post	1 lb/A				
7a	Stoddard Solvent early post	75 gal/A	437.0	588.1	205.7	379.6
b	Linuron late post	2 lb/A				
8	Twice weeded check		507.1	646.5	322.6	489.2
9	Once weeded check		458.2	616.2	278.1	461.9

LSD .05 for comparison of means within a column = 68.63 Cwt./A.

with 1 lb./A. of linuron applied after Stoddard Solvent in comparison to the 2 lb./A. rate after Stoddard Solvent is probably due to less weed control at the low rate. It does not appear to be due to the linuron because the yield of the 2 lb./A. rate of linuron, although low, is not significantly less than that of either check. The susceptibility of Waltham Hicolor variety to linuron is demonstrated by the fact that all post-emergence treatments with this herbicide reduced final yields. It should be noted however that early yields of Waltham Hicolor were not as severely reduced as were final yields. Since this observation is contrary to what would have been expected from an acute injury of short duration, it appears probable that the injurious nature of linuron is due primarily to a long-term chronic adverse effect on some fundamental physiological process within the carrot.

SUMMARY AND CONCLUSIONS

In summary the field experiments with several varieties and seed lots of carrots showed definite differences in tolerance to post-emergence applications of linuron. These results agree with growers observations that some carrot varieties are not fully tolerant of linuron.

Further tests showed Danvers 126 to be relatively tolerant and Waltham Hicolor to be relatively susceptible. Injury was correlated with rate of linuron, but not with timing or with the prior application of Stoddard Solvent.

Damage to a susceptible carrot variety consisted not only of an initial readily apparent foliage necrosis but also and perhaps more importantly to a long-term chronic type of adverse effect which resulted in slower growth, particularly of the carrot storage root.

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WEED CONTROL IN DIRECT-SEEDED AND TRANSPLANTED TOMATOES [1/]

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Weed control in direct-seeded and transplanted tomatoes must be broad-spectrum and long lasting. Despite the importance of tomatoes as a vegetable crop, relatively few herbicides have been developed which provide the necessary spectrum of control. Making the task of finding selective herbicides for both crops difficult is the fact that the basis of herbicidal selectivity may differ. With direct-seeded tomatoes, an herbicide is needed which will be toxic to weeds during an early stage of growth while not influencing germination or growth of tomato seedlings. Here the basis of selectivity is likely to be physiological. In transplanted tomatoes, the basis of selectivity could be a difference in stage of crop and weed growth. For these reasons an herbicide may be useful in only direct-seeded or transplanted tomatoes.

The research reported herein was conducted to evaluate the capacity of several herbicides to provide broad-spectrum weed control in direct-seeded and transplanted tomatoes. Considered of primary importance was a wide margin of crop safety.

Materials and Methods

Research was conducted at the Eastern Shore Branch, Virginia Truck Experiment Station, Painter on Sassafras sandy loam soil. Four experiments were included in this study; they consisted of preplant incorporated and preemergence herbicide treatments in direct-seeded tomatoes and preemergence and post-transplant treatments in transplanted tomatoes. Experiments were designed as complete randomized blocks with three replications. Land was prepared for planting in a conventional manner. For direct-seeded studies, a single row of tomatoes (var. Heinz 1370) was seeded in beds on April 22, 1968 at a depth of 1/2 in. Tomato transplants (var. Campbells 17) were planted on April 30, 1968 for studies involving transplanted tomatoes. Plots 5 ft wide by 20 ft in length were established to receive herbicidal treatments. All herbicides were applied on the dates of planting with the exception of post-transplanting applications which were made on May 3. Water dilutions of herbicides were applied at a delivery rate of 55 gpa using propane as the source of pressure. Granular herbicides were applied with hand shakers. Incorporation, where appropriate, was with a power driven rototiller to the depths indicated in Tables 1 and 3. Chemical descriptions for all herbicides evaluated are presented in the Appendix. Precipitation in the amount of 0.5 in was recorded

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2 days following herbicide application in direct-seeded tomatoes. In transplanted tomatoes, 0.3 in of rain was recorded on the date of planting and 1.0 in of irrigation was applied to all tomatoes on May 6.

Predominant weeds in the experimental area included lambsquarters (Chenopodium album L.), fall panicum (Panicum dichotomiflorum Michx.) and large crabgrass (Digitaria sanguinalis (L.) Scop.). Weed control and crop injury were rated using the scale 0 to 10 where 0 = no control or crop injury and 10 = complete reduction in plant stand or vigor.

Yields of transplanted tomatoes were determined by harvesting mature fruits four times at weekly intervals. Yields were analyzed statistically and plot weights were converted to an acre basis. Direct-seeded tomatoes were not harvested.

Results and Discussion

For ease of discussion, direct-seeded and transplanted tomatoes will be discussed separately.

Crop and weed responses to herbicides applied in direct-seeded tomatoes are presented in Tables 1 and 2. Diphenamid effected good control of both broadleaf weeds and grasses and caused no crop injury. Both methods of application resulted in good initial and residual activity. With H-16993, preplant incorporated applications provided better control than did preemergence treatments with control of lambsquarters being better than grass control. It was also noted with H-16993 that the wettable powder formulation was more effective than the granular formulation. With reference to crop response, tomatoes generally exhibited a satisfactory margin of safety to H-16993 although some stand reduction resulted from applications of the wettable powder formulation preplant incorporated. The ester formulation of amiben was more effective when incorporated but slight reductions in tomato stand were observed. Amiben did not provide control which lasted for a satisfactory period of time. Notwithstanding that pebulate, diphenamid + DNBP and nitralin effected control which was generally good, crop injury from these materials was extensive.

Data relating to herbicide applications in transplanted tomatoes are presented in Tables 3 and 4. Excellent broad-spectrum weed control was obtained with diphenamid in transplanted tomatoes, with application method having little influence on herbicide activity. Control of lambsquarters with H-16993 was excellent at all rates although satisfactory control of grasses was obtained only when applications were incorporated. Notwithstanding that trifluralin effected excellent control of lambsquarters and grasses, the analogue, nitralin, was weak on lambsquarters when applied preplant incorporated; nitralin failed to adequately control any weed species when applied post-setting. Tomatoes outgrew what appeared to be some initial stunting from either trifluralin or nitralin and produced good yields. The combinations of DCPA + metobromuron effected good weed control although some vigor reductions of tomatoes were apparent, especially when the combination included the higher rate of metobromuron.

Table 1. Weed control and crop response to herbicides applied preplant incorporated to direct-seeded tomatoes in 1968.

Herbicide	Rate, lb/A	Incorp. depth, in.	Crop Response 1/	Weed Control 1/	
				Lambs-quarters	Grasses 2/
diphenamid	3	3	0.0	9.9	7.2
nitralin	1	1	10.0	8.9	9.6
amiben (methyl ester)	3	1	1.7	9.2	4.0
pebulate	4	3	3.2	9.4	8.9
	6	3	4.3	9.7	9.5
H 16993 (50 W)	4	3	0.0	10.0	5.7
	6	3	2.3	10.0	5.5
	8	3	2.0	10.0	6.3
H 16993 (5 G)	4	3	0.0	10.0	2.2
	6	3	0.7	10.0	3.2
	8	3	0.0	10.0	5.0
Check	-	-	0.0	0.0	0.0

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of stand.

2/ Fall panicum and large crabgrass.

Table 2. Weed control and crop response to herbicides applied preemergence to direct-seeded tomatoes in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 1/ Lambs-quarters	Weed Control 1/ Grasses 2/
diphenamid	3	0.0	9.7	10.0
nitralin	1	10.0	9.7	9.8
amiben (methyl ester)	3	0.8	7.9	1.7
diphenamid + DNBP	1 1/2 + 1 1/8	2.3	8.8	8.2
H-16993 (50 W)	4	0.5	10.0	4.4
	6	0.7	10.0	5.2
	8	0.8	10.0	5.4
H-16993 (5 G)	4	0.8	10.0	0.7
	6	0.0	10.0	2.0
	8	0.3	10.0	3.2
Check	0	0.0	0.0	0.0

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of stand.

2/ Fall panicum and large crabgrass.

Table 3. Weed control and crop response to herbicides applied preplant incorporated to transplanted tomatoes in 1968.

Herbicide	Rate, lb/A	Crop Response 1/	Weed Control 2/ Lambs-quarters	Weed Control 2/ Grasses 3/	Yields, Ton/A Harvest 1st	Yields, Ton/A Harvest Total
trifluralin	3/4	1.4	9.8	9.8	6.5	13.4
	1 1/2	1.8	9.9	10.0	9.2	17.4
nitralin 4/	3/4	1.1	7.7	9.1	6.1	12.5
	1	0.8	8.2	9.2	8.2	17.1
DCPA +	4 1/2 + 3/4	1.0	10.0	8.3	7.0	14.8
metobromuron	4 1/2 + 1	1.6	10.0	8.6	6.7	12.9
pebulate	3	0.9	6.6	8.8	5.2	10.4
	4 1/2	1.5	9.1	9.0	7.4	14.5
	6	2.5	9.2	9.8	6.1	13.8
diphenamid	3	0.8	9.7	9.6	8.7	19.2
H-16993	4	0.5	10.0	5.2	7.9	17.0
(50 W)	6	0.0	9.9	9.1	8.9	17.8
	8	0.5	9.8	9.7	8.7	19.2
Check	-	0.0	0.0	0.0	1.7	3.4
Check	-	0.0	0.0	0.0	0.0	0.5
LSD 0.05					2.5	6.2

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of vigor.

2/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of stand.

3/ Fall panicum and large crabgrass.

4/ Depth of incorporation was 1 to 2 in for nitralin; other herbicides were incorporated to a depth of 2 to 3 in.

Table 4. Weed control and crop response to herbicides applied post-transplant to tomatoes in 1968.

Herbicide	Rate, lb/A	Crop Response 1/ May 7	Crop Response 1/ June 13	Weed Control 2/ Lambs-quarters	Weed Control 2/ Grasses 3/	Yields, Ton/A Harvest 1st	Yields, Ton/A Harvest Total
nitralin	3/4	1.0	1.0	7.0	7.3	3.3	7.7
	1	1.0	1.0	7.4	7.4	4.4	10.8
amiben	3	2.4	1.6	7.9	7.0	4.3	9.2
(methyl ester)	4	2.9	1.3	8.5	8.5	4.1	8.6
amiben	3	4.1	1.4	5.5	8.4	3.0	6.4
(ammonium salt)	4	4.3	1.6	8.0	9.1	4.3	10.1
diphenamid	3	0.9	0.1	8.6	9.7	9.4	20.1
H-16993	4	0.9	0.0	10.0	4.9	4.2	11.2
(50 W)	6	0.9	0.4	10.0	7.1	5.0	14.1
	8	1.1	0.1	9.9	8.6	6.9	16.5
CP 50144	1	1.0	0.9	0.3	10.0	-	-
	2	2.0	1.6	4.9	10.0	-	-
	4	1.1	1.4	8.6	9.8	-	-
DCPA	9	1.3	2.2	10.0	9.6	6.9	13.4
Check	-	1.1	0.0	2.0	0.0	0.9	1.6
LSD 0.05						2.5	5.2

1/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of vigor.

2/ Scale: 0 to 10; 0 = no effect and 10 = complete reduction of stand.

3/ Fall panicum and large crabgrass.

Although not shown in Table 3, the only herbicide to control nutsedge (*Cyperus esculentus* L.) was pebulate. In addition, pebulate afforded good control of lambsquarters and grasses at rates of 4 1/2 and 6 lb/A. Tomatoes exhibited increasing injury with rate increases of pebulate although yields did not reflect these vigor reductions. Notwithstanding that the methyl ester formulation of amiben caused less tomato injury than did the ammonium salt, formulation had little effect on weed control. With amiben, the independent effects of initial crop injury and uncontrolled weeds on tomato yields cannot be assessed but it is believed that the major cause of lower yields was competition from weeds. Control of lambsquarters and grasses with DCPA was good but some crop injury was observed to develop by the second rating date. Little control of lambsquarters was obtained with CP 50144 and tomatoes treated with this herbicide were not harvested.

Summary

Several herbicides were evaluated for weed control in direct-seeded and transplanted tomatoes. Diphenamid effected excellent, long lasting weed control in both direct-seeded and transplanted tomatoes. The experimental herbicide H-16993 was more satisfactory in both crops when incorporated although crop stands were reduced slightly in direct-seeded tomatoes. Amiben, nitralin, pebulate and diphenamid + DNBP caused injury to direct-seeded tomatoes. In transplanted tomatoes, trifluralin, DCPA, DCPA + metobromuron and pebulate provided good broad-spectrum weed control. Nitralin was more effective when incorporated than when surface applied. The methyl ester formulation of amiben was less injurious to tomatoes than was the ammonium salt formulation. Weed control with CP 50144 was not satisfactory.

Appendix

Common names or code numbers of herbicides evaluated in direct-seeded and transplanted tomatoes.

amiben	3-amino-2,5 dichlorobenzoic acid
CP 50144	2-chloro-2'6'-diethyl-N-(methoxymethyl) acetanilide
DCPA	dimethyl 2,3,5,6-tetrachloroterephthalate
diphenamid	N,N-dimethyl-2,2-diphenylacetamide
DNBP	4,6-dinitro-o-sec-butylphenol
H-16993	chemistry not disclosed
metobromuron	N-(p-bromophenyl)-N'-methyl-N'-methoxyurea
nitralin	4-(2-methylsulphonyl)-2,6-dinitro-N,N-dipropylaniline
pebulate	S-propyl butylethylthiocarbamate
trifluralin	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine

ENVIRONMENTAL EFFECTS ON DIPHENAMID ACTIVITY - A PROGRESS REPORT [1/] [2/]

M. R. Lynch and R. D. Sweet [3/]

INTRODUCTION

Diphenamid (N,N-dimethyl-2,2-diphenylacetamide) is considered to be an extremely "safe" herbicide for the control of grasses and many broadleaved weed species in tomatoes (Lycopersicon esculentum). There is no report in the literature of injury to tomato, following application of diphenamid. However, in the early spring of both 1966 and 1967, there were some observations in New York of severe injury to seedling tomatoes, grown under greenhouse conditions, following application of diphenamid. The first objective of these studies was to determine if diphenamid per se can be toxic to tomato, and if so, under what specific environmental conditions.

EXPERIMENTAL

Some of the experiments reported here were conducted in the greenhouse, the remainder in small reach-in growth chambers. Plants were either direct seeded or transplanted and grown in commercial styrofoam trays containing a general greenhouse potting mixture. Transplanting of seedlings was done one day before chemical application. Direct seeded trays were thinned to the appropriate number of seedlings at the same time. Chemical application was usually done fourteen days after seeding, when the first true leaf of the tomato plants was from 1/4 to 1/2 centimeter long. The rate of chemical application was 6 pounds a.i. per acre unless otherwise specified. A further fourteen days elapsed between chemical application and data collection. All plants were grown at a day temperature of 75°F and a night temperature of 65°F. Light intensity in the growth chambers was modified by running the chambers with all or half the lights operating. Adjustment of shelf height gave further flexibility of light intensity at plant height.

An initial experiment was conducted in the greenhouse in the winter time, in which the two tomato varieties Fireball and New Yorker were used. The results confirmed that diphenamid per se can be toxic to tomato (Table 1). This experiment also indicated that diphenamid might, under some conditions, be more toxic when applied to the leaves as opposed to the soil. Transplanting of seedlings did not increase the amount of injury found. Of the two varieties, New Yorker was the more susceptible. The 80 w.p. formulation was more toxic than the 50 w.p. formulation.

1/ Paper No. 577. Department of Vegetable Crops, Cornell University, Ithaca, New York.
2/ This research was partially supported by a grant-in-aid from the Upjohn Company.
3/ Research assistant and Professor respectively.

Visual symptoms in this, as in all subsequent experiments, did not become apparent until 6 to 8 days after chemical application. Symptoms customarily take the following pattern: development of a water soaked area at the tips and margins of the cotyledons, followed by development of necrotic areas. This necrosis gradually, where injury is severe, progresses back along the cotyledons until the whole leaf and plant is dead. Similar symptoms have been observed on true leaves, however they are never as severe. In all cases stunting of plant growth occurs.

Table 1. Summary of visual ratings and fresh weights[1/] of two varieties of tomato seedling to diphenamid application.[2/]

Cultural Method	Site of Chemical Application	Chemical Formulation	Rating[3/]		Fresh Weights	
			Fireball	New Yorker	Fireball	New Yorker
Transplanted						
	soil & leaf	50 wp[4/]	5.33	6.00	2.70	2.27
	" "	50 wp[4/]	5.67	5.67	2.70	2.20
	" "	80 wp	3.67	2.67	1.70	0.77
	soil	50 wp[4/]	5.33	4.33	2.90	1.83
	"	50 wp[4/]	6.33	5.33	3.27	2.23
	"	80 wp	6.00	3.67	2.73	1.60
	control		7.00	7.00	3.83	2.80
Direct Seeded						
	soil & leaf	50 wp[4/]	8.67	8.33	6.27	5.00
	"	50 wp[4/]	8.00	8.00	5.20	5.03
	"	80 wp	4.33	4.67	2.40	2.03
	control		9.00	9.00	6.80	6.60
"F" test	treatments		**		**	
	variety		**		**	
	interaction		**		n.s.	

** significant at P = 0.01
n.s. Not significant
1/ each number represents the sum of the fresh weights of three plants.
2/ treatments were replicated 3 times.
3/ 9 is perfect crop, no injury. 7 is slight injury but commercially acceptable. 1 is complete kill of crop.
4/ represents a particular batch of chemical used commercially in Western New York, where injury following diphenamid application was first observed.

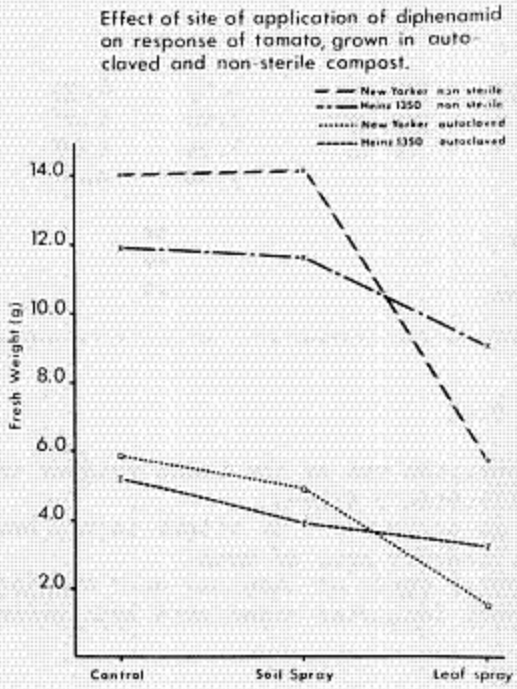
Experiment 2: Site of Uptake

The two varieties New Yorker and Heinz 1350 were used in this experiment. Nineteen days elapsed between seeding and chemical application. In certain cases the chemical (80 w.p.) was sprayed on the surface of the soil before transplanting seedlings into it. The foliage spray treatments were applied after transplanting. The surface of the soil was covered with absorbent tissue during spraying to avoid contamination. One half of the soil used was autoclaved, the other half was not. The trays were placed in tin foil dishes to allow sub-irrigation. No attempt was made to maintain sterile conditions subsequent to treatment. There were six plants per treatment, replicated four times.

The results of this experiment are summarized in Figure 1. A leaf application was more toxic than the soil application, although this difference was not as great when the soil was autoclaved. It has been reported that microbial breakdown of diphenamid occurs in the soil (1,2,3). Reduced activity of diphenamid in the unsterile soil indicates that this breakdown involved a detoxification of the chemical. The work of Gentner (4) supports this hypothesis.

The variety New Yorker was injured more than the variety Heinz 1350.

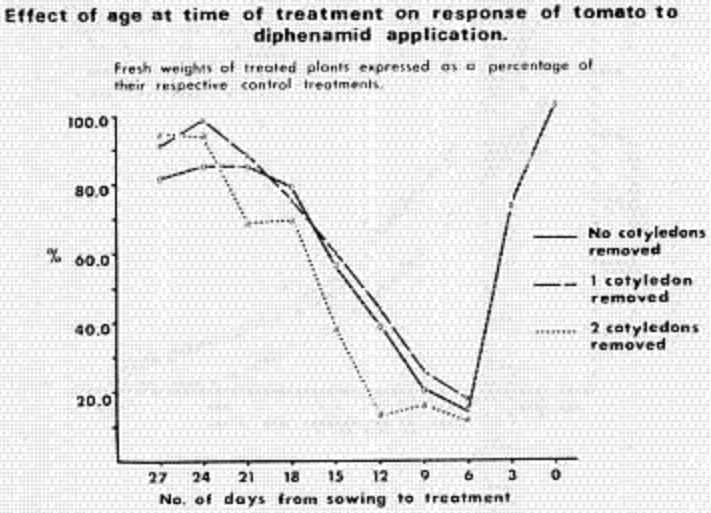
Figure 1



Experiment 3: Effect of Age of Seedlings at Time of Treatment

In the previous experiments the true leaves were injured only slightly if at all. This suggested that only very young seedlings were injured by diphenamid and further that perhaps this was due to the chemical being absorbed with more ease by the cotyledons than by the true leaves. To test this hypothesis seeds of Heinz 1350 were sown at 10, 3-day intervals. The chemical (80 w.p.) was applied on the final sowing date. Both the cotyledons from 1/3 of the seedlings from each sowing date, were removed 24 hours before chemical application. One cotyledon was removed from a further third, cotyledons from the remaining third were left intact. Cotyledons were not removed from plants sown on the final two sowing dates, as these seedlings had not emerged. There were four plants in each treatment. The treatments were replicated three times.

Figure 2



Plants treated 6, 9 or 12 days after seeding were the most susceptible (Figure 2). This covers the period from emergence to development of 2 or 3 true leaves. Removal of cotyledons did not reduce the amount of injury.

Experiment 4: Rate of application

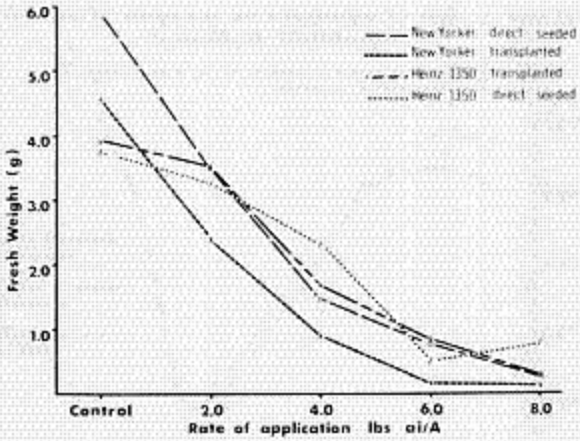
One of the first factors which needed to be studied was the influence of dosage on seedling response. Five rates of application, 0, 2, 4, 6 and 8 lbs active ingredient per acre of the 80% w.p. formulation were applied to New

Yorker and Heinz 1350 varieties. Half were direct seeded and half transplanted and grown in the greenhouse. Procedures used were as previously described at the beginning of the experimental section. There were 6 plants per treatment and three replications.

There was significant injury at all rates to both varieties whether direct seeded or transplanted (Figure 3). However there was greatly increased injury as the rates increased. Since approximately an 80% reduction in fresh weight occurred with the six pound rate, it was decided to use this dosage in most of the subsequent experiments.

Figure 3

Effect of rate of diphenamid application on response of tomato.



Experiments 5, 6 and 7: Effect of Light Intensity

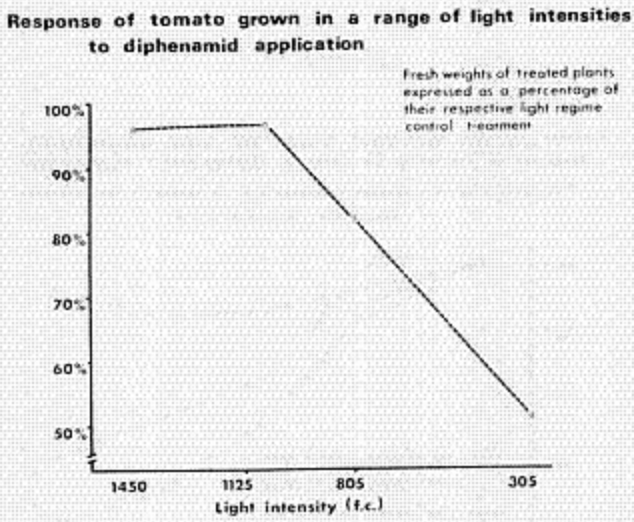
Field reports reaching the authors indicated that diphenamid injury was almost exclusively limited to seedlings being produced in greenhouse during the winter or very early spring. The experiments reported above clearly showed that injury does occur. They too were on winter-grown seedlings. Since no reports had ever been received on damage to summer, field grown seedlings, it was speculated that injury was probably a seasonal effect and most likely had some relationship to the low light levels which generally prevail in New York during the winter and very early spring.

To test this hypothesis several experiments involving light were

conducted in small reach-in growth chambers and in the greenhouse. A preliminary experiment involving only high light (2,400 f.c.) and low light (450 f.c.) confirmed that indeed low light did increase diphenamid injury to tomato seedlings. A more elaborate experiment (No. 5) was then initiated to determine whether there was a proportional response as light decreased, and whether there was a critical light level which determined whether or not injury would occur. The variety Heinz 1350 was direct seeded and grown at 16 hours per day at light intensities of 1,450, 1,125, 805 and 305 f.c. Diphenamid (80 w.p.) at 6.0 lbs active per acre was applied as an overall spray 14 days after seeding. Data on crop response was taken two weeks following spraying. There were 4 plants per treatment and 6 replications.

The unmistakable interaction between light intensity and diphenamid injury to tomato is illustrated in Figure 4. In this experiment the critical intensity was between 1,125 and 805 f.c.

Figure 4



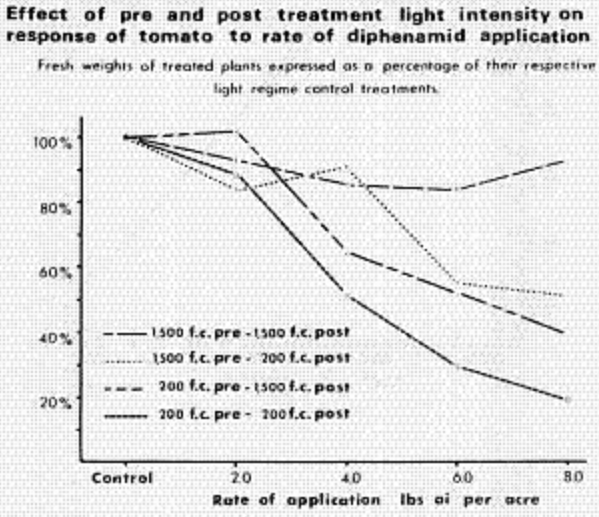
Smith and Sagar (1966) showed that a dark period was necessary following application of diquat to tomato to allow adequate penetration and local distribution of the chemical within the leaf. Mellor and Salisbury (1965) showed that the phytotoxicity of 2,4-dinitrophenol increased with the amount of darkness plants received after treatment. This increase reached a maximum at 12 to 16 hours of darkness. Furthermore if light were supplied immediately after chemical application no injury resulted. Dark treatment prior to chemical application increased toxicity, but to a lesser degree than

did darkness following application. Meggitt, et al (1956) found similar results with DNBP.

The above findings stimulated the authors to examine the effects of light intensity both before and after diphenamid application to tomato seedlings (experiment 6). Seed of Heinz 1350 was sown and grown for 14 days at 1,500 and 200 f.c. in small growth chambers. Diphenamid (80 w.p.) was then applied as an overall spray at 5 rates (Figure 5) and half the plants returned to the same light intensity and the other half put in the opposite light level. Data was collected 14 days following spraying. There were four plants per treatment and 4 replications.

As can be seen in Figure 5, the highest light level, 1,500 f.c. both prior and subsequent to spraying had the least damage; the lowest light level had the most damage; and the other two treatments were intermediate. There was no clear cut response to high light intensity applied before chemical application as opposed to after chemical application. Again there was a definite increase in damage with increase in rate except for the high light, where only slight damage occurred at any dosage.

Figure 5



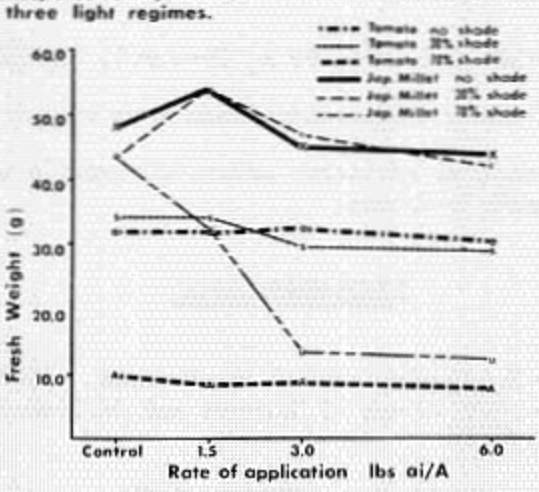
In order to better understand the response to diphenamid of tomato, a relatively tolerant species, it was decided to investigate the response in Japanese millet (Echinochloa crusgalli, var. frumentacea) a species relatively susceptible to diphenamid. Experiment 7 was conducted in the greenhouse. Plastic shade cloth woven at different densities was suspended 30 inches above

the benches. Approximately 30% and 70% shade or reduction in "normal" light was achieved. This experiment was conducted in May 1968 and "normal" mid-day intensities were about 3,000 f.c. The shade treatments were about 2,000 and 1,000 f.c. Seed of Heinz 1350 and Japanese millet were planted and grown for 14 days at each light intensity. Shortly after emergence trays were thinned, in the case of tomato to 6 seedlings and in the case of millet, to 20 seedlings. After 14 days diphenamid (50 w.p.) was applied as an overall spray at 4 rates and 14 days later data was obtained. There were 4 replications.

The results are presented in Figure 6. The most striking effect of shade was the overall reduction in tomato growth. There was no truly significant influence of shade on tomato response to diphenamid. Japanese millet reaction to shade was dramatically different from that of tomato. Shade had little effect on millet growth, provided no chemical was added. However, millet, when heavily shaded was severely injured by diphenamid. This was true even at the 3 lb. rate.

Figure 6

Response to diphenamid of two plant species grown under three light regimes.



Further experiments on light intensity, not reported in detail here were conducted during the summer and fall in the field, the greenhouse and in the growth chambers. In no instance, contrary to the previous results, could diphenamid injury be induced with low light intensity. Current research indicates this seasonal effect may actually be conditioned by relative humidity, with increased tomato susceptibility being correlated with higher humidities. Light quality and pH of the water in the spray mixture have shown no influence on tomato response to diphenamid.

DISCUSSION AND SUMMARY

Diphenamid often causes severe injury to tomato seedlings grown in the winter time. The injury is readily correlated with low light intensity whether the seedlings are in the greenhouse or in growth chambers. However, it is exceedingly difficult and almost impossible to cause comparable damage even in the same growth chambers when seedlings are grown in the summer.

It is abundantly clear that the adverse response of tomato to diphenamid is not simply a matter of low light. However the precise controlling factors are not understood at this time. Some modifying influences were studied and the results indicate:

a. Young seedlings are more susceptible than those several weeks old.

b. High rates cause more injury than low rates.

c. Tomato varieties differ in the degree of injury, but the same trends occur with many varieties.

d. Transplanting and accompanying root damage did not increase the damage.

e. Leaf applications were more toxic than soil applications.

f. Light quality had no apparent influence on tomato response.

g. Research in progress indicates relative humidity may have a bearing on tomato response.

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EFFECT OF HERBICIDES ON DIRECT-SEEDED CRUCIFERS[1,2]

J. A. Ivany and R. D. Sweet[3]

INTRODUCTION

In recent years the direct-seeding of Crucifer crops has increased in importance. The problem of finding herbicides to give effective weed control without adverse effects on these crops is a continuing process. Several workers have evaluated many new compounds for possible use on Crucifers (1, 2, 3, 4). Certain herbicides have been cleared for use but with some of these early injury has been noted in field tests by the authors. Trifluralin (2, 6-dinitro-N,N-dipropyl-4-trifluro-methylaniline) caused early stunting on cabbage and Tok E-25 (2,4-dichlorophenyl-4-nitrophenyl ether) caused severe foliage burn when applied post-emergence to cabbage, broccoli and radish.

The purpose of this research was to evaluate new herbicides for use on Crucifers and to determine if the early injury noted with trifluralin and Tok E-25 reduced the yields of direct-seeded cabbage.

MATERIALS AND METHODS

Newer herbicides as well as certain standards were evaluated in field trials in 1967 and 1968 on a gravelly loam soil. Field plots were 6 ft x 15 ft containing one row each of cabbage, variety Golden Acre, broccoli, variety Waltham 29, and radish, variety Early Scarlet Globe, seeded with a Planet Jr. seeder. Some plots had the chemical left on the surface while in others the soil was incorporated after spraying by running a double disc harrow set at three inches in both directions through the plots.

The yield trial was conducted in 1968 using the cabbage hybrid King Cole. On June 3, two rows of cabbage were seeded 36 inches apart in a plot 6 ft x 20 ft in size. Ratings were taken on July 2 and the plants were then thinned to 10 inches apart in the row. The entire experiment was hand weeded on July 18. The time required was recorded for each plot. An early and late yield was taken. The early yield was taken on September 4 by randomly selecting either the back or front half of a plot and recording the number and total weight of the heads present. The remaining half of the plots was harvested on September 19 for the late yield. The first or last head in the row was discarded as it was generally larger than the rest due to border effects.

1/ This, as well as other research projects, were partially supported by grants-in-aid from CIBA, Monsanto, Rohm and Haas, and Stauffer.

2/ Paper no. 578 of the Department of Vegetable Crops, Cornell University.

3/ Research Assistant and Professor, respectively.

RESULTS AND DISCUSSION

The crop and broadleaf weed control ratings are presented in Tables I and II. Dacthal (dimethyl-2,3,5,6,-tetrachloroterephthalate) at 8 and 12 lb/A. incorporated gave good results in both years. Trifluralin at 1/2 and 1 lb/A. incorporated caused a slight stunting of cabbage both years.

Tok E-25 at 2 and 4 lb/A. pre-emergence gave unsatisfactory weed control. At these rates post-emergence however weed control was excellent but crop foliage was so severely damaged the leaves developed necrotic areas a few days after spraying. Surprisingly the crops recovered and appeared normal two weeks later. In 1968 the 50 wp formulation of Tok was tested and found to be less toxic to both crops and weeds than the Tok E-25 where applied either pre- or post-emergence.

Ramrod (2-chloro-N-isopropylacetanilide) gave no crop injury however the 4 lb/A. rate was needed for effective weed control.

Of the newer herbicides tested CIBA C-7019 (2-azido-4-isopropylamino-6-methylmercapto-s-triazine) gave excellent results pre-emergence but gave severe injury post-emergence even at the lowest rate. CIBA C-6989 (2,4-dinitro-4-trifluoromethyldiphenylether) gave very unsatisfactory results in the 1968 test. R-7465 (2-α napthoxy)-N,N-diethyl pvopioramide), was very toxic to cabbage and broccoli at 6 lb/A incorporated but gave good results pre-emergence. Monsanto's CP-50144, (2-chloro-2',6'-diethyl-N-methoxymethyl acetanilide), gave good results applied at 1.5 and 3.0 lb/A. pre-emergence however the incorporated and post-emergence treatments were unsatisfactory.

The cabbage and weed control ratings for the yield test are presented in Table III and the yield data in Figure I. Only trifluralin and Tok E-25 caused any early injury to the cabbage. Trifluralin at 1 lb/A. incorporated caused a slight stunting. Tok E-25 at 2 lb/A. pre-emergence caused slight stunting and at 4 lb/A. severe stunting. At these same rates post-emergence Tok caused severe leaf burn and necrosis. The cabbage in all the above treatments recovered visually and appeared normal two weeks later.

Weed control was rather poor except for Tok post-emergence. Dacthal, Ramrod and Trifluralin did not perform as well as expected. The higher rate was needed for effective weed control with both Ramrod and Trifluralin. The data for average time required to weed a plot (Table III) shows this aspect quite well. This poor performance is undoubtedly due to the presence of white cockle a species somewhat tolerant of these compounds.

The early yields show very little difference between treatments except for the lower yield for Tok post-emergence. The slightly higher yield for the higher rate of application for all herbicides except Trifluralin can be attributed to better early weed control. The lower yield with Trifluralin is probably due to the early stunting observed.

Although the same trends as in the early harvest continue, the late yields show even greater differences between treatments. Note however the excellent yield of the Tok post-emergence plots. It appears the early damage suffered by the cabbage in this treatment does not adversely affect final yields. The yield at the high rate of Trifluralin was less than the low rate however in comparison to the check even the yield of the high rate is somewhat better.

SUMMARY

Dacthal and Trifluralin continued to perform well on direct-seeded crucifers. Weed control however, was variable depending on weed species present. C-7019, CP-50144 and R-7465 looked promising as pre-emergence herbicides. C-6989 caused too great injury to be of commercial value. The wettable powder formulation of Tok was less toxic than the emulsifyable concentrate formulation to both crops and weeds whether applied pre- or post-emergence.

The burning caused by post-emergence application of Tok E-25 did not cause any late yield reduction. Trifluralin at 1 lb/A. incorporated caused much more stunting of cabbage than the 1/2 lb. rate but the plants recovered and late yields were not reduced below that of the no chemical handweeded treatment. For satisfactory results with Ramrod dosage needed to be at least 4 lbs.

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Table I. Response of Crucifers and Weeds to Several Herbicides

Chemical	Timing	lb/A. Rate	Crop and Weed Rating[1/] 1967 Cabbage	Broccoli	Radish	Lambs-quarters	Ladys Thumb	Rag Weed
Dacthal	ppi	8.0	8.0	9.0	9.0	6.5	5.0	6.5
"	"	12	7.5	8.0	8.0	9.0	4.5	4.5
Trifluralin	"	0.5	7.5	9.0	8.5	8.0	7.5	5.0
"	"	1.0	7.5	9.0	9.0	8.5	6.0	6.0
Tok E-25	pre	2.0	8.0	9.0	8.0	6.0	7.0	4.5
"	"	4.0	6.0	7.5	7.0	6.5	7.5	6.0
"	post	2.0	5.5	8.5	5.5	9.0	9.0	6.5
"	post	4.0	4.5	6.0	3.5	9.0	8.5	7.5
C-7019	pre	2.0	7.5	8.5	9.0	7.0	7.5	7.0
"	"	4.0	8.0	9.0	8.5	9.0	8.5	8.5
"	"	6.0	7.5	7.5	9.0	9.0	9.0	9.0
"	post	2.0	5.0	6.0	5.5	9.0	9.0	8.0
"	"	4.0	2.0	3.5	3.0	9.0	9.0	9.0
"	"	6.0	2.0	3.0	1.5	9.0	9.0	9.0
Ramrod	pre	2.0	8.5	9.0	9.0	3.0	1.5	7.0
"	"	4.0	7.5	9.0	9.0	8.0	7.5	8.5
CP-50144	ppi	1.5	6.5	9.0	8.5	7.5	4.5	5.0
"	"	3.0	4.0	8.0	9.0	8.0	7.0	7.5
"	pre	1.5	8.0	8.5	9.0	7.0	8.0	8.5
"	"	3.0	6.0	7.5	8.0	6.5	8.0	8.0
"	post	1.5	8.0	8.0	7.5	5.0	3.0	5.0
"	"	3.0	7.0	8.0	7.0	6.0	9.0	6.5
Check	-	-	9.0	9.0	9.0	3.0	1.0	1.5
LSD .05			0.8	0.7	0.6	1.0	0.9	1.6

[1/] crop rating: 1= complete kill, 7= slight injury but acceptable crop, 9= perfect crop.
weed rating: 1= no control, 7= acceptable control, 9= perfect control.

Table II. Response of Crucifers and Weeds to Several Herbicides

Chemical	Timing	lb/A. Rate	Crop and Weed Ratings[1/] 1968 Cabbage	Broccoli	Radish	Lambs-quarters	White Cockle
Dacthal	ppi	8	8.0	9.0	9.0	6.0	8.5
"	"	12	9.0	9.0	9.0	7.5	9.0
Trifluralin	"	1/2	8.5	9.0	9.0	7.0	8.5
"	"	1	7.5	8.5	9.0	7.0	9.0
Tok (2 ec)	pre	2	8.5	9.0	9.0	5.0	3.0
"	"	4	7.5	8.0	8.5	8.0	5.0
"	post	2	6.5	9.0	6.0	9.0	9.0
"	"	4	4.5	8.0	4.5	9.0	9.0
Tok (50 wp)	Pre	2	8.0	8.5	9.0	6.5	2.5
"	"	4	8.0	9.0	8.5	7.5	3.0
"	post	2	8.0	8.5	6.0	6.5	7.5
"	post	4	7.0	8.5	6.0	6.5	9.0
C-7019	pre	2	7.5	8.0	8.5	9.0	8.0
"	"	4	8.5	8.0	9.0	9.0	8.5
C-6939	"	2	5.0	7.0	5.0	7.5	1.5
"	"	4	2.0	4.5	3.5	9.0	4.0
CP-50144	"	1-1/2	8.0	9.0	9.0	6.5	7.5
"	"	3	8.0	8.5	9.0	8.0	8.5
R-7465	ppi	3	6.0	9.0	8.5	8.5	9.0
"	"	6	4.0	5.0	8.0	7.5	8.5
"	pre	3	7.5	9.0	9.0	9.0	8.0
"	"	6	7.5	9.0	9.0	9.0	9.0
Check	-	-	9.0	9.0	9.0	1.5	1.5
LSD	.05		0.7	0.7	0.4	0.6	1.3

[1/] crop rating: 1= complete kill, 7= slight injury but acceptable crops 9= perfect crop.
weed rating: 1= no control, 7= acceptable control, 9= perfect control.

Table III. Weeding Time per Plot and Cabbage and Weed Control Ratings When Exposed to Certain Herbicides.

Chemical	Timing	lb/A. Rate	Weeding Time (min)	Rating 1/ cabbage	lambs-quarters	white cockle
Dacthal	ppi	8.0	9.3	8.8	5.5	5.8
"	"	12.0	8.6	8.5	6.5	6.5
Trifluralin	"	0.5	10.2	8.6	6.2	6.5
"	"	1.0	6.7	7.8	7.5	8.2
Tok E-25	pre	2.0	9.2	7.2	7.5	3.8
"	post	4.0	7.5	5.5	9.0	6.3
"	"	2.0	5.8	5.0	9.0	9.0
"	pre	4.0	4.5	4.0	9.0	9.0
Ramrod	"	2.0	14.0	8.5	5.0	3.8
"	-	4.0	10.3	8.8	6.3	5.5
Early weeded check	-	-	12.8	8.8	1.3	1.3
Late weeded check	-	-	16.3	8.8	1.3	1.3
	LSD .05		4.6	0.5	0.8	0.8

1/ crop rating: 1= complete kill, 7= slight injury but acceptable crop, 9= perfect crop.
weed rating: 1= no control, 7= acceptable control, 9= perfect control.

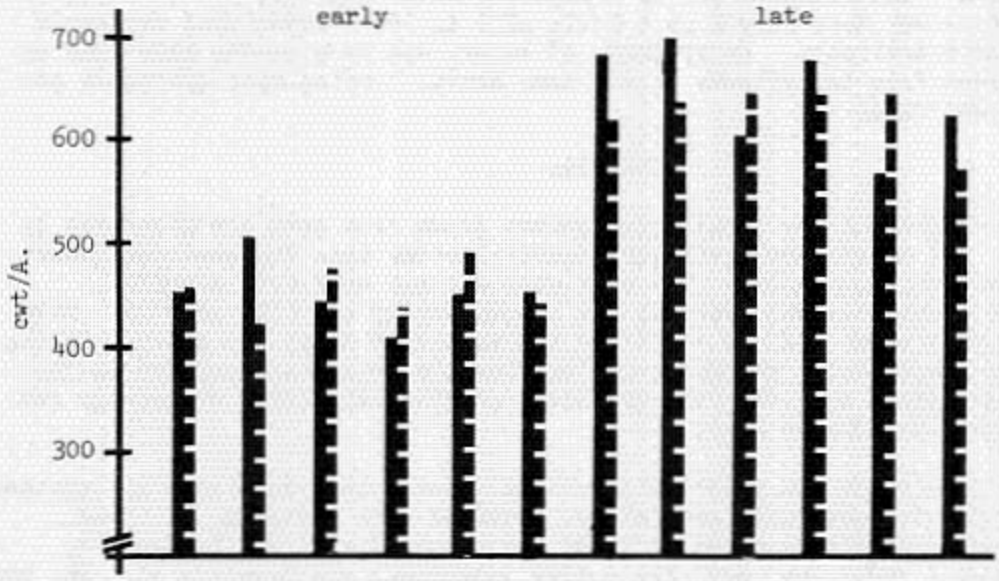

Figure I: Yields of Cabbage From Early and Late Harvests. Treatments for Each Harvest are in Same Order as Table III Above. Solid Bar= Low Rate and Broken Bar= High Rate of Each Treatment.

CHEMICAL WEEDING OF SET AND TRANSPLANT ONIONS GROWN IN MINERAL SOILS

Charles J. Noll[1]

Limited acreages of onions are grown in Pennsylvania from sets and transplants. If this acreage is to be maintained and possibly increased weed control becomes a major problem. This report is a summary of work done during the 1968 growing season. Treatments are in part based on the most successful treatments in trial during 1965 to 1967.

Procedure

The chemical weeding trials were conducted at the Horticulture farm located 10 miles west of University Park. The soil, a Hagerstown silt loam, was plowed in the fall of 1967. On April 16 the seedbed for the onions grown from sets was prepared, the incorporation treatments applied and the sets planted.

For transplants the seedbed was prepared and incorporation treatments applied April 22. Planting followed the next day with variety Yellow Pennsylvania Dutch. Post planting treatments varied from 1 to 59 days following planting. Major weeds present were ragweed, yellow foxtail and lambs quarter.

Single row plots, 18 feet long were 2 feet wide. Treatments were randomized in each of 6 blocks. All chemicals were applied over the total area of the plot. Cultivation was practiced. Onions grown from sets were harvested August 26 and onions grown from transplants September 3.

Rainfall was adequate and no irrigation water applied. An estimate of weed control was made July 8 on a basis of 1 to 10: 1 being most desirable and 10 least desirable. An estimate of injury was made at the same time on onions grown from transplants on the same basis: 1 being most desirable and 10 least desirable.

Results

The results of the trials with onions grown from sets are presented in table 1. All treatments were significantly better than the unweeded check in the weed control rating. The best weed ratings were with nitralin, CP 50144, propachlor and combinations of propachlor and CIPC or DCPA. Only nitralin treatments reduced the stand and weight of bulbs as compared to the untreated check plot. Yields were significantly better as compared to the check plot with M & B 14255-92, CP 50144, CP 50144 and CIPC, Propachlor and propachlor with CIPC or DCPA.

The results of the trials with onions grown from transplants are presented in table 2. The best weed control was observed with nitralin, CP 50144, propachlor or combinations of CP 50144 and propachlor with CIPC or DCPA. Nitralin at 2 and 3 lbs. per acre active ingredient and Brominil at ½ lb. per

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acre significantly injured onions as compared to the untreated plot. Nitralin at 3 lbs. per acre and Brominil at ¼ and ½ lb. per acre significantly reduced the stand of plots. The best yields were obtained with propachlor applied 3 times during the season at 5 lbs. per acre active ingredient, and the combination treatments of propachlor and CIPC or DCPA and DCPA plus Brominil applied twice during the season.

Taking into consideration weed control, plant injury, number of harvested bulbs, and weight of bulbs the best treatments were: with onions grown from sets propachlor or combinations of propachlor with CIPC or DCPA, CP 50144 or in combination with CIPC and M & B 14255. With onions grown from transplants propachlor or combinations of propachlor with CIPC or DCPA, CP 50144 or a combination of CP 50144 with CIPC and DCPA applied as a pre-emergence application.

Table 1. Weed control, number of plants and weight of bulbs of onions grown from sets under chemical treatments.

Treatment	Active Rate Lbs/A	Application Days From Planting	AVERAGE PER PLOT Weed Control 1-10	Number of Bulbs	Wt. Bulbs Lbs.
1. Nothing	---	---	9.0	81.3	11.0
2. M & B 14255-92	3	Post +18	2.5	87.2	15.1
3. Nitralin (Planavin)	2	Inc -0	1.8	41.8	6.7
4. "	3	"	1.3	28.2	3.3
5. DCPA	10	"	5.7	81.2	11.6
6. DCPA	10	Pre +1	6.5	91.7	12.0
7. DCPA & Brominil	10 & ½	" & Post +13	4.5	87.3	13.5
8. Propachlor (Ramrod)	5 & 5 & 5	" & Post +35 +58	1.0	89.0	16.6
9. "	10 & 5	" & Post +35	1.2	89.7	16.4
10. "	15	"	1.3	88.2	15.7
11. CP 50144 (Lasso)	2	"	5.5	85.2	11.3
12. "	2 & 2	" & Post +35	1.5	87.8	14.9
13. "	4	"	2.3	82.8	12.7
14. DCPA + Propachlor	10 + 5	"	2.2	88.5	14.8
15. Propachlor + CIPC	3 + 3 & 3 + 3 & 3 + 3	" & Post +35 +58	1.0	89.5	15.2
16. CP 50144 + CIPC	2 + 3	Post +18	2.7	82.0	13.0
17. DCPA + CIPC	10 + 3	"	6.7	86.7	11.9
Least Significant Difference 5%			1.5	8.2	1.8
" " " 1%			1.9	10.4	2.2

Table 2. Weed control, injury, number of plants and weight of bulbs of onions grown from transplants under chemical herbicide treatments.

Treatment	Active Rate Lbs/A	Application Days From Planting	AVERAGE PER PLOT Weed Control 1-10	Injury 1-10	Number of Bulbs	Wt. Bulbs Lbs.
1. Nothing	---	---	8.7	1.8	58.5	6.5
2. M & B 14255-92	2	Post +10	3.0	1.3	45.3	8.2
3. Nitralin (Planavin)	2	Inc -1	1.0	5.7	49.7	4.9
4. "	3	"	1.3	6.2	38.8	4.2
5. DCPA	10	"	4.2	2.0	50.7	5.1
6. "	15	"	4.3	1.7	55.5	8.7
7. "	10	Pre +1	2.7	2.5	61.7	10.0
8. DCPA + Brominil	10 + ¼	Pre +1 & Post +10	3.0	1.0	63.5	9.0
9. " "	10 + ½	" "	3.2	1.3	47.2	7.6
10. Brominil	½	Post +10	6.7	2.0	45.7	3.6
11. "	3/4	"	5.0	2.5	40.3	5.2
12. "	¼	Pre +1 Post +10 +37	5.3	2.5	52.8	7.3
13. "	½	" " " "	5.8	3.0	31.0	3.7
14. "	3/4	" " " "	5.2	4.8	26.3	3.1
15. Propachlor (Ramrod)	5	Pre +1 Post +37 +59	1.0	1.5	58.3	8.6
16. "	10 + 5	" " " "	1.0	1.5	63.3	12.2
17. "	15	Pre +1	1.3	2.7	59.2	8.8
18. CP 50144 (Lasso)	2	"	2.0	2.2	58.0	9.1
19. "	2 + 2	Pre +1 +37	1.3	1.7	59.3	8.9
20. "	4	Pre +1	2.0	1.7	53.7	6.0
21. DCPA + Propachlor	10 + 5	"	1.7	1.8	59.5	11.4
22. Propachlor + CIPC	3 + 3	Pre +1 Post +37 +59	1.3	1.3	54.7	11.3
23. CP 50144 + CIPC	2 + 3	Post +8	1.3	2.2	60.7	8.6
24. DCPA + CIPC	10 + 3	"	5.2	1.3	57.7	8.4
25. CP 50144 + DCPA	2 + 10	"	2.2	2.0	62.3	7.1
Least Significant Difference 5%			1.6	1.5	13.3	2.9
" " " 1%			1.9	1.8	16.0	3.5

WATER-SOLUBLE FILM FOR DISTRIBUTING HERBICIDES ACCURATELY IN SMALL-SCALE PLANTINGS[1/]

Vernon J. Fisher[2/]

A possible technique for applying herbicides on a small scale with greater accuracy than is feasible by spraying came about through the discovery of water-soluble plastic films. The technique consists of incorporating herbicides in the film during the manufacturing process, and unrolling the "herbicidal film" over new plantings, like strips of carpet. Once the film dissolves, the herbicide is deposited in place in precisely the desired manner.

This is a preliminary report on comparisons of films[3/] with sprays of the same herbicides. The films were of polyvinyl alcohol, 1.5 mils thick by 16 inches wide, containing either dacthal[4/] or diphenamid[5/]. In 1967 tests were made at four locations having widely different soil textures. Each plot contained strawberry, tomato, pepper, and snapbean. Dacthal and diphenamid were applied to separate plots, soon after transplanting. In 1968 tests were limited to strawberry at two locations (Table 1). Test No. 5 utilized 3 cultivars, 6 plants per plot, replicated three times. Test No. 6 utilized one cultivar, 6 plants per plot, replicated four times. In the 1968 tests dacthal was applied at transplanting time for early weed control with minimal chance of phytotoxicity; weeds were removed by hand, if any were present, at about four weeks after transplanting; and diphenamid was then applied to the same plots that had received dacthal earlier, in order to extend the control of weeds through most of the

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3/ Appreciation is due Mr. T. S. Bianco, Mono-Sol Division, Baldwin-Montrose Chemical Company, for supplying the films.

4/ Dimethyl-2, 3, 5, 6 - tetrachloroterephthalate.

5/ N, N - dimethyl - 2, 2 - diphenylacetamide.

season. A convenient way to apply the films is shown in Figure 1. A light covering of soil was needed to prevent film edges from rolling, and to hold the film in place until dissolved.

Herbicidal films usually controlled weeds almost as well in both years as corresponding sprays, and when inferior, the differences were not extreme (Table 1). A wide variety of annual weeds was present in adjacent untreated areas. Herbicidal film apparently affected soil structure, causing soil surfaces to be more friable. This may or may not be important. There was essentially no phytotoxicity at any time, except that in test No. 5 serious injury was observed 115 days after treating. The injury was just as severe for spraying as for herbicide film, and was attributed to a combination of unfavorable soil and moisture conditions.

It appears from these limited tests that water-soluble film provides an accurate method for distributing herbicides. Potential advantages are eliminating human errors involved in calculating, measuring, mixing, and applying sprays, and eliminating spray drift.

Figure 1. Herbicidal film being applied. A strip of film is in place to the right of the row of strawberry plants. Note tendency of film edges to roll, necessitating a light covering of soil.

Table 1. Comparison of film and spray applications of Dacthal followed by Diphenamid herbicides on strawberries (1968).

Test No.	Soil Type	Experimental Chronology	Percent weed control	
			Film	Spray
5	Loamy sand	Dacthal[1/] treatment at transplanting time; plus 25 days...	86	90 NS
		Surviving weeds removed by hand and Diphenamid[2/] applied 25 days after transplanting; plus 13 days.....	94	96 NS
6	Sandy loam	Dacthal[1/] treatment at transplanting time; plus 32 days...	90	96 NS
		Surviving weeds removed by hand and Diphenamid[2/] applied 32 days after transplanting; plus 80 days.....	79	99**

1/ 6 lb ai/A
2/ 4 lb ai/A
** t test significant at 1% level for comparing spray and film,
NS t test not significant at 5% level for comparing spray and film.

A COMBINATION LOGARITHMIC AND STEP-LOGARITHMIC SPRAYER FOR SMALL PLOTS

J. C. Cialone 1/

Abstract

The logarithmic sprayer, introduced in 1955, has become a valuable tool in the evaluation of herbicides. More recently the step-logarithmic sprayer has been adapted for field use.

A portable, hand operated sprayer has been developed which can be used for logarithmic or step-logarithmic herbicide applications to small plots.

With this equipment logarithmic applications are accomplished in the conventional manner. The result is the standard "log" plot in which dosage is continuously changing. Step-logarithmic applications, however, consist of discrete dosages being applied to plots in much the same way that single dosage applications are made. The unique aspect of step-logarithmic spraying is that many dosages can be generated from an initial dosage. The equipment utilizes the principle of serial dilution to change concentrations of chemical. This avoids separate measuring of chemical for each desired dosage. The mechanisms for accomplishing dilution are rapid and in most cases plots can be sprayed as rapidly as with standard logarithmic applications.

Extensive field testing during 1968 indicates that step-logarithmic applications are most useful where many dosages of a chemical are to be evaluated and also where combinations of chemicals are of interest. In addition it was found that step-logarithmic plots can be arranged in more effective experimental designs than can standard logarithmic plots and that they are easier to read.

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POISON IVY CONTROL ON CRANBERRY BOGS

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INTRODUCTION

The infestation of cranberry bogs by poison ivy (Rhus toxicodendron) presents the grower with a problem to which he has no adequate solution. Bog soils offer an environment that encourages vigorous growth of this weed. Consequently, in a matter of a few years poison ivy, if left unchecked, can completely cover a cranberry bog.

Because of its toxic properties, physical grubbing of poison ivy is somewhat hazardous. Thus, hiring people to work in this capacity is difficult and many times impossible. Finally, chemicals such as 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) which are used to control poison ivy, have to be applied at rates that severely damage and even kill cranberry vines.

In the present study good control of poison ivy--with no damage to cranberry vines--was achieved through the use of combinations of cultural practices and chemicals known to give partial control of poison ivy.

MATERIALS AND METHODS

Field studies. A cranberry bog heavily infested with poison ivy was chosen for testing. Part of the bog received a fall treatment of 2,6-dichlorobenzonitrile (dichlobenil-4% granular) applied at the rate of 4 lbs/A. Winter water was held late, a practice normally followed to extend the harvest date. In this study, however, winter water was held late to retard the development of the poison ivy plant. In the spring, plots 25 sq ft in area were staked out in both the dichlobenil-treated and the dichlobenil sections of the bog. Silvex was applied at 25 and 50 ppm alone and in combination with 100 ppm indole-3-acetic acid (IAA). The same concentrations of silvex were also applied in combination with 100 ppm gibberellic acid (GA). The herbicide 2,4,5-T was applied at 25 ppm alone and in combination with 100 ppm IAA or 100 ppm GA. All treatments--excluding dichlobenil--were applied during bloom and at a rate equivalent to 300 gal/A. All treatments were replicated 3 times.

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Residue analysis. Immediately after harvest treated and untreated berries were frozen and kept in this condition until analyzed for herbicide residue with a gas chromatograph. An Aerograph 204 with E.C.D. (250 mc titanium tritide) was used in the study. The column was prepared from a 6 ft length of 1/8 in stainless steel tubing and packed with 5% QF-1 on 60/80 mesh chromosorb W. regular. The column was operated isothermally at 165°C. The injection part and detector were both operated at 190°C. The flow rate of nitrogen (carrier gas) was set at 40 cc/min. The recorder chart speed was ½ in/min and peak areas were measured manually using a disc intergrator.

The following procedure was used in the extraction of silvex and 2,4,5-T residues from the berries. Thirty g of berries were ground in a semi-micro Waring Blendor for 2 min with 50 ml of double distilled acetone and 1 ml of 85% phosphoric acid. The pulp was filtered through a glass fritted funnel fitted with a thin layer of glass wool. Blendor and funnel were rinsed with a total of 50 ml of acetone. Pulp in the funnel was compressed to remove any remaining acetone. The filtrate was evaporated to 25 ml in a rotary evaporator. A 3 ml aliquot was then evaporated to dryness with an air stream. After a 3 ml volume of 10% BF_3 in methanol was added, the sample was placed in boiling water for 2 min. While in the boiling water the sample was continually agitated with the aid of a wrist shaker. After cooling to room temperature, 1 ml of distilled hexane was added and the resulting solution brought up to 10 ml with 10% $NaSO_4$. After a vigorous shaking for 20 sec, 5 microliters of the hexane layer were injected into the gas chromatograph.

Standard curves were developed for each herbicide with 0.2, 0.4, and 0.6 ml of a 0.25 ug/ml solution in acetone. The acetone was evaporated and the samples subjected to the same treatment as in the analysis of berries. Recovery tests, run at the 0.5 ppm level, were 69-76% efficient. All residue data presented in this study have been adjusted to agree with the recovery efficiency.

RESULTS

Without dichlobenil. In the absence of a fall application of dichlobenil only fair control of poison ivy could be achieved with silvex or 2,4,5-T (Table 1). In fact, silvex at a concentration of 25 ppm and applied at a rate equivalent to 300 gal/A, gave no control at all. However, silvex at 50 ppm and 2,4,5-T at 25 ppm did control poison ivy to a small extent. Control was significantly increased when IAA at 100 ppm was added to either the lighter or heavier application of silvex. On the other hand, GA at 100 ppm had little, if any, effect on the toxic efficiency of the silvex applications. No increase in control was observed when either IAA or GA was added to the 2,4,5-T treatments (Table 1).

Table 1. Effect of silvex and 2,4,5-T on poison ivy in a cranberry bog. Water was held late on the bog to retard the development of the poison ivy. Control is rated on a 1 to 4 basis with 1 representing excellent control, 2 good control, 3 fair control, and 4 no control.

Treatment (ppm)	No growth regulator	IAA 100 ppm	IAA 500 ppm	GA 100 ppm	GA 500 ppm
Control	4	4	4	4	4
25 silvex	4	2	3	3	2
50 silvex	3	1	3	3	1
25 2,4,5-T	3	3	4	3	2

With dichlobenil. Applications of either 50 ppm silvex or 25 ppm 2,4,5-T during bloom gave excellent control of poison ivy that had been pretreated with a fall application of 4 lb/A dichlobenil (Table 2). With the addition of dichlobenil only the lower concentration of silvex (25 ppm) failed to give complete control. However, 25 ppm silvex did give adequate if not complete control.

The effect of the addition of IAA and GA to the applications of 50 ppm silvex and 25 ppm 2,4,5-T could not be ascertained since both treatments gave excellent control in the absence of the growth regulators. However, IAA and GA did improve the effect of 25 ppm silvex on poison ivy (Table 2).

Table 2. Effect of silvex and 2,4,5-T on poison ivy in a cranberry bog. The bog received a fall treatment of dichlobenil and water was held late. Control is rated on a 1 to 4 basis with 1 representing excellent control, 2 good control, 3 fair control, and 4 no control.

Treatment (ppm)	No growth regulator	IAA 100 ppm	IAA 500 ppm	GA 100 ppm	GA 500 ppm
Control	4	4	4	4	4
25 silvex	2	1	2	1	1
50 silvex	1	1	3	1	1
25 2,4,5-T	1	1	4	1	2

Residue analysis. After harvest the berries were analyzed for silvex and 2,4,5-T residues. When silvex and 2,4,5-T were applied in the absence of GA and IAA no residue was found (Table 3). When the growth regulators were applied simultaneously with the herbicides minute residues of silvex and 2,4,5-T were detected. The suggestion here is that more of the herbicide is taken up by the plant when it is applied in combination with either IAA or GA.

Table 3. Residue, in ppm, from berries treated with silvex and 2,4,5-T. Analyses were performed on berries that were immediately frozen after harvest.

Treatment (ppm)	No growth regulator	IAA 100 ppm	GA 100 ppm
25 silvex	-	-	-
50 silvex	-	0.03	0.02
25 2,4,5-T	-	0.03	0.03

DISCUSSION

In this study several factors, which are innocuous to cranberry vines but which inhibit or in some way damage the poison ivy plant, were combined to give excellent control of poison ivy on cranberry bogs. The cultural practice of holding water late on cranberry bogs inhibits the growth of poison ivy. The chemicals dichlobenil, silvex, and 2,4,5-T, at the concentrations used in this study, all will damage but not kill poison ivy plants. However, when these factors are combined excellent control is achieved.

Several recent studies have shown that exogenously applied plant growth regulators can influence the uptake and direction of transport of materials in the plant (1,2,3,4,5). For example, the application of IAA to decapitated pea and bean plants has a marked stimulatory effect on the uptake and accumulation of C^{14}-sucrose and P^{32}-phosphate in the decapitated internode(1). The stimulatory influence of IAA on the uptake and accumulation of these compounds is enhanced considerably when it is applied simultaneously with GA (5). Devlin (3) has demonstrated that treatment of redtop grass (Agrostis alba L.) with IAA or GA increases its sensitivity to simazine. His findings suggest that the exogenously applied plant growth regulators stimulate an increase in the uptake and translocation of the herbicide.

The data accumulated in this study suggest that both IAA and GA enhance the herbicidal effect of silvex on poison ivy. This, again, may be due to an increase in herbicide penetration and distribution as a consequence of IAA or GA application. It is interesting to note that the only berries yielding silvex or 2,4,5-T residues were those treated simultaneously with the herbicide and the plant growth regulator.

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THE EFFECT OF DICHLOBENIL AND AMMONIUM SULPHATE ON THE GROWTH AND DEVELOPMENT OF LOWBUSH BLUEBERRY PLANTS AND WEED CONTROL IN LOWBUSH BLUEBERRY PLANTS

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One of the most difficult problems facing New Hampshire producers of lowbush blueberry (Vaccinium angustifolium Ait., and related species and hybrids) is weed control. The use of nitrogen fertilizer has become a necessity for maximum yields in fields that have been commercially operated for more than ten consecutive years. Because lowbush blueberries are poor competitors for nutrients, the addition of nitrogen fertilizer usually results in excessive stimulation of herbaceous (grassy and broad leaf) weeds and sedges, with little benefit to the blueberries. The weed control could result in less competition and perhaps in greater blueberry response under a fertilization program.

The objectives of this study were to evaluate the effects of dichlobenil G-4 on the growth and development of lowbush blueberry; to investigate the effects of dichlobenil G-4 on the control of herbaceous weeds in lowbush blueberry fields; and to study and observe any interaction between the herbicide and fertilizer combinations applied to lowbush blueberries.

Materials and Methods

Dichlobenil (Casoron) G-4, /2, 6-dichlorobenzonitrile/ was used at the rate of 5, 10, and 20 pounds active ingredient per acre.

Fertilizer used for this study was ammonium sulfate at the rate of 100 and 200 pounds per acre.

Preliminary greenhouse trials were conducted using flats containing blocks of soil populated with blueberry plants. Dichlobenil at the rate of 5, 10, and 20 pounds per acre and ammonium sulfate at the rate of 100 pounds per acre were applied in a random fashion separately and in combination. These treatments were applied after the plants had been exposed to several months of cold temperatures and after the tops were burned off. Several weeks later the flats were moved into the greenhouse, and visual evaluations were made of treatments.

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Three commercial lowbush blueberry fields were chosen for field trials. Two of the fields were burned in the spring before application of treatments and the third field was in the first crop year stage of growth. Dichlobenil was applied at the rate of 5 and 10 pounds a/i per acre and ammonium sulfate at the rate of 100 and 200 pounds per acre. Treatments consisted of each material applied alone and combined, thus resulting in nine treatments per block. Treatments were replicated and randomized three times per location. Each plot represented one four-hundredth of an acre.

Evaluation of treatments was made visually and by the following criteria: weed fresh and dry weight per square foot of plot, plant fresh and dry weight per square foot of plot, the fruit bud ratio (number of fruit buds per inch of stems), stem length per square foot of plot, and fresh and dry weight of blueberry fruit per square foot of plot.

Results

The results of the greenhouse trials showed that all rates of the herbicide were injurious to blueberry plants. This injury increased as the rate increased. Stunted growth, retardation and inhibition of stem development were observed. Herbaceous weeds were eradicated at the 20 pound rate but, at the 5 and 10 pound rate, certain herbaceous weeds were not controlled by the herbicide. The 5 pound rate provided inadequate weed control.

The results of the field trials showed that dichlobenil when applied in the late spring at the rate of 5 or 10 pounds a/i per acre, with or without fertilizer, is injurious to blueberry plants in the new burn year stage of growth under New Hampshire conditions. Injury showed up in reduced fresh and dry weights, in reduced stem lengths per square foot and in inhibition of stem development. Apparently, growth of the stem apical meristems originating from buds below the soil surface on new burn year plants is disrupted when coming into contact with the dichlobenil located in the upper layer of the soil. After first crop year plant stems are developed, no growing points contact the dichlobenil and no injury results. The addition of 200 pounds per acre of fertilizer to either rate of dichlobenil when applied to first crop year blueberries resulted in significantly better results than dichlobenil alone. Low organic matter content in the soil also appears to increase the activity of dichlobenil.

The fruit bud ratio of first crop year stems was not significantly affected by any of the treatments. The fruit bud ratio of new burn year stems was increased. This increase was interpreted as the result of stunted stems caused by the dichlobenil or of fertilizer stimulation of stems that developed in treated

plots receiving a light and uneven burning. This would affect the regrowth from buds originating from stems above the soil surface.

Table 1. The observed effect of dichlobenil and fertilizer treatment on injury to blueberry plants and weed control in the field trial.

Treat-ments	Dichlo-benil	Ammonium Sulphate	Injury to Blueberry Plants*		Weed Con-trol**
			Burn Year	First Crop Year	
1	0	0	0	0	0
2	5	0	5	0	6
3	10	0	9	0	8
4	0	100	0	0	0
5	5	100	4	0	5
6	10	100	8	0	7
7	0	200	0	0	0
8	5	200	4	0	4
9	10	200	8	0	7

* - 10 = 100% injury 0 = no injury
** - 10 = 100% control 0 = no control

There was no significant difference in blueberry fruit response to treatments of dichlobenil with or without fertilizer.

Except for certain perennial weeds which were found to be resistant to the herbicide (*Danthonia spicata* and *Panicum* sp.), at both 5 and 10 pounds a/i per acre significantly reduced the fresh weight of weeds per square foot. The 10 pound rate provides significantly better control than the 5 pound rate. Fertilizer appeared to reduce effectiveness of the herbicide.

Summary

This investigative work suggests that it would be safe to apply dichlobenil as high as 150 pounds of 4% granules per acre to first crop year or older lowbush blueberry stems.

The data inferred that fall application of the dichlobenil would probably give better weed control and perhaps less damage to the new burn fields.

Nitrogen fertilizer at 200 pounds per acre showed a definite increase in stem and bud growth for the second crop year. Nitrogen fertilizer did not show any increase in berry production or quality when applied in the first crop year.

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REPEATED ANNUAL APPLICATIONS OF HERBICIDES AROUND BEARING APPLE TREES

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The repeated application of herbicides in orchards is still a relatively new practice which must be fully evaluated with respect to its effect on the trees, weeds and soils.

In order to evaluate the effect of repeated applications of herbicides around apple trees, an experiment was started in 1964 in the orchards of the Fruit Research Laboratory at Biglerville, Pennsylvania, with the most promising herbicides available at that time. The trees were planted in 1957, and so were seven years old when the experiment was started and eleven years old at the end of 1968, when this phase of the experiment was concluded. Thus there were five years of cumulative treatments around the trees. The varieties consisted of McIntosh, Rome Beauty, Red Delicious and York Imperial.

The fourteen treatments as shown in Table 1 were, in most cases, applied each year from 1964 to 1968 inclusive. The exceptions were treatment numbers 4, 5, 8, 9 and 12, which were started in 1965 and continued to and including 1968. There were three replicates of two plots per replicate, making a total of six plots or tree areas for each treatment. A 6' x 6' area was sprayed around each tree. The treatments were applied with a hand gun and timed to deliver calculated amounts on each plot. As the trees in this experiment have now been pulled out, this phase of the experiment has been concluded and so justifies a terminal report.

The results of this experiment with respect to weed control obtained from the use of the various herbicides, as recorded in October, 1968, are presented in Table 1. Under the heading of Weed Control are two columns which show the results with and without the consideration of a late grass (fall panicum) infestation which later died back. The significance of the results in these two columns will be discussed later. Under the column marked "Disregarding fall panicum" is shown the excellent weed control that has been obtained from the use of the various herbicides throughout the season, with the exception of the single herbicide treatments of amitrol-T and paraquat which, while giving quite effective weed control early in the season, did not last throughout the season. The dalapon treatment only controls grasses but was used in this experiment as a basis for showing the beneficial effect to be obtained from this material when a second herbicide was added. The addition of simazine or diuron to amitrol-T, paraquat and as just indicated, dalapon, greatly increased the effectiveness of these three herbicides as compared to their

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performance when used alone. As these individual or combined herbicides have been continued each year, it has been noticed that their repeated use has given better weed control in successive years. This was especially noticeable in the case of the two pre-emergence herbicide materials - simazine and diuron - when used alone.

This year an important feature of two of these herbicides showed up towards the end of the season. In treatments 2 and 3, and to a lesser extent in 4, 11 and 14, a grass (Panicum dichotomiflorum) appeared in certain plots and to quite an extent covered these plots. Although the grass was dead at the time the final evaluation was made in October, the presence of a dead grass at this time of the year will cause a serious potential mouse haven for the winter months. All the plots with the late grass infestation received simazine as the entire or part of the treatment. On the other hand, treatments 5, 6, 7, 8 and 12, which included diuron, had no such grass infestation.

In addition to evaluating the effect of these continuous herbicide treatments on weed population, their effect on tree performance and foliage was also noted. As far as could be observed, there was no injury or beneficial effect on the growth, yields or foliage on any of the trees in the experiment, irrespective of varieties.

From the results of this experiment, it can be concluded that:

(1) Combinations of herbicides in most cases gave better weed control than when used alone.

(2) Weed control of effective herbicides improved with repeated annual applications.

(3) No visible injury to the trees could be observed after four and five years of repeated annual applications of the same herbicide(s) around the same trees.

Table 1 - Weed Control Around Bearing Apple Trees - 1968

Treatments No.	Materials	Rates (lbs.AI/A)	Weed Control (0-10)1/ Disregarding fall panicum	Considering fall panicum	No. plots with fall panicum
1	Amitrol-T	2.0	0	0	0
2	Amitrol-T +	2.0			
	simazine	4.0	9.8	6.2	4
3	Amitrol-T +	2.0			
	simazine +	4.0			
	dalapon	8.5	9.2	7.0	4
4	Simazine	4.0	7.2	6.7	1
5	Diuron	3.2	9.3	9.3	0
6	Amitrol-T +	2.0			
	diuron	3.2	9.9	9.9	0
7	Amitrol T +	2.0			
	diuron +	3.2			
	dalapon	8.5	9.9	9.9	0
8	Dalapon +	8.5			
	diuron	3.2	9.0	9.0	0
9	Check	-	0	0	0
10	Paraquat	1.0	0	0	0
11	Paraquat +	1.0			
	simazine	4.0	8.9	8.3	1
12	Paraquat +	1.0			
	diuron	3.2	9.4	9.4	0
13	Dalapon	11.0	0.2	0.2	0
14	Dalapon +	8.5			
	simazine	4.0	8.9	8.6	1

1/ Where 0 = no control and 10 = complete control or bare ground.

WEED CONTROL TRIALS WITH GROUND COVERS

Arthur Bing /1

Introduction

Ground covers are low growing ornamental plants used to cover areas where the use of grass is not practical or desirable. Typical situations are on a steep slope, in the shade or where a different landscape effect is desired. The ground covers are not only beautiful but also may prevent soil erosion. Some ground covers are fast-spreading herbaceous perennials, others are slow-growing herbaceous perennials or woody plants. Weed control is generally a problem until the desired ground cover plants become established and can shade out the weeds. Of course weed control is even more a problem with slow-growing plants. Although rapidly growing plants are desirable because of their quick take-over of an area, some may be difficult to control in certain garden situations. The landscape contractor or gardener can plant the ground cover plants closer together to hasten covering the ground but this greatly increases the cost. Weeds growing between the ground cover plants are unsightly and delay the establishment of the ground cover planting.

Landscape and home gardeners are interested in means of controlling weeds that are safe, effective and economical. Weed control methods used depend upon the weed population already in the soil. Perennial weeds should be controlled by herbicide treatments before planting the ground covers. Herbicides are not usually selective enough to control the perennial weeds and not severely injure perennial ground cover plants.

Research at the Cornell Ornamentals Research Laboratory and elsewhere have shown various herbicides to give control of weeds and to be safe on various ornamental plants. The herbicides showing most promise on other ornamentals were used in this study.

This investigation is concerned only with the control of annual weeds by treatments shortly before and after planting and with the tolerance of the ground covers to these treatments.

Materials and Methods

Annual grasses are the most troublesome weeds in ground cover plantings. Emphasis in this study was on herbicides that control seedling grasses. Preplant treatments of diphenamid, EPTC and trifluralin and postplant treatments of DCPA, diphenamid, simazine, trifluralin and a combination of diphenamid and simazine were used. The common name, chemical names and formulations used are shown in Table 1.

In the greenhouse, screening test preplant treatments incorporating diphenamid, EPTC and trifluralin in soil at several rates were made on garden soil in flats. Ground cover plants were planted in the soil immediately after treatment and then at weekly intervals for 4 weeks. The flats of plants and weeds were observed for crop tolerance and weed control.

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Table 1. Herbicides used on ground covers

Common Name	Chemical Name	Formulation
DCPA	dimethyl tetrachloroterephthalate	75% wettable powder
Diphenamid	N, N-dimethyl-2,2-diphenylacetamide	4% granular
EPTC	S-ethyl dipropylthiocarbamate	5% granular
Simazine	2-chloro-4,6-bis (ethylamino)-S triazine	4% granular
Trifluralin	a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	5% granular

In early spring in another small scale test, the most promising herbicidal treatments were applied to small plots outside. Granular herbicides were applied with the augur type spreader developed by Danielson (1). Liquid herbicides were applied with a 1 gallon stainless steel pump type sprayer with a flat spray nozzle.

In a subsequent large scale test, granular formulations of trifluralin 1.5 lb/A and 3.0 lb/A, diphenamid 4.6 lb/A, and EPTC 3.5 lb/A were applied to 24 x 19 foot plots on June 21, 1968 and the soil immediately rototilled to a depth of 3-4 inches. One June 24, just before planting, another plot received trifluralin 1.5 lb/A raked into the soil. All plots were planted on June 24 with the plants shown in Table 2.

Table 2. Ground cover plants used in this experiment

Common Name	Scientific Name
Carpet bugle	*Ajuga reptans*
English ivy	*Hedera helix*
Japanese spurge	*Pachysandra terminalis*
Myrtle	*Vinca minor*
Stonecrop	*Sedum album*

The pots of plants or clumps were set 1 foot apart with 3 feet between rows. There were 24 plants of each species in each treatment with no replications.

The English ivy, Japanese spurge and myrtle were from 3" pots and the clumps of carpet bugle and stonecrop were separations from a bench planting in a greenhouse. Weed growth was observed during the growing season and recorded on August 27. The crop growth was recorded September 23. A scoring system of 1 to 10 was used for measuring weed and crop growth. A rating of 1 was for dead or missing plants and a rating of 10 was for excellent plant or weed growth. A rating of 2-3 would show poor growth while 7-9 would indicate good growth. Thus a high crop rating and low weed growth rating would indicate an effective treatment.

The postplant treatments were applied on July 10. Each of the 2 replicates was 4 clumps of plants. The soil was moist and the weather cloudy. The treatments and rates are listed in Tables 4 and 5. The diphenamid and trifluralin granules were cultivated into the soil with a hand rake immediately after application. The simazine granules and DCPA sprays were not incorporated.

When a combination of diphenamid and simazine was used, the diphenamid was applied and incorporated before the simazine was applied. The area was irrigated when rainfall was not adequate for good crop growth. Weed growth was recorded

on August 27 and crop growth on September 23 after weeds were removed. The ground cover plants were left in the ground to observe the effect of the treatments on winter hardiness.

Discussion of Results

In the greenhouse and field tests, trifluralin incorporated in the soil before planting at rates up to 8 lb/A, the highest rate was used, was safe on the plants. However, trifluralin gave poor control of smallflower galinsoga (Galinsoga parviflora) especially at the lower rates. The small scale treatments with preplant soil incorporated EPTC showed poor tolerance of carpet bugle at the minimum rate of 3 lb/A. At rates of EPTC above 5 lb/A, all plants tested were adversely affected.

The larger preplant and postplant treatment experiments were in an area that had been treated with metham (sodium methyldithiocarbamate) the previous season. The metham had been applied with a chisel applicator giving good control of perennial weeds but it did not effectively control weed seeds on the soil surface. The predominant weeds in 1968 were purslane (Portulaca oleracea), redroot pigweed (Amaranthus retroflexus), lambsquarter (Chenepodium album), and smooth crabgrass (Digitaria ischaemum). These weeds were the result of ineffective fumigation at the soil surface plus seeds blown in by the wind or carried in by cultivation equipment.

All preplant treatments gave good temporary weed control. However, by August 27, as seen in Table 3, only the trifluralin at 3.0 lb/A gave satisfactory control of broadleafed and grassy weeds. Of the weeds coming into the plots, purslane and redroot pigweed were most numerous. Trifluralin and EPTC gave good control of crabgrass and various mustards. Diphenamid failed to control weeds for a long enough period in the treated area. EPTC was ineffective against purslane and redroot pigweed. Except for carpet bugle which grew very poorly in the EPTC 3 lb/A treated soil, all plants grew well in the various preplant plots.

The effectiveness of the postplant treatments on weed control is shown in Table 4 and the effect on crop growth in Table 5. A high rating indicates good weed or crop growth. A high crop and low weed rating indicate an effective treatment. All treatments were effective against the low stand of crabgrass and lambsquarter. Only DCPA at 20 lb/A, diphenamid 4.5 lb/A plus simazine 1.4 lb/A and simazine 2.8 lb/A were effective against all weeds. The higher rates of diphenamid, simazine and trifluralin were necessary for purslane control.

Crop tolerance to postplant applications of herbicides was very good. There was no clear indication of crop injury at the rates used. The diphenamid plus simazine combination gave the highest crop and lowest weed ratings. The DCPA at both rates was also effective and safe on plants. Diphenamid and trifluralin were safe on all crops but ineffective against purslane except at the highest rates.

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Table 3. Effect of preplant treatment (a) on weed growth (b)

Treatment		Weed Growth (c)				
Material	Rate lb/A	Purslane	Redroot Pigweed	Lambs-quarter	Mustards	Crab-grass
Trifluralin immediate preplant	1.5	7	2	3	1	1
Trifluralin early preplant	1.5	3	5	3	2	1
Trifluralin early preplant	3.0	3	2	2	6	2
Diphenamid	4.5	10	5	5	2	4
EPTC	3.5	5	6	3	1	1
Untreated		8	5	2	3	3

(a) Treatment - early preplant June 21, immediate preplant June 24 incorporated immediately after application.

(b) Observation - August 27, 1968

(c) Ratings on single plots per treatment - 1 no growth to 10 excellent growth

(d) Various crucifers not identified as to genus and species.

Table 4. Effect of postplant treatment (a) on weed growth (b)

Treatment		Weed Growth (c)				
Material	Rate lb/a	Purslane	Redroot Pigweed	Lambs-quarters	Crabgrass	All Weeds
DCPA	12	3	3	1	1	3
DCPA	20	2	2	1	1	3
Diphenamid	4.5	7	2	1	1	6
Diphenamid	7.5	7	5	1	1	7
Diphenamid	12.0	3	4	1	1	5
Diphenamid	4.5					
+ Simazine	1.4	2	1	1	1	2
Simazine	1.4	5	3	1	1	5
Simazine	2.8	2	1	1	2	2
Trifluralin	1.5	8	2	2	1	7
Trifluralin	4.5	6	2	2	1	5
Trifluralin	8.5	2	1	1	1	2
Untreated		8	5	2	3	8

(a) Treatment - July 10, 1968 - all diphenamid and trifluralin incorporated by raking immediately after treatment.

(b) Observation - August 27, 1968

(c) Average of 2 replicates - 1 no growth to 10 excellent growth

Table 5. Effect of postplant herbicides (a) on the growth of some ground cover plants (b)

Treatment		Ground cover growth (c)				
Material	Rate	English ivy	Japanese spurge	Carpet bugle	Myrtle	Stonecrop
DCPA	12	5	6	8	6	6
DCPA	20	6	7	8	7	7
Diphenamid	4.5	7	7	7	8	7
Diphenamid	7.5	8	7	8	6	7
Diphenamid	12.0	6	5	8	7	4
Diphenamid	4.5					
+ Simazine	1.4	8	6	7	9	9
Simazine	1.4	8	7	7	5	9
Simazine	2.8	6	5	7	8	8
Trifluralin	1.5	7	7	7	3	7
Trifluralin	4.5	9	8	8	5	3
Trifluralin	8.5	7	7	3	5	7
Untreated		7	5	7	4	5

(a) Groundcovers planted week of June 24, treated July 10, 1968

(b) Observations - September 23, 1968

(c) Growth ratings - average of 2 replicates of 4 plants - 1 dead or missing to 10 excellent growth.

HERBICIDE INCORPORATED HARDWOOD BARK MULCH FOR WOODY ORNAMENTALS

C. Haramaki, J. R. Nuss, and P. H. Williams[1/]

Changes in the lumber industry and techniques used at the saw mills have caused an accumulation of large quantities of tree bark at the mill. Restrictions on disposal methods have necessitated a search for possibly profitable uses for the bark by product. At the same time there has been an increased interest in plant care and garden maintenance from the point of weed control. Garden mulches can control weeds and chemical herbicides can give extended control of these weeds.

The objective of this experiment was to determine if oak bark could be used as a mulch to control weeds effectively either alone or in conjunction with chemical herbicides. The bark was treated with various chemical herbicides in an attempt to increase its effectiveness as a weed controlling agent around plants. Also of interest was the optimum thickness of mulch material for best weed control and plant response. It is hoped that an esthetically desirable mulch can be developed, which when treated with a herbicide will give an extended period of weed control with no plant injury.

Methods and Materials

The experimental area was on a Hagerstown silt loam located at the Agricultural Research Farm at Rock Springs, Pennsylvania. The land was plowed, cross-disked and then formed into beds which were four and a half feet wide; six inches high. The beds ran in an east to west direction. The test plots were four and a half feet by three feet and contained three ornamental plants. A split plot design with three replications was used for a total of 288 plots. Potted ornamental liners of *Forsythia* 'Spring Glory', and *Taxus media hunnewelli* were planted on June 14, 1968. One inch of water was sprinkler irrigated after planting and repeated as necessary.

Three herbicides at three rates of application plus a check was used.

Dichlobenil, 50W (Thompson-Hayward)	- 0, 1, 2, 4#/A.
Diphenamid, 50W (Upjohn)	- 0, 1, 2, 4#/A.
Simazine, 80W (Geigy)	- 0, 1, 2, 4#/A.

The oak bark was applied at the following depths: 0, 1, 2, and 3 inches. The herbicide was incorporated into the oak bark by spraying it on a given amount of bark while it was tumbling in a concrete mixer. The herbicides and bark were applied during the week of June 17-22, 1968. The weather during the week was partly cloudy with occasional showers and the day temperatures ranged in the 70's.

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Table 1. Effect of herbicide incorporated oak bark mulch on weed prevalence six weeks after application, 1968.

Herbicide	Depth of Oak Mulch 0"	1"	2"	3"
Dichlobenil				
Check	9.4	2.0	0.2	0.0
1#/A	1.6	0.9	0.0	0.1
2#/A	1.3	0.8	0.0	0.0
4#/A	0.7	0.1	0.0	0.0
Diphenamid				
Check	9.3	2.2	0.2	0.1
1#/A	2.2	1.2	0.4	0.0
2#/A	1.3	2.2	0.0	0.0
4#/A	0.8	0.4	0.1	0.1
Simazine				
Check	9.9	2.4	0.6	0.0
1#/A	0.3	1.4	0.1	0.0
2#/A	0.4	0.8	0.0	0.0
4#/A	0.1	0.2	0.0	0.0

Weed Prevalence

0 - No weeds
10 - 100% weed coverage

Table 2. Effect of herbicide incorporated oak bark mulch on the growth of *Forsythia* 'Spring Glory', 1968.

	Depth of Bark Mulch							
	0"		1"		2"		3"	
Herbicide	Height (inches)	Grade*	Height	Grade	Height	Grade	Height	Grade
Dichlobenil								
Check	10.2	1.8	18.6	2.8	20.5	3.3	17.7	3.0
1#/A	20.0	3.5	14.2	2.5	21.1	3.3	19.8	3.1
2#/A	23.0	2.7	17.8	2.4	22.1	4.0	19.5	3.3
4#/A	20.8	3.5	22.4	3.2	21.5	3.0	18.6	3.5
Diphenamid								
Check	12.3	2.2	14.1	2.1	16.5	2.6	15.7	2.7
1#/A	21.6	3.0	19.7	3.3	20.3	3.2	19.3	3.1
2#/A	21.3	3.2	18.1	3.0	20.4	3.6	18.2	3.1
4#/A	18.2	3.2	18.8	2.8	21.7	3.2	21.5	3.5
Simazine								
Check	10.1	2.0	15.6	2.6	18.6	2.6	16.7	2.8
1#/A	18.4	3.0	18.8	3.1	19.8	3.5	21.6	3.5
2#/A	20.5	3.2	18.6	3.4	19.0	3.2	19.6	3.5
4#/A	17.1	2.8	18.1	3.2	20.7	3.3	17.4	3.1

* - Grade

1 = Dead
4 = Well branched, dense growth

Table 3. Effect of herbicide incorporated oak bark mulch on the growth of *Taxus media hunnewelli*, 1968.

Herbicide	Depth of Bark Mulch 0" Height (inches)	0" Grade*	1" Height	1" Grade	2" Height	2" Grade	3" Height	3" Grade
Dichlobenil								
Check	9.8	2.8	9.4	3.1	8.8	3.6	9.4	3.0
1#/A	11.4	3.5	10.5	3.2	8.4	2.6	10.8	3.6
2#/A	10.5	2.7	11.6	2.7	8.4	3.5	7.7	2.5
4#/A	11.4	3.5	11.1	3.1	8.4	3.1	7.7	2.7
Diphenamid								
Check	9.5	2.7	8.0	3.0	9.1	3.0	7.4	3.4
1#/A	8.4	3.5	8.4	3.6	7.4	3.3	8.0	3.1
2#/A	9.0	3.5	9.7	3.5	9.5	3.2	8.5	3.0
4#/A	10.2	3.0	9.4	3.3	8.8	3.2	7.4	2.8
Simazine								
Check	9.8	2.7	8.1	3.7	8.0	2.7	8.7	3.4
1#/A	9.4	3.1	8.7	3.5	8.4	3.8	9.0	3.0
2#/A	9.7	3.2	10.0	3.1	9.5	3.4	6.7	2.6
4#/A	10.7	3.3	9.3	3.3	8.3	3.4	7.6	2.6

* - Grade

1 = Dead
4 = Well branched, dense growth

Results and Discussion

The plots were examined for weed growth on July 26, 1968. (Table 1) The check plots with neither herbicide nor oak bark mulch had extremely dense weed growth. The predominant weeds in the check plots were common lambsquarter, redroot pigweed, yellow foxtail, tumble pigweed, deer tongue grass, and giant foxtail. Less frequent weeds included Pennsylvania smartweed, common ragweed, shepardspurse, yellow woodsorrel, common purslane, and henbit. Oak bark with no herbicides gave fair weed control with an one inch application and excellent weed control with both the two and three inch applications. When dichlobenil was sprayed on the clean cultivated soil, fair to good weed control was obtained. When it was mixed with the oak bark, the weed control improved. With the one inch mulch the control was good and with the two and three inch mulch, the weed control was excellent. The weed control improved when either the depth of the mulch or the concentration of dichlobenil was increased. Both diphenamid and simazine had a similar response. In general when either the concentration of the herbicide, the depth of the mulch or their combinations were increased the weed control was increased.

