FALL PANICUM CONTROL IN FIELD CORN WITH TRIAZINES[1]

Jonas Vengris[2]

Abstract

For fall panicum (Panicum dichotomiflorum Michx.) simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) at 2 and 4 lb/A gave excellent control when incorporated prior to planting or applied preemergence. Preplant and preemergence applications of atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) at the 4 lb/A rate were also satisfactory. Under drier soil conditions both triazines were less effective.

Introduction

The main objective of our 1971 field trials was to evaluate simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) and atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) for the control of fall panicum (Panicum dichotomiflorum Michx.) in field corn. Butylate (S-ethyl diisobutylthiocarbamate) and alachlor (2-chloro 2',6'-N-(methoxymethyl) acetanilide) treatments were included for comparison only.

Materials and Methods

The exact experiment was conducted at two locations, one at Brooks Experimental farm in Amherst and the other at the South Deerfield farm. Although the soil is a fine sandy loam on both farms there is a considerable difference in drainage. The Brooks farm area is bottomland, poorly drained, and with a good supply of moisture while the South Deerfield farm soil has excellent drainage and drier soil conditions prevail. Materials, methods and procedures were the same for both locations. Each plot consisted of four corn rows 25 ft long. Ohio M15 field corn was planted May 19. A list of treatments and their application dates are presented in Table 1. Postemergence treatments were applied with 1 gal/A Agway Booster oil.

---

[1]Contribution of the Massachusetts Agricultural Experiment Station, College of Agriculture, University of Massachusetts, Amherst, Massachusetts. This study was supported in part by the Cooperative Extension Service, Smith-Lever funds.

[2]Professor, Department of Plant and Soil Sciences, University of Massachusetts, Amherst, Massachusetts.

Fall panicum seedlings were at the 2-4 leaf stage (2-4 cm) when postemergence treatments were applied. A randomized block design with four replicates was used. Herbicide rates presented in Table 1 are expressed in lb of active ingredient per acre. Experimental areas were uniformly infested with fall panicum of the same origin and kept free of other weeds by continuous hand weeding.

Fall panicum stands in the various plots were evaluated at different times during the growing season and the average control determined. Silage corn yields were determined at the South Deerfield trials only (Table 1).

Table 1. Effect of herbicidal treatments on fall panicum control and yields of silage corn.

Treatments	Date of application	Percent control		Yields Check = 100
		Amherst	South Deerfield	South Deerfield
1. Check		0	0	100
2. Check, clean		100	100	196
3. Alachlor 2 lb/A, Pre	5/20/71	82	81	195
4. Butylate 4 lb/A, PPI	5/18/71	81	92	200
5. Atrazine 2 lb/A, PPI	5/18/71	73	62	190
6. Atrazine 4 lb/A, PPI	5/18/71	88	85	196
7. Atrazine 2 lb/A, Pre	5/20/71	70	59	188
8. Atrazine 4 lb/A, Pre	5/20/71	92	74	200
9. Atrazine 2 lb/A, Post + oil	6/ 7/71	47	32	152
10. Atrazine 4 lb/A, Post + oil	6/ 7/71	69	39	150
11. Simazine 2 lb/A, PPI	5/18/71	90	86	184
12. Simazine 4 lb/A, PPI	5/18/71	98	95	184
13. Simazine 2 lb/A, Pre	5/20/71	80	64	189
14. Simazine 4 lb/A, Pre	5/20/71	92	84	199
15. Simazine 2 lb/A, Post + oil	6/ 7/71	62	42	171
16. Simazine 4 lb/A, Post + oil	6/ 7/71	75	52	164
LSD at 5% level		10	13	31

Results and Discussion

With the exception of butylate and alachlor all simazine and atrazine treatments were more effective at the experimental farm in Amherst than in the South Deerfield trials under drier soil moisture conditions. In both locations simazine was more effective than atrazine in controlling fall panicum. Preplant and preemergence applications of simazine at 2 and 4 lb/A rates were most effective treatments. Preplant and preemergence applications of atrazine at the 4 lb/A rate were also satisfactory. Postemergence applications of both triazines were less effective as compared to preplant or preemergence treatments. The highest silage corn yields were obtained from the plots with the best weed control.

RATIOS OF ATRAZINE AND SIMAZINE FOR THE CONTROL OF FALL PANICUM IN CORN[1]

M. G. Schnappinger, Jr. and H. P. Wilson[2]

Abstract

Research was conducted from 1968 to 1971 at three locations to determine the best combination of 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) and 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine) for the control of fall panicum (Panicum dichotomiflorum Michx.) in corn (Zea mays L.). The ratio of atrazine to simazine that would consistently give the best fall panicum control was difficult to determine. Under dry weather conditions, the 1:1 ratio of atrazine to simazine appeared to give the best control while under conditions of normal or excessive rainfall there appeared to be little overall difference between the various ratios. In general, combinations of these two triazines gave better fall panicum control than atrazine and control which equaled or was superior to simazine.

Introduction

Fall panicum has become increasingly important as an annual grass in corn. Attempts to control fall panicum with atrazine have generally met with limited success in conventionally tilled corn (2). In contrast, simazine has been more effective in the control of this species (1,2). Previous research also indicates that tank mixes of atrazine and simazine in a 1:1 ratio will give good fall panicum control (1,2). Observations in the field have led to the hypothesis that increasing the proportion of simazine to atrazine might enhance the effectiveness of this mixture. The research reported herein is the result of studies conducted over a period of years at several locations to confirm that a tank mix of atrazine and simazine is effective for control of fall panicum and to determine the best ratio of these triazines.

Materials and Methods

Research was performed at the Virginia Truck and Ornamentals Research Station near Painter, Va., the Ernest Kuster Farm near White House Station, N. J., and the Key-de-blue Farm near Detour, Md. Descriptions of various soils as well as treatment dates and soil moisture at the time of treatment

---

[1]Joint contribution from CIBA-Geigy Corporation and the Plant Physiology Department, Virginia Truck and Ornamentals Research Station. Paper No. 152, Journal Series. Approved for publication November 15, 1971.

[2]Research Representative, Geigy Agricultural Chemicals Division of CIBA-Geigy Corporation, College Park, Md., and Plant Physiologist, Virginia Truck and Ornamentals Research Station, Painter, Va., respectively.

are presented in Table 1. Plot size varied with year and location. At Painter, plots were two rows wide, either 1.54 or 1.83 m X 6.10 m. Plots at the other locations were four rows wide or 3.65 m X 9.15 m. Treatments were replicated either three or four times. All herbicides were applied preemergence using hand operated plot sprayers with either carbon dioxide or propane as the pressure source. Rainfall data for each study are shown in Table 2.

Fall panicum control was evaluated using the scale 0 to 10 where 0 represents no control and 10 equals complete reduction of stand and vigor. Corn was harvested at White House Station, N. J., yields were adjusted to kg/ha at 15.5% moisture and analyzed statistically.

Table 1. Treatment dates, soil moisture conditions and soil information pertaining to fall panicum test locations.

Location	Date Treated	Soil Moisture	Texture	Organic Matter	C.E.C.
Painter, Va.	7/27/68	V. Moist	Sandy loam	-	-
Painter, Va.	6/3/69	Dry	Sandy loam	-	-
Painter, Va.	6/10/71	Dry	Sandy loam	-	-
Painter, Va.	6/8/71	Moist	Sandy loam	4.1	4.5
White House Station, N.J.	5/12/71	Moist	Silt loam	3.7	11.2
Detour, Md.	6/8/71	V. Moist	Clay loam	1.4	10.7

Table 2. Monthly rainfall at locations where fall panicum trials were conducted.

Year	Location	Rainfall (cm) May	June	July	Aug.	Sept.
1968	Painter, Va.	5.4	8.9	10.2	6.1	5.8
1969	Painter, Va.	4.8	4.3	13.2	17.3	7.1
1970	Painter, Va.	5.6	11.3	13.7	3.6	6.1
1971	Painter, Va.	15.9	3.2	5.1	12.5	4.1
1971	White House Station, N.J.	10.1	4.3	15.4	22.1	14.2
1971	Detour, Md.	8.4	2.8	4.3	16.3	9.2

Results and Discussion

Fall panicum control in 1968 with simazine alone or mixed with atrazine was better than with atrazine alone (Table 3). Cultivation generally improved fall panicum control, particularly with atrazine and the low rate of simazine.

Table 3. Fall panicum control in corn with atrazine and simazine at Painter, Va. in 1968.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[a] No Cultivation 8/21	No Cultivation 9/20	Cultivation 9/20
Atrazine	1.12	7.8	6.9	8.2
Atrazine	2.24	8.8	8.1	8.8
Simazine	1.12	9.6	8.9	9.6
Simazine	2.24	9.8	9.2	9.8
Atrazine + Simazine	1.12 + 1.12	9.8	9.5	9.6
Check		0.0	0.0	6.0

[a]Scale:0 to 10; 0 = no effect and 10 = complete control.

Initial fall panicum control in 1969 appeared to be acceptable for all treatments except the low rate of atrazine (Table 4). Atrazine at 2.24 kg/ha and simazine at 1.12 kg/ha gave equivalent control while the higher rate of simazine and the atrazine-simazine combination resulted in superior control. At the later rating, all treatments gave less than acceptable fall panicum control with the highest rates of atrazine, simazine, or the combination of these giving the best control. It is interesting to note that soil conditions at treatment time were dry and that only 2.5 cm of rain fell on this site during June following treatment. It would seem possible that the lack of early rainfall prevented sufficient activation of the herbicides; therefore, fall panicum may have grown to a stage that was not susceptible to preemergence treatment when adequate rainfall did occur in July and August.

Table 4. Fall panicum control in corn with atrazine and simazine at Painter, Va. in 1969.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[b] 6/27	Fall Panicum Control[b] 8/22
Simazine	1.12	7.5	3.0
Simazine	2.24	8.6	5.2
Atrazine	1.12	6.3	3.2
Atrazine	2.24	7.6	5.0
Atrazine + Simazine	1.12 + 1.12	8.6	5.0
Check		0.0	0.0

[b]Scale:0 to 10; 0 = no effect and 10 = complete control.

In 1970, fall panicum control was best with simazine at 2.24 kg/ha and the atrazine-simazine combinations (Table 5). Atrazine alone at either rate gave little or no fall panicum control while the low rate of simazine was marginal but still not acceptable. The combination of atrazine plus simazine at 0.56 + 1.68 kg/ha respectively, gave control similar to that obtained with the highest rate of simazine at the initial rating. In contrast, at the September rating it appeared that both atrazine-simazine combinations were superior to simazine applied alone.

Table 5. Fall panicum control in corn with atrazine and simazine at Painter, Va. in 1970.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[c] 7/28	9/3
Atrazine	1.12	0.0	0.0
Atrazine	2.24	1.5	1.7
Simazine	1.12	6.8	5.0
Simazine	2.24	8.9	7.2
Atrazine +	0.56 + 1.68	8.6	8.2
Simazine	1.12 + 1.12	7.8	8.3
Check		0.0	0.0

[c]Scale: 0 to 10; 0 = no effect and 10 = complete control.

Due to the findings mentioned above, it appeared that further research was required to determine the best ratio of atrazine to simazine for fall panicum control. In an attempt to accomplish this, expanded research was carried out both at Painter and at several locations in the mid-Atlantic area in 1971.

Results from the study conducted at Painter can be seen in Table 6. Various ratios of atrazine and simazine were applied with the total triazine rate equaling either 1.68 or 2.24 kg/ha. Early July ratings from this study indicated that all treatments were giving good to excellent fall panicum control. The various triazine combinations appeared to be slightly superior initially to single applications of atrazine or simazine. At the later rating, control with atrazine at 2.24 kg/ha had fallen below an acceptable level, while an equal rate of simazine maintained a good level of fall panicum control. In all instances weed control with the combinations decreased somewhat during the season but were still adequate in October. Generally, 1.68 kg/ha total triazine combination gave control equal to the high rate of simazine alone. The atrazine + simazine combination at 1.12 + 1.12 kg/ha appeared to give superior fall panicum control throughout the test.

Table 6. Fall panicum control in corn with atrazine and simazine at Painter, Va. in 1971.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[d] 7/3	10/18
Atrazine	2.24	8.3	5.3
Simazine	2.24	8.3	8.0
Atrazine + Simazine	0.56 + 1.12	9.2	8.2
	0.56 + 1.68	9.4	8.0
	1.12 + 1.12	9.6	8.8
	1.68 + 0.56	9.4	8.0
	1.12 + 0.56	8.8	7.8
Check		0.0	0.0

[d]Scale: 0 to 10; 0 = no effect and 10 = complete control.

In a test conducted at White House Station, N. J., atrazine and simazine were applied in various ratios with the total triazine rate being either 2.24 or 3.36 kg/ha (Table 7). The fall panicum stand in this study was extremely heavy and growth was vigorous. Atrazine applied alone gave poor control at the low rate and was fair at the high rate for the initial rating. Simazine alone at both rates and the various triazine combinations gave equally good early control. At the later rating, atrazine applied alone at either rate gave less than acceptable control but did suppress growth of fall panicum at the 3.36 kg/ha rate. Simazine alone at 3.36 kg/ha or a total triazine rate of 3.36 kg/ha appeared to give slightly better control than the 2.24 kg/ha rate of either simazine or the atrazine-simazine combination. There were no differences however, among the various ratios within a given rate. Reduction in competition from fall panicum by herbicide application can be seen in the yield data presented. All treatments except the lowest atrazine rate resulted in significant yield increases over the check.

Table 7. Fall panicum control in corn with atrazine and simazine at White House Station, N. J. in 1971.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[e] 6/15	6/29	Corn Yield kg/ha
Atrazine	2.24	5.2	1.5	5650
Atrazine	3.36	7.0	6.0	7950
Simazine	2.24	8.0	7.3	8070
Simazine	3.36	8.0	7.8	8270
Atrazine + Simazine	1.12 + 1.12	7.8	7.0	7400
	0.75 + 1.49	7.8	7.0	8120
	1.68 + 1.68	7.7	7.5	8320
	1.12 + 2.24	8.2	7.6	7840
Check		0.0	0.0	4550
LSD 0.05				1145

[e]Scale: 0 to 10; 0 = no effect and 10 = complete control.

In a test located near Detour, Md., atrazine and simazine were applied at various ratios with the total triazine rate being equal to 2.70 kg/ha. Cultivation was also a factor in this test. Due to an extremely dry June and July, growth of both corn and weeds was extremely limited until August when rainfall was abundant. Atrazine applied alone gave fair control and was improved to very good with a cultivation while simazine was equally effective with or without cultivation. The combinations gave excellent fall panicum control whether cultivation was a factor or not. Without cultivation, it appeared that the 1:2 atrazine to simazine ratio was slightly superior to the 1:1 ratio while there were no differences with cultivation.

Table 8. Fall panicum control in corn with atrazine and simazine at Detour, Md. in 1971.

Herbicide	Rate, kg/ha ai	Fall Panicum Control[f] 9/8/71 No Cultivation	Cultivation
Atrazine	2.70	7.3	8.8
Simazine	2.70	8.0	8.2
Atrazine +	1.35 + 1.35	9.2	10.0
Simazine	0.9 + 1.8	10.0	10.0
Check		0.0	3.7

[f]Scale: 0 to 10; 0 = no effect and 10 = complete control.

Literature Cited

1. Parochetti, J. V. 1969. Herbicides and combinations for weed control in corn. Proc. NEWCC 23:173-180.

2. Pruss, S. W. 1969. Control of fall panicum (Panicum dichotomiflorum) in corn with triazine herbicides. Proc. NEWCC 23:182-188.

FALL PANICUM CONTROL IN FIELD CORN 1971[1]

Jonas Vengris[2]

Abstract

In field trials alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide) and Mon-097[3] (2-chloro-N-(ethoxymethyl)-6'-o-acetotoluidide) in combination with triazines as well as alachlor plus Outfox[4] (2-chloro-4-cyclopropylamino-6-isopropylamino-1,3,5-triazine) were the best treatments used in fall panicum (*Panicum dichotomiflorum* Michx.) control. These combinations controlled better than standard accepted butylate (S-ethyl diisobutylthiocarbamate) or alachlor alone. No corn injury was observed.

Introduction

In recent years fall panicum (*Panicum dichotomiflorum* Michx.) has become a prominent weed in corn in the Eastern United States. The need for controlling this weed has therefore become urgent.

The main objective of our 1971 field trials was to determine the effectiveness and practicability of some of the new promising herbicides or herbicide combinations which would give better fall panicum control in field corn.

Materials and Methods

The experiment was conducted at the South Deerfield experimental farm on a fine sandy loam with good drainage. A randomized block design with four replicates was used. Each plot consisted of four rows 25 ft long. In the fall of 1970 before seeding of the cover crop the area was infested with fall panicum seed

---

[1] Contribution of the Massachusetts Agricultural Experiment Station, College of Agriculture, University of Massachusetts, Amherst, Massachusetts. This study was supported in part by the Cooperative Extension Service, Smith-Lever funds.

[2] Professor, Department of Plant and Soil Sciences, University of Massachusetts, Amherst, Massachusetts.

[3] Monsanto Company designation.

[4] Trademark of Gulf Oil Corporation.

and again when preparing the seedbed in 1971 fall panicum was overseeded. Preplant treatments were applied on May 18 and immediately mixed into the soil by rototilling 3 inches deep. On May 19 Funk G-10A field corn was planted. Preemergence treatments were applied on May 20. Slight rain (0.25 in) occurred the following day, May 21. Postemergence treatments were applied on June 7. Fall panicum seedlings were in the 3-4 leaf stage (3-5 cm) when postemergence treatments were applied. All experimental area was kept free from broad-leaved weeds by continuous hand weeding. Four weeks after corn emergence the experimental area was topdressed with ammonium nitrate at 70 lb N/A.

The effect of different treatments on fall panicum and corn was observed throughout the growing season. Weed stands in the various plots were evaluated three times during the course of the study and the average percentage weed control determined.

All herbicide rates presented in Table 1 are expressed in pounds of acid equivalent or active ingredient per acre.

Herbicides used in this study:

Alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
Atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
Basamaize[5]	2-chloro-N-(1-methyl-2-propynyl) acetanilide
Butylate	S-ethyl diisobutylthiocarbamate
Mon-097[6]	2-chloro-N-(ethoxymethyl)-6'-ethyl-o-acetotoluidide
Outfox[7]	2-chloro-4-cyclopropylamino-6-isopropylamino-1,3,5-triazine
S-6176[8]	mixture of a carbamate and Outfox
Simazine	2-chloro-4,6-bis(ethylamino)-s-triazine

Results and Discussion

All herbicides or their combinations used in this experiment significantly controlled fall panicum. Overall the best weed control was obtained by combination treatments of alachlor plus simazine, alachlor plus atrazine, alachlor plus Outfox and Mon-097 plus atrazine. These combinations at the rates used did an excellent job in controlling fall panicum and were much more

[5] Trademark of BASF Ag Chemicals.

[6] Monsanto Company designation.

[7] Trademark of Gulf Oil Corporation.

[8] Gulf Oil Corporation designation.

effective than butylate or alachlor alone (Table 1). As in earlier tests (Robinson and Vengris, 1971) simazine was more effective in the control of this weed than atrazine. Preplant applications of simazine appear to be more practical to use.

Table 1. Effect of herbicidal treatments on fall panicum control and yields of silage corn.

Treatments	Percent control	Yields Check = 100
1. Check	0	100
2. Check, clean	100	133
3. Atrazine 2 lb/A, Pre	69	118
4. Butylate 4 lb/A, PPI	90	126
5. Alachlor 2 lb/A, Pre	92	134
6. Alachlor + atrazine 2.5 + 2 lb/A, PPI	99	133
7. Alachlor + simazine 2.5 + 2 lb/A, PPI	99	127
8. Alachlor + atrazine 2 + 1 lb/A, Pre	94	128
9. Alachlor + simazine 2 + 1 lb/A, Pre	99	121
10. Mon-097 1 lb/A, Pre	89	118
11. Mon-097 2 lb/A, Pre	94	123
12. Mon-097 + atrazine 1 + 1 lb/A, Pre	95	136
13. Mon-097 + atrazine 2 + 2 lb/A, Pre	99	117
14. Basamaize 4 lb/A, Pre	84	126
15. Basamaize + atrazine 3 + 1 lb/A, Pre	83	133
16. Outfox 1.5 lb/A, Pre	75	126
17. Outfox + alachlor 1 + 2 lb/A, Pre	98	130
18. Outfox 1 lb/A, Post	40	114
19. S-6176 4.75 lb/A, PPI	77	134
LSD at 5% level	9	16

In the fall at corn harvest time in plots with bare ground, where fall panicum was well controlled, few small seedlings of other annual weedy grasses, such as crabgrass (*Digitaria* spp.) and barnyardgrass (*Echinochloa crusgalli* (L.) Beauv.), were observed. No significant differences were observed in their frequency with regard to various treatments.

Corn yields were significantly lower on plots that received Outfox at 1 lb/A rate postemergence treatment than on hand weeded plots. No corn injury was observed by treatments used.

Literature Cited

Robinson, D. E. and Jonas Vengris. 1971. Fall panicum control in field corn with triazines. Proc. NEWSS 25:43-45.

ANNUAL WEED CONTROL IN SILAGE AND SWEET CORN AT TWO LOCATIONS IN CONNECTICUT

R. A. Peters, R. A. Ashley and W. M. Dest 1/

Abstract. The same herbicide treatments were applied on sweet corn and silage corn at one location and on sweet corn only at a second location. At the Vegetable Research Farm, control of both grass and broadleaf weeds was satisfactory except for poor control of crabgrass from 2 lb. of atrazine and of redroot pigweed from 2 lb. of SD15418. Early stunting of corn was observed when treated with 4 lb. of SD15418. The only yield reductions associated with chemical treatment were the result of poor weed control. The injury associated with the 4 lb. rate of SD15418 was not seen at the Agronomy Research Farm where the soils are finer-textured than at the Vegetable Research Farm.

Atrazine continues as the standard corn herbicide in the Northeast for broadleaf weed control. It does not control crabgrass or fall panicum adequately and on some soil types there is concern about residual carry-over effects. Evaluation of new materials alone and in combination which may give broad spectrum weed control with less residual carry-over has been continued.

Materials and Methods

Field corn (Zea mays) cv. Funk's G11A and sweet corn (Zea mays var. rugosa) cv. Iochief were planted June 11, 1971 in 36-inch wide rows on a Merrimac fine sandy loam soil at the University of Connecticut Vegetable Research Farm in Coventry, Connecticut. Treatments were arranged in a randomized block design with 3 replications with treated plots consisting of 3 rows 30 feet long for field corn and 3 rows 10 feet long for sweet corn. Treated area was 210 and 70 square feet for field and sweet corn respectively with an untreated strip 2 feet wide between plots.

Preemergence applications of the herbicides appearing in Table 1 were applied to field and sweet corn on June 11-12, 1971. All combinations were applied as tank mixes and all treatments were applied at 40 gallons per acre.

The predominant weed species present in the experimental area were large crabgrass (Digitaria sanguinalis (L.) Scop.), witchgrass (Panicum capillare L.), and redroot pigweed (Amaranthus retroflexus L.). Also present in lesser amounts were lambsquarter (Chenopodium album L.) and barnyardgrass (Echinochloa crusgalli (L.) Beauv.).

On the sweet corn plots a rating scale of 0-10 was used with 0 indicating no effect and 10 complete kill. Ratings were made for separate species as given in Table 1 and for corn injury. Yields of fresh weight of corn ears per acre were obtained on September 3, 1971. On the silage corn plots a rating scale of 1-9 was used with 1 denoting no effect and 9 complete kill. Yield samples were taken on September 10 expressed as T/A of 30% dry matter silage.

On the Agronomy Research Farm at Storrs a planting of sweet corn of the same variety, Iochief, was made on June 2. The soil type was a Paxton fine

1/ Professor of Agronomy, Assistant Professor, and Research Assistant, Plant Science Department, University of Connecticut, respectively.

Table 1. Evaluation of Several Herbicides for Weed Control and Growth of Silage and Sweet Corn at the Vegetable Research Farm.