The forsythias and yews were examined during the period of October 7-12, 1968 for plant height and quality (Tables 2 and 3). The height was measured in inches and the quality was based on the number of stems, lateral branches, color, vigor of growth and denseness of the plant. In the check plots where no herbicide or oak bark was applied the forsythia plants had the shortest height and the poorest quality. Plants in plots covered with untreated oak bark tended to have plants which were shorter and poorer quality, than those in plots with herbicide incorporated oak bark mulch. The forsythia in plots treated with dichlobenil and no oak bark had good growth. When dichlobenil was incorporated into the bark the plants in these plots had good growth except in those which were covered with one inch of oak bark which had been treated with dichlobenil at one and two pounds per acre. The plots treated with diphenamid either alone or incorporated in the oak bark mulch had forsythia with good growth. The plots treated with simazine either alone or incorporated in the bark also had forsythia with good growth. Initially the forsythia in the plots treated with simazine at 2 and 4 pounds per acre and no mulch had some injury but in general outgrew it. Yew plants in plots treated with neither herbicide nor oak bark tended to have poorer quality than those treated with herbicide, oak bark or both. The yews in plots with the combinations of the higher concentrations of herbicide and deeper mulch tended to be shorter and lesser quality.

Summary

Dichlobenil, diphenamid and simazine were applied to beds of *Forsythia* 'Spring Glory' and *Taxus media hunnewelli* either alone or incorporated in oak bark mulch. In general weed control was improved when either the concentration of the herbicide, depth of the mulch, or their combinations were increased. The plants in plots treated with either herbicide, oak mulch or both tended to be taller and of better quality than those in untreated plots.

WEED CONTROL IN LANDSCAPE PLANTINGS WITH DICHLOBENIL-LICORICE ROOT MULCH [1/]

By C. W. Dunham, T. A. Fretz and V. A. Rubin [2/]

Use of dichlobenil in licorice root mulch has been shown to be an effective method of weed control in small test plots(1). The experiment described in this paper was undertaken to determine if equally good results could be obtained in a large scale test where both the preparation of the herbicide-mulch and the application was handled by regular maintenance crews.

METHODS

Thirty-seven and one half pounds of Casoron 4G[3/] was mixed with 15 tons of licorice root mulch and spread to a depth of one inch over 8,425 sq. ft. of landscaped planting beds on the University of Delaware campus. This was calculated to have applied the dichlobenil at a rate of 7.85 lb. ai/A.

To prepare the mulch, the licorice root was placed in the body of a dump truck with a front end loader to a depth of 7 inches. A weighed amount of granular dichlobenil was then spread on top of the mulch with a granular spreader and mixed in with manure forks. The Casoron mulch was then dumped and the operation repeated. The mixed mulch was trucked to the planting beds, dumped in the beds with wheel barrows and raked to a uniform depth of one inch.

The mulch was mixed on March 28, and spread on April 1 and 2, 1968. At this date many grass and broad leaf weeds were several inches high.

The plant material treated consisted of a number of diverse species. All were landscape-size specimens that had been in place for at least two years and included the following:

1/ Contribution # 2, The Plant Science Department and miscellaneous paper #595 published with the approval of the Director of the Agricultural Experiment Station, University of Delaware.

2/ Associate Professor, Graduate Assistant, Department of Plant Science, and Superintendent of Grounds, respectively, University of Delaware.

3/ Trade name of dichlobenil, 4% active, supplied by Thompson Hayward Co.

Azalea cultivars
Berberis thunbergi
Carpinus betulus
Cedrus deodora
Cercidiphyllum japonicum
Chamaecyparis obtusa
Chionanthus virginicus
Cornus florida
Cotoneaster salicifolia 'Autumn Fire'
Crataegus sp.
Deutzia gracilis
Enkianthus campanulatus
Exocorda micrantha 'The Bride'
Hypericum sp.
Ilex opaca
Jasminium nudiflorum
Kalmia latifolia
Laburnum vossei
Leucothae catesbaei
Mahonia aquifolium
Nandina domestica
Oxydendron arboreum
Prunus serrulata
Pseudetsuga douglasii
Pyracantha coccinea
Rhododendron cultivars
Taxus cuspidata
Viburnum rhytidiphyllum
Zelcova serrata

In addition to observations of weed control, plants were checked periodically for symptoms of injury.

RESULTS AND DISCUSSION

Treated beds were essentially weed free for the entire season whereas untreated beds were filled with both grasses and broad-leaf weeds (Fig. I and II). One area treated with the Casoron mulch had a serious infestation of Bermuda grass, Cynodon dactylon, which was not controlled by the mulch.

Plant injury occurred on an appreciable number of plants of four species. Treated Hypericum plants developed a marginal tip burn early in the summer. These plants, however, appeared to outgrow the symptoms by the end of the summer. Treated plants of Deutzia gracilis developed a tip and marginal scorch late in the summer which persisted until leaf drop. Scattered plants of Exocorda, 'The Bride', Cotoneaster 'Autumn Fire' and Mohonia aquifolium all developed a marginal chlorosis late in summer. The extent of damage to these plants cannot be assessed until after bud break in 1969. None of the other treated plants evidenced any visual symptoms of adverse effects.

The results of the test were deemed highly satisfactory. It appeared that large scale mixing and application of a herbicide-mulch is a practical solution to weed control in landscape plantings.

REFERENCES CITED

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CONTROL OF ESTABLISHED WINTER ANNUAL WEEDS, DANDELION AND VETCH IN TAXUS

J. F. Ahrens[1/]

Although fall preemergence treatments are commonly used by nurserymen to prevent spring weed infestations, growers often are faced with the problem of established winter annual and perennial weeds in the spring. Common chickweed (Stellaria media L.) and annual bluegrass (Poa annua L.) are two winter annual weeds that may require costly hoe labor during the busy spring season (2). In recent years perennial vetches (Vicia Cracca L. and possibly others) and dandelion (Taraxacum officinale Weber) have become increasingly troublesome in nurseries. Once established both are resistant to many herbicides and they grow close to nursery stock, becoming so entwined that hand removal is necessary. In the work reported here we sought chemical means of controlling these weeds in Taxus.

Materials and Methods

Trials were conducted in cooperation with commercial nurserymen in Rocky Hill, Connecticut during the 1968 season, on Hartford sandy loam soils. The herbicides and additives tested are given in Table 1.

Test A was conducted in a stand of Taxus cuspidata capitata lined out at close spacings in 1966. In April 1968 the area was infested with common chickweed, annual bluegrass, dandelion, marshcress (Roripa palustris Bess.) and seedlings of lambsquarters (Chenopodium album L.) and groundsel (Senecio vulgaris L.). The treatments were applied with a calibrated knapsack sprayer in 50 gal of solution per acre or with an auger-feed granular applicator. The treatments were applied on April 8 and 9 over plots 6 ft wide (4 rows) and 20 ft long that were arranged in three randomized complete blocks. Visual ratings of weed control were made on April 30, May 17 and June 4. On June 7 the plots were weeded and then cultivated with a tractor. To evaluate residual weed control the plots were rated on July 23, weeded and cultivated on July 25 and rated again on September 7, 1968.

The first rain following treatment was on April 22 when .08 in fell. The first soaking rain was on April 24 (1.4 in). Rainfall was about normal in May (3.61 in), almost twice normal in June (6.36 in), one-third normal in July (1.11 in), and about half normal in August (1.55 in).

Test B was conducted in an established planting of 7-year-old Taxus cuspidata capitata. Vetch-infested Taxus were tagged to receive applications of dichlobenil or no treatment. Dichlobenil granules were applied by hand over a 2 ft x 2 ft area over the vetch-infested plants on December 13, 1967. Eighteen Taxus received a rate of 5 lb/A and 10 Taxus received a rate of 10 lb/A (5.2 and 10.4 grams of 4% dichlobenil per 4 sq ft respectively). Observations of vetch control were made the following May and June.

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Table 1. Herbicides and additives tested.

Common name or abbreviation	Chemical name(s)	Formulation(s)
simazine	2-chloro-4,6-bis(ethylamino)-s-triazine	Simazine 80W, 4G
diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	0.3% diuron on 0-10-30 fertilizer
CIPC	isopropyl N-(3-chlorophenyl)carbamate	0.5% CIPC on 0-10-30 fertilizer
diphenamid	N,N-dimethyl-2,2-diphenylacetamide	Enide 50W, 5G
dichlobenil	2,6-dichlorobenzonitrile	Casoron 4G
norea	3-(hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea	Herban 80W
trifluralin	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	Treflan 5G, ec
nitralin	4-(methylsulfonyl)2,6-dinitro-N,N-dipropylaniline	Planavin 6G
MH	1,2-dihydropyridazine-3,6-dione (maleic hydrazide)	MH-30
simazine + prometryne	2-chloro-4,6-bis(ethylamino)s-triazine + 2,4-bis(isopropylamino)-6-methylmercapto-s-triazine	5% simazine + 5% prometryne granules
GA	gibberellic acid	Gib-Sol
surfactant	dodecyl ether of polyethylene glycol	Surfactant WK
emulsifiable oil	with 1% Rohm and Haas 9D-207 surfactant	Sun Superior Spray Oil 11E

Results and Discussion

The herbicide treatments in Test A and the ratings of their effects on established weeds are given in Table 2. Their residual effects on weeds in July and September are given in Table 3. The herbicides differed greatly in their selectivity and speed of kill of the weeds, and in their persistence. Despite the absence of rainfall for 13 days following application, and the known volatility of dichlobenil (1), the initial kill of weeds with this herbicide was rapid and almost complete. Dichlobenil also was the only herbicide to kill established dandelions. By June, however, purslane (*Portulaca oleracea* L.) was beginning to invade the dichlobenil plots and in July, purslane and crabgrass (*Digitaria spp.*) were abundant in dichlobenil plots. Had rain fallen sooner after treatment longer control of weeds with dichlobenil may have been expected. Pearson and Kitchin (2) reported good control of summer weeds with applications of granular dichlobenil in November followed by rainfall 6 days later.

Table 2. Percentage control of established weeds with treatments on April 8-9.

Herbicide and formulation	Rate, a.i. lb/A	Chickweed			Annual bluegrass			All weeds		
		4/30	5/17	6/4	4/30	5/17	6/4	4/30	5/17	6/4
control		0	0	0	0	0	0	0	0	0
simazine wp	1	25	80	63	0	37	90	20	67	73
simazine wp + surf.	1 + 0.5%	73	95	85	23	80	90	37	80	86
simazine wp + oil	1 + 1 gal	67	80	75	30	82	95	57	87	80
simazine wp + GA	1 + 20 ppm	53	87	80	7	57	70	40	78	83
simazine wp + IN	1 + 3	43	77	75	7	47	93	33	78	88
simazine wp	2	43	90	80	3	80	99	33	80	87
simazine wp + surf.	2 + 0.5%	60	73	59	10	73	80	40	68	72
simazine wp + oil	2 + 1 gal	83	98	99	20	92	99	57	90	96
simazine wp + GA	2 + 20 ppm	60	93	95	13	77	92	40	88	95
simazine G	2	0	7	70	0	17	40	4	37	56
simazine G	4	10	30	90	0	33	93	17	57	88
simazine + prometryne G	1.5 + 1.5	17	80	93	0	50	75	13	72	88
diuron + fert.	1.5	7	47	57	0	37	40	4	52	45
CIPC + fert.	2	57	77	80	27	30	30	53	58	43
diphenamid wp	5	40	40	25	0	20	20	20	55	40
diphenamid G	5	0	67	40	0	58	48	7	60	57
trifluralin ec	3	43	40	50	0	0	20	33	37	30
trifluralin G	3	23	17	48	17	0	25	37	27	37
dichlobenil G	6	97	93	95	92	95	85	92	93	88
norea wp	5	97	98	99	83	99	99	87	95	92
nitralin G	3	0	0	0	0	0	0	0	0	20
Least significant difference	p=.05							27	27	33
	p=.01							36	36	44

Norea was second only to dichlobenil in speed of kill of chickweed, seedling lambsquarters and annual bluegrass, but it did not kill marshcress or dandelion. Weed control was unsatisfactory in July and September with norea applied in April.

The effectiveness of simazine in killing the established weeds varied greatly with the formulation and rate of application. Wettable simazine at 2 lb/A effectively killed most chickweed, annual bluograss and seedlings of lambsquarters and groundsel within 5 weeks. Marshcress was severely injured by June. With granular simazine at 2 lb/A kill of established weeds was poor

at all dates and at 4 lb/A kill was poor in May but good in June. Kill of chickweed, lambsquarters and groundsel was more rapid than kill of annual bluegrass.

Table 3. Percentage control of summer weeds with treatments in April.

Herbicide and formulation	Rate, a.i., lb/A	July 23 1/ Broadleaves	July 23 1/ Grasses	September 7 2/ All weeds
check		5	30	0
simazine wp	1	27	37	7
simazine wp + surf.	1 + 0.5%	75	60	27
simazine wp + oil	1 + 1 gal	40	53	0
simazine wp + GA	1 + 20 ppm	42	37	15
simazine wp + MH	1 + 3	50	70	0
simazine wp	2	84	80	17
simazine wp + surf.	2 + 0.5%	62	37	13
simazine wp + oil	2 + 1 gal	95	91	43
simazine wp + GA	2 + 20 ppm	76	90	25
simazine G	2	99	99	90
simazine G	4	99	99	92
simazine + prometryne	1.5 + 1.5	82	83	60
diuron + fert.	1.5	78	68	61
CIPC + fert.	2	20	43	15
diphenamid wp	5	75	68	20
diphenamid G	5	80	88	15
trifluralin ec	3	20	60	0
trifluralin G	3	80	93	35
dichlobenil G	6	47	10	0
norea wp	5	65	58	7
nitralin wp	3	92	95	86
Least significant difference	p=.05	34	38	31
	p=.01	46	51	42

1/ Predominant grasses - crabgrass and fall panicum; Predominant broadleaves - purslane, groundsel, pigweeds, dandelion

2/ Predominant weeds - purslane, crabgrass, common chickweed, lambsquarters, annual bluegrass

The addition of gibberellic acid, maleic hydrazide (MH), surfactant, or emulsifiable oil to the wettable simazine gave somewhat erratic results. Generally the speed of kill of established weeds was improved with the additives and simazine at 1 lb/A. However, the combinations of simazine with gibberellic acid were the only ones to produce noticeable injury to the Taxus, manifest in reduced growth. Combinations of wettable simazine with surfactant or oil deserve further attention for weed control in nurseries.

Although less effective on established weeds than wettable simazine, granular simazine was more persistent and controlled weeds more effectively in July and September following the June weeding. Granular simazine at 2 or 4 lb/A was the most effective herbicide during the summer with only dandelions and few crabgrass plants in the plots. These results with simazine wettable powder and granules on established chickweed and in residual qualities are consistent with experience.

The granular combination of simazine and prometryne killed established weeds faster but did not control summer weeds as well as granular simazine at the rates applied.

The treatments of diuron, CIPC, trifluralin, diphenamid and nitralin gave poor to fair control of established weeds in the spring but certain of these treatments persisted to effectively control summer weeds. In July, granules of diphenamid were slightly more effective and granules of trifluralin were significantly more effective than sprays on the soil surface in April. Granular nitralin was very effective in July and second only to granular simazine in September. Granular trifluralin and nitralin deserve further attention for early spring soil surface applications; possibly in combination with simazine.

Except for the combinations of simazine and gibberellic acid, none of the treatments seemed to affect growth of the Taxus.

Test B, while modest in scope, confirmed other observations on the effectiveness of dichlobenil in controlling wild vetch. Complete kill of vetch around a nursery plant is considered necessary to prevent reinfestation and hand removal. Twelve out of the 18 clumps of vetch surrounding Taxus plants were completely killed with dichlobenil at 5 lb/A. At 10 lb/A eight of the 10 treated clumps of vetch were completely killed. No injury to the Taxus was detected. Treating individual plants with granular dichlobenil during the late fall or winter is considered a practical means of controlling widely scattered perennial weeds in nursery stock. Timing of applications of dichlobenil to minimize surface losses could be an important factor in the success of spot treatments for the control of vetch (1). Spot applications of dichlobenil during the growing season by the grower at the Test B location generally were ineffective against vetch.

Summary

A number of herbicides were applied in April to control established weeds in *Taxus cuspidata capitata*. In June and again in July the plots were weeded

and cultivated and residual weed control was evaluated. In another test dichlobenil was applied in December over Taxus plants infested with wild vetch.

Rapid kill of established chickweed, annual bluegrass, dandelion, marshcress and seedling lambsquarters and groundsel was obtained with granular dichlobenil at 6 lb/A. Dichlobenil at 5 or 10 lb/A in December also gave satisfactory kill of wild vetch. Norea at 5 lb/A was very effective against established chickweed, annual bluegrass and seedlings of lambsquarters and groundsel. Granular simazine was ineffective against established weeds but gave the longest weed control after the established weeds were removed. Wettable simazine killed established weeds more rapidly but was not as persistent as granular simazine. Trifluralin also was more persistent when applied in granular form than when applied as a spray.

The addition of emulsifiable spray oil or surfactant to wettable simazine improved the speed of weed kill and warrants further evaluation. A combination of gibberellic acid and wettable simazine was the only treatment that caused injury to Taxus.

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CONTROL OF QUACKGRASS IN ESTABLISHED NURSERY STOCK WITH DICHLOBENIL

O. S. Johnson, W. J. Bennett, and J. R. Havis[1/]

Nurserymen in Massachusetts have been fighting a quackgrass problem in established nursery stock for years. Many of these growers operate a landscape service along with the nursery and labor is more profitably used in it rather than in manual weed control, consequently the nursery receives only intermittent attention. Even if time were available to properly cultivate the nursery, quackgrass would not be controlled because of its vigorous underground stems which sends up new plants with each cultivation. The vigorous mat of interlacing roots competes with the nursery stock for moisture and nutrients resulting in declining vigor of the plants. In addition, when plants are dug, quackgrass is also transplanted to the new location, becoming a problem in the landscape planting.

The purposes of these trials were to determine if Dichlobenil would control quackgrass in established nursery stock, at what rate, and to observe any damage to plants.

MATERIALS AND METHODS

Trial areas were established on three nurseries in Massachusetts, two in 1965 and one in 1966. These were located in Osterville, Springfield and Westfield. All plots were treated in late November and December since earlier work by the authors had determined that no control of any species of weed resulted from warm weather applications of Dichlobenil. All plots had a heavy quackgrass sod, and a scattering of miscellaneous weeds. Dichlobenil, 4% granules, was used at the rates of 5, 6, 7 1/2, and 8 lbs. of actual ingredient per acre. Simazine, 4% granules was used in two plots at the 5 lb. per acre rate.

Weed control ratings were based on 9.0 for perfect control, and 1.0 for no control. Ratings on the following table were made in late May 1967. However, evaluations of control were made for two years. During 1968, quackgrass was creeping in from the adjacent untreated areas.

[1/] Regional Nursery Agent, Barnstable; Regional Nursery Specialist, West Springfield; Professor of Plant and Soil Science, Amherst, Mass., respectively.

ocation	Herbicide	Rate a.i.a	Weed Control ave. rating	Nursery Stock Present	Plant Maturity
pringfield	Dichlobenil 4% GR	5 lbs.	6.5	Taxus sp.	Field plants
"	"	7½ lbs.	8.5	"	"
"	Simazine 4% GR	5 lbs.	5.0	"	"
"	Check	--	1.0	"	"
estfield	Dichlobenil 4% GR	5 lbs.	7.5	Pigmy Spruce	Nursery beds
"	"	7½ lbs.	9.0	Picea glauca conica Picea nudiformis	" "
"	"	5 lbs.	8.0	Juniperus pfitzeriana	"
"	"	5 lbs.	7.0	Flowering almond (white)	Stock plants
"	"	5 lbs.	7.0	Philadelphus virginalis	"
"	"	5 lbs.	6.5	Virburnum tomentosum	"
"	"	5 lbs.	8.0	Arbor vitae (Dark American) * (applied Dec. 13, 1966)	Field plants
"	"	5 lbs.	7.0	Arbor vitae (Dark American) * (applied Apr. 3, 1967)	Field plants
sterville	"	6 lbs.	9.0	(Rhododendron sp., Lilac,) (Taxus sp., and)	Field plants
"	"	8 lbs.	9.0	(Pieris floribunda)	
"	"	check	1.0	"	Field plants

Applied to compare fall and early spring applications

RESULTS AND DISCUSSION

Dichlobenil applied in December, on frozen or unfrozen ground, directly on the weed sod controlled quackgrass and other weeds for one complete growing season with no injury to established nursery stock.

A rating of 7.0 is considered commercially acceptable control. Dichlobenil 4% granules applied at the rates of 6, 7 1/2, and 8 lbs. of actual ingredient per acre gave nearly perfect control on all plots. Five pounds per acre did not result in commercial control on all plots.

Even though commercial control was achieved with an early spring application, the period of cold weather, following the disappearance of snow, is too short or even non-existant, for the grower to apply Dichlobenil and expect to get reliable control.

SUMMARY

Herbicide plot work and grower applications showed that Dichlobenil at the rate of 6 lbs. actual ingredient per acre applied just prior to freeze-up in early winter on the weed stubble, on established nursery stock, controlled quackgrass and most other weeds for a period of one year or more. No injury was observed to any of the nursery species tested.

CHEMICAL CONTROL OF CHICKWEED IN NURSERY CROPS

W.J. BENNETT; J.R. HAVIS; AND J. BARDZIK 1/

Chickweed (Stellaria media (L.) Cyrill.) has been a problem weed in Massachusetts nurseries for many years. Nurseries which have been following a program of fall weed control with granular Simazine have reduced the problem to some degree. Complete control of chickweed has not been accomplished with this type of program except in rare instances. It was felt that additional trials were needed to determine the effectiveness of several herbicides for chickweed control, and where feasible, to compare wettable powder and granular formulations.

Methods

Trials were established in a commercial nursery in Turners Falls, Massachusetts on November 30, 1967. Nursery plants included in the trial area consisted of two to three year old flowering crabs and maple species and five to six year old Taxus. The weed species present at the time of chemical applications were chickweed, (80% cover); annual bluegrass (20% cover); and a scattering of dandelions. No chemical weed control materials had been applied prior to these trials. The air temperature at the time of application was approximately 30°F. and the soil surface was frozen. The chickweed and annual bluegrass were well established and completely covered the trial area. It was assumed that the weeds were dormant at the time of application.

Treatments are listed in Table 1. The plot size was 200 sq. ft. and treatments were replicated three times. The soil was a fine sandy loam with reasonably high organic matter resulting from previous applications of poultry manure. Herbicide applications were made with a three gallon compressed air sprayer and a hand operated granular applicator.

Weed control ratings were based on 9.0 for perfect control, 7.0 for acceptable commercial control, and 1.0 for no control. Plots were evaluated and ratings were made on three occasions in March and April 1968.

Results

The effectiveness of various herbicides in the control of chickweed are shown in Table 1. Dichlobenil provided the most effective control of chickweed in these trials. In fact complete control was obtained. The wettable powder formulation of Simazine also gave very satisfactory control, while the granular Simazine provided less than acceptable control. The combination of Simazine and diphenamid in the wettable powder formulation gave satisfactory control although each was used at less than normal rates. CIPC granules gave acceptable commercial control, but were not as effective as the better materials.

1/ Regional Nursery & Floriculture Specialist, West Springfield; Professor of Plant Science, Amherst; Graduate Assistant, Dept. of Plant and Soil Science, Amherst, respectively.

TABLE 1. WEED CONTROL RATINGS OF LATE FALL APPLICATIONS OF SEVERAL HERBICIDES TO CONTROL ESTABLISHED CHICKWEED IN NURSERY PLANTS

Treatments (lbs. a.i./A)	Formulation	Average Weed Control Ratings March 26	April 4	April 9
1. Diphenamid 6 lbs.	50% W.P.	5.3 1/	7.0	6.7
2. Diphenamid 6 lbs.	5% Gr.	4.0	5.3	4.7
3. Simazine 2 lbs.	80% W.P.	5.6	6.7	8.0
4. Simazine 2 lbs.	4% Gr.	4.0	5.7	5.7
5. Simazine 1 lb. + Diphenamid 4 lbs.	80% W.P. 50% W.P.	5.3	7.3	7.7
6. CIPC 10 lbs.	5% Gr.	3.6	6.7	7.0
7. Dichlobenil 4 lbs.	4% Gr.	7.3	9.0	9.0
8. Check		1.0	1.0	1.0

1/ Weed control rating - 9.0 = perfect control; 7.0 = acceptable commercial control; 1.0 = no control

Diphenamid was included in these trials because a previous report (1) indicated effective control of established chickweed with the wettable powder formulation. Results of these trials showed that wettable diphenamid provided slightly less than acceptable commercial control. Granular diphenamid rated considerably lower than the wettable powder. In general the wettable powder formulations were superior to granulars in controlling established chickweed.

Ratings over a three week period beginning on March 26, 1968 showed improved weed control over the rating period. We assume that the herbicides had little effect on the chickweed during winter dormancy, and that the gradual improvement in control during the rating period was related to growth activity.

The weed control ratings in Table 1 refer only to chickweed although annual bluegrass and dandelion occurred in these plots. Dichlobenil gave complete control of both weeds. Simazine in both wettable and granular form controlled annual bluegrass but not dandelion. Other materials did not control these weeds effectively.

Summary

Trials were established in late fall 1967 to determine the effectiveness of several herbicides for the control of established chickweed in nursery plantings. Evaluations were made in early spring 1968. Dichlobenil granules provided the most effective control of all materials in these trials. Simazine wettable powder gave very satisfactory control although Simazine granules were much less effective. The combination of Simazine 1 lb. a.i./A + diphenamid 4 lbs. a.i./A in wettable powder formulation also resulted in satisfactory control. Several other herbicides including CIPC granules and diphenamid wettable powder resulted in acceptable commercial control but both were rated considerably lower than the better materials listed above. Wettable powder formulations were superior to granules in all cases where they could be compared.

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CONTROL OF DODDER IN POTATOES WITH DIMETHYL 2,3,5,6-TETRACHLOROTEREPHTHALATE

R. L. Schauer 1/

Dodder (Cuscuta spp.) causes tremendous losses in yields of potatoes in the Northeast. For several years, an application of dimethyl 2,3,5,6-tetrachloroterephthalate (DACTHAL® or DCPA) after dragoff has effectively controlled dodder infestations in potatoes grown on the Eastern Shore. On Long Island single applications of dimethyl 2,3,5,6-tetrachloroterephthalate were reported not to have controlled dodder in 1967 (4).

Experience has shown that dodder normally germinates in mid May on the Eastern Shore and in mid June on Long Island. Also, the potatoes on Long Island are harvested much later in the season and so the rows are ridged much higher than potatoes grown on the Eastern Shore. Obviously the differences in germination times and cultivation practices between the two locations are affecting the degree of control of dodder with dimethyl 2,3,5,6-tetrachloroterephthalate. Therefore, this study was conducted to determine the proper time of application of dimethyl 2,3,5,6-tetrachloroterephthalate for controlling dodder under Long Island cultivation regimes.

Methods and Materials

This study was conducted on the farm of Mr. Philip Karlin, Riley Avenue, Calverton, Long Island. Since Mr. Karlin had suffered severe yield reductions from a heavy dodder infestation the previous year, treatments were selected which were most likely to give control. Treated plots were 10 rows wide by 1100 feet long. The check plot was 6 rows wide by 1100 feet long. The large plot size was chosen because of the spotty but severe nature of the dodder infestations and also to prevent overlapping of dodder plants from treatment to treatment.

The potatoes (Katadhin) were planted on April 20, 1968. Drag off, first cultivation and layby cultivation were performed on May 11, May 27, and June 24, 1968, respectively. Table 1 lists the treatments and dates of application. The dimethyl 2,3,5,6-tetrachloroterephthalate was applied using 35 gallons of water per acre.

TABLE 1. Dates of application of dimethyl 2,3,5,6-tetrachloroterephthalate for control of dodder in potatoes, Calverton, Long Island.

Treatment	Lbs.a.i./A	Date of Application
1. After dragoff and	9	May 15, 1968
After layby	9	June 24, 1968
2. After first cultivation and	9	May 27, 1968
After layby	9	June 24, 1968
3. 2X rate after dragoff	18	May 15, 1968
4. 2X rate after layby	18	June 24, 1968
5. Check	0	-

1/ Technical Service Representative, Diamond Shamrock Corporation, Union, N. J.

Results and Discussion

Inspection of the field on June 24, 1968, revealed that dodder plants were present in both the check and treated plots. On July 1, dodder was found which had become twined about the potato plants in the check area. No established dodder was found in any of the treatments. Inspection of areas in the treatments where dodder was seen on June 24 revealed that these dodder plants had dried up and disappeared. Apparently, all treatments had prevented establishment of the dodder.

On August 13, 1968, a second evaluation was made. At this time the vines were mature, thus leaving much of the soil exposed. The results from this evaluation are presented in Table 2.

TABLE 2. Dodder and annual grass control with dimethyl 2,3,5,6-tetrachloroterephthalate in potatoes, Calverton, Long Island.

Treatment	lbs/a.i./A	No.spots/plot	Square feet Infested	Grass rating*
1. After dragoff and	9	2.5	92.5	9.5
After layby	9			
2. After 1st cult. and	9	1.5	50.0	8.5
After layby	9			
3. 2X rate after dragoff	18	7.0	478.0	9.0
4. 2X rate after layby	18	20.0	1200.0	7.0
5. Check		39.0	1468.0	5.0

The results indicate that split applications of dimethyl 2,3,5,6-tetrachloroterephthalate at either dragoff or first cultivation plus a second application after layby were most effective in controlling dodder under Long Island conditions. The high rates of dimethyl 2,3,5,6-tetrachloroterephthalate applied alone after either dragoff or layby were not very effective in controlling dodder, but did give satisfactory control of annual grasses.

Dawson (3) reported that whenever moisture and temperature were favorable, germination of field dodder (Cuscuta campestris) occurred throughout the growing season. Allred and Tingey (1) found that the maximum rate of germination occurs when dodder seeds are not at a depth greater than one-fourth inch.

Upon germination, the dodder seedling uses up the stored food reserves in producing a fine golden shoot about 4-5 inches in length. A rhytmic circumnutation of the dodder seedling begins very soon after germination. The tip revolves in a counter-clockwise direction about once every hour. Normally, the tip rotates until it twines about the potato plant. Once the dodder stem has encircled the potato stem, haustoria penetrate into the food-conducting tissues of the potato plant. Once this attachment has been made, the base section of the dodder stem shrivels up and the dodder plant loses all contact with the

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* 0 = no control and 10 = complete control.

soil (6). Pattee, et. al. (8) stated that after attachment, the dodder and its host behave in many respects as a single organism. Littlefield, et. al. (7) found that even when the metabolic activities of the host were limited, dodder continued to withdraw sugars from the host thus leading to great yield reductions.

Light plays an important role in the establishment of dodder. Shortly after emergence, the dodder seedlings respond to a single saturation by red light which causes the opening of a hook which resembles the hypocotyl hook of a bean plant. Continuous exposure to white light accelerates hook opening. Twining depends on a prolonged exposure to blue or far-red light. Without a terminal exposure to far-red light, the seedlings will undergo circumnutational movements, but they do not incline sharply and twine (5).

Field inspections revealed that dimethyl 2,3,5,6-tetrachloroterephthalate does not interfere with germination of dodder, but it does prevent the establishment of the plant. Danielson and Gentner (2) reported that dimethyl 2,3,5,6-tetrachloroterephthalate prevented dodder plants from undergoing circumnutation. Since the dodder plants could not twine about the potato plants, they died from lack of nourishment.

The dodder plants which became established and were present in the fields on August 13, probably germinated in mid July when the potato plants had matured thus exposing the soil surface. In addition, potatoes on Long Island are ridged quite high. The extreme slope of the ridges invites the leaching of dimethyl 2,3,5,6-tetrachloroterephthalate off of the ridge thus leaving untreated soil where dodder can germinate. The split applications insured that all of the surface soil contained a lethal dose of dimethyl 2,3,5,6-tetrachloroterephthalate.

Further work is anticipated next season to refine the use of dimethyl 2,3,5,6-tetrachloroterephthalate for dodder control in potatoes on Long Island.

Summary

Field tests were conducted to determine the best time of application of dimethyl 2,3,5,6-tetrachloroterephthalate to potatoes for the control of dodder under Long Island conditions. Results showed that applications of dimethyl 2,3,5,6-tetrachloroterephthalate at either dragoff or after first cultivation plus a second application after the layby cultivation gave commercial control. A discussion of the mode of action of dimethyl 2,3,5,6-tetrachloroterephthalate in controlling dodder is presented.

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Effect of Rates of DCPA, Diphenamid and EPTC for Weed Control in Potatoes

Arthur Hawkins[1]

DCPA and diphenamid (alone and in combination with DNPB) in spray formulations, and EPTC in a granular formulation were applied just after ridge-off in Katahdin potatoes. DCPA and EPTC were also compared in fields of Katahdin potatoes, applied just after ridge-off in one field, and when potatoes were 3-4" in another.

Materials and Methods

Commercial fields of Katahdin potatoes with a history of crabgrass and/or barngrass in the Connecticut River Valley were selected for test sites. The soil was fine sandy loam at location C and silt loam at location F.

At Farm C the chemicals were applied after ridge-off, just before emergence of potatoes. At Farm F, DCPA 75WP and EPTC 5G were applied following ridge-off and weeding when potatoes were 3-4 inches.

Spray formulations of the chemicals were applied with a 1 gallon hand sprayer equipped with a T-Jet Nozzle, at 100 gallons solution per acre rate on plots 3 rows wide x 12 feet long. EPTC 5G was applied with a Midget Duster and raked into the soil, depth 1½-2". Plots were replicated four times in randomized blocks.

The soil at both locations was moist at time of application of materials; rain occurred shortly after applications. July and early August were warm and dry. Irrigation was not applied at either location.

Yields were obtained on two rows x 8 ft. at location F. At location C the stand was poor; yields were taken on smaller samples.

Results and Discussion

1. Comparison of DNBP, diphenamid (with and without DNBP) and EPTC, Table 1.

A combination of 3 lbs. diphenamid plus 2¼ lbs. DNBP per acre, and EPTC at 4 lbs. per acre gave excellent control of crabgrass. They were superior to diphenamid at 3 lbs. per acre. Crabgrass control resulted in higher potato yields. However, yield differences were not statistically significant.

2. Comparison of DCPA and EPTC at location C, crabgrass problem, Table 2.

DCPA at 7½ pounds active per acre gave acceptable control of crabgrass. EPTC at 4 pounds per acre gave good control of crabgrass. Highly significant

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1/ Agronomist and Potato Specialist, University of Connecticut, Storrs, Connecticut

increases in yield were obtained from all treatments, over the untreated plots.

Excellent control of crabgrass in potatoes was obtained in 1963 with DCPA at 6 lbs. active per acre applied the day after DNBP had been applied preemergence to potatoes (1). Acceptable control of crabgrass in potatoes was obtained with 8 lbs. active DCPA per acre applied after the last hilling (2).

3. Comparison of DCPA and EPTC for barnyard grass control, Location F, Table 3.

DCPA gave poor control of barnyard grass even at the highest rate used, 9 lbs. active per acre; while EPTC at 4 lbs. active per acre gave good control.

Injury to Potato Crop.

During the early part of the growing season, growth of potatoes appeared slightly less vigorous on plots which received the higher rate of diphenamid at location C and to the higher rates of EPTC at both locations. Potatoes which received higher rates of DCPA were slightly less thrifty at location C.

There was a small reduction in yield from higher rates of EPTC as compared with the 4 lb. rate; these yield differences were not statistically significant.

Summary

In a comparison of rates of diphenamid, alone and with DNBP, and rates of EPTC 5G, applied late preemergence to Katahdin potatoes, excellent control of crabgrass was obtained with 3 lbs. diphenamid plus 2¼ lbs. DNBP per acre, and with EPTC at 4 lbs. active per acre. These treatments gave control of crabgrass superior to 3 lbs. of diphenamid alone per acre. DCPA at 7½ lbs. active per acre gave acceptable control of crabgrass.

DCPA and EPTC were applied for potatoes at the 4-inch stage following ridge-off and second weeding in a field infested with barnyard grass. DCPA gave poor control of barnyard grass at rates up to 9 lbs. active per acre, the highest rate used. EPTC gave good control of barnyard grass at 4 lbs. active per acre.

Potatoes treated with EPTC at 8 and 12 lbs. per acre were slightly less vigorous early in the season as compared with those which received 4 lbs. EPTC per acre. Slightly lower yields were obtained to higher rates of EPTC, but the yield differences were not statistically significant.

Literature Cited

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Table 1. Effect of Diphenamid (alone and with DNBP), DNBP, and EPTC Applied After Ridge-off Preemergence to Potatoes on Crabgrass Control and Yield of Katahdin Potatoes - Location C[1/] - Connecticut - 1968. Season Wet until late June followed by Hot and Dry. No Irrigation.

Chemical	Active lbs/A	Crabgrass[2/] Control	Crop Rating[3/] 7/23/68	Yield[4/] cwt/A above 1½"	Yield[4/] cwt/A above 1 7/8"
0	0	1.0[2/]	10	145	116
DNBP	3	4.3	10	162	143
Diphenamid	2	7.3	10	188	164
"	3	8.6	9	179[5/]	158[5/]
Diphenamid plus DNBP	2 1½	9.0	10	189	165
Diphenamid plus DNBP	3 2¼	9.9	8	192	167
EPTC 5G	4	9.6	10	172[5/]	155[5/]
"	8	10.0	8	169[5/]	150[5/]
L.S.D. .05				NS	

1/ Plots 3 rows wide x 12 ft., replicated 4 times. Late planted. Rows ridged-off 6/23/68. Treatments applied 6/24/67. EPTC 5G raked in 1½ inches.

2/ Weed rating: 10 = complete control; 7 = acceptable; 3 = poor control; 1 = medium to rank crabgrass, 50-80% coverage 9/25/68.

3/ Crop rating: 10 = no effect; 0 = complete kill.

4/ Sampled two middle rows x 8 ft. Sampled shorter areas where stand not good.

5/ 3 reps only.

Table 2. Effect of DCPA Applied on Soil Surface and EPTC 5G Incorporated[3/], Applied Late Preemergence to Potatoes on Crabgrass and Yield - Location C[1/] - Connecticut - 1968. Season: Wet until late June followed by Hot and Dry, no Irrigation.

Chemical	Active lbs/A	Crabgrass[2/] Control	Crop[4/] Rating 7/23	Crop[4/] Rating 8/29	Yield[5/] cwt/A above 1 1/2"	Yield[5/] cwt/A above 1 7/8"
Control	0	1.0[3/]	10	10	130	109
DCPA 75WP	6	6.3	10	10	190	173
	7½	7.0	9	9	166	152
	9	7.2	9	9	182	170
EPTC 5G	4	9.6	10	10	209	181
	8	10.0	9	10	203	187
	12	10.0	8	10	198[6/]	186[6/]
L.S.D. .05					38.6	
.01					52.7	

1/ Plots 3 rows wide x 12 ft., replicated 4 times. Late planted. Rows ridged-off 6/23/68. Treatments applied 6/24/67. EPTC 5G raked in 1½ inches.
2/ Weed rating: 10 = complete control; 7 = acceptable; 3 = poor control; 1 = medium to rank crabgrass, 50-80% coverage 9/25/68.
3/ Moderate to heavy stand of crabgrass 50 to 80% coverage 9/25/68.
4/ Crop rating: 10 = no effect; 0 = complete kill.
5/ Sampled two middle rows x 8 ft. Sampled shorter areas where stand not good.
6/ 3 reps only.

Table 3. Effect of Spray Formulation of DCPA[1/] Applied on Soil Surface[2/] and EPTC 5G Incorporated[3/] for Katahdin Potatoes Post Emergence (4") on Barnyard Grass Control and Yield -- Location F -- Connecticut - 1968. Season Wet until late June, followed by Hot and Dry. No Irrigation.

Chemical	Active lbs/A	Barnyard Grass Control[4/] 9/30	Crop Rating[5/] 7/10	Yield[6/] (Total) cwt/A
Control	0	1.0[4/]	10	209
DCPA 75WP	6	3.5	10	211
	7½	5.0	10	234
	9	5.5	10	212
EPTC 5G	4	9.8	10	222
	8	10.0	10	217
	12	10.0	8	213
L.S.D. .05				NS

1/ DCPA = dacthal
2/ Rows "ridged-off" some time previously. Rain 6/10 to 6/14. Weeder and hand rake used to eliminate established weeds prior to treatment on 6/15.
3/ Granules raked in to depth of 1½-2".
4/ Weed rating: 10 = complete control; 7 = acceptable; 3 = poor control; 1 = moderate to heavy barnyard grass.
5/ Crop rating: 10 = no effect; 0 = complete kill.
6/ Yield on 2 rows x 8 ft., 4 reps. Plots 3 rows x 12 ft. were replicated 4 times in randomized blocks. Season dry, no irrigation.

THE CONTROL OF WILD RADISH AND OTHER ANNUAL WEEDS IN KATAHDIN POTATOES (1968) 1/

R. S. Bell and W. R. Hillebrecht 2/

Introduction

Wild radish (Raphanus raphanistrum L.) is a cold-tolerant annual weed which grows rapidly in late spring and early summer so that it competes with potatoes early in the season. It suppresses other annual weeds until late July when it ripens. Other annual weeds may appear by mid-August. A second crop of wild radish occurs where potatoes are dug in late August and the first week of September. This late crop of radish starts flowering by October 1 and lasts through several frosts.

Recent research papers (1, 2, 3, 4) indicate that a few new herbicides provide all-season control of annual weeds in Irish potatoes. Two most often reported are linuron and patoran. Preemergence herbicides applied after planting but before the potato sprouts show are generally most satisfactory.

Materials and Methods

The soil in the experimental area is Bridgehampton silt loam and was cropped to potatoes in 1966 and 1967. Previous to that it was occupied by a silage corn-alfalfa hay rotation. Past observations indicated that there was a large reserve of wild radish seed in the soil.

Ammonium nitrate at 120 lb/A was spread on the rye cover crop before plowing. As the potatoes were being planted on April 23, a low chloride 10-10-10-2 fertilizer was banded along the rows at the rate of 2000 lb/A.

The plots were four rows (12 feet) and 36 feet long. There were four blocks and the treatments were randomized within blocks. All treatments were applied on May 6 and 7 before the potato sprouts emerged from the soil, with the exception of RP 17623 which was not received until after the sprouts were up and one treatment of SD 15418 (80W). They were applied June 6. Two-gallon, pressure-controlled knapsack sprayers delivered the herbicide at the rate of 50 gallons per acre. The SD 15418 preparations were incorporated into soil by a wooden hay rake.

The herbicides used, the amounts of active ingrediant per acre, weed control ratings and yields of US #1 tubers are shown in Table 1. The chemical names of the herbicides and the manufacturers are presented in the Appendix.

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[1] Contribution No. 1296, Agricultural Experiment Station, Kingston, R.I. 02881.

[2] Professor and Graduate Student, respectively, Department of Agronomy and Mechanized Agriculture.

Table 1. The control of wild radish and other annual weeds in Katahdin potatoes (1968).

Herbicide	Active ingredient lb/A	Yield cwt/A	Wild Radish control 7/3/68	Other annual weeds 8/6/68
Maloran	3	283 a*	10.0 a**	9.6 a**
Linuron + Atrazine	1 + 1	273 ab	9.9 a	9.3 ab
M + B 14255	4	269 ab	10.0 a	8.4 abc
Linuron + Atrazine	1 + 1.5	265 ab	9.9 a	9.5 a
SD 15418 (80W)	2	258 ab	9.9 a	8.4 abc
SD 15418 (80W)	3	250 abc	9.8 a	7.6 bc
Linuron + Patoran	1 + 1	248 abc	9.9 a	9.3 ab
SD 15418 (pre) WEL)	3	245 abc	9.8 a	8.3 abc
M + B 14255	2	244 abc	9.7 a	8.9 ab
Patoran	2	244 abc	9.9 a	9.5 a
Maloran	2	241 abc	7.5 bc	8.8 ab
Atrazine + Patoran	1 + 1	240 abc	10.0 a	9.8 a
Linuron	2	237 abc	9.9 a	8.8 ab
Atrazine	2	223 abc	9.7 a	9.1 ab
Hand-hoed check	-	212 bc	8.4 ab	8.1 abc
SD 15418 (80W)	4	186 c	10.0 a	8.4 abc
CP 44939	4	185 c	6.0 cd	5.0 d
RP 17623	1	183 c	7.0 bc	6.9 c
SD 15418 (post)(WDL)	3	121 d	8.8 ab	2.2 efg
CP 44939	1	116 d	3.7 de	1.5 fg
CP 44939	2	108 d	5.6 d	1.5 fg
SD 15418 (gran)	4	106 d	9.8 a	3.0 e
SD 15418 (gran)	3	101 d	9.8 a	3.2 ef
Check	-	38 e	1.0 e	1.0 g

*Data having letters in common are not significantly different at the 5% level by Duncan's multiple range test.

**(10 = complete weed control, 1 = no control)

Except for the hand-hoed check, the potatoes were not cultivated. None of the potatoes was hilled. The checks were hoed on June 14, 27 and July 10.

Results and Discussion

During the early part of the growing season wild radish was the dominant weed. When the radish ripened off in late July a few other annual weeds such as red rooted pigweed and lambsquarters appeared in some plots.

All herbicides produced adequate control of wild radish excepting the CP 44939 compounds, RP 17623 and maloran at 2 lb/A. By mid-August there was little difference between the weeds on the plots receiving the lower rates of CP 44939 and the checks. The granular preparation of SD 15418 and the post-emergence of SD 15418 (80W) also permitted a heavy growth of weeds after mid- July. Consequently, yields from these treatments ranged from 121 to 101 cwt/A, which was significantly lower than yields from all other treatments excepting the control. These untreated check plots averaged only 38 cwt/A of US #1 tubers compared to 212 cwt/A from the hand-hoed checks.

The named herbicides, atrazine, linuron and patoran produced yields statistically comparable to the hand-hoed checks. Maloran at 3 lb/A produced the highest significant yield, 283 cwt/A. Experimental herbicide M + B 14255 and the lower rates of SD 15418 (80W) also had yields in this higher range. These herbicides alone or in various combinations produced acceptable, all season control of wild rasish and other annual broadleaved weeds.

Among the herbicides which still averaged better than 90% weed control on August 6 were maloran at 3 lb/A, linuron + atrazine at 1 + 1 and 1 + 1.5 lb/A, linuron + patoran at 1 + 1 lb/A, patoran at 2 lb/A, atrazine + patoran 1 + 1 and atrazine at 2 lb/A. The yields from all these treatments were statistically comparable to the hand-hoed checks and the yields were 283 cwt/A, 273 cwt/A, 265 cwt/A, 248 cwt/A, 244 cwt/A, 240 cwt/A and 223 cwt/A, respectively.

Summary

Wild radish and other broadleaved annual weeds were controlled from May until mid-August by 2 lb active ingredient per acre of the following herbicides, atrazine, linuron and patoran. Combinations of any two of these herbicides at one lb ai/A were also effective. Maloran at 3 lb ai/A, and SD 15418 at 2 or 3 lb ai/A were also effective. Yields from each of the above treatment were comparable statistically to those from the hand-hoed checks.

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Appendix

Material	Chemical Name	Company
Atrazine(80W)	2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine	Geigy
Linuron(50W)	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	DuPont
Maloran(50W)	3-(4-bromo-3-chlorophenyl)-1methoxy-1methylurea	Ciba
Patoran(50W)	3-(p-bromophenyl)-1-methyl-1-methoxyurea	Ciba
CP 44939(4 lb/gal)	6'-*tert*-butyl-2-chloro-N-(methoxymethyl)-*O*-acetotoluidide	Monsanto
M+B 14255(50W)		Chipman
RP 17623(3.4 lb/gal)	2-tertiobutyl-4-(2,4-dichloro-5-isopropyloxyphenyl)-5-oxo-1,3,4-oxadizole	Chipman
SD 15413 (80W)	2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile	Shell
SD 15413 Gran(10%)	" " "	Shell
SD 15413 WDL(4 lb/gal)	" " "	Shell

1968 PRE-EMERGENCE WEED CONTROL EXPERIMENTS IN WHITE POTATOES ON LONG ISLAND[1/]

Daniel H. Fricke [2/]

Introduction

Although a number of potato herbicides are available to potato growers, some weed species continue to escape control and appear to be becoming more serious where the same herbicide is used annually. On Long Island potato growers continue to use a relatively large number of tillage treatments whether or not a chemical herbicide has been applied. These usually include a cultivation and harrowing at drag-off, two cultivations with or plus weedings, and three or four additional cultivations or hilling treatments. A question needing attention is, with currently available herbicides can the usual amount of tillage be reduced and still obtain adequate weed control, and would fewer cultivations improve yield by less damage to potato roots?

Experiments were conducted in 1968 to determine possible effect of amount of tillage on potato yield in the absence of weeds, to evaluate weed control and yield in potatoes with herbicides comparing varying amounts of tillage, and to compare newer pre-emergence herbicides for crop safety and weed control.

Procedure

The experiments were conducted at the Long Island Vegetable Research Station and on a commercial farm where rather heavy weed populations existed. At all locations the Katahdin variety was planted in 34 inch rows on Sassafrass sandy loam soils. Fertilization was standard for the area, i.e., 3000 lbs. 6-12-6 in bands plus 40 lbs. actual nitrogen as a sidedress or applied to the rye cover crop the preceeding fall.

Procedure used for evaluating weed control was to use a rating scale of 1-9. One being no weed control, 7 commercially acceptable and 9 no weeds present.

Experiment I

Potatoes were planted April 1. Three tillage treatments were compared in plots 4 rows wide and 60 feet long in a random block design. The tillage treatments compared in 4 replications were "A"-standard; "B"-somewhat limited and "C"-hilling at

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emergence with no further cultivation. Eighty pounds of 5% granular Eptam was applied to all plots and cultivated in prior to emergence on May 1. The "A" plots were hilled just prior to emergence and the "B" and "C" treatments as listed in Table I. All plots remained essentially weed free. Potatoes were harvested from a 30 foot section of one of the inner rows of each plot to determine yields and are also listed in Table I.

Results

Yield differences between treatments were not significant, however there was a trend toward higher yield with the "C" or minimum tillage treatment. No cultural problems were encountered with the early hilling in this trial where weed population pressure was very low and no differences due to tillage treatment were observed in amount of Rhizoctonia lesions on potato plants or greening of tubers.

Table I - Time and Number of Tillage Treatments on Potatoes and Effect On Yield In The Absence of Weeds.

Treat-ment	Date 50% Emergence	Drag-Off and Eptam	Culti-vation(s)	Hilling	Yield Cwt./A US#1 Size A
A	May 10	May 1	May 10 May 24 June 5	June 18	363
B	May 10	May 1	May 10 May 24	June 5	366
C	May 18	May 1	---	May 7	417 N.S.

Experiment II

Potatoes were planted by the grower April 25 and following 1 inch of rain on May 11 were lightly harrowed on May 13 to allow the soil surface to dry. Three tillage treatments similar to those outlined in Experiment I were compared along with 9 herbicide treatments as listed in Table 2. A factorial design with five replications was utilized. Plots were 4 rows wide and 30 feet long. On May 16 herbicides were applied in 44 gallons per acre of spray at 30 psi with a tractor mounted sprayer having a 4 row boom. All treatments requiring incorporation immediately tilled with a 4 row weeder, the entire experiment was cultivated and the "A" tillage treatments were than hilled. Finally all surface pre-emergence herbicide treatments were applied. The "B" tillage treatments were cultivated on June 4 and hilled on June 15. The "A" tillage treatments were cultivated on June 4, 15 and hilled on June 24, similar to a

normal tillage program on Long Island. Plots were rated for weed control on June 15 and September 4. Potatoes were harvested on September 24 from one of the two center rows in each plot and graded to determine yield. A rye cover crop was planted and stand rated on November 11 for any carry over effect of the herbicides. The most common weed was barnyard grass, but also present were smart weed, mustard, lambsquarters, ragweed, crabgrass and fall panicum. Herbicide and tillage treatments, weed control and yield are listed in Table II.

Results

A heavy weed population was present in the Experiment II area. Weed pressure of this sort on herbicides would be found only in the worst commercial situations. Under these conditions none of the herbicide treatments tested gave acceptable weed control of both broad-leaves and grasses in the C tillage treatments, where no tillage occurred after potato emergence. Eptam came the closest however, lacking adequate control only of broadleaf weeds.

A summary of mean yield and weed control for the three tillage treatments is presented in Table III. Significant differences in crop yield were obtained between the three tillage treatments. There was no significant difference in weed control between the A and B tillage, but a large difference was observed between the C treatment and the other two.

In Table II, there were significant differences in both yield and weed control ratings between herbicide means. Mean yields were significantly better than the check with Eptam and the Diphenamid-Linuron combination. Mean broad-leaf weed control was significantly better than the check with all herbicide treatments except the two lower rates of trifluralin. In control of grasses only the diphenamid-dinitro combination failed to give weed control significantly better than the check.

In examining the weed control obtained with each herbicide treatment between the A and B tillage levels, the weed control was not significantly different between the A and B tillage treatments for individual herbicide treatments, except Linuron where control of grasses was superior with the B tillage. Although not significant, control of grasses with most chemicals was slightly better in the B rather than the A or maximum tillage program.

The only chemical herbicide treatment which provided adequate commercial control of both grasses and broadleaf weeds at both the A and B levels of tillage was Eptam at 6 pounds. Other treatments which were rated close to adequate

control of both grasses and broadleaf weeds at both the A and B levels of tillage were trifluralin at 0.75, 1.0 and 2.0 pounds and the diphenamid-linuron combination adequately controlled broadleaf weeds but fell down in grass control in either or both the A and B tillage.

Comparing herbicides in the C tillage treatment, all three rates of trifluralin controlled grasses, but fell down severely on broadleaf weeds, particularly ragweed and mustard. Diphenamid was weak on both grasses and broadleaves. Linuron controlled broadleaves fairly well but missed grasses as did the diphenamid-dinitro combination.

Stand of rye cover crop planted after potato harvest was reduced in the treatments that included diphenamid at 2 pounds.

Experiment III

In this experiment newer chemicals incorporated at drag-off or applied pre-emergence were compared with standard herbicides. Potatoes were planted on a commercial farm by the grower on April 25. Planting ridges were harrowed off on May 14. Weed control treatments listed in Table IV were applied on May 16 and 17. Spray formulations were applied in 38 gallons water per acre at 30 psi with a tractor mounted 2-row boom sprayer. Granular formulations were applied with a hand held double funnel gravity applicator. Incorporated treatments were applied and tilled first by a 2-row weeder and then tractor cultivator. The remaining pre-emergence treatments were then applied. A randomized block design was used with individual plot size two rows wide by 30 feet long, with five replications. A number of showers totaling about one inch occurred during the following 6 days. On May 23, with approximately 30% of the potatoes emerged, some damage was noted. Daxtron at 6 oz. and 12 oz. and the granular combination of linuron 1.5 plus randox 0.5 both caused some chlorosis and stunting of potato plants. The symptoms remained on June 20 with the 12 oz. rate of Daxtron and the linuron-randox treatments. Normal tillage and other cultural practices were continued for the season by the grower. Weed control was rated on September 4.

Results

The amount of weeds present in this experiment was much less than in Experiment II. Smartweed, lambsquarters and crabgrass were the primary weeds present, with only a light population of panicum, ragweed and barnyard grass.

In this experiment with only a moderate amount of annual grass type weeds present the following herbicide treatments applied at drag-off, with normal tillage during the remainder of the season provided acceptable commercial weed control; Maloran 4 lbs. as a granular, Patoran 2 and 4 lbs. as a spray, Patoran 4 lbs. as a granular, Daxtron 12 oz. (.66 lbs.), and diphenamid 2 lbs. plus dinitro 1.5 lbs. combination.

Those materials with acceptable control of either broadleaf or annual grasses and fair weed control of the other include: linuron 1.5 lbs. plus randox 0.5 lbs., granular, maloran at 2 and 4 lbs., linuron at 1.5 lbs. both as a spray and granular formulation, trifluralin incorporated at 0.75, 1.0 and 2.0 lbs., Eptam at 6 lbs., Eptam 3.0 lbs. plus linuron 1.0 lbs. incorporated.

Dacthal at 10.5 lbs., Daxtron 6 oz. (.33 lbs.) were weak on both type weeds. The Eptam 3 lbs. plus trifluralin 1.0 combination controlled grasses, but, not broadleaved weeds.

Because of late planting of the rye cover crop it was impossible to determine effect on stand in time for inclusion in this paper.

Conclusions

1. A reduction in the number of post-emergence cultivations from the standard of three plus hilling to one cultivation and one hilling appears promising without seriously reducing amount of weed control with the standard potato herbicides tested.

2. In some cases a crop yield increase may be obtained by reducing the amount of post-emergence mechanical tillage.

3. Contrary to popular grower opinion it was mechanically possible and feasible to hill potatoes just prior to emergence without any detrimental effect on potato quality or yield.

4. Under conditions of heavy weed populations and with the herbicides tested, it was not possible to eliminate all cultivations after potato emergence and obtain commercially acceptable weed control.

5. With heavy weed populations Eptam at 6 lbs. was the only herbicide tested which gave commercial control of both annual grasses and broadleaf weeds with both normal and reduced post-emergence tillage.

6. A number of chemicals applied at drag-off time on potatoes appear promising for weed control. These include Maloron, Patoran, Daxtron, Linuron, trifluralin, Eptam plus linuron and diphenamid plus dinitro. Effect of Daxtron on potato growth and yield should be studied further.

7. Diphenamid used at 2 lbs. per acre seriously effected stand of fall seeded rye cover.

Table II - Potato Yields and Weed Control for Various Herbicides Under 3 Tillage Programs.

Herbicide Treatment	Lbs. AIA.	Tillage	Yield Cwt./A Size A	Weed Control BL	Weed Control G	% Stand Rye Cover
Trifluralin	0.75	A	169	6.3	6.6	
4 E.C.,		B	244	6.6	7.1	
Incorporated		C	81	1.2	7.2	
		Mean	165	4.73	6.97	100
Trifluralin	1.0	A	176	6.7	7.0	
4 E.C.,		B	189	6.2	6.7	
Incorporated		C	103	2.2	6.9	
		Mean	156	5.03	6.87	100
Trifluralin	2.0	A	179	7.0	7.0	
4 E.C.,		B	210	6.7	7.8	
Incorporated		C	152	2.0	7.0	
		Mean	181	5.23	7.27	100
Diphenamid	2.0	A	177	6.6	5.6	
50 W.P.		B	218	6.7	5.9	
		C	148	4.7	5.0	
		Mean	181	6.0	5.5	44
Linuron	1½	A	161	7.3	4.8	
50 W.P.		B	178	7.1	6.2	
		C	202	6.5	4.3	
		Mean	181	6.97	5.1	100
Eptam	6	A	225	7.3	7.6	
6 E.C.,		B	259	7.1	8.1	
Incorporated		C	188	5.6	7.8	
		Mean	224	6.67	7.83	100
Diphenamid	2	A	196	8.0	5.3	
50 W.P. +		B	210	7.4	5.8	
Linuron 50 WP	1	C	222	5.9	5.2	
		Mean	209	7.1	5.43	55
Diphenamid	2	A	216	7.3	5.8	
Dinitro	1½	B	200	7.3	6.0	
E.C. combination		C	156	5.9	3.2	
		Mean	191	6.83	5.0	40
Check		A	200	5.0	4.8	
		B	221	5.7	4.7	
		C	49	2.4	2.8	
		Mean	157	4.36	4.10	100
LSD 5% Herbicide Means			40	.78	.98	
Herbicides in same tillage			70	1.09	1.28	

Table III - Mean For Tillage

Tillage	Yield Cwt./A.	Weed Control BL	Weed Control G
A	*188	6.83	6.06
B	*214	6.76	6.49
C	*144	*4.06	*5.49
LSD 5%	20	1.07	.64

Table IV - Newer Herbicides For White Potatoes Applied At Drag-Off.

Material	Lbs. AIA.		Weed Control 1/ Broad-leaves	Grass
1. Londax 15G Linuron	1.5		8.1	6.7
+ Randox	0.5			
2. Dacthal 75 WP	10.5		5.7	6.6
3. Maloran 50 WP	2		7.7	6.8
4. Maloran 50 WP	4		8.2	6.3
5. Maloran 10G	4		8.2	7.2
6. Patoran 50 WP	2		7.7	7.1
7. Patoran 50 WP	4		8.9	7.8
8. Patoran 10G	4		8.4	7.5
9. Daxtron 1.5 lbs. EC	0.33		6.0	6.2
10. Daxtron 1.5 EC	0.66		7.7	8.2
11. Linuron 10G	1.5		7.3	6.6
12. Linuron 50 WP	1.5		7.5	6.3
13. Trifluralin 4 lbs. EC	0.75	Inc.	5.8	7.7
14. Trifluralin 4 lbs. EC	1.0	Inc.	6.7	7.7
15. Trifluralin 4 lbs. EC	2.0	Inc.	6.1	7.4
16. Eptam 6 lbs. EC	6.0	Inc.	6.3	7.5
17. Eptam 6 EC +	3.0	Inc.	7.3	6.4
Linuron 50 WP	1.0			
18. Diphenamid +	2.0		7.6	7.2
dinitro	1.5			
19. Eptam 6 EC +	3.0	Inc.	5.7	7.1
Trifluralin 4 lbs. EC	1.0			
20. Check			3.4	5.6
21. Check			5.0	4.4

1/ Weed Control 1=No Control, 7=Commercial Control, 9=No Weeds.

POTATO VINE KILLING IN MAINE - 1967

Hugh J. Murphy and Michael J. Goven[1/]

The following paper represents a report of potato vine killing studies conducted in Aroostook County, Maine during the 1967 growing season. Evaluation of harvested tubers was made during the 1967-68 storage season and emergence trials were conducted during the 1968 growing season.

Materials and Methods:

All desiccants unless otherwise indicated were applied in 80 gallons of water per acre at 40 pounds pressure to actively growing potato vines on the dates indicated in each table. A compressed air sprayer equipped with a two-nozzle brush type boom was used for foliar application to single row, 25 foot plots. Experimental plot designs were randomized blocks with buffer rows between replicated treatments.

Using a five step rating system as listed in Table 1, vine kill ratings were made at two or three time intervals after application of vine desiccants.

Table 1. Potato vine-kill rating code. Maine - 1967

1. Poor or no kill of leaves or stems.
2. 90% of leaves killed but poor stem kill.
3. 100% of leaves killed and 40% of stems killed.
4. 100% of leaves killed and 70% of stems killed.
5. 100% of leaves and stems killed.

Approximately twenty-five pounds of tubers were collected from each plot at harvest time and stored at 50°F for examination during the winter months. Storage studies consisted of observing tubers from each treatment for excessive storage breakdown or shrinkage and examination of individual tubers of each treatment for internal and possible external discolorations which might be caused by chemical vine desiccants. From these samples, tubers were also made available upon request to each company who supplied desiccants, for residue analysis.

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Tubers examined for discoloration were saved and stored at 38°F. In the spring of 1968 tubers from each treatment were planted in replicated emergence trials to determine possible effects of desiccants on sprouting, emergence, and vigor of seed potato tubers.

Results and Discussion:

Data presented in Table 2 compare the effect of chemical desiccants on vines, tubers, and plant emergence of the Kennebec variety. Dow General at rates of 2 to 5 pounds of active per acre, RP 2929 and Premerge provided satisfactory vine desiccation in this study. Paraquat and sodium arsenite were only fair as vine desiccants and fuel oil alone as suggested by two western states was not satisfactory in Maine during 1967 as a potato vine desiccant.

Dow General at the 5 pound rate caused more discoloration than all other materials and Dow General at lesser rates of application. Through the years the discoloration caused by Dow General at high rates of application has been one of the reasons for potato growers to hesitate on its use for potato vine desiccation.

None of the materials, at any rate of application as listed in Table 2 had any effect on plant emergence from tubers harvested from treated plants in 1967.

Data presented in Table 3 indicate the results of a test designed to determine if the use of additives would permit lower rates of Des-I-Cate to be used. Checks or standards in this study were Premerge and sodium arsenite.

Des-I-Cate at 1½ gallons per acre plus TD 1123 gave as good vine desiccation as Des-I-Cate at the 2 gallon rate and as the combination of 4 gallons of Des-I-Cate and F.S. oil. The manufacturers of Des-I-Cate have indicated that the 1½ gallon rate would be economically compatible with approved materials such as the dinitro compounds for potato vine desiccation. Without some type of surfactant or oil to boost activity of Des-I-Cate it would appear that a minimum of 2 gallons will be needed for satisfactory vine desiccation under Maine conditions. More study on compatible surfactants for Des-I-Cate is needed.

Des-I-Cate in combination with TD 6079 caused slight vascular discoloration in 3% of the tubers examined. This discoloration was associated with the additive and not speed of kill. The reduction in emergence by a few of the Des-I-Cate treatments was due to seed-piece decay and blind seedpieces rather than chemical desiccation treatment.

Data presented in Table 4 are from a continuing study to determine the effects of hexafluoroacetone trihydrate (GC 7887) on potato vines and tubers. Previous study of this compound has indicated it might serve as a sprout inhibitor as well as a vine desiccant. In general, rates of GC 7887 such as 2 or 3 gallons alone gave satisfactory desiccation of vines and 1 gallon per acre was about as effective as 8 lbs. of arsenic trioxide from sodium arsenite. Also worthy of note was that the addition of 4 lbs. of TBP increased the activity of sodium arsenite and all rates of GC 7887 used.

All rates of GC 7887 affected plant emergence and the addition of TBP appeared to improve the sprout inhibition possibilities of the compound. Commercially, 50% reduction in seedpiece germination would not be sufficient for GC 7887 to qualify as a potato sprout inhibitor. The growth regulating characteristics of GC 7887 are interesting enough, however, to test its herbicidal value as a pre-emergence application on weeds and grass.

Table 5 presents source and chemical names of compounds used in the 1967 vine killing tests in Maine.

Summary:

Data presented in this progress report on 1967 potato vine killing tests in Maine indicated RP 2929, Dow General, Des-I-Cate, and GC 7887 all have promise for potato vine desiccation. Some rates of Des-I-Cate and Dow General at 5 pounds per acre caused undesirable amounts of vascular discoloration of tubers. Emergence of plants from tubers harvested from GC 7887 plots was substantially reduced by the material alone and in combination with TBP.

Table 2. Effect of several chemicals on potato vine desiccation, vascular discoloration of tubers, and emergence of plants from tubers used for seed. Kennebec variety. Maine - 1967.

Treatments 1/			Vine kill ratings 2/		Percent Vascular Discoloration 3/			Percent emergence
Material	Rate/Acre	Additive	Aug.30	Sept. 6	Slight	Medium	Severe	1968
No treatment	-		1.0	1.0	0.0	-	-	100
Sodium Arsenite	8 lbs. AS_2O_3		2.8	3.3	0.6	-	-	100
Paraquat	1 pt.		2.5	3.2	0.6	Trace	-	100
R.P. 2929	4 lbs.	5 gals. #2 oil	3.8	4.2	0.0	-	-	100
Dow General	1 lb. A.I.	5 gals. #2 oil	2.8	3.2	0.3	0.1	-	100
Dow General	2 lbs.	5 gals. #2 oil	3.7	4.2	-	-	-	100
Dow General	3 lbs.	5 gals. #2 oil	3.7	4.2	0.3	-	-	100
Dow General	4 lbs.	5 gals. #2 oil	3.8	4.2	-	-	-	100
Dow General	5 lbs.	5 gals. #2 oil	3.8	4.2	1.1	-	-	100
Premerge	1 gal.	5 gals. #2 oil plus 1 pt. emulsifier	3.3	4.0	0.2	0.1	-	100
Fuel oil #2	5 gals.		1.3	1.0	-	-	-	100
		L.S.D. (0.05)	0.5	0.8				
		(0.01)	0.7	1.0				

1/ Materials applied August 24, 1967. Air temperature 78°F. Weather clear. Soil conditions very wet. Precipitation during rating period was 4.36 inches.

2/ Kill rating code presented in Table 1.

3/ Examinations made on 15 pound samples from each of six replicates on December 22, 1967.

ble 3. Effect of Des-I-Cate combinations on potato vine desiccation, vascular discoloration of tubers, and emergence of plants from tubers used for seed. Katahdin variety. Maine - 1967.

Treatments 1/			Vine kill ratings 2/			Percent vascular discoloration 3/			Percent emergence
Material	Rate/Acre	Additive	Aug.29	Sept.5	Sept.8 3/	Slight	Medium	Severe	1968
dium Arsenite	8 lbs. AS_2O_3					0.3	-	-	100
emerge	1 gal.	5 gals. #2 oil +	2.2	3.0	3.0				
		1 pt. emulsifier	2.0	2.0	2.2	0.3	0.2	-	100
s-I-Cate	1½ gals.		2.2	2.8	2.5	1.0	-	-	99
s-I-Cate	1½ gals.	5 gals. #2 oil	3.0	3.5	3.2	1.0	-	-	100
s-I-Cate	1½ gals.	1 gal. F.S. oil	2.7	3.0	3.2	1.0	-	-	100
s-I-Cate	1½ gals.	5 gals. F.S. oil	3.0	3.0	3.0	-	0.3	-	100
s-I-Cate	1½ gals.	1 lb. T.D. 6079	2.3	3.2	2.8	3.0	-	-	100
s-I-Cate	1½ gals.	2 lbs. T.D. 1123	3.2	4.0	3.8	0.7	-	-	100
s-I-Cate	2 gals.		3.8	4.0	3.7	0.6	-	-	100
s-I-Cate	2 gals.	5 gals. F.S. oil	3.5	3.5	3.5	0.8	-	-	98
s-I-Cate	4 gals.		3.8	4.0	4.0	-	-	-	100
s-I-Cate	4 gals.	5 gals. F.S. oil	4.0	4.0	3.8	0.4	-	-	99
		L.S.D. (0.05)	0.5	0.3	0.5				
		(0.01)	0.6	0.5	0.6				

Materials applied August 22, 1967. Air temperature 70°F. Weather cloudy. Soil conditions wet. Light shower evening of August 22. Precipitation during rating period.
Kill rating code presented in Table 1.
Examinations made on 15 pound samples from each of six replicates on December 21, 1967.

able 4. Effect of Hexafluoroacetone trihydrate (GC 7887) and tributyl phosphate (TBP) on potato vine desiccation, vascular discoloration of tubers, and emergence of plants from tubers used for seed. Kennebec variety. Maine - 1967.

Treatments 1/			Vine kill ratings 2/		Percent vascular Discoloration 3/			Percent emergence
Material	Rate/Acre	Additive	Aug.29	Sept. 6	Slight	Medium	Severe	1968
odium Arsenite	8 lbs. AS_2O_3		2.5	3.5	0.1	-	-	100
odium Arsenite	8 lbs. AS_2O_3	10# N from Uran	3.0	3.3	0.4	0.4	-	100
odium Arsenite	8 lbs. AS_2O_3	4# of TBP 4/	3.7	4.3	-	-	-	100
GC 7887	1 gal.		2.3	3.3	0.8	-	-	84
GC 7887	1 gal.	10# N from Uran	2.7	3.7	-	-	-	98
GC 7887	1 gal.	2# of TBP	3.0	3.8	-	-	-	88
GC 7887	1 gal.	4# of TBP	3.3	4.3	0.7	-	-	76
TBP 4/	2 lbs.		1.3	1.5	0.2	0.2	-	100
TBP	4 lbs.		1.8	2.0	0.5	-	-	100
GC 7887	2 gals.		3.2	4.2	0.8	-	-	69
GC 7887	2 gals.	10# N from Uran	3.3	4.0	-	-	-	91
GC 7887	2 gals.	2# of TBP	3.5	4.0	0.7	-	-	68
GC 7887	2 gals.	4# of TBP	3.7	4.2	0.7	-	-	50
GC 7887	3 gals.		3.3	4.3	0.5	0.1	-	75
		L.S.D. (0.05)	0.6	0.6				
		(0.01)	0.8	0.8				

/Materials applied August 23, 1967. Weather partly cloudy. Air temperature 70°F. Soil condition moist. Some rain evening of August 23.
/Kill rating code presented in Table 1.
/Examinations made on 15 pound samples from each of six replicates on December 26, 1967.
/TBP or tributyl phosphate a formulation of 4 lbs. of TBP, #2 oil, and an emulsifier in a gallon mixture.

Table 5. Chemicals used for Maine potato vine killing studies - 1967.

Compound	Active ingredient	Source
Sodium Arsenite	Arsenic trioxide	C. W. Staples Co. Inc.
Paraquat		Chevron Chemical Company
RP 2929	4-dimethylaminothiocyanobenzene	Chipman Chemical Company
Dow General	dinitro-sec-butylphenol	Dow Chemical Company
Premerge	dinitro-sec-butylphenol	Dow Chemical Company
Des-I-Cate	Mono (N, N-dimethylathylanion salt of endothol	Pennsalt Chemical Corp.
F.S. oil		Sunoco Oil Company
TD 6079	A Pennsalt product	Pennsalt Chemical Corp.
TD 1123	A Pennsalt product	Pennsalt Chemical Corp.
Uran	Ammonium Nitrate-Urea solution	Allied Chemical Corp.
TBP	tributyl phosphate	Allied Chemical Corp.
GC 7887	hexafluoroacetone trihydrate	Allied Chemical Corp.

WEED CONTROL IN WHITE POTATOES IN MAINE - 1968.

H. J. Murphy and M. J. Goven[1/]

Introduction

The following manuscript represents a progress report on several herbicides tested for control of broadleaf weeds and annual grasses in white potatoes grown at Presque Isle, Maine during 1968.

Rainfall in 1968 as presented in Table 1, was below normal, particularly during June when most of the herbicides were applied. Temperatures during June were very cold and far below normal for Presque Isle. Dry conditions and cool temperatures presumably favored water soluble materials and reduced the effectiveness of wettable powders.

Weed seedlings germinated slowly in 1968, were showing signs of moisture stress at time of herbicide applications. Because of low moisture during the growing season only Lamb's quarters persisted and continued to emerge well into late August.

1968 was not a normal season in Maine, therefore, yield of tubers, broadleaf weed control and annual grass control ratings reported in this paper should not be considered typical for the compounds tested.

Table 1. 1968 Rainfall - Presque Isle, Maine.

May	4	0.13	June	2	0.01	July	2	0.07	August	1	0.45
	10	0.07		3	0.06		10	0.66		4	0.04
	17	0.23		13	0.08		16	0.03		6	0.04
	18	0.14		14	0.05		18	0.66		7	0.05
	19	0.38		18	0.08		19	0.73		10	0.06
	20	0.02		20	0.36		20	0.41		11	0.01
	21	0.06		21	0.06		25	0.08		12	0.05
	22	0.06		23	0.11		28	0.68		17	0.44
	23	0.04		24	0.03		29	0.05		18	0.17
	24	0.02		28	0.04			3.37		20	0.04
	30	0.23		29	0.67					21	0.02
	31	0.04		30	0.07					25	0.68
		1.42			1.62					26	0.15
										28	0.10
										31	0.08
											2.38

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Procedure

Katahdin potatoes were planted on May 16, 1968, fertilized with 1200 pounds of a 10-10-10 fertilizer. Soil type was a Caribou gravelly sandy loam with organic matter content of 4.65 percent. Plot area had been fall plowed, rock picked, and harrowed twice before planting.

Experimental design of test was a randomized block with each treatment replicated six times. Plot size was single 25 foot rows with untreated buffer rows between treated plots. Herbicides were applied with one pass of a small plot sprayer using a pressure of 40 pounds and a volume of 80 gallons of water per acre. Herbicides were applied at the following dates: Planting (PL), May 17; Pre-emergence (PE), June 5; Emergence (EM), June 10; and Post emergence (PM), June 17. Potato plants were about 0.1% emerged on June 10, and about 2-3 inches high on June 17.

Potatoes were hilled on July 2 and again on July 16. No broad-leaf weeds were visible at either hilling on treated plots. Annual grasses on July 16 were small but growing vigorously. Final readings on August 23 indicated some new growth of Lamb's quarter and annual grass.

Principal weed species were: Lamb's quarter (Chenopodium album L.), Wild rutabaga (Brassica rapa L.), Wild Mustard, (Brassica campestis L.), Redroot pigweed, (Amaranthus retroflexus L.), Heartweed (Polygonum persicaria L.), Barnyard grass (Echinochloa crusgalli L.), and Green foxtail (Setaria viridis Beaux.).

Weed control ratings were made on June 17, June 27, and August 23 using a five step rating scale of 1 = no control to 5 = excellent control. All data was subjected to statistical analysis after harvesting of plots on September 17, 1968.

Source and designation of herbicides tested are presented in Table 2.

Results

Weed control: - Data presented in Table 3 indicate herbicides and combinations of herbicides that gave satisfactory broadleaf weed control (rating of 4.0 or better). Only Linuron, Linuron plus Dalapon CP 44939 at 1 and 2 pound rates, and UC 22463 were unsatisfactory for broadleaf weed control. Two pounds of UC 22463 and Paraquat were providing satisfactory weed control on June 27 but residual effect,

as indicated by the August 23 readings, was not enough for full season control. The poor performance of Linuron in 1968 was not expected but presumably occurred because of cool weather and abnormally dry soil conditions.

Table 2. Herbicides used in white potatoes. Maine - 1968

Designation	Active ingredient	Source
DNBP	4,6-dinitro-O-sec-butylphenol	Dow
Dalapon	2,2-dichloropropionic acid	Dow
Linuron	3-(3,4-dichlorophenyl)-1-Methoxy-1-Methylurea	Dupont
Enide-Dinitro	N,N-dimethyl-2,2-diphenylacetamide + DNBP	Upjohn
Daxtron	2,3,5-trichloro-4-pyridinol	Dow
NC 4780	6 chloro-2-trifluoromethyl imidozo (4,5-6) pyridine	Fisons
MB 14255	A Rhodia Inc. product	Chipman
Planavin	4-(methylsulfonyl)-2,6-dinitro-N,N dipropylaniline	Shell
CP 44939	6'-test-Butyl-2-Chloro-N-(Methoxymethyl)-O-acetotoludide	Monsanto
UC 22463	80% of 3,4 dichlorobenzyl Methylcarbonate + 20% 2,3-isomer	Union Carbide
Paraquat	1,1'-dimethyl-4,4'-bipyridinium salt	Chevron

Grass control data also presented in Table 3 indicate Daxtron alone, at both 9 and 12 ounce rates and Paraquat were the only herbicides that controlled annual grasses in 1968. Grass control with Daxtron was very good early in the season but failed to kill late emerging grass seedlings. Considering broad spectrum and full season control of weeds and grass, only Daxtron approaches these conditions.

Potato yields: - Yield of tubers from herbicide treated plots are presented in Table 3. Linuron treatments and both rates of UC 22463 appeared to reduce yields significantly when compared to the DNBP check. Possible reasons for these yield reductions were not clear cut. Neither compound reduced plant stands but yield reduction caused by Linuron could be associated with plant injury. In the case of UC 22463, yield reductions could have been because of inadequate weed control. No visible evidence of plant damage was noticed on UC 22463 treated plots.

Potato quality: - Specific gravities of potato tubers, usually accepted as a partial measure of internal potato quality, were not significantly affected by any herbicide or combination of herbicides. External quality as judged by detailed appearance ratings will be determined during the 1968-69 storage season.

Conclusions

Under the climatic conditions of cool temperatures and low rainfall during and following the application of several herbicides and combination of herbicides to white potatoes in Maine during 1968, the following conclusions were possible:

1. Only Daxtron approached broad spectrum and full season control of broadleaf and grass weed species present at the test site.

2. Linuron and UC 22463 reduced yields significantly as compared to DNBP standard check plots.

3. Internal potato quality was not affected by any herbicide or combination of herbicides in 1968.

4. Considering the adverse conditions present during and immediately following herbicide application, 1968 results probably are not a good indication of typical herbicide performance.

Table 3. Yield, specific gravity, and annual weed control in white potatoes following application of various herbicides. Maine 1968.

Treatments - lbs. of active material per acre	Yield cwt./acre	Specific gravity	Weed control ratings 2/ Broadleaf 3/ 6/17	6/27	8/23	Annual grass 4/ 6/17	6/27	8/23
4.5# DNBP, EM 1/	228	1.088	5.0	5.0	5.0	1.8	1.5	1.3
4.5# DNBP + 5# Dalapon, EM	309	1.086	5.0	5.0	4.8	3.0	3.2	2.0
1# Linuron, PL 1/	171	1.090	3.7	3.8	3.5	1.0	1.5	1.3
1# Linuron + 5# Dalapon, PL	169	1.089	3.7	3.5	2.0	2.2	2.0	1.2
4# Enide-DNBP, EM	268	1.088	5.0	5.0	5.0	1.3	1.7	1.5
8# Enide-DNBP, EM	296	1.087	4.8	5.0	5.0	2.7	2.3	1.8
9 oz. Daxtron, EM	302	1.088	5.0	5.0	5.0	4.5	3.8	2.2
12 oz. Daxtron, EM	312	1.089	5.0	5.0	4.8	5.0	4.7	3.5
9 oz. Daxtron + ½# Linuron, PE	302	1.090	5.0	5.0	4.8	4.2	2.5	2.5
3/4# NC 4780, PE	260	1.089	5.0	5.0	5.0	1.3	1.5	1.7
1½# NC 4780, PE	284	1.088	5.0	5.0	4.8	1.8	1.7	1.7
1½# NC 4780, EM	296	1.087	5.0	4.7	5.0	1.7	1.7	1.5
2# MB 14255, PE	283	1.088	5.0	5.0	4.8	1.5	1.7	1.5
3# MB 14255, PE	289	1.088	4.8	5.0	4.8	1.5	2.2	1.8
3/4# Planavin + 3/4# DNBP, PE	256	1.089	5.0	5.0	4.3	1.2	1.3	1.0
1# Planavin + 3/4# DNBP, PE	244	1.089	4.8	5.0	4.7	1.2	1.2	1.0
1# CP 44939, PE	208	1.090	3.8	3.3	3.2	1.3	1.7	1.3
2# CP 44939, PE	230	1.087	3.7	4.0	3.7	1.0	1.2	1.5
4# CP 44939, PE	276	1.088	4.7	4.7	4.7	1.0	1.8	2.0
5# UC 22463, PL	157	1.090	3.7	3.0	1.8	1.2	1.5	1.0
6# UC 22463, PL	164	1.090	3.8	3.3	2.0	1.3	1.2	1.2
25# Paraquat, PM 1/	207	1.087		4.7	2.8		5.0	4.5
L.S.D. (0.05)	58	N.S.	0.6	0.5	0.7	0.7	1.0	1.0
(0.01)	77		0.8	0.7	0.9	0.9	1.3	1.4

1/ EM = applied at emergence. PL = applied at planting. PM = applied early post-emergence.
2/ Weed control ratings. 1 = no control; 5 = excellent control.
3/ Broadleaf weed species: - Chenopodium album, Brassica campestris, Brassica rapa, Amaranthus retroflexus, and Polygonum persicaria.
4/ Annual grass species: - Echinochloa crusgalli and Setario viridis.

EFFECT OF SEVERAL COMBINATIONS OF HERBICIDES ON THE WEIGHT AND DEVELOPMENT OF MIDWAY STRAWBERRY PLANTS IN THE GREENHOUSE 1/

Oscar E. Schubert 2/

Combinations of herbicides are being used more frequently to control the wide array of broadleafed and grassy weeds in strawberry plantings since individual herbicides often have not provided adequate control. General effects of several herbicides on daughter plant production and growth have been reviewed and reported (2, 3, 4). With the registration of N'-4-(4-chlorophenoxy)phenyl-N,N-dimethylurea (chloroxuron) for use on strawberries a herbicide possessing some postemergent activity on weeds is available. One objective of this investigation was to determine the effects of chloroxuron, alone and with other herbicides, on the growth and development of Midway mother and daughter plants. Another objective was to evaluate dimethyl 2,3,5,6-tetrachloroterephthalate (DCPA), N,N-dimethyl-2,2-diphenylacetamide (diphenamid), 4-(methylsulfonyl)2,6-dinitro-N,N-dipropylaniline (nitralin), sodium 2,4-dichlorophenoxyethyl sulfate (sesone), and 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine), alone or in combinations, because these herbicides have been effective in many growing regions.

MATERIALS AND METHODS

Daughter plant experiment: For this experiment dormant, virus-free Midway strawberry mother plants, weighing 11 to 15 g each, were set into No. 10 cans containing a greenhouse soil mixture of two parts fine-textured silty clay loam and one part slightly decayed leaf mold. The plants were set out May 19, 1967 and the various herbicide treatments were applied to the cans of soil for runner plants on July 24, 1967. Four cans of herbicide-treated or untreated soil were placed around each mother plant for the purpose of rooting the daughter plants. These cans were labelled A, B, C, and D at random and the first runner plant was placed into can A, the second into can B and so forth until all cans were filled in the order the runners developed. A second runner plant was allowed to develop from each of the first four runners. These runner plants also were rooted in cans A, B, C, and D respectively All other runners and runner plants were removed periodically as they developed; thus, only eight runner plants were rooted from each mother plant set. As runner plants started to develop, but before peg roots were longer than one-fourth inch, a common hairpin was used to hold the runner in the can, and to provide each runner plant with a better opportunity to root.

Mother plant experiment: Dormant virus-free Midway strawberry plants, weighing 16 to 20 g each, were set into No. 10 cans of greenhouse soil on May 19, 1967. These plants were given the same herbicide treatments as did the cans of soil for the runner plants on July 24, 1967. All runner plants were removed as they developed on the mother plants in order that the effects of the herbicides would be on the development of the mother plant.

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2/ Department of Horticulture, West Virginia University, Morgantown, West Virginia.

Herbicide treatments: The following treatments were applied in both the daughter and mother plant experiments:

Check - no herbicides applied
Chloroxuron, 4 lb/A ai
Chloroxuron + DCPA, 4 + 9 lb/A ai
Chloroxuron + diphenamid, 4 + 6 lb/A ai
Chloroxuron + DCPA + sesone, 4 + 9 + 4 lb/A ai
Chloroxuron + diphenamid + simazine, 4 + 6 + 0.75 lb/A ai
DCPA + diphenamid, 9 + 6 lb/A ai
DCPA + sesone, 9 + 4 lb/A ai
Diphenamid, 6 lb/A ai
Diphenamid + nitralin, 6 + 0.75 lb/A ai

The herbicides were formulated as follows: chloroxuron 50 wp, DCPA 75 wp, diphenamid 50 wp, sesone 90 ws, simazine 80 wp, and nitralin 75 wp.

Harvest procedure: During the last two weeks of March, 1968 the plants were harvested. Dead and live leaves were counted on each plant and then the weights of the live leaves were recorded. The cans containing the crowns and roots then were soaked in water, and the soil carefully washed from them. Daughter plants were tagged '1' and '2' according to whether they were the first or second runner plant. All 'plants' (the crown plus roots) were wrapped in moist paper towels and placed in cold storage until subsequent data could be taken and recorded. Additional data included number of primary roots, length of primary roots, crown weight, and root weight.

Replications and statistical analyses: Both experiments were set up as randomized complete blocks. The runner plant experiment had ten replications and the mother plant experiment had five replications. The data were analyzed by Duncan's Multiple Range Test at the 5 per cent level of significance.

RESULTS AND DISCUSSION

Daughter plant experiment: Growth measurements for each of the eight runner plants are given in Tables 1, 2 and 3. No herbicide treatments were consistently poorer than the check for leaf weight, root weight, crown weight, total weight, primary root length and number of leaves per plant. In the diphenamid + nitralin treatment the earliest formed runners in Can A were lighter in weight and had a smaller number of primary roots than the check plants. It is likely that the nitralin component, in the combination of diphenamid + nitralin, exerted the major influence on root growth. Previous reports on corn (1) and strawberries (4) have shown marked reductions in root growth following nitralin applications.

Inasmuch as the data presented in Tables 1 to 3 reflect some general trends, it seemed expedient to analyze the mean data from all runners, rather than separate runners from each can. These data are presented in Table 4. The runners grown in diphenamid + nitralin-treated soil were lower in leaf, crown, root and total weights than check plants, as well as those grown in soil treated with chloroxuron + diphenamid, DCPA + diphenamid, DCPA + sesone, and diphenamid. In addition, plants in the diphenamid + nitralin-treated

Table 1. Average fresh leaf, crown, and root weights of Midway strawberry runner plants grown in soil previously treated with herbicides 1/

Treatment	Runner 1 Can A2/	Runner 2 Can A	Runner 1 Can B	Runner 2 Can B	Runner 1 Can C	Runner 2 Can C	Runner 1 Can D	Runner 2 Can D
				Average fresh leaf weight (g)				
Check.....	29.2ab3/	24.2a	24.0ab	22.0ab	22.1a	24.2a	24.5a	21.4ab
Chloroxuron...	28.3ab	23.0a	24.3ab	17.0ab	25.3a	20.6a	24.8a	15.1 b
Chlor.+DCPA...	27.7ab	22.8a	19.9ab	19.9ab	22.8a	20.7a	26.4a	20.9ab
Chlor.+diphen.	23.3ab	24.2a	23.6ab	23.6ab	25.1a	24.5a	21.5a	22.3ab
Chl.+DCPA+ses.	23.7ab	20.0a	18.6 b	16.2 b	20.6a	22.7a	20.2a	20.8ab
Chl.+Dip.+sim.	26.9ab	19.7a	16.3 b	23.6ab	25.1a	23.5a	18.5a	19.7ab
DCPA+diphen...	21.7ab	23.6a	22.0ab	20.9ab	23.2a	22.0a	28.4a	17.3ab
DCPA+sesone...	22.6ab	23.5a	27.5a	22.6ab	24.4a	17.5a	27.2a	23.8a
Diphenamid....	31.2a	21.6a	22.4ab	25.4a	21.7a	22.8a	21.4a	21.1ab
Dip.+nitralin.	20.3 b	17.6a	22.0ab	17.2ab	18.8a	20.0a	19.1a	19.9ab
				Average fresh crown weight (g)				
Check.....	4.4ab	4.0a	3.4ab	3.5a	3.1 b	3.1ab	3.3a	4.2a
Chloroxuron...	4.0ab	4.0a	3.4ab	3.7a	3.8ab	3.7ab	3.8a	2.4a
Chlor.+DCPA...	4.0ab	4.5a	4.7a	3.2a	3.4ab	3.4ab	3.4a	2.9a
Chlor.+diphen.	4.8a	4.1a	3.4ab	3.8a	4.9ab	3.8ab	4.2a	3.4a
Chl.+DCPA+ses.	5.4a	3.6a	3.6ab	3.6a	3.8ab	3.2ab	3.9a	2.8a
Chl.+dip.+sim.	3.4ab	3.8a	3.7ab	3.1a	4.8ab	3.0ab	3.6a	3.6a
DCPA+diphen...	4.8a	3.8a	4.5a	4.5a	5.3a	3.6ab	4.0a	4.3a
DCPA+sesone...	4.6ab	4.1a	4.3ab	4.1a	4.2ab	4.5a	4.0a	4.6a
Diphenamid....	5.1a	4.4a	4.5a	3.9a	3.8ab	4.3a	3.8a	3.5a
Dip.+nitralin.	2.4 b	3.0a	2.9 b	3.8a	3.7ab	2.6 b	3.2a	3.0a
				Average fresh root weight (g)				
Check.....	9.4a	7.9a	5.6ab	6.3ab	5.5 bc	5.2ab	5.3 bc	3.6 b
Chloroxuron...	6.0ab	6.0ab	4.1 b	4.8 b	4.8 c	6.5ab	6.5abc	4.5 b
Chlor.+DCPA...	4.3 b	5.9ab	5.8ab	4.8 b	5.1 c	5.2ab	5.7abc	4.6 b
Chlor.+diphen.	6.3ab	6.2ab	6.4ab	8.4a	9.6a	6.7ab	7.6ab	5.7ab
Chl.+DCPA+ses.	7.5ab	7.2ab	5.9ab	7.3ab	7.7abc	6.6ab	6.5abc	5.7ab
Chl.+dip.+sim.	7.4ab	9.2a	6.4ab	5.8ab	6.6abc	6.2ab	5.5abc	6.1ab
DCPA+diphen...	8.6a	7.0ab	7.3a	8.3a	8.4abc	7.4a	8.0ab	5.8ab
DCPA+sesone...	9.2a	6.0ab	7.7a	7.0ab	6.5abc	7.5a	8.6a	8.7a
Diphenamid....	8.5a	7.5a	7.8a	7.8ab	9.2ab	6.8ab	6.3abc	5.9ab
Dip.+nitralin.	3.6 b	3.9 b	5.5ab	6.0ab	5.7abc	4.2 b	4.4 c	5.3ab

1/ Plants were harvested during the last two weeks of March, 1968, about eight months after herbicides were applied to the soil (July 24, 1967).

2/ Average of ten plants for runner plant data.

3/ Averages followed by a common letter, in the same column and data group, are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 2. Average fresh total plant weight, root length and leaf number of Midway strawberry runner plants grown in soil previously treated with herbicides 1/

Treatment	Runner 1 Can A2/	Runner 2 Can A	Runner 1 Can B	Runner 2 Can B	Runner 1 Can C	Runner 2 Can C	Runner 1 Can D	Runner 2 Can D
				Average fresh total plant weight (g)				
Check.....	43.0a3/	36.1a	33.0ab	31.8abc	30.8a	32.5a	33.1a	29.2ab
Chloroxuron...	38.3ab	33.0a	31.8ab	25.5 c	34.0a	30.8a	35.1a	21.9 b
Chlor.+DCPA...	36.1ab	33.2a	30.4ab	27.9 bc	31.3a	29.3a	35.5a	28.4ab
Chlor.+diphen.	34.4ab	34.4a	33.4ab	40.3a	40.0a	35.0a	33.3a	31.4ab
Chl.+DCPA+ses.	36.6ab	30.8a	28.2 b	27.2 bc	32.1a	32.7a	30.6a	29.3ab
Chl.+dip.+sim.	37.6ab	35.0a	26.4 b	32.6abc	36.5a	32.6a	27.6a	29.4ab
DCPA+diphen...	35.1ab	34.4a	33.8ab	33.7abc	36.9a	33.0a	40.4a	27.4ab
DCPA+sesone...	36.4ab	33.6a	39.6a	33.6abc	35.1a	29.5a	39.8a	37.2a
Diphenamid....	44.8a	33.5a	34.7ab	37.2ab	34.7a	33.9a	31.5a	30.5ab
Dip.+nitralin.	26.3 b	24.6a	30.3ab	27.0 bc	28.1a	26.8a	26.7a	28.2ab
				Average primary root length (cm)				
Check.....	18.0 b	18.8ab	17.9 b	17.7a	18.1ab	18.0 bc	17.7a	17.6a
Chloroxuron...	19.5 b	17.2 b	17.7 b	18.4a	18.5ab	18.3 bc	19.2a	16.4a
Chlor.+DCPA...	18.8 b	19.6ab	19.0 b	18.4a	18.7ab	19.3 bc	19.9a	18.9a
Chlor.+diphen.	19.0 b	19.4ab	18.7 b	19.8a	19.8ab	17.9 bc	19.5a	18.6a
Chl.+DCPA+ses.	20.4ab	19.4ab	20.5ab	20.7a	22.9a	20.2abc	19.4a	18.1a
Chl.+dip.+sim.	19.0 b	19.1ab	18.4 b	18.1a	18.6ab	17.4 bc	19.2a	19.4a
DCPA+diphen...	20.0ab	19.1ab	19.7ab	20.3a	21.6ab	23.3a	20.0a	18.4a
DCPA+sesone...	23.1a	20.9a	22.6a	19.6a	21.1ab	20.8ab	20.2a	18.7a
Diphenamid....	19.9ab	20.9a	19.8ab	20.0a	18.0 b	17.8 bc	18.3a	17.8a
Dip.+nitralin.	18.1 b	17.1 b	19.1 b	17.9a	20.0ab	16.7 c	18.7a	17.8a
				Average number of leaves per plant				
Check.....	18.0ab	17.5ab	17.7a	14.8a	17.0a	15.5a	13.8a	15.2a
Chloroxuron...	19.6ab	15.8ab	16.3ab	13.8a	18.0a	14.2a	14.3a	13.8a
Chlor.+DCPA...	17.9ab	19.1a	13.7ab	16.2a	13.5a	16.3a	19.3a	13.8a
Chlor.+diphen.	16.5ab	17.5ab	15.8ab	18.6a	18.0a	17.1a	14.4a	14.4a
Chl.+DCPA+ses.	17.9ab	17.2ab	13.5ab	13.4a	15.0a	16.7a	15.0a	15.1a
Chl.+dip.+sim.	17.6ab	15.9ab	12.6 b	16.7a	15.3a	15.8a	14.2a	17.0a
DCPA+diphen...	18.2ab	17.1ab	15.2ab	17.5a	18.7a	14.7a	19.3a	14.9a
DCPA+sesone...	15.9ab	15.9ab	16.5ab	17.7a	16.3a	13.2a	17.1a	15.3a
Diphenamid....	22.4a	14.7ab	16.7ab	16.4a	16.7a	17.6a	14.9a	16.3a
Dip.+nitralin.	14.8 b	14.2 b	14.9ab	13.8a	15.2a	15.7a	13.9a	17.4a

1/ Plants were harvested during the last two weeks of March, 1968, about eight months after herbicides were applied to the soil (July 24,1967).

2/ Average of ten plants for runner plant data.

3/ Averages followed by a common letter, in the same column and data group, are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 3. Average number of primary roots of Midway strawberry runner plants grown in soil previously treated with several herbicides 1/

Treatment	Runner 1 Can A2/	Runner 2 Can A	Runner 1 Can B	Runner 2 Can B	Runner 1 Can C	Runner 2 Can C	Runner 1 Can D	Runner 2 Can D
	Average number of primary roots							
Check.....	16.8a3/	15.2ab	12.1abc	11.4a	11.9 b	11.5a	11.6a	10.8a
Chloroxuron...	13.1ab	12.8abc	10.9 c	12.1a	11.1 b	12.1a	13.9a	9.9a
Chlor.+DCPA...	11.9ab	12.6abc	13.3abc	10.7a	12.2ab	11.7a	13.2a	11.5a
Chlor.+diphen.	13.4ab	12.4 bc	12.8abc	14.7a	16.8a	13.5a	14.9a	11.4a
Chl.+DCPA+ses.	14.9ab	13.3abc	13.3abc	13.1a	14.6ab	13.1a	12.7a	11.5a
Chl.+dip.+sim.	13.3ab	16.9a	13.2abc	11.7a	14.7ab	12.2a	12.8a	13.1a
DCPA+diphen...	15.1ab	12.9abc	13.9ab	14.2a	14.1ab	13.5a	13.7a	12.0a
DCPA +sesone..	17.2a	13.0abc	14.2a	12.9a	12.5ab	13.8a	13.3a	14.0a
Diphenamid....	15.4ab	14.1ab	14.8a	13.1a	15.2ab	12.8a	12.9a	12.6a
Dip.+nitralin.	9.9 b	9.3 c	11.1 bc	13.5a	12.6ab	10.3a	11.7a	11.9a

1/ Plants were harvested during the last two weeks of March 1968, about eight months after herbicides were applied to the soil (July 24, 1967).
2/ Average of ten plants for runner plant data.
3/ Averages followed by a common letter in the same column are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 4. Average growth data of all runner plants grown in soil previously treated with several herbicides 1/

Treatment	Fresh Leaf Weight (g)2/	Fresh Crown Weight (g)	Fresh Root Weight (g)	Fresh Total Plant Wt.(g)	Primary Root Length (cm)	Number of Primary Roots	Number of Leaves per Plant
Check.....	23.6a3/	3.6 b	6.0 bc	33.2abc	18.0 bc	12.5abcd	16.2a
Chloroxuron...	22.3ab	3.6 b	5.4 cd	31.3 c	18.2 bc	12.0 cd	15.7a
Chlor.+DCPA...	22.6ab	3.7 b	5.2 cd	31.5 c	19.1 b	12.1 bcd	16.5a
Chlor.+diphen.	23.5a	4.1ab	7.1a	34.7ab	19.1 b	13.7a	16.5a
Chl.+DCPA+ses.	20.4 bc	3.7 b	6.8ab	30.9 c	20.2a	13.3abc	15.4a
Chl.+dip.+sim.	21.7abc	3.6 b	6.5ab	31.8 bc	18.4 bc	13.5ab	15.5a
DCPA+diphen...	22.4ab	4.4a	7.6a	34.4abc	20.3a	13.7a	16.9a
DCPA+sesone...	23.6a	4.3a	7.7a	35.6a	20.9a	13.9a	15.8a
Diphenamid....	23.5a	4.2ab	7.5a	35.2ab	19.1 b	13.9a	16.9a
Dip.+nitralin.	19.4 c	3.1 c	4.8 d	27.3 d	17.9 bc	11.3 d	14.9a

1/ Plants were harvested during the last two weeks of March 1968, about eight months after herbicides were applied to the soil (July 24, 1967).
2/ Average of 80 plants for runner plant data (ten replications of eight runners).
3/ Averages followed by a common letter in the same column are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 5. Comparison of growth measurements for herbicide-treated mother plants with 'untreated' mother plants in which only the soil for the rooting of runner plants was treated with herbicides 1/

Treat ment	Fresh Leaf Weight (g)	Fresh Crown Weight (g)	Fresh Root Weight (g)	Fresh Total Plant Wt.(g)	Primary Root Length (cm)	Number of Primary Roots	Number of Leaves per Plant
			Herbicide-treated mother plants 2/				
Check.....	55.8a3/	31.1a	21.8a	108.7a	21.2 b	36.8a	40.0a
Chloroxuron...	46.8a	26.0a	20.1ab	92.9ab	21.7ab	35.2ab	35.8a
Chlor.+DCPA...	45.0a	15.7a	12.4 b	71.4 b	19.9 b	22.8 b	35.2a
Chlor.+diphen.	51.3a	22.9a	20.0ab	94.2ab	26.3a	31.8ab	38.9a
Chl.+DCPA+ses.	63.0a	26.4a	23.1a	112.6a	23.1ab	38.8a	40.4a
Chl.+dip.+sim.	52.7a	23.4a	16.8ab	93.0ab	21.6ab	30.4ab	38.0a
DCPA+diphen...	60.4a	25.8a	15.9ab	101.5ab	21.0 b	28.2ab	40.2a
DCPA+sesone...	52.6a	30.9a	18.9ab	103.9a	22.3ab	36.8a	42.6a
Diphenamid....	53.0a	28.0a	16.6ab	97.6ab	20.7 b	32.8ab	36.0a
Dip.+nitralin.	47.7a	14.8a	17.0ab	79.4 b	23.0ab	32.0ab	35.2a
			'Untreated'-mother plants 4/				
Check.....	43.7a	8.6a	8.0a	60.3a	17.6a	16.9a	26.1a
Chloroxuron...	45.2a	10.4a	10.2a	65.0a	19.2a	21.5a	29.4a
Chlor.+DCPA...	40.3a	8.9a	8.0a	57.2a	18.8a	16.7a	25.5a
Chlor.+diphen.	48.3a	9.7a	9.7a	67.6a	17.3a	18.9a	27.7a
Chl.+DCPA+ses.	44.2a	10.1a	11.1a	65.4a	17.4a	22.1a	26.1a
Chl.+dip.+sim.	43.4a	10.5a	10.6a	64.5a	19.0a	22.0a	28.2a
DCPA+diphen...	50.4a	11.1a	11.0a	72.5a	20.6a	23.5a	33.3a
DCPA+sesone...	48.8a	10.8a	12.1a	71.7a	19.7a	22.5a	31.8a
Diphenamid....	43.4a	11.5a	12.0a	66.9a	18.3a	25.0a	28.2a
Dip.+nitralin.	46.4a	9.0a	9.9a	65.5a	20.0a	21.4a	28.8a

1/ Plants were harvested during the last two weeks of March 1968, about eight months after herbicides were applied to the soil (July 24, 1967).
2/ Average of five plants for herbicide-treated mother plants.
3/ Averages followed by a common letter, in the same column and data group, are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.
4/ Average of ten plants for 'untreated-mother' plants.

soil were lower in leaf, crown, and total weights than plants in chloroxuron- and chloroxuron + DCPA-treated soil. Plants in diphenamid + nitralin-treated soil also were lower in crown, root, and total weights than plants grown in chloroxuron +DCPA + sesone and chloroxuron + diphenamid + simazine-treated soil. Primary root lengths and numbers of primary roots for runner plants grown in diphenamid + nitralin-treated soil were smaller than from plants from six other treatments but not different from the check. On the basis of the average figures in Table 4 it would appear that four treatments were better (chloroxuron + diphenamid, DCPA + diphenamid, DCPA + sesone, and diphenamid) than the other treatments (chloroxuron, chloroxuron + DCPA,

Chloroxuron + DCPA + sesone, and chloroxuron + diphenamid + simazine) even though these generally were not different from the check plants with respect to overall growth measurements taken. The number of leaves per plant did not vary significantly among plants from any treatments.

Mother plant experiment and 'untreated' mother plants in runner experiment: Growth measurements for herbicide-treated and untreated mother plants are presented in Table 5. Several interesting observations can be made from this table. Mother plants from herbicide-treated plants generally had heavier weights, longer and more primary roots and more leaves than 'untreated' mother plants. This probably resulted from the removal of all runners from herbicide-treated plants and larger initial plant weights, 16 to 20 g each for the herbicide-treated mother plants compared with 11 to 15 g plants for the 'untreated' mother plant experiment in which the runner plants were grown in herbicide-treated soil. Only the mother plants treated with chloroxuron + DCPA were appreciably poorer than check plants with respect to root weight, total weight, primary root length and number of primary roots. Diphenamid + nitralin-treated mother plants were lower in total plant weight than check plants although the individual components of the total plant (leaf, crown and roots weights) were not significantly different. The 'heavy' herbicide treatments, even though two or three herbicides were combined at 'full' rates, did not have any appreciable detrimental effect on plant growth of established Midway strawberries, except possibly the chloroxuron + DCPA and the diphenamid + nitralin treatments.

No differences in growth were noted among untreated mother plants whose first eight runner plants were grown in herbicide-treated soil.

SUMMARY AND CONCLUSIONS

Runner plants from untreated Midway strawberry mother plants were grown in cans of soil treated with the following herbicides: chloroxuron, 4 lb/A ai; chloroxuron + DCPA, 4 + 9 lb/A ai; chloroxuron + diphenamid, 4 + 6 lb/A ai; chloroxuron + DCPA + sesone, 4 + 9 + 4 lb/A ai; chloroxuron + diphenamid + simazine, 4 + 6 + 0.75 lb/A ai; DCPA + diphenamid, 9 + 6 lb/A ai; DCPA + sesone, 9 + 4 lb/A ai; diphenamid, 6 lb/A ai; and diphenamid + nitralin, 6 + 0.75 lb/A ai. Growth data (fresh weights of leaves, crowns, and roots; primary root length; number of primary roots and number of leaves) showed only a few differences between treatments of the first eight runner plants. When data for all runners were pooled, runner plants from the diphenamid + nitralin treatment were lower in fresh leaf, crown, and root weights than runner plants from check plots and nearly all other herbicide treatments. Primary root numbers and lengths were decreased over most other treatments, but not more than the check plants. The other eight herbicide treatments did not have any appreciable detrimental effects upon runner growth and many produced as good, or better, growth than the check plants. This indicated that newly-formed runners will grow and develop well with several combinations of chloroxuron, DCPA, diphenamid and sesone even though these treatments contain each herbicide at the rate most often used for weed control when used alone in the field.

Growth data of 'untreated' mother plants from plots where herbicides were applied to the soil in which the runner plants were rooted indicated no harmful effects upon growth. When these herbicide treatments were applied to established mother plants in another experiment only the chloroxuron + DCPA and the diphenamid + nitralin treatments reduced growth as compared to check plants.

The main conclusion to be drawn was that several combinations of herbicides can be used at 'full' weed control rates without appreciably affecting growth of strawberry runner plants or established mother plants. If similar results are obtained in the field, it should be possible to achieve longer control of a greater number of broadleafed and grassy weeds in strawberry plantings.

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EFFECT OF NITRALIN ON THE GROWTH OF SURECROP STRAWBERRY PLANTS IN THE GREENHOUSE1/

Oscar E. Schubert 2/

In the matted-row system of strawberry culture, it is desirable to limit the row width to facilitate harvesting and other cultural operations. Runner plants that root in the interrow must be removed by cultivation or hoeing. This operation disturbs the soil, and weeds germinate freely, especially if the herbicides used previously could not be mixed or diluted with soil without resultant loss of weed control. If, on the other hand, the soil in the interrow were sprayed with a chemical that prevented runner plants from rooting, it would be possible to cut the runners off along the edge of the row with a sharp coulter or disc blade. The runners and runner plants in the interrow would consequently die if rooting was prevented.

One objective of this experiment was to determine the effect of 4-(methyl-sulfonyl)2,6-dinitro-N,N-dipropylaniline (nitralin) on the growth of Surecrop mother plants whose runner plants were grown in cans of soil previously treated with several rates of nitralin. The other objective was to evaluate the effect of nitralin on the growth of the first eight runner plants formed.

MATERIALS AND METHODS

On May 17, 1967, dormant virus-free Surecrop mother plants, weighing 11 to 15 g each, were set into No. 10 cans containing field soil. On August 1, 1967, similar cans of soil were treated with nitralin (75 wp) at rates of 0, 0.19, 0.38, 0.75, 1.50, 3.00, 6.00 and 12.00 lb/A ai. Four cans of the same rates of nitralin-treated soil were placed around each mother plant for rooting the runner plants. These cans were marked A, B, C, and D at random and the first four runners were pinned down successively in cans A to D as they developed. A second runner plant was allowed to develop and to be rooted in each can. All other runners and runner plants were removed from time to time as they developed; thus, eight runner plants were rooted from each mother plant. To encourage rooting of runner plants, a common hairpin was used to hold the runner in the can. Each runner plant was pinned down before peg roots were longer than one-fourth inch.

Replications and analyses of data: Each treatment of mother plants with four cans for eight runner plants was replicated ten times in a randomized complete block. The data were analyzed by Duncan's Multiple Range Test at the 5 per cent level of significance.

Harvest procedure: During the first two weeks of April, 1968, the plants were harvested. Dead and live leaves were counted on each plant and the weights of live leaves were recorded. The cans containing the crowns and roots were then soaked in water, and the soil carefully washed from them. Runner plants were tagged '1' and '2' according to whether they were the first or second runner plant in each can. The labelled crowns and roots were wrapped in moist paper towels and placed in cold storage until subsequent data could be taken and recorded. Additional data included: number of primary roots, length of primary roots, crown weight and number, and root weight.

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RESULTS AND DISCUSSION

Untreated mother plants: Growth data are presented in Table 1 for the untreated mother plants. Fresh leaf weights of all mother plants from runner plants growing in previously treated soil at all rates of nitralin were less than for mother plants with untreated runner plants. Differences among crown weights were not consistent with increasing application rates. Root weights of mother plants from runner plants growing in nitralin-treated soil at rates from 0.75 to 12.0 lb/A were heavier than root weights from runner plants in the check, 0.19 and 0.38 lb/A treated cans, respectively. When leaf, crown, and root weights were combined, the total weights of the mother plants from treated runner plants were not different from 'check' mother plants. Thus individual differences among plant parts (leaf, crown and root) cancelled each other when the entire plant weight was analyzed. The number of primary roots was higher for mother plants whose runner plants were rooted in soil treated with nitralin from 0.75 to 12.0 lb/A. Differences among live and total leaves per plant were neither appreciable nor consistent with application rates. No differences were noted among numbers of crowns per plant (data not presented).

In a previous experiment (1) in the greenhouse where nitralin (Planavin) was applied to soil in which Midway strawberry runner plants were grown in a greenhouse soil mix no growth differences were noted among treated and untreated mother plants. These data included average number of crowns, fresh total weight of plant, root weight, and root length.

Table 1. Growth of 'untreated' mother plants1/ in which only the soil for the rooting of the runner plants was previously treated with nitralin2/

Rate of Nitralin (lb/A ai)	Fresh Leaf Weight (g)	Fresh Crown Weight (g)	Fresh Root Weight (g)	Fresh Total Plant Wt.(g)	Primary Root Length (cm)	Number of Primary Roots	Number of Leaves per Plant	
							Live	Total
0.00	36.0a3/	8.4 b	32.9 b	77.3ab	27.6a	21.6 c	11.4ab	17.5a
0.19	25.0 b	11.3ab	32.7 b	69.0 b	28.0a	25.8 bc	8.9 b	14.8ab
0.38	23.4 b	11.5ab	35.5 b	70.4 b	25.5a	26.1 bc	8.9 b	14.6ab
0.75	23.2 b	11.3ab	50.9a	85.4a	25.7a	28.1ab	9.8ab	13.6 b
1.50	22.4 b	13.0a	44.6a	80.0ab	29.1a	32.7a	9.5ab	13.7 b
3.00	23.9 b	12.3ab	49.0a	85.2a	27.4a	27.2abc	10.3ab	14.4ab
6.00	23.1 b	11.6ab	50.6a	85.3a	27.1a	30.1ab	9.8ab	16.5ab
12.00	25.8 b	14.0a	50.3a	90.0a	29.0a	30.8ab	12.0a	16.1ab

1/ Average of ten plants for mother plant data.
2/ Plants were harvested during the first two weeks of April 1968, about eight months after nitralin was applied to the soil (August 1, 1967) in which the runner plants were rooted.
3/ Averages followed by a common letter in the same column are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Runner plants: Average fresh leaf, crown, root, and total weights of all runner plants grown in soil previously treated with nitralin at 1.5, 3.0, 6.0 and 12.0 lb/A, respectively, were lower than for runner plants from untreated cans (Table 2). Root weights also were lower at the 0.75 lb/A treatment than for the runner plants from untreated cans. In addition at least five of the eight runner plants were lower in crown and root weights than runner plants from untreated cans, thus further demonstrating the great influence of nitralin even at rates as low as 0.19 lb/A on strawberry runner plants. Runner plants on runners three and four (Cans C and D) were generally smaller than the runner plants from the first and second runners (Cans A and B). The effects of nitralin on leaf, crown, and root weights showed similar trends on all runner plants but the numerical values of the differences were not as great on runner plants of the last two runners as on the first two. No differences were found among number of crowns of runner plants grown in soil previously treated with nitralin (data not presented).

The number of 'long' primary roots on runner plants was decreased when plants were grown in cans treated with nitralin at rates of 0.75 to 12.0 lb/A compared to check (Table 3). Six or seven of eight runner plants had smaller numbers of long primary roots, even at rates of 0.19 and 0.38 lb/A, compared with check. The magnitude of actual differences was greater with the first runner plant as compared to the last.

Average primary root length was not affected as greatly as numbers of long primary roots (Table 3) or root weights (Table 2). No differences were noted among root lengths of runner plants at the 0.19 and 0.38 lb/A rates compared with checks. Average root lengths of seven of eight runner plants were less at the 0.75 lb/A rate compared with check. At rates of 1.5 lb/A and higher all runner plants had shorter roots than checks. The measurements reflected the length of the longer rather than the shorter primary roots. Most of the runner plant roots in treatments of 3.0 lb/A and over were less than 0.5 cm long; however, one or two roots were often much longer (2 to 6 cm). These long primary roots may be able to establish the plant sufficiently well after secondary roots develop to keep the plant alive after the runners are cut from the mother plant.

When growth data for all runner plants in the nitralin experiment were pooled and analyzed (Table 4), the growth comparisons among rates were not as variable as among rates and individual averages of ten runner plants for each can. Significant reductions in crown weights, root weights, and number of long primary roots occurred at the 0.19 lb/A rate of nitralin compared with the respective checks. With leaf weights and number of leaves per plant, reductions were noted compared to the check at the 0.38 lb/A rate. Primary root lengths were decreased at the 0.75 lb/A rate and a still greater reduction in root lengths occurred at rates of nitralin at the 1.5 lb/A and higher rates.

In the previous experiment (1) with Midway strawberry runner plants, harvested about five months after treatment, roots were heavier and longer in the cans treated at 0.38 and 0.75 lb/A than in the check and 0.19 lb/A treatments. These differences were not observed with the Surecrop variety,

Table 2. Average fresh leaf, crown, root and total weight of Surecrop Strawberry runner plants grown in soil previously treated with nitralin 1/

Rate of nitralin (lb/A ai)	Runner 1 Can A2/	Runner 2 Can A	Runner 1 Can B	Runner 2 Can B	Runner 1 Can C	Runner 2 Can C	Runner 1 Can D	Runner 2 Can D
				Average fresh leaf weight (g)				
0.00	25.3a3/	23.4a	26.8a	16.1b	20.8a	17.7a	18.4a	12.7a
0.19	22.1a	19.8a	18.8b	23.3a	18.0a	16.7a	19.8a	9.0abc
0.38	12.7b	19.4a	13.3bc	15.4bc	12.7b	16.3a	10.2b	10.7ab
0.75	12.8b	12.9b	11.9cd	13.1bc	10.3bc	13.0a	7.8bc	10.7ab
1.50	9.2bc	9.8bc	6.6de	10.5cd	6.4cd	8.2b	6.2cd	6.8bcd
3.00	4.8c	5.6c	5.2e	5.8d	4.8d	4.8b	4.4cd	5.3cd
6.00	6.3c	5.6c	6.3de	6.4d	4.5d	4.4b	2.5d	2.6d
12.00	5.6c	5.7c	6.1de	5.4d	5.2d	4.4b	3.7d	6.6bcd
				Average fresh crown weight (g)				
0.00	8.9a	7.0a	7.7a	4.5a	5.6a	4.0a	5.8a	3.7a
0.19	4.2b	3.6bc	3.4bc	4.6a	3.9b	4.0a	2.8bc	3.2ab
0.38	3.1bc	3.8b	4.1b	3.6ab	2.5bc	3.6ab	3.0b	2.1bc
0.75	2.4bcd	2.3bcd	2.0bc	3.0abc	1.3cd	2.4bc	1.7cd	2.3bc
1.50	1.8cd	1.9bcd	1.8bc	2.3bcd	1.6cd	2.0c	2.3bc	1.5cd
3.00	1.2cd	1.3cd	1.0c	1.5cd	1.0cd	1.0c	0.5d	1.0d
6.00	1.0cd	1.2cd	0.9c	1.5cd	1.0cd	1.7c	0.7d	0.7d
12.00	0.8d	0.8d	0.9c	0.9c	0.8d	0.9c	0.8d	1.0d
				Average fresh root weight (g)				
0.00	27.6a	19.2a	25.2a	13.4a	14.9a	13.0a	17.8a	10.8a
0.19	10.6b	10.9b	10.0b	12.6a	9.4b	11.4ab	7.7b	9.4a
0.38	8.1bc	10.3b	10.4b	9.3ab	5.8bc	8.7bc	7.8b	3.3bc
0.75	4.9bcd	5.9c	3.8b	6.7bc	3.5cd	6.4c	3.3c	5.6b
1.50	2.8cd	3.1cd	3.5b	3.1c	2.5cd	2.7d	3.1c	2.2bc
3.00	1.0d	0.9d	0.7b	2.0c	1.1d	1.0d	0.9c	2.8bc
6.00	0.7d	0.9d	0.8b	1.0c	0.8d	1.5d	0.5c	0.3c
12.00	1.0d	0.8d	1.0b	1.1c	0.8d	1.4d	1.2c	0.2c
				Average fresh total weight (g)				
0.00	61.7a	49.6a	59.8a	34.0ab	41.3a	34.7a	42.1a	27.2a
0.19	36.9b	34.4b	32.2b	40.6a	31.2b	32.0a	30.2b	21.6b
0.38	23.9c	33.5b	27.8bc	28.2bc	20.9c	28.6ab	21.1c	16.1bc
0.75	20.1cd	21.1c	17.6cd	22.9cd	15.1cd	21.8b	12.8d	18.6b
1.50	13.9de	14.7cd	12.0d	15.9de	10.6de	12.4c	11.6d	10.5cd
3.00	7.0e	7.8d	6.8d	9.2e	6.9e	6.8c	5.8de	9.2cd
6.00	7.9e	7.7d	7.9d	8.8e	6.3e	7.6c	3.7e	3.6d
12.00	7.3e	7.5d	8.0d	7.4e	6.8e	6.7c	5.7de	7.9d

1/ Plants were harvested during the first two weeks of April 1968, about eight months after nitralin was applied to the soil (August 1, 1967).

2/ Average of ten plants for runner plant data.

3/ Averages followed by a common letter, in the same column and data group, are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 3. Average number of primary roots, root length, and number of leaves of Surecrop strawberry runner plants grown in soil previously treated with nitralin 1/

Rate of nitralin (lb/A ai)	Runner 1 Can A2/	Runner 2 Can A	Runner 1 Can B	Runner 2 Can B	Runner 1 Can C	Runner 2 Can C	Runner 1 Can D	Runner 2 Can D
				Average number of primary roots				
0.00	22.0a	16.3a	18.8a	13.3a	14.0a	14.7a	14.1a	12.6a
0.19	13.1b	13.3ab	11.0b	14.5a	10.6b	11.1b	7.9b	8.5b
0.38	10.9b	10.7b	10.1b	9.9ab	7.6b	11.4b	10.5b	7.6bc
0.75	5.7c	6.3c	4.3c	6.6bc	3.8c	6.7b	4.2de	5.1cd
1.50	3.1cd	3.2d	4.9c	4.2cd	3.8c	3.0c	4.7cd	3.4de
3.00	1.9cd	1.1d	1.5c	2.2cd	1.2c	1.3c	1.5e	2.4de
6.00	1.0d	1.4d	1.3c	1.4d	1.1c	1.5c	1.0e	1.1e
12.00	1.0d	1.4d	1.1c	1.2d	1.2c	1.1c	1.1e	1.0e
				Average primary root length (cm)				
0.00	30.6a	28.9a	29.3a	24.0a	30.0a	27.5ab	28.6a	25.7a
0.19	29.7a	27.4ab	27.7a	24.8a	28.6a	24.6ab	25.9a	27.2a
0.38	24.9ab	25.0ab	27.0a	27.9a	24.5a	30.8a	25.9a	21.6ab
0.75	18.0b	20.1b	16.8b	19.1ab	14.4b	22.5b	12.6b	16.1b
1.50	10.6c	11.8c	16.3b	10.3bc	10.2b	9.2c	16.5b	7.4c
3.00	4.8cd	3.3d	2.2c	8.5c	1.2c	3.8cd	3.7c	5.2c
6.00	1.3d	5.6cd	2.5c	4.9c	0.9c	5.3cd	1.2c	0.4c
12.00	1.1d	1.1d	1.1c	3.7c	1.2c	1.4d	3.7c	1.0c
				Average number of leaves per plant				
0.00	13.2a	11.2a	15.9a	8.6bc	12.0a	9.7a	10.5b	8.6a
0.19	12.5a	11.5a	10.7b	12.1a	8.8bc	9.7a	12.6a	8.4ab
0.38	9.0b	10.9a	8.9bc	9.4ab	9.3ab	9.8a	7.3cd	7.9ab
0.75	8.8b	10.4a	8.3bc	9.5ab	8.2bc	9.5a	6.8d	8.1ab
1.50	8.2bc	8.5ab	7.2bc	9.1bc	7.0bc	8.3ab	6.3d	7.7ab
3.00	6.1b	6.6b	6.2c	6.4c	5.9c	6.7bc	6.2d	6.9ab
6.00	6.6bc	6.4b	6.6bc	6.7bc	6.2bc	5.6c	5.4d	5.7b
12.00	6.9bc	6.7b	7.0bc	6.7bc	6.4bc	6.5bc	6.6d	6.9ab

1/ Plants were harvested during the first two weeks of April 1968, about eight months after nitralin was applied to the soil (August 1, 1967).

2/ Average of ten plants for runner plant data.

3/ Averages followed by a common letter, in the same column and data group, are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

Table 4. Average growth data of all runner plants 1/ grown in soil previously treated with several rates of nitralin 2/

Rate of Nitralin (lb/A ai)	Fresh Leaf Weight (g)	Fresh Crown Weight (g)	Fresh Root Weight (g)	Fresh Total Plant Wt.(g)	Primary Root Length (cm)	Number of Primary Roots	Number of leaves per Plant
0.00	20.2a3/	5.9a	17.7a	43.8a	28.1a	15.7a	11.2a
0.19	18.5a	3.7 b	10.2 b	32.4 b	27.0a	11.3 b	10.8a
0.38	13.8 b	3.2 b	8.0 bc	25.0 c	26.0a	9.8 b	9.1 b
0.75	11.6 b	2.2 c	5.0 d	18.8 d	17.4 b	5.3 c	8.7 bc
1.50	7.9 c	1.9 c	2.9 de	12.7 e	11.5 c	3.8 cd	7.8 cd
3.00	5.0 d	1.1 d	1.3 e	7.4 e	4.1 d	1.6 d	6.4 e
6.00	4.8 d	1.1 d	0.8 e	6.7 e	2.8 d	1.2 d	6.2 e
12.00	5.4 d	0.9 d	0.9 e	7.2 e	1.8 d	1.1 d	6.7 de

in which root weights were lower at all rates of nitralin applied compared with check. In contrast to Midway, Surecrop runner root lengths were unaffected at the 0.19 and 0.38 applications but were decreased at 0.75 lb/A and higher rates as compared with runner plants grown in untreated soil.

SUMMARY AND CONCLUSIONS

Surecrop strawberry runner plants were grown in cans of field soil previously treated with nitralin at rates of 0, 0.19, 0.38, 0.75, 1.50, 3.0, 6.0 and 12.0 lb/A ai. In general, growth of at least four of the eight runner plants which were permitted to root was decreased at application rates as low as 0.38 lb/A. At rates of 0.75 lb/A, growth of nearly all runner plants was reduced significantly. At rates of 1.5lb/A and higher average fresh leaf weight, crown weight, root weight, number of long primary roots, and primary root length of all runner plants growing in nitralin-treated soil were less than for runner plants growing in untreated soil.

The growth of untreated mother plants whose runner plants were grown in nitralin-treated soil also was affected. Leaf weights of these mother plants were lower at all rates of nitralin from 0.19 to 12.0 lb/A; however, root weights and numbers of long primary roots were greater at rates of 0.75 lb/A and higher compared with mother plants from untreated runner plants. Crown weights and primary root lengths of these untreated mother plants were unaffected by nitralin applications to the soil used to root the runner plants. Since leaf weights of mother plants were generally lower with runner plants grown on nitralin-treated soil and root weights generally higher, the total plant weight (leaf, crown and root) was not

1/ Average of 80 plants for runner plant data (ten replications of eight runners).

2/ Plants were harvested during the first two weeks of April 1968, about eight months after nitralin was applied to the soil (August 1, 1967) in which the runner plants were rooted.

3/ Averages followed by a common letter in the same column are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

different for mother plants with treated or untreated runner plants.

Although the roots of runner plants were extremely short, at nitralin rates of 3.0 lb/A and higher, it is possible that an occasional longer root would penetrate into the soil far enough to keep the runner plant alive if the runners were cut from the mother plant along the edge of a matted-row. This problem undoubtedly could be corrected in the field by cutting runners off several times during the season.

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COMPARISON OF DIFFERENT HERBICIDES AND DIFFERENT METHODS OF HERBICIDE APPLICATION FOR CONTAINER GROWN PLANTS 1/

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INTRODUCTION

The use of herbicides for weed control where ornamental plants are being grown in soil has increased vastly during the past ten years. Progress has been considerably slower in the use of herbicides where ornamental plants are grown in containers. This is understandable since the media used in container plant production is more porous than soil and may contain a large proportion of substances low in organic matter. The use of large amounts of irrigation water and a low organic matter content media result in much leaching which in turn has led to generally ineffective weed control in container grown plants.

Incorporation of herbicides in organic mulch material and then spreading the mulch around ornamental plants has been shown to be an effective method of herbicide application (1, 2, 3, 4, 5). The method has not been reported for use on container media. Another method of application recently developed by the manufacturer of dichlobenil, 3/ and as yet still in the experimental stage is the impregnation of dichlobenil on paper like discs cut to fit around the plant. According to the manufacturer the disc has the equivalent of 6 lbs./A. This method would provide an easy way to apply the herbicide with no problems of calibration of equipment or chance for error, unless more than one disc is applied to a container. An experiment was carried out using dichlobenil at 6 lbs./A in each of these two methods and the herbicide D986-5G 4/ applied as a granule at the rate of 13.5 lbs./A.

MATERIALS AND METHODS

Four cultivars were used in the experiment: *Rhododendron obtusum* 'Hinodegiri', *Rhododendron* 'Kaempo' *Rhododendron* 'Firedance' and *Salix* sp. Five plants of each cultivar were used in five replications for each of four treatments making 100 plants in each treatment, and 400 plants in the experiment. Treatments consisted of:

1. Check (no treatment) not weeded
2. Dichlobenil discs (6 lbs./A)
3. Dichlobenil on peatmoss mulch 1" depth/can (6 lbs./A)
4. D986-5G (3,3 Dimethyl-1-(m-nitrophenyl)triazene 13.5 lbs./a

Treatments were applied between May 1 and 5; plants were harvested between September 5 and 10. A rooted cutting with a root ball of 3" diameter was placed in a 6 inch plastic container (1 gallon). The medium used

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4/ UniRoyal Chemical, Naugatuck, Connecticut

was equal parts by volume of sandy loam, sphagnum peatmoss, and horticultural grade perlite. The plants were watered at least three times each week and they were fertilized with a 20-20-20 fertilizer solution at the rate of 150 ppm N twice each week.

Treatments were in a complete randomized block design and treatment means were separated by Duncan's Multiple Range Test. Effectiveness of treatments was determined by measuring dry weight and height of the plants. Visual scores of plant injury and a count of the weeds in each container were also made.

RESULTS AND DISCUSSION

It was readily apparent that the dichlobenil treatment using impregnated peatmoss as a 1" mulch was injurious to the azalea cultivars. The plants were smaller when harvested as shown by the dry weight determinations given in Table 1. A significant retardation in growth was also evident in the disc treatment but it was not as pronounced as that in the mulch treatment. There was a significant reduction of growth in both mulch treatments when compared to the untreated plants or to the other herbicide treatment. Plants in the D986 treatment were not inhibited when compared to the check and total plant weight was significantly better than the check undoubtedly due to the lack of competition from weeds in that treatment.

The same trend may be seen in the plant height data given in Table 2. There were no differences between the D986 treatment and the check but plants in both treatments were significantly taller than those in the dichlobenil treatments. The dichlobenil disc application was significantly better than the dichlobenil mulch treatment.

A scoring of the plants was used to estimate the amount of injury visible. A score of 4 indicated a dead plant and a score of 0 indicated no damage. It is evident that there was no apparent injury from the D986 treatment or the check but considerable damage resulted from the other treatments (Table 3). The most damage resulted from the mulch treatment.

It was evident that D986 has potential as an herbicide for container grown plants but there is room for improvement which might be obtained at either higher application rates or by using a series of applications. The methods of application of dichlobenil used in these tests were not successful. If lower application rates were used perhaps the results would have been more favorable.

Table 1. Average dry weight (grams) of four cultivars four months after application of different herbicides.

Treatment	Cultivar				
	Kaempo	Hinodeqiri	Firedance	Salix	Mean
Dichlobenil mulch	5.1	9.0	4.0	12.3	7.6 c x/
Dichlobenil disc	11.9	19.7	5.9	19.2	14.2 b
D986-5G	17.6	24.8	10.9	23.4	19.2 a
Check	16.0	19.1	8.3	21.4	16.2 b

x/ Means followed by the same letter are not significantly different from each other. P. 0.05.

Table 2. Average plant height (inches) of four cultivars four months after application of different herbicides.

Treatment	Cultivar				
	Kaempo	Hinodeqiri	Firedance	Salix	Mean
Dichlobenil mulch	2.5	4.7	2.0	19.4	6.9 c x/
Dichlobenil disc	7.9	6.4	6.4	31.2	13.7 b
D986-5G	10.3	9.6	9.6	34.3	16.2 a
Check	10.6	9.4	9.4	34.2	16.3 a

x/ Means followed by the same letter are not significantly different from each other. P.0.05.

Table 3. Average visual score of plant injury of four cultivars four months after application of different herbicides.

Treatment	Cultivar				
	Kaempo	Hinodegiri	Firedance	Salix	Mean
Dichlobenil mulch	3.4 y/	2.7	3.4	1.8	2.8 a x/
Dichlobenil disc	1.5	1.0	1.7	0.5	1.2 b
D986-5G	0.3	0.2	0.2	0.1	0.2 c
Check	0.1	0.2	0.2	0.2	0.2 c

x/ Means followed by the same letter are not significantly different from each other. P. 0.05.

y/ Values determined by visual score: 0= no injury 4= dead plant.

Table 4. Average number of weeds in each container of four cultivars four months after application of different herbicides.

Treatment	Cultivar				
	Kaempo	Hinodegiri	Firedance	Salix	Mean
Dichlobenil mulch	0.0	0.0	0.2	0.2	0.1 c x/
Dichlobenil disc	0.7	0.6	0.8	0.7	0.7 b
D986-5G	1.8	0.6	0.6	0.6	0.9 b
Check	3.2	2.8	2.5	2.1	2.6 a

x/ Means followed by the same letter are not significantly different from each other. P. 0.05.

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EFFECTS OF ALKYL ARYL POLYETHER ALCOHOL ON THE GROWTH OF CORN

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Abstract

Experiments were conducted with field and sweet corn to compare the performance of combinations of 2-chloro-4-ethylamino-6-isopropylamino-S-triazine (atrazine) with either phytobland oil or the surfactant, alkyl aryl polyether alcohol. Minimal differences were found between the spray additives when applied to corn 3 inches in height. In July, however, a local grower found that the surfactant plus atrazine combination applied to corn which was "knee-high" was followed by severe injury to the corn. The injury symptoms included leaf crinkling, necrosis and rolling; distortion of the stalk at the point of ear attachment and crook-necking of the apical end of the stalk. Later observations showed that this injury predisposed the plants to infection by corn smut.

Further research was focussed on investigating the tolerance of corn to the surfactant when treated at different stages of growth with recommended and higher concentrations. A split plot experimental design was employed with growth stage (6, 12, 18 and 24 inches) of corn when treated as main plots and concentration of the surfactant (0, 0.5, 1.0, 1.5 and 2.0 percent v/v) as subplots. All treatments were applied with atrazine at 2 lb/A at a pressure of 30 psi. Injury symptoms characteristic of those following atrazine plus surfactant application were successfully duplicated. Epinastic corn plants were observed in all plots treated at the 18 or 24 inch stage of growth. The data on height and weight of the corn indicated that the maximum concentration of the surfactant that could be safely used was 1.0 percent and that this concentration could be safely applied only to plants 6 inches in height. All other treatments reduced the height and/or weight of the corn. Injury severe enough to cause a 76 and 51 percent reduction in weight and height of corn, respectively, was obtained. This injury also caused a 19 percent reduction in the stand of corn.

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THE RELATIVE EFFECTIVENESS OF CORN HERBICIDES IN THE NORTHEAST ON SELECTED WEED SPECIES

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Over the past four years, 1965 through 1968, a total of six field experiments were conducted in Pennsylvania, New Jersey and New York to investigate the relative effectiveness of certain corn herbicides. Treatments were thus evaluated under varying soil and climatic conditions and weed populations.

Methods and Materials

The Pennsylvania experiments were conducted in 1965 and 1966 on a silt loam soil in that state's northern tier. In New Jersey the two experiments were conducted in 1967 and 1968 on a light soil, low in O.M., near Bordentown. The New York work was also carried out in 1967-68. These tests were both at the Agway development farm at Lafayette - soil type is a gravelly silt loam.

All materials were applied with a CO_2 pressure, hand carried, glass bottle sprayer. Volume was equivalent to 60 gals. per acre and pressure 30 lbs. p.s.i.

The New York and Pennsylvania tests were replicated four times - in New Jersey in 1967 and 1968, two and three times respectively.

All plots consisted of two rows of corn and were 6 X 30 feet. A randomized block design was used as the experimental design.

Corn varieties included Pennsylvania 555, Pennsylvania 290, Cornell M-3, Agway Exp. 701 and Michigan 250. Weather conditions at time of spraying were suitable and growing conditions were adequate for a good corn crop all four years.

The timing of preemergence applications was at the day of planting or 1-2 days afterward. Early postemergence treatments were sprayed when weeds were in $1\frac{1}{2}$-3" stage. The post directed spray of linuron was applied when the weeds were approximately 8".

The weed spectrum varied between and within locations. The earliest test in New Jersey provided a good infestation of common ragweed, *Ambrosia artemisifolia* L., lambsquarters, *Chenopodium album* L., and yellow foxtail,

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Setaria glauca (L.) Beauv. In 1968 the New Jersey experiment was moved to a nearby field which was heavily infested with: fall panicum, Panicum dichotomiflorum Michx. It also provided information on the control of green foxtail, Setaria viridis (L.) Beauv., common ragweed and lambsquarters.

The Pennsylvania tests were conducted in the same field on two succeeding years. Weed population did not vary greatly and included: wild mustard, Brassica kaber, lambsquarters, redroot pigweed, Amaranthus retroflexus L., common ragweed, green foxtail and a scattering of witchgrass, Panicum capillare L., and yellow nutsedge, Cyperus esculentus L.

The New York experiments conducted in 1967-1968 also remained at the same location each year. The broadleaf weeds consisted of redroot pigweed, lambsquarters and in 1967 common mallow, Malva neglecta Wallr. In 1968 the spectrum modified itself somewhat to include both yellow and green foxtail and an excellent stand of fall panicum.

Results and Discussion

The results are summarized in Table I. This table presents ratings by species of selected treatments from the six experiments. All ratings represent the average or range from at least half the tests. While over 150 treatments were evaluated over the four-year period, only the potential commercial ones are reported here.

Visual corn injury was relatively minor or nonexistent in all cases except with EPTC. This injury occurred in 1966 at the Pennsylvania site when there was an inadequate time lapse between treatment and planting. The other thiolcarbamate, butylate, did not cause any injury in this series of experiments.

Mustard was controlled by the triazines and the substituted ureas. The thiolcarbamates and the acetanilides were weak on this specie.

Lambsquarters and redroot pigweed appeared to be controlled equivalently by the same treatment. Most materials controlled these species, however control with butylate was both poor and variable. This may have been due to variability in incorporation methods between experiments. Another specie not controlled by butylate was ragweed.

The triazines as a group gave excellent control of the setaria spp. and in this respect were somewhat superior to the substituted ureas. CP-50144 gave better control of green and yellow foxtail than propachlor.

Fall panicum was not controlled by atrazine either pre or postemergence. However, several of the newer triazines were active in this specie. These

Table I

Ratings on Crop Injury and Weed Response 1965-1968
Selected Treatments from Experiments
in New York, New Jersey and Pennsylvania

Treatment No. and Formulation	Rate	Timing	Corn Injury	Annual Grass Control: Yellow & Green Foxtail	Annual Grass Control: Fall Panicum	Annual Grass Control: Witchgrass
1. atrazine	1.0	pre	0[1/]	8-10[2/]	2	-
	2.0	pre	0	9-10	4	-
	2.0	pre inc	0	9-10	1-2	-
2. atrazine +	.75 + .75	pre	0-1	9-10	9	-
linuron	1.0 + 1.0	pre	0-1	8-9	9-10	10
3. atrazine +	1.0 + 2.0	pre	0	9-10	7-8	-
propachlor	1.0 + 4.0	pre	0	9-10	8-9	10
4. atrazine +	1.0 + 1.0	pre	0	10	9-10	-
CP-50144	1.0 + 2.0	pre	0	10	10	-
5. atrazine + butylate	1.0 + 1.0	ppi	0	9	-	-
6. atrazine +	1.0 + 1.0	pre	0	10	8	-
prometryne	2.0 + 2.0	pre	0	10	9	-
7. atrazine +	.6 + 2 gals.	early post	0	5-7	1	-
Booster Oil[3/]	1.0 + 2 gals.	early post	0	7-10	1-3	-
	2.0 + 2 gals.	early post	0	8-10	4	-
8. atrazine + Booster Oil + 2,4-D (amine or ester)	1.0 + 2 gals. + .125 lbs.	early post	0	9-10	2	-
9. atrazine +	1.0 + 1 qt.	early post	0	-	-	-
Booster Plus[4/]	1.0 + 1 qts.	early post	0	10	-	-
10. GS-13529	2.0	pre	0	5-9	1	5
	4.0	pre	0	10	5	6
11. GA-278	2.0	pre	0	8-9	3-8	-
(atrazine + GS-14254)	4.0	pre	0	10	10	-
12. SD-15418	2.0	pre	0	10	9	-
	4.0	pre	0	10	10	-
13. EPTC	3.0	ppi	0-9	4	-	-
	4.0	ppi	0-9	8	-	-

[1/] Crop Response 0 = no injury 10 = crop dead
3 = commercially acceptable injury - = not enough data

[3/] Booster Oil - Paraffin base petroleum oil SUS 106.

Table I

Continued

Treatment No.	Nutsedge Control	Broadleaf Weed Control: Wild Mustard	Lambsquarters	Redroot Pigweed	Common Ragweed	Common Mallow
1.	-[2/]	10	8-10	10	8-10	10
	-	10	10	10	10	-
	3	10	10	9-10	10	10
2.	-	-	10	10	-	-
	3	10	9-10	10	10	-
3.	-	10	10	10	10	-
	4	10	10	10	10	-
4.	-	-	10	10	10	-
	-	-	10	10	10	-
5.	-	-	10	10	-	-
6.	-	-	10	10	-	-
	-	-	10	10	-	-
7.	2	10	9-10	10	9-10	6
	1	10	10	10	10	10
	4	10	10	10	10	10
8.	1	-	10	10	10	10
9.	-	-	10	10	-	10
	-	-	10	10	-	10
10.	-	-	9-10	10	10	-
	3	10	10	10	10	-
11.	-	-	10	10	10	-
	-	-	10	10	-	-
12.	-	-	9	8	10	-
	-	-	10	9	10	-
13.	6	-	8	10	9	-
	9	-	9	10	9	-

[2/] Weed Control 0 = no control 10 = perfect control
7 = commercially acceptable - = not enough data

[4/] Booster Plus - 80% Paraffin base oil + 16% polyoxyethylene sorbitan fatty acid ester.

Table I

Continued

Treatment No. and Formulation	Rate	Timing	Corn Injury	Annual Grass Control: Yellow & Green Foxtail	Fall Panicum	Witchgrass
14. butylate	3.0	ppi	0-1	7-10	8	-
	4.0	ppi	0-1	9-10	8	-
15. dicamba	1.0	pre	1	1	-	-
	0.5	post	1	1	-	-
16. 2,4-D amine	0.5	at emerg.	0	2	0	-
17. amiben	3.0	pre	1	9	-	9
18. C-6313	1.0	pre	0	-	-	-
	2.0	pre	0	5-10	8	-
19. VCS-438	2.0	pre	0	-	-	-
	4.0	pre	0	5-10	0-10	-
20. linuron	0.5	pre	0	5	-	-
	1.0	pre	0	6-7	5	9
	1.5	pre	0-1	8-9	9	8
21. linuron + surf WK	2.0 + 1.5 pts.	post directed	0	7-10	5-6	10
22. linuron + propachlor	.75 + 1.5	pre	0	8-10	7	-
	1.0 + 1.0	pre	0	10	8	-
	1.5 + 3.0	pre	0	10	10	-
23. linuron + CP-50144	.75 + .9	pre	0	8-10	8-9	-
	1.0 + 1.2	pre	0	9-10	10	-
24. propachlor	3.0	pre	0	4	-	-
	4.0	pre	0	5-9	6	-
	6.0	pre	0	8-10	8	-
25. CP-50144	1.0	pre	0	9	9	9
	2.0	pre	0	10	7-10	10
	4.0	pre	0	9-10	10	10
26. check			0	0	0	0

Table I

Continued

Treatment No.	Nutsedge Control	Broadleaf Weed Control				
		Wild Mustard	Lambsquarters	Redroot Pigweed	Common Ragweed	Common Mallow
14.	6	0	0-7	3	1	-
	8	0	0-2	3-10	0-3	-
15.	0	8	9-10	7-8	-	-
	0	9	9-10	5-10	-	-
16.	0	10	8	7-9	7-10	0
17.	0	9	9	10	10	-
18.	-	-	5	9	-	-
	-	-	10	10	-	-
19.	-	-	9	9	-	-
	-	-	10	10	-	-
20.	0	-	-	6	6	-
	0	10	8	8-10	8-9	10
	0	10	8	9	7-9	-
21.	10	10	10	8-10	8-10	-
22.	-	-	10	9-10	-	-
	-	-	10	10	10	-
	-	-	10	10	10	-
23.	-	-	10	10	10	-
	-	-	10	10	10	-
24.	0	-	5	5	-	-
	2-3	0	-	5-9	5	-
	2-7	0	6	8-9	-	-
25.	8	-	8	9-10	0-3	-
	6	4	6	8-10	3-9	-
	-	10	9	8-10	9-10	-
26.	0	0	0	0	0	0

included GA 278 (atrazine + 14254), atrazine plus prometryne and SD-15418. The substituted ureas and acetanilides also provided excellent control.

The data on witchgrass and nutsedge is spotty. It is suspected that witchgrass would be susceptible to those chemicals which control fall panicum. Nutsedge was controlled most adequately by the thiolcarbamates.

Summary and Conclusions

Six experiments were conducted in three Northeast states over a period of four years to determine the relative effectiveness of certain corn herbicides on ten weed species.

Atrazine gave excellent control of all broadleaf weeds, green and yellow foxtail, but did not control fall panicum. However, several other triazines appear promising for control of fall panicum. These include prometryne, GS-14254 and SD-15418. Postemergence applications of atrazine with oil did not appreciably enhance its activity on that specie.

The substituted ureas also gave effective control of the broadleaf weed species, green foxtail, yellow foxtail and fall panicum.

The acetanilides were less effective on broadleaf species, but gave excellent control of green foxtail, yellow foxtail and fall panicum.

Combinations of atrazine plus CP-50144 or atrazine plus linuron gave broad spectrum control.

The thiolcarbamates were somewhat variable on broadleaf weeds but gave good control of the setaria spp. fall panicum and nutsedge.

Acknowledgments

The author gratefully acknowledges the assistance of N. A. Ferrant, Agway Crop Specialist, with the two New Jersey experiments.

THE CONTROL OF ANNUAL WEEDS IN SILAGE CORN (1968) 1/

W. R. Hillebrecht and R. S. Bell 2/

A few years ago Atrazine became a standard herbicide for weed control in corn. It eliminates the broadleaved annual weeds but allows a build up of annual grasses such as crabgrass and fall panic grass. A few recent reports (1, 2, 3) indicate that a few new experimental herbicides may control both types of weeds all season long. The objective of this experiment was to test some of the new herbicides alone and in combination for season long control of annual weeds.

Procedure

The area of Bridgehampton silt loam used for this test was previously cropped to silage corn. The previous history of the field indicated that seeds of lambsquarter, redroot pigweed, common ragweed, wild radish, crabgrass, and fall panicum (P. dichotomiflorum) should be present.

Before planting, a 10-10-10 fertilizer, spread at the rate of 700 lb/A, was disked into the soil. At planting, 300 lb/A of the same grade of fertilizer was banded along each row.

The area was planted to silage corn, Penn 209, on May 10. Preemergence herbicides were applied May 20 and 21. The treatments were randomized in a complete randomized block experiment with four replications. The corn was not cultivated after planting except in the hand-hoed checks. These were hoed on June 14, 27 and July 10.

Weed ratings were taken on June 24 and August 20 (1 = no weed control and 10 = complete weed control). The corn was harvested on August 26.

The herbicides used, their rates per acre, weed ratings and yields are shown in the ensuing tables. The chemical names of the herbicides are listed in the appendix.

Results

Preemergence applications of Lasso + atrazine at 1½ + 1 or 1½ + 0.8 lb/A of active ingredient produced all-season control of broadleaved weeds and grasses. These plots averaged 24.6 tons/A green weight compared to only 5.4 tons/A from the untreated check plots. An experimental herbicide SD 15418, incorporated into the soil with a wooden rake, at 3 lb ai/A was as good. It equaled the weed control rating for the hand-hoed checks.

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Table 1. The control of wild radish and other annual weeds in Katahdin potatoes (1968).

Herbicide	Active ingredient lb/A	Yield cwt/A	Wild Radish control 7/3/68	Other annual weeds 8/6/68
Maloran	3	283 a*	10.0 a**	9.6 a**
Linuron + Atrazine	1 + 1	273 ab	9.9 a	9.3 ab
M + B 14255	4	269 ab	10.0 a	8.4 abc
Linuron + Atrazine	1 + 1.5	265 ab	9.9 a	9.5 a
SD 15418 (80W)	2	258 ab	9.9 a	8.4 abc
SD 15418 (80W)	3	250 abc	9.8 a	7.6 bc
Linuron + Patoran	1 + 1	248 abc	9.9 a	9.3 ab
SD 15418 (pre)(WDL)	3	245 abc	9.8 a	8.3 abc
M + B 14255	2	244 abc	9.7 a	8.9 ab
Patoran	2	244 abc	9.9 a	9.5 a
Maloran	2	241 abc	7.5 bc	8.8 ab
Atrazine + Patoran	1 + 1	240 abc	10.0 a	9.8 a
Linuron	2	237 abc	9.9 a	8.8 ab
Atrazine	2	223 abc	9.7 a	9.1 ab
Hand hoed check	-	212 bc	8.4 ab	8.1 abc
SD 15418 (80W)	4	186 c	10.0 a	8.4 abc
CP 44939	4	185 c	6.0 cd	5.0 d
RP 17623	1	183 c	7.0 bc	6.9 c
SD 15418 (post)(WDL)	3	121 d	8.8 ab	2.2 efg
CP 44939	1	116 d	3.7 de	1.5 fg
CP 44939	2	108 d	5.6 d	1.5 fg
SD 15418 (gran)	4	106 d	9.8 a	3.0 e
SD 15418 (gran)	3	101 d	9.8 a	3.2 ef
check	-	38 e	1.0 e	1.0 g

*Data having letters in common are not significantly different at the 5% level by Duncan's multiple range test.

**(10 = complete weed control, 1 = no control)

Atrazine alone did not control the grasses and Lasso alone allowed a heavy growth of broadleaved weeds. The combination of atrazine and Lasso produced the good effect of each herbicide.

Combinations of Ramrod and atrazine, Ramrod + linuron, atrazine + patoran, or single applications of atrazine, linuron, patoran or Primaze allowed annual grasses to grow. In general the annual grasses were not as competitive as the redrooted pigweed and ragweed that grew in most of the other treatments.

Three preparations of SD 15418 were used. Where they were incorporated into the soil they were more effective than when allowed to remain on the surface. Significantly higher yields of corn were harvested where they were incorporated.

All plots receiving chemical herbicides yielded significantly more corn than the untreated check plot.

Summary

Lasso + atrazine at 1.5 + 1 or 1.5 + 0.8 lb/A active ingredient applied preemergence to the corn produced season-long control of broadleaved and grassy annual weeds. The hand-hoed check and SD 15418 (80W) incorporated at 3 lb/A active ingredient also allowed acceptible season-long weed control. All other treatments allowed considerable growth of either grasses or broadleaved weeds before harvest time. The untreated check plots averaged on 5.4 tons/A of silage corn compared to 24.6 tons/A for Lasso + atrazine. Annual grassy weeds were not as competitive with corn as the broadleaved weeds.

Literature Cited

1. Curry, W. L. 1968. Comparisons of herbicide formulations and combinations for weed control in silage corn. Proc. NEWCC 22: 115-118.

2. Duke, W. B. 1968. Herbicides for zero tillage corn production - A preliminary report. Proc. NEWCC 22: 127-129.

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Appendix

Material	Chemical Name	Company
Atrazine (80W)	2-chloro-4-ethylamino-6-isopropyl-amino-a-triazine	Geigy
Linuron (50W)	3(3,4-dichlorophenyl)-1-methoxy-1-methylurea	DuPont
Ramrod (65W)	2-chloro-N-isopropylacetanilide	Monsanto
Lasso (4 lb/gal)	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide	Monsanto
Patoran (50W)	3-(p-bromophenyl)-1-methyl-1-methoxyurea	Ciba
Primaze (80W)	atrazine + caparol	Geigy
Caparol (80W)	2,4-bis(isopropylamino)-6-methyl-thio-A-triazine	Geigy
SD 15418 (80W)	2-(chloro-6-ethylamino-S-triazine-2-ylamino) 2-methylpropionitrile	Shell
SD 15418 (4 lb/gal)	" " " "	Shell
SD 15418 (10% gran)	" " " "	Shell

EVALUATION OF SEVERAL PREEMERGENCE HERBICIDES FOR CONTROL OF CRABGRASS IN CORN

J. R. Mitchell and O. S. Wells 1/

The problem of controlling crabgrass in corn fields in New Hampshire has grown sharply in recent years with the increase in the acreage of continuous corn. Investigations were conducted to evaluate individual herbicides and herbicide combinations that have shown promise in previous trials in New Hampshire and other states in the Northeast. The results of this investigation are recorded in this report as percent weed control, crop injury, silage yield and plant population at harvest.

Materials and Methods

A field at the Plant Science Research Farm in Madbury, New Hampshire, was selected for testing preemergence herbicides to control crabgrass in corn. The soil at the site of the trial is described as a Hollis-Charlton fine sandy loam. Silage corn was grown on this field for five years prior to the establishment of the weed control plots. An extremely heavy stand of crabgrass has been present in the last three corn crops.

Preemergence treatments as shown in Table 1 were applied on May 17, 1968, with a CO_2 plot sprayer immediately following planting. A single row approximately in the middle of the 12x25 foot plot area was hand planted at a population of 24,400 plants per acre. The remaining rows in the plot area were planted by machine in 36-inch rows. Each treatment was replicated six times in a randomized block design.

Upon the completion of the herbicide applications, a heavy rain soaked the plots. Rainfall amounting to 9.05 inches occurred between the date of herbicide application (May 17) and June 28. Rainfall accumulation during the months of July and August was only 3.04 inches.

Visual ratings were taken on June 4 and 18, July 2 and 16 to assess the degree of weed control (0 = no control and 10 = complete control of weeds).

Results and Discussion

The first rating of the weed control plots showed a heavy infestation of crabgrass (Digitaria sanguinales (L.) Scop.) and wild radish (Raphanus saphanistrum L.) in the check plots.

Atrazine 80W at 1.25 pounds per acre in combination with Lasso 4E at 1 pound per acre provided very good annual grass and broadleaf weed control throughout the sixty day rating period. Observations at the time of harvest

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indicated that crabgrass and wild radish were controlled during the entire season. This combination is very promising for commercial use in the control of common broadleaf and annual grass weeds. The highest silage yield was harvested from plots receiving this combination.

Linuron 50WP and Atrazine 80W at 2 and 1.25 pounds per acre, respectively, provided control of annual grasses and broadleaf weeds throughout the entire season. The same combination at 1.20 and .80 pounds per acre, respectively, did not provide comparable control of annual grasses. This combination at the low rate produced 4.2 tons of silage per acre less than the combination at the high rate.

Linuron 50WP applied at 2 pounds per acre gave slightly less control of all weeds than the high rate of the linuron and atrazine combination, but the silage yield was about equal.

Londax 45WP at a 5 pound per acre rate gave grass control equal to that of Linuron at 2 pounds per acre but the broadleaf weed control was somewhat inferior. The silage yield was 0.4 ton per acre less on the Londax plots.

The combination of equal amounts of Atrazine 80W and Simazine 80W, totaling 2.5 pounds of herbicide per acre, provided season-long control of both annual grasses and broadleaf weeds. Silage yields were within 1.5 tons of the best treatment (Atrazine-Lasso).

Lasso and Linuron in combination gave total weed control similar to Atrazine plus Simazine. The grass control was slightly superior and the broadleaf control slightly inferior.

Primaze 80W at 2.5 pounds per acre was slightly inferior to Atrazine or Atrazine-Simazine in the control of broadleaf weeds but gave crabgrass control which was lacking on the Atrazine plots. Atrazine 80W at 2.5 pounds per acre resulted in a low yield due to the heavy infestation of crabgrass.

Ramrod 65WP and Atrazine 80W in combination at rates of 4 and 1.25 pounds per acre, respectively, provided good broadleaf control during the entire season. Grass control was slightly superior to Atrazine alone during the first month of the trial. Following heavy rains, this combination appeared to lose its effectiveness for control of crabgrass.

As is shown in Table 1 there was little grass control with Dicamba, Ramrod, or the Dicamba-Atrazine combination.

Silage yields from plots receiving a combination of Atrazine-Dicamba, Dicamba, Ramrod, or Lasso were reduced by 30 percent or more due to the lack of weed control. However, Lasso provided acceptable grass control and the Atrazine-Dicamba combination gave good broadleaf control.

Summary

There were severe reductions in silage corn yields in those plots treated with chemicals that were not effective in controlling either crabgrass or

broadleaf weeds, or both. Where there was a lack of broadleaf control during the entire season, the yield reduction was largely due to a reduction in the corn population.

Lack of broadleaf control, especially wild radish, was more critical in producing a high yield than lack of annual grass control, more specifically crabgrass. In the check plots, crabgrass growth was markedly reduced as the wild radish approached the flowering stage.

Crabgrass was a problem only when there was good control of broadleaf weeds. Consequently, a treatment to control broadleaf weeds must include a chemical to also control crabgrass. Any combination of chemicals which included 1.25 pounds per acre of Atrazine gave good control of wild radish and other broadleaf weeds.

Several combinations of herbicides gave satisfactory broad-spectrum weed control. Linuron was the only single herbicide that gave equally good control.

Table 1. The effects of 15 herbicides and herbicide combinations on the control of weeds in corn.

		Weed Control Ratings							
		Grasses				Broadleaves			
Herbicide	Rate	6-4	6-18	7-2	7-16	6-4	6-18	7-2	7-16
Atrazine 80W	1.25	9.4	9.4	9.2	8.2	9.7	9.6	9.6	9.1
Lasso	1.0								
Igran 80W	2.5	7.3	7.3	6.2	4.0	9.4	9.0	8.9	8.3
Atrazine 80W	1.25	8.3	8.7	8.5	8.0	9.4	9.8	9.6	9.6
Linuron 50WP	2.0								
Linuron 50WP	2.0	7.9	8.9	9.0	7.5	8.5	8.6	8.7	8.0
Londax 45WP	5.0	9.5	8.7	8.7	8.3	7.7	7.8	7.5	7.0
Atrazine 80W	1.25	9.3	8.2	8.7	8.2	9.5	9.6	9.7	9.7
Simazine 80W	1.25								
Lasso 4E	1.0	8.2	9.6	9.6	9.0	9.3	9.6	9.0	9.0
Linuron 50 WP	2.0								
Primaze 80W	2.5	9.2	7.8	7.7	7.8	9.2	9.3	9.3	9.4
Atrazine 80W	2.5	7.0	3.6	2.3	1.0	9.8	9.8	9.7	9.7
Atrazine 80W	1.25	8.5	6.1	4.5	2.0	9.1	9.3	9.0	9.0
Ramrod 65 WP	4.0								
Atrazine 80W	.8	8.2	8.0	7.4	6.2	9.2	9.0	8.9	8.5
Linuron 50 WP	1.2								
Atrazine 80W	1.25	7.0	3.0	2.3	1.0	9.5	9.5	9.5	9.5
Dicamba	1.0								
Lasso 4E	1.0	9.1	9.1	8.0	7.3	4.2	4.4	2.3	0
Ramrod 65WP	4.0	9.0	6.1	5.6	5.0	3.0	3.5	.7	0
Dicamba	1.0	5.0	2.0	1.9	1.3	4.5	4.6	4.6	3.0
Check (uncultivated)		0	0	1.3	2.7	0	0	0	0

Table 2. The effects of 15 herbicides and herbicide combinations on the silage yield and plant population.

Herbicide	Rate lbs./acre	Tons of silage/acre	Plant count at harvest
Atrazine 80W	1.25	19.2	21,300
Lasso 4E	1.0		
Igran 80W	2.5	18.8	23,200
Atrazine 80W	1.25	18.3	22,500
Linuron 50WP	2.0		
Linuron 50WP	2.0	18.3	22,200
Londax 45WP	5.0	17.9	22,900
Atrazine 80W	1.25	17.8	22,700
Simazine 80W	1.25		
Lasso 4E	1.0	17.5	20,900
Linuron 50WP	2.0		
Primaze 80W	2.5	16.9	22,600
Atrazine 80W	2.5	15.1	23,000
Atrazine 80W	1.25	14.3	22,900
Ramrod 65WP	4.0		
Atrazine 80W	.75	14.1	20,900
Linuron 50WP	1.2		
Atrazine 80W	1.25	13.4	22,200
Dicamba	1.0		
Lasso 4E	1.0	11.4	20,100
Ramrod 65W	4.0	10.2	18,100
Dicamba	1.0	8.6	16,900
Check (uncultivated)		7.1	13,500

ANNUAL WEED CONTROL IN FIELD CORN 1968

Jonas Vengris 2/

The main objective of our 1968 field trials was to determine the effectiveness and practicability of some new and more promising herbicides or herbicide combinations which would give better annual weed control in field corn.

Procedure

The trials were conducted at Amherst on a fine sandy loam with only fair drainage. A randomized block design with three replicates was used. Each plot consisted of four corn rows 25 feet long. The seedbed was prepared on June 4 and on June 6 G-17A field corn was planted. Pre-emergence treatments were applied on June 7. Within 48 hours after application of pre-emergence treatments rain occurred and thus soil moisture conditions for herbicides should be considered as good. Post-emergence treatments were applied 14 days after corn was planted on June 20. At that time corn was about 5-6 inches tall and the barnyardgrass was about 2-3 inches tall and in 3-leaf stage of growth. Red root pigweed, lambsquarters and purslane seedlings were in 4-leaf stage of growth and ½ to 2 inches tall.

A list of treatments is presented in Table I. All herbicide rates presented in Table I are expressed in pounds of acid equivalent or active ingredient per acre. The month of June was rather rainy and assumingly soil moisture conditions were above optimum. On the contrary, July and August were dry and the water supply for normal corn was below optimum.

The effects of different treatments on weeds and corn were observed throughout the growing season. The weed population, in the order of their relative frequency, was made up of the following species: barnyardgrass (*Echinochloa crusgalli* (L.) *Beauv.*), red root pigweed (*Amaranthus retroflexus*), crabgrass (*Digitaria sanguinalis*), common purslane (*Portulaca oleracea*) and lambsquarters (*Chenopodium spp.*). Some plots were infested with nutsedge (*Cyperus esculentus*). This perennial weed was not uniformly scattered throughout the experimental area.

Results and Discussion

Weed control as well as corn yield results are recorded in Table I. Without exception all herbicides or their combinations on the whole significantly controlled weeds.

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1 Contribution of the Massachusetts Agricultural Experiment Station, College of Agriculture, University of Massachusetts, Amherst, Massachusetts.

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Also all treatments without exception produced significantly higher yields than the check plots. No significant differences were found in yields between various herbicides or their rates applied. Post-emergence applications of dicamba in combination with Ramrod produced the lowest yields. This is due to the relatively poor control of barnyardgrass.

Close observations during the growing season indicated that corn was somewhat stunted or impared by the following treatments: (a) atrazine plus oil (b) primaze at 4 lb/A rate and (c) RP 17623 at 1 lb/A. Apparently in all of these cases the corn injury was slight and yields were not significantly affected.

TABLE I
WEED CONTROL AND SILAGE CORN YIELDS IN 1968
RELATIVE VALUES. CHECK = 100

Treatments	Weed stands			
	Barnyard-grass	Crab-grass	Broad-leaved w.	Corn yields
1. Atrazine, 2 lb/A, pre-e.	3	10	1	155
2. Atrazine, 2 lb/A, post-e.	3	5	1	156
3. Atrazine and oil, 2+2 g/A post-e.	1	2	1	148
4. Primaze, 2 lb/A, pre-e.	8	11	3	160
5. Primaze, 4 lb/A, pre-e.	2	3	2	148
6. CP 50144, 1 lb/A pre-e.	21	9	21	151
7. CP 50144, 2 lb/A pre-e.	9	3	31	145
8. CP 50144 + atrazine, 1+1, pre-e.	2	3	1	155
9. Dicamba + Ramrod ½ + 2, pre-e.	19	12	45	150
10. Dicamba + Ramrod ½ + 3, pre-e.	14	5	83	142
11. Dicamba + Ramrod ¼ + 2, post-e.	49	13	10	132
12. Dicamba + Ramrod ¼ + 3, post-e.	51	12	3	137
13. Dicamba + atrazine ¼ + 1, post-e.	5	15	1	160
14. RP 17623, ½ lb/A, pre-e.	23	5	5	165
15. RP 17623, 1 lb/A, pre-e.	13	4	8	157
LSD at 5%	6	7	12	NS
LSD at 1%	9	9	17	

Over all, the best weed control and the most practical treatments were those where atrazine alone or in combination with oil, primaze or CP 50144 was used (treatments 1, 2, 3, 4, 5 and 8). Poorest barnyardgrass control was obtained by dicamba and Ramrod post-emergence treatments, dicamba and Ramrod pre-emergence treatments and CP 50144 1 lb./A rate. Pre-emergence treatments of CP 50144 and combinations of dicamba plus Ramrod did a rather poor job in broadleaved weed control (e.g. purslane, lambsquarters and red root pigweed). Here it is interesting to note that dicamba and Ramrod post-emergence treatments did much better at purslane control (treatments 11,12) than these herbicides applied as pre-emergence treatments (treatments 9,10). Apparently this was due to the poor control of barnyardgrass by treatments 11 and 12; heavy shading of thick and tall barnyardgrass excluded growth and development of purslane.

Nutsedge was effectively suppressed by atrazine, primaze and 2 lb/A rate of CP 50144. Atrazine alone in comparison with atrazine and oil was less effective in nutsedge control.

In the fall at harvest time some annual weedy grasses such as crabgrass increased. This weedy grass was more common in plots treated with dicamba and Ramrod.

Summary and Conclusions

The best weed control was obtained by atrazine 2 lb/A pre-emergence or post-emergence treatments. Oil added to atrazine significantly increased annual weedy grass control in field corn. Monsanto CP 50144 in combination with atrazine appears to be a practical treatment where annual weedy grasses or atrazine residual effects are a problem.

HERBICIDE USAGE IN NO TILLAGE CROP PRODUCTION

R. A. Peters[1/] and W. L. Currey[2/]

The possibility of growing corn without tillage has been shown by the work of Shear (2) and Triplett (3). The advantages of omitting plowing, seedbed fitting and cultivation are several. There are labor savings on any type of field. The principle gain, however, is on sloping sites where a mulch of dead plant residues markedly reduce soil erosion hazards. Soils difficult to work because of soil texture and/or restricted drainage can be planted much earlier.

Because of the variation between soil types and farming practices it cannot be assumed that no tillage methods which are successful in one area will be so in another. The experiments discussed below give results in situations characteristic of southern New England.

I. No Tillage Planting in Old Sod

The experimental field was a field on the Agronomy Research Farm, Storrs which had not been plowed for over eight years. It was predominantly orchardgrass, Kentucky bluegrass and Colonial bent grass with a fairly heavy infestation of dandelion.

The soil was a Woodbridge fine sandy loam. Several areas in the field are very poorly drained a condition which was aggravated by the high rainfall of May and June. Spotty drainage was the principal factor in the uneven growth obtained.

Methods

A uniform application of 2,4-D at 1 lb ai/A was applied to control the dandelion on November 3, 1967.

The experimental plan used was a randomized block design with three replications. Plots were 21 x 21 feet in size. The cultural and chemical treatments used are given in Table 1.

Fertilization was 200 lb N, 150 lb P_2O_5, and 150 lb K_2O in the form of NH_4NO_3, treble superphosphate and muriate of potash applied as a surface topdressing. G17A corn was seeded on May 28, 1968 at a rate of 26,000 plants per acre. Seedings were made both with a standard Allis Chalmers corn planter

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Table 1. Effects of Treatment on Sod Control and Silage Corn Yields

Treatments[1/, 2/]	Sod Control (0-No-Kill; 10-Complete-Kill) Orchardgrass	Dandelion	Corn Hgt. (cm) July 26, 1968	Silage Corn Yields T/A 30% d.m.
All plots received 2 lb ai atrazine at planting				
1. No treatment prior to seeding	2.7	7.7	133	17.3
2. Paraquat 1 lb Nov. 3, 1967	8.7	6.0	148	23.1
3. Dalapon 10 lb Nov. 3, 1967	9.3	6.3	133	19.1
4. Paraquat 1/2 lb April 25, 1968	8.7	8.3	143	19.7
5. Paraquat 1/2 lb April 25, 1968 followed by rotovation	10.0	10.0	120	21.3
6. Paraquat 1 lb April 25, 1968	8.7	8.7	160	22.4
7. Plowed Nov. 3, 1967 - Disked April 14, 1968	10.0	10.0	127	23.6

1/ All rates in lb ai or ae per A. 2/ X-77 spreader used with paraquat

Table 2. Response of Sod Species, Crabgrass and Corn to Several Herbicides

Treatments[1/, 2/]	Control Ratings - June 29, 1968 (0-No-Kill; 10-Complete-Kill) Alfalfa	Timothy	Dandelion	Crab-grass	Control Ratings Aug. 15, 1968 Crabgrass	Silage Corn Yields T/A 30% d.m.
1. Check	2.0	0.0	8.7	6.4	3.4	7.0
2. Paraquat 1/2 lb + atrazine 1 lb	9.0	10.0	7.0	4.7	2.2	16.8
3. Paraquat 1/2 lb + atrazine 1 lb (June 4)	5.0	10.0	10.0	10.0	6.1	19.5
4. Paraquat 1/2 lb + atrazine 1 lb + 2,4-D 1/2 lb	10.0	10.0	7.0	2.0	1.7	14.0
5. Paraquat 1 lb	6.7	10.0	6.7	3.7	0.6	10.9
6. Paraquat 1 lb + 2,4-D 1 lb	8.0	9.3	7.3	2.7	2.5	10.9
7. Paraquat 1 lb + dicamba 1/2 lb	10.0	10.0	7.3	1.0	1.4	10.7
8. Atrazine 2 lb + 2,4-D 1 lb	9.3	10.0	7.3	6.0	3.1	19.4
9. Plowed + atrazine 1 - linuron 1	10.0	10.0	10.0	10.0	10.0	24.3

1/ All treatments in terms of ai or ae per A.
2/ All were applied on April 29, unless specified.

with double disk openers and with a series 600 Allis Chalmers No-Til corn planter designed specifically for no tillage plantings.

Results and Discussion

Sod Control

There were distinct differences in response to treatment among the species present in the sod. Kentucky bluegrass was readily controlled by all treatments including the 2 lb atrazine at time of planting. Orchardgrass control was very poor, however, without supplemental treatment. While paraquat alone was not included in this experiment, other trials have shown poor control of orchardgrass from this material alone. The combination of paraquat and atrazine appears to have a synergistic effect on this species.

Dandelion control was distinctly poorer in the plots receiving the fall treatments than in the spring treated plots. The relative inactivity of the dandelion at the time of the treatment (November 3) may have been responsible for the poor control obtained.

Corn Growth

The non-tilled plots could be readily discerned early in the growing season because of the greater height of the corn. Table 1 gives the height for each treatment on July 26, 1968. By the end of the season the height differences were not distinct.

Corn yields in two of the treatments approached the plowed plots in tonnage (Table 1). These treatments were paraquat 1 lb per acre in either November or April followed by atrazine at 2 lb per acre at the time of corn seeding.

Yields were somewhat lower when dalapon or the 1/2 lb rate of paraquat was used but these treatments were distinctly superior to the plots which received only atrazine at the time of planting. The poorer yield in the latter plots were clearly related to the poor orchardgrass control.

In plots seeded with the conventional disk opener corn planter the stand was reduced by 13% reflecting the poorer coverage obtained in planting. Further work should be done on possible small modifications of commonly available corn planters which would permit their use in no-tillage systems.

II. Relative Effectiveness of Several Herbicides Used in Sod Kill

Methods

The experimental area at the Agronomy Research Farm had been seeded in August, 1966 to adjacent strips of alfalfa, timothy-alfalfa, and timothy.

Chemical and cultural treatments (Table 2) were applied across these strips replicated three times. Spraying was done at a rate of 40 gal per acre. At the time of the April 29 treatment the forages were 4-6 inches tall.

The chemical treatment applied on June 4, seven days after corn planting, was applied after mowing of the existing vegetation. Crabgrass seedlings in the 1-2 leaf stage were numerous in these plots at the time of treatment.

One plot in each replication was plowed and disked in mid-April in the conventional manner including disking in of the fertilizer application. This strip received a mixture of atrazine and linuron at 1 lb ai per acre on June 4, just prior to corn emergence.

Fertilization was a broadcast application using NH_4NO_3 to give 200 lb N, treble superphosphate to give 100 lb P_2O_5 and muriate of potash to give 150 lb K_2O per acre.

G17A corn was seeded on May 28 with the Allis Chalmers Series 600 No-Til Planter at a rate of 25,000 stalks per acre.

Results and Discussion

Control of timothy sod was complete with all chemicals. With alfalfa, however, control from paraquat alone was poor as shown in Table 2. Paraquat combined with 2,4-D, dicamba or atrazine gave kill as did atrazine plus 2,4-D. The low injury rating in Treatment 3 (June 3) was due to the short time lapse since application. Kill, however, eventually occurred.

The dandelion infestation was actually greater in some of the treated plots than in the checks due to release from competition with the other sod species present.

Crabgrass proved to be a major problem in this experiment. Growth of crabgrass in the untreated plots was less than in most treated plots since the crabgrass was released from competition from the perennial sod crop. Except for Treatment 3 all the treatments were applied before the crabgrass germinated. Only the atrazine 2 lb + 2,4-D had sufficient residual influence to inhibit crabgrass growth. As of June 29 Treatment 3, paraquat 1/2 lb plus atrazine 1 lb, gave good initial control since the paraquat killed the young seedlings which had germinated (Table 2). Crabgrass subsequently germinated in all plots, however. Paraquat has no residual effect thus kills only plants emerged at the time of spraying. Atrazine has been shown to be quite weak in controlling crabgrass (1).

In this experiment corn yields were greatest in the plowed plots (Table 2). Yields approaching the plowed plots were realized, however, from two treatments: paraquat 1/2 lb + atrazine 1 lb applied on June 4 and atrazine 2 lb + 2,4-D 1 lb applied in advance of planting. These were also the treatments which gave the best crabgrass control. The other treatments all gave yields greater than the check in which the sod was not killed. The severe competition realized from the crabgrass volunteering in the dead sod seriously restricted the potential yields.

Two conclusions can be drawn from this experiment, namely, 1) that alfalfa-timothy sod can be sufficiently controlled by chemicals to permit growth of corn on this soil type without tillage and 2) some method must be used to control crabgrass if optimum yields are to be realized.

III. Demonstrations on Commercial Farms

In cooperation with Mr. David Breakell of the Woodbury, Connecticut Vo-Ag Center, large scale trials were conducted on three commercial dairy farms with a variety of conditions. In each instance the treatments were paraquat 1/2 lb ai per acre with X-77 wetting agent plus atrazine 1 lb ai per acre applied at a 1X and 2X rate on May 8, 1968. An Allis-Chalmers No-Til corn planter was used for planting. Pa 602A corn was used at one location and Todd 645 at the other two locations.

A. Planting in a Rye Cover Crop

In corn stubble from 1967 the No-Til planter seeded readily in the standing rye up to 3 feet in height when seeded on June 6 one month following chemical treatment. Kill was not yet complete but eventually occurred at both chemical rates. Silage corn growth was very satisfactory. At the end of the season the only weed growth was a very limited infestation of crabgrass.

B. Planting in Corn Stubble

The only vegetation present at the time of spraying was scattered patches of quackgrass. This species was sufficiently suppressed so as not to be competitive to the corn. There was no difficulty in getting a satisfactory corn stand. Yields in parts of the block were seriously depressed, however, by a heavy invasion of crabgrass.

C. Planting in Established Sod

Two sod plantings were made. Site 1 was a very poorly drained area containing Kentucky bluegrass, orchardgrass, quackgrass and dandelion. At the time of planting the higher rate (paraquat 1 lb - atrazine 2 lb) had given good kill of all the grass species but not of dandelion. The lower rate killed the bluegrass but gave poor control of the orchardgrass and quackgrass as well as dandelion. At the time of planting, water was standing in some places in the block. Corn stands were erratic as was corn growth in large part due to soil conditions. It was apparent in September that only the higher rate of chemical had suppressed the sod enough to be non-competitive to the corn. Where the lower rate (paraquat 1/2 lb + atrazine 1 lb) was used there was a 75% cover of quackgrass and dandelion.

The second sod area contained alfalfa, Kentucky bluegrass, smooth bromegrass, orchardgrass and dandelion. As in the field above the high rate on June 6 controlled top-growth of bluegrass, orchardgrass and bromegrass. Alfalfa and dandelion control was quite poor on this date. At the lower rate bluegrass was killed but only a 75% top-kill of brome and quackgrass was obtained. Corn stands were again erratic but growth was very good. By September 25 the only plants remaining in the sod at either rate of treatment were dandelions. The competition of the corn plants was probably a factor in the eventual elimination of the other sod species.

Summary

The potential for no tillage silage corn production in three cropping systems was shown. They were 1) corn stubble, winter cover crop and in perennial sod. Atrazine is a satisfactory basic herbicide but if a cover crop or a sod is involved paraquat hastens and increases the degree of kill. Since established alfalfa and dandelion are rather resistant to both of these chemicals, 2,4-D may be added to insure kill.

Surface application of the standard granular fertilizer proved to be quite satisfactory during the 1968 season, a year with above normal rainfall during the first part of the growing season.

Crabgrass proved to be a very serious problem in some plots. Paraquat, applied before emergence, and atrazine, regardless of time of application, was weak on this species. Delaying paraquat applications until just before corn emergence will kill any emerged crabgrass plants. In fields where crabgrass is expected a preemergence treatment of an herbicide effective on annual grasses will be needed.

The fine sandy loam soils involved in these experiments appear to be of ideal texture for the no tillage practices described since they do not seriously restrict penetration of the corn planter nor do they tend to crust over without cultivation as do many silty soils.

In terms of silage corn yields the results were very encouraging but somewhat erratic. While commercial no tillage corn production can be encouraged in fields with stubble or cover crops, direct seeding into treated sod remains inconsistent and should be evaluated further.

Acknowledgments

We wish to acknowledge the commercial companies who supplied us with herbicides. We also wish to thank the Allis Chalmers Company for supplying the AC series 600 No-Til Planter used in these investigations.

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HERBICIDES AND COMBINATIONS FOR WEED CONTROL IN CORN[1/]

J.V. Parochetti[2/]

One of the most important steps in herbicide combination work is careful planning. For each component the following should be known: weed spectrum (susceptible, intermediate, and resistant), crop tolerance, fate in plants and soils, and formulation compatibility. If all goes well the herbicide combinations should result in one or more of the following advantages: broader spectrum of weed control (2), reduced residues in soils and crops, reduced cost, extended control over a longer time, insurance against adverse weather, reduce possible injury on a wide range of soil types and result in desirable interactions.

Many workers have reported favorable results with herbicide combinations in corn (*Zea mays*)(1,3,4,5). The objective was to evaluate herbicides and combinations at three sites in Maryland.

Materials and Methods

In 1967, a corn herbicide combination experiment was established at Royal Oak, Maryland. During 1968, similar studies were conducted at the Forage Research Farm, Clarksville, Maryland and at the Wye Institute. Soil characteristics are noted in Table 1.

TABLE 1. Soil characteristics of experimental sites used in the study.

Experiment Site	Soil	% Mechanical Analysis Sand	Silt	Clay	pH	O.M.
Royal Oak, Md.	Fallsington Sandy Loam	64	29	7	6.4	1.0
Wye Inst., Md.	Bertre Silt Loam	27	54	19	6.4	2.1
Forage Res. Farm, Md.	Elsinboro Clay Loam	31	37	32	6.8	1.9

1/ Scientific Article No. 1484 and Contribution No. 4123 of the Maryland Agricultural Experiment Station, Department of Agronomy.

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Tables 2,3, and 4 give the results obtained for Experiments 1, 2, and 3. The common or coded names and the chemistry of herbicides studied are listed in Appendix 1. Spraying was done with an experimental sprayer at 30 gpa volume. Preplanting incorporated treatments (PPI) were facilitated by rototilling between the planted rows to a depth of three inches.