Sweet Corn

Treatment Herbicides lbs. ai/A	Weed Injury Ratings: Large Crabgrass 7/21	Large Crabgrass 9/4	Witchgrass 7/21	Witchgrass 9/4	Pigweed 7/21	Pigweed 9/4	Corn Injury Ratings 7/21	Corn Yield T/A 9/3/71 Fresh Ears
Propachlor 65W + Atrazine 80W 2½+1	7.7	5.7	9.7	9.7	10.0	10.0	0.0	8.3
Alachlor 4EC 3	7.7	7.0	9.3	6.7	8.0	8.0	0.3	6.7
Alachlor 4EC + SD15418 80W 2+1½	9.0	9.3	9.7	8.7	9.3	10.0	0.0	7.8
Alachlor 4EC + Atrazine 80W 2+1	7.7	7.3	8.3	7.0	9.0	8.3	0.0	7.3
BAS 2903H 4EC 3	9.0	7.0	9.0	8.0	9.0	9.3	0.0	8.1
BAS 2903H 4EC 4	7.7	6.3	9.7	6.3	9.3	7.7	0.7	4.9
BAS 2903H 4EC + SD15418 80W 3+1½	8.3	8.0	9.0	9.7	9.3	9.7	0.0	7.3
BAS 2903H 4EC + Atrazine 80W 3+1	7.7	6.3	7.0	6.7	9.0	9.0	0.0	8.1
SD15418 80W 2	6.0	6.3	7.3	6.0	2.0	0	0.0	1.2
SD15418 80W 4	9.0	8.0	9.3	8.0	8.3	7.7	2.0	5.3
Propachlor 65W + SD15418 80W 2+1½	8.3	6.3	8.7	8.3	6.7	7.0	0.3	6.2
Atrazine 80W 2	0.0	0.0	9.0	6.0	9.0	10.0	0.0	3.3
Hoed Check	10.0	10.0	10.0	10.0	10.0	10.0	1.7	5.4
LSD 5%	1.5	1.2	1.8	2.0	1.9	2.5	1.1	3.5

Silage Corn

Herbicide lbs. ai/A	Weed Injury Ratings: Grass Weeds 7/8	Grass Weeds 9/10	Broadleaf Weeds 9/8	Broadleaf Weeds 9/10	Corn Injury Ratings 9/10	Corn Yield T/A 9/10/71 30% DM
Propachlor 65W + Atrazine 80W 2½+1	9.0	8.3	9.0	9.0	1.0	12.2
Alachlor 4EC 3	8.0	8.7	7.3	7.7	1.0	20.0
Alachlor 4EC + SD15418 80W 2+1½	8.0	7.3	7.7	7.7	1.0	14.6
Alachlor 4EC + Atrazine 80W 2+1	8.0	6.7	8.7	9.0	1.0	14.4
BAS 2903H 4EC 3	8.0	8.7	9.0	9.0	1.0	16.0
BAS 2903H 4EC 4	8.7	7.7	8.7	9.0	1.3	18.4
BAS 2903H 4EC + SD15418 80W 3+1½	8.3	8.0	9.0	9.0	1.3	16.8
BAS 2903H 4EC + Atrazine 80W 3+1	8.7	8.3	9.0	9.0	1.0	15.4
SD15418 80W 2	3.0	2.0	6.7	1.3	3.3	12.8
SD15418 80W 4	8.0	8.0	8.3	8.3	1.3	16.4
Propachlor 65W + SD15418 80W 2+1½	8.0	7.5	8.0	8.5	1.0	13.6
Atrazine 80W 2	5.7	2.0	9.0	8.3	2.3	12.8
Hoed Check	9.0	8.0	9.0	8.7	1.6	11.4

sandy loam. The herbicide treatments, the same as those applied at the Vegetable Research Farm, were applied on June 3. The weed species present were the same as those found at the Vegetable Farm, but the population was very sparse. Weed control ratings were taken on these plots but no yield data were obtained.

Results and Discussion

With the exception of atrazine and SD15418 at 2 lb/A, all treatments gave satisfactory control of annual grass.

In terms of specific grasses, atrazine gave significant control of witchgrass but essentially no control of crabgrass. Those treatments containing propachlor were also relatively more active on witchgrass than on crabgrass.

Broadleaf weed control was satisfactory except for SD15418 at 2 lb/A. The poor broadleaf control associated with this material was due to limited kill of redroot pigweed (Table 1). The other broadleaf weeds were satisfactorily controlled.

Sweet corn injury, as rated on July 7, was observed only when treated with SD15418 at 4 lb/A. The injury shown for the hoed check was due to mechanical injury associated with hand hoeing. The injury, a 20% stunting in height, was largely outgrown, as evidenced by the yield data. The low yield of sweet corn at the SD15418 2 lb. rate was due to the heavy competition from the redroot pigweed. The low yields on the atrazine plots was associated with heavy crabgrass competition.

Silage corn injury ratings, in a 1-9 scale rather than 0-10, were made two months later than those on the sweet corn. The ratings, therefore, reflect growth reductions associated with weed competition. As in the sweet corn, marked effects on the corn were found at 2 lb. of SD15418 and 2 lb. of atrazine.

At the Agronomy Research Farm the only treatment not giving good annual grass control was atrazine 2 lb/A. Broadleaf weed control was satisfactory in all treatments. Since injury ratings were consistently 8-9, except for atrazine, no tabular data has been included. No corn injury was observed. The difference in response from the SD15418 at the two locations may have been associated with differences in soil texture. While both soils are mapped as fine sandy loam, the soil at the Vegetable Farm is on the coarse end of the range of particle size. The greater effectiveness of SD15418 at 2 lb. at the Agronomy Research Farm may have been associated with more rainfall in the first two weeks following treatment. At the Vegetable Research Farm only .37 inches of rain fell two weeks after herbicide application and 1 inch three weeks after treatment. At the Agronomy Research Farm, however, an inch of rain fell within 24 hours and on the 5th day after treatment.

HERBICIDE COMBINATIONS FOR EFFECTIVE WEED CONTROL IN SWEET CORN

W. F. Smith and R. D. Ilnicki[1]

Abstract

Herbicide combinations of 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) + 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) at 1½ + 1 lb/A; alachlor + 2-chloro-4-(1-cyano-1-methylethylamino) -6-ethylamino-3-triazine (SD 15418) at 1½ + 1½ lb/A; 2-chloro-N-isopropyl= acetanilide (propachlor) + atrazine at 3 + 1 lb/A; and 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorbromuron) + alachlor at 1½ + 1 lb/A resulted in better control of lambsquarters (*Chenopodium album* L.), ragweed (*Ambrosia artemisiifolia* L.), and fall panicum (*Panicum dichotomiflorum* Michx.) than did single treatments of alachlor at 3 lb/A, atrazine at 2 lb/A, propachlor at 3 lb/A, SD 15418 at 2 lb/A, and chlorbromuron at 1½ lb/A. Best overall weed control was obtained with alachlor + atrazine at 3 + 2 lb/A. This combination, in addition to controlling lambsquarters, ragweed, and fall panicum, was also noted to have some activity on nutsedge (*Cyperus esculentus* L.). In all instances yields of sweet corn (*Zea mays* L., var. Iochief) treated with herbicide combinations did not differ significantly from the yield of the cultivated check. In some cases plots treated with herbicide combinations had yields significantly greater than plots treated with only one herbicide.

Introduction

Complete or broad spectrum chemical weed control is rarely obtained with one compound. Generally excellent control of a few weed species can be expected with a single herbicide and depending on the prevalence of the weeds escaping control a problem of either minor or major proportions could result. In order to minimize weed problems resulting from use of one herbicide, active research continues to be conducted on effective use of herbicide combinations. This study was undertaken to evaluate the effectiveness of combinations of herbicides for weed control in sweet corn in New Jersey. Particular interest was directed toward establishing the effect herbicide combinations had on weed control and yield when compared to single herbicide treatments.

1/ Graduate Assistant and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

Methods and Materials

Sweet corn was planted May 24, 1970 in Freehold sandy loam at the Adelphia Research Station, Adelphia, New Jersey. The area was primarily infested with fall panicum, nutsedge, lambsquarters, and ragweed. The field was divided into 4-row plots 14' x 19' and all treatments were applied May 27, 1970. Treatments consisted of varying rates of atrazine, alachlor, SD 15418, propachlor, chlorbromuron, and selected combinations of two of these herbicides. Treatments were applied with a portable knapsack CO_2 sprayer at 40 gpa prior to corn seedling emergence.

Visual ratings on both vigor and stand of the corn and weeds were made July 22, 1970. A scale of 0 to 9 was used in which 0 = no effect on stand or vigor and 9 = complete control or elimination of stand. The corn was harvested by hand on two separate dates with the final harvest being made on August 11, 1970. Yield data are expressed in cwt/A and are the sum of both harvests. The experiment was designed as a randomized complete block and comparisons between treatments were made using Duncan's Multiple Range Test at the .05 level.

Results and Discussion

Alachlor alone at rates of 2, 3, and 4 lb/A gave excellent control of fall panicum. However, no control of ragweed was obtained with 2 lb/A and only mediocre control was obtained with 4 lb/A. No control of nutsedge was noted with any rate of alachlor. Yields of sweet corn treated with alachlor did not differ significantly from the cultivated check.

Atrazine alone at rates of 1½ and 2 lb/A failed to control fall panicum. A significant reduction in yield was noted for the 1½ lb/A treatment when compared to the check. No nutsedge control was noted for these treatments.

SD 15418 alone at rates of 2 lb/A also failed to control fall panicum or nutsedge. Higher rates of 3 and 4 lb/A resulted in better control of fall panicum but were ineffective in controlling nutsedge.

Propachlor at 3 lb/A was ineffective on lambsquarters, ragweed, or nutsedge; however, the higher rate of 4 lb/A effectively controlled the two broadleaf species but was ineffective for nutsedge.

Chlorbromuron at 1½ lb/A provided little control of fall panicum with no control of nutsedge. The higher rate of 2 lb/A provided better control of fall panicum but did not control the growth of nutsedge.

In most instances combinations of herbicides resulted in better control of the four weed species than did any single herbicide treatment. The liquid commercial formulations of alachlor + atrazine at 3 + 2 lb/A offered best overall weed control with some control of nutsedge being noted. The granular commercial formulation of the same combination was slightly less effective on fall panicum. A tank mix of the same combination but at a rate of 3 + 1 lb/A was less effective in controlling nutsedge.

Combinations of alachlor + SD 15418 at $1\frac{1}{2}$ + $1\frac{1}{2}$ lb/A, propachlor + atrazine at 3 + 1 lb/A, and alachlor + chlorbromuron at $1\frac{1}{2}$ + 1 lb/A all gave good control of fall panicum, lambsquarters, and ragweed but were ineffective in controlling nutsedge.

In all cases yields of herbicide combinations did not differ significantly from the cultivated check and in some instances combinations resulted in significantly higher yields than single herbicide treatments, as can be seen by an examination of the yield data in Table 1.

Table 1. The effect of varying rates of herbicides and herbicide combinations on weed control and yield of sweet corn. Adelphia, New Jersey. 1970.

Treatment	Rate, lb/A	Weed Control[1/]				Sweet Corn	
		Fp	Lbsq	Rag	Nut	Vigor[2/]	cwt/A[3/]
alachlor, ec	2	8.5	2.5	0.0	0.0	0.0	64.5 a-d
	3	8.0	8.0	2.3	0.0	0.0	70.4 a-d
	4	8.0	8.0	5.3	0.0	1.0	62.2 b-d
atrazine, wp	1½	0.7	9.0	9.0	0.0	0.7	38.6 de
	2	3.3	8.3	8.0	0.0	0.3	52.7 cd
alachlor + atrazine	1½ + 1	8.0	9.0	8.0	2.5	0.0	93.3 ab
(comm. prod.)	3 + 2	8.3	9.0	8.3	7.0	1.0	87.8 a-c
15G	1½ + 1	8.0	8.7	8.0	0.0	0.7	70.1 a-d
	3 + 2	5.7	9.0	9.0	7.0	1.5	70.4 a-d
tank mix	1½ + 2	7.3	9.0	7.7	0.0	0.7	78.3 a-c
	3 + 1	8.3	8.7	6.7	3.0	0.0	93.3 ab
SD 15418, wp	2	1.5	7.5	8.0	0.0	1.0	63.5 b-d
	3	8.0	8.5	9.0	0.0	0.0	80.9 a-c
	4	8.0	8.0	9.0	1.5	0.0	72.7 a-c
alachlor + SD 15418	1½ + 1½	8.0	8.7	9.0	0.0	0.0	96.0 a
	2 + 2	8.0	8.3	8.3	0.0	0.3	85.2 a-c
	1 + 3	7.0	8.3	7.3	0.0	0.3	73.4 a-c
	1-1/3 + 4	8.0	8.3	8.7	1.0	0.7	82.9 a-c
propachlor, wp	3	7.7	0.0	2.0	0.0	0.7	67.5 a-d
	4	7.0	8.5	8.0	1.0	0.0	83.8 a-c
propachlor + atrazine	3 + 1	7.0	8.5	8.0	0.0	0.0	83.8 a-c
	4 + 1	7.3	8.7	8.7	0.0	0.3	77.6 a-c
	3 + 1½	7.7	9.0	7.7	0.0	0.3	77.6 a-d
	4 + 1½	8.0	9.0	8.7	0.0	0.0	78.0 a-c
chlorbromuron, wp	1½	2.0	8.7	5.7	0.0	0.0	65.5 a-d
	2	6.0	7.5	6.0	0.0	0.0	73.0 a-d

Table 1. cont.

Treatment	Rate lb/A	Weed Control[1]				Sweet Corn	
		Fp	Lbsq	Rag	Nut	Vigor[2]	cwt/A[3]
alachlor +	1½ + 1	7.3	9.0	8.7	1.0	0.7	76.3 a-c
chlorbromuron	1½ + 1½	8.0	8.7	5.7	0.0	0.7	70.4 a-d
	2 + 1	7.5	9.0	9.0	0.0	0.5	87.4 a-c
	2 + 1½	8.0	9.0	8.7	0.0	0.0	72.7 a-c
check - cultivated	-	9.0	9.0	9.0	9.0	0.0	86.8 a-c
not cultivated	-	0.0	0.0	0.0	0.0	0.0	24.6 e

1/ Based on scale 0 to 9; 0 = no effect on stand, 9 = complete control or elimination of stand.
2/ Based on scale 0 to 9; 0 = no effect on vigor, 9 = complete kill.
3/ Averages followed by a common letter are not significantly different from each other according to Duncan's Multiple Range Test at 0.05.

Fp = fall panicum, Lbsq = lambsquarters, Rag = ragweed, Nut = nutsedge.

VARIETAL RESPONSE OF SWEET CORN TO ALACHLOR AND ALACHLOR-ATRAZINE COMBINATIONS

R. A. Ashley[1]

Abstract

Significant yield reductions were observed with sweet corn varieties, Seneca Scout, Silver Cross Bantam, Continental and Bravo when treated with alachlor 4EC at 1½ or 3 lbs ai/A or alachlor 4EC + atrazine 80W at 1½ + 1 or 3 + 2 lbs ai/A. Seneca Chief also produced significantly reduced yields when grown in plots treated with alachlor + atrazine at 3 + 2 lbs ai/A as compared to 1½ + 1 lbs/A of the same combination. No visable injury symptoms, stand or vigor reductions were observed.

Introduction

Experiments were conducted at the University of Connecticut Vegetable Research Farm in North Coventry, Connecticut to determine the response of ten sweet corn varieties to alachlor and alachlor-atrazine combinations.

Materials and Methods

Ten varieties of sweet corn (Zea Mays var. rugosa) were planted June 18, 1971 in 3-foot rows, 30 feet long. The same day alachlor 4EC at 1½ and 3 lbs ai/A, atrazine 80W at 2 lbs ai/A and alachlor 4EC + atrazine 80W at 1½ + 1 and 3 + 2 lbs ai/A were applied to plots 6 feet wide and 30 feet long running perpendicular to the corn rows and including each variety. Herbicides and varieties were replicated three times. Soil type was a Merrimac fine sandy loam with an organic matter content of 3½%. Significant rainfall before and after treatment included 1.16 inches on June 9, 0.37 inches on June 25-26, and 1.02 inches on July 2. No irrigation was applied to this experiment.

Stand counts and average height measurements were taken July 21, 1971. Yield data was taken as the varieties matured beginning August 24, 1971 and ending September 16, 1971.

Results and Discussion

Use of alachlor at 1½ or 3 lbs/A or alachlor + atrazine at 1½ + 1 or 3 + 2 lbs/A resulted in no significant change in crop stand (Table 1), or crop vigor as indicated by average height one month after planting (Table 2) in any of ten sweet corn varieties as compared to an atrazine 2 lbs/A control.

Seneca Scout and Silver Cross Bantam sweet corn showed significant yield reductions when treated with alachlor at 1½ or 3 lbs/A as compared to atrazine at 2 lbs/A. The sweet corn variety, Continental, showed a similar yield reduction at the higher rate of alachlor.

1. Assistant Professor of Horticulture, University of Connecticut, Storrs, Connecticut.

The Silver Cross Bantam and Continental varieties of sweet corn also produced significantly reduced yields when treated with alachlor + atrazine combinations at either 1½ + 1 or 3 + 2 lbs/A. In addition, the Seneca Scout variety showed reduced yields from the low rate of the combination while Bravo produced reduced yields from the 3 + 2 lbs/A rate only. Seneca Chief showed significant yield reductions when the alachlor + atrazine 1½ + 1 lb/A rate was compared to the 3 + 2 lbs/A rate. This reduction was not significantly different from atrazine at 2 lbs/A.

It is interesting to note that the five varieties not showing yield reductions were the early maturing varieties (65–67 days), while the five varieties showing yield reductions were the mid to late season varieties (80–93 days). This, coupled with the lack of discernable stand or vigor reduction, suggests interference with some physiological process.

Table 1. Effect of alachlor and alachlor-atrazine combinations on stand of ten sweet corn varieties.

Varieties[a]	Herbicides[b] — Rate ai/A				
	Alachlor 4EC 1½ lbs	Alachlor 4EC 3 lbs	Atrazine 80W 2 lbs	Alachlor + atrazine 1½+1 lbs	Alachlor + atrazine 3+2 lbs
Early Golden Giant Hybrid	7.7[c]	7.7[c]	8.3[c]	7.3[c]	5.0[c]
Garden Treat	6.3	6.3	7.7	6.0	5.0
Spring Gold	8.3	7.0	8.0	6.7	7.0
Sprite	7.7	6.3	7.3	6.0	6.3
Spring White	7.3	7.3	7.3	7.3	8.7
Seneca Scout	13.3	11.7	13.0	12.7	12.0
Bravo	10.0	11.0	11.7	9.3	11.3
Seneca Chief	7.3	8.3	8.3	7.3	8.3
Silver Cross Bantam	13.3	12.7	12.0	11.3	13.3
Continental	5.0	2.7	4.7	3.7	3.3
LSD 5% = NS					

a. Planted 6/18/71.
b. Applied preemergence 6/18/71.
c. Average of 3 replicates of single row plots 6 feet long. Rated 7/2/71.

Table 2. Effect of alachlor and alachlor-atrazine combinations on height of ten sweet corn varieties.

Varieties[a]	Herbicides[b] — Rate ai/A				
	Alachlor 4EC 1½ lbs	Alachlor 4EC 3 lbs	Atrazine 80W 2 lbs	Alachlor + atrazine 1½+1 lbs	Alachlor + atrazine 3+2 lbs
Early Golden Giant Hybrid	17.7 inches[c]	17.7 inches[c]	16.7 inches[c]	13.3 inches[c]	15.7 inches[c]
Garden Treat	16.7	17.7	16.3	18.0	15.3
Spring Gold	17.7	18.0	19.3	17.3	15.3
Sprite	16.0	15.3	14.3	16.0	15.7
Spring White	17.0	18.3	16.0	15.7	14.0
Seneca Scout	17.7	16.0	15.7	15.0	13.3
Bravo	19.0	18.7	19.0	18.0	17.0
Seneca Chief	13.3	12.7	13.0	14.3	13.7
Silver Cross Bantam	20.7	19.3	18.7	18.7	18.3
Continental	13.7	9.7	11.7	11.3	10.3

LSD 5% = NS

a. Planted 6/18/71.
b. Applied preemergence 6/18/71.
c. Average of 3 replicates.

Table 3. Effect of alachlor and alachlor-atrazine combinations on yield of ten sweet corn varieties.

Varieties[a]	Herbicides[b] — Rate ai/A				
	Alachlor 4EC 1½ lb	Alachlor 4EC 3 lb	Atrazine 80W 2 lbs	Alachlor + atrazine 1½+1 lbs	Alachlor + atrazine 3+2 lbs
Early Golden Giant Hybrid	4.0 lbs[c]	3.3 lbs[c]	4.2 lbs[c]	4.1 lbs[c]	4.8 lbs[c]
Garden Treat	1.1	2.8	2.2	1.8	1.6
Spring Gold	5.6	4.4	4.7	3.5	4.3
Sprite	5.2	6.6	6.7	4.8	5.8
Spring White	1.8	2.0	1.5	3.9	3.8
Seneca Scout	4.3	5.0	7.7	5.5	5.8
Bravo	4.7	7.1	6.8	7.7	4.0
Seneca Chief	5.0	5.5	5.0	5.8	3.6
Silver Cross Bantam	5.8	6.5	9.1	6.4	6.9
Continental	9.5	4.4	9.7	5.4	5.0

LSD 1% = 2.8   LSD 5% = 2.1

a. Planted 6/18/71.
b. Applied preemergence 6/18/71.
c. Average of 3 replicates each comprising a single row 6 feet long.

VARIETAL RESPONSE OF SWEET CORN TO ALACHLOR AND BUTYLATE[1/]

F. D. Schales, C. D. Altman*, and C. E. Beste[2/]

ABSTRACT: An evaluation of twenty two sweet corn (Zea mays L.) varieties showed a variation in tolerance to preplant incorporated treatments of the combination S-ethyl diisobutylthiocarbamate (butylate) plus 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) (2.6 plus 1 lb. ai/A) and 2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide (alachlor) (1.5 lb. ai/A). Both herbicide treatments reduced plant height in susceptible varieties. Butylate injury reduced yields and reduced the quality of canned corn. These studies indicate that new sweet corn hybrids should be tested for tolerance to alachlor and butylate.

INTRODUCTION

The development of S-ethyl diisobutylthiocarbamate (butylate) and 2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide (alachlor) for use in sweet corn (Zea mays L.) has provided the grower with very useful chemical tools for control of grasses and sedges. Field use of butylate has resulted in occasional grower reports of injury and these reports were usually associated with periods of cool weather in which the corn grew slowly. However, butylate is restricted from use on seed corn production acreage due to the variation in the tolerance of inbred lines. Niccum (2) showed that varietal and inbred corn growth as measured by emergence counts and injury ratings was significantly affected by butylate, alachlor, and propachlor at the recommended rates. He also observed that in most cases herbicide injury to a particular inbred also occurred in the single and three-way crosses made with that inbred. An evaluation of 4 sweet corn varieties over a 5 year period with alachlor indicated only slight injury on some varieties in different years and alachlor did not affect the marketable yield of sweet corn (1). Wilson and Waterfield (3) did not observe butylate or alachlor injury on NK-199 in 2 years of testing.

MATERIALS AND METHODS

The experiment was conducted on Norfolk loamy sand at the Vegetable Research Farm at Salisbury, Maryland. Adjacent halves of the field were treated on April 21, 1971 with alachlor or the combination of 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) (1 lb. ai/A) plus butylate (2.6 lbs. ai/A and the treatments were incorporated by following the sprayer with a disc, and then cross-discing. The spray volume was 32 gal./A.

1/ Misc. Publication No. 800, Contribution No. 4514, of the Maryland Agricultural Experiment Station, Department of Horticulture.

2/ Associate Professor, Research Assistant, and Assistant Professor respectfully, University of Maryland.

* Deceased.

A single plot of four or ten rows (36 inch row spacing) of each variety was planted on April 22 in 75 foot rows with 32.5 feet of row in each adjacent herbicide treatment.

Injury ratings were based on three observations on June 15, June 30, and July 1. On June 30, 1971, the average corn height in each treatment plot was determined with a surveyor's level rod. Four varieties which exhibited a range of herbicide response were selected for evaluation of root and stalk growth. The root and stalk fresh weight of four samples of ten plants chosen randomly from each plot was determined by digging the entire stalk, washing the roots, and dividing the plant at the soil level for root and stalk weight.

Forty ear samples of each variety were harvested at the optimum stage of maturity and samples of whole kernel corn was canned using standard commercial techniques. Six to eight weeks after canning, compression and shear tests were made on the canned samples to determine grade.