Percent weed control was rated visually from 0 to 100. A rating of 70 or higher is equivalent to commercially acceptable control and weeds could be removed by cultivation at that stage. Percent vigor reduction was rated from 0 to 100. A rating of 30 or higher was designated as commercially unacceptable crop injury.

The experimental design was a randomized complete block with three replications. Three row plots were 30 feet long and row width was 2.5 feet. No cultivation was employed in these studies.

EXPERIMENT NUMBER 1. Corn hybrid, Pioneer MF 3306, was planted on April 29, 1968, at the Wye Institute, Queenstown, Maryland and treated preemergence and preplant incorporated on May 2. Postemergence application was done on June 5, to three inch tall grass.

EXPERIMENT NUMBER 2. Corn hybrid, Funk G-4473, was planted on June 5, 1968, at the Forage Research Farm, Clarksville, Maryland, and treated preemergence and preplant incorporated on June 6. Postemergence application was made on July 12 on 30 inch high corn.

EXPERIMENT NUMBER 3. Corn was planted on May 3 and treated preemergence on May 5 at Royal Oak, Maryland.

Results and Discussion

EXPERIMENT NUMBER 1. A primary objective of this experiment was to determine the minimum rates of CP 50144 in combination with several herbicides to provide acceptable weed control. Results on weed control and corn yields are reported in Table 2. CP 50144 preemergence at 1.5 lb/A and higher resulted in excellent giant foxtail (*Setaria faberii*) control throughout the season; whereas fall panicum (*Panicum dichotomiflorum*) was almost completely controlled at the low rate of 1 lb/A. CP-50144 was notably weak on lambsquarter (*Chenopodium alba*) and ragweed (*Ambrosia artemisiifolia*). CP 50144 postemergence with

or without Sun oil 11E missed weeds which were controlled by preemergence application; in contrast ragweed control was 85% with a 2 lb/A application plus oil.

There was a little giant foxtail control resulting from atrazine and linuron applied alone at low rates; however, 93% fall panicum control was recorded for 0.5 lb/A linuron.

At the rates studied CP 50144 plus linuron resulted in an inferior giant foxtail control, but other weeds were adequately controlled including smartweed (Polygonum pensylvanicum).

The best combination which resulted in season long, full spectrum, weed control was 1.5 lb/A CP 50144 plus 1.0 lb/A atrazine. A combination of these two herbicides each at reduced rates, resulted in full spectrum weed control; whereas alone at these rates some weeds were not controlled.

EXPERIMENT NUMBER 2. Herbicides and combinations were evaluated at the Forage Research Farm in 1968 (Table 3). Crabgrass (Digitaria sanguinalis) control on July 14 was 100% except for the control, 2,4-D preemergence (80%) and 2,4-D postemergence (33%). Pigweed (Amaranthus retroflexus) control, except for the control, was 85% or higher with all treatments on July 14. Pigweed control declined below 70% on August 26 for linuron (spray), propachlor, CP 50144, and linuron plus CP 50144.

Purslane (Portulaca oleracea) control was generally 80% or greater except for the control, 2,4-D postemergence (40%) and butylate (77%).

Nutsedge (Cyperus esculantus) was a late invader of the plots appearing one month following planting. Butylate and butylate plus atrazine were the only treatments which resulted in 90% or greater control. An unexpected and unexplainable reduction in corn yield was noted with atrazine (1 lb/A) plus butylate (3 lb/A).

A 23% reduction in corn vigor was noted from a granular application of linuron at lb/A; however, a 1 lb/A linuron spray application of linuron did not adversely affect corn vigor. Granular linuron plus propachlor reduced vigor 17% as compared to a 10% reduction with a similar combination as the spray. These vigor reductions did not reduce yields.

EXPERIMENT NUMBER 3. Weed control ratings were made on July 27, 1967 at Royal Oak, Maryland. Similar results (Table 4) were obtained with the following herbicides used alone or in combinations; atrazine plus propachlor, prometryne, simazine, and linuron; grass control was 80% or higher and broadleaved weed control was 93% or higher. Herbicides and combinations which resulted in marginal weed control were linuron plus propachlor, C-6898, metobromuron, C-6898 plus metobromuron, and propachlor alone.

The site was a Fallsington sandy loam and propachlor used alone did not perform well. Simazine used alone at 2 lb/A was the only herbicide which resulted in season long weed control.

SUMMARY

Most of the herbicide combinations studied resulted in equal or better weed control when compared to these herbicides used alone at comparable rates. Linuron plus propachlor and propachlor alone did not perform adequately on a sandy loam in 1967. Linuron and many combinations with linuron resulted in corn vigor reduction on a clay loam soil at the Forage Research Farm in 1968.

Increased spectrum weed control was observed with many of the herbicide combinations investigated. Butylate and butylate plus atrazine were the only herbicides to result in 90% or higher nutsedge control at the Forage Research Farm. This combination and other herbicides with CP 50144 were effective on fall panicum and lambsquarter.

Herbicide combinations have a definite use in weed control. An applicator must know the weed species present, the crop tolerance, and compatibility of the formulations before proceeding. With proper planning, reduced herbicide rates may be possible without reducing herbicidal activity on weed species.

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Appendix I

Common Name	Code Name	Chemical Name
atrazine		2-chloro-4-ethylamino-6-iso-propylamino-triazine
butylate		S-ethyl diisobutylthiocarbamate
	C-6989	p-nitrophenyl 2-nitro-4(trifluo-rometyl) phenol ether
	CP 50144	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
linuron		3-(3,4-dichlorophenyl) - 1-methoxy-1-methylurea
metobromuron		N-(p-bromophenyl)-N'-methyl-N'-methoxyurea
prometryne		2,4-bis (isopropylamino) - 6-methylmercapto-s-triazine
propachlor		2-chloro-N-isopropylacetanilide
simazine		2 chloro-4,6-bis (ethylamino)-s-triazine
2,4-D		2,4-dichlorophenoxyacetic acid

TABLE 2. Evaluation of several herbicides and herbicide combinations for weed control in corn at the Wye Institute, Queenstown, Maryland, 1968.

		% Weed Control, June 19				Oct. 2 % Weed Control		
Treatment	lb/A	Giant Foxtail	Lambsquarter	Smartweed	Ragweed	Giant Foxtail	Fall Panicum	Yield Bu/A
Control	-	0	0	0	0	0	0	59.8
CP 50144 pre	1.0	58.5	73.6	96.8	0	56.7	96.7	92.6
CP 50144 pre	1.5	90.0	65.5	35.0	0	81.3	100.0	93.2
CP 50144 pre	2.0	88.5	57.5	94.4	23.5	92.7	100.0	126.6
CP 50144 pre	2.5	80.0	21.5	85.0	58.8	86.3	100.0	116.6
CP 50144 post	2.0	0	42.5	11.9	62.7	13.3	100.0	67.7
CP 50144+4 gal/A oil post	2.0	76.5	0	5.6	85.0	0	71.7	77.2
Atrazine pre	0.5	0	100.0	100.0	95.4	25.0	56.7	95.1
Atrazine pre	0.75	0	100.0	100.0	100.0	68.3	0	92.4
Atrazine pre	1.0	18.5	100.0	100.0	100.0	46.3	20.0	97.8
Linuron pre	0.5	0	100.0	98.3	78.4	15.0	93.0	79.0
Butylate ppi	2.0	61.5	91.9	55.6	0	20.0	100.0	89.9
CP 50144 + Atrazine pre	1.0+0.75	90.0	100.0	55.6	100.0	78.3	99.0	114.1
CP 50144 + Atrazine pre	0.75+0.5	93.5	100.0	100.0	100.0	86.3	75.0	135.3
CP 50144 + Atrazine pre	1.5+1.0	98.5	100.0	100.0	100.0	96.7	95.0	131.8
CP 50144 pre + Butylate ppi	1.0+2.0	96.5	69.0	46.2	32.7	83.3	100.0	127.4
CP 50144 pre + Butylate ppi	1.5+2.0	98.5	96.5	96.8	78.4	96.3	98.0	112.7
CP 50144 + Linuron pre	1.0+0.5	61.5	100.0	98.3	100.0	83.0	98.0	126.6
CP 50144 + Linuron pre	1.5+0.5	61.5	100.0	100.0	98.0	88.3	98.3	114.6

$LSD_{0.05}$ = 33.8

TABLE 3. Evaluation of several herbicides and herbicide combinations for weed control in corn at the Forage Research Farm, Clarksville, Maryland, 1968.

Treatment	lb/A	July 14 vigor reduction corn	% Weed Control July 14 Purslane	Aug. 26 Pigweed	Aug. 26 Nutsedge	Yield Bu/A
Control pre		0	0	0	0	61.5
Atrazine pre	2	0	100.0	100.0	75.0	125.0
Linuron pre	1	3	100.0	58.0	83.0	94.4
Linuron (granular) pre	1	23	83.0	93.0	65.0	114.1
Propachlor pre	5	0	90.0	68.0	82.0	94.2
CP 50144 pre	2	0	100.0	65.0	75.0	98.9
Linuron + CP 50144 pre	1+1	10	100.0	37.0	58.0	85.9
Prometryne pre	2	7	100.0	98.0	75.0	96.3
Atrazine + Linuron pre	.5+.5	3	100.0	100.0	57.0	81.9
Atrazine + Linuron pre	.75+.75	0	100.0	100.0	75.0	90.6
Atrazine + Prometryne pre	1+1	0	100.0	97.0	55.0	89.9
Atrazine + Butylate pre	1+3	0	100.0	97.0	93.0	75.7
2,4-D pre	1	3	100.0	83.0	75.0	101.5
2,4-D post	1/2	0	100.0	95.0	37.0	75.8
Atrazine + CP 50144 pre	1+1	0	40.0	97.0	85.0	88.3
Atrazine + CP 50144 pre	1+1.5	3	100.0	93.0	52.0	93.9
Atrazine + Propachlor pre	1+3	3	100.0	97.0	87.0	103.7
Linuron + Propachlor pre	.875+1.75	10	98.0	96.0	60.0	90.4
Linuron + Propachlor (granular) pre	.875+1.75	17	100.0	87.0	50.0	98.9
Linuron + Butylate pre	.5+2	0	100.0	97.0	78.0	82.4
Linuron + Butylate pre	.5+1.5	0	100.0	97.0	71.0	100.8
Linuron + CP 50144 pre	.5+1.5	10	98.0	97.0	55.0	111.5
Butylate ppi	4	0	77.0	82.0	97.0	90.4
					$LSD_{0.05}$ =	26.8

TABLE 4. Evaluation of several herbicides and herbicide combinations used preemergence for weed control in corn at Royal Oak, Maryland, 1967.

Treatment	lb/A	July 27, 1967 % Control GW[1/]	BLW[2/]	Yield Bu/A
Control	-	0	0	102.0
Atrazine + propachlor	1+3	83	100	118.4
Atrazine + prometryne	1+1	95	100	123.1
Atrazine + simazine	1+1	90	100	119.6
Linuron + atrazine	0.5+0.5	80	93	115.4
Linuron + propachlor	0.5+1.5	70	70	115.3
Atrazine	2	95	100	-
Propachlor	3	57	70	123.1
Linuron	1	82	95	121.2
C-6989 + metobromuron	2+1	78	53	113.8
C-6989	2	72	68	117.2
Metobromuron	1	73	73	112.7
Prometryne	2	90	95	114.0
Simazine	2	100	100	102.5
			$LSD_{0.05}$ =	18.6

1/ GW = fall panicum and goosegrass

2/ BLW = lambsquarter, pigweed, morningglory

CHEMICAL COMBINATIONS FOR CORN WEED CONTROL[1/]

W.B. Duke and R.F. Lucey[2/]

Abstract

Competition of weeds with corn is known to cost the farmer millions of dollars each year. Some weed problems have been controlled through proper choice and use of herbicides, however, other weeds, especially grasses, have escaped control and are serious problems. These shifts in weed ecology or populations due to the continuous use of one herbicide or practice, coupled with the need for broader spectrum weed control and need for reduced residues has increased the interest in herbicide combinations to combat these problems.

A three year study was established in 1967 to study the effects of several herbicide combinations on the control of weeds in corn. Sites chosen for the experimental areas had received from 2 to 4 lb/A atrazine for a period of one to three years. These sites were specifically chosen because of the known grass weed escapes. The variables studied were 2-chloro-4-isopropylamino-6-ethylamino-s-triazine (atrazine) at 1 lb/A in combination with the following materials: a) 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron) at 1 lb/A; b) 2-chloro-N-isopropylacetanilide (propachlor) at 3 lb/A; c) 2-chloro-2'6'-diethyl-N-(methoxymethyl)acetanilide (CP 50144) at 1 and 2 lb/A; and d) 2,4-bis(isopropylamino)-6-methylmercapto-s-triazine (prometryne) at 1 lb/A. Each chemical was applied alone for comparison. Primary weed species present were yellow foxtail (*Setaria glauca* L. Beauv.), witchgrass (*Panicum capillare* Michx.), green foxtail (*Setaria verides* L. Beauv.), pigweed (*Amaranthus spp.*), and lambsquarter (*Chenepodium album* L.).

Combinations of atrazine with CP 50144 were the most effective for control of the annual grasses and broadleaves followed in order of effectiveness by atrazine plus linuron, atrazine plus propachlor, and atrazine plus prometryne. Distinct advantages for combining herbicides were obvious. For example, plots receiving atrazine at 1 or 2 lb/A were infested with yellow foxtail and witchgrass while plots treated with propachlor or CP 50144 had high levels of broadleaves. Plots receiving combinations were clean indicating additive effects as a result of mixing compatable chemicals. Herbicide combinations were also shown to have no effect on succeeding crops such as alfalfa or oats.

1/ Contribution from the Department of Agronomy, New York State College of Agriculture, Cornell University, Ithaca, New York.

2/ Assistant Professor and Associate Professor, respectively. Department of Agronomy, Cornell University.

CONTROL OF FALL PANICUM (PANICUM DICHOTOMIFLORUM) IN CORN WITH TRIAZINE HERBICIDES

S. W. Pruss 1/

Changing practices in corn production such as reduced or no tillage, continuous corn, and the elimination of previously troublesome weeds with herbicides have contributed to increasingly heavy infestation of weeds that were of no economic importance a few years ago.

The control of one such weed, fall panicum (Panicum dichotomiflorum), with triazine herbicides was studied in several tests conducted in Virginia in 1968.

Materials and Methods

Experiments were conducted at Riner, Virginia, on a Groseclose silt loam soil and at Leesburg, Virginia, on a Huntington silt loam.

Ohio 765 hybrid field corn was planted May 18 at the Leesburg location in a seedbed that had been plowed and disked. A heavy and uniform infestation of fall panicum, moderate infestations of hedge bindweed (Convolvulus sepium) and giant foxtail (Setaria faberii) and spotty infestations of horse nettle (Solanum carolinense) and yellow nutgrass (Cyperus esculentus) were present in the area. Preplant incorporated treatments were applied May 9 and the area disked immediately after application.

Preemergence treatments were applied at this location three days after planting. The soil was extremely wet from a heavy rain that fell the day of planting. Rainfall was above normal for the first six weeks after planting. Because of poor germination of corn at this location plant population and yield are lower than expected on this soil type.

At the Riner location Southern States 820 S was planted May 20 in corn stubble that had been disked once but not plowed. Preemergence treatments were applied May 22 and early postemergence June 11. Corn was approximately four inches tall at the time of the early postemergence treatment. Primary weeds in the area were fall panicum, giant foxtail, and yellow nutgrass. The infestation of fall panicum was heavy and uniform, however, the foxtail and nutgrass infestation was spotty.

1/ Field Research Representative, Geigy Agricultural Chemicals, Shawsville, Virginia.

The plot size for the experiments was 12' x 30' with the weed control ratings and yield being taken from a 24 foot section of the middle two rows.

All herbicides were applied with a CO_2 pressurized sprayer with a 6' boom which delivered thirty gallons of solution per acre at 35 psi through four Tee Jet 8003 nozzles.

Each experiment was a randomized complete block design with three replications.

Results and Discussion

Preplant Incorporated vs. Preemergence

Fall panicum control reported in Table 1 indicates that preplant incorporation of the herbicides weakens their effectiveness against this grass. Simazine was more effective than Atrazine whethe incorporated or not, with the 2 lb. a.i./A rate of Simazine being mor effective than the 4 lb. rate of Atrazine. Atrazine plus Simazine at 2 + 2 was as effective as Simazine at 4, however, the 1 + 1 treatment was less effective than Simazine at 2 and did not provide commercially acceptable control when applied preplant incorporated. When applied preemergence this treatment was rated just acceptable.

Preemergence -- Cultivation vs. No Cultivation

Cultivation greatly increased the effectiveness of Atrazine, Simazine and Atrazine plus Simazine treatments on fall panicum (Table 2). Atrazine applied preemergence with no cultivation did not provide satisfactory control even at the 4 lb. rate. However, Simazine and Primaze®1/ provided acceptable control at the 2 lb. rate.

Atrazine plus Simazine at 1+1 was about equal to Atrazine at 2 while the 2+2 treatment was equal to Simazine at 4 lbs.

All cultivated treatments, including Atrazine at 2 lbs., provided acceptable fall panicum control. Cultivation increased the effectiveness of Atrazine more than that of Simazine.

Grain yields were increased with cultivation by nearly 20 bushels with some herbicide treatments and nearly 50 bushels in the check. Assuming no phytotoxicity to corn from Atrazine and Simazine,

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1/ Primaze is a 1:1 combination of Atrazine and Prometryne

it appears the increase was not due only to improved weed control with cultivation. This can be observed by comparing the 4 lb. rate of Simazine not cultivated with the 2 lb. rate of Atrazine cultivated. Both treatments resulted in a weed control rating of 8.0. However, the yields were 75 and 89 bushels respectively. The same treatment is noted between Atrazine plus Simazine at 2 + 2 with no cultivation and Atrazine at 4 lbs. with cultivation.

It should be noted that even the herbicide treatment providing the least control (which was not commercially acceptable) of fall panicum increased the yields over the check by 24 bushels. All other treatments without cultivation more than doubled the yield of the check.

Preemergence -- experimental triazine herbicides

Igran® (GS-14260) was more effective for fall panicum control than either GS-13529 or Atrazine (Table 3). Any treatment containing over 1 lb. of Igran provided commercially acceptable control while rates of up to 4 lbs. of GS-13529 and Atrazine were comparatively ineffective. Slight corn injury was recorded at the Riner location at the 3 and 4 lb. rates of Igran when the corn plants were 6 inches tall. By the time the corn was 24 inches tall injury was no longer apparent. This early injury did not appear to affect the yield, with one treatment in which early injury was recorded producing the highest yield.

Postemergence

Atrazine, Simazine and GS-13529 applied postemergence with non-phytotoxic oil when fall panicum was 1½ to 2 inches tall were ineffective against this grass when rates of up to 4 lbs. a.i. per acre were applied. Corn injury was unacceptable when GS-13529 or Atrazine was applied at 4 lbs. with 1 gallon of oil (Table 4).

Although oil increased the activity of all three herbicides on fall panicum it also increased corn injury.

Summary

Fall panicum was controlled with Simazine, Simazine plus Atrazine, Primaze and Igran at 2 lbs. per acre applied preemergence. Atrazine at 4 lbs. was less effective than the above-mentioned products at 2 lbs. for fall panicum control.

Preplant incorporation reduced the effectiveness of Simazine and Atrazine for controlling this grass.

One properly timed cultivation will greatly improve the control of fall panicum with triazine herbicides.

Atrazine, Simazine, or GS-13529 applied postemergence with non-phytotoxic oil was more effective than the same herbicide applied at the same time without oil, but less effective than preemergence application.

Table 1. Effects of preplant incorporated and preemergence application of triazine herbicides on fall panicum control in corn planted May 18, rated August 9 and harvested August 27, 1968, at Leesburg, Virginia.

Herbicide	Rate lbs/A	F. P. Control 1/ PPI 2/	PE 3/	Yields Bu/A PPI	PE
Atrazine	2	3.0	4.0	77.5	67.6
Simazine	2	7.7	8.7	75.9	80.7
Atrazine	4	7.0	8.3	68.8	83.3
Simazine	4	8.7	9.7	63.8	85.9
Atr. + Sim.	1+1	6.3	7.0	85.3	88.4
Atr. + Sim.	2+2	8.7	10.0	83.9	70.2
Primaze	2		7.7		80.8
Check		0		54.4	

1/ Scale 0 to 10; 0 = no effect; 7 = commercially acceptable control; 10 = 100% control
2/ Preplant incorporated
3/ Preemergence

Table 2. Effects of Atrazine, Simazine, and Primaze with and without cultivation on fall panicum control rated July 30 and on corn yields taken September 17, 1968, at Riner, Virginia.

Herbicide	Rate lb/A	F. P. Control 1/ Cult. 2/	Not Cult.	Yields Bu/A Cult.	Not Cult.
Atrazine	2	8.0	4.3	89.0	59.2
Simazine	2	8.3	7.7	89.4	76.4
Atrazine	4	8.3	5.7	90.4	70.8
Simazine	4	9.3	8.0	78.1	75.0
Atr. & Sim.	1+1	8.7	5.0	90.8	85.9
Atr. & Sim.	2+2	10	8.3	82.6	76.1
Primaze	2		7		70.2
Primaze	4		9		75.2
Check		4.7	0	83.0	34.6

1/ Scale 0 to 10; 0 = no effect; 7 = commercially acceptable control; 10 = 100% control
2/ Cultivation was simulated by rototilling one month after planting.

Table 3. Effects of experimental triazine herbicides applied at two locations in Virginia on fall panicum and corn.

Herbicide	Rate lbs/A	Riner, Va. Corn (July 9)	F. P. Control[1] (July 9)	F. P. Control[1] (July 30)	Yields (Bu/A)[2]	Leesburg, Va. F.P.Control (August 8)
Igran + GS-13529	0+4	0	4.7	4.3	64.4	6.7
Igran + GS-13529	1+3	0	8.0	7.0	94.7	8.3
Igran + GS-13529	2+2	0	7.7	7.7	99.5	9.7
Igran + GS-13529	3+1	1.0	9.3	8.3	102.2	8.3
Igran + GS-13529	4+0	1.7	9.7	9.7	91.4	9.7
Igran + GS-13529	1+1	.7	5.6	6.0	84.4	7.3
Igran + GS-13529	.5+1.5	0	8.0	6.0	79.9	6.7
Igran + GS-13529	1.5+ .5	0	9.0	8.3	95.0	7.0
Igran + GS-13529	0+2	0	7.6	4.7	97.0	2.3
Igran + GS-13529	2+0	0	9.3	9.0	94.1	8.7
Atrazine	2	0	8.0	6.0	76.2	4.0
Atrazine	4	0	8.7	6.0	90.3	7.7
Check		0	0	0		

1/ Scale 0 to 10; 0 = no effect; 3 = maximum acceptable crop damage; 7 = commercially acceptable weed control; 10 = complete control.

2/ No. 2 Corn

Table 4. Effects of triazine herbicides plus non-phytotoxic oils applied June 11 (early postemergence) to corn and fall panicum at Riner, Virginia.

Herbicide	Rate lbs/A	Oil Gal/A	Phyto to Corn 1/ June 18	Phyto to Corn 1/ July 13	F. P. Control 1/2/ June 18	F. P. Control 1/2/ July 13
GS-13529	2	1	2.7	2.7	1.3	1.3
GS-13529	4	1	3.3	3.3	2.7	3.0
Atrazine	1	1	1.3	1.3	1.0	1.7
Atrazine	2	1	2.7	2.7	4.0	3.0
Atrazine	4	1	4.0	4.0	5.0	5.0
Simazine	2	1	2.0	2.0	2.3	1.3
Simazine	4	1	3.0	2.7	2.3	2.0
Atrazine	2	0	0	0	0	0
GS-13529	2	0	0	0	0	0

1/ Scale 0 to 10; 0 = no effect; 3 = maximum acceptable crop damage; 7 = commercially acceptable weed control; 10 = 100% control.

2/ F. P. = Fall panicum

TIMING OF POSTEMERGENCE HERBICIDE APPLICATIONS FOR CRABGRASS CONTROL IN CORN

W. L. Currey[1] and R. A. Peters[2]

Preemergence application of herbicides for weed control in corn (Zea mays L.) has been superior to postemergence treatments in producing maximum yields (1, 2, 5, 9). However, all too often the desired timing of application is delayed by inclement weather, equipment problems and other factors until after the corn has emerged.

The situation is further compounded by large populations of crabgrass (Digitaria spp.) which have built up in recent years (8). Limited success has been achieved with postemergence applications of atrazine-oil and atrazine-surfactants for crabgrass control (1, 2, 9, 10, 11).

The problem then, is the importance of timing of postemergence applications for maximum control of competing grasses (3, 4, 5, 6, 7).

Three experiments were established at the Agronomy Research Farm, Storrs, Connecticut, each with different herbicides and herbicide combinations but all with the purpose of establishing the optimum time of application.

Materials and Methods

Experiment I - The dimethyl amine salt of 2-methoxy-3,6-dichlorobenzoic acid (dicamba) was applied at 3 stages (Table 1) and 5 rates to evaluate weed control and effect on corn. The rates of active ingredient were:

1. Check -
2. Dicamba 1/8 lb/A
3. Dicamba 1/4 lb/A
4. Dicamba 1/2 lb/A
5. Dicamba 1 lb/A

Experiment II - Combinations of 2,2-dichloropropionic acid, sodium salt (dalapon) plus 2-chloro-4-ethylamino-6-isopropylamino-s-triazine (atrazine) and dalapon plus dicamba were applied at 3 stages (Table 1) for broad spectrum weed control. The active ingredient rates applied were:

1. Check
2. Dalapon + atrazine 1/2 + 1 lb/A
3. Dalapon + atrazine 3/4 + 1 lb/A
4. Dalapon + atrazine 1 + 1 lb/A
5. Dalapon + dicamba 1/8 + 1/8 lb/A

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Experiment III - Combinations of atrazine plus a 110 second viscosity phytobland oil and atrazine plus oil plus amine salt of 2,4-dichlorophenoxy acetic acid (2,4-D) were applied at 3 stages (Table 1) to control annual and perennial grasses. The treatments (a.i./A) were:

1. Check
2. Atrazine + oil — 1 lb/A + 1 gal
3. Atrazine + oil — 2 lb/A + 1 gal
4. Atrazine + oil + 2,4-D — 1/2 + 1 gal + 1/8 lb/A
5. Atrazine + oil + 2,4-D — 1 + 1 gal + 1/8 lb/A

Table 1. Height of Plants at Each Stage of Growth and Each Application Date.

Experiments and Stage of Growth				Height of Plants in Inches			
Date	Dicamba	Dalapon	Atrazine-Oil	Corn	GrW	BLW	A. repens
7/3	A[a]	A	-	0.75	0.25	-	1.50
7/9	B	B	B	5.00	0.75	0.75	6.00
7/13	C	C	C	6.25	1.50	2.00	6.75
7/23	-	-	D	15.75	8.00	8.50	12.50

[a] Letters indicate the stage of plant growth

Prior to planting, 200 lbs each of N, P_2O_5, and K_2O were broadcast and disked in on a Paxton fine sandy loam soil. The organic matter content was 6.0% and the pH 6.5. Rainfall during the growing season was 6.02 inches below normal with 10.72 inches occurring between planting and harvest. Above average rainfall was recorded in the month prior to planting and there was no evidence of moisture stress during the season.

A randomized complete block design was used for each experiment with 3 replications. Each plot was 2 rows wide and 18 feet long. Wisconsin 335A corn was planted in 30 inch rows at 22,000 plants per acre on June 27, 1968.

The postemergence sprays were applied at 40 p.s.i. in 40 gallons of water per acre with a bicycle plot sprayer.

Weed species which predominated were heavy stands of large crabgrass (*Digitaria sanguinalis* L. Scop.) and smooth crabgrass (*Digitaria ischaemum* Schreb. Muhl.) a smaller population witchgrass (*Panicum capillare* L.) and quackgrass (*Agropyron repens* L. Beauv.) with only occasional plants of redroot pigweed (*Amaranthus retroflexus* L.) and common ragweed (*Ambrosia artemisiifolia* L.).

Weed control ratings were taken on July 25, and September 24, 1968 using a scale of 0-10 were 0 = no control and 10 = complete control.

Silage yield samples were taken from a 12 foot section of each plot on

October 21, 1968. The green weight data were converted to tons of 30% dry matter per acre. Crabgrass yields were taken just prior to corn harvest by removing two 1 x 2-foot sub-samples per plot with a frame and hand shears. These results were converted to tons of dry matter per acre. All data were subjected to analysis of variance and means compared by LSD and Duncan's Multiple Range Tests.

Results and Discussion

Experiment I - Dicamba provided excellent broadleaf weed control even at low rates. The broadleaf weed population was light as seen by the check plot ratings and was the only experiment where density was sufficient to obtain a rating. The control of crabgrass by dicamba was poor and only the 1 lb/A rate applied at stage A gave any indication of suppression greater than 55 percent (Figure 1).

Yields of corn silage decreased as yields of crabgrass increased (Figure 2). The slope of the line for crabgrass check plots was quite similar to that of the treated plots indicating very little control of crabgrass by dicamba. Corn yields in check plots remained constant. Corn silage yields for all experiments were low due to late date of planting which gave insufficient number of growing degree days and the great competition from annual grasses. No corn injury was observed in any experiment.

Experiment II - Applications of dalapon plus atrazine gave excellent grass control with 1 lb/A of atrazine combined with 1/2, 3/4 or 1 lb/A of dalapon applied at stage A when crabgrass was 1/4-inch or less in height and corn in the spike stage (Figure 3). The longer application was delayed the poorer the control with the exception of the combination of dalapon plus atrazine at 1 + 1 lb/A which maintained reasonably good control at both stages B and C. This treatment would appear to give the most consistent results over a longer period of timing of application. The combination of dalapon plus dicamba 1/8 + 1/8 lb/A proved no better than the check.

Yields of corn decreased as crabgrass yields increased in linear fashion with each delay in application while the respective checks produced constant straight line results (Figure 4).

Experiment III - All combinations of atrazine plus oil and atrazine plus oil plus 2,4-D produced 80 percent or better control when applied to crabgrass 3/4-inch in height (Figure 5). One or 2 pounds of atrazine plus 1 gallon of phytobland oil continued to give excellent control at the stage C date. Atrazine 1 lb/A plus oil plus 1/8 lb/A 2,4-D gave excellent control at the first application date but control was significantly poorer when application was delayed 4 days and crabgrass was 1 1/2 inches high. Previously, this treatment and the mixture without 2,4-D failed to control grasses 2 inches or more in height (2, 11). Two pounds of atrazine gave the highest consistent results in either B or C stages of application. It is important to note that stage D applications were made 2 weeks following the B stage and completely failed to control any species in the weed population.

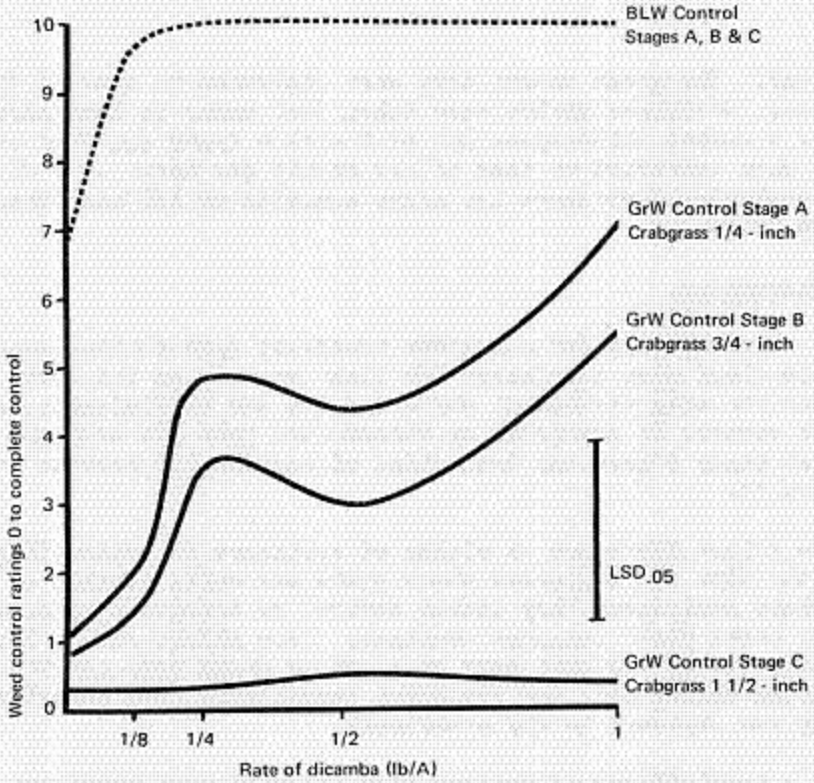

Figure 1. Weed control with 5 rates of dicamba applied at 3 stages of plant growth.

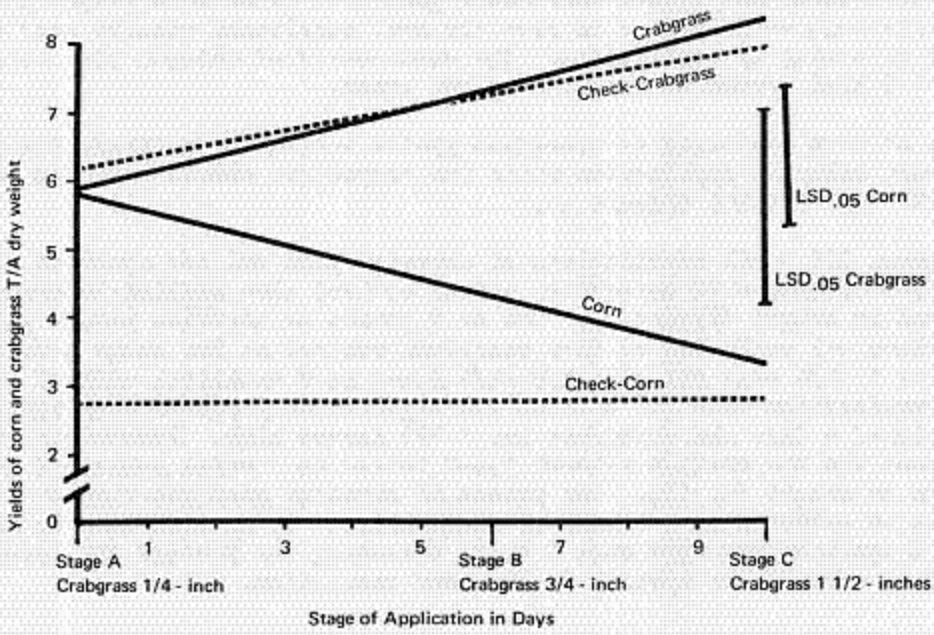

Figure 2. Yields of corn and crabgrass from dicamba treated plots.

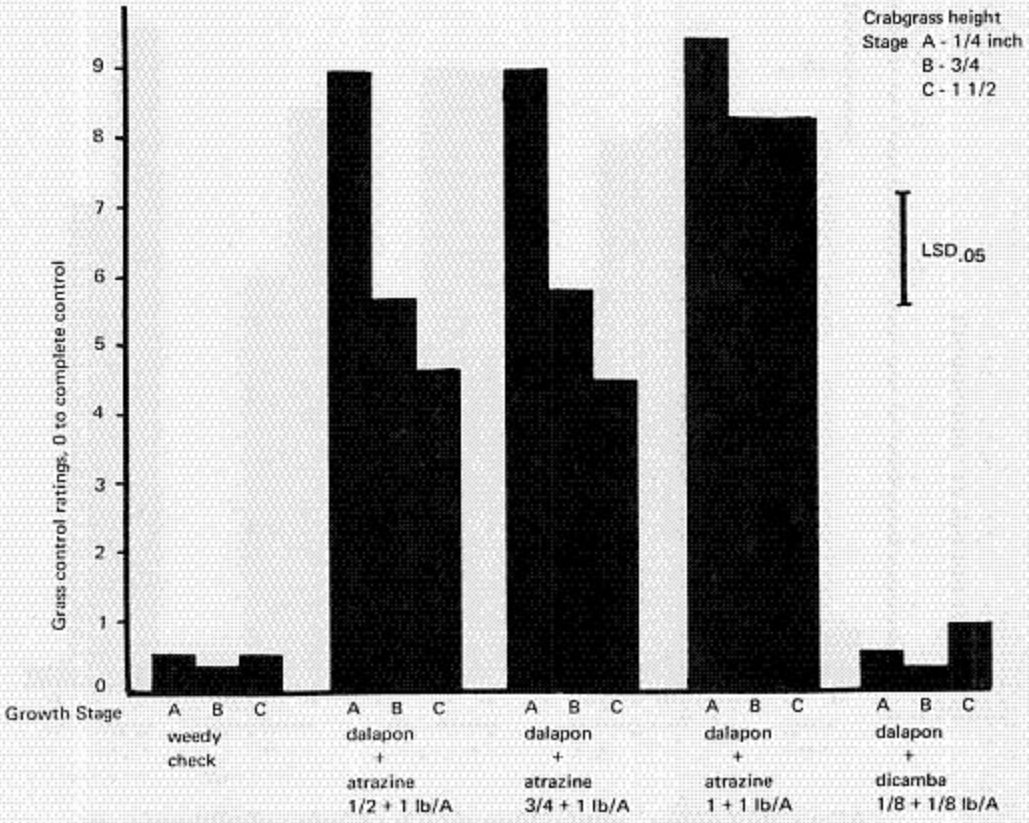

Figure 3. Effect of dalapon combinations applied at 3 stages on crabgrass control in corn.

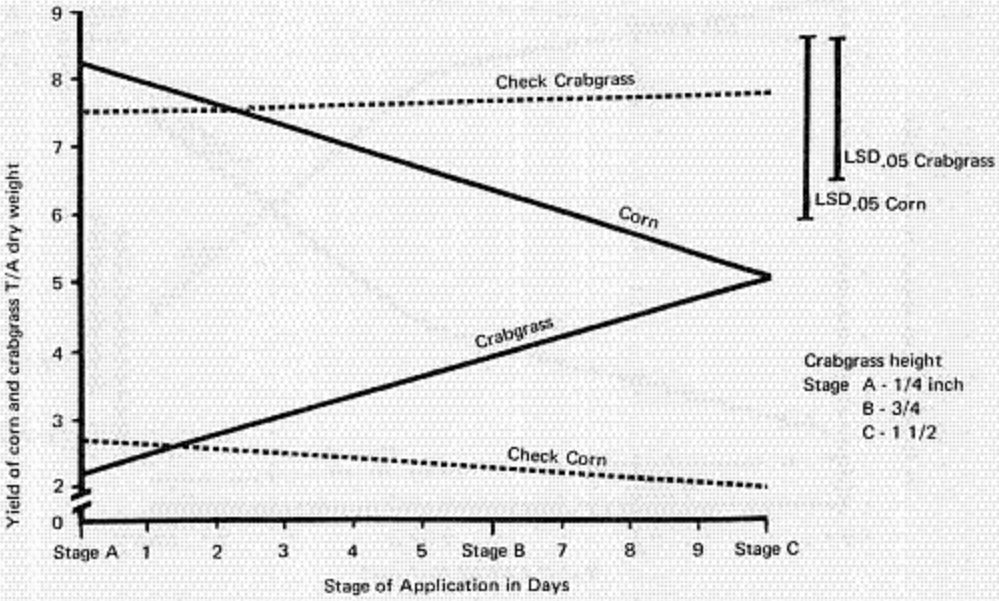

Figure 4. Effect of delayed postemergence dalapon combinations on yields of corn and crabgrass.

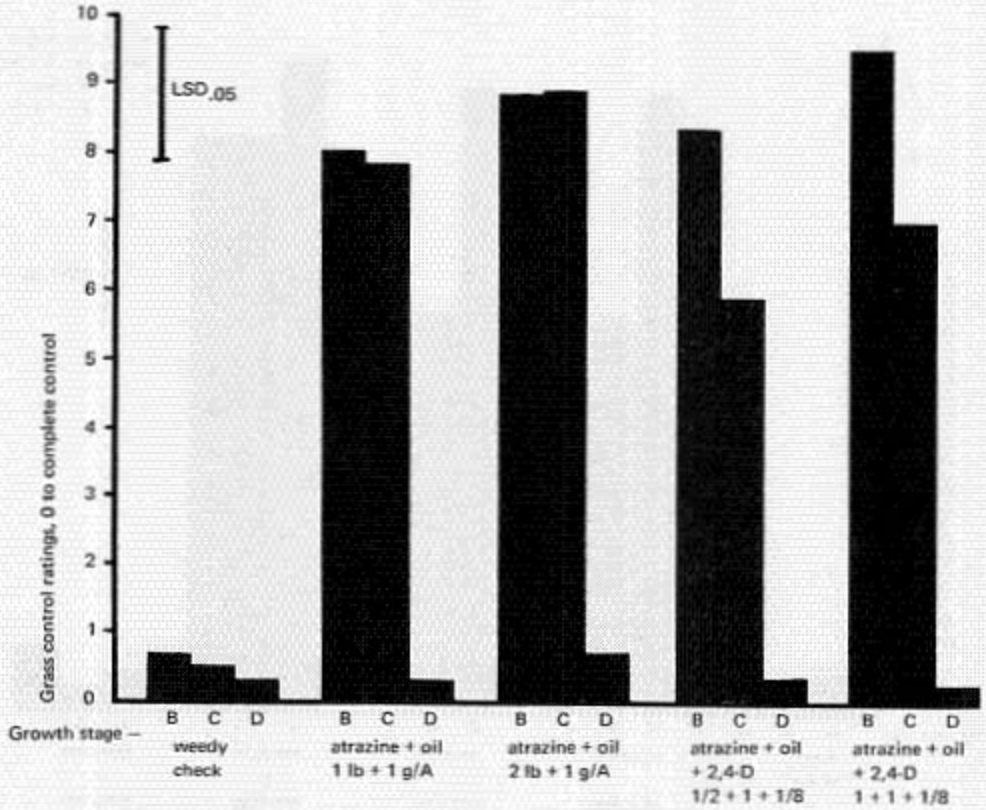

Figure 5. Effect of atrazine + oil combinations applied at 3 stages for crabgrass control in corn.

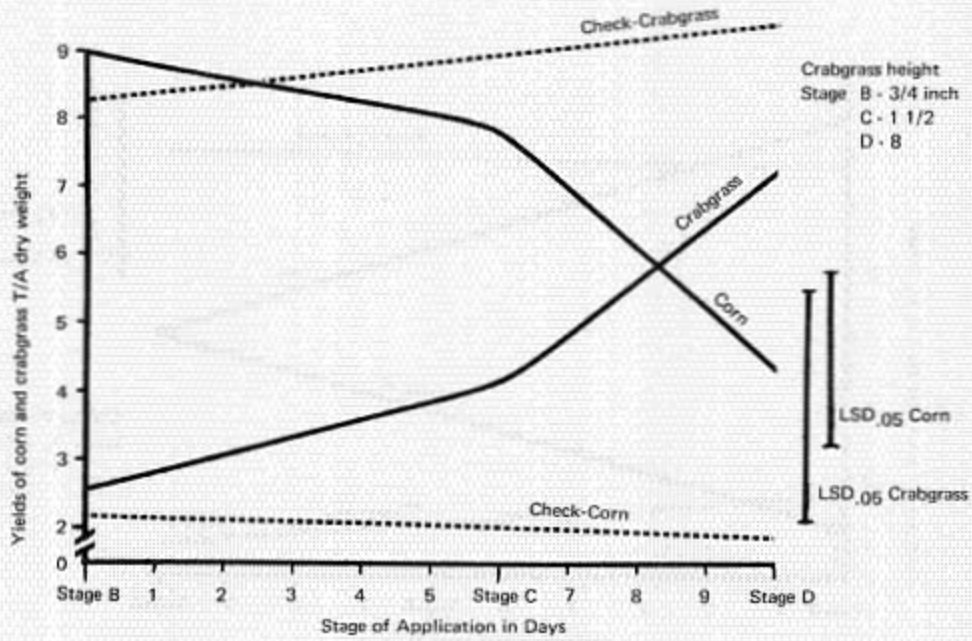

Figure 6. Effect of delayed postemergence atrazine + oil combinations on yields of corn and crabgrass.

The stand of quackgrass did not develop sufficiently to evaluate control.

The curves for yields show that corn yields decreased with increasing grass yields and these accelerate due to poorer control beyond 10 days after grass emergence or after crabgrass is 0.75 to 1.50 inches in height (Figure 6). Check plot yields were significantly greater and smaller than treated plots for crabgrass and corn respectively with the exception of stage D applications which were insignificantly different from the checks in both crabgrass and corn yields.

Significance of visual crabgrass ratings - Late season visual observations of crabgrass stands are a poor criterion of the actual amount of crabgrass growth and, indirectly, of competition with corn (9). This has been attributed to tillering and the sprawling growth habit of crabgrass which may result in a complete ground cover from only a few plants.

A comparison of late season visual ratings with yields of crabgrass from the same plots indicate that visual ratings approach validity only when excellent season-long crabgrass control is provided (Figure 7). Crabgrass yields increased 4 times without a significant change in visual rating. These results are from the atrazine-oil experiment but similar results were obtained from the other 2 experiments.

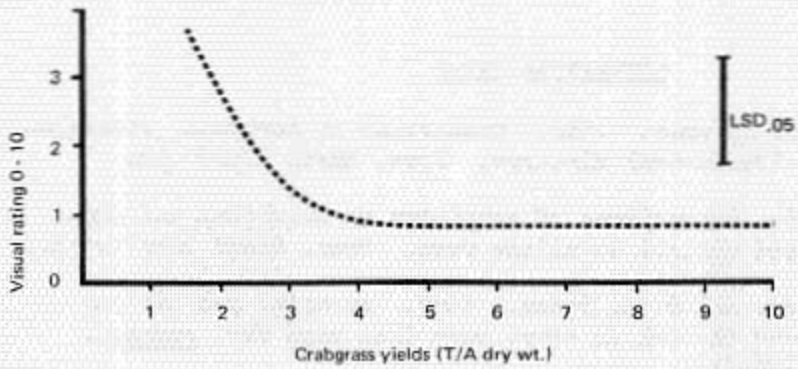

Figure 7. Accuracy of late season visual ratings for crabgrass control.

Summary

Three experiments were established, each with different herbicides and herbicide combinations for the purpose of establishing optimum timing of post-emergence applications for maximum control of crabgrass in corn.

Experiment I - Dicamba provided excellent broadleaf weed control but very poor grass control. Crabgrass yields from treated plots were not significantly different from yields of check plots.

Experiment II - Applications of 1 lb/A of atrazine combined with 1/2, 3/4 or 1 lb/A of dalapon gave excellent control, applied when crabgrass was 1/4-inch or less in height. The longer application was delayed the poorer the control. However, the combination of dalapon plus atrazine at 1 + 1 lb/A continued to give consistent results even when application was delayed 10 days and crabgrass was 1.5 inches high and corn 6.25 inches in height. No corn injury was observed with any of the dalapon combination treatments.

Experiment III - One or 2 pounds of atrazine plus 1 gallon of phytobland oil gave good control of crabgrass up to 1 1/2 inches in height. Atrazine 1 lb/A plus oil plus 1/8 lb/A 2,4-D gave excellent control when applied to 3/4-inch high crabgrass but control was significantly poorer when application was delayed 4 days and crabgrass had doubled in height to 1 1/2 inches. It is significant that applications made beyond 10 days after crabgrass emergence failed to show any significant results.

Corn silage yields in all experiments decreased as yields of crabgrass increased with delay in herbicide application.

Significance of visual crabgrass ratings - Late season visual observations are a poor indication of the actual amount of crabgrass growth, due to tillering and sprawling growth habit of the plant. Visual ratings approach validity only when excellent season-long crabgrass control is provided. Crabgrass yields increased 4 times without a significant change in visual rating.

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YELLOW FOXTAIL CONTROL IN CORN

S. M. Raleigh 1/

A field known to have a large amount of yellow foxtail Setaria lutescens (Weigel) Hubb (according to Hitchcock) was plowed in early May. The area was disked and planted to Pennsylvania 444 corn on June 5, 1968. The pre-emergence treatments were applied June 6 and 7. The post-emergence treatments in Table I were appied June 21. The treatments in Table II were applied July 1st and 2nd. The yellow foxtail had three leaves and the corn was 4-6 inches tall.

The chemicals for each treatment were weighed or measured in the field into a pint bottle, then water added so that 40 gallons were applied per acre. Each bottle was sprayed on an area 6 x 20 feet. Ten feet of untreated area was at the end of each plot. There were 3 replications in Table I and 2 replications in Table II.

The oil used in Table II was Sun Oil 11E. The wetting agents were: Triton GR5 which is highly active anionic surfactant. Surfactant DF16 is a nonionic surface active agent. Triton x 114 is a nonionic surface active agent. GA224 is an oil extendable atrazine and GA239 is a water extendable atrazine.

Control of yellow foxtail with atrazine and oil or wetting agent was much poorer in 1968 than in 1967. There was no apparent injury from atrazine when used with a wetting or oil when water was added to make an application of 40 gallons per acre. Where oil was used without water at 40 gallons per acre some corn was killed and all looked sick soon after application. Where the oil was held in the base of the leaf sheath, many plants died. Where 5 gallons of soil were used without water, no injury and little weed control was obtained.

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Table I. Yellow foxtail control (90 complete control, 10 no control) (all treatments pre-emergence unless noted)

Chemical	Rate (actual pounds per acre)			
Simazine				
	1	67		
	2		77	
	3			8
Atrazine				
	1	8		
	2		8	
	3			83
Linuron				
	1	7		
	2		77	
	3			8
Ramrod				
	2	37		
	4		6	
	6			7
CP50144				
	1	8		
	2		8	
	3			8
Atrazine + linuron				
	1/2 + 1/2	67		
	1 + 1		8	
	1 1/2 + 1 1/2			8
Atrazine + Ramrod				
	1/2 + 1	6		
	1 + 2		77	
	1 1/2 + 3			8
Atrazine + CP50144				
	1/2 + 1/2	77		
	1 + 1		8	
	1 1/2 + 1 1/2			8
Atrazine + linuron + 50144				
	1/3 + 1/3 + 1/3	8		
	2/3 + 2/3 + 2/3		8	
	1 + 1 + 1			8
LR12				
	1/2 + 1	63		
	1 + 2		8	
	1 1/2 + 3			8
CP50144 + linuron				
	1/2 + 1/2	7		
	1 + 1		77	
	1 1/2 + 1 1/2			8

Table I. (Continued)

Chemical	Rate (actual pounds per acre)				
GA223					
	1/2 + 1/2			7	
		1 + 1			8
			1 1/2 + 1 1/2		8
GS13529					
	2			8	
		4			8
			6		87
SD15418					
	1			4	
		2			67
			3		77
Cotoran					
	1 1/2			53	
		3			67
			6		8
Patoran					
	2			57	
		4			77
			6		8
C6989					
	2			67	
		4			77
			6		8
C6313					
	1 1/2			33	
		3			5
			6		73
MB14255					
	1			3	
		2			3
			4		73
RP17623					
	1/2			63	
		1			73
			1 1/2		8
VCS438					
	1			33	
		2			6
			3		7
VCS438 Post					
	1/2			13	
		1			57
			2		67

Table I. (Continued)

Chemical	Rate (actual pounds per acre)		
VCS438 + Banvel 4S			
	1/2 + 1/4	2	
	1 + 1/4	5	
	1 1/2 + 1/4		6
R11913			
	1	3	
	2	37	
	4		6
R11913 Post			
	1	13	
	2	27	
	4		4
Fenac + Ramrod			
	1/4 + 1	47	
	1/2 + 2	53	
	3/4 + 3		63
Fenac + 50144			
	1/4 + 1/2	53	
	1/2 + 1	6	
	3/4 + 1 1/2		73
Dinoben + Ramrod			
	1/2 + 1	37	
	1 + 2	5	
	1 1/2 + 3		7
Dinoben + 50144			
	1/2 + 1/2	43	
	1 + 1	6	
	1 1/2 + 1 1/2		73
17735 Post			
	1	2	
	2	27	
	4		3
17961 Post			
	1	2	
	2	2	
	4		27
TOK Post			
	2	2	
	4	23	
	-		-

Table II. Control of yellow foxtail post-emergence (90 complete control 10 no control)

Pounds of Atrazine per acre	Gallons of oil per/A.	Wetting agent oz/A.	Pts. of Joy soap per acre	Pounds 2,4-D per/A.	Pounds Dalapon per acre	Control
.5 (80W)						2
1						2
2						5
.5	1					2
.5	2					2
.5	3					3
1	1					33
1	2					55
1	3					35
2	1					65
2	2					75
2	3					75
(GA224)						
.5	1					2
.5	2					33
.5	3					15
1	1					2
1	2					3
1	3					5
2	1					45
2	2					55
2	3					55
.5 (80W)		2 GR5				2
.5		4				2
.5		8				25
1		2				2
1		4				25
1		8				65
2		2				55
2		4				65
2		8				55
.5		2 DF16				2
.5		4				2
.5		8				2

Table II. (Continued)

Pounds of Atrazine per acre	Gallons of oil per/A.	Wetting agent oz/A.	Pts. of Joy soap per acre	Pounds 2,4-D per/A.	Pounds Dalapon per acre	Control
1		2				25
1		4				2
1		8				45
2		2				3
2		4				45
2		8				5
.5		2 X114				2
.5		4				2
.5		8				2
1		2				2
1		4				2
1		8				2
2		2				4
2		4				55
2		8				6
.5			.5			2
.5			1			2
.5			2			2
1			.5			2
1			1			2
1			2			25
2			.5			2
2			1			25
2			2			65
(GA239)						
5						2
1						2
2						5
.5	1					2
.5	2					2
.5	3					2
1	1					2
1	2					2
1	3					3

Table II. Control of yellow foxtail post-emergence (90 complete control 10 no control)

Pounds of Atrazine per acre	Gallons of oil per/A.	Wetting agent oz./A.	Pts. of Joy soap per/A.	Pounds 2,4-D per/A	Pounds Dalapon per/A.	Control
2	1					3
2	2					5
2	3					6
.5	1			1/8 Ester		2
.5	1			1/4		2
.5	2			1/8		2
.5	2			1/4		2
.5	3			1/8		2
.5	3			1/4		2
1	1			1/8		2
1	1			1/4		2
1	2			1/8		2
1	2			1/4		25
1	3			1/8		25
1	3			1/4		2
2	1			1/8		5
2	1			1/4		3
2	2			1/8		6
2	2			1/4		55
2	3			1/8		45
2	3			1/4		5
.5	1			1/8 Amine		2
.5	2			1/8		2
.5	3			1/8		2
1	1			1/8		2
1	2			1/8		3
1	3			1/8		2
2	1			1/8		35
2	2			1/8		5
2	3			1/8		5
.5					1/2	2
.5					3/4	2
.5					1	55
1					1/2	25
1					3/4	45
1					1	5

Table II. (Continued)

Pounds of Atrazine per acre	Gallons of oil per/A.	Wetting agent oz/A.	Pts. of Joy soap per acre	Pounds 2,4-D per/A.	Pounds Dalapon per acre	Control
.5	40 (oil only)					55
1	40					75
2	40					8
3	40					85
4	40					9
.5	5 (oil only)					2
1	5					2
2	5					25
3	5					2
4	5					4

CHICKWEED CONTROL IN DORMANT ALFALFA WITH PARAQUAT, DIQUAT, AND EXPERIMENTAL HERBICIDES 1/

J.V. Parochetti 2/

The control of chickweed (Stellaria media (L.) Cyrillo) has become a major problem in alfalfa (Medicago sativa L.). A dense population of chickweed can not only reduce alfalfa yields but has also been reported to adversely affect the control of weevil by flaming (3). Paraquat at 1/4 lb/A sprayed on dormant alfalfa has been used to pre-condition fields prior to flaming (3).

This paper reports two experiments conducted to find new and better methods of chickweed control in alfalfa. The first experiment evaluates the effect of bipyridylium quaternary salts alone and in combination with flaming. The second experiment which was conducted at the same site as Experiment 1 evaluates the effectiveness of three new herbicides.

METHODS AND MATERIALS

Established dormant Williamsburg alfalfa and orchardgrass (Dactylis glomerata L.) heavily infested with chickweed were treated at the Forage Research Farm, Clarksville, Maryland. The soil was a Delanco clay loam, pH 6.8 and organic matter 1.9. Chickweed control was recorded as an estimate of the percentage of ground not covered by chickweed. The spray volume was 30 gpa. The experimental design was a randomized complete block with three replications. Appendix 1 lists the common names, code names and chemistry of herbicides used in these studies.

Experiment 1 was treated on November 22, 1966 with 1/4 and 1/8 lb/A paraquat and 1/4 and 1/8 lb/A diquat plus 0.5% V:V surfactant Ortho X-77. During the second weed of March, 1967, plots were flamed in the manner of Steinhauer, et. al. (6).

Experiment 2 was treated on March 9, 1968. Treatments are noted on Table 2. Chickweed control estimates were taken on April 22 and May 9.

1/ Scientific Article No. 1485 and Contribution No. 4124 of the Maryland Agricultural Experiment Station, Department of Agronomy.

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RESULTS AND DISCUSSION

Paraquat, diquat and flaming experiment (Exp. 1)

Both herbicides investigated gave good control of chickweed at 1/4 lb/A and only about 50% control at 1/8 lb/A at 6 months after treatment (see Table 1.) Several other workers have reported that a good top kill was obtained with 1/2 lb/A of paraquat (1,2,4,5,6). Percentage chickweed control was very similar between the two herbicides. Yields of alfalfa and grass, however, appear to be reduced by paraquat but not by diquat. No yield differences were, however, statistically different at the 5% level.

The control of chickweed by paraquat and diquat was enhanced by a flaming treatment. The control was increased by approximately 30% for both chemicals at the 1/8 lb/A rate. Increases of control by flaming were also found at the 1/4 lb/A rate. Approximately 100% control of chickweed was obtained at 1/4 lb/A plus flaming. Flaming alone, however, resulted in only 33% chickweed control. Steinhauer, et. al. (7), have also found poor control of chickweed with flaming alone. They attributed this to regrowth after initially what appeared to be good control.

It was also noted that the action of both paraquat and diquat was slow during the winter months. This conforms to the findings of Sewell (6) who reported that desiccation by paraquat was slower in cooler temperatures.

Experimental herbicides for chickweed control. (Exp.2)

Experimental herbicides investigated are listed in table 2. The most promising was RH 315 at 2 lb/A and Benezolin at 1/2 lb/A. Due to the late March application CIPC did not perform as well as an early application might. Only the RH 315 and Benezolin treatments were harvested; in every case, except one, yields were higher than the weed-free control. The exception was RH 315 at 4 lb/A which almost completely eliminated the orchardgrass from the plots. On the other hand, alfalfa yields were significantly increased.

SUMMARY

Chickweed control by paraquat and diquat was similar at comparable rates. The herbicidal action was quite slow due to the cooler temperature of winter. Flaming following sub-phytotoxic levels of herbicides enhanced chickweed control.

Of the experimental herbicides evaluated, RH 315 and Benezolin effectively controlled chickweed. RH 315 at 4 lb/A almost completely eliminated the established orchardgrass and alfalfa yields were significantly increased when compared to the weed-free check.

APPENDIX I

Common Name	Code Name	Chemical Name
	AC72,031 Benezolin	
CIPC		isopropyl N-(3-chlorophenyl) carbamate
Diquat		6,7-dihydrodipyrido (1,2-a:2', 1'-c) = pyrazidiinium salt
Paraquat	RH 315	1,1' - dimethyl-4,4'-bipyridinium salt

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TABLE 1. An evaluation of the effect of Paraquat, Diquat, and flaming for chickweed control and on alfalfa-grass yields, 1967.

Treatment	lb/A	May 17 % Chickweed Control	Tons/A of Dry Matter Harvest 1 Alfalfa	Harvest 1 Grass	Harvest 2 Total	Harvest Total
Control	-	13.3	0.83	0.21	2.01	1.17
Paraquat	1/8	51.7	0.63	0.17	1.76	1.01
	1/4	97.7	0.48	0.13	1.72	1.04
Diquat	1/8	48.3	0.68	0.36	1.79	0.93
	1/4	88.3	0.78	0.17	2.02	1.02
Flame	-	33.3	0.69	0.16	1.98	1.14
Paraquat + Flame	1/8	77.0	0.77	0.21	1.83	0.96
	1/4	100.0	0.65	0.14	1.78	1.14
Diquat + Flame	1/8	75.0	0.62	0.15	1.58	1.03
	1/4	97.7	0.76	0.15	1.49	1.22
$LSD_{0.05}$ =		42.5	n.s.	n.s.	n.s.	n.s.

TABLE 2. An evaluation of the effect of experimental herbicides for chickweed control and on alfalfa-grass yields, 1968.

Treatment	lb/A	% Chickweed Control		Tons/A of Dry Matter Harvest 1	
		Apr. 22	May 9	Alfalfa	Grass
Control	-	3.3	0.0	0.42	0.21
RH 315	1	75.8	50.0	0.58	0.56
	2	84.2	100.0	0.52	0.54
	4	95.0	100.0	0.76	0.01
Benezolin	1/8	58.3	33.3	-	-
	1/4	65.8	73.0	0.57	0.67
	1/2	98.3	100.0	0.71	0.31
AC 72,031	1/8	13.3	0.0	-	-
	1/4	61.7	33.3	-	-
	1/2	16.7	0.0	-	-
DNBP	1	10.0	0.0	-	-
CIPC	2	36.7	66.7	-	-
			$LSD_{0.05}$ =	0.30	0.40

WEED CONTROL IN ESTABLISHED LEGUMES[1/]

W.B. Duke and E.S. Spear[2/]

Introduction

Heavy infestations of herbaceous annual, biennial and perennial weeds such as common chickweed (Stellaria media [L.] Cyrillo), red deadnettle (Lamium purpurcum L.), wild carrot (Daucus carota L.), white cockle (Lychnis alba Mill.), yellow rocket (Barberea vulgaris R. Br.) and common dandelion (Taraxacum officinale Weber) which are known to reduce hay quality and quantity (1,2,4,5) often become established in legumes during the seedling establishment year. Delaying control measures for any period of time allows development of higher populations and harder to control plants. The fall of the year of establishment would offer an opportune time to control these weeds because they would be small and most susceptible to phytotoxicants. Herbicides which have given varied control of several weeds in legumes include: 2-chloro-4,6-bis (ethylamino)-s-triazine (simazine), 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron) and 3-tert-butyl-5-chloro-6-methyluracil (terbacil) (1,2,4,5). Annual weeds can be killed easily with each of these herbicides, however, rates required to remove perennial weeds usually cause legume injury (1,2). Timing of applications may improve selectivity (1,2).

The investigations reported herein were conducted to examine weed control as affected by applications of herbicides to alfalfa the year of or the year following establishment and the possible influence of different soil types.

Materials & Methods

During 1967 and 1968, experiments on alfalfa (Medicago sativa L.) were conducted at several New York locations including the Mt. Pleasant Research Farm on Bath gravelly silt loam (OM 4.5%), Marcellus on Honeoye silt loam (OM 5%), Aurora on Honeoye-Lima silt loam (OM 3.2%), Candor on Howard gravelly silt loam (OM 4%), and Canton on Wallington silt loam (OM 4.5%). The experimental design at each location was a randomized complete block with four replications. Plots 8 x 30 ft. were established to receive chemical treatments. Herbicides were applied in 30 gpa with a boom type experimental sprayer referred to as the Mater Plot Sprayer (3).

Applications after the seedling establishment year - Narragansett alfalfa was established in oats in April, 1966. Chemical treatments were applied on April 27, 1967 at Mt. Pleasant; October 12, 1967 at Marcellus and October 30, 1967 at Aurora. Spring application was made prior to the visible initiation of spring

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growth. Fall treatments were applied to stubble within seven days after removal of the forage with a forage chopper. Spring applied herbicides included rates of simazine, terbacil and 5-bromo-3-sec-butyl-6-methyluracil (bromocil). Treatments at Aurora varied in that 2-sec-butylamino-4-ethylamino-6-methoxy-2-s-triazine (GS 14254) was used instead of bromocil, and at Marcellus, diuron, 4,6-dinitro-O-sec-butylphenol (dinoseb) and simazine + dinoseb were added. Major weeds at these locations were yellow rocket, dandelion and mouseear chickweed (Cerastium vulgatum L.) at Mt. Pleasant; dandelion, daisy fleabane and common chickweed at Aurora; and white cockle, mouseear chickweed and dandelion at Marcellus.

Applications during the year of seedling establishment - Saranac alfalfa was established without a companion crop in April, 1967. Herbicides were applied to alfalfa stubble on October 31 and October 9 at Canton and Candor, respectively. At both locations, the alfalfa was removed with a forage chopper immediately before chemical treatment. Herbicides used at both locations were simazine, terbacil, diuron and simazine plus dinoseb. Major weeds at these locations were dandelion, white cockle and yellow rocket at Canton and yellow rocket and dandelion at Candor.

Weed control ratings were taken three to four weeks before the first harvest date at each location using the system where 0 = no effect and 10 = a complete reduction in stand and vigor. A swath 3.25 x 20 ft. through the center of each plot was cut and weighed at each harvest date for total yield determinations. Samples of each plot harvest were hand separated to determine weights of legume and weeds. All yield data are expressed on a oven-dry basis (75C to constant weight). The dates of alfalfa harvest at each location were: June 11, 1967 at Mt. Pleasant; June 20 and August 3, 1968 at Marcellus; June 21 and August 6, 1968 at Aurora; June 19, 1968 at Candor; and June 19, July 29 and October 10, 1968 at Canton.

Results and Discussion

Application after the seedling establishment year - Applications of simazine, terbacil and bromocil in the spring effected 57, 90 and 93% control of broadleaf weeds with the major variation occuring in yellow rocket and dandelion control (Table 1). High rates of simazine resulted in satisfactory control of all weeds except dandelion. Terbacil and bromocil gave dandelion control. Rates of the uracil herbicides which gave excellent control of all weeds were injurious to alfalfa as evidenced by significant reductions in alfalfa yields at first cutting. Control of yellow rocket and chickweed with simazine appeared to increase yields, although not significantly. Alfalfa began spring regrowth within two weeks after herbicide application indicating that lateral buds, while not visible, were actively growing at treatment time. This may account for the low crop tolerance to the uracil herbicides (4).

Herbicides applied in the fall at Marcellus and Aurora significantly reduced the tonnage of broadleaf weeds below that harvested from the untreated plots (Table 2 and 3). At Marcellus, simazine and terbacil effected excellent control of mouseear chickweed while only simazine gave any degree of control of white cockle and dandelion. This may in part help explain the significant reduction in broadleaf weed yields evident in the 3 lb/A simazine plots as compared to other treatments. Combining dinoseb with simazine did not increase broadleaf

Table 1. Weed control ratings and yields of alfalfa, broadleaf weeds and grasses as affected by herbicides applied in the spring. Mt. Pleasant, New York. 1967.

Chemical[a/]	Rate lb/A	Yield, first cutting[b/] T/A Alfalfa[c/]	BLW	Weed Control Ratings[d/] Yellow Rocket	Mouseear Chickweed	Dandelion
simazine	1	.86 ab	1.25 ab	3.2	8.1	1.0
	1 1/2	.99 ab	.78 bc	8.0	8.9	1.2
	2	1.36 a	.67 bc	9.2	9.4	2.2
terbacil	1/2	1.05 a	.58 cd	10.0	10.0	4.1
	1	.51 bc	.41 cd	10.0	10.0	7.1
	2	.31 c	.04 d	10.0	10.0	9.8
bromacil	1/2	1.04 a	.44 cd	10.0	10.0	5.1
	1	.35 c	.06 d	10.0	10.0	9.0
	2	.00 d	.00 e	10.0	10.0	10.0
check		1.07 a	1.64 a	0.2	0.0	0.0

a/ Herbicides were applied on April 27, 1967 to alfalfa established in 1966.

b/ First cutting was taken June 11, 1967. No further yields were taken because of water damage.

c/ Yield values within a column followed by identical letters are not significant at the 0.05 level of significance.

d/ Weed control ratings based on the system where 0 = no effect and 10 = a complete reduction in stand and vigor.

weed control, however it seemed to decrease crop tolerance. Diuron was ineffective for dandelion or white cockle control. Releasing weed competition appeared to increase yields (Table 2).

Simazine, terbacil and GS 14254 treatments at Aurora gave good control of common chickweed and daisy fleabane and poor control of dandelion except at rates injurious to alfalfa (Table 3). On a unit weight basis, GS 14254 gave comparable results with simazine. Both s-triazines were slightly more effective than terbacil.

Herbicides were not a significant factor in reducing yields at either Marcellus or Aurora, although at Aurora there was a trend of lower alfalfa yields with increasing herbicide rates. Weed yields were also reduced more at Aurora than Marcellus with comparable herbicide rates. The only major difference between locations was percentage of soil organic matter, which was 3.2 and 4.9% at Aurora and Marcellus, respectively.

Table 2. Yields of alfalfa and weeds as affected by herbicides applied in the fall. Marcellus, New York. 1968.

Chemical[b/]	Rate lb/A	Yield, 1st. cut.[c/] T/A			Weed Control[d/]			Total Yield, 2 cuttin T/A		
		Alfalfa[a/]	BLW	Grass	Mouse. Chick.	White Cock.	Dande-lion	Alfalfa	BLW	Gras
simazine	1 1/2	1.29	.20	.67	9.1	4.3	2.1	2.58	.32 b	1.0
	2	1.22	.15	.67	9.6	4.8	2.1	2.59	.34 b	.9
	3	1.05	.09 a	.58	10.0	6.3	4.2	2.80	.15 a	.8
terbacil	0.4	1.11	.30	.77	8.9	2.1	1.0	2.30	.45 c	1.0
	0.8	.98	.21	.75	10.0	4.7	2.2	2.45	.33 b	1.0
diuron	1	1.09	.27	.79	10.0	1.0	1.0	2.90	.34 b	1.0
dinoseb	1	.83	.19	1.06	8.6	3.2	1.1	2.06	.36 b	1.4
simazine + dinoseb	2 + 1	.97	.17	.37 a	9.8	4.9	3.2	2.41	.27 b	.5
control		.85	.24	.99	0.4	0.2	0.1	2.00	.37 b	1.3

a/ Yield values within a column followed by identical or no letters are not differe at the 0.05 level of significance.

b/ Herbicides were applied on October 12, 1967 to alfalfa established in 1966. Alfalfa was removed with a forage chopper one week prior to treating.

c/ First cutting taken June 20, 1968 and second cutting taken August 3, 1968.

d/ Weed control figures are based on a scale where 0 = no effect and 10 = a complete reduction in stand and vigor.

The lack of control of certain perennials such as dandelion (Table 2) or white cockle (Table 3) with available selective herbicides may be due to the growth habit of these weeds in relation to time of herbicide application. Delaying treatment for twelve or more months after weed emergence (4) allows the weed to develop an extensive tap root system with available reserve materials. The well-established weed then is in many respects similar in its physcology and ecology of growth to the crop plant we are trying to selectively remove it from. Effecting control of these weeds may result in control of alfalfa (Table 1 and 3). Weeds should be treated at a stage when they do not have the reserve supply from which to draw upon and before extensive tap root systems are developed. For these reasons studies were established to examine herbicide effects on alfalfa and weeds when applied the same year alfalfa was established.

Table 3. Alfalfa and weed yields as affected by herbicides applied in the fall. Aurora, New York. 1968

Chemical[a]	Rate lb/A	Yield, First Cutting[b] T/A Alfalfa	BLW	Grass	Weed Control Ratings[d] Comm. Chick	Daisy Flea-bane	Dande-lion	Yield, All Cuttings[c] T/A Alfalfa	BLW	Grass
terbacil	.4	1.94	.24 c	.10 b	6.2	6.2	2.1	4.00	.31 c	.18 ab
	.8	1.96	.13 ab	.06 a	9.0	8.0	2.0	4.10	.19 b	.07 b
	1.0	1.77	.08 a	.04 a	10.0	8.2	6.6	4.10	.16 b	.11 bc
simazine	1 1/2	1.88	.06 a	.20 c	8.1	8.1	3.2	4.02	.13 ab	.36 a
	2	1.80	.04 a	.07 a	8.9	8.0	3.1	4.15	.18 b	.11 bc
	3	1.75	.04 a	.09 a	10.0	9.2	6.2	3.90	.06 a	.09 bc
GS 14254	1 1/2	2.2	.06 a	.04 a	9.0	9.0	3.2	4.77	.14 ab	.10 bc
	2	2.0	.05 a	.02 a	9.1	9.1	3.6	4.37	.12 ab	.02 c
	3	1.9	.04 a	.01 a	9.8	9.1	6.8	4.24	.11 ab	.02 c
check		2.2	.24 c	.18 c	0.0	0.1	0.2	4.38	.38 c	.26 a

a/ Herbicides were applied October 30, 1967 to alfalfa established in 1966. Alfalfa was removed with a forage chopper one week prior to treating.

b/ Yield vlaues within a column followed by similar letters are not significant at the 0.05 leve.

c/ First and second cuttings were taken June 21 and August 6, 1968, respectively.

d/ Weed control ratings based on the scale where 0 = no effect and 10 = a complete reduction in stand and vigor.

Applications during the year of seedling establishment - The responses of weeds and alfalfa to herbicides applied the fall of the same year of seedling establishment are presented in Tables 4 and 5. Terbacil at 0.4 and 0.8 lb/A and simazine at 1.5 and 2 lbs/A effected significant control of all weeds as evidenced by weed ratings and yields of botanical separates. At Candor, simazine + dinoseb at 2 + 1 lb/A gave excellent control of yellow rocket and fair control of dandelion (Table 4). Diuron was not satisfactory at either location. At Canton, terbacil appeared to give better weed control than other herbicides although differences were not statistically significant (Table 5). Dandelion control at both locations were better than obtained at Marcellus or Aurora (Tables 2 & 3).

Alfalfa yields were not significantly affected by herbicides at Candor (Table 4) but there was a trend towards reduced yields as a result of high rates of simazine or terbacil. At Canton, simazine at 4 lbs/A and terbacil at 1.2 lbs/A significantly reduced alfalfa yields in the first cutting, however, these differences were not apparent in total yields.

Table 4. Yields of alfalfa and weeds as affected by herbicides applied in the fall. Candor, New York. 1968.

Chemical[b/]	Rate lb/A	Yield, 1st cuttings[a/] T/A Alfalfa	BLW	Grass	Weed Control[c/] Yellow Rocket	Dandelion
simazine	1 1/2	.89	.07	.70	7.1	2.0
	2	.86	.04	.62	8.3	2.2
	3	.64	.03 c	.44	10.0	6.2
terbacil	0.4	.85	.06	.55	6.6	2.0
	0.8	.60	.04 c	.36	10.0	6.0
diuron	1	.75	.17 b	.65	2.3	1.2
	2	.74	.18 b	.59	4.6	1.9
simazine + dinoseb	2 + 1	.78	.01 c	.64	10.0	6.6
dinoseb	1	.83	.18 b	.95	5.0	1.1
control		.73	.27 a	.74	0.2	0.3
control		.78	.30 a	.73	0.1	0.1

a/ Yield values within a column with identical or no letters are not different at the 0.05 level of significance.

b/ Herbicides were applied to alfalfa stubble on October 9, 1967. Alfalfa at this location was established in May, 1967.

c/ Weed control figures are based on a scale where 0 = no herbicidal effect and 10 = a complete reduction in stand and vigor.

Results from all locations indicate that more complete weed control can be obtained when herbicides are applied to alfalfa stubble the fall of the year the crop is established. Reasons for this may be because 1) of more complete spray coverage and/or 2) the weeds are small and more susceptible to phytotoxicants than they would be if allowed more time to become established. Notwithstanding that herbicides are more effective on most weeds in the fall, some materials may also injure alfalfa because it has not reached a state of physiological maturity that insures tolerance.

Simazine and terbacil applied to alfalfa in the fall will control certain herbaceous weeds such as mouseear chickweed, yellow rocket and common chickweed. Control of these weeds increases legume yields and improves quality. Increasing the spectrum of weeds controlled will increase farmer interest in this practice.

Table 5. Yields of alfalfa and weeds as affected by herbicides applied in the fall. Canton, New York. 1968.

Chemical[b/]	Rate lb/A	Yield, First Cutting[a/] T/A Alfalfa	BLW	Weed Control Ratings[c/] Dande-lion	B.L. Dock	Common Chick	Yield All Cuttings T/A Alfalfa	BLW
simazine	1 1/2	1.70 bc	.03	4.0	8.0	10.0	4.18 bc	.04
	2	1.53 c	.02	4.1	9.3	10.0	3.90 c	.05
	4	.56 d	.01	8.0	10.0	10.0	2.11 d	.01
terbacil	0.4	2.77 a	.01	6.8	10.0	10.0	5.08 a	.04
	0.8	2.07 b	.00	10.0	10.0	10.0	4.65 ab	.00
	1.2	1.41 c	.00	10.0	10.0	10.0	3.87 c	.00
diuron	1.0	1.86 bc	.06	3.2	8.2	9.3	4.13 bc	.06
	2.0	1.79 bc	.04	2.6	10.0	10.0	4.20 bc	.03
control		1.95 bc	.12	1.8	1.0	0.1	4.43 ab	.44
control		2.14 b	.12	2.1	1.1	0.6	4.63 ab	.43

a/ Yield values within a column followed by identical or no letters are not significant at 0.05 level of significance.

b/ Herbicides applied to alfalfa stubble on October 12, 1967. Alfalfa was established in April, 1967.

c/ Weed control ratings based on the system where 0 = no effect and 10 = a complete reduction in stand and vigor.

d/ Total yield data are derived by adding total of each separate taken from the plots at three cutting dates, namely June 19, July 29 and October 10, 1968.

Acknowledgement

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STUDIES ON THE EFFECTS OF SIMAZINE AND TERBACIL FOR ESTABLISHED ALFALFA[1/]

E.D. Spear and W.B. Duke[2/]

Abstract

Studies to examine the use of 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine) and 3-tert-butyl-5-chloro-6-methyluracil (terbacil) for weed control in established alfalfa were conducted at the Mt. Pleasant Research Farm near Ithaca, New York on Erie channery silt loam, pH 6.0, with an organic matter of 5.8%.

Saranac alfalfa was seeded in oats May 1, 1967. On November 10 the alfalfa was treated with simazine at 1.5, 3.0 and 6.0 lbs/A and terbacil at 0.4, 0.8, and 1.6 lbs/A. Field design was a split plot with main plots being time of first harvest in 1968, May 28 versus June 10, and subplots corresponding to six chemical treatments plus three checks. There were six replications.

Total forage yields were obtained from a 3.25 x 20 ft. swath cut from the center of each 8 x 30 ft. plot. When yields were taken, a subsample was separated in legume, broadleaf weed species and weedy grasses for botanical separate yields. All yield data are expressed on a oven-dry basis (75C to constant weight). At each harvest date, forage samples were taken to determine the levels of terbacil or simazine present and to determine levels of protein as a result of herbicide treatment. Carbohydrate reserves present in alfalfa roots as affected by herbicide treatment was also examined.

Analysis of the data showed the following: First cutting -- Plots receiving terbacil at 0.8 and 1.6 lb/A and simazine at 6.0 lbs/A had significantly less yellow rocket (Barbarea vulgaris r. Br.) than all other plots. Untreated plots yielded the highest amount of yellow rocket. Total and alfalfa yields were significantly greater for the June 10 cutting than for the earlier cutting. Year totals -- Yellow rocket yield was significantly reduced by all terbacil treatments and simazine at 6.0 lb/A. Untreated plots recorded highest yellow rocket yields. Total broadleaf yield at first cutting was reduced more by removing forage on May 28 than June 10; however subsequent cuttings indicated that the later first cutting was more effective for reducing the broadleaf weeds. The three terbacil treatments had the highest alfalfa yields although this did not appear significant. Total alfalfa yields where the crop was removed on June 10 were significantly greater than when the crop was cut May 28.

1/ Contributions courtesy of Department of Agronomy, Cornell University, Ithaca, New York.

2/ N.S.F. Trainee and Assistant Professor, respectively. Department of Agronomy, Cornell University.

Analysis of plant samples taken at each harvest from the plots receiving 1.6 lbs. terbacil indicates no measurable residue in the forage.

Further work and analyses are being completed with the material and data at hand. Thus far it appears that terbacil at 0.8 or 1.6 lb/A is an treatment for the type soil used in this experiment. Further research needs to be conducted with this chemical to determine optimum rates and the effects of treatment for more than one year.

WEED CONTROL IN DORMANT ALFALFA[1/]

R. D. Ilnicki and L. F. Hist[2/]

The control of annual weeds in new seedings of alfalfa is no longer the problem it used to be since the advent of effective herbicides. Depending on the existing or anticipated weed problem, herbicides can be applied either before planting, immediately after planting, or after alfalfa emergence. With regard to postemergence treatments, applications should be made when weeds and alfalfa are seedlings.

Research on weed control in old or established alfalfa stands has received little attention to date. Invasion of troublesome biennial and perennial weeds in established stands contribute to the thinning of these stands and create problems, particularly that of reducing the quality of the harvested forage.

The object of the research reported here was to evaluate promising herbicides for the control of troublesome biennials and persistent perennials, as well as some winter annuals, that often invade stands of alfalfa.

Materials and Methods

Investigations were conducted on a one-year-old stand of alfalfa (var. Vernal) which was seeded on April 21, 1967 on Freehold sandy loam soil near Adelphia, New Jersey. Plots 5 feet x 20 feet were established to receive herbicidal treatments. All applications were made with a knapsack sprayer calibrated to deliver 40 gpa of spray material.

Two experiments were included in this study. One study consisted of a comparison of herbicide treatments applied late in the fall with those applied early in the spring, in both instances while the alfalfa was in a relatively dormant stage. The second experiment consisted of an evaluation of a number of experimental herbicides applied only in the spring.

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[2/] Research Professor and Research Technician in Weed Control, respectively.

Weeds in the experimental area included curlydock (Rumex crispus L.), white cockle (Lychnis alba Mill.), yellow rocket (Barbarea vulgaris R.Br.), daisy fleabane (Erigeron annua L.), and the winter annuals, common chickweed (Stellaria media L.) and corn chamomile (Anthemis arvensis L.).

Weed control and crop injury were rated using the scale 0 to 10, where 0 = no control or crop injury and 10 = complete weed control or 100% reduction in crop stand or vigor. Ratings were made in late April and early May. Yields were not taken.

For ease of presentation, details relating to the individual experiments will be discussed separately. Chemical descriptions of the herbicides investigated are presented in the Appendix.

Fall vs. Spring Treatments

The following herbicides and rates, expressed in lb/A, were applied on December 13, 1967 and on April 3, 1968:

terbacil	1, 1½, 2
diuron	1, 1½, 2
chlorpropham	1, 1½, 2
simazine	1, 1½, 2
GS-14254	1, 1½, 2
dinoseb	3/4, 1½, 3

Because of an error in choosing the proper formulation of GS-14254, this herbicide was also applied at 3-1/5, 4-1/5, and 6-2/5 lb/A, only, in the fall.

New Spring Treatments

The following herbicides and rates, expressed in lb/A, were applied on April 4, 1968:

RH 315	1, 2, 3
chloroxuron	1½, 3
RP 17623	2, 4
C-6989	3, 6
C-6313	2, 4
C-9122	2, 4
C-7019	2, 4
RD 7693	¼, ½
EH 72031	¼, ½, 3/4
AP 20	1, 2, 4

Results and Discussion

For ease of discussion, each experiment will be discussed separately.

Spring vs. Fall Treatments

Curlydock, daisy fleabane, and white cockle were difficult weeds to control. These weeds were not affected by any herbicide treatment applied in the fall. Only two herbicides, terbacil and simazine, at the two-pound rates, effected a slight response on these difficult-to-control weeds. The highest rates of these herbicides produced approximately 25-40% reductions in stand with about the same percentage of reductions in vigor in the surviving plants. There were no great differences in susceptibility between these weeds and in their response to these two herbicides.

Yellow rocket was particularly sensitive to terbacil. All rates effectively controlled yellow rocket either from spring or fall applications. Simazine only at the highest rate almost completely controlled yellow rocket when applied in the fall. The lower rates reduced stand and vigor about 50%. No rate of simazine was effective on yellow rocket when applied in the spring.

The experimental herbicide GS-14254 was very effective on yellow rocket at all rates, applied in the spring; however, applications made in the fall produced no control or reductions in vigor of this biennial.

Yellow rocket was only slightly responsive to diuron treatments applied in the spring. Fall applications had no effect on this weed. Yellow rocket was completely insensitive to chlorpropham and dinoseb.

The winter annual weeds, common chickweed and corn chamomile, were much easier to control than the other weeds. Chickweed was completely controlled from fall applications of all rates of terbacil, diuron, chlorpropham, simazine, and dinoseb. Corn chamomile was almost completely controlled from fall applications of all rates of terbacil, diuron, and simazine.

That chickweed was easier to control than corn chamomile was demonstrated from spring applications of herbicides. Practically all spring-applied herbicide treatments had some effect on chickweed stand, whereas chlorpropham, simazine, GS-14254 and DNBP had no effect on corn chamomile when applied in the spring. It is noteworthy that chlorpropham and GS-14254 were ineffective on corn chamomile regardless of the time of application.

Alfalfa was not injured by any herbicide treatment regardless of the time of application. This also included the high rates of GS-14254 which were applied by error.

New Spring Treatments

The difficulty in controlling curlydock, daisy fleabane, and white cockle was also shown in this experiment. None of the new herbicides were effective in reducing stands of these weeds. Only C-6313 effected slight reductions in vigor of these weeds but this response was short-lived.

Yellow rocket was completely eliminated by the higher rate of C-6313 and almost completely controlled by the lower two-pound rate. The experimental compound C-9122 at the higher rate had a moderate effect on yellow rocket. RP 17623 had no effect on stand, but reduced the vigor by almost 50%.

That corn chamomile is more difficult to control than common chickweed was also demonstrated here. With the exception of C-6313, no herbicide or herbicide treatment effected reductions in stand of corn chamomile. Slight reductions in vigor were produced by RD 7693 and the higher rate of chloroxuron

Common chickweed was effectively controlled with applications of chloroxuron, C-6313, and C-7019. Control to a lesser degree was produced by C-6989 and RH 315.

Only two herbicides had an effect on the vigor of alfalfa. Temporary reductions were effected by RP 17623 and C-6313 at the two rates used.

Summary

This study consisted of two experiments. In one experiment, comparisons were made of fall versus spring applications of common herbicides. In the other, new experimental herbicides were evaluated only in the spring. In both experiments the objective was to control some typical weeds found in established stands of alfalfa. These included curlydock, white cockle, yellow rocket, daisy fleabane, common chickweed, and corn chamomile.

No general principle could be established as to the best time to control these weeds. Responses of these weeds differed with regard to the herbicide used and the time it was applied. Generally, common chickweed and corn chamomile were easier to control with fall applications of effective herbicides than with spring applications. Yellow rocket, on the other hand, was controlled with fall applications of some herbicide treatments, spring applications of other herbicide treatments, and both spring and fall applications of still other herbicide treatments.

Some promising new herbicides for spring applications that warrant additional study include C-6313, C-7019, and C-9122.

Appendix

Chemical names, code numbers, and chemical descriptions of herbicides used in these alfalfa experiments.

AP 20	cis-2,3,5,5,5-pentachloro-4-ketopentenoic acid
chlorpropham	isopropyl-N-(3-chlorophenyl) carbamate
chloroxuron	N'-4-(p-chlorophenoxy)-phenyl-N,N-dimethylurea
C-6313	N-(4-bromo-3-chlorophenyl-N'-methoxy-N'-methylurea
C-6989	2,4'-dinitro-4-trifluromethyl-diphenylether
C-7019	2-azido-4-isopropylamino-6-methylmercapto-s-triazine
C-9122	3,5-dibromo-4-hydroxy-benzaldoxime-0-2,4-dinitrophenylether
diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea
DNBP	2-sec.butyl-4,6-dinitrophenol
EH 72031	chemistry not disclosed
GS-14254	2-sec.butylamino-4-ethylamino-6-methoxy-s-triazine
RD 7693	chemistry not disclosed
RH 315	chemistry not disclosed
RP 17623	2-tert.butyl-4-(2,4-dichloro-5-isopropyloxyphenyl)-5-oxo-1,3,4 oxadiazoline
simazine	2-chloro-4,6-bis (ethylamino)-s-triazine
terbacil	5-chloro-3-tert.butyl-6-methyluracil

CONTROL OF WINTER ANNUAL WEEDS IN ESTABLISHED ALFALFA WITH SIMAZINE

S. W. Pruss 1/

Simazine has been used for several years to control winter annuals in alfalfa in the Pacific Northwest. Many of the problem weeds found in alfalfa in the Northeast are also quite susceptible to this herbicide.

In order to better define the weed spectrum, safety margin, and optimum time of application of Simazine, six experiments were conducted in Virginia and West Virginia in 1968.

Materials and Methods

The experimental design for all experiments was a randomized complete block with three replications. Plots were 6 by 17½ feet with a 3 by 14½ foot section being harvested.

The sprayable materials were applied in a volume of 48 gallons of mixture per acre with a CO_2 pressurized sprayer equipped with a 6 foot boom. Fertilizer-herbicide combinations were spread by hand.

Location 1

A uniform established stand of Williamsburg alfalfa was treated December 5, 1967, at Opel, Virginia, with rates of 1, 1½ and 2 pounds a.i./acre of Simazine.

Soil moisture was at field capacity at the time of application. A uniform and heavy infestation of common chickweed (*Stillaria media*) and downy brome (*Bromus tectorum*) was present in the area.

Results

It was found at an early observation (January 30) that all rates of Simazine had eliminated the chickweed that had emerged prior to herbicide application. Some chickweed seedlings had emerged since application, however, and were in the 3 to 5 leaf stage. There was no difference among treatments in the number of seedlings or their vigor. Downy brome was also appearing in all

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1/ Field Research Representative, Geigy Agricultural Chemicals, Shawsville, Virginia.

plots at this time. By the next rating date, April 18, Simazine at 1 lb. a.i./A was providing 100% control of chickweed and nearly complete control of downy brome. The 1½ lb. rate was causing some chlorosis and the 2 lb. rate was causing unacceptable damage.

Yields of weed-free forage (Table 1) show a yield increase of nearly 1 ton per acre for the 1 lb. rate of Simazine over the check. Injury from the 1½ and 2 lb. rates are reflected in the total yields. It should be noted, however, that all herbicide treatments outyielded the check.

Location 2

Simazine at rates of 1, 1½ and 2 lbs. a.i./A was applied December 7, 1967, to Williamsburg alfalfa seeded in the spring of 1966. Soil type was Cecil sandy loam. The major weed problems were common chickweed, speedwell (*Veronica arvensis*), whitlow-grass (*Draba verna*) and Shepherdspurse (*Capsella bursapastoris*). The infestation of chickweed and speedwell was uniform and heavy and that of whitlow-grass and Shepherdspurse uniform and moderate.

Results

Observations made in late January showed that the 1½ and 2 lb. a.i./A rate of Simazine resulted in nearly complete kill of the chickweed present at the time of application, however, as reported under Location 1, seedlings were coming back. When observed March 8 all treated plots were completely free of all weeds.

Ratings made April 26 and reported in Table 2 indicate that chickweed and Veronica were coming in all treatments, however, even the lowest rate of Simazine was providing acceptable control of these two weeds. Whitlow-grass and Shepherdspurse were controlled 100% with all three rates of Simazine.

The 2 lb. rate of Simazine was causing slight injury when observed April 16. There was no apparent injury at harvest time, however.

There was little difference in total alfalfa yields between the three rates of the herbicide with all three rates outyielding the check by over ¼ ton per acre of alfalfa dry matter. The biggest advantage for the herbicide treatment was in the first cutting as would be expected.

Location 3

A seedling of Atlantic alfalfa and domestic orchardgrass established in the spring of 1966 on Fullerton silt loam soil was treated with 1, 1½ and 2 lbs. a.i./A of Simazine on December 8, 1967. Primary weeds in the area were common chickweed, mouseear chickweed (Cerastium vulgatum), speedwell, tansy mustard (Descurainia sophia), and fleabane daisy (Erigeron annuus).

Results

All weeds were completely controlled with all three rates of Simazine. There was no alfalfa injury and although orchardgrass was injured with all three rates of Simazine, none of the treatments caused unacceptable injury.

Yield data reported in Table 3 indicates that although orchardgrass injury was not rated unacceptable at any of the rates, the two higher rates of Simazine did cause a reduction in yield.

Location 4

A date of application study was established on a 1965 Williamsbu alfalfa and domestic orchardgrass seeding. The soil type was a Bland stony silt loam.

Treatments were: Simazine at 1, 1½ and 2 lbs. applied December 0-10-30 fertilizer impregnated with .375% Simazine on December 27 and Simazine at 1½ lbs. applied February 7.

The major weed problems were common chickweed, henbit (Lamium amplexicaule), mouseear chickweed, speedwell, Kentucky bluegrass (Poe pratensis), and fleabane daisy. The infestation of chickweed was uniform and heavy. The infestation of all the other weeds was moderate.

Results

All herbicide treatments resulted in 100% control of all weeds except for fleabane daisy at the 1 lb./A rate. This treatment was rated 9.7 on a 0 to 10 scale.

Orchardgrass injury was unacceptable with all treatments of 1½ or more lbs. of Simazine. The 2 lb. rate caused unacceptable alfalfa injury as did the fertilizer and Simazine treatment.

From the phytotoxicity to alfalfa and orchardgrass it appeared that 1½ lbs. of Simazine on fertilizer was equal to 2 lbs. of Simazine applied in water.

There was no difference in weed control between the December 27 and February 7 applications.

Location 5

A late winter application of Simazine, Simazine + non-phytotoxic oil and 0-10-30 + Simazine was applied February 8, 1968, to a 1964 fall seeding of Williamsburg alfalfa and Timothy with volunteer orchardgrass.

The soil type was Huntington silt loam. Common chickweed was the major weed problem.

Results

One month after application there was no difference between treatments.

Data taken April 18 and reported in Table 4 indicates that Simazine applied at 1 pound with or without non-phytotoxic oil at 5% V/V provides adequate but not complete control of chickweed. The 1½ lb. rate of Simazine without oil was about equal to 1 lb. Simazine with oil. The same relative comparison was found between Simazine alone at 2 lbs. and Simazine with oil at 1½ lbs. Phytotoxicity to alfalfa and the grasses was unacceptable with the 2 lb. rate of Simazine.

Simazine impregnated on fertilizer and applied at a rate of 1½ lb. a.i./A provided control equal to Simazine at 2 lbs. per acre applied in water.

The alfalfa stand was variable, therefore, the yields reported in Table 4 may not be a true response of the herbicide performance. It does appear, however, that Simazine applied alone at 2 lbs. and the fertilizer + Simazine treatment reduced the yield.

Summary

Common chickweed, Shepherdspurse, downy brome, henbit and speedwell were controlled with one pound per acre a.i. of Simazine. Applications made from December 5 to February 8 were satisfactory. The addition of oil to the mixture will increase chickweed control over an application of Simazine in water, as will the application of Simazine impregnated on fertilizer.

Table 1. Effects of Simazine on alfalfa, chickweed and downy brome when applied December 5, 1967, rated February 1, and April 18 and harvested May 8 and July 18, 1968, at Opel, Virginia.

		Herbicidal Response 1/						Yields 2/		
	Rate	C.Weed		D.Brome		Alfalfa				
Treatment	lbs/A	2/1	4/18	2/1	4/18	2/1	4/18	5/8	7/18	Tot.
Simazine	1	4	10	0	9	0	0	1.25	1.37	2.62
Simazine	1½	3	10	0	10	0	2.7	.92	1.28	2.18
Simazine	2	4.3	10	0	10	0	3.3	1.00	1.29	2.29
Check		0	0	0	0	0	0	.57	1.10	1.67

1/ Scale 0 to 10, 0 = no effect; 3 = maximum acceptable crop damage; 7 = commercially acceptable weed control; 10 = 100% control

2/ Yields are reported in tons of dry matter per acre.

Table 2. Effects of Simazine on alfalfa and winter annuals at Gretna, Virginia, when applied on December 7, 1967, rated April 26 and harvested May 1, June 18 and August 20, 1968.

	Rate	Herb. Response1/						
Treatment	lbs/A	Cw.2/	Ver.	Alfalfa	1st	2nd	3rd	Tot.
Simazine	1	7.3	7.3	0	1.34	1.19	.52	3.05
Simazine	1½	8.7	9.3	0	1.23	1.28	.58	3.09
Simazine	2	9.3	9.3	1.3	1.24	1.29	.48	3.01
Check	0	0	0	0	.87	1.34	.52	2.73

1/ Scale 0 to 10; 0 = no effect; 3 = maximum acceptable crop damage; 7 = commercially acceptable weed control; 10 = 100% control.

2/ Cw = common chickweed, Ver. = Veronica

Table 3. Effects of Simazine applied December 8, 1967, at Jonesville, Virginia, on first cutting alfalfa-orchardgrass yields.

Treatment	Rate lbs/A	% Alfalfa	% Weeds	Yield/A T Dry Matter
Simazine	1	40.0	0	2.46
Simazine	1½	58.3	0	2.38
Simazine	2	56.7	0	1.95
Check		46.7	6.7	2.46

Table 4. Effects of Simazine on chickweed, alfalfa, and orchardgrass when applied February 8, rated April 18 and harvested May 18, 1968, at Winchester, Virginia.

Treatment	Rate lbs/A	Herbicides 1/ Cw.	Alfalfa	Og.	Yields/A T. alf. Dry Matter
Simazine	1	8	0	1	1.80
Simazine	1½	8.7	1.7	.7	1.71
Simazine	2	10	3.3	3.7	1.54
Simazine+5%Oil*	1	9	0	.7	1.70
Simazine+5%Oil*	1½	10	1	2.3	1.84
Simazine+5%Oil*	2	10	2.3	1.3	1.68
0-10-30+.375% Simazine	400	10	2.7	2	1.45
Check		0	0	0	1.71

* by volume

1/ Cw = Chickweed, Og = Orchardgrass

SOME PROMISING POSTEMERGENCE TREATMENTS IN NEWLY-SEEDED ALFALFA

R. D. Ilnicki and L. F. Hist[1/]

Abstract

Notwithstanding that annual weeds can be controlled successfully in new seedings of alfalfa with herbicides, the quest for better herbicides and/or better herbicide treatments continues. Control for longer periods and the need for safer herbicides prompt this search. Postemergence control is often necessary because of failure of preemergence treatments or failure to use preemergence treatments. Because of the need for effective postemergence treatments, the research work reported here was conducted.

Alfalfa was treated at two different times. The first treatments were applied approximately one month after planting when alfalfa was in the unifoliate stage. A second set of plots was treated when alfalfa was in the two-trifoliate stage, two weeks after the first treatments were applied. Weeds in the experimental area included pigweed (Amaranthus spp.), lambsquarters (Chenopodium album L.), hedgemustard (Sisymbrium officinale L.), crabgrass (Digitaria spp.), and barnyardgrass (Echinochloa crusgalli (L.) Beauv.).

The herbicides used in this study included methyl-(4-aminobenzene) sulfonyl carbamate (M & B 9057), 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) 3,5-dibromo-4-hydroxybenzonitrile (bromoxynil), 4,6-dinitro-o-sec.butylphenol (dinoseb), N,N-dimethyl-2,2-diphenylacetamide (diphenamid), and 2,2-dichloropropionic acid (dalapon). Combinations of herbicides were also evaluated in addition to the ones applied singly. The combinations included M & B 9057 + 2,4-DB, dinoseb + diphenamid, dalapon + bromoxynil, and 2,4-DB + bromoxynil.

Effective herbicide treatments at the earlier stage of alfalfa development included M & B 9057 at $1\frac{1}{2}$ and 2 lb/A only on hedgemustard, 2,4-DB at $\frac{1}{2}$ lb/A on pigweed, combinations of M & B 9057 + 2,4-DB at $1\frac{1}{2}$ to 2 + $\frac{1}{2}$ lb/A on all broadleaves, bromoxynil at 3/8 lb/A on broadleaves, dinoseb at 3/4 and $1\frac{1}{2}$ lb/A on broadleaves, combinations of dinoseb + diphenamid at $1\frac{1}{2}$ to 3 + 2 to 4 lb/A on broadleaves, and dalapon + bromoxynil at 2 to 3 + 3/8 lb/A on all weeds. The combination of dinoseb + diphenamid was extremely injurious to alfalfa.

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The later applications of herbicides were in some instances less effective and in other instances equally as effective for weed control as the earlier ones. Generally, M & B 9057, 2,4-DB, and combinations of the two were not as effective at this time as the earlier applications. The same applied to dinoseb and dalapon. Effective treatments included bromoxynil at 3/8 and $\frac{1}{2}$ lb/A on broadleaves, 2,4-DB + bromoxynil at $\frac{1}{2}$ to 3/4 + 3/8 to $\frac{1}{2}$ lb/A on most weeds, and the combination dinoseb + diphenamid at 3/8 to $1\frac{1}{2}$ + $\frac{1}{2}$ to 2 lb/A. Most of the latter combinations injured alfalfa. The only safe combination, which effected only a moderate degree of weed control, was 3/8 + $\frac{1}{2}$ lb/A.

Additional studies with these herbicides and combinations are anticipated in the future.

CHEMICAL WEED CONTROL IN SPRING SEEDINGS OF CROWNVETCH

P. R. Henderlong, C. Veatch, and C. J. Cunningham[1/]

There is considerable interest in the development of a crownvetch seed production program in the Eastern-Panhandle of West Virginia. The major problems encountered thus far in the development of this program have been; (a) the establishment of adequate stands and (b) high populations of grassy weeds.

EPTC, dalapon, DNBP, paraquat, and 2,4-DB have been used successfully by various workers for weed control in establishing legume seedings (1, 2, 4, 5, 7). Most of these reports, however, pertain primarily to alfalfa and/or birdsfoot trefoil. Similar research data for crownvetch establishment is limited. Berggren (3) has recommended that EPTC at 3 lb./acre was effective in controlling weeds in crownvetch seedings in Pennsylvania. In addition, he indicated that 2,4-DB was injurious to crownvetch and should not be used.

EPTC at rates varying from 1 to 4 lb./acre have provided satisfactory weed control in legume seedings (5, 4, 4, 7). Linscott and Hagin (5) reported that EPTC at 3 lb./acre may result in temporary stunting of alfalfa. Oliver, et al. (6) suggested that inhibition of root growth with EPTC may be significant under conditions of moisture stress. Bayer (2) reported that EPTC may not always be effective in controlling broadleaf weeds, especially ragweed. The data of Linscott and Hagin (5) are in agreement with Bayer (2).

Materials and Methods

The study was conducted on an Edom silt loam at the Reymann Memorial Farms, Wardensville, West Virginia. The Farms are located in the Highlands of the Potomac Valley. The average monthly precipitation from March through September is generally between 2-3 inches/month with frequent droughty periods common during June to September.

Both lime and fertilizer were uniformly applied according to the soil test recommendations prior to the initiation of the field study. Dalapon, dalapon + TCA, amitrole, paraquat, and daxtron were applied to the unplowed area, April 2, 1968 or one week before plowing. Vapam was applied on the same date (April 2) to an area that had been plowed the previous day. EPTC and sutan were applied, April 23 just prior to seeding. Vapam, EPTC and sutan were incorporated immediately after application by disking. All herbicides were applied with a small air pressure sprayer in a volume of 50 gpa at 100 psi.

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Chemung crownvetch was then band seeded with 300 lb./acre of 0-20-20 across each herbicide treatment at 4, 8, and 16 lb. of seed/acre with a 7-inch grain drill.

Results and Discussion

Seedling establishment: The overall means show that none of the herbicides, at the rates used in this study, caused a reduction in plant density or stand count (Table 1). All herbicide treatments, except sutan at 3 and 4 lb. and vapam at 32 gal. resulted in significatnly higher overall stand counts than the untreated check.

There was, however, a highly significant herbicide x seeding rate interaction. When crownvetch was seeded at 4 lb./acre, only dalapon + TCA (6 lb. + 3 lb.), amitrole (2 lb.), daxtron (1/2 lb.) and EPTC (3 lb.) improved the stand count over the check. Vapam (32 gal.) and sutan (3 and 4 lb.) showed a significant reduction in plant density compared to the check. Dalapon (8 lb.), dalapon + TCA (6 + 3 lb), amitrole (4 lb.), EPTC (3 lb.) and sutan (3 lb.) indicated a greater plant density than the check when crownvetch was seeded at the 8 lb./acre rate. EPTC (3 lb.) was the only treatment that did not improve the plant density when crownvetch was seeded at rate of 16 lb./acre.

Plant density increased with an increase in crownvetch seeding rates. The 8 lb./acre seeding rate was not significantly better than the 4 lb./acre rate. With the use of proper seeding techniques, crownvetch can be successfully established with seeding rates as low as 4 lb. of seed/acre.

Weed control: All herbicides, except vapam (32 gal.). significantly reduced the weed population compared to the check (Table 2). EPTC, sutan, dalapon and dalapon + TCA generally resulted in the best overall weed control based on visual estimates. Amitrole, paraquat, and daxtron, in general, did not provide adequate weed control although they did significantly reduce the weed population when compared to the check plots.

The experimental area used for this study was rather heavily infested with quackgrass and the foxtails. EPTC and sutan at 6 lb. were both effective in controlling the quackgrass and to a lesser degree green and yellow foxtail. Dalapon at 8 lb. and dalapon + TCA at 6 + 3 lb. provided moderate control of quackgrass and foxtail. EPTC and sutan at 3 and 4 lb. were about equal to dalapon and dalapon + TCA in quackgrass and foxtail control. EPTC was not as effective in ragweed control as was sutan at the same rate.

Seedling weights: Crownvetch seedlings in the plots treated with daxtron appeared to be severely stunted and in most cases exhibited a marked chlorosis on the outer leaf margins. In an attempt to evaluate the possibility that some of the herbicides, in addition to daxtron, may have inhibited the crownvetch seedling shoot and/or root growth; a total sample (tops and roots) was obtained from each of the treatments from one field replication. From these samples data were recorded with respect to top and root weights and a top:root ratio was calculated (Table 3).

The shoot and root data were not subjected to statistical analyses since only one replication was sampled. The data indicated a trend, however that amitrole and paraquat in addition to daxtron reduced both the top and root weight/plant. The top:root ratio data were highly variable, but indicate that both top and root growth were inhibited equally by daxtron and paraquat. Amitrole may have inhibited top growth more than root growth.

EPTC at 6 lb. appeared to have reduced root growth to some degree. If this effect is significant the data would be in agreement with that of Oliver, et al. (6).

Summary

Based on these data, the use of EPTC, sutan, dalapon, and dalapon + TCA provided the most effective control of grassy weeds in crownvetch seedings. EPTC and sutan at 4 to 6 lb. were very effective in controlling quackgrass but less effective in controlling foxtail. EPTC was less effective than sutan in controlling ragweed.

Daxtron caused a definite chlorsis on crownvetch seedlings at both 1/2 and 1 lb. rates. Daxtron, amitrole and paraquat at the rates used in this study stunted crownvetch seedling growth to some degree. Vapam at 32 gal. ai/acre did not provide satisfactory weed control.

Table 1: The Effect of Herbicides and Seeding Rate on Crownvetch Establishment 32 days after Seeding. (Number of plants/sq. ft.)

Herbicide	Rate (A.I./acre)	Seeding Rate 4 lb/A	8 lb/A	16 lb/A	Mean
Dalapon	8 lb.	5.1 bc*	5.3 bcde*	9.2 ef*	6.56 def*
Dalapon + TCA	6 lb + 3 lb	6.2 a	6.0 ab	11.1 bc	7.78 a
Amitrole	4 lb	5.0 bc	5.9 abc	10.8 cd	7.21 bc
Amitrole	2 lb	5.9 ab	4.9 def	10.3 cd	7.03 bcd
Paraquat	1/2 lb	4.0 d	4.5 efgh	13.2 a	7.26 ab
Paraquat	1 lb	5.0 bc	5.0 cdef	10.1 de	6.70 bcd
Daxtron	1/2 lb	6.1 a	4.1 fgh	10.0 de	6.74 bcd
Daxtron	1 lb	4.0 d	4.7 efg	10.5 cd	6.38 def
Vapam	32 gal	2.2 f	3.8 gh	9.9 def	5.31 hij
EPTC	3 lb	5.1 b	6.8 a	5.1 i	5.67 ghi
EPTC	4 lb	4.5 cd	4.7 efg	8.9 fg	6.02 efg
EPTC	6 lb	4.0 d	4.7 efg	11.9 b	6.86 bcd
Sutan	6 lb	3.6 de	4.2 fgh	10.2 cd	6.00 fg
Sutan	3 lb	2.1 f	5.8 bcd	7.8 h	5.21 ij
Sutan	4 lb	2.8 ef	3.6 h	8.1 gh	4.82 j
Check	-	4.2 cd	4.2 fgh	5.9 i	4.79 j
Mean		4.4 y**	4.9 y	9.6 x	6.27
L.S.D.(.05)		0.98	0.98	0.98	0.56

*Values in the same column not having the same letter differ significantly at the 5% level.

**Values in this row, not having the same letter differ significantly at the 5% level.

Table 2: Visual Weed Control Ratings

Herbicide	Rate (A.I./acre)	Control Rating*
Dalapon	8 lb	5.8 abc**
Dalapon + TCA	6 lb + 3 lb	6.2 abc
Amitrole	2 lb.	4.5 bc
Amitrole	4 lb	4.5 bc
Paraquat	1/2 lb	3.8 cd
Paraquat	1 lb	4.8 bc
Daxtron	1/2 lb	4.2 c
Daxtron	1 lb	4.3 c
Vapam	32 gal	1.3 dc
EPTC	3 lb	5.2 bc
EPTC	4 lb	6.3 abc
EPTC	6 lb	8.2 a
Sutan	3 lb	5.3 bc
Sutan	4 lb	7.0 ab
Sutan	6 lb	8.0 a
L.S.D. (.05) = 2.62	C.V. = 30%	

*Rating Scale: 0 = no control, 9 = complete control

**Values not having the same letter differ significantly at the 5% level.

Table 3: Crownvetch Seedling Weights as Effected by Herbicide Treatment.

Herbicide	Rate (A.I./acre)	Plant Weight (gms) Shoot	Plant Weight (gms) Root	Shoot:Root Ratio
Dalapon	8 lb	.1817	.1471	1.23
Dalapon + TCA	6 lb + 3 lb	.4607	.2514	1.83
Amitrole	2 lb	.1246	.0964	1.29
Amitrole	4 lb	.1162	.0867	1.34
Paraquat	1/2 lb	.0857	.0629	1.36
Paraquat	1 lb	.1389	.0778	1.78
Daxtron	1 lb	.0719	.0681	1.05
Vapam	32 gal	.1707	.1007	1.69
EPTC	3 lb	.3476	.2010	1.72
EPTC	4 lb	.8192	.4717	1.73
EPTC	6 lb	.3369	.2855	1.18
Sutan	3 lb	.3153	.1953	1.61
Sutan	4 lb	.4419	.2688	1.64
Sutan	6 lb	.3650	.2600	1.40
Check	-	.1683	.1052	1.59

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WEED CONTROL IN TREFOIL WITH SIMAZINE

T. R. Flanagan[1]

Weed competition continues to be a major problem in fields of birdsfoot trefoil managed for seed production. In addition, the seeds of certain perennial weeds when present in the harvested crop, are detrimental to the production of clean certified seed. Quackgrass (Agropyron repens L. Beauv.) is the most prevalent grass weed and among the broadleafs, chicory (Chicorium intybus L.), fleabanne (Erigeron spp.), sulfur cinquefoil (Potentilla recta L.), hairy vetch (Vicia sativa) and dandelion (Taraxacum officinale) are most troublesome.

The need for weed control has been well documented (1,3,5). The initial work in 1957 with herbicides in Vermont indicated that dalapon could be useful in controlling undesirable grasses and certain broadleaf weeds (2). Dalapon in combination with certain of the 2,4-DB's held promise, but synergism from such tank mixes was held to be contributory to trefoil injury (3). Simazine was included in the 1963 test series with average seed yields second only to those from 3 lb./A of dalapon. Additionally, simazine was particularly effective in controlling fall chickweed, mustard, and at the 1½ lb./A ai rate, the highest in the test, in suppressing fleabane.

In 1964, yields were taken from an old stand of Mansfield trefoil which had been treated with several herbicides immediately following harvest the year previously. The 1½ lb./A ai rates of simazine were as or more effective than the several butyrics tested in controlling alsike clover, fleabane and kale. While simazine suppressed chickory somewhat in comparison with the unsprayed check plots, vetch was not affected at all at this rate (5). However, total broadleaf weed populations, as represented by dry weights of botanical separations, were cut almost in half by simazine, and grass was reduced by 75% or more. Seed yields from the high rate (1½ lb./A) of simazine were three times greater than those from the unsprayed check plots.

Several herbicides were applied in the early spring of 1964 to an established stand of Mansfield trefoil. Yields were taken the following year but due to an extremely dry season all plots were not harvested. The best single plot yields are shown in Table 1, and could be considered as indicative of trends. Yields from the simazine treatments made two years previously (1963) are also included in this table.

In 1965, yields of trefoil were also taken from a series of plots where the herbicides had been applied earlier that same spring. Again, due to the same droughty conditions, great variation in stands existed, preventing harvesting of many plots. Average yields of dry trefoil forage and of seed are shown in Table 2, together with the highest, single plot yields. Yields of forage and of seed were greatest where the trefoil had been previously treated with dichlobenil or simazine. This was also true for the 1965 harvest from early spring treatments from the year before (Table 1).

Also, in 1965 in the late fall, an additional series of trials were established using simazine alone and in combination with dichlobenil and with

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bromacil. Yields were measured in July of 1966 with the results shown in Table 3.

It would appear that the bromacil and dichlobenil treatments out-yielded those of simazine, however the block containing the simazine plots was located in a different section of the field where previous erosion had depleted the soil fertility. However, it is of interest to note that the 3 lb. rate of simazine was optimum as reflected by yields and that as the rate of bromacil was increased, the yields decreased. This was due to moderate to severe trefoil stunting concurrent with increasing rates. The maximum seed yield obtained from the bromacil treatments occurred where 4½ lb. of simazine was mixed with 1½ lb. of bromacil.

As previously noted, dichlobenil was again a superior treatment with the highest average seed yields obtained from these tests occurring where 1½ lb. of dichlobenil was applied along with 4½ lb. of simazine. The 3 lb. of dichlobenil plus 3 lb. of simazine mixture afforded the best treatment with respect to quackgrass and perennial broadleaf weed control together with minimal or no trefoil injury.

During 1966 and 1967, several large areas of trefoil in commercial seed production were treated with simazine. One in particular deserves mention. In 1965, simazine at 0, 3, 6, and 9 lb./A ai was applied to an old, weedy stand of trefoil. The three, and in particular, the 6 lb. rate resulted in very good seed set and a stand reasonably free of weeds. Weed control ratings plus seed yields are shown below in Table 4. The 9 lb. rate afforded some stunting of the trefoil but resulted in an outstanding seed set.

Also, in 1966, yield samples were taken from field treatments of 7 acres each of simazine at 0, 2, and 4 lb./A ai, applied the previous year to an old, weedy stand of Mansfield. Rough seed yields were determined to be, in average grams per sample area, 144, 134, and 162 in the same order.

A series of half acre plots were established in the fall of 1967 on an old, very grassy stand of Mansfield and also, that same year, several 4 acre plots on a weedy Viking field. Yields, taken in 1968, are shown on the following table (Table 5).

It appears that simazine applications, especially fall applications of 6 lb./A, show great promise in controlling quackgrass and other grasses, and in eliminating or suppressing a number of broadleaf weeds, with resulting increases in yield of clean seed. At this rate, however, chicory continues to be a problem. Tests underway include several combinations with phenoxys, especially silvex, in an effort to determine an efficient but economical control for this particular weed.

Fall treatments with simazine are now a recommended practice in Vermont. Such are suggested on a "trial basis" with "no feeding" restrictions applying to the forage or straw ("hay") from the combine. Several hundred acres of trefoil in commercial production have been so treated and grower response has been enthusiastic. Costs of spray material are more than offset by resultant seed yield increases.

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Table 1. Yields of trefoil seed from plots treated with several herbicides.

Treatment	Date	Rate lb./A ai	Highest single plot yield gms.
Simazine	8/1963	0.5	6.0
Simazine	8/1963	1.5	18.0
Simazine	4/1964	0.5	19.0
Simazine	4/1964	1.0	22.0
Diuran	4/1964	0.5	13.5
Diuran	4/1964	1.0	18.5
Diphenamid	4/1964	0.5	17.5
Dichlobenil	4/1964	3.0	20.5
2,4-DB	4/1964	0.5	4.5
2,4-DB	4/1964	1.5	4.0
No treatment		---	20.5

Table 2. Yields of trefoil seed plots treated with several herbicides applied in May 1965.

Treatment	Rate lb./A ai	Highest single plot yield, gm.	Average yield, gm.	Trefoil forage, gm.
2,4-DB	3/4	3.5	1.2	61
Dalapon	2	5.0	1.7	68
Simazine	1	12.0	4.3	170
Dephenamid	1	3.5	1.7	161
Dichlobenil	3	12.5	7.6	175
2,4-DB + dalapon	3/4 + 2	1.5	2.0	105
2,4-DB + simazine	3/4 + 1	1.5	1.3	139
Diphenamid + simazine	1 + 1	5.0	2.8	82
Diphenamid + dalapon	½ + 1½	4.5	1.5	66
No treatment	---	8.5	3.3	110

Table 3. Yields of trefoil forage, clean seed, and average ratings for weed control from herbicidal treatments.

Treatment	Rate lb/A ai	Forage gm.	Seed gm.	Weed Control* A	T	P	C	V
Simazine	0	326	1.1	0	0	0	0	0
Simazine	1½	628	2.7	3	1	0	1	0
Simazine	3	371	4.4	7	2	2	2	2
Simazine	6	275	1.2	10	3	6	5	4
Simazine	12	157	1.0	10	8	10	9	10
Bromacil	0	292	3.8	0	0	0	0	0
Bromacil	3	204 i	1.8	10	9	5	5	10
Bromacil	6	104 ii	0.5	10	9	10	9	10
Bromacil + Simazine	1½+4½	268 i	4.5	10	9	4	3	9
Bromacil + Simazine	3+3	217 i	1.6	10	9	5	6	10
Dichlobenil	0	250	5.7	0	0	0	0	0
Dichlobenil	3	225	6.5	9	8	9	9	7
Dichlobenil	6	384	8.5	9	9	8	10	9
Dichlobenil + Simazine	1½+4½	544	11.3	8	8	6	5	2
Dichlobenil + Simazine	3+3	446	10.5	10	8	7	8	9

* A= Agropyron repens, T= Taraxacum officinale, P= Potentilla recta, C= Chicorium intybus, V= Vicia sativa, 0= no control, 10= best, i= injury to trefoil, ii= severe injury to trefoil.

Table 4. Yields of trefoil seed and average ratings for weed control from several rates of simazine applied in 1967.

Treatment	Rate lb/A ai	Seed gm.	Weed Control* A	T	P	C	V
Simazine	0	5.6	1	1	1	1	1
Simazine	3	7.4	3	2	3	5	3
Simazine	6	20.1	6	1	5	8	4
Simazine	9	25.4	9	6	9	9	10

* A= Agropyron repens, T= Taraxacum officinale, P = Potentilla recta, C= Chicorium intybus, V = Vicia sativa, 0 = no control, 10 = best.

Table 5. **Average yields of clean trefoil seed from simazine treatments made in 1967.**

Variety	Treatment	Rate lb/A ai →	Yield of clean seed - gm. 0	3	6
Mansfield	simazine		1.4	6.6	8.6
Viking	simazine		4.0	8.7	13.9

THE USE OF CHEMICALS TO CONTROL WEEDS IN SUGAR BEETS

by T.W. Scott and T.W. Bateman[1/]

Introduction:

The control of weeds in sugar beets continues to be of primary concern to the commercial sugar beet grower as well as to the processor. The problem is emphasized during growing seasons where rainfall is limiting and weeds, particularly the broadleaf species, offer serious competition for soil moisture. Even in periods of adequate moisture, such as 1968 in Central New York, weed competition can restrict the growth and development of the sugar beet root and lower net returns to the commercial grower. Weedy fields of marketable beets present harvesting problems as well as increasing tare and storage problems at the refinery.

This study was conducted to determine the best methods of chemical weed control in sugar beets.

Experimental Method:

This field study was conducted at the Aurora Research Farm in Central New York. The soil type on the experimental field, a Honeoye-Lima silt loam is typical of the soils recommended for the commercial production of this crop. The seed used was Kleinwanzleben IS 5-93 and was the same seed grown commercially in New York in 1968. This was planted in four row plots with a four-row precision drill.

Land preparation was accomplished on April 15-16 by spring plowing followed by a clodbuster. A 10-20-20 fertilizer at the rate of 400 lbs. per acre was broadcast and disced in prior to planting. The same grade and rate was applied through the planter in a band at planting time.

After seedbed preparation and prior to planting, weed seeds were broadcast over the experimental area with a wheel-barrow type seeder. Weeds that were broadcast included black mustard [*Brassica nigra* (L.) KOCH], ragweed [*Ambrosia artimisiifolia* (L.)], lambsquarters [*Chenopodium album* (L.)], and foxtail [*Setaria glauca* (L.)].

This study included 36 treatments replicated four times. The plot size was 10 x 30 feet and included four rows of sugar beets at a 30 inch row spacing. Plots receiving the incorporated treatments had the chemical applied on April 16 and disced in immediately in two directions with a tandem disc. Sugar beets were planted on April 17 at a two inch spacing with a John Deere precision sugar beet drill. Preemergence treatments were applied immediately after planting. Post-emergence treatments were applied at the four true leaf stage of growth (May 22).

Thinning the stand to one beet per foot of row was accomplished by hand at

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the four-six true leaf stage of growth. Hoes or other mechanical means were not used.

Visual ratings for sugar beet injury and weed control were made on two dates; June 3 and July 8. The ratings are reported in Table 1. Sugar beet roots were harvested in early October. Yields and sugar percentages were determined.

Prior to lifting the beet roots for harvest, petioles and blades were removed by means of a mechanical defoliator. This also permitted the investigators to estimate the size of the roots as a result of various treatments. In plots where roots were small and not of marketable size, the plots were not harvested. In these cases yields were less than 2 tons per acre.

Results and Discussion:

Root yields of sugar beets are substantially higher than those reported in previous years. This is a reflection of more favorable moisture conditions during the 1968 growing season (Fig. 1 and Fig. 2).

Chemical treatments applied to sugar beets influenced weed populations and caused sugar beet yield differences ranging from less than 2 tons to 25 tons on an acre basis. Although actual weed counts were not made, visual ratings were made on two dates. Since the growth of annual grasses was not good, the ratings reflect primarily the effect of herbicides on broadleaf weeds. The ratings are given in Table 1. It should be noted that the two early ratings are consistent with the final sugar beet yields.

To serve as checks, one treatment did not receive chemical treatment and a second treatment received no chemicals but was hand weeded. These two treatments represented the extremes in treatment yields.

Only one treatment (4), received cultivation. This was done in combination with the chemical treatment currently recommended to commercial growers, namely pyrazon + TCA. This also resulted in the highest yield of beet roots. Chemicals or combinations of chemicals used that were the most effective in controling weeds that resulted in yields of approximately 20 tons or more were treatments 23, 16, and 28. Other treatments that looked good and resulted in yields of 14 tons or more were treatments 18, 26, 27 and 20.

Several chemicals gave outstanding weed control in the 1968 trials when used alone or in combinations with other chemicals. These included, Schering 4075, BAS 2430, BAS 2920, and BAS 2572 postemergence treatments. Cycloate did not control weeds sufficiently when used alone but did work effectively in combination with other preemergence or postemergence chemicals.

Summary:

As a result of various chemical treatments, sugar beet yields ranged from approximately 2 to 25 tons. Cycloate incorporated plus Schering 4075 postemergence, BAS 2430 postemergence, and Schering 4075 plus pyrazon were superior treatments. Other outstanding chemicals were BAS 2920. Schering 4075, BAS 2572 when used alone, all postemergence, and BAS 2920 and BAS 2430 preemergence. These

chemicals or combinations all gave better weed control than pyrazon alone or pyrazon plus TCA without cultivation.

Cycloate incorporated alone did not give satisfactory weed control but is good when used in combination with several other chemicals which include the following: pyrazon; pyrazon plus dalapon plus surfactant; pyrazon plus surfactant and Schering 4075.

Percentage of sugar in the beets was not affected by chemical treatment although there was a tendency for the higher yielding plots to have a higher sugar percentage.

Table 1. Injury Ratings, Yields, Sugar Percentage and Dominant Weed Species as Influenced by Treatment

eat o.	Chemical	Rate/A lbs a.i.	Method of Application Inc	Pre	Post	Injury Ratings[1/] Beets 6/3	Beets 7/8	BLW 6/3	BLW 7/8	Net Yield Roots T/A	Sucrose %	Predominant Weeds Present Mus-tard	Rag-weed	Lambs-quarter	Pig weed
4	pyrazon + TCA + 3 cult.	4+6		X		1.3	0.0	9.6	9.5	25.3 a	16.5	X			
1	hand weeded check	-	-	-	-	1.0	0.0	8.7	10.0	24.7 a	16.0	-	-	-	-
6	BAS 2430	4			X	2.7	1.0	10.0	9.5	19.9 ab	14.3[2/]	X	X		
8	cycloate + Schering 4075	4+3	X		X	2.7	1.0	9.8	9.0	19.8 ab	16.6		X		X
2	Schering 4075 + pyrazon	2+4			X	2.2	1.5	10.0	9.0	19.2 bc	14.9[2/]		X		X
7	cycloate + pyrazon + dalapon + surf.	4+5+3+2	X		X	4.2	2.0	9.5	8.5	17.7 bcd	16.1	X			
6	BAS 2920	5			X	2.0	2.5	7.2	8.0	17.4 bcd	16.0	X			X
8	cycloate + pyrazon + surf.	4+4	X		X	1.5	1.5	8.8	8.0	17.1 bcd	15.4	X	X		
0	Schering 4075	3			X	2.0	1.5	9.5	7.5	14.0 bcde	15.8	X	X		X
5	pyrazon + lenacil	4+1			X	1.7	3.5	8.5	6.0	13.8 cde	15.5	X	X	X	X
5	BAS 2430	4		X		1.8	3.5	8.2	6.0	13.6 cde	15.4	X	X	X	X
1	Schering 4075	4			X	2.4	2.0	9.9	7.5	13.4 cde	15.5		X		X
4	pyrazon + lenacil	4+2	X			2.9	6.0	9.0	7.0	13.3 cde	15.7	X	X		X
2	BAS 2572	4			X	1.7	2.5	8.8	7.5	13.2 de	15.1	X	X	X	X
3	BAS 2920	5		X		1.9	3.0	7.6	7.0	12.7 de	15.3	X	X	X	X
1	Schering 4075 + oil	2+1/2			X	2.6	3.0	9.2	7.0	12.1 def	15.8	X	X	X	X
9	Schering 4075 + pyrazon + benzadox	1+1+1			X	1.7	2.0	9.7	7.0	9.1 efg	15.3	X	X		X
0	Schering 4075	2			X	1.7	3.0	8.9	5.0	7.0 fgh	15.6	X	X		X
3	pyrazon + TCA	4+6		X		1.4	5.0	7.6	4.0	6.7 fgh	15.4	X	X	X	
9	pyrazon + dalapon + surf.	4+3+2		X		1.2	6.0	6.0	3.5	6.6 fgh	14.0	X	X		
3	pyrazon	4			X	1.2	5.0	5.6	4.5	6.5 fgh	15.0	X	X	X	

Table 1. (Cont'd) Injury Ratings, Yields, Sugar Percentage and Dominant Weed Species as Influenced by Treatment

eat o.	Chemical	Rate/A lbs a.i.	Method of Application Inc	Pre	Post	Injury Ratings[1/] Beets 6/3	Beets 7/8	BLW 6/3	BLW 7/8	Net Yield Roots T/A	Surcose %	Predominant Weeds Present Mus-tard	Rag-weed	Lambs-quarter	Pig-weed
7	pyrazon + oil	4+2			X	3.2	3.5	8.2	6.0	5.8 ghi	-	X	X		X
5	pyrazon + dalapon + surf.	4+3+2			X	3.0	5.5	6.9	4.0	5.4 ghi	-	X	X		
7	pyrazon + tropachlor	4+3		X		1.9	6.0	6.5	3.0	3.6 ghi	-	X	X		
9	pyrazon	4		X		1.2	5.0	6.6	5.0	2.9 hi	-	X	X	X	
0	benzadox + pyrazon + lenacil	1+1+1			X	1.1	7.0	6.2	3.0	2.7 hi	-	X	X		
6	pyrazon + tropachlor	4+2		X		3.2	5.5	8.2	4.0	1.9 hi	-	X	X		
5	BAS 2572	4		X		0.8	6.0	7.5	4.0	1.4 hi	-	X	X	X	
3	CP 52223	3		X		1.6	5.5	8.2	4.5	0* i	*	X	X		
4	Schering 4075 + benzadox	1+1			X	1.5	8.0	4.9	2.0	0* i	*	X	X		
4	MB 14255	2		X		4.0	8.0	7.0	2.0	0* i	*	X	X		
2	CP 52223	2		X		1.6	8.0	6.7	1.0	0* i	*	X	X		
5	tropachlor	4		X		1.4	9.0	3.2	0.0	0* i	*	X	X		
8	cycloate	4	X			0.6	9.0	4.6	0.0	0* i	*	X	X		
1	CP 52223	1		X		0.3	9.0	2.7	0.0	0* i	*	X	X		
2	Check (no chem. or mech. control)					0.0	9.0	0.2	0.0	0* i	*	X	X	X	X

Not harvested because of apparent size of roots after tops were removed. Estimated to be less than 2 tons per acre.

Injury ratings 0-10 0 = No injury 10 = 100% injury or kill

Only one sample for sugar analysis

Table 2. Herbicides Used in 1968 Sugar Beet Investigation

Compound	Trade Name	Chemical Name
pyrazon	Pyramin	5-amino-4-chloro-2 phenyl-3 (2H) pyridazinone
TCA	TCA	tichloro acetic acid
cycloate (phenmedipham)	RoNeet	S-ethyl-N-ethelthiocyclohexane-carbamate
Schering 4075	Betanal	3-methoxycarbonylaminophenyl-N-(3'-methyl-phenyl) carbamate
BAS 2430	-	1 phenyl-4-amino-5-bromo-pyridazone
BAS 2572	-	1 phenyl-4-(α-hydroxy-β,β,β-trichloroethyl)-amino-5-bromo-pyridazone-(6)
dalapon	Dowpon	2,2 dichloropropionic acid
lenacil	Venzar	2-cyclohexyl-6,7-dihydro-1H-cyclopenlapyrimidine 2,4(3H, 5H)-dione
benzadox	Topcide	(benzamidooxy) acetic acid
tropachlor	Ramrod	2 chloro-N-isopropylacetanilide
CP 52223	-	2-chloro-N-(isobutoxymethyl)-2', 6'-acetoxylidide

FIG. 1. A COMPARISON OF 1968 GROWING SEASON RAINFALL WITH THE LONG TERM AVERAGE

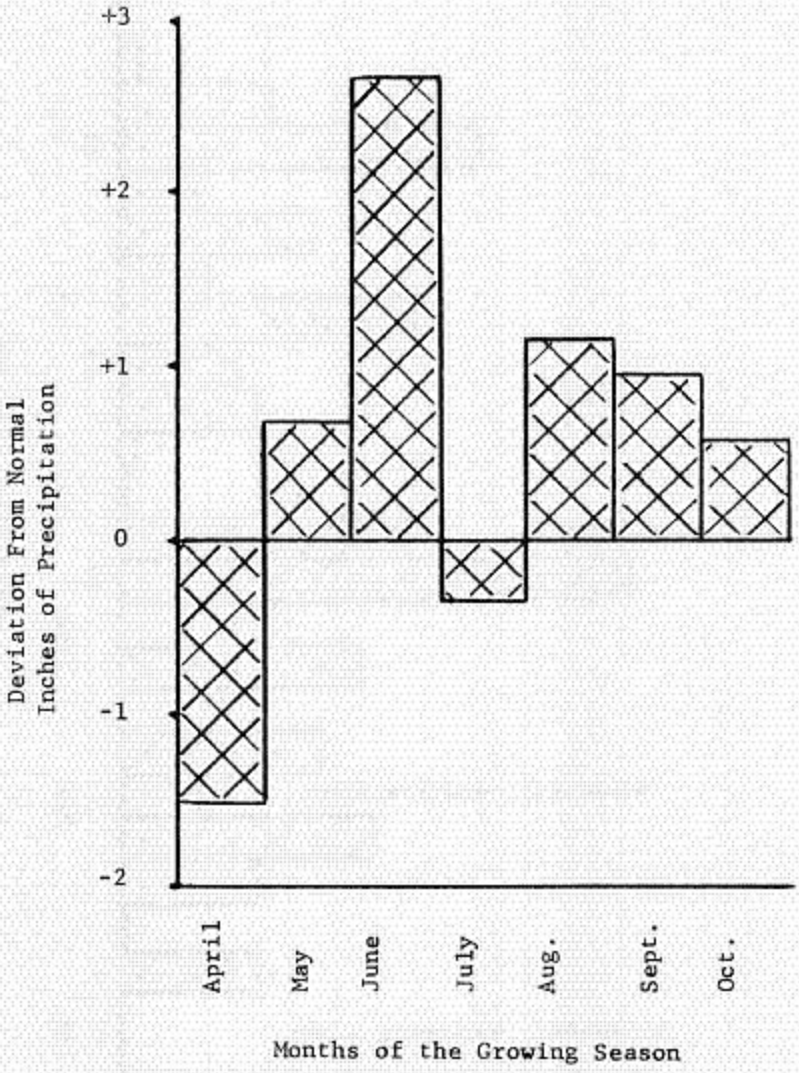
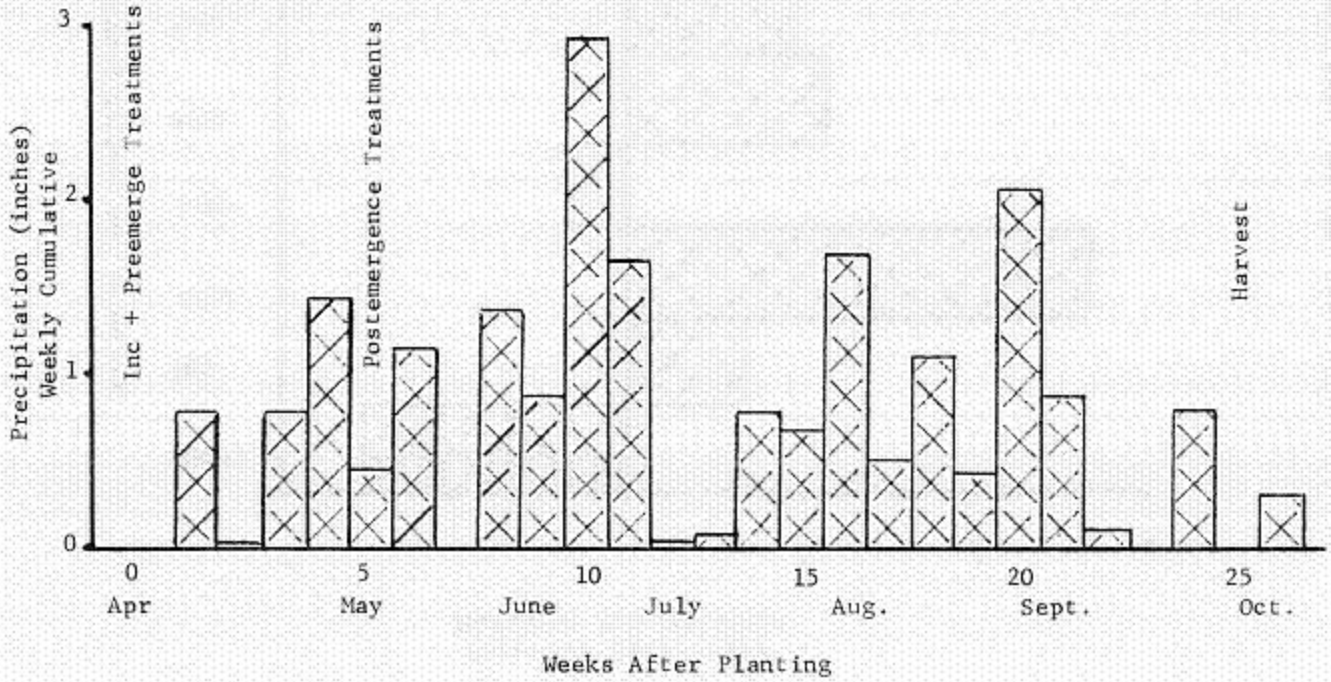


FIG. 2. WEEKLY PRECIPITATION AT THE AURORA RESEARCH FARM 1968



WEED CONTROL IN SUGAR BEETS WITH PREPLANTING, PREEMERGENCE AND POSTEMERGENCE HERBICIDES.

M.F. Trevett and William Gardner[1/]

This is a report of annual weed control in sugar beets with the herbicides listed in Table 1.

PROCEDURE

Sugar beets (Variety IS 5-922, Kleinwansleben E Brand) were planted on 7 June '68 in a loam soil for preemergence treatments, on 19 June '68 in a loam soil for early postemergence treatment, and on 2 July '68 in a field with soil varying from loam to silt loam to loamy sand for preplanting incorporated treatments.

Herbicides were applied with one pass of a small plot sprayer at 40 pounds pressure and 50 gallons per acre volume.

The principal weeds were: Wild rutabaga (*Brassica rapa* L.); Redroot pigweed (*Amaranthus retroflexus* L.); Lambsquarters pigweed (*Chenopodium album* L.); Barnyard grass (*Echinochloa crusgalli* (L.) Beauv.). Weed counts and ratings were made 6 to 10 weeks after herbicides had been applied.

Appropriate transformations were made in the statistical analyses but only the reconverted means are given in the tables. Lower case letters following the means in the tables indicate the array of Duncan's Multiple Range Test. Means with the same letter do not differ significantly at the 5% level.

At the time this report was written statistical analysis of yields was not available, hence only averages are given.

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RESULTS

Preemergence treatments: Table 2

MB 14255 at 1 and 2 pounds active ingredient per acre, and RP 17623 at 1 pound per acre are not included in Table 2: each severely reduced beet emergence. TOK alone is not included because 1 to 4 pounds active ingredient did not control Brassica species.

All the herbicide treatments in Table 2 significantly reduced beet stand compared to hand hoed plots. There were no significant differences in stand between chemical treatments. These treatments and average yield per 25' of row follow:

Treatment	Pounds roots per 25' of row
Check - Hand hoed	49.6
2# TOK + 3# Pyrazon	29.4
3# CP 52223	19.8
2# Pyrazon + 2# CP 52223	31.8
3# TOK + 3# Pyrazon	20.1
4# Pyrazon + 6# TCA	25.7

Three pounds per acre of CP 52223 gave poor control of Brassica species. All treatments gave excellent control of annual grass. All chemical treatments reduced vigor of beet plants (rated 23 July '68) compared to hand hoed plots. The rating for 4 pounds of pyrazon plus 6 pounds of TCA was numerically higher than for the other chemical treatments.

As in past years, reduced plant vigor resulted in reduced yields compared to hand hoed non-chemically treated plots.

How much the heavy rainfall in June contributed to the apparent large reduction in vigor is not known. The preemergence treatments were applied to a soil nearly at field capacity and 1.06 inches of rain fell in the 9 day period following application: with rain falling in 7 of the 9 days.

Postemergence treatments: Table 3

All postemergence treatments gave fairly severe foliage injury to beets. In addition, 8 pints per acre of TD 1472 plus 4 pounds pyrazon and 12 pounds per acre ACP 65-223A (with surfactant) significantly reduced beet stand compared to all other treatments. 2 and 4

pounds per acre of R 11913 did not satisfactorily control (less than 40% in either case) Lambsquarters and Redroot pigweed. 4 pints of TD 1472 added to 2 pounds of R 11913 did not increase control.

Average yields for the best postemergence treatments follow:

Treatment	Pounds beets per 25' of row
2# R 11913 + 4 pints TD 1472	13.1
4 pts. TD 1472 + 4# Pyrazon	13.5
10 lbs. 65-285	10.6
4# Pyrazon + 6# TCA	9.9
4 pts. TD 1472 + 3# Pyrazon	16.7
Check - Hand hoed	23.3

As usual the somewhat reduce vigor of beet plants due to chemical treatment combined with not always adequate weed control (particularly of annual grass) reduced yields below that of hand hoed plots Yields are lower than are commercially acceptable for all treatments (a consequence of late planting: 2 July), but it is assumed that they are adequate for comparing herbicide effect on both weed control and phytotoxicity to beets.

A period of near drought followed the application of postemergence treatments (16 July): only .47 inches fell in the next 14 days.

Preplanting incorporated treatments: Table 4

Neither RO-NEET alone or less than 6 pounds per acre of R 11913 adequately controlled Brassica species. 4 pounds of RO-NEET gave excellent control of annual grass, 6 pounds of R 11913 gave essentially adequate control.

R 11913 even at a 6 pound per acre rate did not adequately control either redroot pigweed, lambsquarters pigweed. 4 pounds of RO-NEET gave excellent control of redroot pigweed but poor control of lambsquarters.

Evidently for satisfactory all-around weed control, both RO-NEET and R 11913 need supplementing. Thus, RO-NEET and R 11913 were applied together at different rates, and separately with CP 52223. In addition, RO-NEET was combined with Pyrazon: RO-NEET being applied preplanting, Pyrazon, preemergence.

Best overall weed control and highest average yield of beets was obtained with:

4# RO-NEET preplant + 3# Pyrazon preemergence
4# " " + 4# " "
4# " " + 4# R 11913 preplant
4# R 11913 preplant + 1# CP 52223 preplant
4# Pyrazon preemergence + 6# TCA preemergence

(Subsequent statistical analysis may show that other treatments may not differ statistically from the five treatments listed above).

Some of the treatments significantly reduced the before-thinning stand of beets. 6# R 11913 significantly reduced beet stand below than any other treatment. 4# R 11913, 4# R 11913 plus 4# RO-NEET, and 4# R 11913 plus CP 52223 all had significantly lower stands than the top 4 treatments in Table 4. However, enough seedling beets remained to provide a commercially acceptable stand: 6# R 11913 not hand hoed had 15.6 plants per 10 feet of row before thinning: this gave on the average, one plant every 7.7 inches.

CONCLUSIONS

As in past years, any single herbicide or combination of herbicides that effectively and adequately controls annual weeds in beets also reduces the vigor of beet plants compared to hand hoeing.

To adequately control annual weeds in beets it appears that in most fields - or at least in fields having a fairly wide spectrum of broadleaf weeds - combinations of herbicides will be needed.

In the present series of tests, combinations that appear to be as good or better than the standard recommendation in Maine (4# Pyrazon per acre plus 6 pounds TCA) are:

4# RO-NEET + 3 or 4# Pyrazon
4# RO-NEET + 4# R 11913
4# R 11913 + 1# CP 52223.

Table 1. Herbicides used in sugar beets, 1968.

Designation	Active Ingredient
ACP 65-285	Pyrazon + Dalapon: 5# + 3# per 10 lbs. product
ACP 65-223A	Pyrazon + Dalapon + Surfactant (5 + 3 + 2) per 12 pounds of product
CP 52223	2-chloro-N (isobutoxymethyl)-2',6'-acetoxylidide
MB 14255	A Rhodia-Chipman product
Pyrazon	5-amino-4-chloro-2-phenyl-3(2H) pyridazinone
R 11913	A Stauffer product
RO-NEET	S-ethyl cyclohexylethylthiocarbamate
RP 17623	A Rhodia-Chipman product
TCA	Trichloroacetic acid
TD 1472	3-methoxycarbonylaminophenyl-N-(3'-methylphenyl) carbamate
TOK	2,4-dichlorophenyl p-nitrophenyl ether

Table 2. Pre-emergence application of herbicides in sugar beets.

Treatment and acre rate of active ingredient	No. beet plants per 25' of row 21 Aug. '68 - after thinning	Percent broadleaf weed control		% annual grass control	Vigor rating: beets 23 July '68
		Brassica spp.	Redroot pigweed		
Check - Hand hoed	33.6 a 1/	100.0a	100 2/	100 a	100 3/
2# TOK + 3# Pyrazon	24.1 b	98.0a	61.3	93.1 b	44
3# CP 52223	23.6 b	52.2b	--	97.0ab	50
2# Pyrazon + 2#CP 52223	20.0 b	99.3a	87.5	97.7ab	44
3# TOK + 3# Pyrazon	20.0 b	99.4a	--	94.2 b	29
4# Pyrazon + 6# TCA	18.5 b	99.3a	86.0	94.1 b	64

1/ Duncan's Multiple Range Test: 5% level.
2/ Statistical analysis not run on figures for redroot pigweed: the weed was not uniformly distributed in the field.
3/ Not analyzed statistically.

Table 3. Early post-emergence applications of herbicides in sugar beets.

Treatment and acre rate of active ingredient	No. beet plants/25' of row - 13 Aug. '68 not thinned	Percent broadleaf weed control			Number of annual grass plants/ 3 sq. ft.	Vigor rating: beets 23 Aug. '68
		Brassica spp.	Lambsquarters pigweed	Redroot pigweed		
2# R 11913 + 4 pts. TD 1472	98.9 ab[1/]	90.6 a	45.9 c	52.4 cd	34.9 cd	85.1
4 pts. TD 1472 + 4# Pyrazon	80.9 bc	99.7 a	79.0 a	71.4 bc	30.8 cde	96.1
10 lbs. 65-285	76.2 c	99.6 a	42.4 c	70.6 bc	13.1 fgh	77.5
4# Pyrazon + 6# TCA	71.8 c	100.0 a	54.0 bc	77.9 ab	40.3 bc	71.0
4 pts. TD 1472 + 3# Pyrazon	69.8 c	99.7 a	78.2 a	78.8 ab	20.8 def	86.7
Check - Hand hoed	101.0 a	100.0 a	100.0 a	100.0 a	0.0 i	100.0

1/ Duncan's Multiple Range Test - 5% level.
Numbers with the same letter do not differ significantly.

Table 4. Preplanting application of herbicides in sugar beets.

Acre rate of active ingredient	No. beet plants/10' of row, 11 July '68 (before thinning)	Percent broadleaf weed control: Brassica spp.	Percent broadleaf weed control: Lambs-quarters pigweed	Percent broadleaf weed control: Redroot pigweed	Number annual grass plants/ 3 sq.ft.	Vigor rating: beets	Pounds beet roots/ 25' of row
4# RO-NEET + 2#CP 52223 pp[1/]	48.4 a[2/]	40.0 cd	34.5 bc	82.0 a	0.0 c	64 bcd	20.3
4# RO-NEET pp	48.0 a	5.2 e	44.0 b	85.2 a	0.4 c	39 d	5.4
Check, hand hoed	46.4 a	100.0 a	100.0 a	100.0 a	0.0 c	100 a	19.9
2# RO-NEET + 2#R 11913 pp	45.0 a	28.8 cde	7.5 c	25.0 c	0.6 c	51 cd	20.0
4# RO-NEET pp + 4#Pyrazon pre	43.6 ab	89.0 a	92.2 a	92.2 a	0.0 c	79 abc	30.2
4# RO-NEET pp + 3#Pyrazon pre	42.0 abc	90.0 a	93.8 a	94.5 a	0.4 c	89 ab	31.8
4# RO-NEET + 2# R 11913 pp	41.8 abc	17.0 de	32.5 bc	28.8 c	0.0 c	64 bcd	9.5
4# RO-NEET + 1# R 11913 pp	41.0 abc	5.0 e	5.0 c	5.0 c	0.4 c	67 bcd	17.7
2# R 11913 pre	41.0 abc	5.0 e	5.0 c	5.0 c	77.0 a	59 cd	6.8
4# Pyrazon + 6# TCA pre	39.6 abc	53.5 bc	47.0 b	38.2 bc	2.5 bc	64 bcd	23.2
4# R 11913 pp	34.2 bc	5.0 e	5.0 c	5.0 c	50.6 a	60 bcd	7.3
4# RO-NEET + 4# R 11913 pp	33.4 bc	75.0 ab	93.2 a	70.0 ab	0.0 c	89 ab	24.3
4# R 11913 + 1# CP 52223 pp	32.8 c	74.5 ab	64.0 ab	64.8 ab	2.0 c	64 bcd	29.6
6# R 11913 pp, hand hoed	18.0 d	100.0 a	100.0 a	100.0 a	4.2 bc	100 a	24.0
6# R 11913 pp	15.6 d	76.8 ab	47.0 b	26.2 c	47.0 a	60 bcd	11.8

1/pp = preplanting, incorporated; pre = preemergence

2/Duncan's Multiple Range Test: 5% level.

THE BONNEVILLE POWER ADMINISTRATION'S VIEW OF RIGHT-OF-WAY BEAUTILITY

Charles J. Slatt 1/

Beautification, Beautility -- Two words rather uncommon in the vocabulary of the electrical utility industry a few years ago, now are prominent in every utility trade magazine and are the subject of much discussion by utility management. Never in the history of the electrical industry in this country have more people devoted more time and effort to create more new and unique hardware or facilities for transmitting power with this thought in mind.

What is beautification though? Is it the process of "prettying" up an existing facility, or is it the pre-planned long range program of designing elements in their proper perspective.

Purposes of human designs can basically be divided into the functional and ornamental categories. The electrical utility industry has to fulfill the functional category, i.e., of supplying continuous uninterrupted power to homes and industries. This is its sole function. But on the other hand, there is no reason why the functional facility cannot be designed and constructed to become a part of the surrounding area. Its presence and functions should be successfully amalgamated and harmonize with the surroundings.

This is the purpose of my talk -- how we can have the lines fit into the native scenery without a decrease in reliability of the basic function of transmitting power without interruption. This is our goal! This is what we would like to achieve, this is what we are working toward. How do we do it? We are not quite certain ourselves, but we are working at it. Our problem is not confined to a few acres but stretches out over approximately 11,000 circuit miles in an area that covers more than 500 miles from north to south and from west to east; from sandy ocean beaches to the wild Rocky Mountains, through fields and deserts, through juniper growing at 2 - 3" per year, to lush rain forests with growth rates of over 6' per year.

This is our task, how to have the lines harmonize with the surrounding area by performing certain measures that are both sufficiently economical and also practical on such a large scale. No matter how pleasing the lines are to the eye, the underground power transmission will always have a higher esthetic value. But undergrounding a high capacity long distance transmission network like ours is presently not economically possible. So we have to continue building lines, but we can build them and maintain them with a new sense of esthetics.

This is what we are trying to do at Bonneville:

In 1964 the Bonneville Power Administration was very much concerned about the lack of consideration given to the overall appearance of its facilities already constructed, as well as for those to be constructed. Staff discussions about improving the appearance were held, but most of us have a tendency to "not disturb the status quo", and "what looks good to one does not necessarily

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look good to another", and "the time and dollars this takes could surely be put to better uses", and so on. No really constructive solution seemed evident.

However, our top management took a more positive approach to the problem. It felt that there is no reason why appearance can not be incorporated in the planning, and also meet the demands for economy, safety, and reliability. Management wanted to get away from the general feeling of going along with the idea of improving appearance by accomplishing a few acts of "beautification" in a few isolated instances.

In the interest of getting a complete system-united appearance program it contracted with an outside architect firm for "A REPORT ON APPEARANCE PLANNING".

The report covered the following points:

1. A general description of the scope of problems faced by BPA.

2. An objective analysis of problems and some of their causes.

3. A rationale upon which to base present and future planning.

4. Recommended solutions and a guide to their implementation.

Fundamentally the report shows that appearance must be included in the initial planning as an essential ingredient to the success of the total operation. It also provided a planning framework to assist in the smooth implementation of the concept over a long period of time. This is important because what we do today has its impact on the area for the years that follow. With this in mind we forecast what we thought the general conditions would be in our area by 1985.

The Bonneville Power Administration is located in the Pacific Northwest. It is an area of 290,000 square miles and has a population of six million people. Half of their electrical needs are supplied by BPA. It has about 11,000 miles of transmission line with voltages ranging from 115,000 volts to 750,000 volts.

The Northwest expects to see a population increase of 70% by 1985. To meet the needs of the area, plus the higher standard of electrical living, the forest lands given over to transmission line rights-of-way will double, the number of substations will double, and the generation and transmission capacity will quadruple.

It is not unlikely that the average work week by then will be 35 hours, or four working days, resulting in a large amount of leisure time available.

The population density in our metropolitan areas will be at a high level. This will manifest itself by recurring weekend explosions into every conceivable less populated section of the Northwest.

New and improved modes of transportation and a vastly expanded network of roads and trails will crisscross the entire area, and people will get in contact with transmission line rights-of-way at all but the most remote locations.

An ever increasing utilization of our timber and agricultural resources will make itself noticeable in the use of presently remote areas where power lines were at the time of construction inconspicuously located and herewith will expose the entire BPA grid to the eye of a critical and progressively conservation-minded public.

The load centers in the Northwest are located great distances from the source of electric power, the net result being that much more transmission line mileage is required than in a more compact area. Our high voltages require considerable area and high clearances.

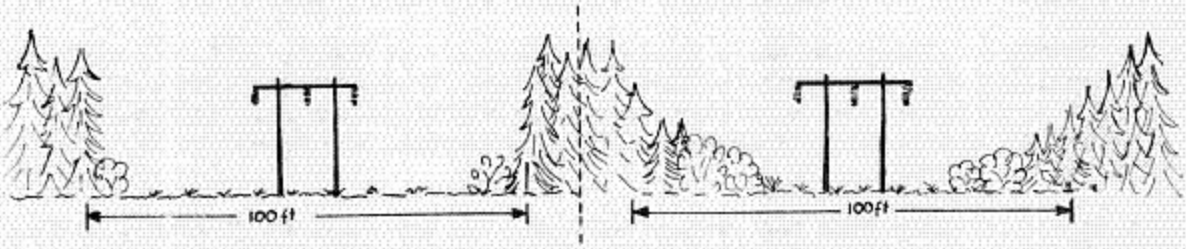
It became necessary then to develop a plan to achieve the total concept to developing a right-of way system that seems to create an impression that it was planted into rather than cut out of the surrounding country side.

Rights-of-way cleared are not only so that a transmission line can be constructed, but more important, once constructed to keep it in operating condition. The operations and maintenance functions should have a definite say then in the location and the width of the right-of-way, the clearances to be maintained, and the manner in which the rights-of-way are to be left at initial energization. Recognizing these conditions, our people reasoned that the plan developed by Maintenance could also be the one put into effect by our Engineering and Construction people. It meant that the new lines would be designed with APPEARANCE as one of the design factors and that the older lines would, over a period of time, achieve this same concept. The plan adopted for BPA calls for the following right-of-way treatment:

Sketch I. RIGHT OF WAY IN LEVEL TERRAIN

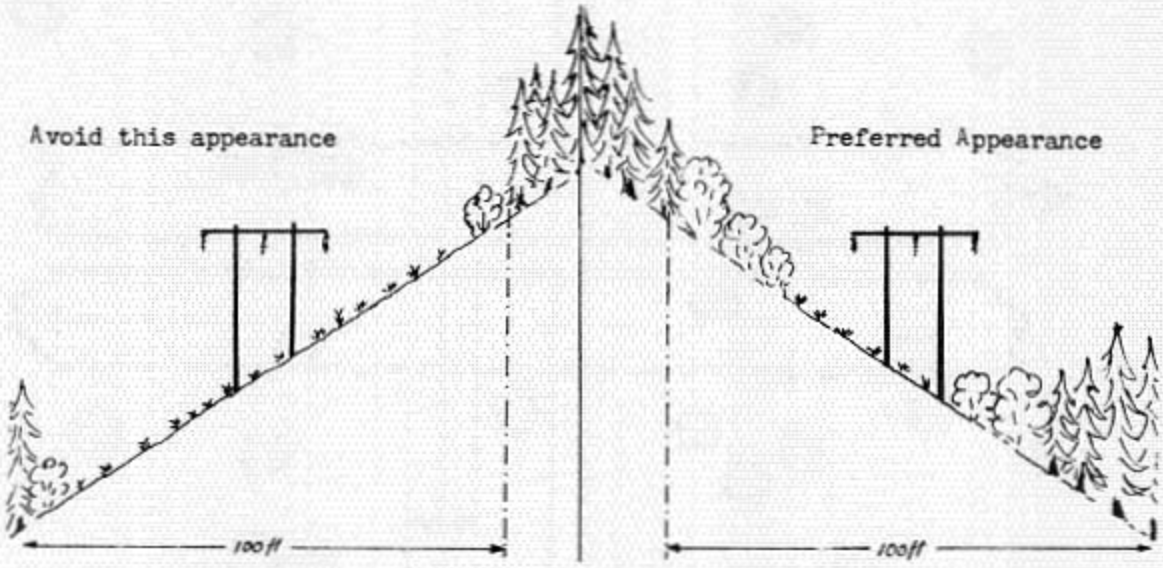
Avoid this appearance

Preferred appearance



The object here is to retain the low-growing brush as much as possible.

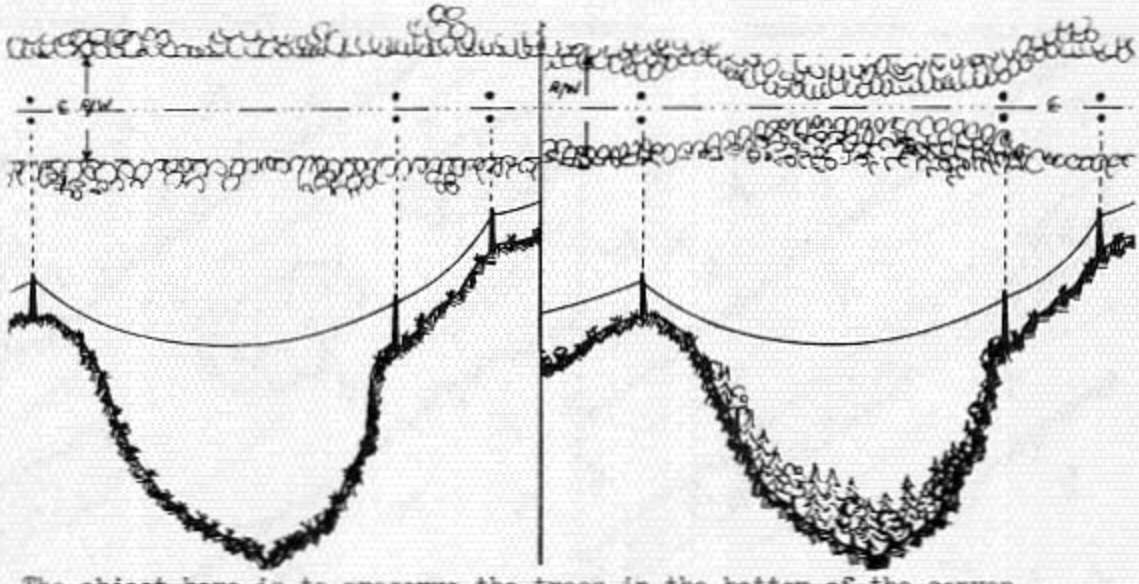
SKETCH II. RIGHT-OF-WAY ON SIDEHILL



The object here is to preserve the trees and vegetation on the downhill side.

SKETCH III. RIGHT OF WAY IN A CANYON (Plan and Profile)

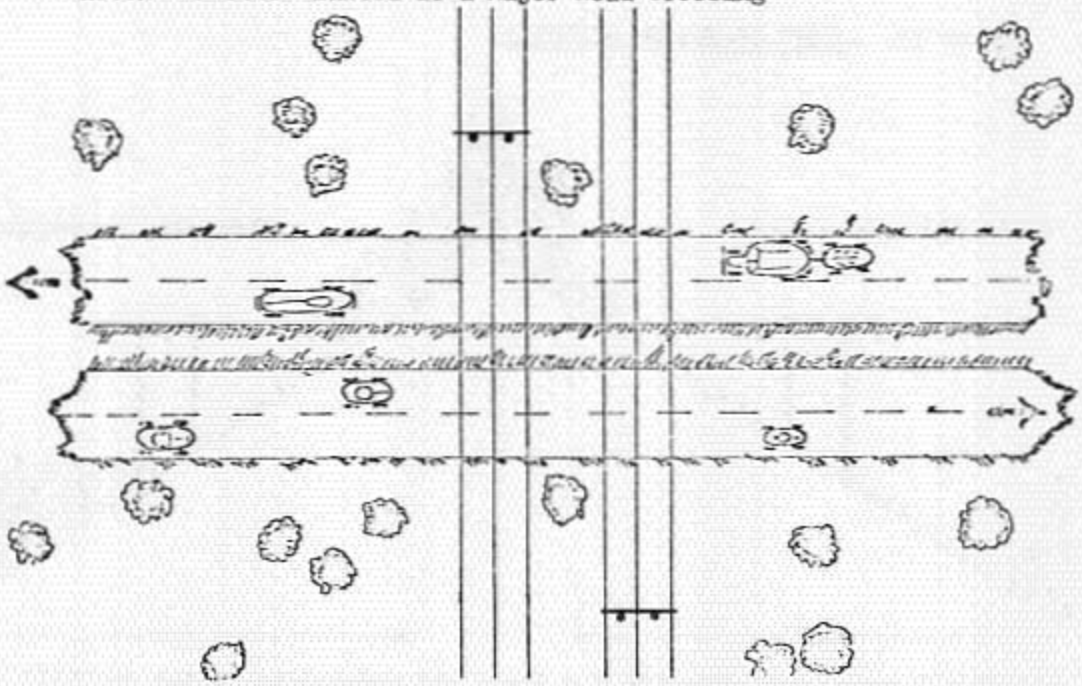
Avoid this appearance Preferred appearance



The object here is to preserve the trees in the bottom of the canyon.

R/W Appearance Near Major Roadways, Recreational or Scenic Areas

Sketch IV. Trees Planted at a Major Road Crossing

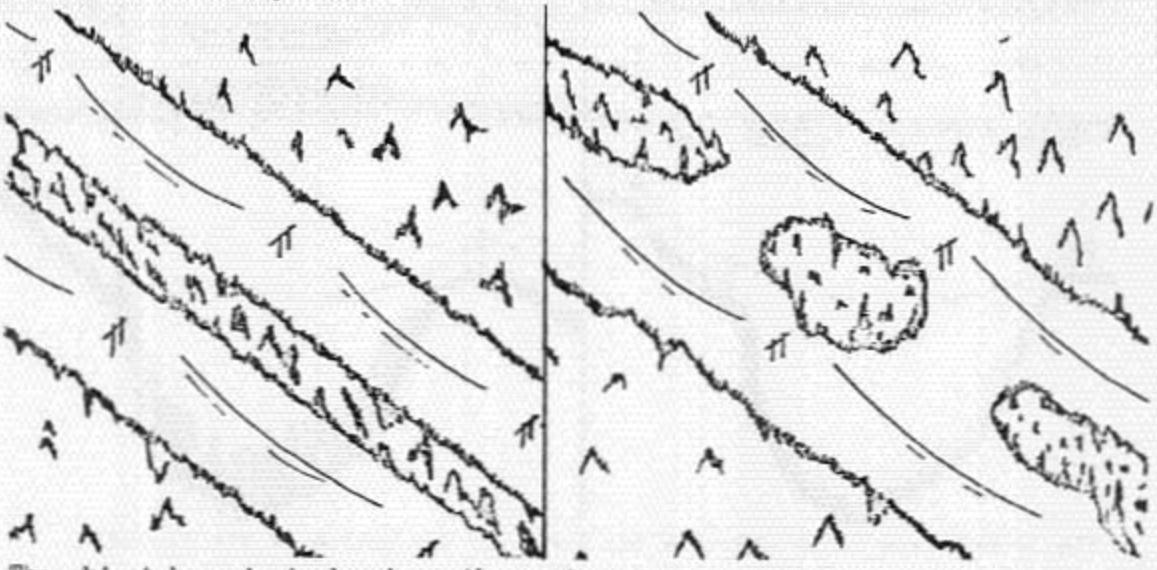


The object here is to screen the right-of-way by plantings.

SKETCH V. MULTIPLE R/W WITH CENTER STRIP

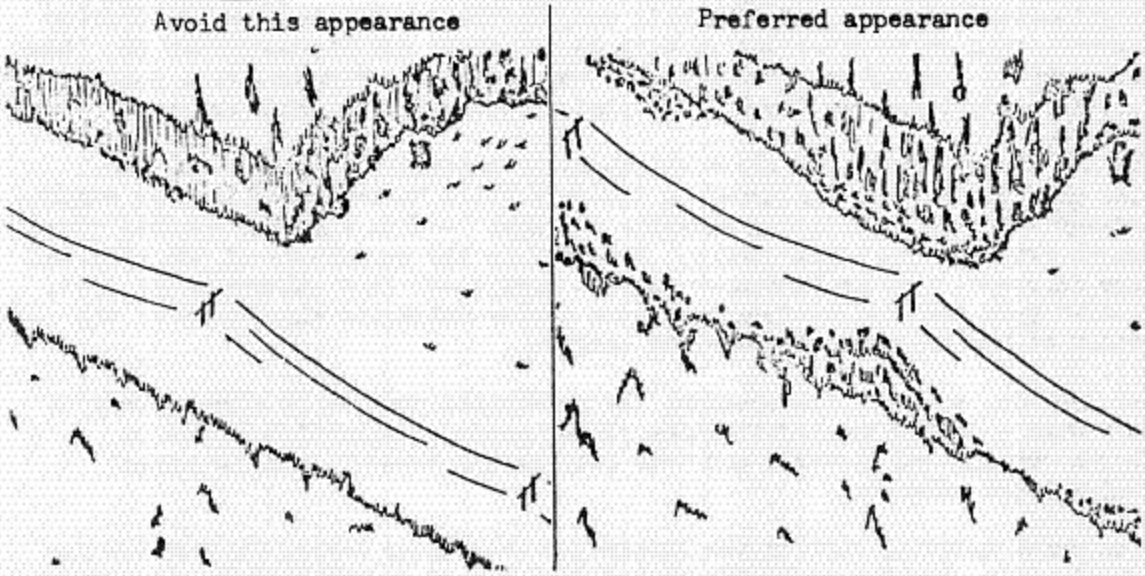
Narrow Center Strip. Avoid!

Broken up Center Strip. Preferred appearance.



The object here is to break up the center strip to look like groves of trees.

Sketch VI. R/W ENTERING (DENSE) TIMBER FROM A MEADOW OR CLEARING



The object here is to avoid the "tunneled-out" corridor appearance.

It is quite obvious from the above that considerable more individual attention to sections of the rights-of-way is required than was the case under our old procedures. Yet in terms of the total concept, there are some very worthwhile and special benefits that accrue from this "Esthetic Right-of-Way Clearing", such as:

1. The buying, cutting, and disposal of none-danger trees which is wasteful and unnecessary is eliminated.

2. The amount of land taken out of useful timber production is considerably decreased.

3. The efforts against erosion and stream pollution due to sudden periodic run-off are dramatically improved.

4. The areas that have to be treated with herbicides are reduced.

5. The problem caused by invasion of fast-growing species like alder is lessened by the retention of more slow-growing species on the right-of-way.

6. Situations where irrepairable damage is done at the time of original construction are avoided.

Sympathetic BPA officials have asked the question -- to what use can utility right-of-way land be put? There is very little problem in farm and grazing lands. Land cultivation and grazing may continue undisturbed under the lines. The same is true of non-arable plains and prairies. However, real conflicts arise in rights-of-way through forested, semi-rural and urban areas.

We are constantly on the alert for mutually beneficial right-of-way uses. The growing of Christmas trees on the Bonneville Power Administration rights-of-way has developed into a sizeable business -- more than one hundred such major projects are in existence. Not only is the appearance of the right-of-way improved, but the landowner makes a profit off land otherwise not used, and we gain because the Christmas tree grower maintains the growth on the right-of-way to stipulated maximum heights.

We propose, that for the present, the appearance problem of right-of-way be met with a review and modification of the power suppliers' practice in brush cutting and control, and tree cutting and control, and subsequent maintenance programs.

Low shrub material left in the foreground will, many times, relieve the severity of a clearing gash when viewed from a road or residential development. Transmission corridors crossing highways can be partially screened by plantings close to or within the highway right-of-way. The closer the plant is to the viewer the smaller it can be and still act as a screen. Also, a small plant on the top of a bank makes an effective screen.

Where transmission lines swing across a sharp valley or canyon and because of this are quite high above ground level, many times full scale trees could be left and still preserve clearance requirements. This practice could not only save clearing costs in difficult areas, but also would serve to reduce the clearing scar when viewed from the road or by the air traveler.

Selective herbicidal treatment properly programmed and managed offers the most promise with respect to initial and future brush control measures.

We believe there is real merit in this matter of APPEARANCE, and that it is truly significant when treated as a total concept. We are a utility dedicated not only to serving the region's low cost power requirements, but we are also dedicated to the conservation of natural resources. We do not believe in removing any more trees than necessary to furnish reliable service. So, with this new approach we not only save many dollars in reduced timber purchases, but we also save the cost of cutting and disposal of slash, improve public relations, and achieve improved appearance as a by-product. We do not anticipate any increase in cost of maintenance if the program is properly managed.

The concept must be implemented! A positive attitude -- the same if you will -- that the utility has for reliable service must be expressed! This will lead to development of new procedures, methods, and a desire to make it "go". Enthusiasm is contagious.

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Stanton, Boles, Maguire & Church.

FIFTEEN YEARS OF ECOLOGICAL RESEARCH ON A UTILITY RIGHT-OF-WAY

W. C. Bramble[1/] and W. R. Byrnes[1/]

A long-term, large-scale study of certain environmental effects of chemical brush control was begun in the Spring of 1953. The location was a Penelec power line right-of-way on state game lands in central Pennsylvania where the dominant vegetation was an upland mixed oak forest. The original objectives were, (1) to determine the effects of chemical brush control on game food and cover, (2) to study game usage of the treatment areas, and (3) to follow the effectiveness of the brush control with particular attention to development of a stable, low plant cover. Recent attention has been centered upon the need for respraying areas treated in 1953 and upon major long-term changes in low plant cover. Emphasis in the 1968 evaluation was placed on deer food and cover developed on sprayed areas and to use of the right-of-way by deer.

DESCRIPTION OF TREATMENTS

The original treatments and their effects on woody brush have been described in a series of progress reports, the latest being published in 1967 (Bramble and Byrnes, 1967).

Briefly summarized, the original treatments were as follows:

A - Unsprayed, cut as needed for control.

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 aehg (acid equivalent per 100 gallons) in 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 aehg 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 aehg in No. 2 fuel oil. Applied June 1953.

E - Selective winter basal spray of 2,4,5-T butoxy ethanol esters at a concentration of 12 pounds aehg in No. 2 fuel oil. Applied February 1954.

F - Broadcast foliage 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.

1/ Department of Forestry and Conservation, Purdue University, Lafayette, Indiana.

B-D, C-D, D-D, E-D, F-D - A follow-up basal spray (D) applied in June, 1954 (June, 1956, for E-D) to one half of each replication of treatments B, C, D, E, and F. The follow-up consisted of a summer basal spray using ACP formula 1054-E containing 2 pounds of 2,4-D and 2 pounds of 2,4,5-T per gallon, used at the rate of 16 pounds aehg in fuel oil.

The control areas (Treatment A) were recut in the winters of 1958-59 and 1966-67. The areas sprayed in 1953 were resprayed for the first time, as needed, in June and July of 1966. On eight of the twenty initial spray areas (5 treatments each with 4 replications), no brush control was needed in 1966. On seven areas a light selective basal spray was applied. On two of the winter basal areas, a stem-foliage spray was used to control sassafras thickets. And, on three treatment areas trees were large enough to warrant cutting and stump spraying.

The resprays applied in 1966 were as follows:

G - Selective basal and stump spray of 1054-E (Amchem) butoxy ethanol ester at 4 pounds ae per gallon. A concentration of 16 pounds aehg in No. 2 fuel oil was used. A standard basal and stump spray application was made, thoroughly wetting all exposed roots and stems to a height of about 10 inches.

H - Stem-foliage waterborne of Amchem Weedar brushkiller, an amine formulation containing 2 pounds of 2,4-D and 2 pounds of 2,4,5-T amine salt per gallon. A concentration of 4 pounds aigh (active ingredient per 100 gallons) in water was used. A standard application was made, thoroughly wetting all foliage and stems.

STATUS OF WOODY BRUSH IN 1968

Herbicide retreatments in 1966 were applied to all tall-growing tree and shrub species in the center portion of the 165-foot wide right-of-way; while low-growing species such as bear oak and witchhazel were left untreated along a 33-foot edge on each side. These species forming a "shrub edge" provide desirable deer food and cover and do not interfere with power line operation and maintenance. In 1968, there were bear oak and witchhazel plants over 3 feet in height scattered along the edge of all areas. Treatments aimed at development of a "shrub edge" in previous years had been limited to the winter basal (Treatment E) areas (Bramble and Byrnes, 1967).

At the time of retreatment in 1966, the total number of woody plants in the Shrub Layer, over 3 feet in height, ranged from 28 to 286 per acre on "initial spray with follow-up basal" areas and 60 to 1136 per acre on "single initial spray" areas (Bramble and Byrnes, 1967). Evaluation of woody brush status in August 1968 revealed that the 1966 retreatments had reduced number of plants in the Shrub Layer on "single initial spray" areas by 43 to 97 percent and on "initial spray plus follow-up basal" areas by 80 to 97 percent (Table 1). Comparison among spray treatments on "single initial spray" areas shows a low of 14 plants per acre on the summer basal (Treatment D) and a high of 55 plants per acre on the winter basal (Treatment E). The woody brush Shrub Layer on the "initial spray with follow-up basal" was very sparse, ranging from 6 to 18 plants per acre, on all areas.

Table 1. Total number of woody plants per acre in the Shrub Layer, over 3 feet in height, in August 1968, 15 years after original treatment.

Original Treatment	Bear Oak	Other Oaks	Red Maple	Sassa-fras	Witch-hazel	Cherry	Misc. Hard-woods	Total	Reduc-tion[1] %
				Single Initial Spray					
A Unsprayed	10	108	30	0	20	2	0	170	82
B Bdcst. D+T	37	2	0	0	6	0	0	45	60
C Semi-basal	30	2	0	0	2	0	0	34	43
D Summer Basal	2	0	0	2	4	2	4	14	97
E Winter Basal	0	2	0	0	53	0	0	55	95
F Bdcst. Ammate	8	0	0	6	7	2	2	25	90
				Initial Spray With Follow-up Basal					
B-D	0	0	0	0	6	0	0	6	86
C-D	6	0	0	0	0	12	0	18	80
D-D	0	2	0	0	5	0	0	7	97
E-D	7	4	0	0	0	2	0	13	87
F-D	2	0	0	0	10	0	0	12	83

[1] Percent reduction in total number of woody plants in the Shrub Layer following 1966 retreatments.

Table 2. Total number of woody plants per acre in the Ground Layer, under 3 feet in height, in August 1968, 15 years after original treatment

Original Treatment	Bear Oak	Other Oaks	Red Maple	Sassa-fras	Witch-hazel	Cherry	Misc. Hard-woods	Total
				Single Initial Spray				
A Unsprayed	680	1,232	552	5,208	640	16	72	8,400
B Bdcst. D+T	92	12	200	240	20	7	18	579
C Semi-basal	48	48	232	124	8	60	52	572
D Summer Basal	132	60	8	732	124	8	4	1,068
E Winter Basal	259	96	92	6,750	73	4	20	7,294
F Bdcst. Ammate	36	28	120	412	0	12	28	636
				Initial Spray With Follow-up Basal				
B-D	44	0	80	236	24	4	0	388
C-D	8	28	256	8	8	120	8	436
D-D	46	28	200	132	100	8	4	518
E-D	107	80	112	244	26	12	36	617
F-D	80	48	84	284	0	0	32	528

Tree seedlings and sprouts in the Ground Layer under 3 feet in height, although greatly reduced by the 1966 herbicide treatments, are still abundant on the right-of-way (Table 2). Species such as sassafras are most abundant along the edges of the right-of-way adjacent to the undisturbed forest, while red maple and cherry, which appear to be more tolerant, are generally found under the canopy of sweet-fern and bracken. Due to deer browsing, plant competition, and spring frosts, it is questionable whether many of these plants will emerge into the Shrub Layer.

Effectiveness of the 1966 spray treatments on topkill of woody brush and suppression of resprouting is shown in Figure 1. The "cut & stump spray", resulting in 94 percent topkill with no resprouting, was slightly better than the "selective basal" with 86 percent of the plants topkilled and not resprouting. The "stem-foliage spray", which resulted in 66 percent topkill with no resprouting, was the least effective treatment, but was the most practical for use on dense thickets of sassafras.

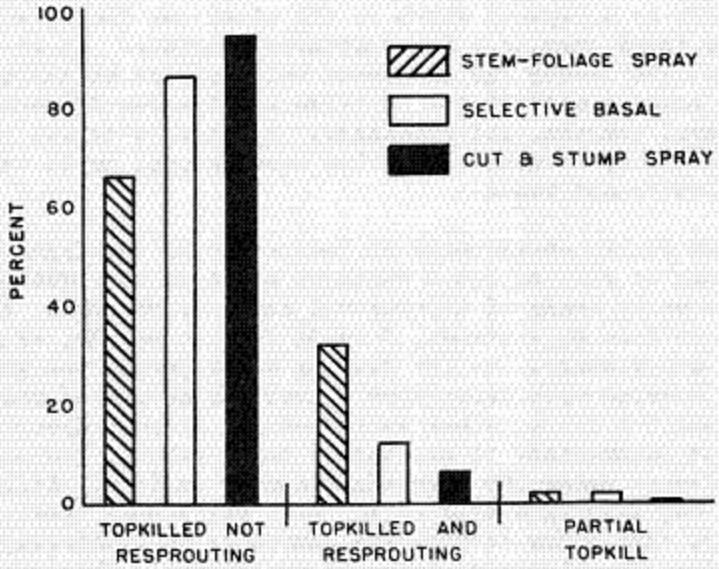

Figure 1. Topkill of woody brush in August 1968 from herbicide retreatment in July 1966.

CHANGES IN THE GROUND LAYER

The Ground Layer has been defined in this study as vegetation under 3 feet in height. At the beginning of the study, a Ground Layer described as a Bracken-Sedge-Herb-Blueberry Community dominated all treatment areas. The woody brush over 3 feet (trees and tall shrubs) had been virtually eliminated

by herbicide treatment. Later, some of the treated plants resprouted to form a Shrub Layer over 3 feet in height. It is important to note that in 1953 the shrub, sweet-fern, was only an occasional or sparse member of the community. It occurred mostly on spots where brush had been burned in the original capital clearance in 1951-52.

After the first spray treatments were applied in 1953, the ground layer reacted more or less as expected (Table 3). The selective basal areas (Treatments D and E) retained the original Bracken-Sedge-Herb-Blueberry Community; the broadcast spray areas (Treatments B and F) and semi-basal (Treatment C) went to a Fireweed or a Sedge-Grass Community and then slowly into Bracken-Sedge-Herb-Sweet-fern. At the end of 12 years (1965) it appeared that a relatively permanent low plant cover had developed on sprayed areas which would persist for many years.

By 1968, however, a marked change had taken place in the Ground Layer. Slowly over the years, the sweet-fern that had appeared in all treatments as an occasional invader developed into a dominant shrub on all treatment areas. Its increase over the years had been steady as it spread from initial invasion centers to form large patches that covered as much as 50 to 75 per cent of some treatment areas (Table 3).

Sweet-fern as a typical shrub in the mixed oak forest surrounding the right-of-way is found only in a few scattered openings. It is an aromatic shrub with fern-like leaves and prominent male catkins at the ends of the branches. Its seed is distributed by birds and invades disturbed areas such as burns, charcoal hearths, and roadsides. Apparently it was introduced into the right-of-way at spots where brush had been burned, or on other disturbed spots such as towers and roads.

As to the future development of sweet-fern on the right-of-way, it appears likely that it will become a dominant plant on all treatment areas. Sweet-fern spreads by means of underground stems or rhizomes, to form patches which coalesce to form pure stands, 3 to 5½ feet in height, with a thin understory of herbs and grasses. At its maximum development, the ground beneath may be totally covered with sweet-fern litter and devoid of understory vegetation. At about 6-8 years, stems in the center of such groups may die, but tend to resprout immediately to maintain a tight cover. Red maple seedlings were common invaders under the sweet-fern canopy in 1968. Although tree seedlings invasion may furnish a clue as to what may happen later, at the present time, it appears that a new two-layered community is developing on the right-of-way, created by invasion and spread of sweet-fern. This community is composed of a pure sweet-fern Shrub Layer, beneath which are remnants of the Bracken-Sedge-Herb-Blueberry as a thin Ground Layer. In openings between the patches of sweet-fern, the Bracken-Sedge-Herb-Blueberry still remains.

USE OF COMMON PLANTS FOR BROWSE

The most prominent species of wildlife inhabiting the mixed oak forest of the plateau and ridges has been the white-tailed deer. Deer and other common game species using the right-of-way have been studied since the beginning of the project (Bramble and Byrnes, 1967). Special attention in 1968 was

Table 3. Changes in dominant species of the Ground Layer, under 3 feet in height, and development of a sweet-fern Shrub Layer, 3 to 5½ feet in height.