RESULTS AND DISCUSSION

Table 1 shows the variation in sweet corn growth response to the herbicides; butylate and alachlor. The injury observed with the combination butylate plus atrazine can be attributed to butylate, since the injury symptoms were characteristic of carbamate-type herbicide injury. Typical symptoms of butylate injury were shortened stalks and twisted leaves, and severely injured varieties produced small or no ears. Butylate reduced the stand of susceptible varieties and reduced the ear size and number of ears developed. Many of the butylate injured varieties formed an ear in the tassel which became infected with smut (Ustilago maydis (DeCondolle) Corda). Alachlor appeared to cause a delay in tasseling of some varieties compared to the butylate-atrazine treatment (Table 1), and the other symptom of alachlor injury was a shortened stalk. The alachlor-injured varieties appeared to have normal ear development and yields, and the varieties Goldie and EXP 667 were wind damaged which indicated that alachlor may reduce the rooting strength in these varieties.

The data of Table 2 indicate that some varieties developed injury symptoms without a decrease in plant height, however, these plants may have been able to outgrow the early growth reduction prior to the time of height measurement. The negative percent height reduction values of some alachlor-treated varieties in Table 2 indicate that the height of these varieties was greater than the butylate treated plants. Varieties EXP 667 and 68-2626 appeared to be susceptible to both butylate and alachlor injury (Table 2). However, there did not appear to be a general correlation between varieties with butylate or alachlor injury.

A significant reduction of stalk weight occurred as a result of severe butylate injury in variety 68-2626 (Table 3). The lack of significance between herbicide treatments with variety EXP 667 indicates that plant height was a more sensitive indicator of injury. These four varieties listed in Table 3 did not show an effect of herbicide treatment on fresh root weight.

The canned-corn quality of the four varieties in Table 2 indicated that corn from variety EXP 667 with the butylate treatment dropped to an extra standard grade compared to a fancy grade of canned corn from the alachlor treatment. The other three varieties were graded as fancy in all treatments except

Table 1. The growth responses of sweet corn varieties to the herbicides butylate and alachlor.

Variety		Herbicide Effect on Growth[1/]			
		atrazine and butylate[2/]		alachlor[2/]	
		Plant ht. (in.)	Injury[3/]	Plant ht. (in.)	Injury[3/]
NK-199	(NK)	60	---	55	(DT)
Yukon	(NK)	48	M-S	56	----
Wondergold	(NK)	56	---	48	Sl (DT)
NK 51036	(NK)	48	M-S	48	----
Dividend	(NK)	56	Sl	48	M (DT)
Goldie	(NK)	60	Sl	60	Sl
EXP 435	(NK)	36	Sl-M	36	----
EXP 667	(NK)	42	M-S	56	M
EXP 668	(NK)	42	Sl-M	48	----
EXP 6617	(NK)	52	Sl-M	52	----
Golden Queen	(RB)	48	---	48	----
Silver Queen	(RB)	56	---	48	Sl
68-2626	(RB)	26	S	64	Sl
68-2633	(RB)	48	M	60	----
68-2636	(RB)	40	S	64	----
Style Pack	(FM)	42	Sl	36	(DT)
Continental	(FM)	42	Sl	42	----
E 9510	(FM)	66	Sl	66	----
XP 1323	(Asg)	60	---	60	----
XP 2172	(Asg)	66	Sl	66	----
Sunchief	(Agw)	60	M	60	----
556	(Ch)	36	S	40	----

1/ Rated on July 1, 1971. (no entry indicates no injury)
2/ atrazine (1 lb. ai/A) and butylate (2.6 lb. ai/A); alachlor (1.5 lb. ai/A).
3/ Injury: Sl = slight, M = moderate, S = severe, DT = delayed tasseling.

Seed Corn Companies: NK - Northrup, King & Company
RB - Rogers Brothers
FM - Ferry Morse
Asg - Asgrow
Agw - Agway
Ch - Charter Seed Company

for the butylate treatment on variety 68-2626 which did not produce enough corn for canning trials.

These observations were made in 1971 which had a cool two week period following planting, and these conditions may have contributed to the severity of the herbicide injury. However, the large variation in the tolerance of new sweet corn varieties to butylate and alachlor shows the importance of this type of testing prior to grower use.

Table 2. Plant height reduction of varieties susceptible to butylate or alachlor injury.

Variety injured by butylate1/	% height reduction2/	Variety injured by alachlor3/	% height reduction4/
NK 51036	0	EXP 667	-33
EXP 6617	0	NK 199	- 8
Sunchief	0	Wondergold	14
EXP 435	0	Silver Queen	14
556	11	Dividend	14
EXP 668	12	Stylepak	17
Yukon	14		
68-2633	20		
EXP 667	25		
68-2636	38		
68-2626	60		

1/ Moderate to severe injury.
2/ Based on the height of the same variety in the adjacent block treated with alachlor.
3/ Moderate injury or delayed tasseling.
4/ Based on the height of the same variety in the adjacent block treated with butylate plus atrazine.

Table 3. Effect of alachlor and butylate on the stalk weight of sweet corn varieties.

		Sweet Corn Varieties							
		Nk-199		EXP 667		Silver Queen		68-2626	
Treatment	Lb. ai/A	Root1/	Stalk1/	Root	Stalk	Root	Stalk	Root	Stalk
butylate plus atrazine	2.6 1.0	2.5	13.7	1.5	13.9	1.6	16.5	2.0	7.4
alachlor	1.5	2.1	14.2	1.6	14.4	1.6	16.5	2.6	16.3
L.S.D. 5%		N.S.	2.6	N.S.	2.6	N.S.	2.6	N.S.	2.6

1/ Average fres. weight (lbs.) of 4 samples of 10 stalks - harvested on June 30, 1971.

LITERATURE CITED

1. Ivany, J. A. and R. D. Sweet. 1971. Sweet corn responses to alachlor and other herbicides. Proc. NEWCC. 25: 47-52.
2. Niccum, C. E. 1970. Variations in inbred and varietal tolerance of corn to butylate, alachlor, and propachlor. Proc. NCWCC. 25: 33-35.
3. Wilson, H. P. and R. L. Waterfield, Jr. 1970. Activity of herbicides in sweet corn. Proc. NEWCC. 24: 47-53.

HERBICIDES FOR CORN ON HIGH ORGANIC MATTER SOILS[1/]

J. V. Parochetti[2/]

Abstract. Of the herbicides studied on soils containing 12 to 23% organic matter, 2-chloro-N-(1-methyl-2-propynyl) acetanilide (prynachlor) resulted in the best (90%) giant green foxtail (Setaria viridis var. major (Gaud.) Posp.) control and 2-chloro-2',6'-diethyl-N-(methoxymethyl)-acetanilide (alachlor), N,N-diallyl-2-chloroacetamide (CDAA) and 2-chloro-N-isopropylacetanilide (propachlor) resulted in fair to good (70 to 90%) foxtail control. Best fall panicum (Panicum dichotomiflorum Michx.) control resulted from alachlor and 6 lb/A propachlor. These herbicides were generally not effective on broad-leaved weeds, but did effect excellent pigweed (Amaranthus retroflexus L.) control. The chemical 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) did not provide satisfactory foxtail, fall panicum or ragweed (Ambrosia artemisiifolia L.) control, but did effect good to excellent control of smartweed (Polygonum pensylvanicum L.), pigweed, morningglory (Ipomea hederacea (L.) Jacq.), carpetweed (Mollugo verticillata L.) and lambsquarters (Chenopodium album L.).

Introduction

In DelMarVa, there are approximately 200,000 acres of Pocomoke soils. In Maryland, these poorly-drained soils range in organic matter from 3 to 25%[3/]. A large variation in organic matter contents occur in the landscapes of these soils; high organic matter contents are associated with the low-lying Pocomoke soils while low amounts of organic matter are found on well drained sandy knolls. At the recommended rate of 2 lb/A atrazine does not perform well on the high organic matter areas. Much higher rates of triazine herbicides are needed as soil organic matter is increased beyond 5% (1, 2, 3, 4, 5). DelMarVa corn (Zea mays L.) growers have used CDAA with success since it was first introduced in the early 1950's. However, growers found that often this material did not perform satisfactorily on the light sandy soils. Upchurch et. al (5) found that CDAA and 2-chloroallyl diethyldithiocarbamate (CDEC) resulted in consistent weed control on soils with 3% organic matter or greater; however, below 3% organic matter, weed control was erratic.

1/ Scientific Article No. A 1740 and Contribution No. 4518 of the Maryland Agricultural Experiment Station, Department of Agronomy, College Park.

2/ Assistant Professor, Department of Agronomy, University of Maryland, College Park 20742.

3/ Personal communication with Dr. John E. Foss, Associate Professor of Soil Classification, Department of Agronomy, University of Maryland, College Park.

Maryland growers have used propachlor with success on high organic matter content soils. Furthermore, alachlor and prynachlor have chemical structures similar to propachlor and might perform satisfactorily on soils with organic matter content in excess of 3%. The purpose of this study was to evaluate CDAA, propachlor, alachlor, prynachlor and atrazine for annual weed control in corn grown on soils with high organic matter.

Materials and Methods

Field studies were conducted in 1968 and 1969 in Worcester and Wicomico Counties, respectively. Weed control was rated using a scale of 0 to 100 with 0 equalling no effect and 100 equalling complete reduction of plant stand. Prior to statistical analysis, the rating data were transformed by arcsin $\sqrt{x}$. Herbicides were applied with an experimental bicycle sprayer at 30 gpa, using water as the diluent. Plot size was 12 ft x 30 ft with four rows spaced at 36 inches. When corn was harvested, yields were expressed in bu/A of 15.5% moisture USDA Grade No. 2 corn. No cultivation was employed in these studies. In all studies, four replications were used.

In 1968, preemergent treatments and preplant incorporated treatments (Table 1) were applied June 7 and postemergent treatments were applied June 26. Corn, var. Pioneer 3306, was planted June 8. The soil was Pocomoke loamy sand with 12.4% organic matter. In 1969, two studies were established. Herbicides (Table 2) were applied only as preemergent applications. One site was located on a Pocomoke loamy sand with 12% organic matter. The corn variety planted was DeKalb XL-66. On the other site located within a 2 mile radius, the soil type was a Pocomoke loam with 23% organcc matter. Pioneer 3369A was planted at this site. Preemergent herbicides at both sites were applied May 7 with corn planted on May 5 and 6.

Results and Discussion

None of the herbicides tested in 1968 and 1969 resulted in a complete spectrum of weed control. Atrazine (Tables 1 and 2) did not result in satisfactory giant green foxtail control, but effected good annual broadleaved weeds, such as smartweed, pigweed, carpetweed, lambsquarters and morningglory. Atrazine resulted in poor ragweed control (Tables 1 and 2). CDAA, propachlor and alachlor resulted in good to excellent giant green foxtail control, but only alachlor resulted in excellent fall panicum control when observed at the end of the growing season (Table 1). All herbicides were effective on pigweed early in the season as well as later in the season. Although early lambsquarters control was observed for all herbicide studies, only atrazine preplant incorporated, propachlor preemergent plus atrazine postemergent, propachlor preemergence at 6 lb/A, or CDAA preemergence plus 2,4-D postemergence resulted in satisfactory lambsquarters control when observed at the end of the growing season.

In 1969, Site A was heavily infested with giant green foxtail (Table 2). All herbicides effected satisfactory to excellent foxtail control when observed early in the season, except atrazine. The best (90%) foxtail control was observed with prynachlor at 3 or 6 lb/A preemergence. Alachlor, 2 and 4 lb/A, or propachlor, 6 lb/A, resulted in 75 to 80% control of foxtail on July 17. Although CDAA resulted in satisfactory foxtail control one month after application, control decreased to 55% when observed on July 17. Only two treatments resulted in a significant corn yield increase over the uncultivated check; they were the cultivated control and atrazine at 4 lb/A.

Site B in 1969 was heavily infested with ragweed (Table 2). Excellent ragweed control was noted one month after herbicide application with propachlor at 6 lb/A and prynachlor at 3 and 6 lb/A. Early control of ragweed decreased as the season advanced. No corn injury was noted at any location.

Acknowledgements

The author wishes to express his appreciation for the computer time made available through the facilities of the Computer Science Center of the University of Maryland.

Literature Cited

1. Burnside, O. C., and R. Behrens. 1961. Phytotoxicity of simazine. Weeds 9:145-157.

2. Sheets, T. J. 1959. The comparative toxicities of monuron and simazine in soil. Weeds 7:189-194.

3. Talbert, R. E., and O. H. Fletchall. 1965. The adsorption of some s-triazines in soils. Weeds 13:46-52.

4. Upchurch, R. P., and D. D. Mason. 1962. The influence of soil organic matter on the phytotoxicity of herbicides. Weeds 10:9-14.

5. Upchurch, R. P., F. L. Selman, D. D. Mason and E. J. Kamprath. 1966. The correlation of herbicidal activity with soil and climatic factors. Weeds 14:42-49.

Table 1. Weed control and corn yields following herbicide treatments on a Pocomoke loamy sand, 12.4% organic matter in Worcester County, 1968.

	Treatment	Rate lb/A	Time Applied	% CONTROL (7/5)						% CONTROL (9/27)				Yield
				Smart-weed	Pig-weed	Morning-glory	Carpet-weed	Giant Green Foxtail	Lambs-quarters	Rag-weed	Fall Panicum	Lambs-quarters	Pig-weed	Corn Bu/A
1.	Control	--	--	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	0 a	33 a	50.1 a
2.	CDAA	4.0	pre	11 a	80 b	28 ab	38 a	89 a	78 b	13 b	70 bc	0 a	80 b	79.0 a
3.	CDAA +	4.0	pre	56 ab	100 b	100 c	99 c	77 c	100 b	33 b	57 b	77 cd	97 b	77.1 a
	2,4-D	0.5	post											
4.	Propachlor	4.0	pre	69 bc	81 b	11 a	81 b	88 c	58 b	33 b	80 cd	45 bc	92 b	66.0 a
5.	Propachlor	6.0	pre	62 bc	95 ab	22 ab	97 c	99 d	65 b	27 b	88 de	88 d	100 b	66.9 a
6.	Atrazine	3.0	ppi	90 bc	100 b	67 bc	100 c	0 a	99 b	67 b	0 a	100 d	98 b	66.5 a
7.	Atrazine	4.0	ppi	100 c	100 b	100 c	100 c	18 b	100 b	67 b	0 a	100 d	100 b	67.5 a
8.	Propachlor +	3.0	pre	93 bc	100 b	89 c	100 c	95 cd	100 b	67 b	62 b	100 d	100 b	----
	Atrazine +	1.0	post											
	2 gal/A oil													
9.	Propachlor +	3.0	pre	100 c	100 b	67 bc	100 c	94 cd	99 b	33 b	58 b	97 d	100 b	80.7 a
	Atrazine	1.0	post											
10.	Alachlor	3.0	pre	61 bc	95 b	8 a	100 c	99 d	62 b	33 b	93 e	0 a	100 b	----
11.	Alachlor	4.0	pre	53 ab	100 b	25 ab	100 c	100 d	65 b	60 b	94 e	13 ab	100 b	66.4 a

Table 2. Weed control and corn yields following preemergent herbicide applications at two locations: Site A had 12% organic matter and Site B had 23% organic matter in Wicomico County, 1969.

	Treatment	Rate	Site A (12% organic matter) % Giant Green Foxtail Control		Bu/A	Site B (23% organic matter) % Ragweed Control	
		lb/A	6/5	7/17	9/9	6/5	7/17
1.	Control	--	0 a	0 a	83.4 a	0 a	0 a
2.	Control Cultivated	--	70 bc	75 ef	110.3 b	0 a	58 bc
3.	CDAA	4.0	73 bc	55 cde	99.1 ab	74 cde	60 bc
4.	Propachlor	4.0	84 cd	70 ef	100.7 ab	74 cde	68 bc
5.	Propachlor	6.0	88 cd	85 efg	98.3 ab	91 efg	80 bc
6.	Alachlor	1.5	84 cd	65 def	95.9 ab	50 c	48 bc
7.	Alachlor	2.0	86 cd	75 efg	103.5 ab	66 cd	55 bc
8.	Alachlor	4.0	89 cd	75 efg	103.4 ab	61 c	55 bc
9.	Prynachlor	1.5	78 bc	33 bc	100.6 ab	88 def	82 c
10.	Prynachlor	3.0	92 cd	90 fg	100.6 ab	95 fg	85 c
11.	Prynachlor	6.0	98 d	98 g	117.6 b	99 g	75 bc
12.	Atrazine	2.4	56 b	40 cd	105.5 ab	33 b	55 bc
13.	Atrazine	4.0	53 b	8 ab	108.6 b	73 cde	43 b

CONTROL OF *Ipomoea* L. spp. IN SWEET CORN[1/]

C. E. Beste[2/]

ABSTRACT: An evaluation of six experimental herbicides and nine commercial herbicides for control of ivyleaf morningglory (*Ipomoea hederacea* Jacq.); *Ipomoea hederacea* Jacq., var. *integriuscula* Gray; and white morningglory (*Ipomoea lacunosa* L.) in sweet corn (*Zea mays* L.) was conducted in 1971. *I. hederacea* Jacq., var. *integriuscula* is a variety of ivyleaf morningglory that has heart-shaped unlobed leaves. This variety comprised about 15% of the *I. hederacea* population in the field plot. Atrazine, SD-15418, cyprozine, and 2,4-D provided good control of *Ipomoea* spp. Experimental MON-097 (3 lb. ai/A), and BAY-KUE 2236 (2 lb. ai/A) provided approximately 80% control of *Ipomoea* spp. with adequate crop safety.

INTRODUCTION

Morningglory (*Ipomoea* spp.) is the third most serious weed in Maryland, and in some areas it is the most serious weed (1). Effective herbicides for use in Maryland vegetable growing areas should control these weeds. Wilson and Cole (4,5) reported that *S*-propyl dipropylthiocarbamate (vernolate) and 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) were effective for control of tall morningglory (*Ipomoea purpurea* (L.) Roth) and ivyleaf morningglory (*Ipomoea hederacea* Jacq.) in soybeans (*Glycine max* (L.) Merr.). Individual or mixed stands of tall morningglory and ivyleaf morningglory were equally competitive in soybeans (6). Buchanan and Burns (2) observed that one tall morningglory plant per three feet of row reduced cotton (*Gossypium hirsutum* L.) yields 40 to 75%. The development of a uniform stand of morningglory weeds in the sweet corn (*Zea mays* L.) herbicide plots provided the basis for this evaluation of experimental and commercial herbicides.

MATERIALS AND METHODS

The experiment was conducted on Othello silt loam at the Poplar Hill Research Farm, 9.2 miles west of Salisbury, Maryland. Three row plots (36 inch row spacing, 25 feet long) were planted on June 23, 1971 with variety NK-199 sweet corn. Preplant incorporated herbicide treatments were applied on June 23, 1971 and incorporated by double discing using a spike harrow the second time. Premergence treatments were applied June 24, 1971. The temperatures on June 23 were: air 75F, soil-2 inch depth 62F, soil surface 79F; and on June 24: air 100F, soil-2 inch depth 88F, soil surface 115F. Post-emergence treatments were applied July 13, 1971. The spray volume was 50 gal./A. All treatments were established in randomized complete blocks with four replications. The first rain was 0.46 inches on June 28, 1971.

1/ Misc. Publication No. 799 , Contribution No. 4513 , of the Maryland Agricultural Experiment Station, Department of Horticulture.

2/ Assistant Professor, University of Maryland.

Corn injury ratings were made on July 17 and July 28, 1971, and they are expressed as an average of the two ratings. On July 21, 1971 weed counts of ivyleaf morningglory; Ipomoea hederacea Jacq., var. integriuscula Gray; and white morningglory (Ipomoea lacunosa L.) were determined in four replicated plots of 150 square feet. Small seedlings, emerging or in the cotyledon stage, which could not be identified were also counted. The weed counts are expressed as the average of four replications.

RESULTS AND DISCUSSION

Ipomoea hederacea Jacq., var. integriuscula Gray is a variety of ivyleaf morningglory that has a simple heart-shaped unlobed leaf (3). This variety very closely resembles tall morningglory vegetatively; however, the flower parts are quite different. The variety integriuscula comprised about 15% of the I. hederacea population in the field plot. The percent control of the three types of morningglory with different herbicides in the experiment indicated that all three types are similar in their responses to the herbicides evaluated (Table 1).

Atrazine, SD-15418, simazine, and cyprozine provided good control of all three morningglories (Table 1). The experimental herbicide MON-097 (3 lb. ai/A) provided about 80% control of morningglory with no control at lower rates. Sweet corn tolerance of MON-097 at the high rate was adequate. BAY-KUE 2236 (1.0 lb. ai/A) controlled 80% of the morningglory with adequate crop tolerance, but higher rates injured the crop. IMC-3950 and MC-4379 were not effective on morningglory. Chlorobromuron was not effective on morningglory and caused injury on the sweet corn. Alachlor at 2 lb. ai/A and dinoseb (3 lb. ai/A) did not control morningglory. Seedling counts greater than the control indicate that the herbicide may be delaying emergence or germination of the weeds (Table 1).

LITERATURE CITED

1. Anon. 1970. Chemical control of weeds in corn and soybeans on Maryland farms - 1969. Maryland State Board of Agriculture. Publication No. 44.
2. Buchanan, G. A. and E. R. Burns. 1971. Weed competition in cotton. I. Sicklepod and tall morningglory. Weed Sci. 19: 576-579.
3. Gleason, H. A. 1958. The New Britton and Brown Illustrated Flora of the Northeastern United States and adjacent Canada. Vol. 3. Lancaster Press, Inc., Lancaster, Pa. 595 p.
4. Wilson, H. P. and R. H. Cole. 1965. Control of Ipomoea purpurea and Ipomoea hederacea in soybeans with 2,4-D and 4 - (2,4-DB). Proc. NEWCC. 19: 226-232.
5. Wilson, H. P. and R. H. Cole. 1966. Control of morningglory in soybeans with N-propyl di-n-propylthiolcarbamate. Proc. NEWCC 20: 358-365.
6. Wilson, H. P. and R. H. Cole. 1966. Morningglory competition in soybeans. Weeds 14: 49-51.

Table 1. Effect of experimental and commercial sweet corn herbicides on *Ipomoea* spp. and sweet corn vigor.