Treatment June 1953	Status in 1953	A.S.[1]	Development from 1954 through 1965	Status in 1968	A.S.[1]
A Unsprayed Control	Bracken	2.3	A stable plant community persisted	Bracken	1.1
	Sedge	2.3		Sedge	1.2
	Herb	+.1		Herb	++.1
	Blueberry	2.2		Blueberry	3.3
	Sweet-fern	++.1	Gradual increase	Sweet-fern	2.4
B Broadcast D+T	Bracken	2.3	After spraying, passed through a Sedge-Grass stage and back to the original community	Bracken	4.4
	Sedge	2.3		Sedge	2.3
	Herb	+.1		Herb	+.1
	Blueberry	1.2		Blueberry	2.3
	Sweet-fern	++.1	Gradual increase	Sweet-fern	3.4
C Semi-basal	Bracken	2.3	After spraying, passed through a fireweed stage and back to the original community	Bracken	4.4
	Sedge	2.3		Sedge	3.4
	Herb	+.1		Herb	1.1
	Blueberry	1.2		Blueberry	2.3
	Sweet-fern	+.1	Gradual increase	Sweet-fern	2.4
D Summer Basal	Bracken	2.3	A stable plant community persisted	Bracken	2.2
	Sedge	2.1		Sedge	2.3
	Herb	+.1		Herb	+.1
	Blueberry	+.2		Blueberry	2.3
	Sweet-fern	+.1	Gradual increase	Sweet-fern	3.4
E Winter Basal	Bracken	1.3	A stable plant community persisted	Bracken	4.4
	Sedge	2.3		Sedge	3.3
	Herb	+.1		Herb	+.1
	Blueberry	1.2		Blueberry	2.3
	Sweet-fern	+.1	Gradual increase	Sweet-fern	3.4
F Broadcast Ammate	Bracken	3.3	After spraying, passed through a fireweed stage and back to the original community	Bracken	3.4
	Sedge	2.3		Sedge	3.3
	Herb	+.1		Herb	1.1
	Blueberry	1.2		Blueberry	2.3
	Sweet-fern	++.1	Gradual increase	Sweet-fern	3.3

[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. For example: 2:3 indicates that a plant covers 1/20 to 1/4 of the ground area and occurs in small patches.

given to deer and their use of vegetation on the right-of-way as compared with the surrounding forest.

For convenience in presentation, the herbaceous and woody plant utilization by deer is considered separately. Data taken in August of 1968 reflect both summer and winter browsing, although seasonal differences in use were evident and have been shown to be important (Bramble and Goddard, 1943). For example, sweet-fern is eaten by deer in the winter and spring and rarely, if at all, in the summer.

The availability and use of the common herbaceous plants is given in Table 4 and Figure 2A as a composite "Utilization Factor" obtained by multiplying average density times the average degree of browsing (Aldous, 1944). Bracken was the most common species and was browsed most heavily in the early summer (Table 4). Other herbaceous plants commonly eaten were goldenrod, loosestrife, and aster. All of these plants were sparse or lacking in the adjacent forest.

The availability and use of common woody plants is given in Figure 2B, as a composite "Utilization Factor". Sweet-fern was the most common species on the right-of-way and was browsed heavily. Sassafras, bear oak, and witch-hazel were also commonly utilized. Sweet-fern and bear oak were sparse and utilized lightly in the adjacent forest (Table 4). Sweet-fern afforded a dense cover for deer on the right-of-way and many tunnel-like paths had been developed by them. This was in marked contrast to the open conditionof the surrounding forest where a Shrub Layer was absent and the Ground Layer sparse.

Of particular interest to this study was the high utilization value of bracken and sweet-fern on the right-of-way in contrast to the adjacent forest. Both of these species have a high feed value and are utilized by deer in different seasons; bracken in the spring and early summer and sweet-fern in the winter and early spring (Bramble and Byrnes, 1967 and Hellmers, 1940). In the adjacent forest, sweet-fern has a low utilization factor owing to its sparse occurrence. Bracken is generally sparse in the forest and is eaten only for a brief period as it soon becomes tough and wiry. Its utilization factor in the forest is very low compared to the right-of-way.

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Table 4. Comparison of availability of plants and their use as browse on the right-of-way and in the adjacent forest.

	Utilization Factor[1]			Utilization of Plants Eaten[2]			Percent of Available Browse[3]		
Herbaceous Plants	Right-of-way Cut	Right-of-way Spray	Forest	Right-of-way Cut	Right-of-way Spray	Forest	Right-of-way Cut	Right-of-way Spray	Forest
Bracken	900	1716	126	70	67	68	62	63	60
Goldenrod	210	627	0	16	24	0	10	17	0
Loosestrife	9	152	18	1	6	10	10	9	10
Aster	0	36	0	0	1	0	0	9	0
Cow Wheat	175	11	0	13	1	0	18	1	3
Sarsaparilla	0	24	40	0	1	22	0	1	27
Woody Plants	Right-of-way Cut	Right-of-way Spray	Forest	Right-of-way Cut	Right-of-way Spray	Forest	Right-of-way Cut	Right-of-way Spray	Forest
Sweet-fern	1260	1620	56	27	55	4	14	44	2
Sassafras	350	244	561	7	8	34	4	6	20
Bear Oak	350	212	72	7	7	5	4	6	5
Blackberry	105	188	-	2	6	-	2	6	-
Witch-hazel	250	156	200	5	5	12	4	6	9
Blueberry	250	90	108	5	3	7	40	15	32
Red Maple	1260	74	255	27	3	16	14	3	9
Black Cherry	-	38	-		1	-	-	2	-
White Oak	525	159	76	11	6	5	12	6	4
Chestnut Oak	210	57	144	5	2	8	2	2	5
Red Oak	175	70	90	4	2	5	4	2	5
Teaberry	-	-	20	-	-	1	-	-	7
Laurel	-	70	43	-	2	3	-	2	2

[1] Average density x average degree of browsing

[2] Utilization factor for each species ÷ Total of utilization factors

[3] Average density of each species ÷ Total density for all species

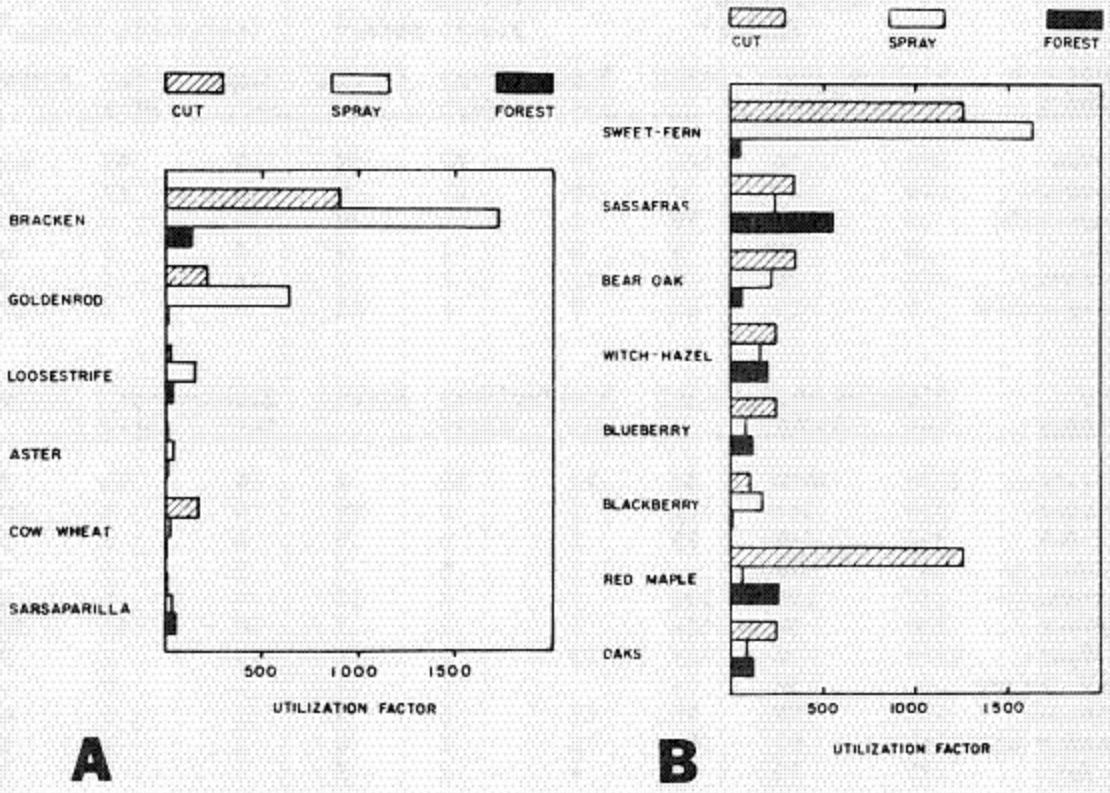

Figure 2. Utilization of common herbaceous (A) and woody plants (B) by deer. Utilization Factor = average density x average degree of browsing. A comparison is made between the control areas (cut), the sprayed areas, and the adjacent forest.

RIGHT OF WAY BEAUTILITY - ECONOMICAL OR EXTRAVAGANT

Ronald L. Harper 1/

I was tempted to request other words for the title of this paper: Beautility - Economical - Extravagant. Try to define them. Then ask some other people for their definitions. Then try to prepare a paper on the subject. Frankly, I could not think of more suitable words for a brief title but I would like to restate the subject theme somewhat. When I personally try to understand the word "beautility" I always come up with a question of relativity. So today lets consider the role of vegetation management in our efforts to make our surroundings relate to the way we live.

Surroundings that relate to the way we live. That is no original conception. Ever since man first began his fight to dominate nature he has altered the appearance of his surroundings to make them relative to his standard of living. Forest land was cleared to make farmland and every home had an outbuilding, not a poolside cabana, that symbolized a primitive technology.

The factory section of town is frequently illustrated today as evidence that industry is ugly. Yet only a few years ago industrial activity was a source of community pride. Poets and politicians waxed eloquently about the busy smokestack, symbol of our growing economy. We were not so concerned then with how industry looked but only with how much it could produce. Of course, in those days when everything was smaller, especially the population, we did manage to keep the tools of industry in the community workshop, far removed from our gentle homes and peaceful countryside.

Suddenly electrification became possible - on farms, in homes, and businesses everywhere. Here was a new symbol of a new way of life. Quantity was still uppermost in our striving against nature and the more wires and more poles we saw, the healthier we knew our community to be. Things really began to happen as we exploited the electrical era and changes in the appearance of our communities were relative. Still, until after the Second World War, change was motivated primarily by technical and operative factors; any improved appearance was merely coincidental.

Then, almost before it had been established, the electrical era was swallowed by the atomic - electronic - space age and we are thrust into a whole new way of living. The world is a new ball of wax. Suddenly our surroundings are irrelevant to the way we live - to television; to communications satallites; and electric home heating.

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The urgent cry to get industry out of sight, back in the workshop or underground, is not a new philosophy or the hobby of a crackpot minority. It is a valid extension of mankinds historic effort to control his environment. But obviously, we can no longer keep all the tools in the workshop. Some of them must be omnipresent to maintain the standards and the growth of our new way of living.

First to feel the pressure in our industry was the distribution substation, ever more needed in every neighborhood of the community. This apparatus is not relative to the modern residential environment so what are we going to do with it. The modern residential community is well landscaped so we landscape our properties too. Not because our management are amateur gardeners or because we have extra money to spend. We landscape because it is economical to do so. And we use low profile equipment and sound barriers and architectural treatment, not because we want to but because it is economical to do so.

We thus avoid zoning litigation and construction delays, siting problems, and building requirements, all of which would be extravagant today, by demonstrating that our facilities will be relative to the character of the community. Landscaping hasn't cost Philadelphia Electric Company, it has paid us.

We have been planting and maintaining our properties for over fifteen years. Some companies have been doing this longer while others are just now becoming involved in the economics of beautility.

In some areas of the country the concern for the appearance of transmission lines has not reached the proportions it has in the Mid-Atlantic metropolitan area. But people are beginning to look at these lines and they are beginning to decide that exposed wiring is no more relevant outdoors than it is in the modern home and a proliferation of industrial towers seems impertinant to the efficiency in our lives. Projecting the substation developments of the past into the future of the transmission network we find the same public outcry.

Put it underground! Get it out of sight! Put it in the industrial section or on a utility corridor! You're not going to put it in my town! The economics of the situation become clear. Forced delays in construction, condemnation proceedings, and general ill-will become extravagant. It becomes economical to try to make the transmission line right of way relative to the standard of living in the community and vegetation management can contribute much to this end.

In a truly agricultural area, the landscape may be balanced, even in today's environment. A single tower line or two parallel lines will not dominate the broad agricultural scale but will actually relate to mechanization on the farm and have valid meaning. There is no more economical vegetation management plan than to let the farmer do it.

But in this section of the country, the broad irregular agricultural landscape is diminishing, being replaced by human development. No longer in crops, the right of way must be maintained by the Company. In the Philadelphia Electric area, anti-weed ordinances generally preclude chemical maintenance and it has been more economical to seed and mow.

The increased visual exposure that accompanies urban sprawl reveals a disparity in scale between human development and transmission structures and the battle to improve the appearance of the community focuses on the electric utility. It will prove economical to find ways to reduce this disparity of scale so that what is visible assumes its visual function as a symbol of our standard of living.

An ideal situation frequently can arise when the concern for open space in the community accompanies the concern for appearance. When a person becomes involved in the right of way by participation, either individually or through developed community use, then it becomes relative to the way he lives. But, the visual problem remains and may arouse hostility in other areas where new transmission lines are proposed.

Of course it is impossible to hide a tower. Yet there is ample evidence that vegetation can serve to reduce the dominance of the overhead line. Then right of way beautility becomes an economical tool in the transmission program.

On existing lines, currently under chemical maintenance, it will be relatively simple to control herbicide application so that desirable species are released and undesireable continue to be suppressed. Because of our mowing practices, we have relatively few such areas on the Philadelphia Electric system, but there are cases where small seedlings will establish as we discontinue mowing and turn to selective chemical maintenance. This is cheap natural landscaping and the landscape of the right of way is the new game.

On many of our existing lines, landscape planting will have to be installed at road crossings, near homes, and other areas of public view. When individuals have extended their residential activity onto the right of way we often permit them to plant low growing trees. Apple and pear and plum are sometimes used. The same type of plant material will be used in our transmission line improvement program; native dogwoods and shadblow for example in wooded areas, ornamental trees and shrubs in developed communities. We will occassionally be planting some trees that may eventually require trimming for maximum safety clearances, but we don't feel we are being at all extravagant.

Past construction practice favored total ground line clearing, converting the right of way through woods to an extension of adjacent agricultural fields. This is no longer acceptable when every country road is a high density viewing area. Today the specification calls for selective clearing.

In some places it will be possible to site towers so that entire wooded areas may be overbuilt, leaving the natural environment virtually undisturbed. More frequently it will be necessary to remove most of the trees but by retaining the shrub, vine, and small tree understory, the continuity of wooded areas may be preserved and the impact of the towers relieved.

There will be critical locations, road crossings in particular, where we are limited by existing plant material. Here we will remove only the immediately dangerous trees; preserve and maintain for clearance other trees. When the public can ride down the road unaware that a transmission line crosses, the art of right of way landscaping has been perfected.

As for the human relationship; when people find a hiking or riding trail through unposted natural surroundings, when they become involved in the land under the transmission line, then the structure and the wires are relative to the technology that affords them the leisure to take a walk in the woods, and the line becomes more acceptable.

What about right of way maintenance on the landscaped transmission line? We have preserved or planted to reduce the impact of our industry on the modern community. What will the impact be on our maintenance budget? Certainly non-selective area spraying would undo all our beautification efforts. Mowing around the trees and shrubs would be very costly and difficult to justify except in residential areas. Selective herbicide application will have to be the answer to inhibit undesirable volunteer growth without danger to desirable vegetation. Costs and manpower requirements will rise.

It would be difficult to predict, with our limited experience, just how much more it will cost to maintain landscaped or natural rights of way. It would be unfortunate to dismiss the concept as an extravagant one. Although our responsibility will continue to be reliable and economic service, we must accept a new challange to contribute to improved appearance in the environment. If we fail to meet this challange, the public demand for suitable surroundings will weigh the scale with opposition, legislation, and obstructionism that will prove far more extravagant than the economics of beautility.

EFFORTS TO REMOVE THE "UGLY" FROM TRANSMISSION RIGHTS OF WAYS

John B. Middleton[1]

Fostered mainly by the opinions and demands of the public, transmission right of way clearing and maintenance has recently taken on the complexion of a natural beauty program. Beautification activities that are currently being done were unheard of ten years ago. The fundamental activity of a power utility company is still the production, transmission, and distribution of electrical energy with the goal of monetary profit for stock holders. In developing a healthy community in which to flourish, power companies are finding it desirable and necessary to enter into this beautification activity. In an effort to remove the so-called "ugliness" from all of their facilities, Pennsylvania Electric Company and Metropolitan Edison Company have undertaken a major beautification effort. The specific items of beautification which I am going to explore that are carried on by these two Pennsylvania Power Companies are as follows: (See Map Page 2)

I. Selective cutting during initial transmission line clearing.

II. Use of herbicides for removing undesirable species from the selective cutting area and for routine chemical brush control maintenance.

III. Planting of vegetative screens at selected locations on transmission line rights of way.

IV. Improvement of routine clearing techniques.

V. Incorporating modifications to the pole and structure locations and sizes to accommodate beautification activities.

VI. Effectively demonstrating to the Pennsylvania Game Commission that herbicides can be used without detracting from the food and cover values of rights of way on Pennsylvania Game Lands.

VII. Installing of food plots on lands controlled by the Pennsylvania Department of Forests & Waters and the Pennsylvania Game Commission.

I. Selective cutting during initial transmission line clearing

In areas where transmission line rights of way are going to be under the surveillance of the public, selective cutting is used to screen and obscure the towers and other items of construction that are necessary for a major power transmission line. At some locations where the topography is favorable, it is

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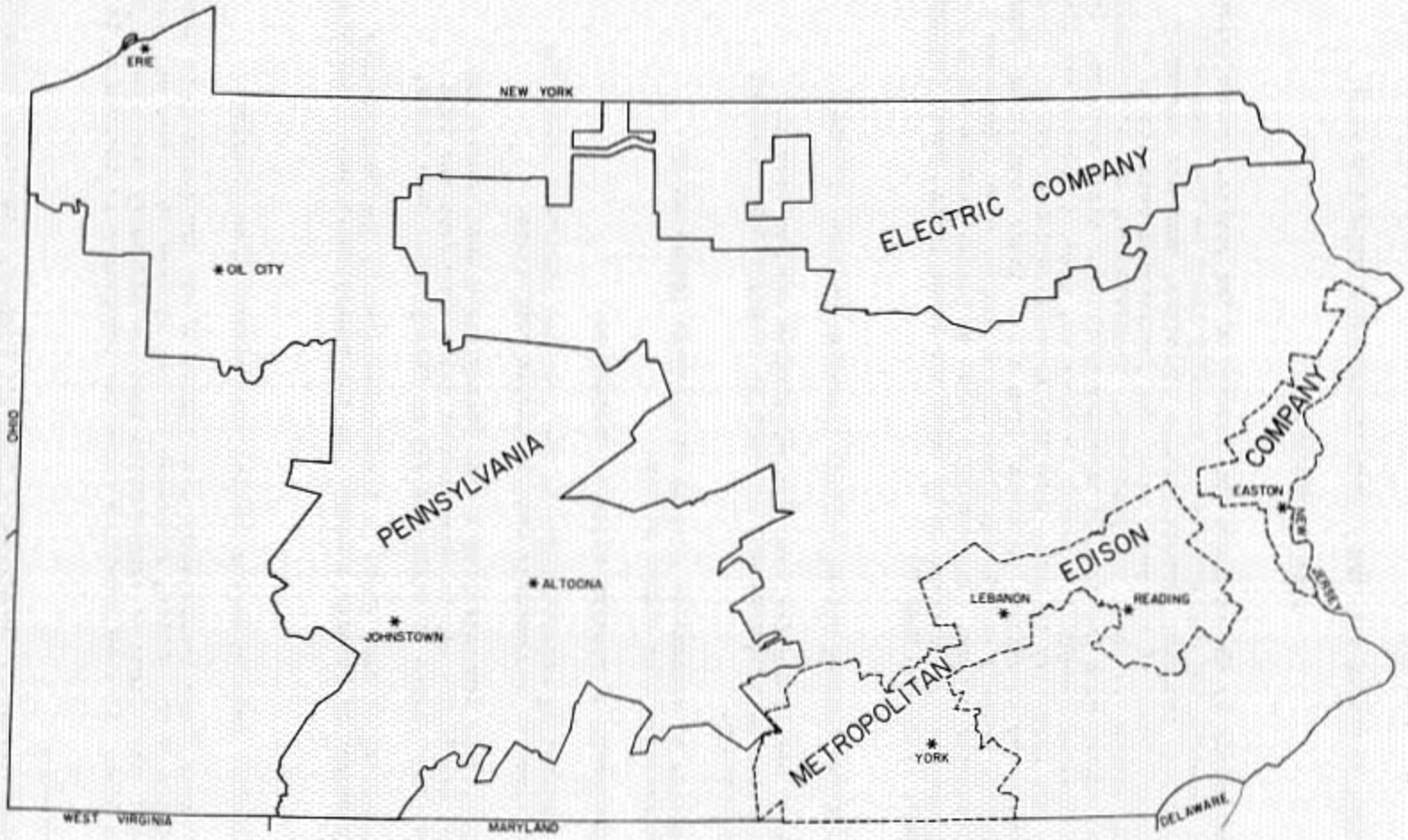

PENNSYLVANIA ELECTRIC COMPANY SERVICE AREA —17,400 SQ. MI.
METROPOLITAN EDISON COMPANY SERVICE AREA — 3,300 SQ. MI.
STATE OF PENNSYLVANIA TOTAL LAND AREA —50,000 SQ. MI.

possible to leave all of the trees and vegetation. Higher elevations for structures and towers make it possible to span the conductors above the ultimate mature height of the trees that are growing on the right of way. In some locations, it is possible to leave all of the tree, shrub, and other growth. The right of way is then barely discernible to the most observant individual.

At the most important highway crossings, both the timber type trees and the trees normally preserved in a pure selective cutting are left on the right of way. The greatest height of trees allowed to remain provides for some height growth. The preserving of the timber type trees is a temporary measure. These temporary type trees will be removed when they threaten the operation of the line. All of the chosen trees for the selective cutting will be preserved as future vegetative material to reduce the observability of the line.

At highway crossings where limited public scrutiny is anticipated, available vegetation from the selective cutting list is left to reduce the prominence of the transmission line. The chosen vegetation which is preserved under selective cutting is as follows:

Small Trees

a. White flowering dogwood (Cornus florida)

b. Redbud (Cercis canadensis)

c. Hawthorn (Crataegus spp.)

d. Blue Beech - American Hornbeam (Carpinus caroliniana)

e. Shadbush (Amelanchier canadensis)

f. Iron wood - Hophornbeam (Ostrya virginiana)

g. Red Cedar - Juniper (Juniperus virginiana)

h. Sumac - Staghorn, Smooth, Dwarf (Rhus spp.)

i. Striped Maple (Acer pennsylvanicum)

j. Mountain Maple (Acer spicatum)

k. Pin Cherry (Prunus pennsylvanicum)

l. White Cedar (Thuja occidentalis)

m. Wild Apple (Malus pumila)

n. American Crabapple (Malus coronaria)

Large Shrubs

a. Alder (Alnus spp.)

b. Hazelnut (Corylus spp.)

c. Witch Hazel (Hamamelis virginiana)

d. Dwarf Willow (Salix humilis)

e. Deciduous Holly
(Ilex verticillata)

f. Spice bush
(Lindera benzoin)

g. Choke cherry
(Prunus virginiana)

h. Elderberry
(Sambucus spp.)

i. Rhododendron
(Rhododendron maximum)

j. Scrub Oak
(Quercus spp.)

k. Viburnum
(Viburnum spp.)

l. Dogwood
(Cornus spp.)

Small Shrubs

a. Mountain Laurel
(Kalmia latifolia)

b. American Yew - Ground Hemlock
(Taxus candensis)

c. Sweet fern
(Myrica peregrina)

d. Bush Honeysuckle - Pinxterbloom, Azalea
(Azalea nudiflorum)

e. Huckleberries
(Gaylussacia spp.)

f. Blueberries
(Vaccinium spp.)

g. Viburnums
(Viburnum spp.)

h. Meadow sweet
(Spiraea spp.)

i. Checkerberry - Wintergreen, Partridgeberry
(Gaultheria procumbens)

j. Trailing arbutus
(Epigaea repens)

k. Blackberry
(Rubus allegheniensis)

l. Raspberry
(Rubus occidentalis)

m. Choke berry
(Pyrus arbutifolia)

n. Green brier
(Smilax rotundifolia)

4. All native grasses, ferns, and herbaceous plants.

5. All annual weeds and annual plants.

The length of the areas designated for selective cutting vary with the topography and the availability of species included in the selective cutting list. Prior to inviting line clearing contractors to bid on any transmission line, a field inspection is made to determine the location, type, and size of selective cutting areas on the line. The construction engineering sections of Pennsylvania Electric Company and Metropolitan Edison Company provide allowable vegetation heights for each highway and road crossing on the proposed transmission line. This allowable vegetation height information provides a means for determining what kind of vegetation and how high it may be left on the right of way.

By working with selected line clearance contractors, it has been possible to instruct and control them so that they perform an acceptable selective cutting operation. Traditionally, transmission line construction contractors are brutal and consider little except building the line efficiently. We still need to control these contractors to avoid damage to vegetation that is left for beautification purposes.

II. Use of herbicides for removing undesirable species from the selective cutting area and for routine chemical brush control maintenance

In each of the three catagories of selective cutting used to shield off the observation of transmission line rights of way, herbicides are used selectively to eliminate timber type trees that would re-establish themselves on the right of way. Either selective basal or stump treatment is done to accomplish the elimination of these unwanted species. We use either 16 pounds of half and half D and T to 100 gallons of solution in fuel oil or diesel oil or 12 pounds of straight 2,4,5-T in the same amount of solution. The esters that are used in these selective treatments are limited to Butoxy Ethanol or Propylene Gylcol. These esters are not effective on root suckering species. Much promise, on a very limited basis, is showing up for Tordon 155. The very limited work which has been done on Pennsylvania Electric Company and Metropolitan Edison Company with this Trichloropicolinic Acid, gives hope that root suckering species will be eliminated when Tordon 155 is applied as a winter dormant application. If this Tordon 155 works as it promises, it will be the valuable tool that we have lacked so long in our over-all chemical brush management program.

In carrying out the routine brush control management on these two power utilities, consideration is given to the beauty of the area following the treatment. One of the requirements for all this treatment is that all applications within 100 feet of any highway or road shall be selective basal. In the selective basal treatment, we use 16 pounds of T in 100 gallons of oil. Here again, if Tordon 155 has the ability to kill root suckering species, we can accomplish much in the way of retaining material beauty. These companies are working toward a 12-month chemical treatment program.

Much of the uglification can be avoided by treating timber type species during the dormant season. This dormant season in the service area of our two companies extends from November 1 until May 1. The routine right of way management program utilizes all of the available tools to assist nature. These tools are: selective basal treatment; water borne, stem-foliage treatment; pre-clearing selective basal; stump treatment; mist blower application; and helicopter application. With water borne, stem-foliage applications; the advantages of each of the chemical solutions is utilized. We use 2,4-D and 2,4,5-T as esters or amines; and Tordon 101. Areas that contain no timber type trees will not be treated at all. An effort is made to isolate and treat timber type species as selectively as possible when applying the water borne, stem-foliage treatment.

III. Planting of vegetative screens at selected locations on transmission line rights of way

At all newly cleared transmission rights of way as well as all older existing transmission rights of way where exposure to public viewing is great, screens of vegetation are planted to provide a shield between the observer on the highway and the power transmission facilities. The planting consists of evergreen trees, shrub, and low growing broad leaf evergreen material.

These screens should show to the public that the power utilities are making an effort to beautify their facilities. Selective cutting is much more effective than transmission screen planting. It must be recognized that some locations have none of the chosen species covered in our selective cutting list; here planting is our only solution at present.

IV. Improvement of routine clearing techniques

An effort is made to improve the beautification aspects of right of way areas that are cleared under our routine clearing specification.

Where the topography permits the elevation of the conductors to give safe and reliable operation above the ultimate mature height of forest type trees, the right of way is left uncut or narrowed as much as construction practices can accommodate. Burning of waste materials from the clearing operation is done in a manner to avoid scorching or damaging the trees adjacent to the right of way. Stump treatment to all stumps 1 inch and greater in diameter is applied where any clearing is done. This 1 inch diameter breaking point allows for timber type tree stumps to be treated and shrub species to be left untreated to later sprout and provide right of way cover. In special cases, where requested, selective clearing is done for the individual property owner. It is very possible that before too long, selective clearing will be done for the entire length of the rights of way. Our greatest problem at this point is to get the logs from the timber type trees off the selective cutting areas without breaking down all of the chosen species.

With the higher voltages that are now being used to transport electric power, rights of way are wider than before. To remove the heavy tree stems from the right of way, heavy equipment is mandatory. This heavy equipment rips up the right of way and makes it difficult to locate stumps for follow-up stump treating. We have been trying pre-treating of the trees on the right of way to kill them before the right of way is cleared. So far, we have tried selective basal with 2,4-D and 2,4,5-T as well as straight 2,4,5-T ester in fuel oil or diesel oil. We are currently trying more concentrated solutions of these materials as mist blower applications. We have set up a line recently for treatment with Tordon 155 to be applied with the mist blower. If this material is effective in killing suckers from root suckering species, there will be great advantages in the field of brush management and beautification.

V. Incorporating modifications to the pole and structure locations and sizes to accommodate beautification activities

Special attention is given to major highway crossings and areas of heavy public observation. To accommodate the requirements of beautification, modifications have been made in structure location and structure size. Poles have been moved to get them away from the immediate area of observation. Taller structures have been used to accommodate taller growing plant material under the conductors.

VI. Effectively demonstrating to the Pennsylvania Game Commission that herbicides can be used without detracting from the food and cover values of rights of way on Pennsylvania Game Lands

In January, 1965, the Pennsylvania Game Commission prohibited the use of any herbicides on Pennsylvania State Game Lands. The Game Commission said that this privilege was removed because power utilities were not properly controlling applicator contractors in using herbicides. They also said that much game food and cover was lost due to the use of chemicals on game lands. In the spring of 1967, the Game Commissioners agreed to permit the private power utilities of Pennsylvania to demonstrate that applicator contractors could be controlled and that the wanton destruction of food and cover would not occur. During 1967, four game land areas were treated as a part of this demonstration. These areas are located in different sections of Pennsylvania. Although the Game Commission does not admit to it, I believe that the appearance aspects of the treated rights of way also had much weight in their decision to prohibit the use of herbicides. The Pennsylvania power utilities have accomplished the work on these four demonstration areas by dormant selective basal only.

It is planned that several more demonstration areas will be completed during the 1968-1969 dormant season to demonstrate the effectiveness of herbicides without degredation of game food and cover. This prohibition of the use of chemicals is something that the Pennsylvania power utilities can blame on themselves. Judicious right of way management is imperative especially where herbicides are used.

VII. Installing of food plots on lands controlled by the Pennsylvania Department of Forests & Waters and the Pennsylvania Game Commission

Two agencies in Pennsylvania, the Department of Forests & Waters and the Game Commission, require that designated areas be established in food plots for game on new transmission rights of way. Food plot preparation is the conversion of forest land to a high grade of cultivated agricultural land. This practice is expensive. It is hoped that the Game Commissioners can be convinced that natural food and cover, developed on rights of way, fulfills the purpose of providing food and cover, to game, better than these extravagant food plots.

WHAT MORE MUST POWER UTILITIES DO TO SATISFY THE BEAUTIFICATION DEMANDS? IT SEEMS REASONABLE THAT TRANSMISSION LINE LOCATIONS WILL HAVE TO BE SELECTED WITH BEAUTIFICATION IN MIND. WHEN I SPEAK OF BEAUTIFICATION I MEAN THE ABSENCE OF CREATING AN INTRUSION TO THE AREA WHERE THE LINE IS BEING BUILT. RECENTLY MORE APPEALING ARCHITECTURAL DESIGN HAS BEEN INCORPORATED INTO THE STRUCTURES FOR USE IN TRANSMISSION LINE CONSTRUCTION. THESE INNOVATIONS AND STRUCTURES

WILL WORK WELL IN SPECIAL SITUATIONS LIKE SEASHORE, RESIDENTIAL, FARM LAND, BUT I HAVE YET TO SEE ANYTHING THAT IS COMPATIBLE WITH FORESTED NATURAL BEAUTY.

WHAT IMPROVEMENTS MUST HERBICIDE USERS EFFECT? HERBICIDES ARE AN EXCELLENT TOOL FOR ELIMINATING UNDESIRABLE SPECIES OF WOODY PLANTS. WITH THE INCREASING DEMANDS FOR BEAUTIFICATION, IT BECOMES MANDATORY THAT A MANAGEMENT PROGRAM WITH CONSIDERATION FOR NATURAL BEAUTY BE PLANNED, INITIATED, AND FOLLOWED BY EVERY USER OF HERBICIDES. WOODY PLANT MATERIAL MANAGEMENT WITH A CONSIDERATION TOWARD NATURAL BEAUTY MAY COST MORE INITIALLY, BUT IF IT IS NOT DONE NOW, WE ARE GOING TO PAY DEARLY IN THE FUTURE.

A WILDLIFE MANAGER'S VIEW OF HERBICIDE USE ON THE RIGHT-OF-WAY

Harvey A. Roberts 1/

Today we are faced with a world that changes more in one year than it did in a decade during the early part of the twentieth century. As a result, new concepts and technologies are being developed at a faster pace than ever before. Idealistically, these changes should be met with an open mind toward new things and their application to everyday life; however, such is not always the case. Being a creature of habit, man dislikes sudden changes, tends to be suspicious and often antagonistic toward things he doesn't understand. As a result there is often an appreciable time-lag between the introduction of a new idea or technique and its acceptance by the public as a whole.

As a case in point, let's consider herbicides. The discovery and utilization of chemical agents to control vegetation, on the scale and in the variety that we know today, is strictly a post-World War II development. Because of their comparative newness, tremendous increase in usage and adverse publicity concerning pesticides in general, herbicides constitute a highly controversial subject.

This brief introduction serves to illustrate the fact that herbicides and their use on agricultural lands, on forest, range and aquatic areas, as well as along rights-of-way, have been met with mixed reactions. Aside from the direct and indirect impact of herbicides on living organisms and their environment, there are a number of non-ecological problems associated with their use. As viewed by a wildlife manager these problems are people oriented and can be classified as external and internal in origin.

Externally, warranted and unwarranted adverse publicity concerning pesticides has cast herbicides in a very unfavorable light. This all-inclusive condemnation of pesticides is responsible in large part for the inability of the man on the street to differentiate between comparatively safe herbicides and the highly toxic insecticides that have been found to be detrimental to all forms of life. Unfortunately, manufacturers, formulators and users have experienced only limited success in counteracting this erroneous impression that all pesticides are dangerous. In combination with an ill-informed public, the industry has occasionally intensified the problem through inept usage of chemical weed and brush killers. Unnecessary and untimely applications of herbicides on rights-of-way, with attendant brownouts, tend to strengthen the convictions of the anti-pesticide element that all chemicals are extremely harmful to both man and wildlife.

External problems involving the public are also of major concern to game departments. As custodians of a renewable resource that belongs to all of the people and as custodians of publicly owned land, game departments are directly dependent on the licensed hunter and others with an interest in wildlife for financial and moral support. Without the continued backing and

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good will of these support groups, wildlife management programs as we know them today would cease to exist. Because of the confusion in the minds of the public concerning pesticides, many wildlife agencies have been reluctant to embark on or endorse large-scale use of herbicides. Despite highly successful experimental use of herbicides in the creation and maintenance of habitat for waterfowl, woodcock, sharp-tailed grouse, rabbits, antelope and deer, chemical weed control remains a largely untried and unused technique.

This sensitivity to adverse public criticism has, on occasion, been intensified by inept use of herbicides on leased rights-of-way crossing state-owned game management areas. Where utilities have employed across-the-board maintenance standards without regard to ownership, location or special use of the land, some game departments have imposed restrictive measures on utilities. Due to real and imagined damage to wildlife habitat, at least one game department has prohibited the use of all herbicides in rights-of-way maintenance on all lands under its control. In this particular case, 700 separate leasing agreements involving some 3,500 acres of right-of-way have been affected. By restricting all brush control work to mechanical cutting, both the utilities and game department have been losers.

Problems of an internal nature further cloud the herbicide picture. Within the wildlife profession there are differences of opinion as to the role of rights-of-way in game management. Should the environment created by a pipeline or powerline right-of-way be primarily woody or herbaceous in nature? Some habitat managers feel that thick shrubby vegetation benefits a wider variety of wildlife than does herbaceous ground cover. In the writer's opinion, the forest type or land use pattern in a particular area should determine what type of right-of-way cover to favor. In other words, those practices should be followed that produce the greatest edge effect.

Manufacturers, formulators and users of herbicides also have internal problems, not the least of which involve economics. Of understandable concern to utilities with miles of transmission lines to maintain is the cost of herbicides, rate and method of application and longevity of treatment. However, the practice of awarding spraying contracts to the lowest bidder and following standardized and unimaginative maintenance practices leaves much to be desired from the standpoint of wildlife management. Repeated applications of herbicides by untrained, poorly supervised spray crews have created an undesirable uniformity of habitat on game management areas. As an example, deer are much more common where brushland merges with forest or where brushland is broken by clearings than where it stretches unbroken. The more merging there is of the various cover types required by a species of wildlife, the more attractive the overall habitat becomes. Since the habitat of any wild animal must contain all of its needs, an environment that lacks any essential element is not habitat at all. It should be emphasized that the mere presence of shrubs and herbaceous vegetation on rights-of-way, regardless of type or composition, does not in itself constitute good wildlife habitat.

Herbicides constitute a small storehouse of tools which can be used or abused. Rightfully employed, they can aid enormously in maintaining desirable vegetative cover on rights-of-way and, at the same time, in improving the wildlife carrying capacity of such areas. The attainment of these mutual goals can be realized through:

1. Better inter-agency liaison and communications. Occasional communication gaps between industry and wildlife agencies have worked to the detriment of both interests.

2. Improved and intensified educational programs designed to acquaint the public with the true nature of herbicides and to dispel the misconception that growth regulators and insecticides are identical chemicals.

3. Better definition by wildlife agencies as to acceptable herbicide practices on utility maintained rights-of-way crossing game management areas.

4. Greater freedom on the part of formulators to market combinations of herbicides manufactured by different chemical companies.

5. Consideration of rights-of-way on game management areas as distinct habitat entities requiring special treatment and monitoring. Maintenance of such lines by contractors should be equated on a time and materials basis rather than on competitive bids.

6. Closer supervision of spray contractors doing the actual work in the field and hiring of workmen able to identify plant materials.

7. Continued research at all levels into the complexities of plant succession and composition following repeated applications of herbicide.

In conclusion it is hoped that we can look forward to the day when ecological effects on wildlife and its environment will be as much a part of thinking and planning in herbicide programs as the effects of these chemicals on the target pests. Wildlife biologists and game departments are not against a managed world. They merely object to unenlightened management.

PRESERVATION OF DESIRABLE SPECIES THROUGH SELECTIVE USE OF HERBICIDES

Herbert J. Cran, Jr.1/

The selective use of herbicides, as they apply to the control of undesirable vegetation along town roadsides and private rights-of-way is an established practice of our investor-owned utility. Through the efforts of users and conservationists alike, a subcommittee of the Connecticut Shade Tree Council was established to prepare recommendations for the use of herbicides in controlling undesirable vegetation along town roadsides. These recommendations were approved by the Committee in the summer of 1960 and The Connecticut Light and Power Company applied them to its own roadside brush control specifications.

The Connecticut Light and Power Company maintains over 11-1/2 thousand miles of pole lines and serves 123 of the 169 towns in our state. The tree trimming maintenance cost is 1-1/2 million dollars, 88 percent of which is distribution, 5 percent subtransmission and 8 percent is transmission.

Since 1962, from 5 to 15 percent of our distribution tree trimming allocation has been used for selective roadside spraying or undergrowth clearing of undesirable vegetation with herbicides. During that period, our trimming cycle has been changed from a three-year to a five-year cycle in most areas except for spot work that up until recently required annual trimming of certain individual trees growing directly under the lines. This two-year bonus extension of our trim cycle is due in large measure to our selective spray program.

The extensive but selective use of herbicide applications along our Connecticut roadsides since 1960 and to private rights-of-way in the late 1950's was not accidental. It was inevitable that, as a result of increasing labor costs and the deeper appreciation of the aesthetic aspects of the landscape, herbicides become a permanent part of our utility operations. Through planned programs of education and training in annual seminars at the line clearance foreman level and through lectures to garden clubs and conservation groups, there has been a wide public understanding and acceptance. As a result of the interest of many individuals, conservationists, ecologists, botanists, arborists, horticulturists, entomologists, state and municipal officials and public utilities, the Connecticut Weed and Brush Control Council was organized in May, 1962. Although we are indebted to the late Rachel Carson for bringing about a re-evaluation of existing pesticide and herbicide practices, the Weed and Brush Control Council did much to eliminate the highly emotional reactions associated with herbicide practices as the public gained in knowledge and understanding through the use of seminars and educational programs through the press, radio and television. The booklet, "Use of Herbicides Along Connecticut Town Roadsides," prepared by the Vegetation Management Subcommittee of the Connecticut Shade Tree Committee, was of no little aid in securing permission from the abutting property owners to carry out the needed chemical control of

1/ Landscape Architect and Arborist, The Connecticut Light and Power Company, Berlin, Connecticut

undesirable vegetation along town roadsides.

Since 1963, these volunteer efforts at education and self-control were taken over by the newly formed Connecticut State Board of Pesticide Control which is under the State Department of Agriculture and Natural Resources. They administer the regulatory control in Connecticut. Our active interest in herbicide controls can be measured by the fact that Mr. Anthony E. Wallace, our President, served as the first president of the state pesticide control board and was instrumental in its founding. All prospective users of herbicides and pesticides must now be licensed and they must pass both rigid oral and written examinations. With such strict pesticide laws in our state now in force, we are assured that the use of herbicides as an effective tool can be continued by the State Highway Department, the farmer, the utilities and the homeowners of Connecticut who wish to achieve aesthetic effects and landscaped vistas, as well as proper line clearances.

The extension of our trimming cycle and the gradual reduction of spot trimming has been due in great measure to the discontinuance of the 2,4-D and 2,4,5-T combination and the standardization of the use of a 2,4,5-T low-volatile ester formulation using propylene glycol butyl ether ester or the low-volatile 2-ethyl-hexyl ester. No waterborne foliage application is now permitted along our town roadsides; only an oil-basal application of 2,4,5-T O.S. containing one of the above low-volatile esters can be used. The formulation contains four pounds acid equivalent per gallon and eight pounds acid equivalent (2-gallon formulation) shall be mixed with a sufficient quantity of No. 2 fuel oil, diesel oil or kerosene to make fifty gallons of spray solution. The two materials are thoroughly mixed before any spray solution is drawn off. The spray mixture is applied by starting at the ground line and working up, thoroughly drenching the exposed trunk area and root collar up to a height of 24 inches so that run-down of solution is noticeable. This same method is applied to all trees earmarked for removal on distribution R/W, spraying the trunk and root collar several weeks prior to removal. This usually assures the elimination of possible sprout development at the root collar. The "knapsack" or cannister-type of spray tank with a 3 to 5-gallon capacity is used with a mechanical agitator. The spray wand tip is equipped with a nozzle to produce a fan-shaped spray pattern. On our transmission and subtransmission lines, the spray is applied to the sides of the stem of trunk to a height of two or three feet and up to four feet on such resistant species as ash, oak, elm, maple and birch. Basal spraying of woody plants can be done at any season of the year, provided the root collar is not covered with water, ice or snow. Basal sprays are usually more effective on root-suckering species such as sassafras, sumac, locust, aspen and beech. Also, willow and ailanthus reproduce vegetatively, sending up suckers from their root systems. Dormant basal treatment, particularly in late summer, is most effective in controlling resprouting as there is a pronounced natural downward movement through the sieve tubes of the cambium into the root system at that season of the year.

Stem-foliage sprays are no longer permitted in the eradication of undesirable plants except in the elimination of greenbrier, blackberry, Japanese honeysuckle and poison ivy. We feel our stem basal treatments provide more effective control

as well as greater selectivity in the preservation of desirable trees and shrubs. The initial cost is a little more. However, since the kill is more effective, sucker resurge has been cut back and follow-up applications are not required.

Every effort is made to conserve the desirable low-growing woody plants along our roadsides and as shrub borders along the edge or as plant colonies within the R/W on our transmission and subtransmission lines. These desirable plants include flowering dogwood, mountain laurel, viburnum spp., high and low bush blueberry, elderberry, huckleberry, juniper, witch-hazel, hawthorne, Hartford fern, sweet fern, sumac spp., bayberry, common red cedar, shadbush (Amelanchier spp.), the native azaleas (Rhododendron spp.), to say nothing of the wild flowers, the winterberry, the American hornbeam, gray dogwood (Cornus racemosa), silky dogwood (C. Amomum), and the red osier dogwood (C. stolonifera).

Some of these plants, including gray dogwood, laurel, blueberry, witch-hazel, sweet fern, winterberry, and the black alder make excellent colonizers. Laurel, blueberry, red cedar, black alder, and the meadow juniper (juniperus communis) are often found across the entire width of the R/W. These plants that become a dominant feature in the plant community and colonize are very important on our R/W for three reasons. They enhance the landscape, they provide refuge and food for wildlife, and they tend to "blanket" out other seedlings that in many cases could be seedling trees, that if released, could pose as potential hazards to our lines and would dictate a more frequent trimming and R/W maintenance cycle. I do not say that an occasional undesirable tree seedling does not break through a plant colony. However, if we have prevented 80 to 85 percent of such seedlings from breaking out, then such plant colonizers are very worthwhile and should be preserved. We have one subtransmission line that for section after section is just a mass planting of witch-hazel about 15 feet in the air. The only thing to mar this unbroken cover was one swamp red maple that had broken through its canopy. You can imagine how inexpensive this portion of that line is to keep properly maintained.

Another important family as far as R/W are concerned is the herb family and consists of grasses, sedges and rushes, as well as wild flowers. These also provide food and cover for our wildlife and to provide a certain stability to the right-of-way that would tend to discourage encroachment of undesirable tree seedlings. Another happy phenomenon that has occurred repeatedly throughout our distribution system is the release of mass plantings of laurel and dogwood, viburnum, sweet fern and bracken fern, when an undesirable canopy of taller trees that endangers our lines have been removed. Some of the viburnums grow to 15 feet in height and are very handsome plants, even when not in flower.

In the May, 1968 issue of the Reader's Digest there is an article entitled "Let's Save a Place to Walk." In it Mr. Gary Jennings, the writer, tells us how important it is for the walker "to stretch his legs and his soul." A walker does not have to be a determined hiker but he can stretch for some minutes or hours in communion with nature, listening to the trees, bird calls or the rustling of the grass, or the flushing of some wild ducks as you quietly approach a nearby pond. Getting over to such a nature walk is actually only as far away as your nearest transmission line, or along that country road with overhead distribution down at the end of your street. In carefully preserving

the shrub borders, we have not only added beauty to our R/W but we have attracted the birds and other wildlife. Scenic woodlands now have become more readily available to the public through such man-made pathways. One of our affiliated companies is now in the process of developing a transmission R/W for a distance of about two miles to permit the student bodies from two colleges to use the R/W as a nature corridor connecting the two institutions, thus permitting an exchange of students in an expanded curriculum without going to the expense of enlarging the facilities at each institution. To top it off, they get an outdoor classroom as a bonus!

We are now in the process of placing some 242 acres of red pine around our hydro facilities in the northwestern part of the state under a forest management program. This is requiring a thinning out operation so that the remaining trees can develop properly. Without such a thinning operation, these stands would have gone into rapid decline. Some of these areas have been set aside as recreational areas for the public and will provide yet another "walkway" without costing the government or the taxpayer a cent. As these stands are selectively thinned out, pine seedlings will be encouraged, but undesirable deciduous plants will be kept down by selective oil basal herbicides.

Since August of 1965, we have been cooperating with Mr. William Mitchell Van Winkle, Jr., and other officials of the White Memorial Foundation and the Litchfield Hills Audubon Society in developing a R/W demonstration area where their nature trails cross our R/W. Here the full width of the R/W has been preserved with colonies of desirable trees and shrubs beneficial to wildlife. Undesirable trees that would endanger our lines have been selectively removed chemically under the direction of Mr. Gordon Lowry, of the L. H. Audubon Society, Mr. Arthur Cedar, Superintendent of the White Memorial Foundation and me and grassy pathways crisscrossing the R/W have been maintained by Mr. Cedar's forces. Large colonies of viburnum dentatum and black alder cover the R/W; even a buckwheat field planted by the White Memorial Foundation is growing under our high line and is a source of food for deer and other wildlife. This area also affords us another opportunity to study plant succession and plant dominance and to see how plant colonization and selective spraying go hand-in-hand in obtaining a trouble-free R/W that costs very little to maintain. Granted, all our R/W's are not blessed with such plant colonizers. However, where they do exist, we capitalize on them in achieving a selective, economically managed R/W that is aesthetically attractive, while at the same time providing a refuge and food for our wildlife. As Mr. Warren G. Kenfield said in his book "The Wild Gardener in the Wild Landscape," this magnicificent chemical tool has created for us "the herbicide-sculptured landscape."

PELLETED VS. LIQUID HERBICIDES FOR CONTROL OF LOW-GRADE WHITE OAK IN CENTRAL PENNSYLVANIA

R. D. Shipman 1/

Previous studies have shown that non-liquid, pelleted and granular herbicides offer the forest resource manager a valuable new tool for controlling unwanted low-grade hardwoods (1,2,3,4,5,6,7). In common with the much-used liquid formulations of 2,4,5-T and 2,4-D, both dry, pelleted herbicides and liquid formulations are affected by many environmental variables. Chief among these many interacting variables are species differences, concentration and rate of herbicide, season of application, spatial patterns in the case of pelleted materials and number and spacing of incisions with liquid herbicides.

The objective of these exploratory trials, begun in June 1968, is to compare the level of defoliation obtained by treating individual white oak trees with two pelleted and two liquid herbicides. The ultimate objective is to determine the minimum costs of controlling weed hardwoods on a "prescription" basis, i.e., the most effective kill at least cost.

Because of the many experimental variables affecting the level of kill, only a single species, white oak (*Quercus alba* L.), was used for a comparison of the combination treatments. Sample trees consisted of single-stemmed white oak ranging in diameter from 4 to 12 inches at breast height (dbh). Trees were selected at random on two upland hardwood stands located in Huntingdon County, Pennsylvania, near State College. The trees were approximately 55 years old; the stand was rather open--about 90 square feet of basal area per acre. Other species in association with the white oak were scarlet and black oaks and hickories. On both sites, the topography was, on-the-average, about 30 percent. Each treatment was replicated on five sample trees of varying tree diameters. A total of 720 trees were treated in the entire experiment: 4 herbicides x 3 methods per herbicide x 3 concentrations (pelleted) x 2 concentrations (liquid) x 5 tree samples x 2 locations = 720. Factors of the treatments were as follows:

Herbicides:
(1) Pelleted fenuron (3-phenyl-1,1-dimethylurea)
(2) Pelleted bromacil (5-bromo-3-sec-butyl-6-methyluracil)
(3) Liquid picloram (4-amino-3,5,6-trichloropicolinic acid)
(4) Liquid 2,4,5-T + 2,4-D (amine salt)

Methods: For pelleted herbicides: (1) circumbasal, (2) 3 separate spots and (3) 4 separate spots.

For liquid herbicides: (1) connected incisions, (2) incisions spaced 2" apart and (3) incisions spaced 3" apart.

1/ Associate Professor of Silviculture, School of Forest Resources, The Pennsylvania State University, University Park, Pennsylvania.

Concentration: For pelleted herbicides: (1) $\frac{1}{2}$ teaspoon per inch diameter, (2) 1 teaspoon per inch diameter and (3) 2 teaspoons per inch diameter. Each of the above concentrations were applied at dbh and 2 dbh distances from the bole of the tree.

For liquid herbicides: (1) Diluted (50%) and (2) Undiluted (100%). Both of the above concentrations were applied at the rate of 1 ml. per incision.

The pelleted fenuron and bromacil was dropped on the soil surface and was not covered; the liquid herbicides were applied with a 3" wide blade tree injector. Treatments were applied with semi-skilled labor and an attempt was made to simulate an actual field operation. Incisions were made as close to the ground as possible and above basal deformities. The percent of total crown defoliated was estimated on three dates during the growing season after initial application of the herbicide.

RESULTS

At the termination of 108 days after initial treatment, the highest crown defoliation (87 percent) occurred on trees treated with fenuron pellets and with the liquid amine salt of 2,4,5-T and 2,4-D. Bromacil pellets and liquid picloram produced 67 and 66 percent defoliation respectively for the same period after treatment (Fig. 1).

A summary of mean crown defoliation by method and rate of application is given in Table 1. Pelleted fenuron was most effective when applied circumbasally or in 3 spots per tree at the rate of 1 or 2 teaspoons per inch of diameter. The liquid 2,4,5-T + 2,4-D amine produced the highest kill with connected incisions at either the diluted or undiluted rates. The lowest crown defoliation among all herbicides tested occurred with liquid picloram when incisions were spaced 3" apart. An analysis of variance (not included here) will be applied to these preliminary findings at a later date. A more precise evaluation of the effects of tree diameter, spacing of pellets and incisions, concentration and herbicide formulation will serve as the basis for defining treatment prescriptions for the variables studied.

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FIG. 1 - PERCENT CROWN DEFOLIATION FOLLOWING TREATMENT OF WHITE OAK (*Quercus alba* L.)

June 3 - Oct. 3, 1968

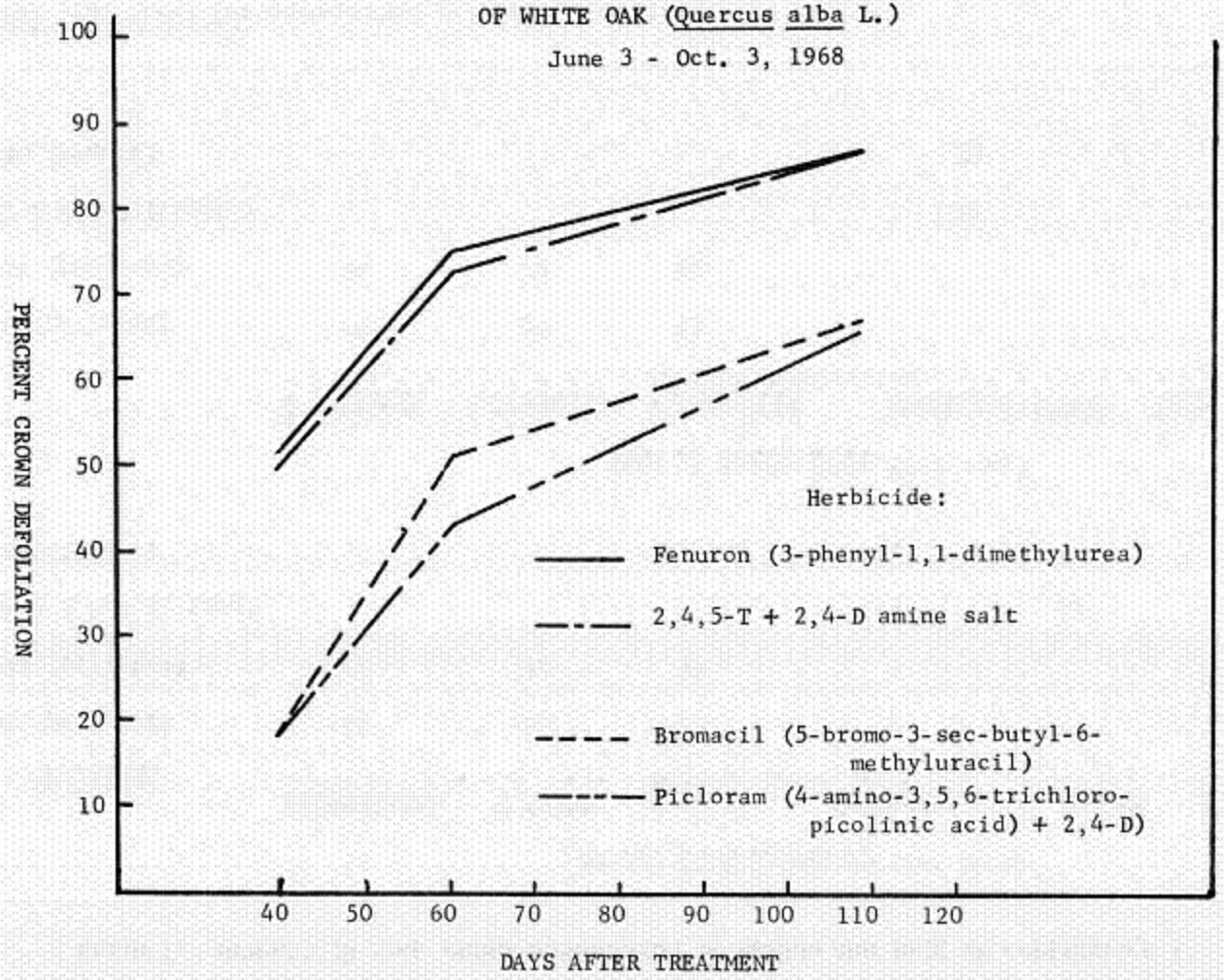


TABLE 1. SUMMARY OF MEAN CROWN DEFOLIATION BY METHOD AND RATE OF APPLICATION [1/]

Herbicide	Method of Application (Per tree)					
	Circumbasal	3 spots	4 spots	Connected	2" spaced	3" spaced
	Percent Defoliation					
Fenuron (pelleted)	88	88	83			
Bromacil (pelleted)	77	66	57			
2,4,5-T + 2,4-D (liquid)				99	82	81
Picloram (liquid)				95	63	39

	Rate of Application (Per tree)				
	½ teaspoon	1 teaspoon	2 teaspoons	Undiluted (100%)	Diluted (50%)
	Percent Defoliation				
Fenuron (pelleted)	70	94	95		
Bromacil (pelleted)	44	72	83		
2,4,5-T + 2,4-D (liquid)				87	88
Picloram (liquid)				72	60

1/ Basis: 720 trees for each method or rate of application.

THE EFFECTIVENESS OF m-(3,3-DIMETHYLUREIDO)PHENYL TERT-BUTYLCARBAMATE, VARIOUS HERBICIDES AND THEIR COMBINATIONS AS SOIL STERILANTS IN THE NORTHEAST

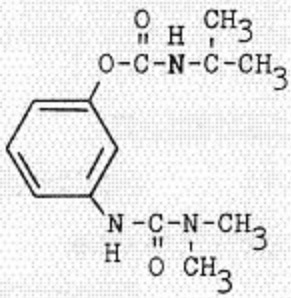
Edward S. Hagood 1/

Introduction

The discovery of m-(3,3-dimethylureido)phenyl tert-butylcarbamate (NIA 11092) in February of 1964 by the Niagara Chemical Division, FMC Corporation, introduced an experimental compound for testing. During the growing season of 1964, NIA 11092 was employed as an experimental pre-emergence and post-emergence herbicide in twenty-six field grown crops. Data from these experiments indicated that NIA 11092, while herbicidally very active, was non-selective in crops. Since that time studies have been conducted by the Research Department of the Niagara Chemical Division to prove its effectiveness and persistence as a non-agricultural herbicide. Data from these studies indicate that NIA 11092 possesses characteristics which will result in its becoming an outstanding industrial herbicide.

Physical and Chemical Properties

The chemical identity of NIA 11092 is m-(3,3-dimethylureido)phenyl tert-butylcarbamate. Its structural formula is:



NIA 11092 is a white crystalline solid, which melts at 176-176.5° C. and is soluble in water at room temperature to the extent of 325 ppm. While several formulations with adjuvants have been prepared and evaluated, the wettable powder and granular formulations appear most practical.

The acute oral LD_{50} of technical grade NIA 11092 to albino rats is 3,000 mg/kg of body weight. The acute dermal to albino rabbits is greater than 15,400 mg/kg. NIA 11092 is nontoxic and nonirritating to mammals. It is also nontoxic to fish.

Materials and Methods

Results of five Western New York test sites are presented:

1/ FMC Corporation, Niagara Chemical Division, Middleport, N.Y.

Location A - These tests were located under a highline and upon a silty clay loam soil in Middleport, N.Y. Twenty-three (Code 1) annual and perennial species infested these three replicate tests, which were first treated in November, 1964.

Locations B and C - These two tests were located at Medina, N.Y. on a silty clay loam soil. Seventeen annual and perennial species and seventeen woody species (Code 2) were growing when these plots were first treated, either August, 1965 or July, 1966. The heights of the woody species ranged from 1 to 30 feet.

Location D - This test site, located upon the Penn-Central Railroad at Gasport, N.Y., included both track and shoulder conditions. Twenty-eight annual and perennial and three woody species (Code 3) infested this well-drained and well-kept right-of-way. Sprays were first applied in this four replicate test during June, 1966.

Location E - The site of this six replicate test was upon a spur line of the Penn-Central at Millers, N.Y. Infrequent use by light, short, and slow-moving trains has been associated with a minimum of maintenance upon this track. Twenty-nine annual and perennial and three woody species (Code 4) infested this site, when the first treatments were applied during July, 1967.

The identity of each species infesting the five test sites is as follows: (The numbers in parentheses identify the locations where each species was a weed or brush pest.)

Pteridophyta

Common horsetail	(1,3,4)	*Equisetum arvense*

Monocotyledons

Annuals		
Barnyardgrass	(3)	*Echinochloa crusgalli*
Green foxtail	(3)	*Setaria viridis*
yellow foxtail	(3,4)	*Setaria glauca*
Perennials		
Bentgrass	(3)	*Agrostis sp*
Hop sedge	(2)	*Carex lupulina*
Orchardgrass	(4)	*Dactylis glomerata*
Quackgrass	(1,2,3,4)	*Agropyron repens*
Timothy	(1,2,3,4)	*Phleum pratense*
Wild barley	(1)	*Hordeum leporinum*
Yellow nutgrass	(2,3)	*Cyperus esculentus*

Dicotyledons-Herbaceous

Annuals		
Common cocklebur	(3)	*Xanthium pennsylvanicum*
Common ragweed	(3)	*Ambrosia artemisiifolia*

Horseweed	(2)	Erigeron canadensis
Narrowleaf vetch	(4)	Vicia angustifolia
Prickly lettuce	(1)	Lactuca scariola
Rough cinquefoil	(3)	Potentilla norvegica
Wild buckwheat	(3)	Polygonum convolvulus
Biennials		
Bull thistle	(3,4)	Cirsium vulgare
Common burdock	(4)	Arctium minus
Common eveningprimrose	(3)	Oenothera biennis
Common mullein	(3,4)	Verbascum thapsus
Field pepperweed	(1,4)	Lepidium campestre
Moth mullein	(3,4)	Verbascum blattaria
Rough fleabane	(3)	Erigeron strigosus
Spotted knapweed	(4)	Centaurea maculosa
Teasel	(1,2,4)	Dipsacus sylvestris
White sweetclover	(1,3,4)	Melitotus alba
Wild carrot	(1,2,3,4)	Daucus carota
Perennials		
Alsike clover	(4)	Trifolium hybridum
Birdsfoot trefoil	(1)	Lotus corniculatus
Broadleaf plantain	(1)	Plantago major
Buckhorn plantain	(1)	Plantago lanceolata
Canada thistle	(1,4)	Cirsium arvense
Catnip	(1,2)	Nepeta cataria
Chicory	(1,2,3,4)	Cichorium intybus
Common dandelion	(1,2,3,4)	Taraxacum officinale
Common milkweed	(3,4)	Asclepias syriaca
Common yarrow	(1,2,4)	Achillea millefolium
Curly dock	(1,4)	Rumex crispus
Gray goldenrod	(1,2,3,4)	Solidago nemoralis
Healall	(2,4)	Prunella vulgaris
Hemp dogbane	(3)	Apocynum cannabinum
Perennial sowthistle	(1)	Sonchus arvensis
Red sorrel	(1,2)	Rumex acetosella
St. Johnswort	(2,3,4)	Hypericum perforatum
Strawberry	(4)	Fragaria vesca
Sulphur cinquefoil	(2,3,4)	Potentilla recta
Tall buttercup	(1)	Ranunculus acris
Yellow toadflax	(1,2,3,4)	Linaria vulgaris

Woody Species

Apple	(2)	Pyrus malus
Ash	(2)	Fraxinus sp.
Blackberry	(2,3,4)	Rubus sp.
Cherry	(2)	Prunus sp.
Common chokecherry	(2)	Prunus virginiana
Dewberry	(2,3,4)	Rubus sp.
Dogwood	(4)	Cornus sp.
Elder blueberry	(2,4)	Sambucus glauca

Elm	(2)	Ulmus americana
Grape	(2)	Vitis sp.
Ligustrum	(2)	Ligustrum sp.
Maple	(2)	Acer sp.
Poison ivy	(2,3,4)	Rhus radicans
Quaking aspen	(2)	Populus tremuloides
Silky dogwood	(2)	Cornus amonum
Sumac	(2,3)	Sumac sp.
Willow	(3)	Salix sp.

The sprayer for all treatments, which applied water or oil-water combinations in the finished spray, was a tractor-mounted unit. Components of the sprayer included a gasoline-driven diaphragm pump, cylindrical tank, by-pass agitation, pressure gauge and appropriate hose to serve a 12-foot boom. Two 3-nozzle booms or a spray gun were employed per plot to treat the sites infested with brush and trees.

The weight of chemicals (stated as lb/A of the active) required for each rate of each treatment was determined. This weight was multiplied by the number of replicates per test plus two, so that one weight plus diluent might be used to fill the sprayer system and one could be discarded after spraying all replicates. The volume of water or water plus oil to spray each plot was determined. This volume was also multiplied by the number of replicates plus two. The active ingredient or ingredients and additives, as shown in each table, were added. During the spraying operation the boom was moved back and forth across each plot until each volume was uniformly applied at a pressure of 40 psi. (Formulations containing NIA 11092 are being developed by the Niagara Chemical Division, FMC Corporation under the trademark "Tandex®")

An exception to the method described for spraying with the tractor-mounted unit was employed in applying the 56 gal/A of oil, containing pentachlorophenol and 2,4-D. This volume per plot was applied with a 3-gal compressed air sprayer. Sufficient Tandex to be equivalent to rates of 3.2 or 4.8 or 6.4 lb/acre was mixed in each volume for each plot as shown in Table VII.

All sandcore and tetraborate-based granular treatments were applied with a small duster. Its molded construction facilitated the placing of the weight of the granular formulation for each plot within the unit and the delivery of the planned weight uniformly over the plot. The size of the particle in the "extruded" granular formulation dictated that this weight for each plot be distributed by hand.

Evaluations of weed, brush and tree kills or injuries were made several times to determine the rapidity of action and persistence of each treatment.

Evaluations included both estimates and counts. Escapes following each program were also identified.

Using the methods described above, maintenance rates were applied and evaluated as shown in the tables. Each table presents the averages of the controls.

Results and Discussion Tests described at Locations A, B, and C were more extensive than described herein. Niagara's experimental formulations which were less effective than Tandex, were eliminated. When last evaluated, some of these tests had been in progress for forty-six months. Programs of sprays were required for this period of control. With exceptions, only those programs which maintained 70% control or better have been included. (Tests described at Locations D and E include all experimental formulations and standards These programs have been compared with similar programs, which employed the better commercialized standards (Table VI and VII).

Post-emergence Sprays upon Herbaceous Species
Twenty-three annual and perennial species (Code 1) infested a silty clay loam soil at the Middleport, N.Y. test site during the growing season of 1964. Tabular data (Table I) summarize the performance data upon selected programs, which started in November 1964. Some of these treatments were maintained during June, 1966, May, 1967 and July, 1968. Six evaluations of the performances during the forty-six month period are presented.

Table I (Location A - Code 1)

Treatments 11-3-64	Avg % Control 9-8-65	Avg % Control 6-7-66	Maintenance Treatments 6-10-66	Avg % Control 9-12-66	Maintenance Treatments 5-23-67	Avg % Control 8-15-67	Avg % Control 7-25-68	Maintenance Treatments 7-25-68	Avg % Control 8-27-68
10 lb/A Tandex 80 WP	89.3	75.3	5 lb/A Tandex 80 WP + Oil	92.0	1 lb/A 2,4-D	85.5	50.0	none	
10 lb/A Tandex 80 WP	89.3	75.3	10 lb/A Tandex 80 WP + WK	90.0	1 lb/A 2,4-D	98.0	64.0	none	
20 lb/A Tandex 80 WP	92.0	61.7	10 lb/A Tandex 80 WP + WK	92.0	1 lb/A 2,4-D	97.0	70.0	3 lb/A Tandex 80 WP	86.5

The treatments (line 1 of Table I) include 10 lb/A of Tandex in 1964, 5 lb/A of Tandex in 1966 and 1 lb/A of 2,4-D during 1967. Controls were 89.3, 75.3, 92.0, 85.5 and 50.0 percent during the forty-six month period. One pound of 2,4-D was employed in an attempt to control the predominant escape, dandelion. It is indicated that a maintenance rate of 2 to 3 lb/A of Tandex during 1967 would have resulted in better controls during 1968.

The only differences between the programs, as summarized in lines 1 and 2 of Table I, were that the maintenance rate of 1966 was 10 lb/A of Tandex + Surfactant WK instead of 5 lb/A of Tandex + oil (8% by volume). In addition to the indications stated above, the maintenance rate of 10 lb/A during the 2nd growing season was in excess of the need.

Line 3, Table I summarizes the results, which followed 20 lb/A of Tandex in 1964, 10 lb/A of Tandex + WK in 1966, 1 lb/A of 2,4-D in 1967 for the dandelion escape, and 3 lb/A of Tandex in 1968. When compared with line 1, Table I, the 20 and 10 lb/A rates presented no advantage over 10 and 5 lb/A rates. To maintain the residual level of Tandex at the soil surface, 2 to 3 lb/A applications of Tandex are suggested for use during the third and fourth years. As employed, the 3 lb/A Tandex application of 1968 returned the weed controls at the forty-sixth month to 86.5%.

During June of 1965 twenty-three annual and perennial species (Code 1) were growing upon a silty clay loam soil in Middleport, N.Y. Two of three programs (lines 1, 2 and 3, Table II) met the minimum standards of a 70% control over this thirty-nine month period. The data indicate that a starting rate of Tandex of 5 lb/A is insufficient to control herbaceous perennial species. A starting rate of 20 lb/A was in excess of the need. These data indicate that 5 and 3 lb/A of Tandex during the second and third years will effectively and economically maintain the weed control, which was established by the original rate of 10 lb/A of Tandex. While 2 lb/A of 2,4-D were applied predominately for dandelion control, the suggested Tandex program appears to be more effective.

Table II (Location A - Code 1)

Treatments 6-3-65	Avg % Control 9-8-65	Avg % Control 6-7-66	Maintenance Treatments 6-10-66	Avg % Control 9-12-66	Maintenance Treatments 5-23-67	Avg % Control 8-15-67	Maintenance Treatments 6-28-68	Avg % Control 7-25-68	Maintenance Treatments 7-25-68	Avg % Control 8-27-68
5 lb/A Tandex 80 WP	89.0	61.6	10 lb/A Tandex 80 WP + WK	94.0	1 lb/A 2,4-D	88.0	1 lb/A 2,4-D	68.0	3 lb/A Tandex 80 WP	90.0
10 lb/A Tandex 80 WP	92.3	73.3	10 lb/A Tandex 80 WP + WK	92.0	1 lb/A 2,4-D	93.5	1 lb/A 2,4-D	83.5	3 lb/A Tandex 80 WP	92.8
20 lb/A Tandex 80 WP	97.0	79.3	5 lb/A Tandex 80 WP + Oil	92.0	1 lb/A 2,4-D	92.0	1 lb/A 2,4-D	90.0	3 lb/A Tandex 80 WP	93.0

In another test, started during June, 1965 and extending over thirty-eight months, the infestation of 23 species was growing upon a silty clay loam soil in Middleport, N.Y. The selected treatments performed as summarized in Table III.

Table III (Location A - Code 1)

Treatments 6-4-65	Avg % Control 9-8-65	Avg % Control 6-7-66	Maintenance Treatments 6-10-66	Avg % Control 9-12-66	Maintenance Treatments 5-23-67	Avg % Control 8-15-67	Maintenance Treatments 6-28-68	Avg % Control 7-25-68	Maintenance Treatments 7-25-68	Avg % Control 8-27-68
Tandex 80 WP 20 lb/A +2,4-D 1 lb/A +2,4,5-T 0.25 lb/A	96.0	80.5	Tandex 80 WP + Oil 5 lb/A	90.0	1 lb/A 2,4-D	90.0	1 lb/A 2,4-D	82.0	Tandex 80 WP 3 lb/A	92.5
Tandex 80 WP 20 lb/A +2,4-D 1 lb/A +2,4,5-T 0.25 lb/A	96.0	80.5	Tandex 80 WP 5 lb/A	95.5	1 lb/A 2,4-D	93.5	1 lb/A 2,4-D	92.0	Tandex 80 WP 3 lb/A	94.0

A comparison of lines 1 and 2 of Table III with line 3 of Table II indicates that the addition of 1 lb/A of 2,4-D and 1/4 lb/A of 2,4,5-T to the 20 lb/A Tandex applications did not improve performance. Tandex 80 WP at 5 lb/A plus Surfactant WK, applied as a maintenance spray in June, 1966, was more effective than the same rate of Tandex, when applied in an 8% oil (Logarithmic dilutions employed a maximum concentration of 50% oil. Studies employing eight herbicidal oils, when applied with Tandex, indicated that the selected oils in these dilutions reduced the effectiveness of Tandex - unreported Niagara data). A program of maintenance rates of 5, 0, and 3 lb/A of Tandex during the three growing seasons were indicated to be effective.

Soil Studies - Woody and Herbaceous Species

Seventeen annual and perennial herbaceous species and seventeen woody species (Code 2) were infesting this silty clay loam soil, located near Medina, N.Y., at the time of the first treatments. Four replicates of each soil treatment were first sprayed during June, 1965 upon an infestation with trees as high as thirty feet.

Maintenance treatments were applied to the soil surface during June, 1967 and July, 1968.

Within one month after the first treatment (20 lb/A of Tandex) the leaves of the woody species were from 15 to 100% defoliated. Extent of the defoliation varied with species. The remaining leaves were partially chlorotic and necrotic. Time of death of the woody species was uncertain. When evaluated during the spring of 1966, the treatment providing 97.6% control (Table IV) allowed several species to establish small, somewhat necrotic leaves. These, also, were defoliated in time. When evaluated during June, 1967, July, 1968 and August, 1968, the controls of the woody species were 99.0% or higher. These kills were attributed to the first treatment, 20 lb/A of Tandex.

Table IV (Location B - Infestation 2)

	Ratings of 9-8-66		Ratings of 6-28-67			Ratings of 7-5-68			Ratings of 8-27-68	
Treatment 8-14-65	% Kill of Woody Species	% Kill of Weeds & Grasses	% Kill of Woody Species	% Kill of Weeds & Grasses	Maintenance Sprays 6-28-67	% Tree & Brush Control	% Weed & Grass Control	Maintenance Sprays 7-8-68	% Tree & Brush Control	% Weed & Grass Control
Tandex 80 WP 20 lb/A + WK	97.6	94.7	99.0	90.0	5 lb/A Tandex 80 WP + WK	99.7	95.3	3 lb/A Tandex 80 WP + 0.25% WK	99.9	99.4
					1 lb/A 2,4-D	100.0 99.7	39.3	8 lb/A Tandex 80 WP + 0.25% WK	99.8	96.7

The original 20 lb/A Tandex treatment controlled 94.7 and 90.0% of the herbaceous species, when evaluated during September, 1966 and June, 1967. Maintenance treatments of 5 and 3 lb/A of Tandex during June, 1967 and July, 1968 resulted in controls of 95.3 and 99.4% during the remainder of the thirty-six months. The

substitution of 1 lb/A of 2,4-D in the first maintenance treatment followed by 8 lb/A of Tandex in the second was less effective as indicated by a 39.3% control of the herbaceous species during July, 1968. While the 8 lb/A maintenance rate of Tandex controlled 96.7% of the herbaceous species, a continued, higher-level control followed the 5 and 3 lb/A maintenance rates of Tandex.

Soil vs. Foliar Studies, Woody and Herbaceous Species
Approximately the same location and infestation (Code 2) were involved in this as in the previous discussion. The methods of application were designed to place all of the 17.6 lb/A Tandex sprays on the soil; 2/3 on the soil, 1/3 on the foliage of the woody species; 1/3 on the soil, 2/3 on the foliage, or 3/3 on the foliage. The data (Table V) indicate that each method of placement was equally effective. Since only a small amount of Tandex is absorbed through the foliage, the results indicate that placement, or runoff, or rainfall, or defoliation or a combination of these placed the Tandex on the soil's surface. Excellent controls of brush and trees indicated a movement of the compound through the soil, root absorption, and apparent systemic activity.

Table V (Location C - Code 2)

Treatment 7-7-66	Rate-lb Act/Acre	Placement of Spray	Evaluations of 9-14-67		Evaluations of 7-5-68	
			% Tree & Brush Kill	% Weed & Grass Control	% Tree & Brush Kill	% Weed & Grass Control
Tandex 80 WP + 1% WK	17.6	3/3 on the soil	100.0	99.9	99.0	82.0
Tandex 80 WP + 1% WK	17.6	2/3 on soil 1/3 on foliage	99.5	99.9	100.0	86.0
Tandex 80 WP + 1% WK	17.6	1/3 on soil 2/3 on foliage	97.0	99.0	99.0	87.0
Tandex 80 WP + 1% WK	17.6	3/3 on foliage	98.0	96.0	100.0	82.0

Throughout the remainder of 1966 and all of 1967 the four placements of 17.6 lb/A of Tandex were controlling 96% or more of the herbaceous species. By July, 1968 these controls ranged between 82 and 87%. Maintenance rates of 3 or 5 lb/A of Tandex plus 1/4% of Surfactant WK were equally effective in controlling the herbaceous species. The results indicate that for twenty-six months of control in a mixed population of herbaceous and woody species that 17.6 plus 3 lb/A of Tandex is an effective program. (The maintenance applications were applied in the twenty-fourth month.)

Weed and Brush Controls on Railroads

Twenty-eight annual and perennial and three woody species (Table VI) infested the well-drained and well-kept railroad test site, located near Gasport, N.Y. This four-replicate test was first sprayed during June, 1966 with maintenance rates being applied during June, 1967 and July, 1968.

The Table VI programs of line 2 (total of 14.8 lb/A of Tandex), line 5 (total of 16 lb/A of Tandex), line 7 (14.8 lb/A of Tandex), and line 9 (16 lb/A of Hyvar XWS or bromacil) were best. Tandex plus Surfactant WK was more effective than Tandex alone or Tandex plus 8% oil. Surfactant WK at 1/4% by weight of the finished spray was adequate. Starting weights of 4.4 or 5 lb/A of Tandex were insufficient, while 17.6 or 20 lb/A of either Tandex or bromacil were in excess of the need for the control of herbaceous annual and perennial species. Tandex, at rates of 8.8, 3 and 3 lb/A, was the equivalent of Hyvar XWS, at rates of 10, 3 and 3 lb/A

These data indicate that Tandex (plus Surfactant WK) in a program of 8 to 10 lb/A the first year, 3 lb/A the second year and 2 to 3 lb/A the third year will be an effective program for railroad weed control. Maintenance rates for the fourth and subsequent years are indicated to be 2 lb/A.

Table VI (Location D - Code 3)

Treatments 6-22-66	Rate Act. lb/A	Average % Control 6-21-67	Maintenance Rates 6-22-67 Active	Average % Control 9-18-67	Average % Control 6-24-68	Maintenance Rates 7-2-68 Active	Average % Control 8-14-68
Tandex 80 WP + 1% WK	4.4	55.3	5 lb/A Tandex 80 WP + 1% WK	92.3	76.7	3 lb/A Tandex 80 WP + 1/4% WK	93.5
Tandex 80 WP + 1% WK	8.8	91.0	3 lb/A Tandex 80 WP + 1% WK	97.3	78.5	3 lb/A Tandex 80 WP + 1/4% WK	91.5
Tandex 80 WP + 1% WK	17.6	97.8	None	89.3	71.3	3 lb/A Tandex 80 WP + 1/4% WK	87.0
Tandex 50 WP + 8% Booster Oil	5.0	75.3	5 lb/A Tandex 80 WP + 1% WK	97.5	88.5	3 lb/A Tandex 80 WP + 1/4% WK	90.8
Tandex 50 WP + 8% Booster Oil	10.0	89.0	3 lb/A Tandex 80 WP + 1% WK	96.8	84.5	3 lb/A Tandex 80 WP + 1/4% WK	93.5
Tandex 50 WP + Booster Oil	20.0	98.5	None	96.0	81.5	3 lb/A Tandex 80 WP + 1/4% WK	92.5
Tandex 80 WP	8.8	82.5	3 lb/A Tandex 80 WP + 1% WK	95.0	77.7	3 lb/A Tandex 80 WP + 1/4% WK	90.0
Tandex 80 WP	17.6	97.4	None	90.3	71.5	3 lb/A Tandex 80 WP + 1/4% WK	86.5
Hyvar XWS or bromacil	10.0	91.3	HyvarXWS 3 lb/A	91.6	89.0	3 lb/A Hyvar XWS	87.3
Hyvar XWS	20.0	98.7	None	96.7	92.3	None	82.0

A six-replicate 42-treatment test was established upon the rights-of-way of a Penn-Central spur line on July 17, 1967. Infrequent use by light, slow-moving trains has been associated with a minimum of maintenance.

Twenty-nine annual and perennial herbaceous and three woody species (Code 4) were actively growing at the time of the July treatments. Five estimates or counts during the first thirteen months have been taken to evaluate these controls (Table VII).

At the thirteenth month interval Tandex WP at rates of 7.5, 10, 12.5, 15 and 20 lb/A was controlling 80.0, 94.7, 96.0, 98.5 and 99.0%, respectively. Tandex, 4% sand-cored granular formulation at rates of 7.5, 10, 12.5 and 15 lb/A was controlling 62.0, 89.0, 94.6 and 98.8%, respectively. The same rates of Tandex as extruded and tetraborate-based granular formulations were of about the same effectiveness. Hyvar XWS or bromacil, as a standard spray application, at rates of 7.5, 10, 15 and 20 lb/A controlled 63.6, 78.0, 87.3 and 92.6% of the infestation. Both the Tandex and the Hyvar XWS treatments exhibited a minimum of lateral movement. If the root systems of trees extended under the Tandex treatments, death or injury followed.

Promising combinations were Hyvar XWS + Tandex and Karmex + Tandex. Combinations, which were less effective than the applied rate of Tandex alone, were TCA + Tandex, Dowpon + Tandex, Banvel D + Tandex, Lorox + Tandex, Phytar 560 + Tandex and Ansar 529 + Tandex.

Partial escapes following 12.5 lb/A of Tandex (96.0% control of the infestation) were common milkweed and quackgrass. Partial escapes following 10 lb/A of Tandex (94.7% control of the infestation) were quackgrass, common mullein, curled dock, goldenrod and horsetail. Partial escapes following 10 lb/A of Hyvar XWS (78.0% control of the infestation) were goldenrod, yellow toadflax, common mullein, quackgrass and orchardgrass. Partial escapes following 15 lb/A of Hyvar XWS (87.3% control of the infestation) were common mullein, yellow toadflax and peppergrass.

Summary

Four years of field data indicate that a new herbicidal compound, m-(3,3-dimethylureido)phenyl-tert-butylcarbamate is nonselective in crops and persistent in its control. Results of seven Western New York tests suggest patterns of use, formulations, rates and combinations of treatments as soil sterilants.

For the control of herbaceous annual and perennial species the most promising program employs the chemical as 80 WP or 4% granular formulations. The rate of application during the first year should be 8 to 10 lb/A active. During the second, third, and fourth years the maintenance rates should be 3 to 4, 2 to 3, and 2 lb/A. For the control of brush and trees the first year's application rate should be raised to 17.5 to 20 lb/A. The mainte-

nance program for understory control in woody species is the same as for herbaceous species. Foliar or soil applied sprays have been equally effective with the action of the chemical following movement into the soil, root absorption and apparent systemic activity. Approximately one month is required for the initial responses of the woody species, such as partial defoliation and leaf necrosis.

Certain additives or combinations have increased the activity of the chemical or broadened the spectrum of control. Surfactant WK, when added at 1/4% of the weight of the finished spray, has been useful surface-active agent. Tandex + Hyvar XWS or Tandex + Karmex have been promising combinations. Other additives or combinations have resulted in less effective controls. Tandex plus oils, or TCA, or Dowpon, or Banvel D, or Lorox, or Phytar 560, or Ansar 529, or 24D, or 24D + 2,4,5-T have been less effective than the same rate of Tandex alone.

Table VII (Location E - Code 4)

Treatments	Rate lb/A Active	Estimates of Controls in %			Weeds, Grass & Brush-Counts per sq ft	% Control 7-30-68	% Control 8-9-68
		8-14-67	9-15-67	6-24-68			
Tandex 80 WP + WK	7.5	93.5	93.1	73.2	11.1	90.0	80.0
Tandex 80 WP + WK	10.0	92.7	90.2	94.1	7.7	93.0	94.7
Tandex 80 WP + WK	12.5	93.7	91.5	97.0	2.3	98.0	96.0
Tandex 80 WP + WK	15.0	90.5	88.6	97.3	1.25	99.8	98.5
Tandex 80 WP + WK	20.0	88.0	88.3	99.1	.25	99.8	99.0
Tandex 80 WP + TCA	7.5 40.0	98.0	89.6	67.0	28.0	74.0	62.5
Tandex 80 WP + TCA	10.0 40.0	91.3	82.8	69.3	21.8	80.0	66.2
Tandex 80 WP + TCA	12.5 40.0	87.8	86.5	90.8	4.5	96.0	94.5
Dowpon Tandex 80 WP	5.0 6.0	81.5	75.0	59.5	30.8	72.0	37.3
Dowpon Tandex 80 WP	5.0 9.0	83.0	83.0	84.5	13.8	87.0	66.2
Dowpon Tandex 80 WP	5.0 12.0	84.3	83.8	93.3	5.2	95.0	89.5
Banvel D Tandex 80 WP	4.0 6.0	82.6	75.6	67.7	54.0	50.8	52.0
Banvel D Tandex 80 WP	4.0 9.0	89.3	82.0	86.6	5.8	95.0	80.6
Karmex 80 WP Tandex 80 WP	8.0 5.0	80.5	90.3	80.7	10.3	90.0	78.2
Karmex 80 WP Tandex 80 WP	8.0 7.5	78.1	88.6	91.5	3.7	97.0	80.5
Hyvar XWS + TMN	7.5	65.5	72.0	56.5	43.0	59.0	63.6
Hyvar XWS + TMN	10.0	83.6	84.8	79.5	9.1	91.0	78.0
Hyvar XWS + TMN	15.0	87.5	89.3	92.5	2.25	98.0	87.3
Hyvar XWS + TMN	20.0	86.3	87.1	95.3	3.3	97.0	92.6

Table VII (Location E - Code 4) (Cont'd)

Treatments	Rate lb/A Active	Estimates of Controls in %			Weeds, Grass & Brush-Counts per sq ft	% Control 7-30-68	% Control 8-9-68
		8-14-67	9-15-67	6-24-68			
Hyvar XWS Tandex + TMN	5.0 5.0	86.8	89.0	86.5	4.6	96.0	90.3
Hyvar XWS Tandex 80 WP + TMN	7.5 7.5	87.5	87.8	98.0	1.3	99.0	98.8
Hyvar XWS Tandex 80 WP + WK	10.0 10.0	92.6	89.1	97.3	2.25	98.0	97.0
Lorox 50 WP	20.0	78.5	49.3	18.7	98.2	8.0	29.6
Lorox 50 WP Tandex 80 WP	7.5 7.5	89.0	89.8	75.8	18.2	83.0	66.8
Phytar 560 Tandex 80 WP	8.0 7.5	87.8	91.5	72.0	11.6	89.0	52.5
Ansar 529 Tandex 80 WP	8.0 7.5	85.5	91.0	82.6	10.8	90.0	64.6
Tandex 4% Sand Core	7.5	69.6	77.5	71.6	10.8	90.0	62.0
Tandex 4% Sand Core	10.0	77.1	80.5	93.6	4.6	96.0	89.0
Tandex 4% Sand Core	12.5	84.0	83.8	97.1	2.6	98.0	94.6
Tandex 4% Sand Core	15.0	85.3	84.6	98.5	.08	99.9	98.8
Tandex 4% Tetraborate Base	7.5	73.8	75.1	74.1	12.7	88.0	75.1
Tandex 4% Tetraborate Base	10.0	74.0	78.1	85.8	12.2	89.0	87.1
Tandex 4% Tetraborate Base	12.5	84.6	80.6	95.5	.16	99.9	95.1
Tandex 4% Tetraborate Base	15.0	73.8	84.8	89.5	5.4	95.0	89.3
Tandex 4% Extruded	7.5	74.3	72.5	88.0	10.2	90.4	77.0

Table VII (Location E - Code 4) (Cont'd)

Treatments	Rate lb/A Active	Estimates of Controls in %			Weeds, Grass & Brush-Counts' per sq ft	% Control 7-30-68	% Control 8-9-68
		8-14-67	9-15-67	6-24-68			
Tandex 4% Extruded	10.0	63.1	73.5	95.3	2.5	98.7	89.8
Tandex 4% Extruded	12.5	67.0	78.0	92.8	2.0	98.2	93.2
Tandex 4% Extruded	15.0	76.6	77.5	98.5	.58	99.6	97.5
Tandex 80 WP 56 gal Nalkil** liquid per acre	3.2	73.8	59.0	20.1	65.5	38.5	21.6
Tandex 80 WP 56 gal Nalkil liquid per acre	4.8	75.3	74.6	56.6	36.2	66.0	39.3
Tandex 80 WP 56 gal Nalkil liquid per acre	6.4	80.8	80.3	62.4	28.6	74.0	56.0
Karmex 80 WP + TMN	16.0	70.3	66.0	63.8	67.5	60.0	69.2

** PCP, 2,4-D + oil equivalent to 56 gal/A

A SUBSTITUTE FOR 2,4,5-T IN EASTERN HARDWOOD SPROUT AND BRUSH CONTROL

J. H. Patric and John Campbell[1/]

ABSTRACT

Two experimental watersheds on the Fernow Experimental Forest were clearcut and maintained barren with 2,4-D and 2,4,5-T. With 2,4,5-T presently unavailable, a mixture of TBA, 2,4-D, and 2, 4-DP has been substituted successfully. Under our conditions of use, the substitute is as effective and economical as 2,4-D and 2,4,5-T for controlling revegetation by eastern hardwoods.

In 1964, portions of two forested watersheds were clearcut on the U. S. Forest Service's Fernow Experimental Forest near Parsons, West Virginia. Our purpose was to eliminate the vegetation from these watersheds, to maintain them barren for several years, and to observe the effects of this treatment on streamflow.

The original forest cover, which contained sawlog-size oak and maple interspersed with birch, beech, hemlock, hickory, black cherry, and yellow-poplar, was clearcut in three stages: (1) an initial timber harvest; (2) a second cutting for pulpwood, fence posts, and other small-tree products; and (3) a final felling of all unsalable trees. By 1967, a total of 120 acres on the two watersheds had been clearcut.

Before clearcutting, 2,4,5-T in diesel oil was basal-sprayed on all trees less than 24 inches d.b.h. to forestall sprouting. Since then, several combinations of the herbicides 2,4-D and 2,4,5-T have been applied with gasoline-powered mist blowers to control revegetation. However, since 1965 almost the entire output of 2,4,5-T has been preempted for military use, and during the past year it has been virtually unobtainable for civilian use. People concerned with hardwood control have been forced to use other more readily available herbicides. The ideal substitute, it was reasoned, would combine the broad herbicidal powers of 2,4,5-T, its relative economy, and its safety to users and to wildlife. In all of these respects, an available brushkiller composed of TBA, 2,4-D, and 2,4-DP seemed

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to suit our needs; and this report summarizes our experiences with it.

Application and Effects of the Brushkiller

The herbicide we used is an amine formulation that minimizes problems of volatility; its ingredients are listed in table 1.

Table 1.--Composition of brushkiller*

Ingredient	Percent	Acid equivalent--lbs. per gallon
2,3,6-TBA (Dimethylamine salt of Trichlorophenoxybenzoic acid)	12.3	1.0
2,4-D (Triethanolamine salt of Dichlorophenoxyacetic acid)	17.2	1.0
2,4-DP (Triethanolamine salt 2,4-Dichlorophenoxypropionic acid)	12.5	0.75
Inert	58.0	--
Total	100.0%	2.75 lb.

*Brushkiller 155, which is manufactured by Amchem Products, Inc., Ambler, Pa. Mention of the product name and manufacturer does not imply endorsement by the U. S. Dep. of Agriculture; this information is provided solely for the convenience of readers.

The manufacturer recommends mixing 2 gallons of the brushkiller with 100 gallons of water. At least 400 gallons per acre of this mixture, or 22.0 lbs. acid equivalent, are recommended for dense brush 6 to 8 feet high. Since the vegetation on our watersheds is scattered and rarely over 2 feet high, a lower application rate seemed feasible. We first tried 8.9 lbs. acid equivalent per acre, but finally settled on a minimum application of 10 lbs. acid equivalent per acre as best suited to our needs. These and other rates of application are itemized in table 2. An area in which 15.6 lbs. acid equivalent gave excellent control is shown in figure 1. Woody plants were best controlled by spraying as soon as possible after leaves had fully emerged in late spring.

Table 2.--Some herbicide applications and costs to prevent revegetation on clearcut watersheds.

Herbicide	Amount of herbicide used per 100 gallons water	Amount of mixture used per acre	Acid equivalent per acre	Cost of herbicide per acre	Remarks
	Gallons	Gallons	Pounds	Dollars	
2,4-D & 2,4,5-T	2.5	130	32.5	$28.53	Provided adequate control under our conditions of use.
Brushkiller	2.0	400	22.0	44.00	Recommended by manufacturer.
Brushkiller	2.5	130	8.9	17.78	Inadequate control.
Brushkiller	2.8	130	10.0	20.11	Provided adequate control under our conditions of use.
Brushkiller	3.75	160	16.5	33.00	Resulted in 85 percent kill with some hard-to-kill species still dying.
Brushkiller	4.38	130	15.6	31.30	Resulted in kill as good or better than above combination of 2,4-D and 2,4,5-T.

Figure 1.--Part of an experimental watershed maintained barren of revegetation following clearcutting. The watershed is on the Fernow Experimental Forest near Parsons, West Virginia.

In our humid climate, clearcuttings ordinarily begin to "green up" a few weeks after cutting. Five years later these clearcut areas usually support a nearly impenetrable tangle of revegetation. When herbicides are used to control revegetation, natural succession is changed. Plants most susceptible to the herbicide tend to die out while plants least susceptible tend to dominate new stands. For example, varying degrees of tree susceptibility to 2,4,5-T permit foresters to use it to free conifers from more susceptible hardwood competition. The substitute brushkiller described above cannot be so used because it is at least as toxic to conifers as to many hardwoods.

In our watersheds, fireweed presents a special problem because it is a prolific seeder that, although susceptible to the brushkiller, must be sprayed during flowering for optimum effect. Because it was inconvenient for us to spray during the late summer flowering period, some areas now support dense stands of fireweed (fig. 2). Spraying during early summer sometimes controls fireweed but more often merely deforms

Figure 2.--A dense cover of fireweed with mature seed-heads.

the plant that later develops normal fruiting bodies (fig. 3). Thus, timing of sprays seems to be at least as important in fireweed control as the concentration of the herbicide. Our experiences with most plants found on our experimental watersheds are summarized in tables 3 and 4.

The herbicide applications used on the Fernow Experimental Forest were the result of considerable trial and error experience. Many users of 2,4-D and 2,4,5-T will object that our application of these materials (table 2) considerably exceeded amounts used successfully to control forest vegetation elsewhere. We found that higher concentrations were needed under our conditions of vegetative control because: (1) our experimental objective was a barren, completely non-vegetated watershed, and (2) with mistblower application on very small plants, much herbicide was wasted on slash, litter, and soil surfaces.

Table 3.--Plant susceptibility to the brushkiller, by species.

(10 pounds acid equivalent per acre)

Common name*	Scientific name*
EASY TO KILL TREES	
Black birch	Betula lenta L.
Black cherry	Prunus serotina Ehrh.
Blackgum	Nyssa sylvatica Marsh.
Black locust**	Robinia pseudoacacia L.
Butternut	Juglans cinerea L.
Chestnut	Castanea dentata Marsh.
Dotted hawthorn	Crataegus punctata Jacq.
Eastern hemlock**	Tsuga canadensis (L.) Carr.
Flowering dogwood**	Cornus florida L.
Fraser magnolia	Magnolia fraseri Walt.
Quaking aspen**	Populus tremuloides Michx.
Red maple	Acer rubrum L.
Red oak	Quercus rubra L.
Sassafras**	Sassafras albidum (Nutt.) Nees
Sourwood	Oxydendrum arboreum (L.) DC.
Sugar maple	Acer saccharum Marsh.
White oak	Quercus alba L.
Yellow-poplar	Liriodendron tulipifera L.
HARD TO KILL TREES	
Basswood***	Tilia americana L.
Beech	Fagus grandifolia Ehrh.
Chestnut oak	Quercus prinus L.
Cucumber tree***	Magnolia acuminata L.
Hickory	Carya spp. Nutt.
Hop hornbeam	Ostrya virginia (Mill.) K. Koch
Striped maple	Acer pensylvanicum L.
White ash***	Fraxinus americana L.
Witch hazel***	Hamamelis virginiana L.

*From: Little, Elbert L. Checklist of native and naturalized trees. U.S. Dept. Agr. Handbook 41. 472 pp. 1953.

**Complete leaf kill occurred at lower concentrations of the brushkiller.

***Higher concentrations were needed for complete leaf kill.

Figure 3.--These fireweeds were sprayed in mid-July with 10 lbs. acid equivalent per acre of the brushkiller. Although badly damaged, they were not killed and recovered sufficiently to produce normal seed.

Conclusions

1. Our results suggest that the mixture of TBA, 2,4-D, and 2,4-DP is at least as effective as 2,4-D and 2,4,5-T for controlling revegetation after clearcutting eastern hardwoods.

2. This brushkiller controls revegetation after clearcutting hardwoods at least as cheaply as 2,4-D and 2,4,5-T.

3. Timing of application may be fully as critical as the herbicide concentration. For optimum control, we used two applications of the brushkiller at 10 lbs. acid equivalent in 130 gallons of water per acre. The first application should come as soon as possible after leaves are fully grown, the second in late summer.

Table 4.--Plant susceptibility to the brushkiller, by species.

(10 pounds acid equivalent per acre)

Common name	Scientific name
EASY TO KILL SHRUBS AND HERBACEOUS PLANTS*	
Bedstraw	*Galium asprellum* Michx.
Blackberry**	*Rubus* spp. L.
Blueberry**	*Vaccinium* spp. L.
Chickweed**	*Stellaria* spp. L.
Cinquefoil	*Potentilla simplex* Michx.
Dock**	*Rumex* spp. L.
Elderberry**	*Sambucus canadensis* L.
False miterwort	*Tiarella cordifolia* L.
Ginseng	*Panax quinquefolius* L.
Grape**	*Vitis* spp. L.
Lobelia	*Lobelia inflata* L.
May apple**	*Podophyllum peltatum* L.
Mullein**	*Verbascum thapsus* L.
Nettle**	*Urtica dioica* L.
Painted trillium**	*Trillium undulatum* Willd.
Plantain	*Plantago* spp. L.
Pokeweed**	*Phytolacca americana* L.
Sheep sorrel	*Rumex acetosella* L.
Smartweed	*Polygonum hydropiper* L.
Staghorn sumac	*Rhus typhina* L.
Virginia creeper**	*Parthenocissus quinquefolia* (L.) Planch
Wild ginger	*Asarum canadense* L.
HARD TO KILL SHRUBS AND HERBACEOUS PLANTS*	
Blue-eyed grass	*Sisyrinchium mucronatum* Michx.
Common Solomon's seal***	*Polygonatum biflorum* (Walt.) Ell.
Deer tongue grass***	*Panicum clandestinum* L.
Fern	*Athyrium* spp. Roth
False Solomon's seal***	*Smilacina racemosa* (L.) Desf.
Fireweed***	*Erechtites hieracifolia* (L.) Rab.
Greenbriar***	*Smilax* spp. L.
Lace grass***	*Eragrostis capillaris* (L.) Nees
Live-for-ever	*Sedum glaucophyllum* R. T. Clausen
Loosestrife	*Lysimachia producta* (Gray) Fern.
Oat***	*Avena sativa* L.
Orchard grass***	*Dactylis glomerata* L.

CONTINUED

Table 4.--Continued

Common name	Scientific name
HARD TO KILL SHRUBS AND HERBACEOUS PLANTS*	
Redtop***	*Agrostis alba* L.
Sedges***	*Carex* spp. L.
Snake root	*Cimicifuga racemosa* L.
Twisted stalk***	*Streptopus roseus* Michx.
Violet***	*Viola* spp. L.

*From: Gray's Manual of Botany. 8th Edition. American Book Co., New York. 1632 pp., illus. 1950.

**Complete leaf kill occurred at lower concentrations of the brushkiller.

***Higher concentrations were needed for complete leaf kill.

WEED CONTROL ON THE SHORE OF QUABBIN RESERVOIR[1]

William P. MacConnell[2] and Bruce A. Spencer[3]

The Metropolitan District Commission (MDC) provides water to 31 cities and towns in the vicinity of Boston as well as to eight cities or towns near the reservoirs or near aqueducts leading to the Boston area. Quabbin Reservoir is the major reservoir in a system supplying water to over one-half of the people of Massachusetts. The high quality water produced by the system requires no expensive water purification works and very little chemical additives like chlorine.

Quabbin Reservoir was created in the Swift River Valley during the 1930's by erecting two large earth dams with a combined length of over a mile and containing 6.5 million cubic yards of earth. This great reservoir impounds the runoff from 119,000 acres in the Swift River Watershed and, during periods of heavy runoff, water from 63,000 acres in the Ware River Watershed. The surface area of the reservoir is 25,200 acres, the capacity is 415 billion gallons, and the shore line, including the 110 islands, is 177 miles in length. This reservoir is believed to be one of the largest, if not the largest, in the world constructed exclusively for domestic water supply purposes. The reservoir is 18 miles long, has a maximum depth of 150 feet and an average depth of 51 feet. Daily consumption of water from this reservoir is about 300 million gallons and, since its construction, no water restrictions have ever been placed on users, even though the supply has been over 50 percent depleted for much of the time since the summer of 1966. Water restrictions have not been imposed because in very wet springs like 1961 so much water was produced that a billion gallons a day went over the spillway to be wasted. In the near future water from a power plant using the Connecticut River will be diverted to this reservoir when needed. This water, spending at least two years in storage, will be of high quality when used. Laws require that 20 million gallons a day must be put through the spillway to maintain the flow of the Swift River at all times and 70 million a day must go over the spillway when the Connecticut River is low in time of drouth like the present. Seventy million gallons of the world's best water are added daily to some of the world's worst water in the Connecticut River during this time of drouth.

MANAGEMENT OF THE PROTECTION FOREST AT QUABBIN RESERVOIR

The MDC owns and manages 55,500 acres of land which is served by 28 miles of paved roads and 111 miles of fire access and logging roads. The Commission

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2/Professor of Forestry, University of Massachusetts, Amherst, Mass.

3/Forester, Quabbin Section, Water Division, Metropolitan District Commission, Belchertown, Mass.

owns and operates 74,880 acres of land and water which accounts for two-thirds of the Swift River Watershed.

The construction of this reservoir and aquisition of the land necessary to protect the water supply abolished four towns from corporate existence and took portions of nine adjoining towns. Thirty-six miles of state highway were relocated and 16 miles of Boston and Albany railroad tracks were abolished by this land taking. About 2500 persons living in 650 homes were required to move and many of the smaller homes were also moved. Older residents residing in 34 cemeteries were moved to a new cemetery built and maintained by the MDC to hold the 7,561 bodies previously buried in cemeteries on the land taken for the reservoir. The filling of Quabbin Reservoir began in August 1939 and it was full for the first time in June 1946.

Most of the land on the Swift River Watershed had been cleared for agriculture in the past, but much of it had already reverted to forest before being purchased during the 1930's for reservoir protection. A program of planting the remaining open lands to conifers began in 1935 and continued for ten years. Six thousand acres of the open land were planted with 8,200,000 coniferous trees. Except for the tree planting program and salvage of timber blown down in the 1938 hurricane, nearly all the forest management activities for a 27-year period were custodial in nature such as road maintenance and forest protection from fire and gypsy moth attack.

Experience and research by many foresters on other properties and at watershed research stations have shown that forest management practices on a watershed can increase the production of quality water while the health and productivity of the forest is being improved.

In 1960 a computer system of Continuous Forest Inventory was installed on the 55,500 acres of protection forest around the reservoir and astride the Swift River and brooks tributary to the reservoir. The 1960 inventory showed 124 million board feet of saw timber on the reservoir lands and measurements showed the annual growth to be 4.2 million board feet. In 1962 a forestry program was initiated and forest improvement and harvest began. The 1965 inventory showed the wood volume to have increased to 142 million board feet. Since 1965 annual harvest has been in the vicinity of four million board feet a year; so forest growth and yield are now in balance.

For over 20 years the MDC has conducted a program of roadside beautification along major highways traversing the area and over 25 miles of this work is under current maintenance. Under closely supervised sanitary rules and regulations shore line fishing and fishing from boats is permitted on over one-half of the reservoir. The Commission maintains three boat mooring areas where boats may be rented during the fishing season at reasonable rates. During the 1963 fishing season over 45,000 people enjoyed these facilities. The Commission maintains an observation tower for surveillance of the reservoir and surrounding lands as well as for public enjoyment of the magnificent view. A large parking area and picnicking facilities make this a popular area.

THE DROUTH AND THE WATER LEVEL AT QUABBIN RESERVOIR

Massachusetts has suffered seven continuous years of drouth conditions. By 1964, after two years of drouth, Quabbin Reservoir was 15 feet low, in 1965 it dropped to 20 feet, in 1966 it hit an all time low of 34 feet and during 1967 and 1968 it has been more than 30 feet below the spillway for much of the year. Since 1965 the reservoir has fluctuated between 22 feet and 34 feet below the spillway height. This annual fluctuation has kept that area free of brush creating a buffer zone between the brush fields at higher elevation and the water.

When full at 530 feet above mean sea level, the reservoir contains 415 billion gallons of water and has a surface area of 25,200 acres. When down 10 feet, its volume drops 19 percent and almost 3000 acres of reservoir bottom are exposed. This condition has existed for six growing seasons and some of the woody vegetation on this area is over 30 feet tall. When the water level drops 20 feet, the volume of water in the reservoir drops by 35 percent and a total of 5350 acres have emerged from the water. This condition has existed for four growing seasons. When the water level drops by 30 feet, the water in the reservoir is 50 percent depleted and 8,200 acres of reservoir bottom are exposed. For the last three years this condition has existed except for periods in the spring when there is heavy runoff.

VEGETATION ESTABLISHMENT ON THE EXPOSED RESERVOIR BOTTOM

The effect of the water level fluctuation has been the establishment of vegetation up to six years old on parts of 3000 acres in a band between the 520 and 530-foot contours around the reservoir. Some of this woody vegetation is now over 30 feet tall. A second band of vegetation between the 510 and 520-foot contours is up to four years old and some of this vegetation is 10 feet tall. The area between the 500 and 510-foot contour when the reservoir is between 20 and 30 feet low has little or no vegetation on it because the water covers this area annually during periods of heavy runoff in the spring. On the 5,350 acres of land exposed bare to receive seed from the surrounding forest for the entire year, 2,150 acres of it has grown up to be young forest while the rest is bare or covered with grass and herbaceous vegetation. The grass and herbs are favorable since they prevent soil erosion. This new forest must be controlled or the shore line will have to be cleared by bulldozing before the reservoir can be filled up again.

A large amount of the exposed land is large flat plains, the rest is shore line with gentle to steep slopes and some of the shore line is very rocky. Most of this land is very accessible because the old roads, under water for over 20 years, are still in good condition for use now.

About 1300 acres of land out of the 2900 acres between the 520 and 530-foot contour have developed into a young forest made up of trembling aspen (Populus tremuloides), bigtooth aspen (Populus grandidentata), eastern cottonwood (Populus deltoides), gray birch (Betula populifolia), and willow (Salix spp.). This forest is the most difficult to control because of its size and

the resistance of cottonwood and the aspens to herbicides.

About 850 acres out of the 2450 acres of land between the 510 and 520-foot contours have developed into brushfields of gray birch, most of it about waist high. These areas are easier to control because the vegetation is smaller and gray birch is more susceptible to herbicide treatment than cottonwood and the aspens.

CONTROL MEASURES

In 1967 the Massachusetts Pesticide Board granted the MDC permission to spray 100 acres of this vegetation with 2,4,5-T at one pound acid equivalent per acre. In August 1967 100 acres of gray birch one to three feet tall were successfully treated with 2,4,5-T diluted 1:9 in kerosene and applied by two shoulder mounted mist blowers at the rate of two and one-half gallons of spray material per acre. In 1968 the Pesticide Board approved more extensive spraying. Since the pure 2,4,5-T had gone to war and was not available for civilian use, a mixture of 2,4,5-T and 2,4-D at two pounds acid equivalent of each per gallon was applied at 1:9 in water at the rate of two and one-half gallons of mix per acre during June and the first two weeks of July. During the second two weeks of July and all of August some kerosene was added to the mix to help penetration through the heavier leaf cuticle occurring at this time of year. A mix of herbicide one part combined 2,4,5-T, 2,4-D, two parts kerosene and seven parts of water was employed. In all the spraying two and one-half gallons of mix were applied per acre putting on only one-half pound acid equivalent of 2,4,5-T and one-half pound acid equivalent of 2,4-D, both in ester form.

The area selected for spraying consisted primarily of gray birch, willow and aspen averaging for the most part two to three feet in height with very heavy stocking. This small amount of herbicide applied per acre proved successful against the predominately gray birch stands which were the target of this operation. Throughout the 500 acres treated there were occasional clumps of larger trees up to 15 feet in height on the high ground near the shore line. These older stands, four to six years old, consisting mainly of eastern cottonwood growing vigorously on coarse gravel and stony soils, were not seriously damaged by the spraying. It therefore has become evident that more intensive steps must be taken to control this large vigorous advanced forest at Quabbin Reservoir.

MIST SPRAYING TESTS WITH 2,4,5-T, 2,4-D COMBINATION; PICLORAM, 2,4-D COMBINATION; 2,4,5-T STRAIGHT, AND AMMONIUM SULFAMATE

It seemed wise to test various herbicides during the 1968 season in an effort to determine the most efficient for use during the 1969 season. The first three herbicides were diluted at 1:9 in water since approval for use at the one pound acid equivalent per acre level could be easily attained. Ammonium sulfamate was used because it is cleared for general use on public water supply areas while the others are not.

The stand treated consisted of gray birch and aspen one to three feet tall with 30,000 to 60,000 stems per acre. Four one-acre plots were laid out and marked with plastic flagging. Some eastern cottonwood and aspen clumps six to 20 feet in height nearby were sprayed with each material.

Conditions during the treatment applied on June 7, 1968 were ideal. It was a very still day, the temperature was 90 to 100° F and went this high during the day for two days after the treatment.

The method of treatment was uniform for the four materials tested. The ester form of 2,4,5-T was diluted with nine parts of water and two and one-half gallons of mixture containing one pound acid equivalent per acre were applied by shoulder mounted mist blower. The ester form of 2,4,5-T, 2,4-D combination was also diluted with nine parts of water and two and one-half gallons of the mixture containing one-half pound acid equivalent of each for a total of one pound per acre were applied the same way. The picloram, 2,4-D combination[1] was diluted with nine parts of water and two and one-half gallons of mixture containing one-quarter pound of picloram and one-half pound acid equivalent of 2,4-D were applied per acre. Ten pounds of ammonium sulfamate were diluted in enough water to make two and one-half gallons of herbicide and this was applied to the acre sample plot. It was known that 70 pounds or more of ammonium sulfamate are usually necessary to get good control of hardwoods, but we wanted to put out an equal volume of spray in each test. At this level of spraying it would take seven mist blower loads of two and one-half gallons each to achieve the 70 pound per acre level of application. Under these conditions, hydraulic spraying would be preferable. Ammonium sulfamate is, however, cleared for general use on public watersheds while the other materials are not and require special permission by the Pesticide Board for this use in Massachusetts. It would require over 71 tons of ammonium sulfamate to control the present vegetation while less than two tons acid equivalent of the other materials would do the job.

The effects of treatment applied on June 7, 1968 were observed on August 20 of the same year. Results were determined by the method suggested by Roe[2] (Table 1). Ninety-two .001-acre plots (radius 3.72 feet) were mechanically located by compass and pacing to evaluate the effect of the treatment on the individual stems in the stand. Over 98 percent of the treated stems were gray birch; the rest were aspen. Fifty percent or less of the aspen treated were dead while 80 percent to 90 percent of the treated birch were dead. There was not enough aspen and cottonwood in the treated area to truly evaluate the effectiveness of the various chemicals used, but it is safe to say that these species are more resistant than gray birch to all of the herbicides used.

All the eastern cottonwood and aspen clumps six to 20 feet in height that

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[1] Trade name Tordon 101.

[2] Roe, Eugene I. 1957. Measuring results of aerial spraying with herbicides for forestry purposes. U. S. Forest Service, Lake States Forest Expt. Sta. Tech. Note 492. 1 p.

Table 1. Response of Gray Birch to Back Pack Mist Blower Applications of Four Herbicides Applied at 2.5 Gallons Per Acre.

Herbicide	Dead[2]		Severe[3]		Light[4]		None[5]		Total	
	S/A[1]	%	S/A	%	S/A	%	S/A	%	S/A	%
2,4,5-T[6]	52,750	83	1,833	3	4,500	7	4,291	7	63,374	100
2,4,5-T, 2,4-D[7]	36,667	89	1,750	4	1,291	3	1,625	4	41,333	100
Picloram, 2,4-D[8]	28,107	90	321	1	1,179	4	1,679	5	31,286	100
Ammonium sulfamate[9]	62	0	7,062	14	16,062	33	26,437	53	49,623	100

[1]S/A - Stems per acre
[2]Dead - 100 percent defoliated
[3]Severe - 51 to 99 percent defoliated
[4]Light - 20 to 50 percent defoliated
[5]None - less than 20 percent defoliated
[6]One pound acid equivalent applied in water per acre
[7]One-half pound acid equivalent of each applied in water per acre
[8]One-quarter pound acid equivalent picloram, one-half pound 2,4-D applied in water per acre
[9]Ten pounds ammonium sulfamate applied in water per acre

were sprayed in addition to the four one-acre plots were less than 50 percent defoliated. It is obvious that the amount of herbicide used is ineffective against large cottonwoods and aspens and not very effective on the smaller ones.

All the herbicides except ammonium sulfamate were effective (Table 1) at the concentrations used on the small gray birch. The picloram, 2,4-D combination and the 2,4,5-T, 2,4-D combination were about equal in their effectiveness. The 2,4,5-T was somewhat less effective. The ammonium sulfamate, as expected, was ineffective at the ten pounds per acre level of application. Sprouting occurred only on the plot treated with ammonium sulfamate. If 70 pounds or more of this material is necessary for a good kill it is probably not sensible to apply it with shoulder mounted mist blowers since seven loads per acre would be required to get good brush control.

SUMMARY AND CONCLUSIONS

The picloram, 2,4-D combination, 2,4,5-T, 2,4-D combination and 2,4,5-T all proved effective against small gray birch at very low concentrations in water in a June 7 shoulder mounted mist blower test. Ammonium sulfamate at ten pounds per acre in water proved ineffective against the same stand. In a 100-acre test 2,4,5-T in kerosene at the one pound acid equivalent per acre level proved very effective in 1967. In a 500-acre operation 2,4,5-T, 2,4-D combination at one-half pound of each per acre gave good control in small gray

birch stands when diluted in water early in the season. Good control was achieved when these materials were diluted in oil and water later in the season. All these spray materials at the concentrations used proved ineffective on eastern cottonwood and aspen species six to 30 feet tall.

Spraying at the levels described here by mist blower can probably continue to be effective against the young gray birch or aspen stands. The older cottonwood and aspen stands will probably need two to four times as heavy an application to be effective. Ground or aerial application could both be effective and there is a good buffer zone with no vegetation on it to be sprayed between the brushfields and the reservoir.

The only alternatives to mist or aerial spraying appear to be hydraulic spraying with ammonium sulfamate or mechanically clearing the 5000 acres of shore line by cutting or bulldozing before the reservoir is filled again. The MDC and Massachusetts Pesticide Board must select among these alternatives during the period of low water levels. The cycle of treatment on the same areas can hardly be less than four years and the period will shorten as conditions for tree reproduction improve while the reservoir bottom is exposed. The Pesticide Board and the MDC are now involved in deciding the best course of action for next year. Annual or semi-annual spraying by helicopter, mist blower, or hydraulic rig will probably be required until the reservoir is filled again.

RESPONSE OF BRUSH TO SEVERAL FORMS OF 2,4-D

John P. Sterrett[1/]

Mixtures of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) or 2,4-D and 4-amino-3,5,6-trichloropicolinic acid (picloram) are some of the more effective herbicides used on woody brush. Since much of the 2,4,5-T and picloram is being used in Vietnam, it has been necessary to look for substitutes. The effects of high rates of 2,4-D on brush were investigated in this study.

Until about 1948, 2,4-D was the major herbicide used on brush, but at low rates, ranging from 2 to 4 lb acid equivalent per hundred gal (aehg) of water (1,3). When 2,4,5-T appeared in 1948 it was found to be more effective on the more resistant woody plants, i.e., oaks, ash, and hickory, than 2,4-D (2). Mixtures of 2,4-D and 2,4,5-T soon became the standard for woody plant control. The effect of higher rates of the ester form of 2,4-D on brush was studied recently when Upchurch and Keaton[2/] reported that a low volatile ester of 2,4-D was only about 5% less effective than a low volatile ester of 2,4,5-T on mixed brush at 8 lb aehg of water.

The objective of this experiment was to determine the effectiveness of higher concentrations and relative costs of three forms of 2,4-D on brush as compared with commercial brush control formulations which contain 2,4,5-T or picloram.

Methods and Materials

The herbicides were applied with a 7 gal per minute pump at a pressure of 400 psi. A John Bean adjustable Spraymiser gun was used to spray the stems and foliage. Three replicates of 25 gal plots were used for each treatment. Total volume per acre was about 500 gal depending on the density and height of the brush. Dimethylamine salt of 2,4-D, butoxyethanol ester of 2,4-D and 2,4-D acid were compared with standard rates of dimethylamine salt of 2,4-D + triethylamine salt of 2,4,5-T, butoxyethanol esters of 2,4-D + 2,4,5-T, and picloram + triisopropanolamine salt of 2,4-D.

Results and Discussion

The results are shown in Table 1. With each formulation of 2,4-D alone, 9 lb acid aehg of water was more effective in killing the tops and controlling the sprouting of the brush than the 6 lb rate. The 9 lb aehg concentration of butoxyethanol ester of 2,4-D gave the best top kill of any 2,4-D formulation, and 9 lb aehg of 2,4-D acid controlled sprouting about the same as the 6 lb aehg of 2,4-D + 2,4,5-T combinations. Sassafras sprouting was stopped completely with the picloram + 2,4-D mixture.

1/ Assistant Professor of Plant Physiology, Virginia Polytechnic Institute, Blacksburg, Virginia.

2/ Upchurch, R. P. and J. A. Keaton. 1965. Woody plant research. A summary of herbicide effects - measured across species. N.C. State of the University of N.C., Raleigh, N.C.

Based on the results of this study 9.0 lb of 2,4-D acid aehg of water was slightly more effective than 6.0 lb of butoxyethanol esters of 2,4-D + 2,4,5-T and nearly as potent as the amine salts of 2,4-D + 2,4,5-T, or picloram + 2,4-D combinations. On the basis of relative costs, 9 lb aehg of butoxyethanol ester of 2,4-D is comparable to the currently used rates of butoxyethanol esters of 2,4-D + 2,4,5-T, dimethylamine salt of 2,4-D + triethylamine salt of 2,4,5-T, and picloram + triisopropanolamine salt of 2,4-D.

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Table 1. Response of brush to various rates and forms of 2,4-D and combinations of 2,4-D + 2,4,5-T or 2,4-D + picloram aehg water, treated in June 1967 and evaluated in August 1968.

	6.0 lb 2,4-D, dimethylamine salt			9.0 lb 2,4-D, dimethylamine salt			6.0 lb 2,4-D, butoxyethanol ester			9.0 lb 2,4-D, butoxyethanol ester			6.0 lb 2,4-D, acid		
Species	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.
Sassafras	10	0	3	10	0	3	10	0	3	10	0	3	10	0	3
Black locust	8	5	2	10	1	2	7	0	3	9	3	3	9	0	3
Sumac							10	0	1						
Red oak	7	3	2	9	3	3	10	2	3	10	8	3	9	9	2
White oak	5	5	1	10	10	1	5	0	2	8	7	2	6	0	2
Chestnut oak	5	0	3	6	2	3	5	0	2	8	2	2	6	4	3
Red maple	1	0	3	3	0	3	5	0	1	8	0	2			
Hickory				10	10	2	5	8	2	10	10	2	10	10	2
Pine	10	10	1				10	10	1	10	10	1			
Sourwood	10	10	1	10	10	2	10	10	2						
Black gum	10	7	2	10	6	3	10	1	3	10	2	3	10	0	3
Dogwood				10	10	3	10	10	2	10	9	3	10	10	1
Chestnut				10	0	1	10	10	2	10	5	2	10	5	2
Aspen	10	10	1										10	10	1
Black cherry	10	10	1										10	10	1
All species 1/	7.2	3.8		8.6	4.4		8.4	3.5		9.4	4.8		8.9	3.9	

1/ Weighted average based on number of replications.

Rating

Top kill	Sprout control
0 - no dead leaves	0 - same or more sprouts than original stems
10 - all dead leaves	10 - no sprouts

Table 1. Continued.

	9.0 lb 2,4-D, acid			3.0 lb 2,4-D, dimethylamine salt + 3.0 lb 2,4,5-T, triethylamine salt			3.0 lb 2,4-D + 3.0 lb 2,4,5-T, butoxyethanol esters			0.54 lb picloram + 2.0 lb 2,4-D, triisopropanolamine salt		
Species	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.	Top kill	Sprout control	Reps. No.
Sassafras	10	4	3	10	8	3	10	3	3	10	10	3
Black locust	10	6	3	9	7	2	10	0	2			
Sumac							10	0	1			
Red oak	10	8	2	9	7	3	9	6	2	8	5	3
White oak	8	5	2	10	6	2	8	5	1	8	7	3
Chestnut oak	8	5	2	10	10	1	5	3	3	8	6	3
Red maple	4	0	2							10	10	1
Hickory	10	9	2	5	0	1	10	4	2	9	10	2
Pine	10	10	1	10	10	1						
Sourwood	10	10	2	10	10	3	10	9	1			
Black gum	10	1	3	10	7	3	10	4	3	10	8	2
Dogwood	10	10	2	10	10	2	10	10	3	10	10	3
Chestnut	10	10	1	10	10	1	8	4	2			
Aspen	10	10	1	10	10	1						
Black cherry										10	10	1
All species[1/]	9.2	6.0		9.6	7.9		9.0	4.4		9.0	8.1	

THE MICROFOIL™

AN AERIAL DEVICE FOR CONTROLLING DRIFT FROM CONVENTIONAL SPRAYS

J. H. Kirch 1/, J. E. Waldrum 2/, & P. W. Bishop 3/

The need for accurate placement of pesticides from aerial application is apparent to everyone. Drift must be controlled to prevent damage to desirable vegetation and to avoid residues on crops for which tolerances have not been established.

The major problem in controlling drift has been the lack of uniformity in droplet size and the presence of very fine (aerosol) droplets in the spray pattern.

The introduction of invert emulsions, thickening agents, and particulating agents has done much to alleviate this problem, but the approach has necessitated going to higher volumes per acre due to the larger more variable size droplets employed. Most aerial applicators and the people who employ them would prefer to use volumes of 5 to 10 gallons per acre in controlling brush and weed vegetation. Even lower volumes are desired for insecticide work. Invert emulsions, thickening agents, and particulating agents require double this 5 to 10 gallon volume or more for the same coverage.

The Microfoil Boom was designed to produce a nearly uniform droplet, with a minimum of sattelites (fines), using conventional carriers such as water, oil, or oil and water emulsions. Thickening agents, invert emulsions, or particulating agents are not necessary with this equipment.

The unit itself is an aerial boom for mounting on helicopters. It is not presently adapted for fixed wing aircraft. The length of the Microfoil Boom can be varied from 10 feet to 26 feet. This is accomplished by bolting three or five foot sections of the boom together to provide the length desired between 10 and 26 feet. Varying the boom length varies swath width. Swaths may be varied from 10 to 70 feet by adjusting boom length, pump pressure, and flying height. Boom length must be adjusted on the ground. With the present design, only slight variations in swath width are possible in flight.

In the center of the Microfoil is an actuator unit that levels the boom 180° into the airstream. The pilot controls this procedure by a switch on the control stick of the helicopter. He may tip the trailing edge of the boom up or down to insure that the streams of chemical are ejected into the air from the nozzles in a straight line.

To even the pressure and flow to each nozzle, a double tubing has been used. Material flows evenly through both tubes in a circular pattern from the center. The second tube also provides additional support for the boom.

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The nozzle of the Microfoil is shaped like an airfoil, and the boom with nozzles is much like the wing of an airplane. This design is to provide a minimum of air turbulence directly behind the nozzle, at the point where droplets are formed. The ability to control air turbulence in this area is one of the major factors in producing uniform droplets without sattelites. Sattelites are the small droplets that break off when the parent droplet forms from a stream or sheet of liquid. They are usually about one-tenth the size of the parent droplet.

Each Microfoil nozzle is six inches long and contains 60 needle-like orifices protruding from the trailing edge. The reason the needles protrude is to allow air between them to clean the nozzles after shut-off. There are two nozzles per foot of boom or 52 nozzles on the maximum 26 foot boom. This gives a total of 3,120 orifices along the 26 foot boom. At the present time there are two orifice sizes measuring .013" I.D. and .028" I.D. These produce droplets with a mass mean diameter of 800 and 1700 microns respectively. Variation from this mean is approximately 200 microns in either direction.

When the Microfoil is properly trimmed in flight, the pattern produced is much like a white sheet. The swath is still three dimensional, having length, breadth and depth, but the depth has been much reduced due to the fact that droplets are all nearly the same size. This sheet-like swath is a unique feature of the Microfoil. Patterns from conventional equipment have considerable depth due to the many sized droplets present.

The manner in which droplets are formed and introduced into the air stream is the key to controlling sattelite droplets. By keeping the pressure on each needle-like orifice to 2 p.s.i. or less, the number of sattelite droplets produced is minimized. It is also essential to keep these streams very small, hence the many needle-like orifices. Further, it appears at this time that forward movement of the Microfoil Boom and nozzles are also an important factor in the control of sattelites.

When the Microfoil nozzles are spraying in a fixed position, considerably more sattelites appear in the pattern than when the nozzle is moving forward at a speed of 30 mph or more. Why this reduction in sattelites occurs is not definitely known. It has been theorized that some recapture of sattelites by the parent droplet could occur, providing perfect laminar flow of the spray streams is maintained in flight. If this is true, it is another reason to keep the boom properly trimmed 180° into the air flow.

Since all droplets from a Microfoil Boom are nearly the same size, it is possible to use lesser volumes per acre and still obtain better coverage than is possible with the variable sized droplets present in thickened, inverted or particulated sprays. For example, using the .028" I.D. nozzles a droplet of approximately 1700 microns is produced. At twelve gallons volume per acre the coverage from this volume is twice that of twelve gallons of an inverted emulsion carrier. To produce nearly this same coverage with an inverted emulsion required 24 gallons volume per acre. Because the Microfoil can produce a nearly uniform droplet, it should now be possible to determine the droplet size and volume per acre required to produce a certain kill on any vegetative

or insect species. Perhaps of more importance, it should also be possible to predict the drift that will occur per foot of fall in winds of different velocity.

One of the most noticeable features of the Microfoil is the absence of fine droplets of spray in the air following a helicopter pass. The entire pattern from the Microfoil strikes the ground before the rotor effect. This occurs regardless of flying height.

To compare the amount of material left in the air with the Microfoil versus a conventional boom, a 100 foot tower was built. Cards were run up this tower at 10 foot intervals and were placed on the ground at 20 foot intervals from the base of the tower for a distance of 200 feet. An ultraviolet sensitive dye was used in the spray solution. Two helicopters were used, one equipped with the Microfoil and .013" nozzles; the second with a conventional boom using tee-jet, vee-jet nozzles. Passes were made with both helicopters at a height of 50 feet.

Using a water emulsion as a carrier in a 10 mph wind, all of the material from the Microfoil pass was deposited on the cards on the ground. At this wind velocity, droplets could be found on all cards in the 200 foot area from the point of spray release to the tower. No material could be found on any of the tower stations when observed under ultraviolet illumination.

After the pass by the helicopter equipped with a conventional boom, droplets were found on all stations on the ground and on the tower. This meant that at a distance of 200 feet from the point of application there were still droplets 100 feet in the air from the conventional boom.

Additional drift studies are planned using potted plants on this tower to determine the biological effect of drift from conventional versus Microfoil Boom sprays.

The potential usefulness of a device such as the Microfoil are many and varied. A number of tests have been applied to investigate its potential in the herbicide and insecticide areas. Many of these are still to be evaluated, and more need to be run.

The potential in the field of brush control is considerable. On utility, pipeline, railroad, and highway rights-of-way the advantage of being able to control drift, to use conventional carriers, and to hold volumes down to 12 gallons per acre or less are obvious.

The increasing need for drift control in conifer release work by timber companies and state and federal forest agencies led to considerable test work in this area. Results look good at this time using the standard 2 quarts of 2,4,5-T, 2 quarts of oil, and 4 gallons of water per acre.

One of the most interesting potentials investigated in the herbicide field was the control of cattails in drainage ditches in Citrus Groves in Florida. By shortening the Microfoil to 10 feet of boom and flying 15 feet off the ground, it was possible to lay a 12 foot swath of spray directly on the cattails with no deposit outside the ditch. Control of the cattails was excellent.

Drainage canals throughout the Mississippi, Missouri, and Ohio River Water sheds offer an excellent market for Microfoil application. It costs as much as $500.00 dollars per mile to dragline some of these ditches now. Herbicide applied through the Microfoil will reduce this cost considerably.

Tests and large scale commercial spraying of water hyacinth were conducted in 1968. Results of this work have stimulated some government agencies to specify the use of the Microfoil in their hyacinth spray contracts for 1969.

A number of demonstrations were conducted on rangeland brush problems in 1968. Mesquite, salt cedar, mixed oak, and sagebrush were treated. Here it is apparent that droplet size and volume per acre are critical factors in final kill. If volumes applied are not high enough, there will be insufficient coverage of the brush to get good kill. If the droplet is made too small, drift control will be lost. More work needs to be done on the relationship of droplet size and volume per acre to kill of rangeland brush.

Tests were applied with various insecticides in 1968. The biggest problem here appears to be one of formulation. Wettable powders cannot be applied through the Microfoil, and most insecticides are wettables. Those liquids that were applied gave good control of the insects, particularly alfalfa weevil.

Tests that were planned on rice and other crops were not completed in 1968. These will be accomplished in 1969. Use of the Microfoil to apply propanil to rice in California and 2,4-D/2,4,5-T to rice in Arkansas and Texas will be tried in 1969.

The Microfoil is a sophisticated piece of equipment. Particular care must be used to keep it clean. A filter system has been designed for both mix truck and helicopter capable of removing any particle over 75 microns in size.

Wherever possible, clean water should be obtained and care taken to prevent dirt falling into it during loading operations. A special aircraft pump was developed to provide the volumes and pressures required to operate the Microfoil properly.

Amchem plans to manufacture and lease several Microfoil units to qualified helicopter operators in 1969. The complete unit will consist of the Microfoil Boom, the filter system and the aircraft pump. Most of the commercial work done with these units is expected to be on brush and aquatic weed problems. Investigations will be continued in other areas where controlling pesticide drift is a must. Suggestions on uses for this unit are welcomed at all times.

FOREST TRANSPIRATION REDUCTION BY CLEARCUTTING AND CHEMICAL TREATMENT

Robert S. Pierce[1/]

ABSTRACT

A 39-acre forested watershed in the White Mountains of New Hampshire was treated to eliminate transpiration. All woody vegetation and timber were cut but not removed. The herbicide bromacil was then broadcast sprayed and 2,4,5-T mist blown on stump sprouts. Streamflow from the treated watershed increased up to five times the amount from an adjacent untreated watershed during normally low-flow periods in late summer.

Large quantities of water are lost to the atmosphere through evapotranspiration (evaporation from soil and transpiration from leaf surfaces). Knowing this, we may ask: can streamflow and ground water supplies be increased by eliminating or reducing evapotranspiration? There is evidence that, for sites fully covered by vegetation, the amount of water removed by transpiration is far greater than the amount lost through evaporation from the soil surface. If this is so, can we increase water yield if transpiration can be eliminated? And, supposing that a site has no vegetation, will the water lost through evaporation from the soil surface equal transpiration in the former case?

Precipitation averages about 40 inches a year in the Northeastern States. About half of this is transferred to the atmosphere as evapotranspiration. The rest contributes to streamflow, deep seepage in bedrock, ground water storage, and soil water.

Because forests occupy 62 percent of the area in the Northeast and about 80 percent in New England, the role forests play in removing about 20 inches of water per year from the land surface has considerable importance. This paper concerns a study to determine the magnitude of water that could be gained in streamflow by eliminating transpiration in a forested watershed in the White Mountains of New Hampshire.

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Experimental Watersheds

Streamflow and precipitation were measured on two contiguous south-facing watersheds (39 and 105 acres) for 8 years at the Hubbard Brook Experimental Forest near West Thornton, New Hampshire. This period was sufficient to develop equations for predicting streamflow on one watershed based on flow from the other.

The watersheds had an unbroken cover of uneven-aged northern hardwoods--beech, yellow birch, and sugar maple. Well drained sandy-loam podzol soils developed from glacial till are predominant throughout the area. A 6-inch layer of raw humus protects the soil from erosion and freezing. Beneath the soil, an essentially unweathered, fissure-free, watertight bedrock of gneiss and schist prevents deep seepage. Thus, all precipitation entering the watershed must leave either as streamflow or evapotranspiration. The average annual precipitation is 48 inches, and this is about equally distributed each month. Streamflow amounts to about 28 inches. Because the tight bedrock permits negligible deep seepage, we can calculate evapotranspiration for the year by subtracting streamflow from precipitation. Differences in soil moisture storage at the start of successive water years (June 1) are assumed to be negligible since the soil is fully recharged with water during the snowmelt period. Streamflow, however, is seasonal. Less than 0.2 percent of the yearly flow occurs in August, whereas about 37 percent of the total flow is discharged in April.

Treatment

In the late fall and early winter of 1965, one of the forested watersheds (39 acres in area) was clearcut of all timber and woody vegetation. The objectives were to eliminate as far as possible all transpiring plants from an entire watershed and to maintain this vegetation-free condition for several years. Several difficult restrictions complicated the treatment and precluded the use of common techniques in removing vegetation. These were the treatment steps:

1. All woody vegetation was felled and left in place; no forest products were removed.
2. Branches and stems were lopped back to a maximum height of 3 feet, and felled branches and logs were removed from the stream channels.
3. Clearcutting was done entirely in the dormant season on snow-covered ground.
4. No roads or trails were constructed, and no wheeled or track vehicles were permitted in the area.

5. After clearcutting, in June, the herbicide bromacil[2/] was broadcast sprayed via helicopter at a rate of 25 lbs. per acre in a mixture of 1 lb. of 80 percent bromacil per 1 gallon of water.

6. A mixture of 4 gal. of 2,4,5-T per 100 gal. of water was sprayed on persistent sprouts the second summer. Spraying was done by personnel carrying backpack pumps.

Logging was not permitted because: (1) an undisturbed forest floor was desired; (2) the quality of the timber was poor, and removal of saw logs or pulpwood was not feasible economically; (3) no roads or trails were present; and (4) the removal of quantities of nutrients (particularly N, P, K, Ca, Mg, Na, Cl, and S) in the logs would upset an important companion study--the measurement of the inflow and outflow of elements in the ecosystem.

Bromacil, a substituted uracil (5-bromo-3-sec-butyl-6 methyluracil) was chosen because it, along with the water carrier, contained the least amount of nutrients likely to cause contamination in the watershed with respect to point (4) above. The mechanism responsible for bromacil's toxicity in plants appears to be associated with an inhibition of photosynthesis.[3/] The normal pathway for bromacil to reach the action site in the leaf is by uptake from the soil and transport through the roots and stem.

The costs of the clearcutting and the first herbicide treatment were:

Clearcutting	$170 per acre
Bromacil	112 per acre
Helicopter	28 per acre
	$310 per acre

Although the treatment costs were exceptionally high, the treatment should be viewed as a tool used to create demanding research conditions. For practical purposes, the cost of such a treatment would normally be prohibitive.

Several reasons seemed to dictate an abnormally high application of bromacil: (1) little knowledge was available on the necessary dosage to kill the stumps of mature hardwood

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[2/] Mention of product names does not imply endorsement by the U. S. Department of Agriculture or the Forest Service.

[3/] Hilton, J. L., T. J. Monaco, D. E. Moreland, and W. A. Genter. Mode of action of substituted uracil herbicides. Weeds 12: 129-131. 1964.

trees as well as the herbaceous ground cover; (2) absorption and possible tie-up of bromacil could occur in the thick raw-humus layer on the forest floor; and (3) interception and adsorption by heavy slash on the ground could reduce the effective amount of bromacil that reached the plant roots.

Results

Within 2 weeks after bromacil was applied, ground cover declined considerably; and about 1 month after spraying, virtually all ground cover was dead. The few sprouts that developed from the stumps of hardwood trees did not show outward signs of stress until late summer. At that time, two readily discernible symptoms appeared: most leaves turned red and yellow, much like normal fall coloration, but many had a dark green metallic appearance with curled brown margins.

We made no further treatment of these sprouts that summer because we felt they were too few to influence overall transpiration in the watershed and we wanted to continue our observations on the effect of bromacil on the sprouts.

In spite of the distinct influence bromacil exerted on some sprouts the next spring, it was obvious that the herbicide would not adequately eliminate transpiration by killing or diminishing the profuse sprout growth from stumps. Yellow birch stump sprouts were almost completely killed, but white ash sprouts were relatively unaffected by the bromacil. Some of the latter were in clumps 8 feet tall and 8 feet in diameter by midsummer. Consequently, sufficient 2,4,5-T was mist blown on the persistent sprouts to wet the leaf surfaces. A good kill resulted from this treatment.

We readily recognized that other chemicals would have killed the plants more quickly and no doubt more cheaply than bromacil, but the choices were severely limited because contamination might have confounded the experiment. Water rather than oil was used as the 2,4,5-T carrier because we wanted to minimize contamination. In addition, it would have been more difficult to hand-carry large quantities of oil over slash-covered, steep, rough terrain than to haul water from nearby brooks.

The content of bromacil and 2,4,5-T in the stream water draining the watershed was determined by analyzing water samples collected weekly (but analyzed monthly).4/ For the first 2

4/ Appreciation is expressed to the Industrial and Biochemicals Department of the E. I. duPont de Nemours & Co., Wilmington, Delaware, for the bromacil analysis; and to the Department of Biological Sciences, Dartmouth College, Hanover, New Hampshire, for supplying 2,4,5-T for the treatment, and for its subsequent analysis.

weeks after application, the concentration of bromacil was about 1 ppm (fig. 1). Shortly thereafter, the concentration dropped to about 0.3 ppm (with two exceptions); this was followed by a long gradual decline. A high concentration of bromacil in August 1967 was coincident with abnormally high streamflow. After almost 1 1/2 years, the concentration remained at about 0.25 ppm. The relatively high sustained concentration of bromacil in runoff led to an interesting observation: Based on calculations of bromacil concentration and the quantity of water discharged, about 200 pounds of bromacil left the watershed through the stream in 1 1/2 years. This was 20 percent of the total application!

The concentration of 2,4,5-T in the stream water was found to be less than 1 part per billion for the entire period following application.

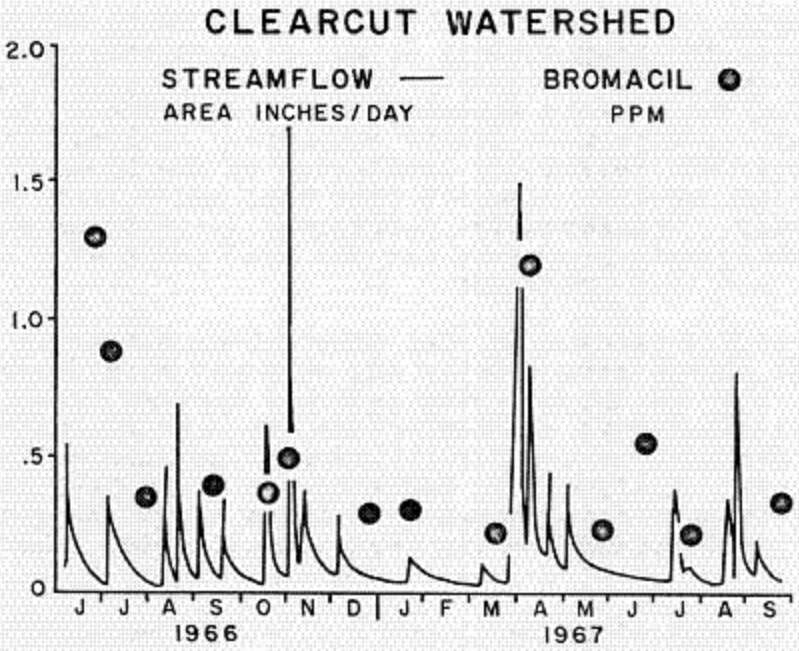

Figure 1.--Water yield and bromacil release from Watershed 2, Hubbard Brook Experimental Forest, West Thornton, N. H.

Treatment Influence on Streamflow

Water yields during the growing seasons of 1966 and 1967 were increased at least twofold above the untreated watersheds. Quantitative water gains were 320,000 and 226,000 gallons per acre, respectively, for the 2 years (table 1). The greatest increase occurred during July, August, and September. Up to five times the normally expected amount of water yield was realized in this period. Although complete elimination of vegetation was not obtained, these streamflow increases must represent nearly the maximum that could be obtained by removing transpiring leaves.

This experiment confirms other data[5/] indicating that low-flow augmentation is possible by manipulating vegetation. Provided other environmental factors are favorable, if transpiration can be eliminated, reduced, or retarded, substantial increases in streamflow from forested watersheds can be achieved.

Table 1.--Streamflow increases from treatment on a 39-acre forested watershed

Period	Water yield increase		
	Area-inches	Gallons per acre	Percent increase
May-Oct.			
1966	11.8	320,000	246
1967	8.3	226,000	200
July-Sept.			
1966	10.3	280,000	535
1967	7.9	213,000	432

[5/] Hewlett, John D., and Alden R. Hibbert. Increases in water yield after several different types of forest cutting. Int. Assoc. Sci. Hydrol. 6: 5-17. 1961.

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THE EFFECTS OF FERTILIZATION ON THE MINERAL COMPOSITION OF POND WATER

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The purpose of this paper is to report the changes in mineral composition of pool water containing bottom sediment and one-year old rooted stands of Anacharis, Myriophyllum, and Potamogeton following fertilization.

Materials and Methods

Preliminary pond fertilization studies were conducted during 1967. Concentrations of NH_4-nitrogen, NO_3-nitrogen, orthophosphate and potassium for that investigation are presented in Table 1. Further information concerning the materials and methods, and results of this study appear in Proceedings of the Northeast Weed Control Conference, Vol. 22, 1968. The remainder of the present report will deal only with results obtained in 1968.

Twelve plastic pools 3 feet deep and 12 feet in diameter were erected in the spring of 1967 on the Rutgers University - Soils and Crops Research Center, Adelphia, New Jersey. Each pool contained soil, water, and the following plant species: Anacharis canadensis, Myriophyllum heterophyllum, Myriophyllum spicatum, and Potamogeton pulcher. At the conclusion of the 1967 study, the pools were left intact and allowed to stand over winter. Upon the resumption of plant growth in the spring of 1968, Anacharis quickly established itself as the dominent plant specie. Fertilization was resumed on June 11. Each pool received the same fertilizer treatment as it did the previous summer. Four pools received 1-heavy application (600 lb/A) of an 8-8-2 granular fertilizer; four pools received 6-light applications (100 lb/A) at 1-week intervals; and four pools received no fertilizer. The 8-8-2 fertilizer was composed of ammonium nitrate (20% soluble nitrogen), ammonium phosphate (61.7% soluble phosphate), and potash (60% soluble potassium). Applications at the above rates were made by hand on the respective pool water surfaces.

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Water samples were taken in plastic bottles at a depth of 5 to 6 inches below the water surface. Samples were taken immediately before the first fertilizer application. After the initial treatment, samples were taken at 24 hours, 3 days, 7 days, and at weekly intervals thereafter. Each water sample was analyzed for ammonia, nitrate, orthophosphate, and potassium. Ammonia was determined by nesslerization, nitrate by the phenoldisulfonic acid method, orthophosphate by the reduced phosphomolybdate method, and potassium by means of Perkin-Elmer Model 303 atomic absorption spectrophotometer.

Results and Discussion

Concentrations of ammonia, nitrate, orthophosphate, and potassium of pool water are presented in Table 2 and are graphically represented in figures 1, 2, 3, and 4 respectively.

Ammonia - Ammonia was present in undetectable amounts in all pools prior to fertilization and remained undectable in the control pools throughout the study. Pool water treated with 1-600 lb/A fertilizer application increased rapidly in $[NH_4^+]$ reaching an average maximum of 18.0 ppm after 72 hours. Ammonia decreased rapidly for 3 weeks and then less rapidly reaching 0.4 ppm 9 weeks after fertilization. Pools receiving 6-100 lb/A applications of fertilizer reached an average maximum of 7.7 ppm NH_4^+ 1 week after the last application. Ammonia then decreased to 2.1 ppm 3 weeks later at the termination of the study. The loss of NH_4^+ from the water medium is probably due to utilization by the pool flora and oxidation to NO_3^- under the existing aerobic conditions.

Nitrate - Nitrate nitrogen averaged 0.10 ppm in all pools prior to fertilization and remained low in the control pools throughout the study. Pool water receiving 1-600 lb/A application of fertilizer increased sharply in $[NO_3^-]$ and reached an average maximum of 4.42 ppm between 3 and 7 days after fertilization. Beyond 7 days $[NO_3^-]$ decreased and was 0.40 ppm after 9 weeks. Pools treated with 6-100 lb/A fertilizer applications increased gradually with each addition and reached an average maximum concentration of 3.51 ppm at the time of the last application. At the termination of the study, $[NO_3^-]$ had decreased to 1.33 ppm.

Orthophosphate - Before fertilization, orthophosphate concentrations averaged 0.01 ppm in the control pools, 0.04 ppm in pools treated with 1-600 lb/A fertilization, and 0.15 ppm in

pools treated with 6-100 lb/A fertilizer applications.

Pools receiving 1-600 lb/A fertilization increased rapidly in orthophosphate and reached an average maximum of 5.28 ppm between 24 and 72 hours. At the termination of the study 9 weeks later, orthophosphate had decreased to 0.37 ppm. Pools receiving 6-100 lb/A fertilizer applications increased gradually in orthophosphate with each application. An average maximum of 3.07 ppm orthophosphate was reached 1 week after the last 100 lb/A applications. By the end of the study, the average orthophosphate concentration had decreased to 1.07 ppm.

Potassium - Before fertilization, potassium concentrations averaged 0.8 ppm in control pool water; 1.4 ppm in pool water treated with 1-600 lb/A fertilization; and 2.2 ppm in pool water treated with 6-100 lb/A fertilizer applications.

Control pools decreased in $[K^+]$ during the summer to 0.3 ppm at the end of the study. Pool water treated with 1-600 lb/A fertilization reached an average $[K^+]$ of 5.3 ppm after 7 days and remained at this level for several weeks. By the end of the study $[K^+]$ had decreased slightly to 3.2 ppm. Pools receiving 6-100 lb/A fertilizer applications reached an average maximum of 4.8 ppm K^+ 1 week after the last 100 lb/A application and at the end of the study had decreased to 3.8 ppm.

Conclusions - The 4 nutrients studied always reached higher average maximum concentrations in the pool water receiving 1-600 lb/A application of fertilizer. These maximum concentrations were reached between 3 and 7 days after fertilization.

The pool waters receiving 6-100 lb/A fertilizer applications reached average maximum concentrations of ammonia, orthophosphate, and potassium within 1 week after the last 100 lb/A application. Nitrate, for an unknown reason, peaked in concentration just prior to the last application.

On the last sampling date (August 13), the 4 nutrients studied had higher average concentrations in the pool waters receiving 6-100 lb/A fertilizer applications at 1-week intervals.

Table I. Analyses of pool water for 1967 pond fertilization study

Date	Control				One Application 600 lb/A				6 Applications 120 lb/A			
	NO_3	NH_4	P	K	NO_3	NH_4	P	K	NO_3	NH_4	P	K
Aug. 1*	0.43	UD	0.01	4.3	0.47	UD	0.01	5.6	0.46	UD	0.01	4.7
Aug. 2	0.44	UD	0.01	4.3	6.55	16.2	1.97	8.1	1.00	1.6	0.44	5.2
Aug. 4	0.39	UD	0.01	4.0	7.30	17.8	2.53	8.0	1.14	1.1	0.36	4.8
Aug. 7	0.34	UD	0.01	3.9	5.48	15.2	2.77	8.4	1.08	0.2	0.32	4.7
Aug. 14	0.26	UD	0.01	3.5	3.50	8.7	2.13	7.6	1.55	2.5	0.71	4.9
Aug. 21	0.18	UD	0.01	3.1	2.70	4.9	1.67	6.9	2.15	3.5	1.19	5.1
Aug. 28	0.12	UD	0.02	2.8	2.32	2.7	1.28	6.1	2.59	4.0	1.57	5.4
Sept. 5	0.15	UD	0.02	2.9	1.37	0.8	1.20	6.3	1.69	10.3	2.50	6.2
Sept.12	0.12	UD	0.01	2.2	1.87	0.2	0.93	5.2	2.43	14.8	3.07	6.0
Sept.19	0.10	UD	0.01	2.2	1.34	0.1	0.85	4.9	3.96	16.2	2.97	6.1
Sept.26	0.12	UD	0.01	2.2	0.61	0	0.65	3.5	4.04	12.7	2.93	6.3
Oct. 3**	0.30	UD	0.01	1.9	0.40	0	0.51	3.1	2.48	5.2	2.37	5.2
Oct. 24	0.28	UD	0.01	1.6	0.48	0	0.28	2.4	3.31	1.8	2.17	4.9
Nov. 14	0.10	UD	0.01	1.7	0.10	0	0.23	2.5	2.05	0	1.90	4.6

UD Undetectable

* Date of first fertilization (analyses for this date represent water samples taken before the addition of fertilizer).

** Date of plant harvest

Table II. Analyses of pool water for 1968 pond fertilization study.

Date		Control				1-600 lb/A				6-100 lb/A			
		NO_3	NH_4	P	K	NO_3	NH_4	P	K	NO_3	NH_4	P	K
March	20	0.12	UD	0.02	1.6	0.12	UD	0.11	2.4	0.12	UD	0.41	2.6
April	30	0.11	UD	0.01	1.4	0.10	UD	0.06	1.8	0.10	UD	0.25	3.0
June	11*	0.10	UD	0.01	0.8	0.10	UD	0.04	1.4	0.10	UD	0.15	2.2
June	12	0.14	UD	0.01	0.8	4.00	15.0	2.10	4.3	0.92	1.7	1.12	3.1
June	14	0.10	UD	0.02	0.7	3.55	18.0	5.28	4.2	0.88	1.5	0.84	2.8
June	18	0.15	UD	0.02	0.7	4.43	16.2	5.05	5.3	0.96	0.4	0.69	3.3
June	25	0.15	UD	0.01	0.5	1.78	13.4	3.18	4.4	0.78	1.6	1.19	3.0
July	2	0.12	UD	0.02	0.7	2.12	5.7	2.98	5.5	1.79	3.9	1.72	4.1
July	9	0.18	UD	0.02	0.7	1.58	4.2	2.26	5.6	3.13	5.2	2.33	4.4
July	16	0.15	UD	0.01	0.5	1.03	4.8	2.10	5.5	3.51	7.0	2.66	4.8
July	23	0.15	UD	0.01	0.4	0.76	3.4	1.62	4.8	2.18	7.7	3.07	4.6
July	30	0.10	UD	0.04	0.4	0.55	1.8	1.13	3.8	1.65	6.7	2.17	4.3
August	6	0.20	UD	0.04	0.3	0.50	1.4	0.72	3.9	1.48	5.3	1.73	4.1
August	13**	0.15	UD	0.06	0.3	0.40	0.4	0.37	3.2	1.33	2.1	1.07	3.8

UD Undetectable

* Date of first fertilization (analyses for this date represent water sample taken before the addition of fertilizer).

** Date of plant harvest

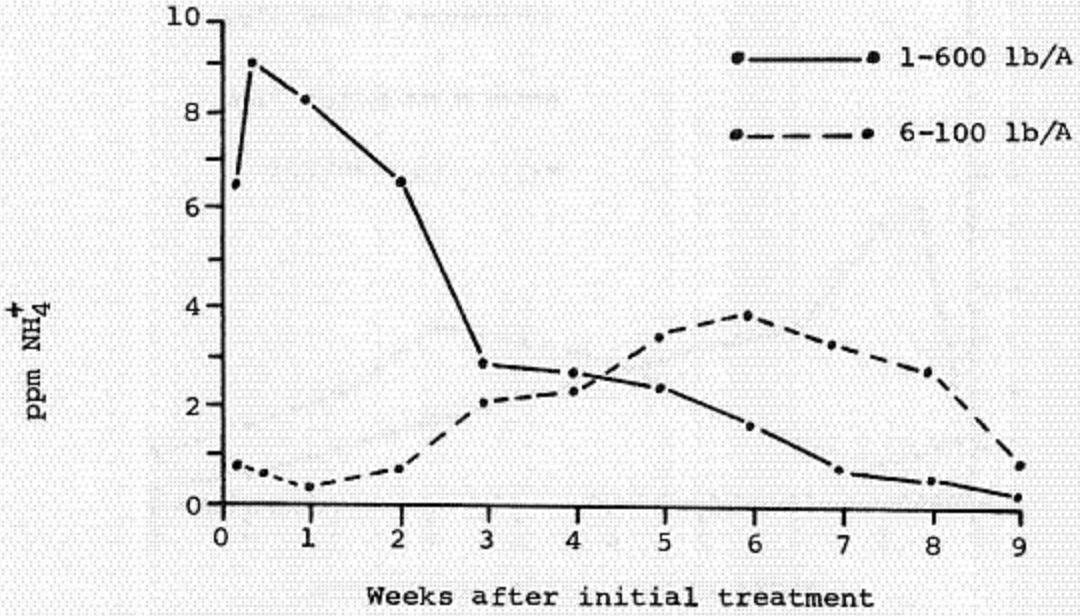

Figure 1. Concentrations of NH_4^+ in fertilized pool waters (average of 4 replicates).

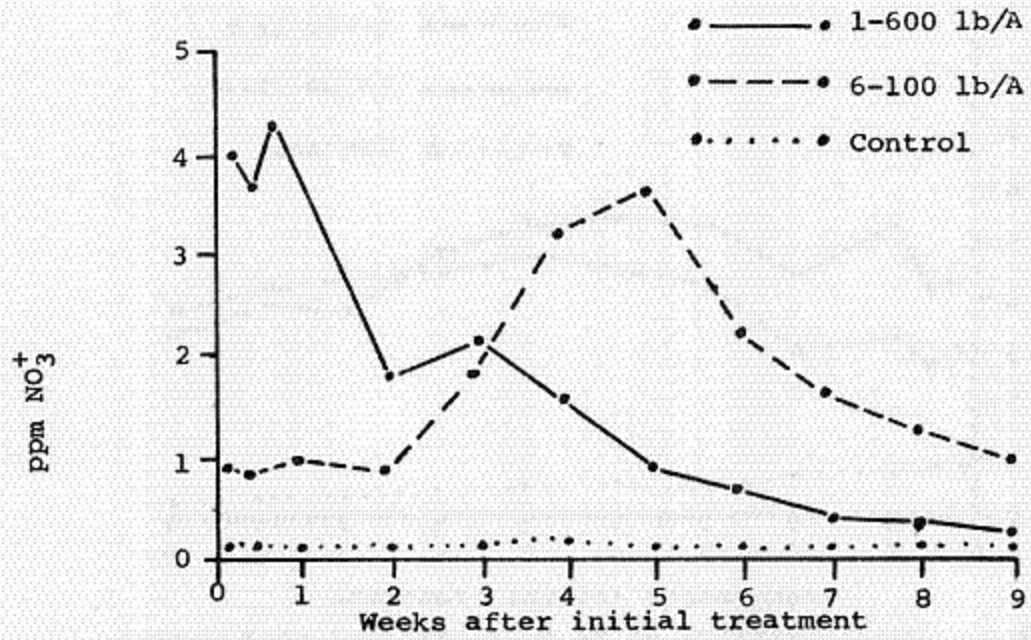

Figure 2. Concentrations of NO_3^- in fertilized pool waters (average of 4 replicates).

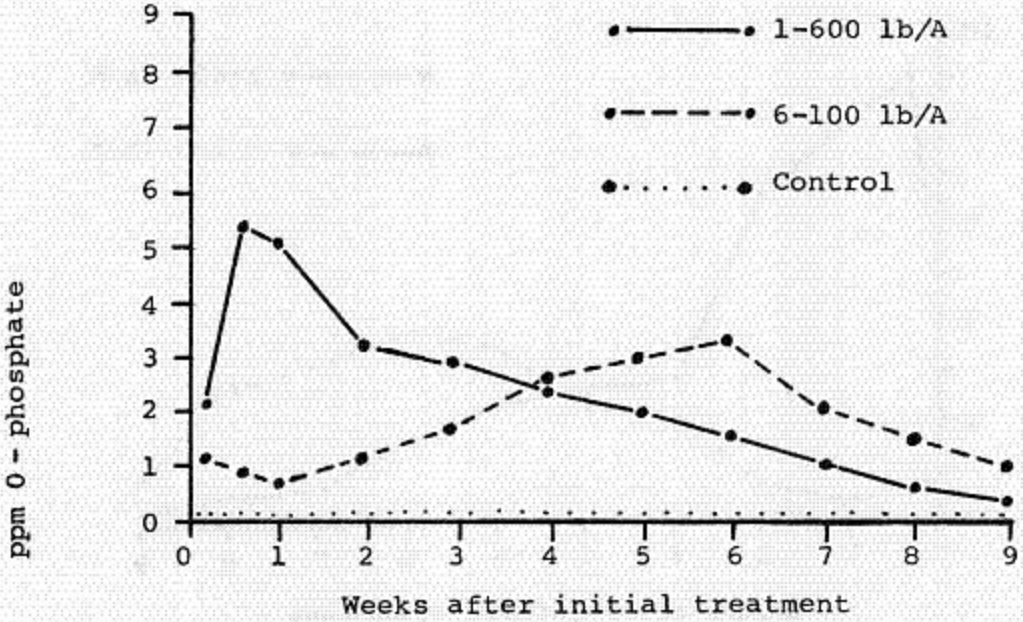

Figure 3. Concentrations of orthophosphate in fertilized pool waters (average of 4 replicates).

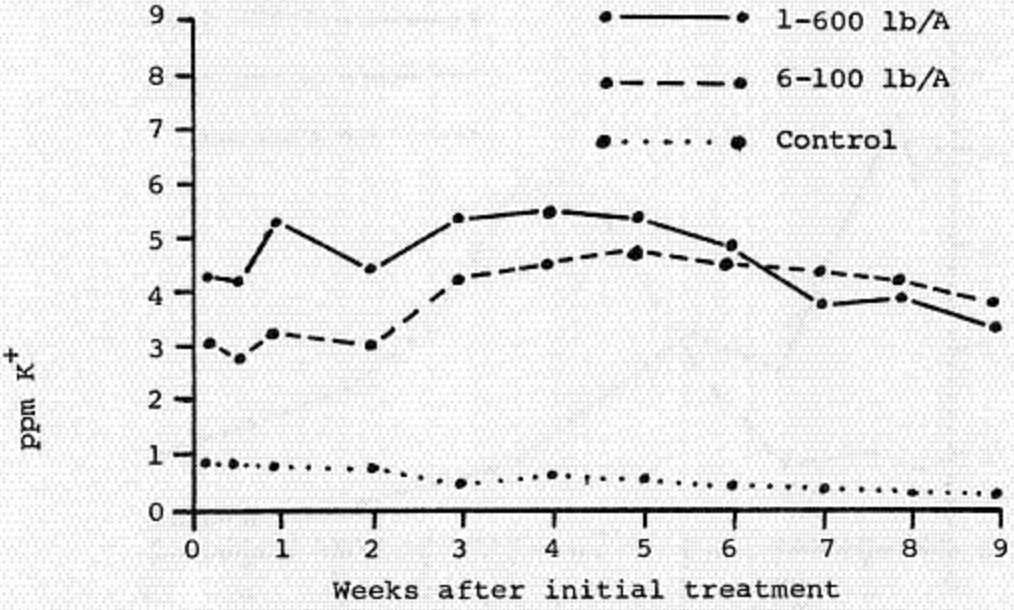

Figure 4. Concentrations of K+ in fertilized pool waters (average of 4 replicates).

THE EFFECTS OF FERTILIZATION ON THE GROWTH AND MINERAL COMPOSITION OF ANACHARIS, MYRIOPHYLLUM AND POTAMOGETON

(Abstract)

by
James B. Ryan 1/

Studies were conducted in 1967 and 1968 to determine the effects of increased nutrient supply on the growth and mineral composition of Anacharis canadensis, Myriophyllum heterophyllum, Myriophyllum spicatum, and Potamogeton pulcher. Stands of each of these species were established in twelve plastic pools, 3 feet deep and 12 feet in diameter, containing pond water and soil. The water nutrient supply was increased by the addition of an 8-8-2 granular fertilizer. Four pools received one heavy fertilization at 600 lb/A. Four pools received six-100 lb/A applications applied at one week intervals. The remaining four pools did not receive fertilizer and were used as controls. At the end of both summers, plants were harvested and dry weight yields and mineral analysis of the tissue determined.

1967 - Study - The four species studied showed luxury consumption of nitrogen, phosphorous, and potassium when fertilized. No significant differences in yield were obtained for Anacharis canadensis or Potamogeton pulcher when fertilized compared to controls. Significantly higher yields of Myriophyllum spicatum were obtained in control pools, while Myriophyllum heterophyllum grew better under fertilized conditions.

1968 - Study - The four species studied all exhibited luxury consumption of nitrogen, phosphorous, and potassium when fertilized. Anacharis canadensis and Potamogeton pulcher showed significantly higher yields when fertilized compared to controls. However, Anacharis c. and Potamogeton p. showed no significant yield differences between the fertilizer treatments.

1/
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Myriophyllum spicatum again showed significantly higher yields in control pools compared to yields from fertilized pools. Myriophyllum heterophyllum grew very poorly under all treatments and yields were less at the time of harvest than at the beginning of the study.

SOME MINIMAL REQUIREMENTS FOR DEVELOPMENT OF SKELETONEMA COSTATUM BLOOMS.

J. C. Prager and R. L. Steele 1/

Skeletonema costatum Greville is the most abundant diatom in most of the coastal and estuarine waters of North America (9) and perhaps of all temperate seas (16). Ecological success over wide and diverse areas suggests that the species' environmental requirements are easily met. Experience with laboratory cultures proved S. costatum to be far more sensitive to the composition of its medium than we had expected it to be, however. To assure successful subculture, our early cultures periodically had to be returned to media containing undefined enrichments or supplemented with natural seawater. These initial difficulties were encountered using common artificial seawater formulations that supported luxurient growth of 35 other species of coastal marine phytoplankters. Much of what we learned about S. costatum requirements resulted from designing synthetic media that would support serial subcultures.

This report is part of a program to identify and quantitate chemical factors which govern the abundance and distribution of important plankton species from both normal and polluted inshore marine environments. It concerns chemical requirements of S. costatum in axenic culture. We may assume safely that the environment must meet these minimal nutritional requirements during development of S. costatum blooms.

Methods:

Our culture originated from R. Guillard's axenic isolates sometime prior to 1964 (E. Zillioux, personal communication). It had been maintained in Guillard's F medium, an enriched seawater (7). Sterility testing at each subculture consisted of inoculating marine bacteriological medium and microscopic examination of the inoculum for intracellular contaminants. Presence of bacterial contaminants negated the experiment or terminated the subculture.

Ten-milliliter cultures in loosely covered 20 x 125-mm borosilicate-glass screw-capped test tubes were incubated at 20-22°C in 250 ft-c of cool-white fluorescent light. Experimental inocula and cells used for isotopic label studies remained in logarithmic growth in a manually operated phytostat sparged with sterile air. Daily cell count and size data were obtained using a Coulter model B particle analyser and mean cell volume computer. Cells were taken for experimentation at mid-log growth, 2.0 - 2.5 x $10^8 \mu^3$/mℓ (OD = 0.23 - 0.27). Large volume cultures for PO_4 depletion and supplementation studies grew in 4-ℓ aspirator bottles plugged with polyurethane foam, magnetically stirred, and utilizing tubulation of surgical-grade silicone

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rubber. Other rubber and plastic tubing materials tested proved toxic to S. costatum (C. S. Hegre, unpublished data).

Studies of salinity, P, N, and S requirements were measured turbidometrically, and population growth curves compared among the varied experimental media. One per cent v/v inocula, washed by centrifugation at 3,640 g/5 minutes followed by resuspension in control medium were used, although no standard OD was employed. Standard medium, prepared by omission of the test nutrient in each experimental series, is given in Table I. Each chemical was of the purest commercially available grade, and 2X glass-distilled, deionized water was used for all purposes, including the final two rinses of washed glassware. Media were inoculated c. 24 hours after autoclave sterilization (15 PSI/15 minutes; 30 minutes for volume > 15 mℓ).

A proprietary artificial seawater formulation, modified as shown in Table I, maintained phytostat and stock cultures during the last 3 months of experimentation. Earlier, Provasoli's DV (15) modified by addition of 2×10^5 M $NA_2S \cdot 9H_2O$ or cysteine, produced equivalent doubling times (22 - 26 hours) but was a greater nuisance to prepare.

Reagent grade $Na_2{}^{35}SO_4$ or $Na_2{}^{35}S$ of known activity served to determine rate of S uptake or loss under various conditions of S concentration or oxidation state. Ten-milliliter aliquots of culture exposed to the isotope indicated were washed on a membrane filter and dissolved in Bray's scintillation fluid. We measured CPM/unit volume of cells in a liquid-scintillation spectrometer and converted DPM to μmoles ^{35}S uptake with sliderule accuracy.

Results:

Increasing salinity by adding a brine of NaCl,KCl, $MgCl_2$ and $CaCl_2$, demonstrated that S. costatum grew most densely at highest salinities (fig. 1). Cells in salinities < 17.2 °/₀₀ did not divide. Optimal doubling times occurred between 28.6 - 47.4 °/₀₀, salinity comparable to coastal waters, seawaters, and tide pools. Subculture from tide-pool salinity failed, regardless of the salinity into which cells were inoculated. Best subcultures came from cells grown at 23.7 - 35.0 °/₀₀.

$NaNO_3$ and NH_4Cl at 2×10^{-4} M produced log growth, and S. costatum responded to as little as 2×10^{-7} M nitrogen source, although at this concentration only a very few more cells divided than in N-free medium. Below 2×10^{-5} M $NaNO_2$ yielded growth response, although 2×10^{-4} M and greater killed the inoculum. NH_4Cl at 1×10^{-3} M also killed cells, although $NaNO_3$ yielded log growth at twice that concentration. Amino N given as glycine or urea produced cultures almost as dense as nitrate N. Other sources of reduced N used by S. costatum were aspartic acid, hydroxylamine, glutamic acid, and methionine.

In static culture, P-depleted S. costatum could not distinguish among sources containing equivalant amounts of P. Potassium glycerophosphate, $Na_2(PO_3)_6$, K_2HPO_4, and $Na_3P_2O_7 \cdot 10H_2O$ at 1 ppm, yielded nearly identical growth

curves (fig. 3). High concentrations, > 50 ppm, caused precipitate formation and lessened cell growth in the medium.

Phosphorus studies in a manually operated phytostat demonstrated a much lower P requirement. Log growth continued after medium was reduced to 0.01 ppm P. Such cultures, allowed to deplete medium of P and reach stationary phase, could be stimulated to further division by as little as 1 ppb P.

Sulfate, SO_3 and $S^{=}$ were successful single S sources at concentrations approximating that of SO_4 in seawater. Sulfate supported growth was closely followed by that of sulfite. Sulfide fed cells divided after a very long lag, and cells given no S died. At termination of this experiment, pE's were within 50 mv (SO_4, 200 mv; SO^3, 182 mv; $S^{=}$, 191 mv; no S, 230 mv pE), indicating that there had been considerable oxidation of reduced S.

$Na_2{}^{35}SO_4$ uptake was directly proportional to concentration between 1.68 - 2001.48 µM. Sulfite above 21 µM suppressed $^{35}SO_4$ uptake, and sulfide above 3.5 µM prevented $^{35}SO_4$ uptake outright in an experiment in which 1.68 µM $^{35}SO_4$ served as the sulfate tracer. A second study showed that $S^{=}$ inhibition was in linear proportion to the $SO_4/S^{=}$ ratio at the sulfur concentration of seawater and thus SO_4 uptake was possible in the presence of $S^{=}$.

Minimum S concentration required for log growth was far below the usual SO_4 concentration of seawater. Static culture studies indicate divisions in response to 1×10^{-7} M SO_4, SO_3, $S^{=}$, and 1×10^{-6} M cysteine, although doubling times under 10 days were not observed in S concentrations less than 1×10^{-5} M. Population growth simulating bloom conditions occurred in 1×10^{-4} and 1×10^{-3} M SO_4 and SO_3 but not in cysteine, which sustained constant low populations, or in $S^{=}$. Below 5×10^{-6} M $S^{=}$, growth response exceeded that of other sulfur sources and above 1×10^{-4} M $S^{=}$ was toxic.

Discussion:

Static phytoplankton cultures are grown in artificial seawater formulations of higher P concentration than S. costatum responded to in this study (15). Our result agreed more closely with Martin's findings in Narragansett Bay, where during a year of extradorinary Skeletonema blooms, P fluctuated between 1 - 2 µg-atom per liter (13). This value is not uncommon for waters in which S. costatum is found (2). Curl has calculated that 1 - 5 10^{-8} µg-atom of P/cell per division is required for S. costatum (1). Should these results prove to be typical of inshore phytoplankton, the allowable concentrations of phosphorus compounds in effluents entering an estuary or embayment would be very low. However, Martin's study of zooplankton effects upon phytoplankton nutrient availability and blooms suggests that P is a less important limiting factor than is commonly supposed.

The role of nitrogen limitation of S. costatum growth, or phytoplankton blooms in general, is obscured because ammonium-N is the preferred source (6) at N concentrations usually found in seawater (13). There are very few data on ammonium-N concentrations since most field studies measure only NO_3. S. costatum and other marine phytoplankton species also utilize nitrite, for which

field data is extremely scarce. Experimental results indicate that the case for very low allowable nitrogen compound additions to marine embayments is analagous to that for phosphorus, given one more order of magnitude. Justification for setting such standards depends upon proof that under normal conditions in inshore waters nitrogen in whatever form available is a dominant factor in limitation of nuisance algae.

Sulfur is also in excess in most seawater formulations, although unlike N and P it is superabundant in seawater itself. We have not found quantitative data for naturally occurring divalent sulfur reported for inshore water masses, but it must be present as a product of bacterial metabolism in anaerobic sediments (5). Diatoms are reported to require divalent S in order to metabolize silicon (10), and early reports described stimulatory effects of sulfide (14) and cysteine (8) on S. costatum growth. Our pE measurements indicate that sulfide oxidizes and some precipitates out in seawater rather rapidly (pE increased + 460 mv in 16 hours in a beaker of sulfide medium exposed to room air). This raises the question of how a divalent sulfur requirement can be met in areas of sufficient salinity to permit bloom growth. One possible answer is that the sulfide requirement is an experimental artifact. If so, any reducing agent capable of changing the ionic activity of trace metals in seawater should promote growth and silicon uptake, perhaps by removal of some inhibitory, redox-active metal. Ascorbic acid (10), aspartic acid, or glutamine (12) restore both cell division and silicon uptake in the absence of sulfide. However, the demonstration that addition of reducing compounds does not produce sulfide from sulfate in the medium under such restorative conditions has never been accomplished, and the question of sulfide requirement remains unresolved.

It is not likely that sulfate either limits or stimulates phytoplankton blooms in marine waters. Our results for S. costatum and those of Lewin and Busby (11) for nine other phytoplankton species, indicate that bloom conditions can occur at two orders of magnitude less SO_4 than is normally present in seawater.

We feel obliged to emphasize that static culture assays can produce misleading high values in nutrient limitation studies. To determine the lowest concentration of a nutrient that will just sustain a population, and that increment above it which will allow growth, a chemical equilibrium must be maintained free of influence from the population itself. This requires a continuous-flow system such as that designed by Droop (3), and knowledge of the relationships between nutrient uptake and growth when both are in flux. Droop demonstrated that it is not safe to assume that all nutrient added to culture medium is available--even under continuous-flow conditions (4). Further, he showed that even measurement of that nutrient which actually enters the cells is valid only if considered throughout the growth cycle.

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TABLE I

Artificial Seawater Formulations

	Skeletonema Medium	S-Free Medium	Proprietary Medium	Unit
NaCl	1.8	1.8	2.1	g
$MgSO_4 \cdot 7H_2O$	-	-	1.2	g
Na_2SO_4	9.4	-	-	mg
Na_2SO_3	8.3	-	-	mg
$Na_2S \cdot 9H_2O$	15.9	-	-	mg
KCl	0.06	0.06	.07	g
$MgCl_2 \cdot 6H_2O$	0.42	0.42	-	g
Ca(as Cl)	10.0	10.0	25.0	mg
$NaNO_3$	5.0	5.0	7.1	mg
K_2HPO_4	0.5	0.5	1.28	mg
$Na_2SiO_3 \cdot 9H_2O$	20.0	20.0	3.07	mg
Fe(as Cl)	0.01	0.01	0.01	mg
Cu(as Cl)	.000998	-	.0005	mg
$ZnSO_4 \cdot 7H_2O$	-	-	.0044	mg
$CoCl_2 \cdot 6H_2O$	-	-	.0020	mg
$MnCl_2 \cdot 4H_2O$	-	-	.0360	mg
$Na_2MoO_4 \cdot 2H_2O$	-	-	.00126	mg
NTA	4.78	-	-	mg
Vitamin B_{12}	1.0	0.1	1.0	µg
Thiamine · HCl	-	-	0.2	mg
Biotin	-	-	1.0	µg
Mannose	5.1	-	-	mg
Ascorbic Acid	.01	-	-	mg
Cysteine	-	-	5.0	mg
Tris	0.1	0.1	.05	g
H_2O	100.0	100.0	100.0	mℓ

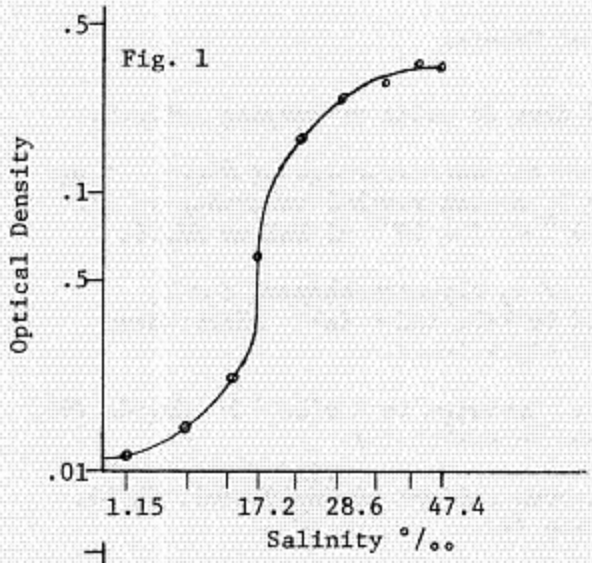


Fig. 1
Optical Density
.5
.1
.5
.01
1.15
17.2
28.6
47.4
Salinity °/₀₀

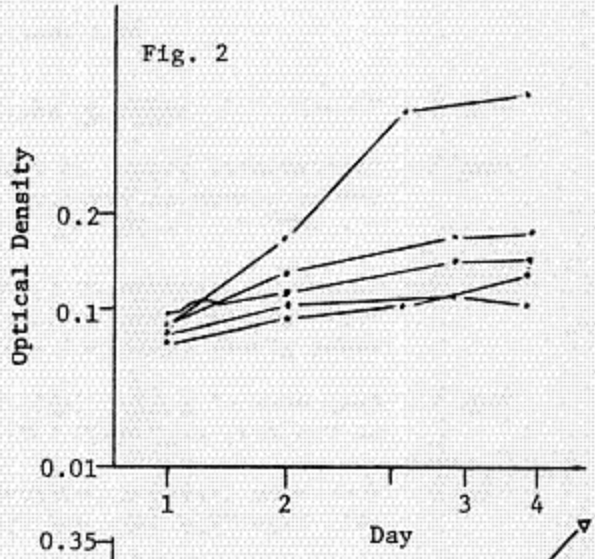


Fig. 2
Optical Density
0.2
0.1
0.01
1
2
3
4
Day

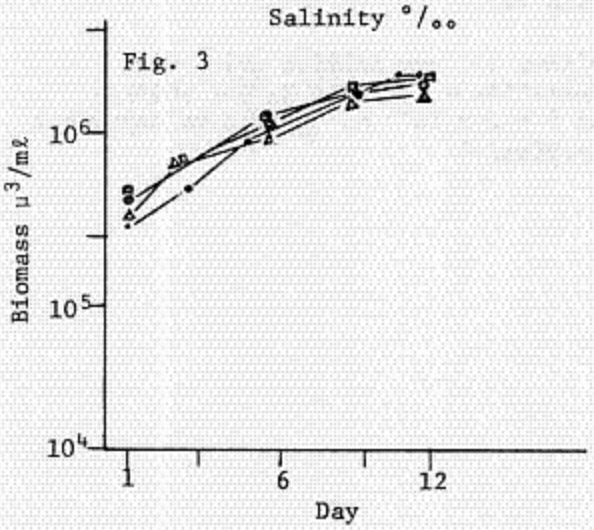


Fig. 3
Biomass μ³/mℓ
10⁶
10⁵
10⁴
1
6
12
Day

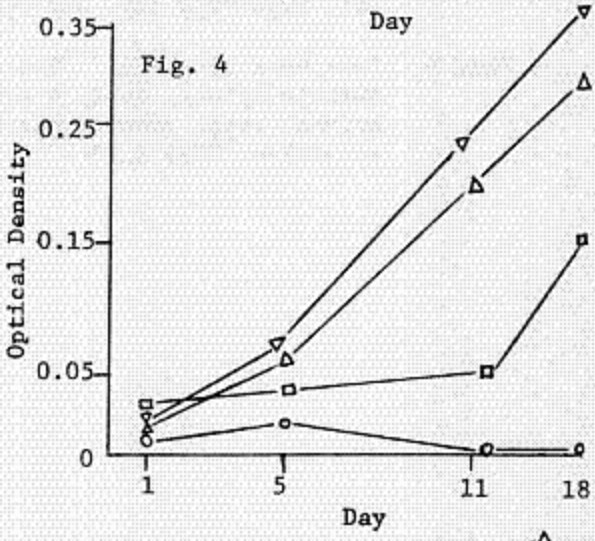


Fig. 4
Optical Density
0.35
0.25
0.15
0.05
0
1
5
11
18
Day

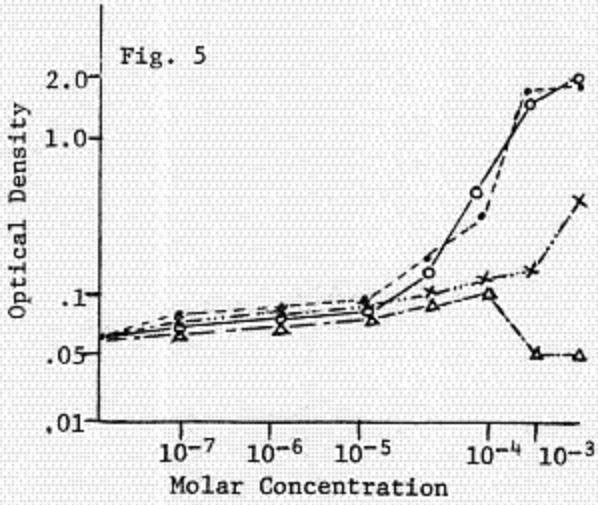


Fig. 5
Optical Density
2.0
1.0
.1
.05
.01
10⁻⁷
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
Molar Concentration

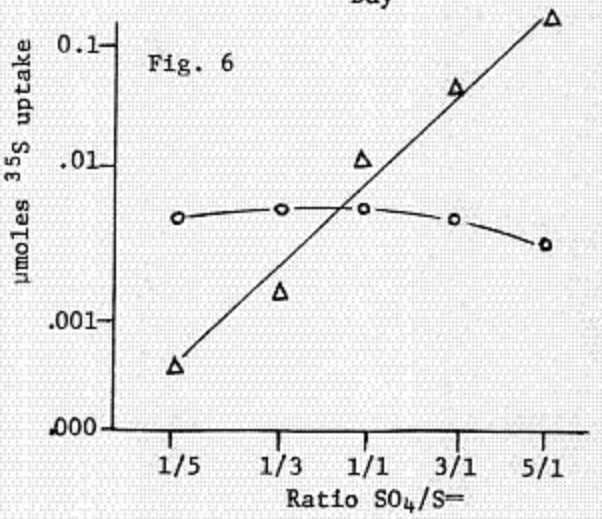


Fig. 6
μmoles ³⁵S uptake
0.1
.01
.001
.000
1/5
1/3
1/1
3/1
5/1
Ratio SO₄/S=

Explanation of Figures

Fig. 1. Growth of S. costatum after 8 days in media of varying salinity.