Treatment	Method[1/]	Rate lb. ai/A	Ivyleaf morningglory (*I. hederacea* Jacq.) No.[2/]	Ivyleaf morningglory % control	*I. hederacea* Jacq., var. *integriuscula* Gray No.[2/]	*I. hederacea* var. *integriuscula* % control	White morningglory (*I. lacunosa* L.) No.[2/]	White morningglory % control	*Ipomoea* L. Seedlings No.[2/]	Crop Vigor[3/]
check	---	---	38.4	0	6.4	0	15.0	0	1.1	10.0
check - weed free	---	---	0	100	0	100	0	100	0	10.0
atrazine	Pre	1.0	0	100	0	100	0	100	0.5	10.0
atrazine	Pre	2.0	0	100	0	100	0	100	1.8	9.8
SD-15418	Pre	1.0	1.0	97	0	100	3.0	80	4.2	10.0
SD-15418	Pre	2.0	0	100	0	100	0.8	95	1.8	9.7
atrazine + alachlor	Pre	1.0 + 1.0	0	100	0	100	0	100	0.75	10.0
atrazine + alachlor	PPI	1.0 + 1.0	0.3	99	0	100	0.5	97	2.5	10.0
atrazine + alachlor	Pre	1.0 + 1.5	0.5	99	0	100	0	100	1.0	10.0
SD-15418 + alachlor	Pre	1.0 + 1.5	3.5	91	0	100	2.0	87	2.2	9.4
alachlor	Pre	1.0	26.3	31	5.3	17	7.0	53	0.3	10.0
alachlor	Pre	2.0	32.8	14	6.5	0	11.5	23	2.3	9.8
dinoseb	Pre	3.0	20.0	48	4.3	33	4.3	71	0.8	10.0
dinoseb + alachlor	Pre	3.0 + 1.5	15.3	60	2.8	56	3.5	77	3.5	9.4
atrazine + butylate	PPI	1.0 + 3.0	0.8	98	0	100	0	100	0.5	10.0
SD-15418 + butylate	PPI	1.0 + 3.0	0	100	0	100	0	100	1.5	9.7
atrazine + simazine	Pre	1.0 + 1.0	0.2	99	0.2	98	1.3	91	2.5	10.0
simazine + alachlor	Pre	1.0 + 1.0	0.5	99	0.2	98	1.5	90	1.8	9.6
alachlor + 2,4-D amine	Pre + Post	1.5 + 0.5	0	100	0	100	0	100	4.0	9.7
2,4-D amine	Post	0.5	0	100	0	100	0	100	3.0	10.0
chlorobromuron	Pre	2.0	10.8	72	1.0	84	3.8	75	1.0	8.6
chlorobromuron + alachlor	Pre	1.0 1.5	13.8	64	0.8	88	5.8	61	1.8	10.0

Table 1. (Continued)

Treatment	Method[1/]	Rate lb. ai/A	Ivyleaf morninglory (*I. hederacea* Jacq.)		*I. hederacea* Jacq., var. *integriuscula* Gray		White morninglory (*I. lacunosa* L.)		*Ipomoea* L. Seedlings	Crop Vigor[3/]
			No.[2/]	% control	No.[2/]	% control	No.[2/]	% control	No.[2/]	
vernolate + atrazine	PPI	1.5 + 1.0	0.3	99	0	100	0	100	1.0	10.0
cyprozine	Pre	1.0	1.3	93	0	100	0.8	95	1.3	10.0
MON-097	Pre	1.0	31.3	18	2.3	64	7.0	53	0.75	10.0
MON-097	Pre	2.0	19.5	50	2.5	61	2.5	83	4.0	10.0
MON-097	Pre	3.0	6.8	82	1.8	72	0.3	92	1.8	9.7
IMC 3950	Pre	3.0	35.0	9	7.3	0	19.0	0	3.8	10.0
IMC 3950	Pre	6.0	28.3	26	4.0	37	9.8	35	3.0	9.5
MC-4379	Pre	2.0	16.0	58	4.3	32	7.2	52	3.8	8.8
BAY-KUE 2236	Pre	0.5	15.0	61	1.0	84	7.3	51	3.3	10.0
BAY-KUE 2236	Pre	1.0	7.3	81	0.3	95	0.8	95	1.5	9.6
BAY-KUE 2236	Pre	2.0	0.3	99	0	100	0	100	1.0	7.1
HOE-6050	Pre	2.0	7.3	81	1.0	84	2.0	87	1.8	9.0
HOE-6050	PPI	2.0	6.8	82	1.5	76	3.5	77	2.5	5.4
HOE-6050	Pre	4.0	0.3	99	0	100	0	100	0.8	7.0
HOE-6050	PPI	4.0	0.8	98	0	100	1.5	90	4.0	3.0
L.S.D. 5%			11.6		3.9		6.8		--	--

1/ Pre - preemergence; PPI - preplant incorporated.
2/ Number of plants per 150 square feet.
3/ Vigor rating: 1 = complete kill, 10 = normal plants.

APPENDIX

Chemical description and suppliers of herbicides used in 1971 sweet corn herbicide trials.

Common Name or Experimental Number	Chemical Name	Supplier
alachlor	2-chloro-2,6'-diethyl-N-(methoxymethyl) acetanilide	Monsanto
atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine	Geigy
BAY-KUE 2236	1,1-dimethyl-3-(m-chloro-p-trifluoromethoxyphenyl) urea	Chemagro
butylate	S-ethyl diisobutylthiocarbamate	Stauffer
chlorobromuron	3-[4-bromo-3-chlorophenyl] -1-methoxy-1-methylurea	CIBA
cyprozine	2-chloro-4-cyclopropylamino -6-isopropylamino-1,3,5-triazine	Gulf
dinoseb	2-sec-butyl-4,6-dinitrophenol	DOW
HOE-6050	not released	American Hoechst
IMC-3950	not released	International Minerals and Chemicals
MON-097	2-chloro-N-(ethoxy-methyl)-6'-ethyl-o- acetotoluidide	Monsanto
MC-4379	not released	Mobil Chemical
simazine	2-chloro-4,6-bis(ethylamino)-s-triazine	Geigy
SD-15418	(2-(4-chloro-6-ethylamino-s-triazin -2-ylamino)-2-methyl-propionitrile)	Shell
2,4-D	(2,4-dichlorophenoxy) acetic acid	Amchem
vernolate	S-propyl dipropylthio carbamate	Stauffer

JOHNSONGRASS CONTROL IN NON-CROPLAND[1/]

J. V. Parochetti[2/]

Abstract. Johnsongrass (Sorghum halepense (L.) Pers.) control in non-cropland conditions resulted from applications of sodium chlorate and sodium metaborate. July applications of 7 and 10 lb/A of 5-bromo-3-sec-butyl-6-methyluracil (bromacil) were more effective than August applications. Two foliar applications of 2,2-dichloropropionic acid (dalapon) at 5, 7, and 10 lb/A resulted in similar johnsongrass control. One application of monosodium methanearsonate (MSMA) resulted in 90% or better johnsongrass control in the year of application, and allowed bermudagrass (Cynodon dactylon (L.) Pers.) to invade the tested area the following year. Although 1,1-dimethyl-4,4'-bipyridinium ion (paraquat) or paraquat plus dalapon resulted in initial kill of johnsongrass, there was no residual control the following year.

Introduction

Johnsongrass is a perennial weed introduced in the United States early in the nineteenth century (4). It is one of the most harmful weeds in the world and one of the most troublesome and costly to control in the United States (2).

The control of johnsongrass in non-cropland areas such as fence rows, utility and highway rights-of-way is important to prevent further infestation of adjacent areas. Historically, chlorates have been used as an effective soil sterilant for many species of weeds; high rates are necessary but the seedling johnsongrass has been noted to reinvade chlorate treated areas one year after application (9). The addition of bromacil has resulted in seedling johnsongrass control (6, 9). The organic arsenics and dalapon have been effectively used for ditch bank control in sugar cane production (6). Although these materials are effective for johnsongrass control, one of the major disadvantages is that repeated applications are necessary (1).

The purpose of this study was to evaluate several foliar herbicides and several soil residual herbicides for johnsongrass control.

1/ Scientific Article No. A 1738 and Contribution No. 4516 of the Maryland Agricultural Experiment Station, Department of Agronomy, College Park 20742.

2/ Assistant Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742.

Materials and Methods

Johnsongrass experiments were conducted at two different locations in 1968 and 1969. Most herbicides were applied as broadcast applications at 30 gpa. The chlorates were applied as a granular material. Four replications were used on all studies and plot size was 10 ft x 20 ft. Johnsongrass control was estimated by observing the regrowth of johnsongrass on a scale of 0 to 100 with 0 equalling no control and 100 equalling 100% control. Statistical analysis was performed by transforming the data by the arcsin $\sqrt{x}$.

In 1968, two experiments were located in the same field in Somerset County. Herbicides that were applied in this particular location are listed in Tables 1 and 2. Treatments which contain chlorates were applied on June 26. Foliar herbicides listed in Tables 1 and 2 were applied two different times. The first application was made June 26 to 12 inch high johnsongrass. The entire area was clipped on July 10 and the 12 inch regrowth of johnsongrass was retreated with the same foliar treatments on July 18. The experimental site listed in Table 2 was also clipped on July 10 and the soil residual herbicides were applied on July 18 to 12 inch high johnsongrass. In Charles County, experiments were established on August 21, 1969. The entire experimental area had been previously clipped and the regrowth of the johnsongrass at the time of treatment was approximately 12 inches high. This particular area was uniformly infested primarily with bermudagrass and johnsongrass.

Results and Discussion

Foliar applications of dalapon applied twice at 4 lb/A with 1.5 gal/A of Sun oil 11E was similar to dalapon applied with a surfactant[3/]. Control of johnsongrass top growth in September was approximately 90% for these treatments and residual control estimated in June of the following year was 80%. Paraquat at 0.5 lb/A applied twice to johnsongrass killed the foliage, but there was no residual control in June the following year. Likewise, dalapon plus paraquat resulted in fairly good initial kill which persisted into August, but regrowth was evident in September of the treatment year and no control was visual in June of the following year. Paraquat was observed to kill the top growth of johnsongrass in one day, probably this prevented the translocation of dalapon to the rhizomes. McWhorter (3) obtained seasonal control of johnsongrass with four applications of dalapon at 3.7 lb/A, seven applications of disodium methanearsonate (DSMA) at 2 lb/A or eight applications of paraquat at 0.5 to 1.0 lb/A. MSMA at 3 lb/A resulted in similar control of johnsongrass when observed in July and August and slightly higher control in September. Residual control the following year was similar to dalapon.

3/ The surfactant used was ½% v:v Adjuvan-T, a product of CIBA-Geigy Corporation.

The soil sterilants containing chlorates resulted in the best johnsongrass control during the year of application and the best residual control. The high rate of sodium chlorate plus sodium metaborate and 2,4 bis(isopropylamino)-6-methoxy-s-triazine (prometone 5%) did result in the best residual control of the herbicides containing chlorates being 97% in June of 1969. Although bromacil at 7 and 10 lb/A did not effect as good initial top growth kill 30 days after treatment, excellent control of johnsongrass leaf and stems was observed in August and September with excellent residual control the following year.

In 1969, the experimental area was infested with both bermudagrass and johnsongrass. The chlorate herbicides were excellent on bermudagrass and johnsongrass control in the treatment year, but when observed one year following application, the combination containing prometone was somewhat better although not significantly different.

A single application of 5, 7, and 10 lb/A of dalapon resulted in about 88% johnsongrass and about 86% bermudagrass top growth control which was not significantly different. Residual control of johnsongrass the following year was 20 to 40%. Repeated applications of dalapon have been reported to increase johnsongrass control (2, 4, 6). The organic soil sterilants did not effect as good control as the chlorate containing herbicides; bromacil and carbutilate effected 70 to 80% johnsongrass control compared to 90 to 100% for the chlorate herbicides. Bromacil, 7 and 10 lb/A, effected good (about 90%) bermudagrass control in the year of application and approximately 70% johnsongrass control. Residual control of johnsongrass the preceding year was only 60% at the high rate of bromacil, 10 lb/A. Sprayberry, Thompson and Hardcastle (10) have previously reported bromacil to be effective for johnsongrass control. Carbutilate resulted in similar control of johnsongrass and bermudagrass as bromacil and similar residual control of johnsongrass the following year.

The late season application of the carbutilate and bromacil in 1969 probably resulted in poorer johnsongrass control because in 1968 an earlier application of bromacil effected excellent johnsongrass control. Woestemeyer and Cooper (9) noted much better johnsongrass control when bromacil was applied early as compared to less satisfactory control resulting from late treatments on well-developed johnsongrass.

One application of MSMA resulted in excellent johnsongrass control, but control the following year was only 58%. MSMA has been reported to be more effective than dalapon (5). Bermudagrass was not controlled by MSMA. Most reports on MSMA indicate as many as five repeated applications of MSMA are necessary for johnsongrass control (1, 3, 6). Bermudagrass was observed to have thoroughly invaded the former johnsongrass infested areas the year following application similar to a previous report by Millhollon (6).

Acknowledgements

The author wishes to express his appreciation for the computer time made available through the facilities of the Computer Science Center at the University of Maryland.

Literature Cited

1. Hamilton, K. C. 1969. Repeated foliar applications of herbicides on johnsongrass. Weeds 17:245-250.

2. Holm, L. 1969. Weed problems in developing countries. Weed Sci. 17:113-118.

3. McWhorter, C. G. 1966. Toxicity of DSMA to johnsongrass. Weeds 14: 191-194.

4. McWhorter, C. G. 1971. Introduction and spread of johnsongrass in the United States. Weed Science 19:496-500.

5. McWhorter, C. G. 1971. Control of johnsongrass ecotypes. Weed Science 19:229-233.

6. Millhollon, R. W. 1969. Control of johnsongrass on drainage ditchbanks in sugarcane. Weeds 17:370-373.

7. Millhollon, R. W. 1970. MSMA for johnsongrass control in sugarcane. Weed Science 18:333-336.

8. Sckerl, M. M. and R. E. Frans. 1969. Translocation and metabolism of MAA-^{14}C in johnsongrass and cotton. Weeds 17:421-427.

9. Woestemeyer, V. W. and R. H. Cooper. 1965. Effect of time of application of borate-chlorate, bromacil and combinations on johnsongrass control. Proc. So. Weed Conf. 18:418-423.

10. Sprayberry, B. A., J. T. Thompson, and W. H. Hardcastle. 1965. Progress report on the effect of experimental soil sterilant formulations on annual and perennial weeds. Proc. So. Weed Conf. 18:337.

Table 1. Foliar applications of dalapon and paraquat on johnsongrass, Somerset County, 1968.

	Treatment	Rate lb/A	Time Applied	% Kill[a/] 7/29/68	% Kill 8/7/68	% Kill 9/26/68	% Kill 6/19/69
1.	Mowed Control	--	--	0 a	0 a	0 a	0 a
8.	Dalapon +	4.0 +	6/26/68	37 b	96 d	87 c	80 b
	1.5 gal/A IIE oil	4.0	7/18/68				
9.	Paraquat	0.5	6/26/68	62 c	60 b	10 ab	0 a
10.	Dalapon +	4.0 +	6/26/68	20 b	93 d	90 c	80 b
	½% Surfactant[b/]	4.0					
11.	Dalapon +	4.0 +	6/26/68	77 c	73 c	13 b	0 a
	Paraquat	4.0					

a/ Data within the same column followed by the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

b/ The surfactant, ½% (v:v) Adjuvan-T was used, a product of CIBA-Geigy Corporation, Ardsley, New York.

Table 2. Soil sterilant and foliar herbicide applications on johnsongrass at Somerset County, 1968.

	Treatment	Rate lb/A	Time Applied	% Kill[a/] 7/29/68	% Kill 8/7/68	% Kill 9/26/68	% Kill 6/19/68
1.	Mowed Control	--	--	0 a	0 a	0 a	0 a
2.	MSMA	3	6/26/68	96 def	64 b	98 def	80 b
3.	Sodium chlorate[b/]	174 +	6/26/68	95 def	99 c	98 def	97 c
	+ Sodium metaborate	218 +					
	+ Prometone	2					
4.	Sodium chlorate[b/]	358 +	6/26/68	100 f	99 c	100 f	100 c
	+ Sodium metaborate	436 +					
	+ Prometone	4					
5.	Bromacil	10	6/26/68	77 bc	95 bc	96 c-f	100 c
6.	Bromacil	7	6/26/68	63 b	93 bc	89 cde	100 c
7.	Dalapon	10 +	6/26/68	95 def	98 bc	65 b	70 b
	+ ½% Surfactant	10	7/18/68				
8.	Dalapon	7 +	6/26/68	83 cd	98 bc	77 bc	73 b
	+ ½% Surfactant	7					
9.	Sodium chlorate[c/]	253	6/26/68	94 de	98 c	85 bcd	80 b
10.	Sodium chlorate[c/]	506	6/26/68	99 ef	100 c	99 ef	83 b

a/ Data within the same column followed by the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

b/ Sold as Pramitol-P, a product of CIBA-Geigy Corporation, Ardsley, New York.

c/ Sold as Atlacide, a product of Rhodia, Inc., New Brunswick, New Jersey.

Table 3. Several soil sterilants and foliar applications of MSMA and dalapon on johnsongrass and bermudagrass in Charles County, 1969.

	Treatment	Rate lb/A	9/16/69 % Bermuda kill[a]	9/16/69 % Johnsongrass kill	9/24/70 % Johnsongrass Kill
1.	Control	--	0 a	0 a	0 a
2.	MSMA	3	10 b	90 f	58 cd
3.	Sodium chlorate[b]	174 +	98 ef	90 ef	90 de
	+ Sodium metaborate	218 +			
	+ Prometone	2			
4.	Sodium chlorate[b]	358 +	100 f	100 g	98 e
	+ Sodium metaborate	436 +			
	+ Prometone	4			
5.	Sodium chlorate[c]	253	100 f	100 g	63 cd
6.	Sodium chlorate[c]	506	100 f	100 g	88 de
7.	Bromacil	10	93 de	75 bc	60 cd
8.	Bromacil	7	88 cd	68 b	28 bc
9.	Dalapon[d]	10	83 cd	85 def	20 b
10.	Dalapon[d]	7	78 cd	89 def	33 bc
11.	Dalapon[d]	5	78 cd	86 def	40 bc
12.	Carbutilate	7	75 c	80 cd	40 bc
13.	Carbutilate	15	89 cde	84 cde	78 d

a/ Data within the same column followed by the same letter are not significantly different at the 5% level of probability according to Duncan's Multiple Range Test.

b/ Sold as Pramitol-P, a product of CIBA-Geigy Corporation, Ardsley, New York.

c/ Sold as Atlacide, a product of Rhodia, Inc., New Brunswick, New Jersey.

d/ The surfactant, ½% (v:v) Adjuvan-T, was used, a product of CIBA-Geigy Corporation, Ardsley, New York.

THE USE OF TREATED FIBREGLASS DISKS FOR WEED CONTROL ON NURSERY CONTAINERS

A. Bing[1] and C. F. Scheer[2]

ABSTRACT

The treatment of fibreglass disks used as a mulch with 2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide (alachlor) plus 2-chloro-4,6-bis (ethylamino)-s-triazine (simazine) or N,N-dimethyl-2,2-diphenylacetamide (diphenamid) plus simazine gave control of liverworts (*Marchantia*) but only temporary control of other weeds.

INTRODUCTION

There is a continued increase in the number of plants grown in containers. Reduced labor costs in handling and the extended marketing season are some reasons for this expansion in production. The plants are grown in plastic or metal 6, 8 or 10 inch containers or rot resistant wood half or full bushel baskets filled with an easily drained medium that is heavy enough to support the plants in a strong wind. Planted containers are placed close together in beds. Before placing the containers, the area is covered with black plastic to prevent weed growth around the containers. The soil mixture is usually relatively weed free. Weed seeds and spores of liverworts can blow on to the containers and grow very rapidly because of the high moisture and nutrient levels that are maintained in the media for fast crop growth (1). The weed species are variable but liverworts, annual grasses, mustards, common chickweed (*Stellaria media*) and woodsorrel (*Oxalis europea*), are usually the most troublesome.

Fibreglass disks and other mulch materials have been used on the containers to reduce weed growth (1). However, blown in weed seeds or spores can still develop on the top of or around the edge of these moist mulch surfaces. The objectives of these tests were to determine (1) if fibreglass disks treated with different herbicides could effectively prevent weed growth without harming the plants, and (2) if addition of activated charcoal to the soil medium would permit increased dosage of herbicides on the disks to improve weed control without plant toxicity.

MATERIALS AND METHODS

All plant materials, 8 inch containers, medium and growing area were furnished by Environmentals, Cutchogue, New York.

The 8 inch fibreglass disks were about $\frac{1}{4}$ inch thick. Because of their variable thickness and weight, they could not be evenly treated by dipping.

---

[1]Professor, Cornell Ornamentals Research Laboratory, Farmingdale, New York.

[2]Cooperative Extension Agent, Long Island, New York.

The 60 disks for each treatment were laid on a 10 x 10 ft area and sprayed with 1 qt water containing calculated amounts of herbicide and wetting agent.[3] Herbicides were those that performed well in other trials: dimethyl tetrachloroterephthalate (DCPA), 2,6-dichlorobenzonitrile (dichlobenil) and diphenamid. Disks received the following treatments: wetting agent alone or with alachlor 4 plus simazine 1, alachlor 8 plus simazine 2, alachlor 12 plus simazine 3, dichlobenil 2 and 4, DCPA 12, and diphenamid 4 plus simazine 1 lb/A. After spraying, the disks were dried a few minutes and then brought into a shed for placement on the containers as they came through the planting operation.

The growing medium was half sand and half shredded peat humus by volume plus 10 lb dolomitic limestone, 2.5 lb 20% superphosphate, 2T chelated iron, and 4 lb 18-9-9 and 6.25 lb 18-6-12 Osmacote, a long lasting fertilizer all per cu yd, mixed in a large converted concrete mixer. Some lots had activated carbon at 100 times the amount of herbicide added to the ingredients.

The three species of ornamentals were cotoneaster (Cotoneaster conglomera), Heller's holly (Ilex crenata helleri) and shore juniper (Juniperus conferta). The small pot grown liners were planted in plastic containers that were 8 inches deep and 8 inches inside diameter. The slotted fibreglass disks were placed over the soil surface immediately after planting, one third of each treatment (20 disks) on each species. The containers were then moved to the growing area.

In the growing area, the containers were placed edges touching on black plastic film. Frequent watering was by over head rotating sprinkler nozzles. All treatments and plantings were done July 1, 1971. Two archegonia of liverwort from 2 year old containers were placed on each experimental container on August 9.

The plants were observed during the growing season. Weed growth and plant survival data were recorded on September 15. Weeds were pulled and recorded as to number and species. Even though some containers were much weedier than others, results were summarized as a percent of containers of each treatment with weeds.

OBSERVATIONS

There were very few plant losses with any of the treatments on holly or juniper but there were many dead cotoneaster both in the treated and in adjacent untreated plants not in the experiment. Table 1 shows the percent tolerance of the three species to the herbicide treatments. All treatments were safe for the holly and juniper. The alachlor 12 simazine 3 treatment was not phytotoxic enough to show any protective value from activated carbon. The cotoneaster observations only show the safety of the alachlor 4 simazine 1 treatment.

Liverworts grew on the top of the moist fibreglass disks and on the soil along the edges. Other weeds did not grow through the disks but in

---

[3]Aqua Gro 2/3 oz per qt per 100 sq ft

Table 1. Tolerance of three ornamentals to chemically treated fibreglass disks used as a mulch.

Treatment		Percent survival[a]		
Herbicide	Lb/A	Heller's holly	Cotoneaster	Shore juniper
Dichlobenil	2	100	67	95
Dichlobenil	4	95	88	100
Alachlor + simazine	4 1	100	100	100
Alachlor + simazine	8 2	100	95	100
Diphenamid + simazine	4 1	95	39	100
DCPA	12	100	75	100
Untreated		100	100	100
Alachlor + simazine	12 3	90	40	89
[b]Alachlor + simazine	12 3	94	88	100
[c]Alachlor + simazine	12 3	100	94	100

[a] 60 containers in each treatment, 20 per species except alachlor 12 simazine 3 which had 29, 49, 50 respectively per treatment.

[b] Soil in each container mixed with activated carbon 1.3 lb/cu yd.

[c] Top 1-2 inch of soil in each container mixed with activated carbon 5.2 lb/cu yd.

many containers there were weeds in the ring of soil at the edge not covered by the disk. In September, most of the chickweed were small plants but they were distributed through all treatments. Table 2 shows the percent of pots of each treatment that had weeds. This was a percent of the total for the treatment including the three ornamentals each of which was in a different growing area. There was no trend for chickweed control in any treatment. The alachlor 8 simazine 2 and DCPA 12 gave some control of woodsorrel. The control of liverworts by the alachlor plus simazine and diphenamid plus simazine was very obvious. The dichlobenil at this time of the year was ineffective. The DCPA was not effective against liverworts or chickweed. Grasses were not a problem in this nursery at the time of the experiment.

DISCUSSION

Except for liverworts the treated fibreglass disks were not effective in controlling chickweed and other weeds long enough under the conditions of this experiment. This may have been due to the leaching of herbicides from the disk and the soil surface by the heavy frequent watering. The alachlor 12 simazine 3 was probably tied up by the activated carbon in the soil surface and therefore did not control chickweed. None of the treatments injured the holly or juniper.

Table 2. Effect of herbicide treated fibreglass disks on weed growth.

Treatment		Percent[a] of containers with weeds			
Herbicide	Lb/A	Oxalis	Liverwort	Chickweed	Any weed
Dichlobenil	2	12	31	34	52
Dichlobenil	4	19	16	51	81
Alachlor	4				
+ simazine	1	9	3	62	74
Alachlor	8				
+ simazine	2	3	0	45	48
Diphenamid	4				
+ simazine	1	10	10	48	65
DCPA	12	3	66	55	88
Untreated		12	51	42	79
Alachlor	12				
+ simazine	3	3	0	69	69
[b]Alachlor	12				
+ simazine	3	29	0	35	60
[c]Alachlor	12				
+ simazine	3	16	8	39	71

[a]60 containers in each treatment, 20 per species except alachlor 12 simazine 3 which had 29, 49, 50 respectively per treatment.

[b]Soil in each container mixed with activated carbon 1.3 lb/cu yd.

[c]Top 1-2 inch of soil in each container mixed with activated carbon 5.2 lb/cu yd.

Both alachlor simazine and diphenamid simazine controlled the liverworts. Control may have been due to the simazine but usually simazine at lower rates is used with a herbicide to control grasses to keep the simazine rate below crop injury level.

There was more weed growth in the plots in November 1. Further observations on weed growth and winter survival of the plants are necessary.

LITERATURE CITED

1. Ahrens, J., 1971. Weed control in container-grown nursery stock. Proc. NEWSS 25:240.

AN EVALUATION OF HERBICIDES FOR THE CONTROL OF WEEDS IN FIELD-GROWN CHRYSANTHEMUMS

W. V. Welker, Jr. and J. C. Cialone[1/]

Field-grown chrysanthemums (Chrysanthemum morifolium Ram.) are planted in the field in spring as rooted cuttings. They remain in the field until late summer or early fall when they are dug and sold. It is desirable to maintain these plantings weed-free during this entire period. Chrysanthemums have been found to be tolerant to isopropyl m-chloro=carbanilate (chlorpropham) and dimethyl tetrachloroterephthalate (DCPA). The effective period of these herbicides, however, is limited (1, 2, 3, 4, 5). Longer residual weed control, without injury to chrysanthemums, has been obtained with a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) (2, 4, 6). Chrysanthemums have been injured by 2-chloro-4,6-bis (ethylamino)-s-triazine (simazine) (2, 5), 2,6-dichlorobenzonitrile (dichlobenil) (4, 6), N,N-dimethyl-2,2-diphenylacetamide (diphenamid), 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron), and 3-(3,4-dichlorophenyl) -1-methoxy-1-methylurea (linuron) (4) when used at rates necessary for effective weed control.

The present study was undertaken to evaluate those herbicides that had shown promise elsewhere as well as others that might have a place in a weed control program for chrysanthemum plantings.

Materials and Methods

Two varieties of chrysanthemums (Scarleteer and Yellow Minnpink) were planted as rooted cuttings June 12, 1970. Each plot consisted of 5 plants of each variety in a single row 20 feet long. A randomized complete block design with 4 replications was used. All herbicide treatments were applied the day of planting. The preplanting incorporated treatments were applied and tilled in to a depth of 2 inches with a power driven tiller just before planting. One-half inch of sprinkler irrigation immediately followed herbicide application. Weed control and injury ratings were made August 3, 1970. All plots were hand-weeded August 11, 1970. The predominant weed species were common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.) and crabgrass (Digitaria sp.). Ratings of the influence of the herbicide treatments upon the flowering of Yellow Minnpink were made October 7, 1970.

[1/] Horticulturist, Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Associate Research Professor, respectively, Rutgers University, The State University of New Jersey, New Brunswick, New Jersey.

The herbicides included in this study were DCPA, diphenamid, chlorpropham, trifluralin, simazine, N-(1,1-dimethylpropyl)-3-5-dichlorobenzamide (RH-315), 2-chloro-2',6'-diethyl-N-(methoxymethyl acetanilide (alachlor), N-isobutynyl-2-chloroacetanilide (BAS-2903H), 2-(α Napthoxy)-N,N-diethylpropionamide (R-7465), 2-tertiobutyl-4-(2,4-dichloro-5-isopropyl=oxyphenyl)-5-oxo-1,3,4-oxadiazoline (RP-17623), O,O-diisopropyl phosphorodithioate s-ester with N-(2-mercaptoethyl) benzenesulfonamide (bensulide), and S ethyl dipropylthiocarbamate (EPTC).

Results and Discussion

Excellent weed control was obtained with a number of herbicides (Table 1). Only R-7465 and diphenamid at 3 lb/A used as soil surface treatments and bensulide gave unsatisfactory control.

The various herbicide treatments were found to affect the growth of the chrysanthemum plants to different degrees as shown in Table 1. Diphenamid (ppi) and the 6 lb/A rate surface-applied along with R-7465 (ppi), EPTC, BAS-2903H and the 4 lb/A rate of alachlor adversely affected the growth of the chrysanthemums. Simazine at 2 lb/A resulted in complete kill of the chrysanthemums. A difference in tolerance between the varieties was noted with Minnpink being more susceptible than Scarleteer when treated with either EPTC or RP-17623. The time of flowering was directly affected by herbicides and indirectly by weed competition. Chrysanthemums are poor competitors with weeds.

The outstanding herbicides in this study were trifluralin, DCPA, RH-315, chlorpropham, and a low rate of alachlor. Improvement in weed control might be accomplished by herbicide combinations, particularly combining one of the herbicides that controls the grasses with trifluralin.

Table 1. Influence of herbicide treatments upon weed control and growth and flowering of field grown chrysanthemums.

Herbicide Trmt.	Rate lb/A	Percent Weed control[1/]	Percent normal plants[2/] Scarleteer	Yellow Minnpink	Percent Flowers open[3/]
trifluralin (ppi)	1	85	88	88	81
	2	94	80	85	83
DCPA	8	80	100	98	83
diphenamid (ppi)	3	88	63	63	68
	6	94	28	20	40
diphenamid	3	63	83	77	56
	6	80	58	48	54
simazine	2	95	0	0	0
RH-315	2	84	100	100	81
	4	98	98	98	85
R-7465 (ppi)	1½	90	45	55	64
	3	96	38	30	58
R-7465	1½	28	93	95	45
	3	43	95	95	80
bensulide (ppi)	6	15	93	93	43
RP-17623 (gran.)	1	93	90	75	83
	2	99	88	48	60
EPTC (ppi)	3	100	68	40	18
	6	100	65	15	13
alachlor	2	89	83	80	74
	4	98	65	53	43
chlorpropham	6	83	88	90	80
BAS-2903H	3	86	77	73	58
	6	98	63	65	63
clean weeded	-	95	88	88	61
unweeded	-	12	23	23	10

1/ Weed control ratings made 3 August 1970.
2/ Plant growth ratings made 3 August 1970.
3/ Flower ratings made 7 October 1971.

Literature Cited

1. Pridham, A. M. S. 1957. Granular versus miscible CIPC in relation to crop and weed growth in *Chrysanthemum morifolium*. Proc. NEWCC 11:76-79.

2. Raulston, J. C., A. J. Overman, D. S. Burgis. 1971. Effect of repeated applications of herbicides in chrysanthemum production. Proc. So. Weed Sci. Soc. 24:241-243.

3. Stadtherr, R. J. and R. E. Widmer. 1959. Chemical weed control in garden chrysanthemums. Weeds 7:82-87.

4. Waters, W. E. 1965. Tolerance of *chrysanthemum morifolium* to several herbicides. Proc. So. Weed Sci. Soc. 18:246-249.

5. Widmer, R. E. and R. J. Stadtherr. 1961. Post planting weed control in garden chrysanthemums. Weeds 9:204-208.

WEED CONTROL ON HARDWOOD CUTTINGS

A. Bing[1]

INTRODUCTION

Some deciduous plants are propagated by hardwood cuttings. In December, strong dormant shoots are cut into 8 inch pieces and stored in plastic bags in a cold room. In the spring, the calloused cuttings are stuck into the soil in beds. They form roots and shoots and by fall are well established plants ready for digging and lining out the next spring.

The large number of closely spaced cuttings make cultivation and weeding difficult. Experiments with weed control in plantings of hardwood cuttings have been conducted for several years at the Ornamentals Research Laboratory on Long Island. This is a review of these experiments with more details on this year's treatments.

MATERIALS AND METHODS

Hardwood cuttings of California privet (Ligustrum ovalifolium) and forsythia (Forsythia ovata) were taken in December, 1970 and stored in plastic bags at 41°F. The basal ends were cut straight across and the top ends cut at an angle to insure putting the basal end in the ground. In April or May, the cuttings were pushed into well prepared soil. They were planted 3 inches apart in rows 4 ft long across the bed. The rows are 6 inches apart, side by side thus forming a long bed. One half of each row was privet and the other forsythia. Frequent irrigation was necessary to prevent the cuttings from drying.

Herbicide treatments were made across the beds to include rows that contained forsythia and privet. In 1971, the cuttings were stuck May 14 and 18 in a bed 112 feet long with 224 rows, each containing 8 privet and 8 forsythia.

In 1971, the treatments were as follows: pre plant 2 lb/A with 2,2,2-trifluro-2,6-dinitro-N,N-dipropyl-P toluidine (trifluralin), immediate post plant 4 lb/A 4-(methylsulfonyl)-2,6 dinitro-N,N-dipropylanaline (nitralin) and on May 21 a combination granular with 2-chloro-2,6 diethyl-N-(methoxymethyl) acetanilide (alachlor) and 2-chloro-2,6 bis (ethylamino)-S-triazine (simazine). The alachlor simazine was applied on untreated and nitralin treated areas at alachlor 4 simazine 1 and alachlor 8 simazine 1 lb/A.

The growth of the privet and forsythia were observed during the growing season and weeds were pulled and counted on July 15.

---

[1]Cornell Ornamentals Research Laboratory

OBSERVATIONS

The predominant weeds in the area in 1971 were common chickweed (Stellaria media), groundsel (Senecio vulgaris), purslane (Portulaca oleracea) and red root pigweed (Amaranthus retroflexus). The areas used in previous years had hairy crabgrass (Digitaria ischaemum) and yellow foxtail (Seteria glauca) as additional serious problems.

Earlier studies showed that simazine alone at 1 or 2 lb was not effective in controlling the annual grasses, especially crabgrass and foxtail, for the growing season; and DCPA and EPTC did not control broadleafed weeds long enough. Experiments and nursery experience show that higher rates of simazine may be harmful to privet or forsythia. Other herbicides were not very effective. Trifluralin and nitralin alone gave good early weed control but did not last long enough. Simazine plus diphenamid gave fairly good broadleaf and grass control but did not last the season.

In 1971, weed control was not complete for any treatment but was highly acceptable in several plots. Very few purslane and chickweed, and no grasses grew in the alachlor simazine or the alachlor simazine over nitralin plots. The untreated and trifluralin areas had some groundsel. Red root and purslane were more evident in the untreated plot. Grasses were not a problem in the area used this year.

Privet and forsythia grew well with no observable injury from any of the treatments.

CONCLUSION

From these experiments we have learned that low rates of simazine combined with a grass killer can be safely and effectively used as a post plant treatment for weed control on forsythia and privet cuttings although both species are known to be sensitive to simazine.

EVALUATION OF SEVERAL HERBICIDES AND HERBICIDE COMBINATIONS FOR WEED CONTROL AND CROP INJURY IN ANNUAL FLOWERS

R. A. Ashley[1]

Abstract

Excellent full season weed control in marigolds, petunias, salvia and verbena was obtained with split applications of alachlor 4EC or 10G at 1½ or 3 lbs/A preplant incorporated + 3 or 6 lbs/A post transplant or single applications of alachlor at 3 or 6 lbs/A post transplant. EPTC 2.3G at 5.5 lbs preplant incorporated + 5.5 lbs post transplant incorporated also gave excellent control of all weed species present. M3251 5G + chloroxuron 5G at 4 + 4 lbs/A preplant incorporated + 4 + 4 lbs/A post transplant gave excellent control of all weed species present except carpetweed.

Prohibitive crop injury to salvia was observed in plots treated with alachlor 4EC at 6 lbs post transplant and in all plots treated with split applications of alachlor. EPTC also severely injured salvia and when two applications were made reduced the stand of verbena.

Introduction

Experiments were conducted on the University of Connecticut Vegetable Research Farm in North Coventry, Connecticut to evaluate single and split applications of several herbicides alone and in combination for crop injury and weed control in petunias, marigolds, verbena and salvia.

Materials and Methods

Marigolds (Tagetes sp.) cv. Harmoney, petunias (Petunia hybrida) cv. Pink Magic, salvia (Salvia sp.) cv. Saint John's Fire, and verbena (Verbena hortensis) cv. Ideal Florists Strain were obtained from commercial sources and field set June 15, 1971. Treated plots consisted of four rows, one of each crop species—10 feet long with 3 feet between rows. Soil type was a Merrimac fine sandy loam with an organic matter content of 3½%. Treatments were replicated 3 times.

Preplant incorporated applications of alachlor 4EC and 10G at 1½ and 3 lbs/A, bensulide 4EC at 6 lbs/A, EPTC 2.3G at 5½ lbs/A and M3251 (a-(2,2,2-trichloraethyl) styrene) 5G + chloroxuron 5G at 4 + 2 and 4 + 4 lbs/A were made June 15, 1971. Herbicides were incorporated to a depth of 1 to 1½ inches by raking, immediately after application.

Post transplant applications of chloramben 4.3G at 4.3 lbs/A, alachlor 4EC and 10G at 3 and 6 lbs/A, DCPA 75W at 10 lbs/A and EPTC 2.3G at 5½ lbs/A were made to clean cultivated plots on June 30, 1971. Post transplant applications in split application treatments were made July 28, 1971 following hand weeding. All rates are in lb ai/A.

1. Assistant Professor of Horticulture, University of Connecticut, Storrs, Connecticut.

Significant rainfall during the treatment of this experiment included: June 9 1.16 inches, June 25-26 0.37 inches, July 2 1.02 inches, July 14 0.28 inches, July 18 0.21 inches, July 20 0.78 inches, and July 30-31 1.92 inches.

The predominant weed species in the experimental areas were lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), purslane (*Portulaca oleracea* L.), carpetweed (*Mullugo verticillata* L.), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), and witchgrass (*Panicum capillare* L.).

Weed control ratings were taken on each of the above species using a 0 to 10 scale with 0 indicating no effect and 10 indicating complete kill. Similar ratings were made for crop injury.

Results and Discussion

Split applications of alachlor or M3251 + chloroxuron applied preplant incorporated and post transplant gave good full season weed control (Table 1). Alachlor 10G at 3 lbs/A preplant incorporated followed by 3 or 6 lbs/A post transplant gave excellent full season control of the weed species present. Minor hand weeding, particularly of lambsquarters and crabgrass, was needed prior to the post transplant application. In the July 31, 1971 rating, alachlor 4EC at 1½ lbs preplant incorporated + 3 lbs/A post transplant gave significantly better control of lambsquarters and large crabgrass than did comparable rates of the 10G material. After the post transplant applications, there was no difference in the performance of these two formulations.

M3251 + chloroxuron at 4 + 2 or 4 + 4 lbs/A preplant incorporated was weak in control of lambsquarters and gave no control of pigweed at the lower rate. After hand weeding, post transplant applications of this combination at 4 + 4 lbs/A gave excellent control of all weeds present except carpetweed while the 4 + 2 lb rate gave poor control of pigweed, purslane, carpetweed and witchgrass.

Single post transplant applications of alachlor 4EC or 10G at 3 or 6 lbs/A gave excellent early weed control but gave poor control of pigweed, crabgrass and witchgrass late in the season.

Bensulide 4E at 6 lbs/A preplant incorporated gave poor early control of carpetweed and crabgrass and no control of pigweed and witchgrass.

EPTC 2.3G at 5.5 lbs/A applied either preplant incorporated or post transplant incorporated gave poor control of pigweed. Split applications of 5.5 lbs/A EPTC preplant incorporated followed by an additional 5.5 lbs post transplant incorporated gave excellent full season control of all weed species present.

Preplant incorporated applications of M3251 5G + chloroxuron 5G at 4 + 4 lbs/A, alachlor 10G at 3 lbs/A, and alachlor 4EC at 1½ or 3 lbs/A gave significant early injury to marigolds (Table 2). This injury took the form of stunting and in all cases was completely outgrown by mid-August.

Early stunting of petunias resulted from applications of alachlor 10G or 4EC at 3 lbs/A and EPTC 2.3G at 5.5 lbs/A post transplant incorporated or the split application of 5.5 lbs/A preplant incorporated + 5.5 lbs post transplant incorporated. Again the injury was completely outgrown by mid-August.

Significant injury to verbena was observed following treatment with chloramben 4.3G at 4.3 lbs/A and EPTC 2.3G at 5.5 lbs/A preplant incorporated. When the preplant incorporated application of EPTC was followed by a post transplant incorporated application, the injury persisted until the termination of the experiment. This injury took the form of reduced plant vigor and, in the case of the split application of EPTC, some reduction in stand.

Salvia showed early injury from alachlor 4EC at 6 lbs/A post transplant and preplant incorporated applications of alachlor 10G, 1½ or 3 lbs/A, alachlor 4EC at 3 lbs/A and EPTC 2.3G at 5.5 lbs/A. In all cases, this injury increased with time eventually resulting in a complete loss of stand in plots treated with alachlor 10G, 3 lbs/A preplant incorporated + 3 or 6 lbs/A post transplant, alachlor 4EC, 3 lbs/A preplant incorporated + 3 lbs/A post transplant and EPTC 2.3G at 5.5 lbs/A preplant incorporated followed by 5.5 lbs post transplant incorporated.

Table 1. Evaluation of several herbicides and herbicide combinations for weed control in marigolds, petunias, salvia, and verbena. 1971.

Treatment[a]	Rate lbs ai/A	Applied	Weed Control Ratings[b] Lambsquarters 7/13	Lambsquarters 9/14	Pigweed 7/13	Pigweed 9/14	Purslane 7/13	Purslane 9/14	Carpetweed 7/13	Carpetweed 9/14	Crabgrass 7/13	Crabgrass 9/14	Witchgrass 9/14
Chloramben 4.3G	4.3	Post	10.0	10.0	10.0	8.0	9.7	10.0	10.0	9.3	9.0	6.0	7.0
Alachlor 4EC	3	Post	10.0	9.7	9.7	6.0	9.0	6.3	10.0	9.0	9.3	7.3	8.0
Alachlor 4EC	6	Post	10.0	10.0	10.0	5.7	9.0	8.3	9.7	9.0	9.0	5.7	6.3
Alachlor 10G	3	Post	10.0	9.0	9.7	5.0	9.7	7.7	10.0	10.0	8.7	1.7	6.0
Alachlor 10G	6	Post	10.0	8.3	10.0	5.0	9.3	9.0	10.0	10.0	8.7	6.0	6.0
DCPA 75W	10	Post	10.0	7.7	9.7	1.7	9.3	9.0	10.0	10.0	8.7	8.3	3.3
M3251 5G +	4 +	ppi											
Chloroxuron 5G +	4	ppi											
M3251 5G +	4 +	Post											
Chloroxuron 5G	4	Post	7.3	10.0[c]	6.3	9.7[c]	8.3	9.0[c]	8.7	6.0[c]	8.0	9.0[c]	9.7[c]
M3251 5G +	4 +	ppi											
Chloroxuron 5G +	2	ppi											
M3251 5G +	4 +	Post											
Chloroxuron 5G	2	Post	6.7	9.7[c]	1.3	7.0[c]	8.7	6.7[c]	7.0	5.0[c]	8.0	9.3[c]	7.3[c]
Bensulide 4E	6	ppi	9.0	9.3	3.0	0	8.7	9.0	5.7	8.3	6.0	9.0	0
Alachlor 10G +	1.5	ppi											
Alachlor 10G	3	Post	5.7	9.3[c]	7.7	9.0[c]	9.3	8.3[c]	9.3	8.3[c]	2.7	8.3[c]	9.3
Alachlor 10G +	3	ppi											
Alachlor 10G	3	Post	7.7	9.3[c]	8.3	10.0[c]	9.3	8.3[c]	9.3	10.0[c]	8.0	9.0[c]	9.7[c]
Alachlor 10G +	3	ppi											
Alachlor 10G	6	Post	8.3	10.0[c]	8.7	9.0[c]	9.7	9.0[c]	9.3	10.0[c]	8.0	9.0[c]	10.0[c]
EPTC 2.3G	5.5	ppi	10.0	8.3	7.3	0	9.3	9.0	10.0	8.7	9.7	9.3	7.7
EPTC 2.3G +	5.5+	ppi											
EPTC 2.3 G	5.5	Post	9.7	10.0	8.3	9.3	9.7	8.7	10.0	9.7	9.0	9.7	10.0
EPTC 2.3G	5.5	Post	10.0	8.3	10.0	4.7	9.0	8.7	10.0	7.0	9.0	7.0	7.0
Alachlor 4EC	1.5+3	ppi+Post	9.7	10.0[c]	8.0	9.0[c]	9.7	8.7[c]	10.0	9.3[c]	9.0	9.3[c]	9.7[c]
Alachlor 4EC	3+6	ppi+Post	9.0	10.0[c]	9.3	9.7[c]	9.3	9.3[c]	10.0	9.3[c]	7.3	9.3[c]	10.0[c]
Hand Hoed Check			10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
LSD 1%			2.2	NS	1.7	2.5	NS	2.0	1.6	2.1	2.2	3.3	2.4
LSD 5%			1.6	NS	1.3	1.9	NS	1.5	1.2	1.6	1.6	2.4	1.8

a. ppi treatments applied 6/15/71. Post transplant treatments applied 6/30/71. Post transplant applications following ppi treatments applied 7/28/71.

b. Average of 3 replicates. 0 = no effect, 10 = complete kill.

c. Hand weeded between first and second ratings.

Table 2. Evaluation of several herbicides and herbicide combinations for crop injury to marigolds, petunias, salvia, and verbena. 1971

Treatment[a]	Rate lbs ai/A	Applied	Crop Injury Ratings[b] Marigolds 7/13	Marigolds 9/14	Petunias 7/13	Petunias 9/14	Verbena 7/13	Verbena 9/14	Salvia 7/13	Salvia 9/14
Chloramben 4.3G	4.3	Post	0	0	1.0	0	3.0	1.0	1.7	0
Alachlor 4EC	3	Post	0	0	1.7	0	1.0	0	2.0	1.0
Alachlor 4EC	6	Post	0	0	1.7	0	0	0	4.3	6.0
Alachlor 10G	3	Post	0.7	0	1.0	0	0	0	2.0	2.7
Alachlor 10G	6	Post	0.7	0	0.7	0	1.0	0	2.0	4.0
DCPA 75W	10	Post	0.3	0	1.0	0	0	0	1.0	0
M3251 5G +	4 +	ppi								
Chloroxuron 5G +	4	ppi								
M3251 5G + Chloroxuron 5G	4+4	Post	3.0	0	1.0	0	0	0	1.0	0
M3251 5G + Chloroxuron 5G +	4+2	ppi								
M3251 5G + Chloroxuron 5G	4+2	Post	0	0	0	0	0	0	0.7	0
Bensulide 4E	6	ppi	0.7	0	0	0	0	0	0.7	0
Alachlor 10G +	1.5	ppi								
Alachlor 10G	3	Post	1.0	1.0	0	0	1.3	0	3.7	8.0
Alachlor 10G +	3	ppi								
Alachlor 10G	3	Post	1.0	0	2.0	0	2.3	0	4.3	10.0
Alachlor 10G +	3	ppi								
Alachlor 10G	6	Post	2.0	0	3.3	0	0.7	1.7	6.3	10.0
EPTC 2.3G	5.5	ppi	1.0	0	2.0	0	5.3	0	7.0	6.7
EPTC 2.3G	5.5	ppi								
EPTC 2.3G	5.5	Post	1.3	0	3.0	0	4.0	4.3	7.0	10.0
EPTC 2.3G	5.5	Post	0	0	4.0	0	1.3	0	0	6.0
Alachlor 4EC	1.5+3	ppi+Post	2.3	0	1.0	0	0	0	0.7	3.0
Alachlor 4EC	3+6	ppi+Post	4.0	0	2.3	0	0.7	0	5.0	9.7
Hand Hoed Check			0	0	0	0	0	0	0	0
LSD 1%			2.1	NS	2.8	-	3.4	2.2	3.0	6.2
LSD 5%			1.6	NS	2.1	-	2.5	1.7	2.3	4.7

a. ppi treatments applied 6/15/71. Post transplant treatments applied 6/30/71. Post transplant applications following ppi treatments applied 7/28/71.

b. Average of 3 replicates. 0 = no effect, 10 = complete kill.

ROOTING OF SOFTWOOD CUTTINGS TAKEN FROM CONTAINER GROWN PLANTS TREATED WITH SIMAZINE AND DIPHENAMID [1/]

J.J. McGuire and J.L. Pearson [2/]

Introduction

Nurserymen throughout the northeast have complained of poor rooting quality in cuttings taken from plants in fields where herbicides have been used. In several cases, cuttings have failed to root. It is common practice in the Rhode Island Nursery Industry to take cuttings from plants that are being produced for sale rather than to have established stock plants grown specifically for cuttings.

The two herbicides most commonly used in Rhode Island field production are simazine and diphenamid. It was decided therefore, to study these two materials on container plants as possible causes of root disorders.