Fig. 2. Differential growth in response to concentrations of NH_4Cl. From top to bottom at level of day 2, concentrations responded to are 2×10^{-4} M, 2×10^{-5} M, 2×10^{-6} M, 2×10^{-7} M, and no NH_4Cl.

Fig. 3. Growth in response to 1 ppm P as K_2 glycerophosphate (▱), $Na_2(PO_3)_6$ (●), K_2HPO_4 (Δ), and $Na_2P_3O_9 \cdot 10H_2O$ (o). Differences among growth responses are not significant.

Fig. 4. Responses of sulfur depleted S. costatum to 2×10^{-3} M Na_2SO_4 (▽), Na_2SO_3 (Δ), $Na_2S \cdot 9H_2O$ (▱), and no sulfur (o).

Fig. 5. Three-day growth in various concentrations of Na_2SO_4 (o), Na_2SO_3 (●), $Na_2S \cdot 9H_2O$ (Δ), and cysteine (x).

Fig. 6. Four-hour uptake of ^{35}S as sulfate (Δ) and Sulfide (o). For sulfate uptake, total S concentration = 2×10^{-3} M; for sulfide uptake, total concentration of S = 2×10^{-4} M. Uptake is expressed in μmoles $^{35}S/1 \times 10^8 \mu^3$ S. costatum/mℓ.

THE DEVELOPMENT CYCLE OF A HYDRAULIC AQUATIC WEED CONTROL DEVICE

Joseph K. Taussig, Jr. 1/

INTRODUCTION

The combinations and permutations involved across the entire spectrum of aquatic weed control problems approach infinity. There are literally hundreds of different kinds of weeds, growing in many different environments, under many different collateral circumstances involved in local ecology, treatable by hundreds of different kinds of chemicals, several mechanical means, and occasionally, though still under development to the most part, by counter-biological means.

Prior to the reduction to practice of the WEED WITCH, most weed control methods were categorized as herbicides, mechanical, or biological. The WEED WITCH introduced a new physical concept - the use of hydraulics.

This paper is not "historical" in the sense of completeness. In the interests of clarity, much of the trial and error inherent in a new device has been treated with poetic license in order to simplify the description of the actual known results of a four year development cycle during which a machine was actually used in an evolutionary manner to achieve the present capability.

THE INITIAL INCENTIVE TO ACTION AND BRIEF HISTORY

Credit for the invention and development of the WEED WITCH belongs to David R. Talbott of Annapolis, Maryland. Mr. Talbott recognized a deficiency in his neighborhood which boasted a "beach" that had been rendered useless for recreational purposes by weed growths which made wading and bathing extremely unattractive. Mr. Talbott had three immediate assets in his favor; a teen-aged son, imagination, and a farm background.

He reasoned that if the weeds which he pulled up by the thousands during his boyhood on a tobacco farm came up easier when the soil was loosened by plow or rain, that aquatic weed roots would come up easier if the sediments holding the roots were agitated by hydraulic pressure.

1/ Aquatic Controls, Inc., Annapolis, Md.

He built a small raft some five feet square, mounted a small engine driven pump discharging through a length of garden hose, and using his son and a neighborhood crony, committed the craft to the beach. The results were fascinating. One boy pushed the raft around and the other held the hose against the bottom. The weeds came up to the surface, and the beach was immediately usable again.

But, though successful, the first system was manifestly clumsy and inefficient. Mr. Talbott then built a flat bottomed barge from plywood. Its dimensions were eighteen feet long by eight feet in beam. On this barge he mounted a thirty horsepower gasoline engine driving a three inch centrifugal pump (eventually he used two engines in what proved to be an unnecessary effort to gain reliability). The pump discharged into two lengths of standard fire hose which were connected to a horizontal pipe. Sixteen poly-vinyl-chloride pipes were hung vertically from the horizontal member, and the water ultimately discharged from specially designed nozzles at the end of these pipes. The whole manifold rig was controlled in depth by a hand winch.

In operation, the WEED WITCH was piloted by one teen-ager maneuvering with a three horsepower outboard motor, while the second boy stood on the bow and handled the winch. Eventually, an electric winch control was installed for operation by the pilot, and from then on, only one youngster was needed to control the craft.

This development cycle covered some three years, during which the boys successively had a better and better system. During the entire period, however, the WEED WITCH was in actual operation, serving numerous customers on a charter basis.

OPERATIONAL-TECHNICAL DEVELOPMENT

The WEED WITCH is fairly typical of a home invented device which has been technically developed concurrently with actual operations.

The inventor was investing time and money while pursuing his full time profession, which in the case of Mr. Talbott was cement contracting. The primary goal of the development was to provide the teen-agers with a profitable business for their summer activities, and this goal was admirably met.

Marketing was strictly "local", and by word of mouth. Not a

single advertisement was placed and the boys handled all of the business details themselves. Interest was generated among several weed control agencies during this development period.

During this phase, several concepts were tried. Some were discarded, some adopted.

Insofar as the total system was concerned, it was recognized that there were certain material limitations, inherent in the choice of hardware.

Major among these was the barge, itself. This was manufactured from plywood, and has a very low freeboard. Hence, in squalls or rough weather, it was necessary to take precautions to insure the safety of the craft to a far greater degree than would have been necessary if a more sea worthy hull had been used. In fact, during one blow, a Good Samaritan thought the barge might founder, and in his inept efforts to save it, actually caused its loss. Future machines will be designed around fiberglass small boat hulls which have been studied and found acceptable.

The next major problem was the engine/pump system. The operating environment was somewhat unusual in that once the pumps commenced working, the sediments were inevitably taken into the intakes, and processed through the impellors. Several commercially available engine/pump combinations were tried before a truly reliable working set was found.

It was also felt that two engine/pumps would be better than one to provide a redundancy in the event of breakdown. However, the teen-agers proved so adept at maintenance that in the final analysis, the two engine concept was discarded, and with it, some of the complexities of cross-talk between the pumps in the discharge line.

The discharge piping system was fortuitously solved through initial decision. It was known that there were snags, rocks, buoy moorings, and other obstructions in the potential operating areas. Difficulties with these had been observed with some mowing machines which had been purchased and operated in the area. Hence, polyvinyl-chloride (PVC) pipes were chosen from the beginning. These pipes will bend to over a ninety degree angle without breaking, and snap back after passing over an obstacle. When large obstructions were encountered which could actually stop the barge, the pilot merely maneuvered around them.

The next engineering problem was involved in designing the nozzles at the end of the pipes. Little was known about the proper design, but through analysis, and then trial and error, it was discovered that jetting down, and jetting forward at the same time, impinged the maximum pressure against the sediments.

The winch system originally required an operator standing on the bow. This was not as efficient as it might be from two points of view. First, it added another laborer to the system, and it required coordination between the pilot and the winch operator to insure maximum back pressure of the nozzles through the sediments consonant with the propulsion system. By engineering a winch control system from the pilot's station, these problems were eliminated. The pilot then was able to feel his own back pressure, and adjust the height of the pipes or the power of his craft.

The intake problem was recognized from the beginning. Large quantities of water were being sucked in by the pumps, and this water was full of floating weeds which tended to clog the intakes. Several schemes were tried....changing the position of the intakes; shrouding the intakes with large spheres of chicken wire; and placing intakes at various angles. Meanwhile, a mechanical-hydraulic system was reduced to drawings for inclusion in a later model if the customer so desired. This is a more expensive modification than the operators felt was warranted by their particular operational profile. They did not mind the inconvenience of stopping the rig when necessary to clear the intakes, for to them, this was all in a days work. On the other hand, it was recognized that customers with a higher degree of aesthetic sensitivity, might not like this sporadic operation. Actually, it is apparent that the best time to use the machine is when the weed problem is in a dormant state, for then the debris is merely small seedlings, root systems, and an occasional tuber.

Removal of the debris was involved in the same concept of time. During dormant periods, the debris was very minor, and was allowed to float out with the currents. After the growing period was established, the problem then evolved more sociologically. Where the debris was no nuisance to other landowners, it was allowed to float to sea. Where it was a nuisance, the barge was rigged with rakes outboard from the bow, and using these in conjunction with the manifold drawn to the water line, the barge was swung through the debris, and it was pushed ashore for disposal. While obviously more expensive, the overall treatment proved still to be the most economical of the available alternatives.

Depth problems never developed on the rivers to which the machine was committed. The PVC pipes were ten feet long, and either the weeds did not grow at these depths, or the landowners desiring to clear for boating and swimming were not concerned to depths much beyond six feet. On the other end of the depth problem, the shallow draft of the barge, coupled with the ability to retract the pipes completely from the water, allowed it to operate in eight to ten inches of water, and to push debris up on the actual beach. The length of pipe is an alternative which should prove little or no problem save possibly some strengthening member of the length gets inordinately long.

OPERATIONAL UNKNOWNS

There are many facets of the operational capability which are either not clear or are not calculable in generalities, or are not known.

One of the immediate questions asked is "how many acres a day will the machine clear?" In theory, the barge, operated at four knots, for eight hours, clearing eight foot swaths would clear some 35 acres a day. In practice, this capability is degraded by so many factors, which in themselves are variables, as to indicate that each environment will provide a different answer.

The WEED WITCH must pass over the bottom to be treated, and unless modification is made for special purposes by varying the bottom configuration of the pipes, the bottom line of nozzles is horizontal. Thus, on sloping beaches it is necessary to run the barge perpendicular to the beach, back and forth. If the beach is very precipitous, this run might be merely a matter of a few feet. If it is a gently sloping beach, the run might be many yards. If there are flat areas, greater speeds can be realized. If there is little debris, the speed of clearance picks up by eliminating problems of intake clearance and debris collecting. In addition, there is a "seaman's eye" input to the equation, for once the machine starts to work, all one can see is muddy roiled water, with whatever debris is present on the surface.

In the cost-effective equation, another variable is introduced to the "acres per day" criteria, since many of the weeds are perennials, and the regrowth or reinfestation cycle becomes important. In some areas, there has been no regrowth for as many as three years. In others, there is minor regrowth after one year. The reasons for this discrepancy are not fully understood.

The size of the total system can vary radically, requiring as a minimum a float large enough to house the pump, and as a maximum, whatever one might wish to use, dependent on the number of pumps, and merely scaling up the whole system. The eight foot dimension was chosen for the prototype machine because of road width restrictions.

Insofar as the types of weeds to be attacked are involved, it is apparent that the machine requires that the weeds be bottom rooted or bottom anchored, since its effect is actually against the sediments, as opposed to the weeds themselves. Given this requirement, to date, no weeds have defeated the machine. From milfoil to badly infested water lilies, the power has been adequate to defeat them. Occasionally, in extremely bad conditions, the barge has been used as a "drag" first, and as a hydraulic machine second. The first pass is a pure propulsion powered pass without using the pumps. This uproots or tears out enough of the weeds to allow more efficient pumping on the second pass.

Insofar as ecological effects are concerned no study whatsoever has been done on these problems, and it is apparent that at the research end of the aquatic weed control spectrum, the WEED WITCH affords an extremely attractive laboratory tool for such work. This is apparent because in the example of a "captive lake" it is possible to take all observations possible while the lake is in its "virgin state", and then progressively clear out any percentage of the lake that is desired....taking readings as the work progresses.

To date, only minor dredging has been undertaken, despite the Patent Examiner's perception that the WEED WITCH is "a Dredge or the Like". In dredging cases, all of the work has been alongside docks or piers where the owner wanted to add depth or against minor sand bars where community owners were plagued by shallow outlets. The "spoils" probably never exceeded a few cubic yards of silt, and these were carried out by the currents.

COMPETITIVE UNKNOWNS

In many respects it is impossible to set up comparative criteria among the herbicide, mechanical, and biological methods of aquatic weed control and the hydraulic method.

Certainly, if brute force weed eradication over large areas

is the controlling criteria, the WEED WITCH is not competitive with those chemicals which are reasonable in price which might eradicate the particular type of weed infestation.

At the other end of the spectrum, there is little doubt that in some restrictive environments where selectivity of eradication, or merely selective control is desired, that chemicals may be ruled out regardless of their cost.

The best judge of these competitive factors is, of course, an informed user who can weigh the various considerations. Easy though the statement is to make, it is obvious to all who have been involved in the development cycle of any new concept, that the translations into a user environment are complex functions, often involved in organizational, planning, administrative, and budgeting problems quite independent of the actual value which might be perceived by the potential operational user.

To date, the only competitive experience for WEED WITCH has been in the Annapolis vicinity, where it has gained ascendancy approaching one hundred percent. However, despite the prolonged use of the machine during its development cycle, it was operated in a rather restricted market. Save for a fairly large area cleared for the Gibson Island Yacht Club, and reasonably large areas cleared for the Sherwood Forest Association and the Americana Apartments, the use was confined to relatively small private waterfronts, and all work was obtained solely from word of mouth and local knowledge.

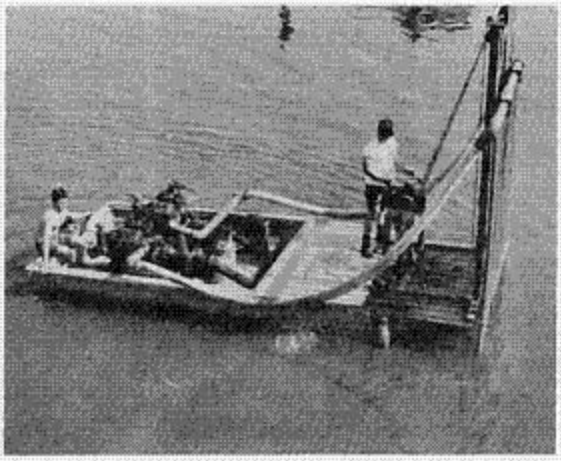
Therefore, it is not even fully known whether a market does exist which can be penetrated by such a machine. Judging from enquiries, there is an apparent dual market within whatever potential does exist. One segment of this market might be called the "Public Works" market, in which the machine is purchased in the same frame of reference that an agency with a public works facility would purchase a snow plow or a bull dozer, or any machine to perform services within the jurisdiction of the agency. The other market is a "Service" market as exemplified by the work done in the Annapolis area, whereby the machine is rented or chartered for specific jobs, and the user is not the same as the owner.

I touch upon these marketing aspects in context of the development cycle of the machine for the basic reason that experience involving more new concepts than I wish to remember has indicated

that marketing is an inseparable part of meaningful engineering development. Undoubtably tens of thousands of perfectly sound concepts of use to mankind are still on the shelves of inventors because of marketing failures. This hardly does mankind much of a service and often mistakes arm length dealings for some kind of quid pro quo which demands an inordinate effort on the part of the vendor before he is privileged to render services to a user. In another context, it is always a simple matter to avoid a confrontation with a new concept, simply on the grounds that mankind has come a long way to date without it, and hence, it is easy to say "no", for there is nothing lost.

In an environment as important to man as aquatic weed control might be, these observations are germane to any new scheme, be it chemical, mechanical, biological, or hydraulic. For there is one certainty, no single means or method is going to meet all of the deficiences injected into mankind's scheme of things by aquatic weeds.

The development cycle of the WEED WITCH has indicated that it is economically feasible under certain broad requirements, to control or eradicate infestations of bottom rooted or anchored aquatic weeds by injecting high pressure water directly into the bottom sediments. It remains to be seen to what degree the concept gains acceptance and to articulate through future use and experimentation the concept might grow.



TIDAL DISPERSAL OF 2,4-D FOR CONTROLLING EURASIAN WATERMILFOIL IN CHESAPEAKE BAY

John H. Steenis 1/

(Abstract)

Eurasian watermilfoil (Myriophyllum spicatum) continues to be one of the major aquatic plant problems in North America. It is obnoxious because it can produce a loosely woven blanket growth up to 7 feet or more thick that can completely dominate a water area. It has been in Chesapeake Bay since the turn of the century. Though detailed history on its early infestation is lacking, it has been a serious problem since the 1930's.

During recent years, periods of ecological stress in the fresh and brackish waters of Chesapeake Bay have disrupted submersed aquatic plants. One such period in 1967 reduced Eurasian watermilfoil and other submersed species to sparse scattered stands in the upper fresh and brackish sections of the bay. However, during the late summer and fall of that year there was considerable resurgence in growth of submersed plants, including Eurasian watermilfoil. In 1968 there was continued reestablishment of watermilfoil into areas it formerly occupied.

Several herbicides effectively control watermilfoil. The butoxyethanol ester of 2,4-D impregnated on attaclay granules at rates of 20 lb. ae/A will control it. It should be applied during the period of aggressive plant growth prior to flowering and during low tide before dead ebb. The temperature of the water should be above 18°C. Diquat and diquat 2,4-D mixtures yield good results when applied during rising tides in deeply indented bays provided there is no silt on the leaves or suspended in the water. The presence of silt on the leaves or suspended in the water deactivates herbicidal affects of diquat but not 2,4-D. Consequently in 1968 tidal dispersal studies were continued with the soluble dimethylamine salt of 2,4-D at rates of 10 lb. ae/A.

Three deeply indented bays, ranging from 20 to 50 acres, were chosen for these studies. The herbicides were poured from a boat moving across the mouth of the bay during a rising tide. Cover-type maps of submersed vegetation were made prior to treatment and 2 months after treatment. Approximately 100 percent control of Eurasian watermilfoil resulted. This control was specific for watermilfoil, and there was a release growth of suppressed native vegetation, such as wildcelery (Vallisneria americana) and naiad (Najas quadalupensis), which have made the upper Chesapeake Bay famous for fish and waterfowl.

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THE EFFECT OF A COMBINED FORMULATION OF 2,4-D AND ENDOTHAL UPON A SMALL POND

Madelene E. Pierce[1]/

The purpose of this study was to determine the effect of the formulation 2,4-D and Endothal upon the plankton, small invertebrates, and especially the pondweed Potamogeton crispus. In one pond (Pierce 1967)[2] this species is known to go through an annual summer subsidence, but simultaneously to produce winter buds which insure new plants for the next season. It seemed desirable to study P. crispus under entirely different conditions to determine if such a subsidence is regularly the case. Therefore this investigation was carried out between August 1 and September 15, 1968, on the Vassar College grounds.

The pond, with a surface area of 6700 feet, had a black mud bottom which was covered by 12 - 18 inches of water. There was no appreciable flow through the pond. On one side it was surrounded by a broad border of purple loosestrife, while on the other was a low man-made embankment.

The floating plants included a moderate stand of Lemna minor and Wolffia columbiana, as well as numerous patches of Oscillatoria sp. Potamogeton crispus occurred in patches along the east and south border. No plants of P. pusillus were observed, although it had occurred abundantly until 1965, (Pierce, 1966, 1967)[3] when it responded to treatment in the summer of that year.

The pond was treated on August 5 with a combined formulation of 7.2% 2,4-D and 3.6% Endothal at a concentration of 2 ppm. Approximately one third of the area was treated, the remainder serving as a control.

1/ Professor of Biology, Vassar College, Poughkeepsie, New York.

2/ 1967 Pierce, M. E. Study of a Second Year Application of Fenac to Two Small Ponds. Proc. N. E. Weed Control Conf. 21, 530-533.

3/ 1966 Pierce, N. E. Application of Fenac to Four Small Ponds on Vassar College. Proc. N. E. Weed Control Conf. 20, 470-475.

The complete sampling routine included information on the following: temperature, O_2 ppm, pH, plankton, small invertebrates. Preliminary sampling was begun on August 4, before the application of the herbicide, and repeated on August 7, 9, 12, 19, and September 10. These samples were obtained between 8:30 - 10:00 A.M.

The sampling of the organisms was qualitative only. A plankton net was hauled, with great difficulty, for a period of six minutes. The contents were carried immediately to the laboratory where they were identified. Sampling by use of an Ekman dredge proved useless because of the buried sticks and branches. Instead, one dip net, filled with duck weeds, algal mat, and debris, was considered a unit of sampling for the small invertebrates. This material was carried to the laboratory where it was carefully sorted in white pans for ease in identifying the organisms.

The temperature of the water, reflecting the hot humid days of August, was 72° F during the early weeks, and fell to 64° F in early September. The dissolved oxygen was low throughout the entire period, and showed little if any difference between the experimental and control areas. The concentration in early August was 2 ppm which rose to 4 ppm as water temperatures became cooler. The pH in all parts of the pond, and for the duration of the experiment remained a constant 7.2.

As a result of the treatment there was little if any effect upon the duckweeds, or upon the blue green algae which continued to float in patches throughout the period of study. In contrast, Potamogeton crispus showed the beginnings of winter buds within five days. At the end of a week the plants appeared very unhealthy, were fragmenting, and were easy to break from the base. Many winter buds were produced. By the end of a month no trace of the plants remained. The control area passed through similar phases but more slowly, lagging by approximately ten days to two weeks. These changes confirm the previous conclusions (Pierce 1967) for believing that in late summer P. crispus exhibits a normal subsidence which may be hastened by the application of at least three herbicides, Fenac, 2,4-D, and Endothal. Such a subsidence, even on the experimental plot, has no lasting effect, for winter buds remain viable to insure the origin of the next season's plants.

The plankton population was rich in species and in numbers. Identification was limited to the use of the low power of a compound microscope. About 30 easily identifiable forms occurred repeatedly, and many more tiny flagellates, ciliates, and diatoms were present but not studied. The groups represented were: Myxophyceae (Oscillatoria);

Chlorophyceae (Spirogyra, Mougeotia, Volvox and related forms); Bacillariophyceae; Chrysophyceae (Synura); Euglenaceae(Euglena, Phacus, and others); Dinophyceae (Ceratium); Sarcodina (Arcella); Rotifera (Asplanchna, Synchaeta, Keratella, and others). Annelids (bristle worms); Ostracoda; Amphipoda; Copepoda; Cladocera, (Daphnia and Bosmina); Insecta (larvae of Mayflies, Damselflies, and Diptera); Arachnida (Mites); Mollusca(Physa, Helisoma). The same species occurred in both the experimental and control area on the same date. There was also a remarkable constancy of species throughout the length of the study as well.

The small invertebrates comprised a variety of species, but relatively few in comparison to the plankton. The number of individuals of some species particularly Amphipoda and Isopoda, was very high. The groups represented were: Annelida (Glossiphonia, Herpobdella, small oligochaetes); Gastropoda (Helisoma, Physa, Stagnicola); Pelecypoda (Sphaerium, occasional); Isopoda (Asellus); Amphipoda (scuds); Ostracoda; Insecta (larvae of midges, damselflies, mayflies, Dytiscidae; and adults of Belostoma, Plea, Peltodytes, Corixidae and Notonectidae); Acarina (mites). These forms occurred in both the experimental and control area throughout the duration of the study. Their abundant numbers occurred with monotonous regularity.

Although no counts were made, small vertebrates were present on the pond throughout the study. These included young sun fish (1 inch), adult gold fish, green frogs, and tadpoles, painted turtles, and water snakes.

SUMMARY

1. A small pond on Vassar College grounds, with no appreciable inlet or outlet, was studied.

2. Records were kept from August 1 - September 15, 1968.

3. Study of the following conditions and organisms was carried out on August 4, 7, 9, 12, 19 and September 10: Temperature, pH, dissolved oxygen, plankton, small invertebrates, and vertebrates, and the pondweed *Potamogeton crispus*.

4. The pond was treated with a formulation of 2,4-D and Endothal at a concentration of 2 ppm on August 5.

5. *P. crispus* exhibited its characteristic subsidence of late summer within three weeks after treatment. This formula appears to hasten the development of winter buds and the death of the plant.

6. The oxygen content was low, 2-4 ppm.

7. The pH was constant at 7.2.

8. Plankton organisms remained constant in species and probably numbers.

9. Small invertebrates also remained constant in species and probably numbers.

10. Young and adult fish, tadpoles, frogs, turtles and water snakes were present and active.

11. *P. pusillus* which had responded to treatment with Fenac in 1965 had not returned.

FURTHER STUDIES ON THE CONTROL OF SPATTERDOCK (NUPHAR ADVENA AIT.)1/

Donald N. Riemer 2/

Spatterdock is a serious problem in many shallow ponds and some slow-moving streams in New Jersey. It is especially abundant in the old mill ponds which exist in many towns in the central portion of the state.

One of the problems associated with the chemical control of spatterdock is regrowth. This is due to the extremely large rhizome which contains considerable amounts of stored food materials which can be used to send up new top-growth.

In a previous report, (Riemer and MacMillan 1967), it was shown that frequent defoliation caused a marked decrease in food reserves in the rhizome and that regrowth continued to decline after each cutting. This opened up the interesting possibility of integrated mechanical and chemical control. If spatterdock could be cut to weaken the plants and reduce food reserves before herbicide treatment, it seemed likely that control would be more satisfactory and regrowth would be reduced or eliminated.

Defoliation Plus 2,4-D

In June of 1967 an experiment was started to test this theory. The experiment was conducted in two ponds in central New Jersey with one complete replicate in each pond. Treatments were as follows:

Treatment #	Treatment
1	cut once
2	cut three times
3	cut once plus 40 lbs 2,4-D ae/A
4	cut three times plus 40 lbs 2,4-D ae/A
5	40 lbs 2,4-D ae/A
6	control

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In all cases, cuttings were made at 2-week intervals and 2,4-D was applied 2 weeks after the last cutting. The 2,4-D used was the 20% granular formulation of the butoxyethanol ester of 2,4-dichlorophenoxyacetic acid. All plots were 0.01 A in size. Since spatterdock has no above-ground stems, defoliation resulted in the removal of all top growth.

The plots were rated visually several times during the summer of 1967 and again during the summer of 1968. The rating system used was 0 to 10 where 0 equals no treatment effect and 10 equals complete control.

The last observations of 1967 were made on 21 September and the ratings were as follows:

Treatment		Rep I		Rep II	
cuttings	2,4-D	Stand	Vigor	Stand	Vigor
1	-	1	1	8	8
3	-	5	5	8	5
1	+	6	6	8	8
3	+	9	6	10	10
0	+	4	5	8	8
0	-	0	0	6	6

The ratings in replication II are abnormally high due to extremely heavy feeding damage by the beetle Galerucella nymphaeae of the family Chrysomelidae. This insect damage not only made the ratings high, but also made rating much less accurate and more difficult.

The following spring, (May 1968), the plots were again rated with the following results:

Treatment		Rep I		Rep II	
cuttings	2,4-D	Stand	Vigor	Stand	Vigor
1	-	0	1	0	0
3	-	6	2	5	3
1	+	5	7	2	3
3	+	9.9	8	10	10
0	+	6	7	1	6
0	-	0	0	0	0

These results indicate that the insect damage of the previous fall had not permanently affected the plants in replicate II. The data also clearly indicate that cutting 3 times followed by an application of 2,4-D is far more effective than either the cutting or 2,4-D used alone.

The final ratings were made 19 August 1968. At this time, beetle damage was so severe in both replications that no attempt was made to rate the vigor of the plants. Ratings of stand, (density of plants in plot), were as follows:

Treatment		Rep I	Rep II
cuttings	2,4-D	Stand Rating	Stand Rating
1	-	0	0
3	-	4	3
1	+	2	1
3	+	10	10
0	+	4	2
0	-	0	0

The data from the 2 replications was very similar and indicated that cutting of spatterdock 3 times followed by an application of 2,4-D may be a means of eliminating this weed. Dilution of the herbicide in these small plots was probably a factor and lighter rates of application may be effective when larger areas are to be treated.

Growth Regulator Plus 2,4-D

A preliminary experiment was conducted during 1968 to evaluate combinations of 2,4-D acid and 68-62 (a mixture of 2-chloroethane phosphonic acid, ester, and anhydride in a glycol base), for controlling spatterdock. Terminal ends of spatterdock rootstocks were transplanted into galvanized metal tanks on 2 May 1968. The rootstock sections ranged from 15 to 20 inches in length and 2 of them were planted in each of 10 tanks (2 replications x 5 treatments).

On 9 July the plants were growing well with up to 13 emergent leaves per plant. Treatments were made on that date as follows:

Treatment No.	Treatment
1	control
2	2,4-D (4 lbs. in 100 gallons of spray solution) sprayed to point of run-off.
3	68-62 (6000 ppm in spray solution) sprayed to point of run-off.
4	2,4-D plus 68-68 (same rates as above) as a tank mix.
5	2,4-D followed by 68-62 seven days later. (Same rates as above.)

Ratings were made on 20 August and 4 October as follows:

	Ratings - 20 Aug.		Ratings - 4 Oct.	
Treatment	Rep I	Rep II	Rep I	Rep II
1	0	0	0	5
2	3	6	2	5
3	0	0	8	7
4	9.5	9.5	10	10
5	9.5	9.5	10	10

The above ratings were made only on leaves which were breaking the water or very close to the surface. Because of algal growth and muddy water, it was impossible to see new sprouts coming up from the bottom. Therefore, on 4 October all of the rhizomes were dug up and the condition of the rhizome itself plus any new sprouts were evaluated. These ratings were as follows:

Treatment	Ratings		Comments
	Rep I	Rep II	
1	0	0	Healthy, strong, solid rhizomes with many new sprouts. One large branch on each of the 4 rhizomes. Many roots - tightly anchored.
2	2	1	Similar to #1 except that the dozens of new shoots were showing moderate epinasty.

Treatment	Ratings		Comments
	Rep I	Rep II	
3	2	0	Similar to #1 except that rhizomes did not show as much elongation. Dozens of new sprouts.
4	9	9	All rhizomes soft and spongy, showing very little elongation. Three of the 4 rhizomes had a single, tiny, malformed shoot. The fourth had no shoots. None of the rhizomes had produced a branch.
5	9.5	9.5	Very similar to #4 except the rhizomes were even softer and spongier with no new shoots at all.

The combination of 2,4-D and 68-62 seems very promising for the control of spatterdock. Further work will be necessary to determine the optimum rates for each material and to determine if they should be applied separately or together.

Literature Cited

Riemer, D. N. and W. W. MacMillan. 1967. Effects of Defoliation on Spatterdock (*Nuphar advena*). Proc. NEWCC 21:556.

FIELD EVALUATION OF NEW CONTROLLED RELEASE AQUATIC HERBICIDES

JASON M. CORTELL1/

Heretofore, aquatic herbicides were available in two basic forms, namely liquid and granular. While some wettable powder formulations are available, their general use in the Northeast has been limited. A new spray-dried particulate carrier system for aquatic herbicides has been developed by the 3M Company2/. Field evaluation of these new materials is discussed herein.

MATERIALS

The 3M System utilizes the basic aluminum salt of various phytotoxic chemicals. Laboratory formulations utilizing aluminum salts of silvex, diquat, endothall, 2,4-D, dalapon, sodium arsenite and others, readily indicate the flexibility inherent in the carrier mechanism. Two formulations, namely dihydroxy aluminum salt of endothall and monohydroxy aluminum salt of silvex, both on mica-carriers, were evaluated and field tested in 1967 and 1968 in the Northeast.

While these new materials can be technically termed "wettable powders", when mixed with water they form a golden-colored aqueous suspension. The mica particles, for the most part, average 100 microns in size, allowing them to pass through conventional spray equipment without clogging. When this aqueous suspension is sprayed onto the surface of floating and emersed plants, a coating of gold colored particles results. As the spray material is released below the surface of the water, it forms a golden cloud of finely divided mica particles. These particles settle on the submersed plants, clearly marking them with the aquatic herbicide.

Upon application, the herbicide is released slowly from the individual particles over a period of many hours. Most of the herbicide is released within the first 24 hours. Since the particles are in contact with the plant tissue of the target species, a prolonged concentration of active ingredient is created on the plant surface. While agitation of the water tends to dislodge some of the particles from the weeds, the herbicide is nevertheless released into aquatic environment in sufficient

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quantity to produce a phytotoxic response. However, in moving water, such as found in streams, ditches, or tidal zones, the particles are not retained in the designated treatment area long enough to produce satisfactory results.

Field Trials

Endothall(DASM) - Series A

In order to evaluate the new aluminum salt of endothall (13.4% a.e.) formulation, a preliminary series of field trials was set up in 1967 using the commercially available dipotassium salt of endothall (28.6% a.e.) product as a standard.

A large 200 acre lake in eastern Massachusetts was selected as a site for the preliminary field tests. Six 2500 square foot plots were established along the perimeter of the lake in an area where the water exchange was minimal and the weed population was constant. The plots, which averaged 3.5 feet in depth, contained numerous submersed, floating and emersed species, commonly found in soft-acid New England waters.

The endothall(DASM) was applied at rates of 1.0, 2.0 and 3.0 parts per million. The dipotassium salt of endothall formulation was applied at rates of 2.0, 4.0 and 6.0 ppm. Table I summarizes the results obtained.

Endothall(DASM) - Series B

Field testing of endothall(DASM) was continued in 1968 with an additional series of test plots. Six 2500 square foot plots and three 5000 square foot plots were set out in a series of state-owned ponds in eastern Massachusetts. Three replicates, at application rates of 0.5, 1.0 and 2.0 ppm, were employed in these field trials.

As in the earlier preliminary tests, the equipment used to apply the particulate formulation was a 2 h.p. Hypro Model N 4100 C Nylon Roller Pump equipped with jet agitator, volume booster, OC-10 nozzle and spray-boom with positive shut-off valve. The test plot treatment pattern established consisted of 75% underwater application and the remaining 25% surface application. The results observed are summarized in Table II.

Silvex(MASM) - Series C

A second controlled release particulate formulation was field tested in 1968. The monohydroxy aluminum salt of silvex on mica-carrier was applied at a rate of 0.5 ppm to a three acre pond with an average depth of 3 feet. In an adjacent body of water, separated from the first by a 15 foot causeway, the propylene glycol butyl ether ester formulation of silvex was applied

at an identical rate of 0.5 ppm. The second pond was slightly larger than the first, being five acres in size, having an average depth of 4 feet. The aquatic weed populations and limnological parameters of the adjacent ponds were similar.

Unlike the endothall field tests, the silvex trials were applied utilizing the Chemical-Injection-System, employing a slurry-proportioning chamber. Considerable mechanical agitation was necessary prior to the silvex(MSDM) application. The results obtained from this series of experimental field trials are summarized in Table III.

Discussion

The results obtained in Series A appeared to indicate that the particulate controlled release formulation was somewhat more effective than the liquid dipotassium salt of endothall material. The 3M formulation produced consistantly better control of *Potamogeton natans* and *P. amplifolius* at equivalent rates than did the standard material. Control of *Myriophyllum heterophyllum* and *Utricularia purpurea* in all three aluminum salt plots were considerably higher than those observed in the dipotassium salt plots. Thirty days after application, the golden particles could still be observed on the dead and dying aquatic plants.

The results obtained from the field testing of endothall (DASM) in Series B confirmed the 1967 results. *Potamogeton natans*, *P. epihydrus*, *Elodea canadensis* and *Utricularia vulgaris* all exhibited significant control in plots treated with 1.0 and 2.0 ppm. However, plots treated at the 0.5 ppm rate proved to be somewhat less effective.

The results obtained in Series C, where the aluminum salt of silvex was compared with the propylene glycol butyl ether ester formulation of silvex at the same rate (0.5 ppm), appear to indicate that this liquid formulation was somewhat more active. However, the field results noted suggest that higher rates of silvex(MASM), 1.0 - 2.0 ppm might result in more uniform findings particularly in the control of floating species such as *Nymphaea odorata* and *Nuphar advena*.

Under similar field conditions and application rates, the silvex(MASM) formulation showed signs of being somewhat less toxic to fishlife than the liquid formulation as evidenced by the large number of dead fish found in the latter pond twenty-four hours after treatment. No sign of fish mortality was observed in the adjacent pond treated with the mica-carrier product.

The major advantages of the new controlled release formulations appear to be increased herbicidal efficiency and subsequent phytotoxic response due to release of the active component in close proximity to plant tissue. Greater safety with regard to operator handling, a wide margin of safety to fish and wildlife, reduced lateral movement and drift control are positive features. The marking capability of the gold-colored particulate formulation should be noted as a plus factor in its use, particularly on floating and emersed plants.

The disadvantages of these formulations appear to be similar to those inherent in the handling of wettable powders. Since the product is a spray-dried powder, on-site mixing equipment is required in the preparation of the spray solution. While several by-passed agitating devices have been field tested, a mechanical paddle agitator tank appears to be the only satisfactory method by which the material can be properly dissolved and subsequently applied. Since the product requires some degree of contact with the target species to be effective at low rates, thorough application to all parts of the designated treatment area is essential. In addition, the treated area should remain undisturbed during the initial 24-hour release period.

Summary

The new aquatic herbicide formulations of endothall and silvex were field tested over a two-year period. These initial trials appear to indicate that the mica-carrier system, utilizing a controlled release particulate, shows promise as a new development in aquatic weed control.

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TABLE I

Species	Endothall (DASM) Parts per Million 1.0	2.0	3.0	Potassium Endothal Parts per Million 2.0	4.0	6.0
Potamogeton natans	7	9	2	2	7	4
P. amplifolius	0	10	9	7	8	9
Myriophyllum heterophyllum	3	7	6	1	5	5
Utricularia purpurea	0	8	9	0	4	9

TABLE II

Species	Endothall (DASM) Parts per Million 0.5	1.0	2.0
Potamogeton natans	10	10	10
P. epihydrus	10	10	10
Elodea canadensis	0	7	7
Utricularia vulgaris	0	7	6
Nymphaea odorata	2	3	5
Sagittaria latifolia	9	9	9
Juncus effusus	9	9	10

TABLE III

0.5 parts per million

Species	Silvex (MASM)	Silvex PGBEE
Elodea canadensis	6	8
Utricularia vulgaris	8	6
Ceratophyllum demersum	9	9
Nymphaea odorata	8	9
Sagittaria latifolia	10	10
Juncus effusus	10	10

Rating System 0 = No Control 10 = 100% Control

IN MEMORIAM

Howard Burton Musser died August 12, 1968 at the age of 74. Agronomy Professor Emeritus of Pennsylvania State University since 1960, he was an outstanding teacher, scientist, grass breeder, lecturer, author and organizer.

Professor Musser's research interests were broad and varied. He was one of the first to study dry formulations of fertilizers with weed control chemicals. He spent a great deal of time and effort in evaluating fertilizers, particularly the ureaforms.

His development of Penncross bent and Pennlawn creeping red fescue are accomplishments that now are part of turfgrass history. Long-time studies of Kentucky bluegrass led to the recent release of Pennstar, an improved bluegrass for turf.

Many students and turfgrass managers will attest to his ability to teach, and he will long be remembered for his widely used book TURF MANAGEMENT.

During World War I he served with distinction as Chief Petty Officer in Naval aviation. In World War II he rose to the rank of Lieutenant Colonel in the Air Force serving as liaison officer to the corps of Engineers in the interests of turf and of dust control.

The Pennsylvania Turfgrass Council was organized along policy lines that he espoused, and he held the position of Executive Director from the time the Council was started until his death. The Pennsylvania Turfgrass Survey is one of the Council's crowning achievements.

"All work and no play" did not apply to Burt Musser. He played golf of sorts, often concentrating more on the turf than on his game. During his prime there was no coon hunter more avid than he. Fishing held a special fascination, especially in the Canadian lakes. Bowling and a friendly game of cards rounded out his non-professional side of life.

Among the many honors that have been conferred on Professor Musser are Fellow, American Society of Agronomy; U. S. Golf Association Green Section Award; and Golf Course Superintendents Association Award of Merit. He was a member of several scientific honor societies including Sigma Xi, Phi Kappa Phi, and Gamma Sigma Delta.

The turfgrass industry has lost an outstanding pioneer leader although the men he trained will partially compensate for the irreparable loss. Professor Musser has left behind him a better world of turf, a rich heritage of research and teaching, and many friends and associates who miss him and who are grateful for having known him through the years.

PRE- AND POSTEMERGENCE CRABGRASS CONTROL RESULTS FOR 1967 AND 1968.

A. T. Perkins, J. M. Duich, and D. V. Waddington[1]

Preemergence control and turf tolerance were evaluated for spring (1967 and 1968) and late fall application dates. The performance of several new postemergence herbicide combinations was also examined.

Materials and Methods

All tests were conducted at the Joseph Valentine Turfgrass Research Center at University Park, Pennsylvania. The 1967 preemergence control test was conducted on a three year old stand of common Kentucky bluegrass and common creeping red fescue. The test area was over-seeded to a mixture of Digitaria spp. in October 1966 and February 1967. Treatments were applied on May 31, 1967 and crabgrass germination was noted from the first week of June through mid-July.

The 1968 pre- and postemergence tests were conducted on a four year old stand of common Kentucky bluegrass and common creeping red fescue. The area was overseeded in December 1967 and March 1968 to a mixture of Digitaria spp.. The late fall application of preemergence herbicides was made on December 7, 1967 while the spring application was on May 13, 1968. Postemergence materials were applied on July 16 and again on July 26, 1968. Crabgrass germination on all areas was noted from late May through mid-July.

Individual plots were triple replicated with four foot control borders. Dry materials were hand applied with shaker jars and sprays applied with a four nozzle plot boom sprayer at 90 gpa. and 35 psi.

Materials, rates, and results are shown in Tables 1 through 4.

Results

1967 Preemergence Test

ACP 66-326B at 8 and 10 lbs. gave 95 and 90 percent, respectively. Both rates showed heavy initial fescue thinning which recovered to 7 percent by September. Four additional ACP experimentals included in the test at 6 and 8 lbs. showed direct proportionality between effective control and

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increased fescue thinning. Recovery following treatment was essentially complete with September thinning ratings ranging from 0 to 10 percent.

CS6166 and CS6302 gave less than adequate control; the 6166 reached 87 percent with no injury while 6302 gave only 50 percent and slight fescue thinning was noted.

U-22326 at 1, 2, 3 and 4 lbs. gave 65, 77, 67, and 75 percent control respectively, with no apparent injury, although a slight chlorotic effect on the bluegrass was noted.

Three formulations of SD-11831 at rates ranging from 1 to 4 lbs. gave excellent control results, but all materials were phytotoxic to both bluegrass and fescue. Early thinning percentages ranged from 20 to 85 percent with final readings in September of from 5 to 73 percent. Of the three materials, the granular formulation at 1 lb. gave the best combination of effective control and turf tolerance. July thinning was at the 20 percent level and it dropped to 10 percent by September while control was rated at 94 percent.

A combination of two commercially available materials proved unsuccessful. Neburon was added to Siduron to give 2 and 6 lbs. respectively. The Neburon increased control over the Siduron alone by 9 percent, from 78 to 87, but it also added some initial thinning of the fescue. The Neburon alone at 2 lbs. gave no control and the same injury as the combination whereas the same formulation of Siduron at 10 lbs. gave 98 percent control and no injury.

The four remaining commercially available materials in the test gave predictable results. DCPA at 10 lbs. showed 93 percent control with fescue thinning at 50 percent early and 12 percent in September. Benefin control was 93 and 100 percent at 1.5 and 3 lbs. but injury to both bluegrass and fescue was noted. The 3 lb. rate particularly, thinned both species at the 65 percent level in July while recovering to 18 percent by September. The granular formulation of Siduron at 10 and 15 lbs. gave 98 and 100 percent control while showing no injury. The control rating for Bensulide was somewhat lower than past experience would have indicated and would suggest that the 12.5 lb. application rate is slightly less than required to give the consistently high level of control expected from this material.

1968 Preemergence Test

With the exception of the 75W formulation of SD-11831 the performance for the commercially available herbicides parallels that reported for 1967. This year, the SD-11831 gave comparable control results, but the rather high phytoxicity reported for this chemical in 1967 did not materialize in the 1968 test. Control was rated at 94 percent whereas injury was limited to fescue at a much reduced level of 10 percent in July and only a trace in September.

A series of four experimental materials, UCS-438, LCS-992, UC-643, and UC-437 included in two formulations showed little or no crabgrass activity but rather high levels of phytotoxicity to both bluegrass and fescue turf.

The U-22326 experimental with rates increased from its 1967 levels of 1, 2, 3, and 4 lbs. to 8 and 12 lbs. showed much improved control ratings of 90 and 96 percent. No injury was noted nor was the chlorosis as reported for 1967.

1968 Fall Applied Preemergence Test

The objectives of this late fall application date were to determine if most commercially available and several promising experimental materials would maintain a sufficient level of toxicity to provide season long crabgrass control. Success with this approach would add managerial flexibility to a crabgrass control program. Results were not totally unpredictable when compared with Spring treatments which were followed by delayed periods of crabgrass germination. Nevertheless, the high levels of control with several materials has to be somewhat unexpected.

Bensulide, both granular and sprayable formulations, showed full season control at 95 and 98 percent respectively. DCPA rated 99 percent control in September with a slight fescue thinning still visible.

The remainder of the materials fell off considerably from their normal performance. Siduron was the most disappointing with a final rating of 0 percent control.

Activity resulting in injury to fescue for ACP 66-326B and fescue plus bluegrass for SD-11831 appeared to occur during the winter and was noted upon spring greenup. The thinning which occurred with Benefin and DCPA occurred mainly during June.

The disparity between the July and September control ratings, particularly for the Siduron, U-22326, and ACP 66-326B, can be attributed to a prolonged crabgrass germination during the latter part of July.

1968 Postemergence Test

After only two applications, several new combination materials showed promising control results. Velsicol's formulation of Dicamba and MSMA applied to give .4 and 2.6 lbs. had the highest control rating of 96 percent with 25 percent fescue thinning noted. The ACP 68-105 combined Siduron and DSMA to give 10 and 3 lbs., and resulted in 91 percent control with no lasting injury.

All other materials fell off considerably with only Vaughn's experimental and a combination of Siduron and PMA reaching better than 50 percent control. Both components of this latter combination showed no control when separately applied.

Varying degrees of discoloration were noted for all formulations containing PMA or methyl arsonates.

The effectiveness of the two combination materials offers hope of making the postemergence approach to crabgrass control more realistic than in the past.

Table 1. 1967 crabgrass (*Digitaria* spp.) control and/or injury ratings from a May application of preemergence herbicides on bluegrass-fescue turf at University Park.

Chemical	Form.	Rate a.i./A	Crabgrass % Control	% Thinning July	% Thinning Sept.	Species Injured*
ACP 66-326B	1ec	8	95	25	7	F
"		10	90	30	7	F
U-22326	50W	1	65	0**	0	
"		2	77	0**	0	
"		3	67	0**	0	
"		4	75	0**	0	
SD-11831	4ec	1	80	30	5	F B
(XP-882)		1.5	98	60	18	F B
"		2	99	75	32	F B
SD-11831	75W	1	90	35	10	F B
"		1.5	98	70	25	F B
"		2	99	75	35	F B
Siduron	50W	10	98	0	0	
"		6	78	0	0	
Siduron + Neburon		6+2	87	10	0	F
Neburon	50W	2	0	10	0	F
DCPA	75W	10	93	50	12	F
Benefin	2.5G	1.5	93	40	10	F B
"		3	100	65	18	F B
SD-11831	0.92G	1	94	20	10	F B
(XP-810)		2	99	60	38	F B
"		4	100	85	73	F B
CS 6166	4.35G	12.5	87	0	0	
CS 6302	3.50G	10	50	20	3	F
ACP 65-27	4V	6	99	35	5	F
"		8	100	40	10	F
ACP 67-140	4V	6	94	25	3	F
"		8	99	30	5	F
ACP 67-143	4V	6	62	0	0	
"		8	45	0	0	
ACP 67-145	4V	6	78	20	0	F
"		8	100	30	0	F
Bensulide	7G	12.5	85	0	0	
Siduron	4.31G	10	98	0	0	
"		15	100	0	0	

*F = red fescue, B = Kentucky bluegrass
**slight chlorosis

Table 2. 1968 crabgrass (Digitaria spp.) control and/or injury ratings from a May application of preemergence herbicides on bluegrass-fescue turf at University Park.

Material	Form.	Rate a.i./A	Crabgrass % Control	% Thinning July	% Thinning Sept.	Species Injured
UCS-438	5G	3	Low*	20	13	F B**
LCS-992	"	"	"	17	35	F B
UC-643	"	"	"	68	60	F B
UC-437	"	"	"	88	80	F B
UCS-438	1EC	"	"	100	98	F B
LCS-992	"	"	"	73	68	F B
UC-643	"	"	"	42	36	F B
UC-437	"	"	" *	87	78	F B
U-22326	50W	8	90	0	0	
U-22326	"	12	96	0	0	
Bensulide	12.5G	12.5	94	0	0	
Benefin	2.5G	2	95	23	10	F
SD-11831	6G	1.5	80	3	0	F
Bensulide	4EC	12.5	96	0	0	
DCPA	75W	10	99+	10	3	F
SD-11831	75W	1.5	94	10	2	F
Siduron	50W	10	91	0	0	

*Due to phytotoxicity of these eight materials, the crabgrass in these plots was very large and covered the entire plot and an estimate of % control was very difficult to obtain. Nevertheless, they did show control ratings in the range of approx. 5-30%

**F = fescue B = bluegrass

Table 3. 1968 crabgrass (Digitaria spp.) control and/or injury ratings from a December 7, 1967 application of preemergence herbicides on bluegrass-fescue turf at University Park.

Material	Form.	Rate a.i./A	Crabgrass % Control July	Crabgrass % Control Sept.	% Thinning July	% Thinning Sept.	Species Injured
U-22326	50W	8	76	58*	0	0	
ACP 66-326B	1EC	10	85	50*	20	10	F
Bensulide	4EC	12.5	99+	98	0	0	
Siduron	50W	10	20	0*	0	0	
DCPA	75W	10	99+	99	15	Sl.	F
SD-11831	75W	1.5	35	10*	65	46	F B
Bensulide	7G	12.5	95	95	0	0	
Benefin	2.5G	2	80	60*	15	Sl.	F

*Decrease in Sept. control rating due to minor crabgrass germination in late July.

Table 4. 1968 crabgrass (Digitaria spp.) control and/or injury ratings from July 16 and July 26 applications of postemergence herbicides on bluegrass-fescue turf at University Park.

Material	Form.	Rate a.i./A	Crabgrass % Control	% Thinning Sept.	Species Injured
Dicamba + MSMA	EC	.4 + 2.6	96	25*	F
ACP 68-105 (Siduron + DSMA)	WP	10 + 3	91	0*	
DSMA	WP	3	15	0*	
Siduron	50W	10	0	0	
PMA	10%	5 pts.	0	0*	
Siduron + PMA	---	10 + 5 pts.	53	0*	
Vaughn's Expt.	---	7.5 qts.	67	0*	

*Characteristic discoloration present following both applications of all materials containing PMA or methyl arsonates.

FALL AND SPRING USE OF PREEMERGENT CRABGRASS CONTROL CHEMICALS IN TURFGRASS 1/

John A. Jagschitz 2/

Preemergent herbicides have been used for the selective control of crabgrass in turfgrass for several years. Each year experimental formulations of herbicides are released by industry. One of the two tests reported in this paper investigates several of these materials to find safer and more effective chemicals. This test also attempts to determine if spring-applied chemicals remain effective for late season crabgrass germination.

The time of herbicide application in spring has been shown to influence the degree of crabgrass control obtained (2, 3). Limited work has been conducted on the use of herbicides in the fall for control in the following year (1, 4). In the other test reported in this paper, herbicides have been applied in the fall to determine if they will control crabgrass the following year.

Materials and Methods

The two tests were conducted at the turfgrass research area at the Rhode Island Agricultural Experiment Station. The soil in the test area is classified as Bridgehampton silt loam. The turfgrass was maintained at a cutting height of one inch and was fertilized during the summer with a 10-6-4 fertilizer at the rate of 20 lb per 1000 sq ft. Irrigation was used during the season to encourage crabgrass germination and avert drought conditions.

Granular herbicides were applied by hand and sprays were applied in water at the rate of 272 gpa. A pressure sprayer adjusted to a constant pressure of 30 psi and equipped with a fan nozzle was used. The herbicides were applied to randomized plots which were 4 ft x 5 ft in size and replicated in three blocks. Irrigation was used after treatment to wash the herbicides into the soil.

Visual estimates of turfgrass injury were made monthly from May through September. The injury scale used was 0-10 with 0 being no injury and 10 representing complete brown or dead turf. An estimate of bare area of each plot was made in September as an indication of stand injury. Estimates of crabgrass coverage on each plot were made in August and/or September. Percent control was obtained by comparing the treated plots with untreated checks. There were a minimum of nine check plots in each test.

Test No. 1 was initiated to evaluate the effectiveness of fall and spring applications of several preemergent herbicides. The turfgrass was established in the fall of 1964 with Kentucky bluegrass, Merion bluegrass, Pennlawn red

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fescue and Exeter colonial bentgrass. A natural stand of crabgrass was present during the 1967 season from prior overseeding with crabgrass seed. It was overseeded again in December 1967 and July 1968 to ensure a crabgrass population. Twelve herbicide treatments were applied in the fall (Oct. 17, 1967) and in the spring (April 29, 1968). Crabgrass control estimates were made on September 5, 1968. The herbicides, formulations and rates used are shown in Table 1.

Test No. 2 was initiated in May 1968 to evaluate standard and new herbicides as well as different formulations and rates. An attempt was also made to determine the control of late season crabgrass germination. The turf was established in the fall of 1966 with red fescue and Kentucky bluegrass.

In the spring of 1967 the area was treated with an aero-blade machine and overseeded with crabgrass. It was overseeded again in December 1967 and on July 23, 1968. Thirty-nine herbicide treatments were applied in May 1968. All herbicides were applied by May 8 with the exception of the bensulide and siduron (wp) treatments, which were applied on May 16. Crabgrass control estimates were made on August 7 and September 3, 1968. The herbicides, formulations and rates used are shown in Table 2. The chemical names and companies supplying the herbicides for these tests appear in the Appendix.

Results and Discussion

Test No. 1 -- Effectiveness of fall and spring treatments

The results of the 12 herbicide treatments applied in the fall and spring are presented in Table 1. Six herbicides applied in the fall and spring produced excellent results, i.e., crabgrass control near 90% or better with minimum turf injury (less than 2.0 injury or 10% bare). These were the bandane, bensulide, and DMPA treatments. Excellent crabgrass control from fall use suggests that these herbicides have relatively long lasting residual effectiveness.

The fall and spring treatments of DCPA produced excellent crabgrass control, but caused severe thinning of fescue and bentgrass. Nitralin produced excellent crabgrass control when applied in the fall or spring, but the fall application caused more than minimum turf injury.

Siduron and terbutol produced excellent results when applied in the spring, but the fall treatments gave poor results. The fall use of nitralin and of terbutol resulted in severe turfgrass injury. In the spring of the last four years injury has been observed in turfgrass treated the previous spring with terbutol. The grasses were slow to green-up and the turf was thin and open. The injury observed in the spring from the fall use of terbutol was much more severe. It appears that high concentration of nitralin and terbutol in turfgrass during the fall to early spring will cause considerable turf injury.

Poor crabgrass control was produced by benefin when applied in either the fall or spring.

Table 1. Percent crabgrass control, turf injury and percent bare estimates from the application of herbicides in the fall and spring.

Herbicide and formulation	ai	Rate lb ai/A	Percent crabgrass control Sept 1968	Max turf injury *	Percent bare Sept 1968
Fall treatment 1967					
bandane (verm)	10%	35	92	.7	5
benefin (gran)	2.5%	2	63	1.0	2
bensulide (cob)	7%	10	99	1.5	3
" " "	"	15	99	.8	8
bensulide (ec)	4#/gal	10	97	.7	7
" " "	"	15	99	1.7	7
DCPA (verm)	4.92%	10	98	2.2	13 **
DMPA (cob)	4.4%	15	90	.7	3
terbutol (verm)	5%	10	32	6.4	3
nitralin (gran)	.46%	2.4	89	3.6	17
siduron (gran)	5.7%	12	7	.1	-
" " "	"	18	24	.3	-
Spring treatment 1968					
bandane (verm)	10%	35	95	.5	6
benefin (gran)	2.5%	2	55	.5	2
bensulide (cob)	7%	10	99	.3	4
" " "	"	15	99	.1	4
bensulide (ec)	4#/gal	10	99	1.0	6
" " "	"	15	100	.5	5
DCPA (verm)	4.92%	10	99	2.8	15 **
DMPA (cob)	4.4%	15	97	1.5	9
terbutol (verm)	5%	10	95	.7	7
nitralin (gran)	.46%	2.4	95	1.1	5
siduron (gran)	5.7%	12	92	.0	4
" " "	"	18	97	.3	6
Checks	-	-	-	.0	-

Ave. crabgrass cover in check plots = 67%

*Turf injury scale 0-10 (0 = none, 10 = complete brown or kill) from May to Sept.

**Reduction in bentgrass and fescue.

Test No. 2 -- Herbicide evaluation and effect of late crabgrass germination

The results of the herbicide treatments applied in early May 1968 are presented in Table 2. Crabgrass control estimates made in August reflect the control of crabgrass which germinated in late May and June. The decrease in control as evidenced by September estimates is due to the increased growth of these crabgrass plants and/or to the presence of new plants from the crabgrass seeding made in late July. Treatments which showed a decrease in control chiefly due to the presence of new plants were as follows: benefin formulations at the 2 and 3 lb rate, nitralin formulations at the 1½ and 2 lb rate, NC-5651 at the 8 lb rate and siduron at rates up to 15 lbs. These herbicides evidently have a relatively short period of residual effectiveness.

The benefin formulations at the 1½ lb rate produced poor crabgrass control (70% or less). At the 2 and 3 lb rate the 0.57% formulation performed slightly better than the 2.5% formulation with control ranging from 70-85%. Turf injury produced by the 3 lb rate of benefin was moderate (2.0-4.0) indicating limited turf tolerance.

Poor crabgrass control was produced by the 12.5% cob formulation of bensulide. Since excellent control was obtained from a 7% cob formulation in Test No. 1, possibly the higher concentrated formulation in this test resulted in poor distribution of the herbicide. Poor control may also have been due to the late herbicide application in relation to crabgrass germination.

The four DCPA formulations gave excellent crabgrass control, but produced a severe reduction in fescue grass plants. Turf injury was not reflected in the injury estimates due to the fertilizer effect of each formulation.

Of the two experimental herbicides, R-3552 and NC-5651, only NC-5651 showed a potential for effective crabgrass control. This herbicide should be investigated further at rates above 8 lbs to determine the safe turf tolerance limits. If economically feasible, R-3552 could also be investigated further since turf injury at the rates used was minimum.

The granular and spray formulations of nitralin at comparable rates produced similar crabgrass control, but the sprays gave greater turf injury. At the 3 lb rate the sprays produced more than minimum turf injury. Crabgrass control was in the 80% range at the 1½ lb rate and in the 90% range at the 3 lb rate. As with benefin the margin of safety to turfgrass is limited.

The herbicide neburon was ineffective in controlling crabgrass, but when applied with siduron at the 6 lb rate the combination was slightly more effective than either herbicide alone. The 5.7% formulation of siduron produced better crabgrass control than the 3.6% formulation. Crabgrass control produced by the 5.7% formulation at rates from 10 to 15 lbs varied between 87-91% with no more than minimum turf injury.

Table 2. Percent crabgrass control, turf injury and percent bare estimates from treatments applied in May 1968.

Herbicide and formulation	ai	Rate lb ai/A	Percent crabgrass control Aug.	Percent crabgrass control Sept	Max turf injury *	Percent bare Sept
benefin (gran)	2.5	1.5	85	68	.3	0
" " "	"	2	88	70	1.3	2
" " "	"	3	93	76	2.5	6
benefin (gran MF-387)	.57	1.5	89	69	.8	-
" " " "	"	2	96	85	.6	0
" " " "	"	3	96	83	2.0	5
bensulide (cob)	12.5	10	73	63	.9	3
DCPA (fert)	2.28	10	100	99	1.0	1 **
" "	"	20	100	99	.7	1 **
DCPA+2,4,5-T (fert)	2.28+.6	10+2.6	99	98	1.7	4 **
DCPA+picloram (fert)	2.28+.125	10+.54	100	99	1.2	3 **
DCPA+U-22326 (fert)	2.28+1	10+2.4	100	99	.7	1 **
NC-5651 (wp)	20	.5	30	13	.0	-
" " "	"	1	4	4	.3	-
" " "	"	2	29	21	.0	-
" " "	"	4	63	45	.2	-
" " "	"	8	98	88	.6	1
R-3552 (wp)	50	1	4	1	.0	-
" " "	"	2	15	15	.1	-
" " "	"	4	21	9	.3	-
" " "	"	8	4	3	.0	-
" " "	"	16	18	5	.0	-
nitralin (gran)	.46	1.5	97	89	.7	1
" " "	"	3	99	99	1.3	1
nitralin (gran)	2	1.5	95	86	.7	2
" " "	"	2	92	79	.7	1
" " "	"	3	99	96	1.4	2
nitralin (wdl)	4#/gal	1.5	96	85	1.3	5
" " "	"	3	99	99	2.5	4
nitralin (wp)	75	1.5	97	86	1.2	1
" " "	"	3	99	99	3.5	11
siduron (verm)	5.7	10	97	89	.5	2
" " "	"	12	93	87	.6	2
" " "	"	15	99	91	1.2	1
siduron (gran)	3.6	10	88	74	.3	0
siduron (wp)	50	6	91	80	.4	0
neburon (wp)	50	2	11	0	.3	-
siduron+neburon (wp)	50+50	6+2	98	89	.5	2
Checks	-	-	-	-	.0	-
Ave crabgrass cover in check plots			80%	95%		

*Turf injury 0-10

**Reduction in fescue

Conclusions

Two experiments were conducted in lawn-type turf during the 1967-68 season to evaluate preemergent crabgrass herbicides. One test evaluated the effectiveness of fall and spring applications. The second test compared standard and new herbicides as well as different formulations and rates. The effect of late season crabgrass germination was also studied. The following conclusions are drawn on based on the results of these studies.

1. Bandane, bensulide and DMPA gave effective crabgrass control with minimum turfgrass injury when applied in either the fall or spring while benefin gave poor control and DCPA caused thinning of fescue and bentgrass.

2. Spring treatments of nitralin, siduron and terbutol gave effective crabgrass control with minimum turfgrass injury while fall treatments produced poor control and/or turf injury.

3. Benefin, NC-5651, nitralin, and siduron have a relatively short period of residual effectiveness.

4. NC-5651 proved to be a potential herbicide for the selective control of crabgrass in lawn-type turf.

5. Granular formulations of nitralin produced less injury than spray formulations while both had comparable degrees of crabgrass control.

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Appendix

Herbicide	Company	Chemical Name
bandane	Velsiocol	polychorodicyclopentadiene isomers
benefin	Eli Lilly Mallinckrodt	N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine
bensulide	Stauffer	O,O-diisopropyl phosphorodithioate S ester with N-(2-mercaptoethyl) benzenesulfonamide
DCPA	Diamond Shamrock	dimethyl tetrachloroterephthalate
DMPA	Dow	O-(2,4-dichlorophenyl) O-methyl isopropyl-phosphoramidothioate
terbutol	Hercules	2,6-di-tert-butyl-p-tolyl methylcarbamate
neburon	DuPont	1-butyl-3-(3,4-dichlorophenyl)-1-methylurea
nitralin	Shell	4-(methyl-sulfonyl)-2,6-dinitro-N,N-dipropyla-niline
siduron	DuPont	1-(2-methyl-cyclohexy)-3-phenylurea
R-3552	Stauffer	4-chlorobenzenesulfono-2-toluidide
NC-5651	Fisons	Not available
2,4,5-T	Diamond Shamrock	(2,4,5-trichloro-phenoxy) acetic acid
picloram	Diamond Shamrock	4-amino-3,5,6-trichloropicolinic acid
U-22326	Diamond Shamrock	Not available

PERSISTENCE AND COUNTERACTION OF BENSULIDE IN TURF

J. F. Ahrens[1/]

ABSTRACT

An established stand of Kentucky bluegrass (Poa pratensis L.) on a loamy sand soil was treated with granular bensulide [N-(2-mercaptoethyl) benzenesulfonamide S-(O,O-diisopropylphosphorodithioate)] at 20 lb/A in early May of 1965 and 1966. Crabgrass (Digitaria spp.) control and stands of bluegrass were observed in 1965, 1966 and 1967. In May 1967 soil cores were taken at depths of 0 to 2 in, 2 to 4 in and 4 to 6 in for the estimation of bensulide residues. To estimate bensulide residues root growth of a sorghum-sudan hybrid in the soil samples was compared with root growth in soil treated with known levels of bensulide.

In greenhouse and field studies during 1965, 1966 and 1967 the counteraction of bensulide in soil with powdered activated carbon (Aqua Nuchar A) was investigated.

Kentucky bluegrass treated with bensulide in 1965 and 1966 and maintained at good fertility and moisture levels showed no thinning. In the fall of 1967, however, following a season of no fertilization and frequent drought stress, the turf was thinned an average of 26% in the bensulide plots. Crabgrass control in 1967 was an estimated 98%. Bensulide residues in the upper 6 in of soil in May 1967 were estimated at 7 lb/A or about 1/3 of the amount applied in 1966. An estimated 80.4% was found at 0 to 2 in, 12.5% was found at 2 to 4 in and 7.1% at 4 to 6 in.

Activated carbon proved effective in adsorbing and counteracting bensulide in soil. Mixed thoroughly into potted soil containing bensulide at 25 ppm, activated carbon at 500 ppm allowed the establishment of a satisfactory stand of ryegrass (Lolium perenne L.). To completely prevent depression of early growth, however, 1000 to 2000 ppm of carbon was required. Raked into the soil 3 weeks after applying bensulide at 15 lb/A, activated carbon at 300 lb/A gave 60 to 70% stands of Kentucky bluegrass, compared with no stands without carbon. Rototilled into the soil soon after applying bensulide at 15 lb/A, activated carbon at 300 lb/A completely protected seeded oats (Avena sativa L.) or rye (Secale cereale L.) but 450 lb/A gave only 40 to 60% protection of seeded crabgrass. Since most of the bensulide residue in turf soil remains near the surface, shallow incorporation of activated carbon before seeding can be expected to be most effective.

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EFFECTS OF SOIL-INCORPORATED HERBICIDES ON TURFGRASS AND WEED ESTABLISHMENT 1/

J. A. Jagschitz 2/

Preemergent herbicides are used to control weedy grasses, such as crabgrass, in turfgrass areas and broadleaf-type weeds as they emerge in other agricultural crops (1, 3, 5). Little information is available on their value for preventing broadleaf-type weeds in turf areas. These weeds are presently controlled after they become established by using such post-emergent herbicides as 2,4-D and dicamba. Work initiated last year at Rhode Island indicated that herbicides may prevent such broadleaf weeds as dandelion from becoming established from seed (6).

In order to determine the effect of eleven herbicide formulations on broadleaf weeds grown alone from seed, a test was conducted in 1968. In addition to broadleaf weeds the test included turfgrasses to confirm previous studies of the effects of some of these herbicides on turfgrass establishment (2,4).

Materials and Methods

The test was initiated in 1968 at the turfgrass research area of the Rhode Island Agricultural Experiment Station. The soil in the test area is classified as Bridgehampton silt loam. The area was tilled, leveled and prepared properly as a seedbed.

On July 2, 1968 eleven herbicide treatments and two checks were randomly applied to the surface of six sets of 13 plots and raked into the top inch of loose soil. Individual plots measured 4 ft x 4 ft. Dry granular herbicides (bensulide, siduron and the DCPA formulations) were applied by hand and the other herbicides as sprays in water at the rate of 109 gpa. The herbicides and rates used are presented in the tables. The chemical name and companies supplying the herbicides appear in the appendix.

Two randomly selected sets of plots were seeded at 2 weeks, two at 5 weeks and two at 8 weeks after herbicide application. The soil was loosened to a depth of about one inch and seeded by hand. Half of each plot was seeded with dandelion and mouseear chickweed at 20 g and 10 g per 1000 sq ft and the other half with carpetweed, Park Kentucky bluegrass and Pennlawn fescue at the rate of 10 g, 1.5 lb and 1.5 lb per 1000 sq ft, respectively.

Estimates of turf establishment were made visually three and six weeks after seeding as percentage of ground cover. Plant counts of

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carpetweed were made three weeks after seeding and dandelion and mouseear chickweed at six weeks. Visual weed coverage was estimated three weeks following the counts as an indication of plant growth and vigor.

Results and Discussion

Turfgrass Establishment

Establishment of turfgrass from seedings made two, five and eight weeks after seedbed treatments with herbicides is presented in Table 1. Considerable reduction in turf stand resulted from bensulide, DCPA and the DCPA formulations. This reduction was evident with the seedings made at all three intervals after herbicide use. Little or no reduction of the bluegrass or fescue stand was noted in seedings made at any interval after the use of bromoxynil, dicamba, ioxynil, picloram, siduron or 2,4-D.

Table 1. Percent turfgrass stand from seedings made two, five and eight weeks after seedbed treatment with herbicides.

		Percent turfgrass stand					
		2 wk seeding		5 wk seeding		8 wk seeding	
Herbicide	Rate lb ai/A	3 wk stand	6 wk stand	3 wk stand	6 wk stand	3 wk stand	6 wk stand
bensulide	15	4	15	6	27	7	13
siduron	12	26	70	38	93	16	74
DCPA	10	1	4	11	58	4	18
DCPA+2,4,5-T	10+2.6	2	7	3	65	6	23
DCPA+picloram	10+.54	4	13	6	40	3	15
DCPA+U-22326	10+4.4	1	3	2	17	4	16
2,4-D	1	41	78	45	94	19	83
dicamba	.25	41	75	45	96	15	75
picloram	.125	25	63	38	93	22	73
bromoxynil	.5	33	63	42	95	21	75
ioxynil	.5	38	73	43	92	30	79
Check	--	39	75	41	95	26	82

Carpetweed Control

Results of the seeding of carpetweed in plots treated two and five weeks earlier with herbicides are presented in Table 2. Data for the eight week seeding is not presented because of the poor germination of carpetweed.

Carpetweed is a summer annual and the climatic conditions in late August appeared to be unfavorable. Good control of carpetweed in the two and five week seedings was produced by picloram, DCPA and the DCPA formulations. Other herbicides appeared to have little effect on carpetweed establishment.

Table 2. Percent carpetweed control in seedings made two and five weeks after seedbed treatment with herbicides.

		Percent carpetweed control*			
		2 week seeding		5 week seeding	
Herbicide	Rate lb ai/A	3 wks after	6 wks after	3 wks after	6 wks after
bensulide	15	10	0	0	0
siduron	12	24	7	5	37
DCPA	10	94	89	79	89
DCPA+2,4,5-T	10+2.6	98	85	86	89
DCPA+picloram	10+.54	100	99	100	100
DCPA+U-22326	10+4.4	100	93	100	99
2,4-D	1	0	0	24	3
dicamba	.25	0	0	4	19
picloram	.125	84	50	68	71
bromoxynil	.5	0	0	0	0
ioxynil	.5	13	11	0	3
Ave carpetweed in check plot		198 plants	14% cover	232 plants	19% cover

*Control 3 weeks after seeding based on plant counts and control 6 weeks after seeding based on plant cover.

Control of Dandelion and Chickweed

Control estimates of dandelion and mouseear chickweed are presented in Tables 3 and 4, respectively. Control based on individual plant counts and those at a later date based on ground coverage were similar with few exceptions. Higher control values obtained from cover estimates was due to the small size of affected plants. Unpublished counts, made at the time of cover estimates, indicated only slight changes in plant numbers. The effect of the chemical on growth was largely reflected in the control figures based on coverage. Both types of control estimates yield valuable information. The plant cover in the check plots indicated that dandelion growth

was very slow in the nine week period following the final seeding. This was due to the cool weather during the later part of the season.

The data in Tables 3 and 4 indicate that some of the herbicides produced good control of both dandelion and chickweed. Establishment of these weeds was greatly reduced in seedbeds treated with picloram, siduron, DCPA and the DCPA formulations. These chemicals prevented weed establishment up to eight weeks after their use. The other herbicides (bensulide, 2,4-D, bromoxynil, dicamba, and ioxynil) appeared to have no consistent effect on suppressing dandelion or chickweed establishment.

Table 3. Percent dandelion control in seedbeds treated two, five and eight weeks earlier with herbicides.

		Percent dandelion control*					
		2 wk seeding		5 wk seeding		8 wk seeding	
Herbicide	Rate lb ai/A	6 wks after	9 wks after	6 wks after	9 wks after	6 wks after	9 wks after
bensulide	15	36	52	11	57	9	17
siduron	12	100	100	88	94	94	99
DCPA	10	74	88	0	81	42	86
DCPA+2,4,5-T	10+2.6	83	88	52	84	35	59
DCPA+picloram	10+.54	100	100	99	100	100	100
DCPA+U-22326	10+4.4	93	100	59	91	44	90
2,4-D	1	13	12	16	36	7	29
dicamba	.25	18	21	0	10	17	29
picloram	.125	100	100	99	99	98	100
bromoxynil	.5	13	13	0	10	27	46
ioxynil	.5	15	43	0	22	10	9
Ave dandelion in check plot		84 plants	34% cover	90 plants	36% cover	79 plants	3% cover

*Control 6 weeks after seeding based on plant counts and control 9 weeks after seeding based on plant cover.

Table 4. Percent mouseear chickweed control in seedbeds treated two, five and eight weeks earlier with herbicides.

		Percent chickweed control*					
		2 wk seeding		5 wk seeding		8 wk seeding	
Herbicide	Rate lb ai/A	6 wks after	9 wks after	6 wks after	9 wks after	6 wks after	9 wks after
bensulide	15	27	50	19	39	12	25
siduron	12	100	100	94	95	97	99
DCPA	10	99	99	72	84	89	99
DCPA+2,4,5-T	10+2.6	86	88	58	51	73	93
DCPA+picloram	10+.54	100	100	99	100	100	100
DCPA+U-22326	10+4.4	98	93	95	96	92	99
2,4-D	1	0	0	12	27	0	12
dicamba	.25	40	49	10	27	0	22
picloram	.125	100	100	99	99	97	99
bromoxynil	.5	15	47	0	6	6	42
ioxynil	.5	10	7	10	14	1	25
Ave chickweed in check plots		80 plants	48% cover	124 plants	51% cover	174 plants	13% cover

*Control 6 weeks after seeding based on plant counts and control 9 weeks after seeding based on plant cover.

Conclusions

During the 1968 season several herbicides were applied to soils in a prepared seedbed area. Seedings of turfgrass, carpetweed, dandelion and mouse-ear chickweed were made at two, five and eight week intervals following herbicide use. Based on the results of this test, the following conclusions may be reached:

Park Kentucky bluegrass and Pennlawn fescue were inhibited in seedbeds treated up to eight weeks earlier with bensulide, DCPA and formulations of DCPA plus 2,4,5-T, picloram or U-22326. Slight or no turfgrass inhibition was produced by bromoxynil, dicamba, ioxynil, picloram, siduron or 2,4-D.

Good control of carpetweed was produced in seedings made up to five weeks after the use of picloram, DCPA and other DCPA formulations in the seedbed.

Establishment of dandelion and mouseear chickweed was greatly reduced in seedbeds treated up to eight weeks earlier with siduron, picloram, DCPA and other DCPA formulations. Little or no consistent effect was noted from bensulide, bromoxynil, dicamba, ioxynil and 2,4-D.

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Appendix

Herbicide	Company	Chemical Name
bensulide	Stauffer	0,0-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl)benzenesulfonamide
bromoxynil	Amchem	3,5-dibromo-4-hydroxybenzonitrile
DCPA	Diamond Shamrock	dimethyl tetrachloroterephthalate
dicamba	Velsicol	2,6-dichloro-o-anisic acid
ioxynil	Rhodia	4-hydroxy-3,5-diiodobenzonitrile
picloram	Dow	4-amino-3,5,6-trichloropicolinic acid
siduron	DuPont	1-(2-methylcyclohexyl)-3-phenylurea
2,4-D	Amchem	(2,4-dichlorophenoxy)acetic acid
2,4,5-T	Diamond Shamrock	(2,4,5-trichlorophenoxy)acetic acid
U-22326	Upjohn	Name not available

Low Volume Extraction Techniques for Increased Trifluralin Recovery

ABSTRACT

W.R. Schmidt and J.V. Parochetti[1/]

Losses of trifluralin (alpha, alpha, alpha trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine) by volatilization and adherance to glass were encountered in metabolic studies under laboratory conditions. Several techniques were developed which increased the percent of recovery of trifluralin. C^{14}-trifluralin treated seedlings were grown in liquid scintillation vials to prevent loss of trifluralin. This procedure eliminated the loss of that portion of the herbicide which adhered to the glass walls of containers used prior to transferring to counting vials. The seedlings were removed, rinsed with counting solution as the toluene and phosphor mixture was being added to the vial, and then this solution was counted.

To prevent the rapid loss of the herbicide from the open vial, a mixture of Florisil and Sephadex was added to the water-trifluralin solution at seeding time. These materials have an affinity for trifluralin, in addition to permitting efficient counting of the ^{14}C-labelled herbicide. Another technique for retaining trifluralin was the placement of 1/4 inch thick foam rubber disks at the bottom of the vials. In studies involving large-seeded plants, the seeds were placed in slits in the foam rubber, thus allowing uniform inhibition and gas exchange.

In order to increase the recovery of the labelled herbicide, treated plant material was crushed in a separate scintillation vial and at the same time one gram of Florisil was incorporated. Then counting solution was added, followed by normal counting procedures. A 30 to 40 percent increase in counts was obtained when vials were counted approximately 24 hours after adding Florisil.

Trifluralin was also lost when using a flash evaporator to remove excess solvent from plant extracts. This was especially true when water was removed. During the evaporation process, the herbicide apparently vaporized and instead of being carried over in the distillate, it adhered to the surfaces of the condensing column and other glass parts. A foam rubber filter at or near the mouth of the flask containing the evaporating extract, greatly reduced such losses.

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THE EFFECT OF CIRSIUM ARVENSE ECOTYPES ON AMITROLE ACTIVITY

(Abstract)

G.W. Burt and T.J. Muzik 1/

A grafting technique was developed to determine if alteration of amitrole activity was important in the different susceptibilities of Cirsium arvense ecotypes. Amitrole resistant and amitrole susceptible ecotypes were grafted to themselves and to the other ecotypes. After these grafts had united, amitrole was applied to the scions and the chlorosis of the stocks was observed. If amitrole activity was either increased or decreased by passage through the scion tissue the change in activity should have been easily detected in the chlorosis of the stocks. For example, if the increase in susceptibility to amitrole of the susceptible ecotype was caused by an activation of amitrole, the resistant stocks on the plants whose scion was susceptible should show more chlorosis than the stocks of the plants whose scion was resistant. In a similar manner a deactivation of amitrole by the resistant ecotype could have been detected.

Results showed that amitrole induced chlorosis of the stocks was not altered by the passage of amitrole through the scion tissue. It is suggested, therefore, that the differential susceptibilities of these Cirsium arvense ecotypes to amitrole is not caused by differential metabolism of amitrole.

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GROWTH HABITS OF WHITE COCKLE AS RELATED TO WEED CONTROL

R. A. Peters[1] and W. L. Currey[2]

Abstract

White cockle (Lychnis alba) seed will germinate as soon as they shatter from the seed capsule. Flowering and seed production occurs over a long season. Blooming has been observed in the field from June 1 to mid-November at Storrs. Growth chamber studies have shown that long days favor white cockle flowering but temperature has relatively little effect with flowering occurring over a range of 40-80° F.

Since white cockle is dioecious not all plants produce seed. Seed production on female plants, however, averages 500 seeds per capsule. Furthermore, more than one series of seed crops a year may occur after clipping.

While generally listed as a biennial or perennial species there is wide variability between plants. Some have flowered within six weeks of a May seeding. New seedlings have come in around the mother plant by the end of the first season.

Because of the growth habits mentioned above, abundant white cockle seed is produced even by a few plants. White cockle germinates throughout the growing season commonly resulting in mixed age populations. Since white cockle has shown a marked resistance to most herbicides once past the seedling stage, control measures are greatly complicated.

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EFFECT OF LINURON ON WATER LOSS AND DROUGHT RESISTANCE IN SOYBEAN[1/]

R. B. Nashed and R. D. Ilnicki[2/]

The following substituted urea compounds were applied in nutrient solution at 1 ppm to juvenile corn (Zea mays L. var. N. J. 9) and soybeans (Glycine max (L.) Merr., var. Kent): 3-(3,4-dichlorophenyl)-1-methoxyurea, 3-(4-bromophenyl)-1-methyl-1-methoxyurea (metobromuron), 3-phenyl-1,1-dimethylurea (fenuron), 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorobromuron), 1-butyl-3-(3,4-dichlorophenyl)-1-methylurea (neburon), 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron), 3-(4-chlorophenyl)-1,1-dimethylurea (monuron), and 3-(3,4-dichlorophenyl)-1-methylurea. All of these compounds reduced water uptake on a fresh weight basis in soybeans as compared to controls by approximately 20 to 30 per cent over a period of one week with the exception of 3-(3,4-dichlorphenyl)-1-methoxyurea. This compound is a metabolite of linuron and has little or no herbicidal activity. In corn reduction in water uptake ranged from approximately 20 to 40 per cent depending on the compound with the exception of 3-(3,4-dichlorophenyl)-1-methoxyurea and neburon where no reduction in water uptake was observed.

Determinations of daily water loss from excised shoots of soybeans treated at 0, 0.1, 0.25, 0.5, 1.0 and 2.0 ppm linuron in complete nutrient solution showed an initial increase in water loss for the first 24 hours at the lower treatment levels. Progressive reduction in water loss occurred with time at the higher linuron levels as compared to controls. The mechanism governing reduced water loss in these experiments appears to reside in the shoot.

In a similar experiment on excised shoots of soybeans the closely related compounds, linuron and chlorobromuron, were compared for their effect on water loss over a 72 hour period. Both compounds reduced transpiration as measured in ml water loss per dec^2 leaf area. Of the two, linuron was the more effective.

The possible effect of linuron on drought resistance or survival under moisture stress was tested in soybean seedings treated preemergence in sand moistened with nutrient solution. Under drought conditions which killed over 90 per cent of the control plants, 70 per cent of the treated plants survived at the optimum linuron level.

1/ This investigation was supported in part by U. S. Public Health Service Grant (GS-00016-02).

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ROOT PERMEABILITY AS AFFECTED BY PICLORAM AND OTHER CHEMICALS

C. P. P. Reid and W. Hurtt[1/]

ABSTRACT

Investigations have been underway concerning the effect of picloram (4-amino-3,5,6-trichloropicolinic acid), a highly biologically-active herbicide, on foliar transpiration. Because increased water deficit in the plant caused by changes in root permeability can result in transpiration reduction, the effects of picloram and several other chemicals on root permeability were studied. Initially, effects on cell permeability were investigated by measuring the betacyanin efflux from red beet (*Beta vulgaris* L.) root sections. Picloram solutions ranging from 10^{-3}M to 10^{-6}M had no significant effect on betacyanin efflux when compared to controls. Similar results were found for 10^{-4}M and 10^{-5}M 2-methoxy-3,6-dichlorobenzoic acid (dicamba), 10^{-4}M 2,4-dichlorophenoxyacetic acid (2,4-D), and 10 ppm of ethylene. Compounds which caused significant pigment leakage were 10^{-4}M and 10^{-5}M phenylmercuric acetate (PMA), 10^{-3}M and 10^{-4}M 2,4-dinitrophenol (DNP), 10^{-3}M and 10^{-4}M 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 10^{-3}M 2,4-D.

Further investigations were conducted with picloram applications to the roots of bean plants (*Phaseolus vulgaris* L. var. Black Valentine) grown in nutrient solution under controlled environmental conditions. Roots treated for 3 hours with 10^{-5}M picloram showed no significant electrolyte leakage as determined by conductivity measurements of the root bathing solution over a period of 52 hours. When bean plants were root-treated for 3 hours with 10^{-5}M, 10^{-6}M and 10^{-7}M picloram and then decapitated, increased stem exudation by the treated plants over controls was observed. Xylem exudate of the treated plants also showed increased electrolytic conductivity. The increased exudation rate accompanied by increased conductivity would indicate that picloram has little effect on root cell membrane integrity, does not act as a metabolic inhibitor and in some way stimulates salt secretion into the xylem.

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REGENERATIVE CAPACITY OF VEGETATIVE PLANT PARTS OF POISON IVY

ABSTRACT

J. P. Sterrett, C. L. Foy, and S. W. Bingham[1/]

Stem, root, and transition zone (root-stem) cuttings of poison ivy were collected in the field and propagated in the greenhouse. Middle stem cuttings developed shoots in either an upright or inverted position, regardless of diam. Inverted stem cutting tips developed fewer shoots than either horizontal or upright cuttings. Root cuttings 3/4 of an inch in diam developed more shoots than 1/4 of an inch cuttings. Transition zone cuttings developed shoots in an upright, inverted, or horizontal position.

Suckering vigor in relation to the annual growth cycle was studied with root sections taken from the same clone monthly or bimonthly. Root cuttings were placed in a mixture of peat moss and weblite in a controlled environment chamber under a regime approximating conditions that normally occur in Blacksburg in June. Cuttings removed in early July and August formed considerably fewer suckers than those removed in October, November, February, April, and June.

The cut surfaces of dormant vegetative propagules were treated with several concentrations of IAA in lanolin. Poison ivy plants were decapitated one inch above the groundline and planted with their roots in white sand under intermittent mist. IAA-lanolin inhibited the formation of sprouts at all concentrations used (5,000 to 20,000 ppm) but mainly in the range of 10,000 to 20,000 ppm. As long as auxin was applied to the stumps, little or no sprouting took place but when the IAA-lanolin was removed every stump that had not sprouted did so. This research was supported in part by USDA Grant 12-14-100-9151 (34).

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A PRELIMINARY REPORT ON HERBICIDE EFFECTIVENESS AS INFLUENCED BY DROP SIZE AND NUMBER

W. Hurtt, C. A. Vile, and C. P. P. Reid[1/]

ABSTRACT

Greenhouse studies with micropipette applications of mixed n-butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid to tree seedlings were conducted. These initial results suggested that a greater effect could be obtained from foliar applications of equal volumes of herbicide when many small drops were used rather than fewer drops of a larger size. Similar studies with bean plants (*Phaseolus vulgaris* L. var. Red Kidney) were initiated in which 0.2, 0.4, and 0.8 µl of herbicide were applied in various combinations of drop size and number such that total volume per plant was constant within each of the three dosages. Using changes in fresh weight as the criterion of effectiveness, an increase in activity was obtained in every comparison when the number of drops was increased as the drop size was proportionally decreased. Eight 0.1-ul drops, for example, were more effective than four 0.2-µl drops which in turn were more effective than two 0.4-µl drops.

A spinning cup apparatus was used to apply drops of herbicide having nominal spherical diameters of 125, 250, and 500 µ to the primary leaves of *P. vulgaris* L. var. Black Valentine beans. The mean number of drops per plant per drop size was 584, 64, and 9, respectively. Volume was held constant at 0.59 µl ± 0.06 S.D. The number of drops on each plant was determined by actual count and the volume of herbicide per plant was calculated from this value and the spherical diameter. The spread factor for each nominal drop size, number of drops per plant, and the spherical diameter were used to calculate the area of each plant contacted by the herbicide. Analysis of the fresh weight data indicated that size of drops was highly significant. A five-fold increase in activity was obtained as drop size was decreased from 500 µ to 125 µ. The 250-µ-size drops were intermediate in their effect and were significantly different from the 500-µ-size but were not statistically different from the 125-µ treatment.

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THE DISSIPATION OF PHENYL CARBAMATE TOXICITY BY A BACTERIUM

G. W. McClure 1/

An as yet unidentified gram negative bacterium isolated from a mixture of soil types grew profusely on a minerel salts solution containing isopropyl-N-phenyl carbamate (IPC) as the sole carbon source. The IPC was degraded by either sterile or nonsterile suspensions of the bacterium. The time required for a concentrated suspension of cells (.5 mg dry wt/ml) to degrade 25 μmoles of IPC and three chlorinated relatives as determined by loss of ultraviolet absorption was as follows: IPC 1 day, 3-chloro IPC 5 days, 2,4,5-trichloro IPC 13 days and 3,4-dichloro IPC 70 days. The latter three chemicals did not appear to support bacterial multiplication during incubation. Suspensions of the bacterium sprayed on nonsterile soil containing from 0 to 15 lbs/A of IPC, 3-chloro IPC and SWEP [methyl-N-(3,4-dichlorophenyl) carbamate] destroyed sufficient material to permit corn and 5 other susceptible grass species to make growth equivalent to the control. No alleviation of phenylurea toxicity in soil was obtained indicating that such compounds are not degraded by the bacterium. These observations suggest that microorganisms may have practical value in destroying residual activity of pesticides in soil. As to whether sensitive crops could be grown in recently treated soils by inoculation of seed with such microorganisms also remains as a possibility.

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