Materials and Methods

Plants from rooted cuttings of five clones of ornamentals were used in the study: *Ilex glabra*, *Rhododendron* X 'Rosebud', *Rhododendron* X 'Mother's Day', *Rhododendron* X 'Stewartianum' and *Juniperus chinensis* or 'San Jose'. All plants were potted in late May, 1971, in six inch nursery containers in a growing medium of equal parts by volume of sand, sphagnum peatmoss and coarse grade perlite. Plants were irrigated with approximately 3/4" of water. Twice each week a complete soluble fertilizer (20-20-20) was injected into the water at a concentration of 150 ppm N.

Seven treatments including herbicides, and a control were applied three weeks after the plants had been established. The herbicides used were: simazine, 2-Chloro-4,6-bis(ethylamino)-s-triazine and Diphenamid N, N-Dimethyl-2, 2-diphenylacetamide.

The rates of application and the formulation used were granular simazine at 2 and 4 lbs. ai/Acre and granular diphenamid at 6 and 8 lbs.Aai/Acre. Combinations of 1 and 2 lbs. of simazine

---

1/ Contribution No. 1418, Agricultural Experiment Station, Kingston, Rhode Island 02881.

2/ Assistant Professors, Department of Plant and Soil Science

and 4 and 6 lbs. of diphenamid, respectively, were also applied.

1.	simazine 4G	2#/A
2.	simazine 4G	4#/A
3.	simazine 4G + diphenamid 5G	1#/A + 4#/A
4.	simazine 4G + diphenamid 5G	2#/A + 6#/A
5.	diphenamid 5G	6#/A
6.	diphenamid 5G	8#/A
7.	control	

Each aliquot of granular herbicide material was mixed with quartz sand to facilitate distribution. Containers were arranged in a factorial design of seven treatments in five replicates and two sameles in the give clones.

Cuttings were taken from the plants after intervals of 30 and 80 days. Four cuttings were taken from each replicate. All cuttings were treated with 1,000 ppm each of Napthalene acetic acid and Indoleacetic acid in an aqueous solution of 40% polyethylene glycol (Carbowax 400). The growth regulator was applied as a ten-second dip. Cuttings were placed in flats containing equal parts by volume of sphagnum peatmoss and coarse grade perlite. Flats were placed under intermittant mist in the greenhouse.

Root quality was determined by measuring diameters of root balls or by counting the actual number of roots per cutting. Numerical values were determined as shown in Table 1.

Table 1. Numerical Evaluation of Root Systems Used in Determining Quality of Rooting of Cuttings

Value	Azaleas	Holly or Juniper
0	no roots	no roots
1	0-10 roots	1-3 roots
2	10 roots - 1½" ball	4-6 roots
3	½ - 1" ball	7-8 roots
4	1-2" ball	9-10 roots
5	over 2" ball	more than 10 roots

Results and Discussions

Some plants died soon after application of herbicides. These were recorded after 30 and 80 days, and are shown in Table 2.

Table 2. Number of Plants Dead as a Result of Herbicide Treatments After Intervals of 30 and 80 Days

	CULTIVAR									
					Rhododendron					
	I.glabra		J.'San Jose'		'Rosebud'		'Mother's Day'		'Stewarts'	
Herbicide rate	30	80	30	80	30	80	30	80	30	80
simazine 2#	5	1	0	0	1	0	6	0	6	0
simazine 4#	9	0	0	8	9	0	5	0	6	0
simazine 1# + diphenamid 4#	1	0	0	0	0	0	0	0	2	0
simazine 2# + diphenamid 6#	6	0	0	0	9	0	0	3	0	3
diphenamid 6#	0	0	0	0	0	0	0	0	0	0
diphenamid 8#	0	0	0	0	0	0	0	0	0	0
Control	0	0	0	0	0	0	0	0	0	0
Totals	21	1	0	8	19	0	11	3	14	3

Only simazine treatments killed plants. Some plants were stunted from the simazine treatment but did not die. This undoubtedly would have an effect on rooting of cuttings taken from these plants. In no case was a plant killed by the diphenamid treatments.

Results of rooting quality are shown in Table 3. Two general trends were evident. Root development was retarded where simazine was used, but not following applications of diphenamid. The retarding effects appear to have dissapated after 80 days but by then the plant material had hardened and rooting of treated plants was less satisfactory. Root quality data were taken after six weeks on the first lot of plants and after only four weeks on those cuttings taken from the 80 day lot. This was necessary in order for data to be processed in the early fall. It is therefore, not possible to make comparisons horizontally in Table 3 but comparisons in the vertical columns do show the same trends on both dates. When totals

Table 3. Total Rooting Quality of Cuttings Taken From Stock Plants Treated with Simazine or Diphenamid

	I. glabra		R. X 'Rosebud'		R. X 'Mothers Day'		R. X 'Stewart.'		J. Chinensis 'San Jose'		
	Days After Treatment										
Treatment	30	80	30	80	30	80	30	80	30	80	Means 30 days
Control	17.4	2.6	13.6	3.3	8.2	3.3	9.8	4.0	15.4	2.6	12.88a
diphenamid 8#	15.0	2.6	16.0	3.7	9.4	3.4	8.2	2.3	9.6	2.5	11.64a
diphenamid 6#	13.0	2.2	11.0	4.4	9.6	3.4	11.0	3.6	10.8	2.7	11.08ab
simazine 1# + diphenamid 4#	3.0	1.8	14.6	4.3	8.2	3.0	7.4	4.0	5.4	3.6	7.72bc
simazine 2# + diphenamid 6#	3.0	0.9	14.4	4.1	7.0	3.8	0.6	1.3	10.6	3.0	7.12c
simazine 2#	1.0	0.8	13.2	4.0	4.8	2.4	2.5	2.5	7.8	2.3	5.86cd
simazine 4#	0.0	0.0	4.0	1.6	5.6	1.5	4.0	2.0	2.0	0.5	3.12d

Means followed by the same letter are not significantly different at the 5% level.

for all cultivars are compared, it is apparent that whenever simazine was used there was a decline in rooting quality with the most severe decline at the highest rate of simazine. It would appear from this data that simazine does have an effect on rooting of cuttings taken from container grown plants. It also appears that the effect can be lost if sufficient time passes before cuttings are taken. Cuttings will be taken from these plants again after one year to determine if there is any long range effects from the herbicide.

Further experimentation will be necessary to determine what rate of application of simazine would create the same effect under standard field grown conditions.

Summary

Two herbicides simazine and diphenamid were applied to container grown plants singly or in combination at commonly used commercial rates. No plants treated with diphenamid died. Cuttings were taken after 30 and 80 days. Retardation in rooting was observed in treatments containing simazine. No retarding effects were observed when diphenamid was used.

These data cannot be related to field grown plants but they do indicate that similar studies should be made under field conditions.

WEED CONTROL IN NURSERY PLANTINGS

A. Bing[1]

ABSTRACT

Combinations of 2-chloro-2,6-bis (ethylamino)-S-triazine (simazine) with 2-chloro-2,6 diethyl-N-(methoxymethyl) acetanitide (alachlor) or N,N-dimethyl-2,2-diphenylacetamide (diphenamid) were very safe and effective as post plant herbicides on nursery liners.

INTRODUCTION

I have reported previously on weed control on ground covers (1) (2), landscape plantings (3) and this year on containers and hardwood cuttings. This article is to bring you up to date on weed control studies under production nursery conditions over the past two years. The experiments carried out at the Cornell Ornamentals Research Laboratory are designed to provide information that can be used, together with that of other research workers and nurserymen, for the development of recommendations for weed control in production nurseries. The herbicide simazine has been the standard for weed control in nurseries, although at lower rates it has not given good control of annual grasses especially yellow foxtail (Setaria glauca) and some perennials. Selected newer materials and also combinations of simazine with grass killers have been used to broaden the spectrum of safe weed control.

The use of herbicides to control annual weeds has reduced the amount of cultivation used by nurserymen. This has caused a greatly increased perennial weed problem especially with field bindweed (Convolvulus arensis), Canada thistle (Cirsium arvense) and quackgrass (Agropyron repens).

MATERIALS AND METHODS

The basic plan for these experiments is to line out young nursery plants 2 ft apart in 400 ft rows 3 ft apart. A wide selection of nursery and landscape plants are planted one cultivar to a row. Included each year are representatives of the more commonly used cultivars such as Japanese yew (Taxus cuspidata), Hetz juniper (Juniperus hetzii), box leafed holly (Ilex crenata convexa) white pine (Pinus strobus), Japanese black pine (Pinus thunbergii), crabapple (Malus seiboldii) and more sensitive species such as California privet (Ligustrum ovalifoliun), forsythia (Forsythia sp) and Viburnum species. From 13 to 19 cultivars are used each year. Treatments are applied in 8 ft bands across the rows. There are 25 treatments with 2 replicates of 4 plants of each cultivar.

---

[1]Cornell Ornamentals Research Laboratory

Weed growth was rated during the growing season from 1 (no weeds) to 10 (many weeds). Crop growth was rated from 1 (dead or missing plant) to 10 optimum growth) for each plant in October and again in the spring to see if the treatments had any effect on winter hardiness.

Herbicides used alone or in combination in 1970 and 1971 included: alachlor, 3-amino-2,5-dichlorobenzoic acid (chloramben), O,O-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) bensenesulfonamide (bensulide), 2,6-dichlorobenzonitrile (dichlobenil), diphenamid, 3-(3,4-dichlorophyenyl)-1,1-dimethylurea (diuron), S-ethyl dipropylthiocarbamate (EPTC), 4-(methylsulfonyl)-2,6-dinitro-n,N-dipropylaniline (nitralin), simazine, 3-tert-butyl-5-chloro-6-methyluracil (terbacil), a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin), and (2,4-dichlorophenoxy) acetic acid (2,4-D).

Simazine was used alone at 1, 2, 4 and 6 lb/A or in combination as alachlor 3-4 simazine 1, alachlor 6-8 simazine 2, or as diphenamid 4-6 simazine 1. Alachlor was used alone at 3 lb/A. Dichlobenil was used at 1.5 and 4.5 lb/A covered with a wood chip mulch in 1971 and at 3 lb alone in 1970. EPTC was used alone at 3 and 5 lb/A. Trifluralin was used alone at 2 lb and at 1 lb with simazine 1 lb in 1970. Terbacil was used at 0.5 and 1 lb in 1970. Nitralin was used at 4, 6 and 8 lb in 1970.

OBSERVATIONS

Most of the liners grew well but there were a few cultivars that regardless of treatment did not do well and are not included in the summary. A composite of treatments and weed observations for 1970 and 1971 are in Table 1. The data show the better weed control by alachlor 3 simazine 1 than alachlor 3 or simazine alone up to 6 lb. Alachlor 3 simazine 1 controlled weeds or well as alachlor 6 simazine 1. EPTC gives fairly good control.

Privet, rose, white pine, crabapple, box leafed holly and yew are tolerant to the herbicides shown in the combined 1970, 1971 data in Table 2. Viburnum may be sensitive to simazine.

Other data not included in these tables show terbacil at 0.5 and 1 lb to be effective against all annual weeds but toxic to Andorre juniper and privet. Trifluralin post plant at 2 lb was effective against most weeds except Galinsoga. Trifluralin 1 lb plus simazine 1 lb was more effective than trifluralin alone against all weeds and safe on all crops. Nitralin was effective for a limited period of time and was safe on all crops tested.

The alachlor simazine was applied as separate applications of alachlor 10G and simazine 4G or as a combined alachlor 8 simazine 2G. The results at lower rates were equally effective.

Dichlobenil at 3 lb only controlled some weeds and killed the Viburnum. Dichlobenil covered with 3 inches of wood chips gave good to excellent control of all weeds at 1.5 and 4.5 lb/A. The higher rate was toxic to hemlock, Viburnum, holly and pines.

Table 1. Control of several weeds in newly planted nursery stock. Combined data from 1970 and 1971.

Treatment		Weed Growth[a]				
Herbicide	Lb/A	All weeds	Pig-weed	Lambs-quarter	Crab-grass	Fox-tail
Alachlor	3[b]	7	3	5	2	2
Alachlor	3					
+ simazine	1	2	2	2	2	2
Alachlor	6					
+ simazine	1	2	2	2	2	2
Simazine	1	9	6	3	7	5
	2	5	5	3	5	4
	4	5	4	2	3	3
	6	4	3	2	3	2
Simazine	1					
+ diphenamid	4	3	2	3	2	2
EPTC	3	3	3	3	1	2
	5	3	2	2	1	2
Untreated		10	8	5	4	5

[a] Rated no weeds (1) to excellent growth (10), composite of 2 years, 2 replicates each year.

[b] Alachlor 3 results from 1971 only.

DISCUSSION

The nursery liners were tolerant to most of the herbicides and combinations. The tolerance of privet to simazine may be due to the higher fertility level used on this cultivar to produce vigorous shoots for hardwood cuttings.

LITERATURE CITED

1. Bing, A., 1970. 1969 Weed control trials with ground covers. Proc. NEWCC 24:15-20.

2. Bing, A., 1969. Weed control trials with ground covers. Proc. NEWCC 23:70-75.

3. Bing, A., and D. Fraser, 1970. Weed control in highway plantings. Proc. NEWCC 24:55-60.

Table 2. Tolerance of some nursery liners to post plant herbicides. Combined data from 1970 and 1971.

Treatment		Crop Tolerance[a]						
Herbicide	Lb/A	Privet	Rose[b]	White pine	Viburnum	Crabapple	Holly	Yew
Alachlor	3[c]	10	10	10	9	9	10	10
Alachlor + simazine	3 + 1	8	9	9	7	9	9	8
Alachlor + simazine	6 + 1	8	9	9	5	8	9	9
Simazine	1	8	10	9	7	9	9	9
	2	8	9	9	4	9	9	9
	4	8	9	9	4	8	9	8
	6	9	9	9	3	5	8	9
Diphenamid + simazine	4 + 1	8	9	10	6	9	9	9
EPTC	3	9	9	9	8	9	9	9
	5	9	10	9	6	9	9	8
Untreated		9	8	9	5	9	8	9

(a) Rated dead or missing (1) to excellent growth (10).
(b) *Rose multiflora* in 1970 *Rose rugosa* in 1971.
(c) Alachlor 3 results from 1971 only.

TRANSLOCATION AND METABOLISM OF ATRAZINE IN *CIRSIUM ARVENSE*

G. W. Burt[1]

Abstract

Postemergent applications of atrazine has the potential of being more effective than preemergent applications if plant parts not directly treated with atrazine would be inhibited. This inhibition could be caused by either basipetal movement of atrazine or by an indirect effect. Two studies were, therefore, conducted to determine if (a) basipetal translocation of atrazine occurs and (b) if postemergent applications inhibit growth of plant parts not directly treated with atrazine. In the first study ^{14}C atrazine was applied only to the above ground plant parts of Canada thistle. Translocation occurred predominantly acropetally. Two weeks after application, approximately 1% of the recovered activity was located in the non-treated plant parts. Sixty percent of this activity was located in the non-treated stems. In the treated stems approximately 80% of the activity was chloroform soluble and chromatographed similarly to standard atrazine. In non-treated plant parts approximately 60% of the activity was chloroform soluble. In the second study the physiological effects on non-treated plant parts were determined in the greenhouse by treating only one stem with atrazine and recording growth of other non-treated stems. The primary stem of control plants was cut to simulate loss of physiological activity caused by atrazine. After two weeks, plants were harvested and the dry weight of underground parts and untreated stems were recorded. Results indicated that atrazine does exert a small but significant effect on non-treated plant parts. This effect cannot be attributed to simply the loss of photosynthetic activity of the treated stem, but may be caused by respiration in this stem.

[1]University of Maryland, College Park, Md.

TRANSLOCATION AND METABOLISM OF SAN-6706-C-14 IN VACCINIUM MACROCARPON VAR. EARLY BLACK

by

R.M. Devlin and R.W. Yaklich [1]

INTRODUCTION

Nutsedge (Cyperus dentatus Tort.) and cutgrass (Leersia oryzoides (L.) Sw.) are weeds of major importance to cranberry growers of southeastern Massachusetts. Over 80% of the cranberry bogs of this region are infested with these weeds and it has been estimated that they cause at least a 20% reduction in yield (2). Cranberry growers manage to keep nutsedge and cutgrass under control with the use of the herbicides 2,6-dichlorobenzonitrile (dichlobenil) and morcran--a formulated mixture of sodium N-1-naphtylphthalamate (naptalam) and isopropyl m-chlorocarbanilate (chlorpropham). However, the use of dichlobenil and morcran on cranberry bogs presents some problems.

Nutsedge and cutgrass are not eradicated by the herbicides but only suppressed for about 75% of the growing season. This necessitates annual applications. Also, by the time berries are beginning to size and color these weeds are sufficiently tall and abundant enough to compete with the cranberry vines for water, nutrients, and light. The results are smaller and inadequately colored berries. Since cranberry vines are only slightly more tolerant of dichlobenil than nutsedge or cutgrass the grower must guard against vine injury. For example, vine injury can be caused by uneven applications of dichlobenil or by a gradual build-up of the herbicide in the soil due to the necessity of annual applications.

Herbicide tests in 1969 and 1970 by the authors uncovered two experimental herbicides of the fluorinated pyridazinone class that gave much better control of nutsedge and cutgrass than either dichlobenil or morcran. The two experimental herbicides were 4-chloro-5-(dimethylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (SAN-6706) and 4-chloro-5-(methylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (SAN-9789).

The purpose of this work was to initiate studies on translocation and metabolism of SAN-6706 in the cranberry plant (Vaccinium macrocarpon Ait.). More detailed studies have been planned with SAN-6706 and its analog, SAN-9789.

---

[1] Associate Professor of Plant Physiology and Research Associate, respectively, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts.

MATERIALS AND METHODS

In order to obtain cranberry plants suitable for experimentation cuttings were taken from the field and grown in the greenhouse. After 80 days healthy plants with good root development were selected for translocation studies. The roots were thoroughly washed clean of soil and the plants then transferred to foil-wrapped 125 ml erlenmeyer flasks. Each flask contained two plants held in place with a cotton plug, 80 ml of distilled water, and 0.34 uc of SAN-6706 (uniformly labeled with C^{14} and having a specific activity of 3.0 mc/mM). The flasks containing the plants were then placed in a Percival growth chamber (model E-54U) where they were subjected to a constant temperature of 22 $\pm 1^{\circ}$C and a photoperiodic cycle of 16 hours light (800 ft-c) and 8 hours dark. The plants were sampled at 1, 3, 8, and 14 days. Three flasks (6 plants) constituted a sampling, four plants being used for extraction and the remaining two plants for autoradiography (1). For autoradiography Kodak single-coated X-ray film SB-54 was used and allowed to develop for 42 days.

Cranberry plants to be extracted were separated into leaves, stems, and roots and blended with a Virtis-45 homogenizer in 50 ml of redistilled benzene-methanol (95:5) solution. The homogenate was then filtered and the retentate washed twice with the aforementioned solvent. The washed retentate was homogenized and extracted twice again in the same manner, the final volume of extract amounting to about 450 ml. This final volume was concentrated down to 0.5 ml. Recovery of radioactivity with the above solvent system was 90% or better. Residual radioactivity was determined by the Sandoz-Wander laboratory in Hanover, N.J.

Samples (5 lambda) of the concentrated extract were chromatographed in two directions by TLC on glass plates coated with a 250 u film of Brinkmann Siliplate-F-22. The plates were activated for one hour at 105°C prior to use. The two solvent systems used to develop the plates were chloroform-methanol (95:5) and benzene-ethanol (95:5). Radioactive compounds were located and identified by using Kodak single-coated X-ray film SB-54, Rf values, and co-chromatography. All radioactive materials were counted by liquid scintillation using a Nuclear-Chicago liquid scintillator (model 6804). All samples were counted for enough time to be statistically significant above background at the 5% level. Water samples were counted in 10 ml of dioxane solution containing 5 g of PPO and 100 g of napthalene per liter. All other samples were counted in 10 ml toluene containing 5 g of PPO and 0.1 g of POPOP per liter solution.

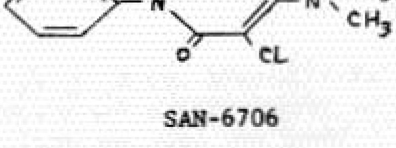
RESULTS AND DISCUSSION

Autoradiographs of plants allowed to absorb SAN-6706-C-14 for 1, 3, 8, and 14 days showed a typical root-to-leaf pattern of translocation for a root-absorbed compound. After one day of treatment C-14 label was only apparent in the root. However, after 3 days radioactivity could be detected in the stem and very faintly in the basal areas of the older leaves. A progressively clearer image of the younger leaves was observed on autoradiographs of plants treated for 3, 8, and 14 days. A sharp image, however, of vein translocation of SAN-6706 in the leaves could not be detected, even in plants treated for 14 days. As was anticipated the autoradiographs showed that most of the C-14 label was in the roots with relatively very little appearing in the stems and leaves. This finding is clearly supported by extractions of radioactivity from the roots, stems, and leaves and subsequent countings (Table 1).

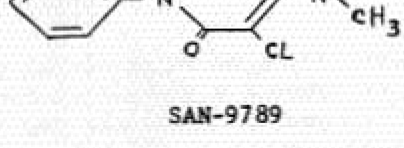
Table 1. Amount of radioactivity (dpm/g wet wt.) extracted from cranberry plants treated with SAN-6706-C-14. An average of two replicates is represented by the data.

	Time of treatment (days)			
Plant Section	1	3	8	14
Leaves	1,081	1,096	3,446	11,810
Stem	9,197	8,088	21,914	41,361
Root	98,554	171,360	312,022	312,110

No image or spot could be detected on the autoradiographs of TLC plates containing chromatographs of the concentrated extracts of the leaves and stems from plants treated with radioactive SAN-6706 for 1, 3, and 8 days. However, a spot, identified by co-chromatography and the use of Rf values as SAN-6706, was observed on the autoradiographs of chromatographs of the extracts of roots treated for only one day. Chromatographs of root extracts from plants treated for 8 days gave the first indication of SAN-6706 breakdown. Two spots were observed, one being the original compound absorbed (SAN-6706) and the other which ran at the Rf of SAN-9789. The identity of these compounds was confirmed by co-chromatography with SAN-6706 and SAN-9789 standards. Both compounds were found in the stems and roots of plants treated



SAN-6706



SAN-9789

for 14 days. However, the metabolite SAN-9789 was not detected in the leaves of these plants.

A surprising number of SAN-6706 metabolites were found in the root medium (distilled water) in which the plants were grown and to which the tagged herbicide was added. When medium that was allowed to stand for 14 days with SAN-6706-C-14 was chromatographed, no less than 10 spots were detected on the autoradiographs. Two of the spots were readily identified as SAN-6706 and SAN-9789. The remaining 8 metabolites will be identified in a future study.

LITERATURE CITED

1. Crafts, A.S. and S.H. Yamaguchi. 1964. The autoradiography of plant materials. California Agr. Exp. Sta. Manual 35.

2. Peterson, B.S., C.E. Cross, and N. Tilden. 1968. The cranberry industry in Massachusetts. Mass. Dept. Agr. Bul. 201:1-76.

SITE OF ACTION OF DCPA ON CORN AND CUCUMBER

S. S. Szabo[1]

Abstract

DCPA (dimethyl ester of tetrachloroterephthalic acid), a preemergence herbicide, was applied to one-day-old corn and cucumber seedlings in the dark to simulate contact of the chemical with the seedlings in the field. The chemical was applied in lanolin paste or as a wettable powder in water and/or glycerin using a 0.25 cc. bacteriological syringe equipped with a metering device. The treated plants were kept in the dark for 12 hours after treatment and then placed in the greenhouse.

The above species were most responsive when the DCPA was applied to the terminal meristematic areas. The cotyledonary leaves of cucumbers became deep green and considerably enlarged following treatment. All terminal growth was inhibited with concentrations of DCPA in lanolin $\geq$ 0.008 mg. per plant. Corn was considerably less sensitive and required 1.7 mg. per plant to cause stunting. Both species were less sensitive to DCPA applied in the wettable powder formulation.

---

[1] Boyce Thompson Institute for Plant Research, Yonkers, N. Y.

EFFECT OF BAY-94337 ON THE GERMINATION OF TOMATO, BARNYARDGRASS, AND FALL PANICUM[1]

D. A. Braden and J. C. Cialone[2]

ABSTRACT

The effect of 4-amino-6-t-butyl-3-(methylthio)-1,2,4-triazin-5(4H)-one (Bay-94337) on the germination and early growth of barnyardgrass (Echinochloa crus-galli (L.) Beauv.), fall panicum (Panicum dichotomiflorum Michx.), and tomato (Lycopersicon esculentum Mill. var. H-1409) was investigated under laboratory conditions in several experiments. Seeds were germinated on solidified agar-agar (0.75%) media in covered recrystallizing dishes at 28 C with continuous lighting of 100 ft-c. In certain experiments the effect of exposure to increased light intensity (1000 ft-c) on treated seedlings was examined at the culmination of the germination studies.

Species were exposed to several levels (0, 0.1, 1, 10, 100 and 1000 ppmw a.i.) of formulated (75% WP) and technical (92%) Bay-94337. The effect of the presence of soil in the germination media on herbicidal activity was examined by placing 3 gms of air-dry Freehold sandyloam soil in 30 ml of media containing the different levels of herbicide.

Counts of germinated seeds were made at various times and for varying lengths of time depending upon species; at the termination of the germination studies heights of plants were measured as well as length of tomato radicle. After exposure to increased light intensity, heights of plants and the number of chlorotic on necrotic plants were recorded.

The germination of barnyardgrass, fall panicum, and tomato was not significantly (p=0.05) inhibited by Bay-94337 except at the 1000 ppm level; and, early germination of barnyardgrass and tomato was stimulated by 0.1 and 1.0 ppm Bay-94337. Fall panicum germination was not inhibited by the 100 ppm level of herbicide.

The technical herbicide was more toxic than the wettable powder formulation although this difference was not significant. Inclusion

---

[1]From a thesis by D. A. Braden to be submitted in partial fulfillment for the Ph. D. degree.

[2]Graduate Assistant and Associate Research Professor, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey 08903.

of soil in the agar-herbicide media, significantly increased the germination of tomato only at the 100 ppm level.

Germination studies with 14 tomato varieties have shown an extreme range of responses to 0, 10, and 100 ppm Bay-94337 in agar. Varietal responses have ranged from: increased germination with increased herbicide level; decreased germination with increased herbicide; and, increased germination at 10 ppm and decreased germination at 100 ppm.

THE EFFECTS OF ATRAZINE AND SIMAZINE ON PHYSIOLOGICAL PROCESSES OF FALL PANICUM

W. F. Smith and R. D. Ilnicki[1/]

ABSTRACT

The effects of 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) and 2-chloro-4,6-bis (ethylamino)-s-triazine (simazine) on physiological processes of fall panicum (*Panicum dichotomiflorum* Michx.) plants in the 3 to 4-leaf stage treated in solution culture and grown under greenhouse conditions were investigated. Herbicide concentrations of 5 uM simazine caused significantly greater reduction in fresh weight of tops than did 5 uM atrazine or a 2.5 uM + 2.5 uM combination of both herbicides. At a concentration of 20 uM no significant differences in the fresh weight of tops or roots were found between atrazine, simazine, or a 10 uM + 10 uM combination of both herbicides. Transpiration in fall panicum plants was reduced with all concentrations of herbicide, although significant differences were not noted between the treatments atrazine, simazine, or the 1 + 1 combination for equivalent concentrations. Photosynthesis of leaf disks taken from fall panicum plants treated in solution culture resulted in no significant differences between the control and plants treated with either 5 uM or 20 uM atrazine. Increasing concentrations of simazine caused significantly greater reduction in photosynthesis. The inhibition caused by 5 uM simazine did not differ from that caused by the 2.5 uM + 2.5 uM combination of atrazine and simazine. Similarly, the inhibition caused by 20 uM simazine did not differ from that caused by the 10 uM + 10 uM combination of both herbicides. *In vitro* studies of the effect of each herbicide on the Hill reaction of isolated fall panicum chloroplasts indicated more inhibition with atrazine than simazine; however, the greatest inhibition was caused by a 1 + 1 combination of both herbicides. Atrazine at 0.2 uM resulted in a 63% inhibition of the Hill reaction, simazine at .2 uM resulted in a 30% inhibition of the Hill reaction and the combination of .1 uM + .1 uM atrazine plus simazine caused a 90% reduction in the Hill reaction.

[1/] Graduate Assistant and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

EFFECT OF ATRAZINE ON GROWTH AND NITROGEN CONTENT OF JUVENILE CORN GROWN UNDER TWO NITRATE-NITROGEN REGIMES

M. M. Lay and R. D. Ilnicki[1/]

Abstract

Young corn seedlings were grown in two levels of nitrogen, 14 and 168 ppm, in nutrient solution and treated with two levels of atrazine, 1 and 5 ppm. It was observed that the low concentration of atrazine produced a slight increase in plant height and fresh weights at the low nitrogen level but not at the higher one. Generally, the higher atrazine level reduced heights, fresh and dry weights at both nitrogen levels. Increases in atrazine at either nitrogen level increased top/root ratios. The total nitrogen content was similarly increased by atrazine in the two nitrogen mediums.

Introduction

Research has indicated that in some instances triazine herbicides may increase the growth and nitrogen content of plants. Doll and Meggitt (1968) pointed out that corn (*Zea mays*) treated with atrazine induced an increase in the NO_3-N at low temperature. Gramlich and Davis (1967) treated corn (var. Dixie 18) with 0, 2, 4, and 8 ppmw atrazine (in nutrition studies) and found plants were smaller than untreated plants and contained higher nitrogen percentages. Corn plants treated with high rates of 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) always contained less nitrogen than untreated plants. The object of this study was to determine if atrazine influences growth, development, and nitrogen content of juvenile corn plants grown in nutrient solution which contained two different levels of NO_3-N.

Materials and Methods

Corn (var. N.J. 8) was germinated in washed sand and seedlings later transplanted, when in the 2 to 3-leaf stage, to gallon jars containing complete nutrient solution but with varying amounts of NO_3-N (14 and 168 ppm). The plants were maintained in these solutions, which were changed every 7 days, prior to the additions of atrazine (0, 1, and 5 ppm) to the growing medium. Additions of atrazine were made twice during the experimental period which was terminated after 5 weeks. There were two

---

[1/] Graduate Assistant and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

replications for all treatments. Height measurements were made weekly by measuring plants from the jar lid to the tip of the tallest leaf extended. All three plants per jar were harvested and composites made. Plants were separated into roots, stalks, and tops, oven-dried at 70-80 C, ground, and further dried to constant weight prior to dry weight, top/root, and total nitrogen (including nitrate) determinations.

Results and Discussion

Corn plants grown in the low nitrogen level appeared to be in a "starved state" during the course of the experiment. This condition commenced after two weeks or just after transplanting. Further evidence of this condition was the death of the lower 3 to 4 leaves on all plants. This deficiency symptom was more pronounced in the no atrazine treatments and was not as severe in the low nitrogen treatments containing 1 and 5 ppm atrazine. It was evident that atrazine additions had some effect on reducing the degree of nitrogen deficiency. Heights at the termination of the experiment were 76.5 and 121.5 cm for the low and high nitrogen levels, respectively, without atrazine.

The effects of nitrogen and atrazine on heights are presented graphically in Figure 1. From this figure it can be seen that growth was affected more by nitrogen that atrazine; however, at the high level of nitrogen growth was retarded by the high level of atrazine. At the low nitrogen level there were no differences in plant heights due to atrazine. These observations were not similar to those of Freney (1965) who observed increased growth of corn with additions of simazine.

Reductions in growth effected by atrazine at the higher nitrogen level may have been due to reduced nutrient absorption and/or reduced photosynthetic activity. With regard to fresh weight of leaves there was considerable difference in the low and high nitrogen regimes. Average total weights for all plants/jar was 43.3 gm for the low nitrogen vs. 145.9 gm for the high nitrogen, or the low level was slightly less than 30% of the high level. Similarly, the fresh weight of stalks differed appreciably. The low nitrogen was only 24.1% of the high nitrogen level, being 45.5 gm and 188.2 gm, respectively. One observation worthy of note was that stalks were heavier than leaves on a fresh weight basis but the reverse was true on a dry weight basis (Figure 2).

In Figure 3 are presented graphically the effects of atrazine additions on dry weight of tops (leaves and stalks) and roots. It is evident that increases in atrazine concentration produced decreases in dry weights. The rate of decrease was greater for the high nitrogen than for the low nitrogen level. One other interesting observation was that differences in top versus root growth were greater at the lower nitrogen level.

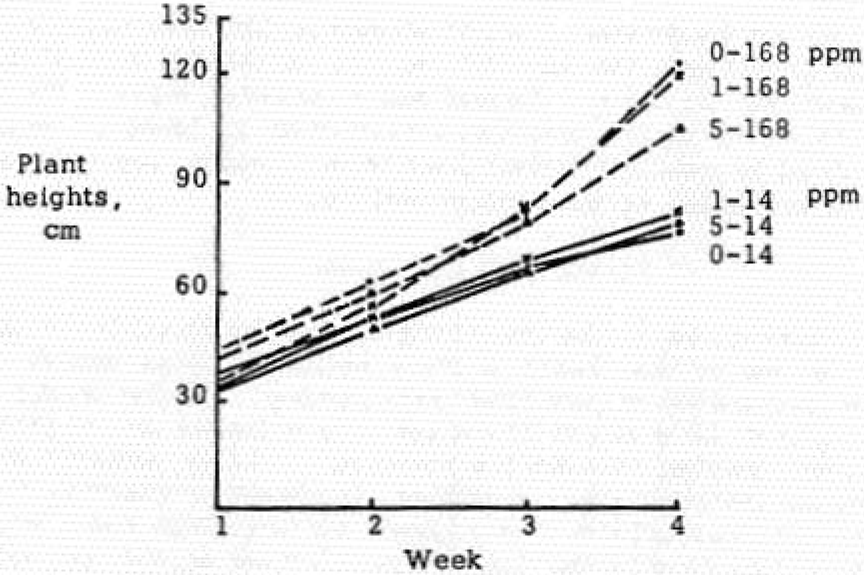


Fig. 1. Average plant heights in corn plants treated with atrazine and grown at two NO_3-N levels.

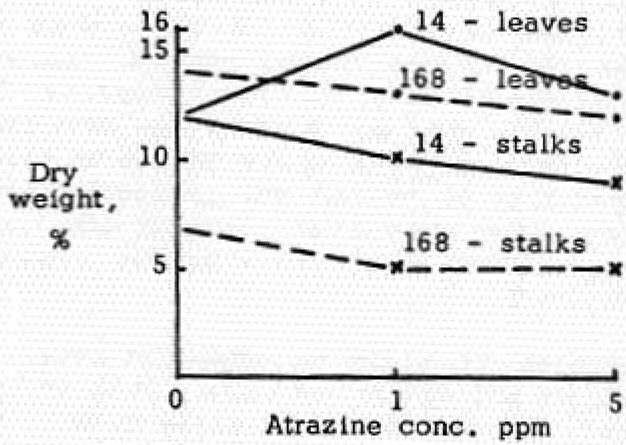


Fig. 2. Effect of atrazine on dry weight yields of corn plants grown at two NO_3-N levels.

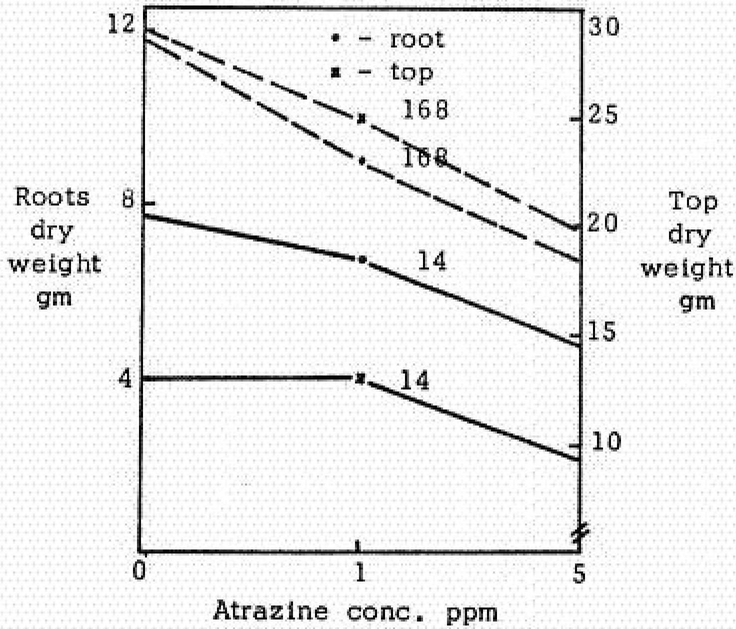


Fig. 3. Effect of atrazine on top and root yields in corn plants grown at two NO_3-N levels

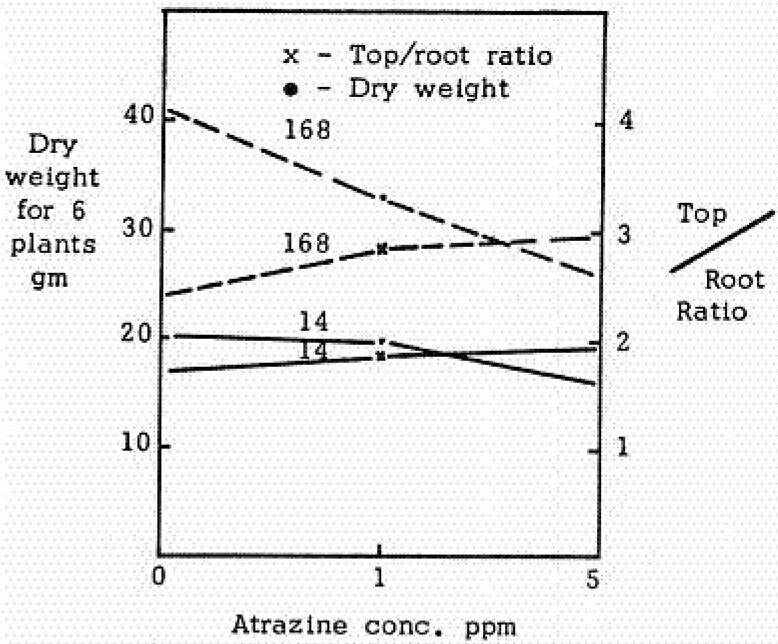


Fig. 4. Effect of atrazine on top and root ratio in corn plants grown at two NO_3-N levels.

When the top/root ratios were compared it was found that increases in atrazine increased this ratio (Figure 4). This was more pronounced at the higher nitrogen level. This effect was also reported by dr Vries (1963).

The total nitrogen content in leaves and stalks increased as the nitrogen level in solution was increased (tables 1 and 2). Similarly, as the atrazine concentration in the two solutions was increased the amount of nitrogen in the tissue increased, being much greater at the higher nitrogen level. This same effect was observed for simazine (de Vries, 1963; Freney, 1965; and Tweedy and Ried, 1966). Doll and Meggitt (1968) found that any NO_3-N increases in corn induced by atrazine occurs only at low temperature (21.1 C) and not at high temperatures (29.4 C). During the period of this study, greenhouse temperatures ranged from 22 to 25 C. Young corn plants treated with atrazine provided a nitrogen source as reported by Gramlich and Davis (1967) and Funk and Fletchall (1967).

Ries and Gast (1965) reported that simazine at certain levels depressed plant growth but increased nitrogen absorption. In the present study, where atrazine was used nitrogen uptake was also increased with a concurrent decrease in dry matter production.

That atrazine depressed top and root growth, in solution culture, may be the direct result of its effect on the Hill reaction (Couch and Davis, 1966) and its indirect suppression of plant growth. The stimulation of growth and total nitrogen content, particularly at the low atrazine level seems to indicate that the herbicide might affect plant metabolism directly. This was also suggested by Ashton (1960).

Literature Cited

1. Ashton, F. M. 1960. The effect of atrazine on the metabolism of C^{14}-sucrose in excised bean leaves in the dark. Plant Physiol. 35:(supplement) XXVIII.

2. Couch, R. W. and D. E. Davis. 1966. Effect of atrazine, bromacil, and diquat on $C^{14}O_2$-fixation in corn, cotton, and soybean. WSA Abst. p.41.

3. de Vries, Martin L. 1963. The effect of simazine on Monterey and corn as influenced by lime, bases and aluminum sulfate. Weeds 11:220-222.

4. Doll, J. D. and W. F. Meggitt. 1968. Atrazine and nitrate content of corn. Agron. J. 65:655-657.

5. Fink, R. J. and O. H. Fletchall, 1967. The influence of atrazine or simazine on forage yield and nitrogen components of corn. Weeds 15:272-274.

6. Gramlich, J. V. and D. E. Davis. 1967. Effect of atrazine on nitrogen metabolism of resistant species. Weeds 15:157-160.

7. Freney, J. R. 1965. Increased growth and uptake nutrients by corn plants treated with low levels of simazine. Aust. J. Agric. Res. 16:257-263.

8. Ries, S. K. and A. Gast. 1965. The effect of simazine on nitrogenous compounds of corn. Weeds 13:272-274.

9. Tweedy, J. A. and S. K. Ries. 1966. The influence of simazine on growth and nitrogen metabolism of corn grown at different temperatures. WSA Abst. p.40.

Table 1. Effects of atrazine concentration on percent nitrogen content of corn leaves from plants grown at two levels of nitrogen in solution culture (dry weight basis).

NO_3-Nitrogen	Atrazine concentration, ppm		
ppm	0	1	5
14	0.87	1.02	1.51
168	3.01	3.30	3.33

Table 2. Effects of atrazine concentration on percent nitrogen content of corn stalks from corn plants grown at two levels of nitrogen in solution culture (dry weight basis).

NO_3-Nitrogen	Atrazine concentration, ppm		
ppm	0	1	5
14	0.66	0.69	0.97
168	2.74	3.52	3.89

EFFECT OF DIURON ON CO_2 COMPENSATION POINT AND PHOTOSYNTHETIC ACTIVITY IN VIVO IN SOYBEAN PLANTS

M. M. Lay and R. D. Ilnicki[1/]

ABSTRACT

Reduction of water loss and inhibition of stomatal openings in soybean (Glycine max. Merr.) by 3-(3,4-dichlorophenyl) 1,1-dimethylurea (diuron) has been observed in this laboratory. This study was, therefore, initiated: (1) to investigate the effect of various concentrations of diuron on photosynthetic activity in vivo in soybean plants; and (2) to determine the CO_2 compensation concentration in the intercellular spaces.

Basal stems of excised shoots and whole plants were suspended in nutrient solution containing equimolar levels of 0, 2, 4, 8, and 10 x 10^{-6} M of diuron. Leaf disks were used for the measurement of O_2 evolution using a respirometer. The amount of diuron absorbed by the plants was determined by a colorimetric measurement of 3,4-dichloroaniline at 560 mu. In this procedure, diuron is quantitatively hydrolyzed to 3,4-dichloroaniline by refluxing the sample with a concentrated sodium hydroxide solution. The CO_2 concentration in the intercellular spaces was determined by measurement of the CO_2 compensation point using a Beckman L/B Infrared Gas Analyzer.

It was observed that O_2 evolution was inhibited at 2 and 4 x 10^{-6}M and inhibition was significantly different when compared to the the control. However, no difference was shown among the treatments at 4, 8, and 10 x 10^{-6}M when the intact roots of plants were treated with the herbicide. On the other hand, the amount of O_2 evolution was reduced as concentrations were increased from 2 to 10 x 10^{-6}M. There were many more herbicide molecules recovered in leaves when whole plants were treated with diuron at low concentrations. However, herbicide uptake was increased as the concentration in solution with excised shoots increased. When the diuron concentration was increased from 2 to 10 x 10^{-6}M the CO_2 concentration in the intercellular spaces increased.

From the results it is suggested that diuron induced closed stomata in soybean due to the increase of CO_2 concentration in the intercellular spaces by inhibiting CO_2 assimilation. As far as the amount of diuron absorption and photosynthetic activity were concerned, diuron may indirectly affect other physiological processes in plants.

[1/] Graduate Assistant and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey

CONTROL OF QUACKGRASS (AGROPYRON REPENS) WITH (3,5-dichloro-N-(1,1-dimethyl-2-propynl)benzamide)

J. B. Ryan[1/]

Introduction

Quackgrass (Agropyron repens (L.) Beauv.) is a perennial species which reproduces by production of both rhizome and seed. The persistence of quackgrass in heavily infested fields, however, is primarily due to the development of new rhizomes, while seed production plays only a minor role. Johnson and Buchholtz (4) have shown that both quackgrass rhizome production and rhizome bud activity follow a seasonal cycle and that the majority of foliar growth in the spring is from buds of rhizomes that were produced the previous year. Effective chemical control of quackgrass must involve the killing of existing rhizomes while preventing the development of new rhizomes. The herbicide Kerb (3,5-dichloro-N-(1,1-dimethyl-2-propynyl)benzamide) has been shown to be highly active against quackgrass (1,2,5,6). Duke (2) has reported decreased rhizome weight and bud activity in Kerb treated soil. The studies reported herein were designed to further investigate the effects of Kerb on quackgrass and in particular its effects on: 1)foliar growth, 2)rhizome bud viability, and 3)new rhizome growth and development.

Methods and Materials

Field Experiment

Field studies were conducted on the Rodriguez Farm in Long Pond, Pennsylvania. Kerb was applied at 0.5, 1.0, 2.0 and 4.0 lb/A on October 30, 1970 to an undisturbed quackgrass sod. Treatments were applied using a small plot bicycle sprayer which was calibrated to deliver 30 gpa using compressed nitrogen as the pressure source. Plots were 12 x 20 feet and were arranged in a randomized complete block design with four replications. The soil was a sandy loam with 3.45% organic matter.

Quackgrass foliar control was determined by counting the number of shoots per 72 square inches in five randomly selected locations in each plot. The five counts were averaged and expressed as a percent reduction in shoots compared to the control.

Rhizomes were collected from each plot by removing all the soil material from an area 12 x 6 inches on the surface and 4 inches deep. These samples were transported to the laboratory where the rhizomes were removed from the soil and washed with tap water. Mature rhizomes were separated from new rhizomes on each sampling date. New rhizomes consisted of all those produced during

---

1/ Agricultural Field Research Representative, Rohm and Haas Company, Research Laboratories, Spring House, Pennsylvania.

the 1971 growing season while the mature rhizomes consisted of all those produced in previous years. Fresh weights for the two rhizome groups were weighed to the nearest 0.1 gram. Rhizomes which were in advanced stages of decay were discarded and not weighed. A schedule of rhizome sampling and evaluation dates is as follows.

Date		Shoot Counts	Rhizome Sample
March	31	x	x
April	22	x	x
May	9	x	
May	26	x	x
June	7	x	
June	25	x	x
July	12	x	
July	26	x	x
August	9	x	
August	23	x	x
September	20	x	x
October	19	x	x

Laboratory Studies

The viability of mature rhizomes was determined by culturing one bud rhizome sections in agar using a modification of the methods described by Johnson and Buchholtz (3,4). One pint wide mouth jars were used containing 150 cc of 0.75% agar. Rhizomes were cut into one bud sections approximately 15 mm long and were grouped according to their nodal position with respect to the apical shoot end of the rhizome. Sufficient rhizome material was collected from each plot to allow a random selection of six buds from each of the first eight rhizome nodes. This amounted to a total of 48 rhizome buds per plot or 192 buds per treatment. The rhizome sections were left in the agar for 14 days at which time the buds were rated as either viable (alive) or nonviable (dead). Shoot lengths (mm) were also measured at 14 days and were considered an indicator of bud activity or dormancy.

An average percent bud viability for all nodes on mature rhizome was determined for each treatment. This percentage was multiplied by the corresponding fresh weight of mature rhizome to give the weight of viable mature rhizome. The total weight of new rhizomes was considered viable since greater than 98% of all buds tested regardless of treatment were found to be viable.

Results and Discussion

Foliar Control

Quackgrass foliar control during 1971 is presented in figure 1. All dosages of Kerb resulted in nearly complete control through early April, 1971. The first evidence of foliar regrowth was seen on April 22 at the 0.5 lb/A dosage. On May 9, quackgrass regrowth was detected in the 1.0 lb/A treatment while significant regrowth at the 2.0 and 4.0 lb dosages did not occur until July 12 and August 23, respectively. The rate of regrowth from the 0.5 lb/A treatment was rapid through June. The decline in foliar control then proceeded slowly

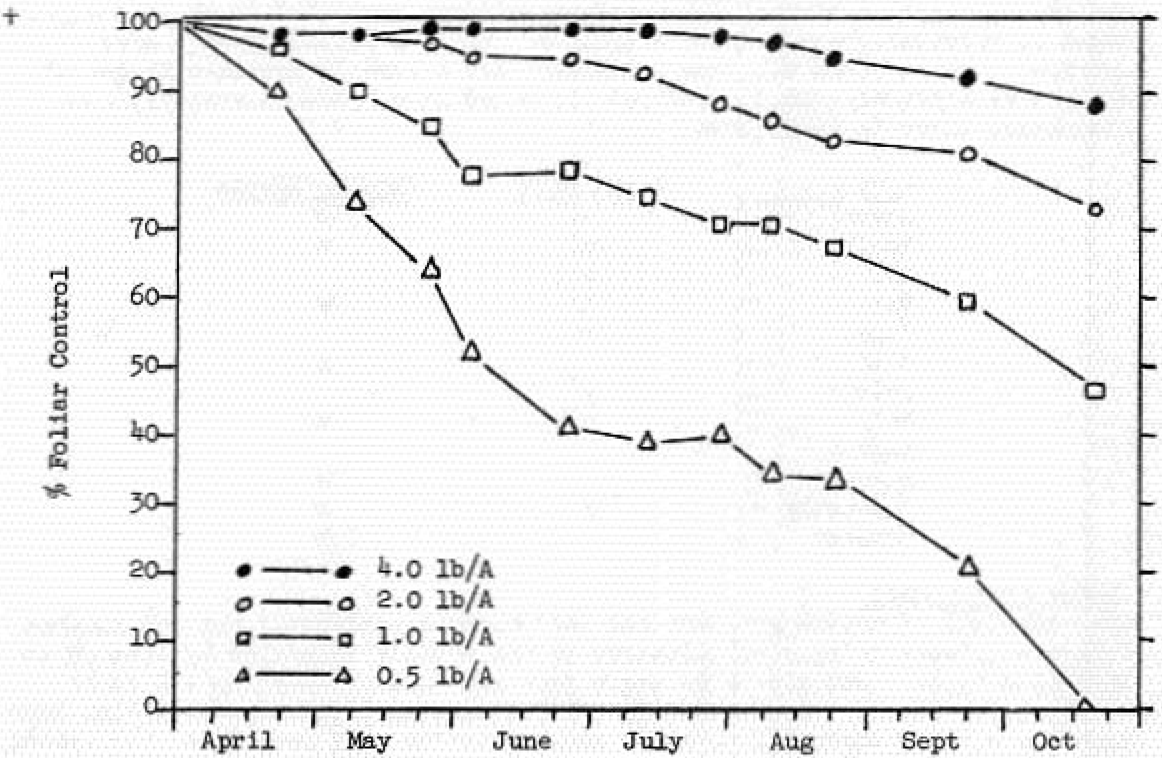


Figure 1. Percent foliar control of quackgrass from Kerb treatments applied on October 30, 1970.

during the summer months. An accelerated rate of regrowth occurred after August 23 for all treatments. On October 19, nearly one year after treatment, the average percent control of shoot growth remaining from the 0.5, 1.0, 2.0 and 4.0 lb/A dosages was 0, 47, 73 and 88%, respectively.

Rhizome Control

The total weight of quackgrass rhizome from the control fluctuated slightly during the 1971 growing season. On March 31, all of the rhizome material present consisted of mature rhizomes produced in previous years (see Table 1). New rhizome growth was first detected in the April 22 rhizome sample and increased in quantity with each successive sample. The weight of mature rhizome, on the other hand, decreased steadily during the season due to loss from decay. On June 25, the weight of new rhizome produced was nearly 50% of the total viable rhizome weight and by October 19 contributed nearly 80% of the total weight. The observed new rhizome production with the concurrent decrease in mature rhizome weight followed the same seasonal pattern of rhizome production described by Johnson and Buchholtz (4).

The total rhizome weight from soil treated with Kerb was decreased slightly compared to the control at the first sampling date regardless of dosage (see

Table 1). This decrease may have been due to the prevention of new rhizome growth during the late fall following Kerb application and to early decay of some rhizome material damaged by the treatment. A rapid decrease in rhizome weight from all Kerb treatments occurred between March 31 and April 22. This was due to accelerated rotting of injured mature rhizomes as the soil warmed.

The production of new rhizomes was also reduced by Kerb. The 0.5 lb/A rate of Kerb reduced new rhizome weight by 50% on October 19, one year after treatment (see Table 1). A 1.0 lb/A Kerb dosage delayed the initiation of new rhizome development approximately one month and reduced the weight of new rhizome produced one year after treatment by 86%. The 2.0 and 4.0 lb/A Kerb dosages delayed the start of new rhizome production by two and three months, respectively, and reduced new rhizome weights by 90 and 98% one year after treatment.

It is interesting to note that in the fall, one year after treatment, the control of quackgrass rhizome by Kerb was much greater than the control of foliage. For example, the 1.0 lb/A rate of Kerb resulted in an 86% reduction of new rhizome weight while the foliar control remaining was only 47%. Since the majority of quackgrass growth in the spring is from rhizomes produced the

Table 1. Fresh weight yield of new and mature quackgrass rhizomes.

Kerb Lb/A	Rhizome Maturity	Fresh weight of quackgrass rhizomes (tons/A)[1] Sampling Date 3/31	4/22	5/26	6/25	7/26	8/23	9/20	10/19
0	Total wt.	5.03	4.66	5.78	6.03	5.46	5.71	6.01	5.91
	Viable mature	4.61	4.21	4.00	3.04	2.06	1.73	1.71	1.08
	Viable new	0.00	0.09	1.46	2.58	2.99	3.37	3.50	4.16
	Total viable	4.61	4.30	5.46	5.62	5.05	5.10	5.21	5.24
0.5	Total wt.	4.25	2.37	2.36	2.77	2.61	2.75	3.07	3.19
	Viable mature	2.45	1.28	1.19	1.07	0.87	0.71	0.66	0.52
	Viable new	0.00	0.04	0.52	1.08	1.17	1.50	1.68	2.10
	Total viable	2.45	1.32	1.71	2.15	2.04	2.21	2.34	2.62
1.0	Total wt.	4.39	2.92	2.42	1.87	1.45	1.29	1.23	1.57
	Viable mature	1.60	0.91	0.76	0.49	0.42	0.30	0.23	0.30
	Viable new	0.00	0.00	0.03	0.21	0.15	0.39	0.36	0.58
	Total viable	1.60	0.91	0.79	0.70	0.57	0.69	0.59	0.88
2.0	Total wt.	4.48	2.67	1.81	1.32	1.33	0.77	0.62	0.84
	Viable mature	0.06	0.04	0.04	0.03	0.13	0.07	0.04	0.04
	Viable new	0.00	0.00	0.00	0.03	0.01	0.17	0.13	0.43
	Total viable	0.06	0.04	0.04	0.06	0.14	0.24	0.17	0.47
4.0	Total wt.	4.60	2.29	1.76	0.82	0.58	0.42	0.50	0.32
	Viable mature	0.05	0.01	0.03	0.01	0.01	0.01	0.01	0.01
	Viable new	0.00	0.00	0.00	0.00	0.01	0.01	0.12	0.08
	Total viable	0.05	0.01	0.03	0.01	0.02	0.02	0.13	0.09

[1] Values are an average of four replications and were converted to tons/A fresh weight from grams fresh weight per 288 cubic inches of soil.

previous year (4), the above data serve to explain how the apparent loss of foliar control from low rates of Kerb in the fall one year after treatment can be followed by a high level of control again in the spring (1.5 years after treatment).

Rhizome Bud Viability

Kerb was highly active against mature quackgrass rhizome buds (see Table 2). A Kerb dosage of 0.5 lb/A resulted in nearly complete kill of all buds located at the first node from the terminal shoot. Approximately 50% of the buds at nodes two and three were killed and the percent bud mortality decreased at nodes further removed from the apical end. The 1.0 lb/A Kerb treatment killed nearly all of the rhizome buds at the first three nodes and approximately 50% at node six. The 2.0 and 4.0 lb/A dosages killed most of the rhizome buds at all nodal positions. The few surviving buds were located primarily at nodes six to eight.

Viable Bud Activity

Viable rhizome bud activity, measured by the length of the shoot produced after 14 days, is presented in Table 3. These values are averages of all shoot lengths produced at nodes one through eight. The 2.0 and 4.0 lb/A treatments were not included because an insufficient number of buds survived.

The shoot length measurements presented in Table 3 show that the control rhizome buds developed dormancy between late April and June. By June 25, the control buds were almost all dormant and incapable of shoot growth. This rhizome bud dormancy was similar in degree and time of occurrence to the "late spring dormancy" described by Johnson and Buchholtz (4). In that study, the onset of mature bud dormancy coincided with the initiation of new rhizome development. This was true in the present study also (see Tables 1 and 3).

The 0.5 and 1.0 lb/A Kerb treatments disrupted the natural "late spring dormancy" cycle of mature rhizome buds (see Table 3). On May 26 when control shoot growth was severely inhibited, the shoot growth obtained from the surviving 0.5 lb/A Kerb buds was only moderately reduced while shoot growth from the 1.0 lb/A Kerb buds was not reduced at all. On this same date, new rhizome production was severely reduced by the 0.5 lb/A treatment and absent in the 1.0 lb/A treatment. The development of new rhizomes increased during June in the 0.5 lb/A Kerb treatment and correspondingly the mature rhizome bud activity decreased. On June 25, the 0.5 lb/A buds were just slightly more active than the control buds. Mature rhizome bud activity from the 1.0 lb/A treatment also decreased between May 26 and June 25 and it was in the June 25 rhizome samples that new rhizomes were first measured. Many of the surviving mature buds from the 1.0 lb/A treatment never became dormant while others exhibited various degrees of dormancy ranging from slight shoot inhibition to complete inhibition. The prevention of many of the surviving mature buds from entering dormancy during the early summer months likely accounts for some of the foliar regrowth observed during this period.

Table 2. Percent viability of mature quackgrass rhizome buds as affected by Kerb applied on October 30, 1970.

Sample Date (1971)	Kerb lb/A	% Viability of Rhizome Buds[1/] Node Position 1	2	3	4	5	6	7	8
March 31	0.0	100	96	96	96	92	88	83	83
	0.5	0	33	50	56	72	78	83	89
	1.0	0	8	17	33	50	58	58	67
	2.0	0	0	0	0	0	6	0	6
	4.0	0	0	0	0	0	0	4	4
April 22	0.0	96	96	96	100	88	83	92	88
	0.5	0	50	50	56	72	67	67	78
	1.0	0	8	12	12	42	58	58	58
	2.0	0	0	0	0	0	0	0	11
	4.0	0	0	0	0	0	4	0	0
May 26	0.0	100	96	96	92	96	96	83	83
	0.5	6	50	61	78	78	83	83	83
	1.0	0	0	8	29	38	50	62	62
	2.0	0	0	0	0	0	6	6	11
	4.0	0	0	0	0	4	0	4	4
June 25	0.0	96	96	83	88	88	88	83	83
	0.5	11	50	61	72	78	83	78	72
	1.0	0	0	4	25	42	46	58	62
	2.0	0	0	0	0	0	6	0	11
	4.0	0	0	0	0	0	0	4	8

1/ Values represent the number of buds which were alive and expressed as a percent of the control.

Table 3. Effect of Kerb on mature rhizome bud activity.[1/]

Sample Date (1971)	Shoot Length (mm) lb/A Kerb 0	0.5	1.0
March 31	125	109	98
April 22	110	92	91
May 26	16	69	92
June 25	6	12	33
July 26	10	10	29
August 23	20	28	37
September 20	32	40	34
October 19	35	34	36

1/ Bud activity was measured as the length of shoot produced after 14 days in agar.

Summary

Kerb dosages of 0.5, 1.0, 2.0, and 4.0 lb/A applied on October 30, 1970 resulted in excellent foliar control of quackgrass the following spring. One year after treatment the average foliar control remaining from the four Kerb treatments was 0% (0.5 lb), 47% (1.0 lb), 73% (2.0 lb), and 88% (4.0 lb). Kerb reduced both the viability of mature rhizomes and the production of new rhizomes. Kerb also affected a change in the normal dormancy cycle of the surviving mature rhizome buds. One year after treatment the percent reduction in total viable rhizome fresh weight (new plus mature) from the four Kerb treatments was 50% (0.5 lb), 83% (1.0 lb), 91% (2.0 lb), and 98% (4.0 lb). Kerbs effectiveness in reducing the production of new rhizomes offers potential of eliminating quackgrass from infested fields if Kerb is reapplied in the second year.

Literature Cited

1. Duke, W. B. 1970. Effects of RH-315 on quackgrass and alfalfa. Proc. NEWCC 24:219-223.

2. Duke, W. B. and J. F. Hunt. 1971. Effects of RH-315 on quackgrass and alfalfa. II. Soil Residual activity in relation to quackgrass regrowth potential. Prox. NEWCC 25:301-308.

3. Johnson, B. G. and K. P. Buchholtz. 1961. An in vitro method of evaluating the activity of buds on the rhizomes of quackgrass (Agropyron repens). Weeds 9:600-606.

4. Johnson, B. G. and K. P. Buchholtz. 1962. The natural dormancy of vegetative buds on the rhizomes of quackgrass. Weeds 10:53-57.

5. Smith, L. W., Peterson, R. L. and R. F. Horton. 1971. Effects of a dimethylpropynylbenzamide herbicide on quackgrass rhizomes. Weed Science 19:174-177.

6. Viste, K. L. and J. M. Sanborn. 1970. Control of quackgrass (Agropyron repens) in alfalfa by Kerb (RH-315). Proc. NEWCC 24:227-231.

SHEPHERDSPURSE -- GERMINATION, FLOWERING, AND RESPONSE TO HERBICIDES -- A PRELIMINARY REPORT[1,2]

C. A. Green and R. D. Sweet[3]

Abstract

Three experiments with germination, two experiments on flowering and two herbicide screenings were conducted in the greenhouse with Shepherdspurse (Capsella bursa-pastoris (L.) Medic.). Observations were made in the field on flowering and germination. Germination was dramatically increased (from 5 to 90%), when 0.2% potassium nitrate was used as an imbibing solution. All of the plants flowered in a 70-80 F greenhouse under a 16 hr photoperiod, however, only 10% of the plants under 8 hr photoperiod had flowered at 13 wk. Temperatures below 65 F for 1 to 4 wk enhanced flower initiation as compared to those grown at 65-75 F. About 90% of the shepherdspurse plants were killed in greenhouse herbicide trials by using isopropyl m-chlorocarbanilate (CIPC), or N,N-diallyl-2-chloroacetamide (CDAA), or by the two combined when each chemical was used at 6 lb/A preemergence. Poor control was obtained with a,a,a-trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine (trifluralin) at 1 lb incorporated, 2,4-dichlorophenyl p-nitrophenyl ether (nitrofen) at 10 lb post, varsol at 55 gpa post, and CDAA at 6 lb postemergence.

Introduction

In the past two years, growers, extension workers, and weed specialists have reported that shepherdspurse has become an increasing problem in vegetable crops. These reports have come from areas in Maryland, Virginia, Delaware, New Jersey, New York and California.

Little is known about the competitive abilities of shepherdspurse. For this reason, a study was undertaken to obtain information emphasizing the ecology and life cycle of the weed.

Literature Reviewed

Little information can be found in the literature on this pest except for taxanomic descriptions in most weed identification books. Shepherdspurse has been included in some seed germination studies and recently, it has often been included in herbicide trials. No information was found on experiments concerning the flowering habits of shepherdspurse.

1/ This research was supported by a grant from the Ford Foundation.
2/ Paper No. 633 of the Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.
3/ Research Assistant and Professor, respectively.

Muenscher (4) lists the common names of Capsella bursa-pastoris (L.) Medic. as shepherds-purse, shepherds-bag, pepper plant, case weed and pick weed. He classified it as an annual or winter annual found in gardens, cultivated fields and waste places. It is common throughout North America and was introduced from southern Europe. The "Agriculture Handbook No. 366, Selected Weeds of the United States", (7) describes it as having a branched taproot with leaves of various shapes forming a rosette at the base. The flowers are small, white and have four petals. Seed pods are triangular and contain many small, yellowish seeds. Phillips (5) characterizes the rosette leaves as 1 to 5 inches long with a rough hairy upper surface and the flower recemes are 6 to 20 inches high.

There are both specific and general references to the germination response of shepherdspurse. Crocker (1) found that breaking the seed coat increased germination by 85% over those with entire seed coat. Walter (8) found that potassium nitrate at a concentration of 1/4 to 1/2 standard Knop's solution improved shepherdspurse germination. Toole, and Goss (6) working with grasses, found that with 0.2% potassium nitrate and exposure to light under alternating temperatures hastened germination. According to Mayer and Poljakoff-Mayber, potassium nitrate is a substitute for light in breaking dormancy in germinating seeds.

Field observations on the flowering of shepherdspurse were made by Kott (2). He found that early germinating seeds produced plants which flowered in the summer and set seed in the year of sowing. Later germination produced plants which flowered and formed partially ripe seed, or over wintered in the rosette stage and flowered early in the spring.

Germination

Preliminary experiments indicated little effect on germination with continuous light as opposed to continuous dark, with temperatures from 65 to 85 F, or when a prior chilling at 40 F for 1 wk was given. The critical factor seemed to be the imbibing solution. Therefore, specific experiments were conducted to investigate this factor.

Materials and Methods

Tap water, distilled water, and 0.1, 0.2 and 0.5% potassium nitrate were used as imbibing solutions. Ten ml of solution was added to 1.5 x 10 cm petri dishes containing three sheets of filter paper. One hundred seeds were placed on the moistened filter paper and each treatment was replicated four times. The dishes were placed in a growth chamber at 50 F on September 21, 1971 and the temperature was raised to 70-85 F on September 28. A 16 hr photoperiod with a light intensity of 900 foot candles was used throughout. Germination counts were taken after 3 wk (October 12) and seeds were considered germinated if the cotyledons were clearly visible.

Results and Discussion

Potassium nitrate at all concentrations greatly increased germination of shepherdspurse seeds while the distilled and tap water checks had only about 5% germination, (Table 1). The highest concentration of potassium nitrate had good germination but molds killed the young seedlings.

Table 1. Effects of different concentrations of potassium nitrate on the germination of shepherdspurse seeds at 70-85 F under 16 hr of light.

Treatment	% Germination
1. Tap water	6
2. Distilled water	5
3. 0.1% potassium nitrate	85
4. 0.2% potassium nitrate	93
5. 0.5% potassium nitrate	94

The exact effect of potassium nitrate on the germination of shepherdspurse is not known. Toole and Goss (6) reported a similar response of grasses to potassium nitrate under the same conditions, but offers no explanation for the increase in germination. Mayer and Poljakoff-Mayber (3) states that potassium nitrate was a substitute for the effects of light, however, our experiment demonstrated a significant response of shepherdspurse to potassium nitrate in the presence of light. Crocker (1) found a definite increase in germination of about 80% with shepherdspurse when the seed coat was broken. This suggests that potassium nitrate might affect the seed coat of shepherdspurse.

Photoperiod and Flowering

In the field, shepherdspurse was flowering by the first of May, when the photoperiod had just reached 14 hr, and again in mid-July when the photoperiod was about 15 hr. This led to an experiment with long, short, and medium day-lengths to investigate the effects of photoperiod on flowering.

Materials and Methods

Plants were started July 23, 1971 in 5 inch styrofoam pots in a 70-80 F greenhouse under natural light. After 2 wk (August 6), 150 plants were equally divided among 16, natural, and 8 hr daylengths. Two weeks later (August 20), half of the plants under long days were moved to short days and vice versa. Also, 20 plants from the natural daylength were placed under long days, and 20 under short days. Long days were provided by supplemental light from four 8 ft, 215 watt, VHO, cool white lights from 6 AM until 10 PM. Short days were accomplished by covering the bench with black shade cloth from 4 PM until 8 AM. The natural daylength in Ithaca, New York was 14.7 hr on July 23 and 10.7 hr on October 23. The criteria established for flowering was appearance of white petals. Observations were recorded daily.

Results and Discussion

Shepherdspurse is a long-day plant (Table 2). Under 16 hr of light, the initial flowering occurred from 4 1/2 to 7 weeks. The only flowering under the 8 hr photoperiod was after 9 wk.

The experiment was carried for 13 wk and at that time only 10% of the plants under short days had flowered. Those plants started under long days and moved to short days were delayed about 5 days in flowering as compared to those under continuous long days. Plants started under short days and moved to long days were 14 to 26 days later in flowering than those under continuous long days.

Table 2. Effect of photoperiod on flowering of shepherdspurse plants at 70-80 F. Treatments began with 14 day old seedlings that had been grown under a 14 hr photoperiod.

Photoperiod Hours	Days After Beginning of Treatments 16	26	36	46	56	66	76
	%	%	%	%	%	%	%
16	0	64	100				
nat[a]	0	15	35	45	70	75	75
8	0	0	4	8	12	12	12
2 wks 16 then 8	0	32	88	100			
2 wks nat then 8	0	20	65	85	85	85	85
2 wks nat then 16	0	20	55	75	90	90	90
2 wks 8 then 16	0	4	24	44	92	100	

[a] Natural daylength July 23 was 14 3/4 hrs and October 23 was 10 3/4 hrs.

Temperature and Flowering

From field observations of shepherdspurse in Ithaca, there appeared to be a flowering response to cold temperature. For example, by the first of May, plants were flowering profusely. From this knowledge, an experiment was designed with a range in initial temperature treatment from 35 to 75 F for periods of 1 to 4 wk.

Materials and Methods

On September 10, 1971, seeds were sown in 4 1/2 inch plastic pots and placed in a 70-80 F greenhouse to germinate. Three days later they were moved into growth chambers. A low light intensity was required in order to maintain the lower temperatures. For this reason, a standard of 200 foot candles was kept in all chambers and the photoperiod was 16 hr. Alternate night-day temperatures were set in four separate chambers as follows: 35-45 F, 45-55 F, 55-65 F and 65-75 F. Ten plants were selected randomly after 1, 2, 3 and 4 wk intervals, and placed in a 70-80 F greenhouse also with a 16 hr photoperiod.

The criterion for flowering was visible white petals. Flowering was observed for 60 days after seeding.

Results and Discussion

Exposure of plants to temperatures below 65 F for 1 to 4 wk hastened flowering as opposed to those grown at 65-75 F (Table 3). The 45-55 F treatment seemed optimum for enhancement of flowering A decrease in flowering occurred when plants were kept at 35-45 F for more than 2 wk. This was probably the result of slow growth at these low temperatures.

Table 3. Percentage of plants flowering 60 days after seeding when grown at 70-80 F following exposure to various temperatures for periods of 7 to 28 days. Plants were germinated at 70-80 F for three days.

Temperature night-day	Duration of Exposure 7 days	14 days	21 days	28 days
	%	%	%	%
35-45 F	40	90	10	0
45-55 F	70	100	70	10
55-65 F	40	30	50	80
65-75 F	20	10	10	0

Response to Herbicides

Onions and cabbage were the major crops where shepherdspurse was reported to be a problem. On this basis, two experiments were set up in the greenhouse to examine the response of shepherdspurse to selective herbicides used on these crops. The liquid concentrate formulation of isopropyl m-chlorocarbanilate (CIPC) and N,N-diallyl-2-chloroacetamide (CDAA) and the emulsifiable formulation of a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) and 2-chloro-N-(1 methyl-2-propynyl) acetanilide (basamaize) and the 50% wettable powder form of 2,4-dichlorophenyl p-nitrophenyl ether (nitrofen) were used.

The first experiment was started on August 24, 1971, and the follow-up experiment which omitted the postemergence treatments was started on September 17, 1971. Seeds were placed in 5 inch styrofoam pots, watered, then sprayed with the herbicides using a fixed nozzle, moving belt sprayer at a total volume of 55 gpa. The pots were placed in a 70-85 F greenhouse until data was taken 4 weeks later.

Consistency was lacking in the data from every treatment. Only possible indications of control could be made accurately. Results were based on stand counts, but these varied from pot to pot within the same treatment. CIPC and CDAA alone and in combination when each was used at 6 lb/A preemergence gave satisfactory, but not complete control. Post application of 6 lb of CDAA, 10 lb of nitrofen or 55 gpa of varsol initially injured the plants when sprayed at the 6 to 8 leaf stage, but they recovered within 3 wk. Basamaize at 3 lb preemergence had an indefinite effect on the seedlings.

Greenhouse screening of herbicides on shepherdspurse was complicated by a combination of irregular germination and the watering procedure used. Shepherdspurse seed must be kept very moist to germinate in the greenhouse. The unusually large volume of water needed is most likely responsible for the wide fluctuation within a treatment. A new procedure for seed germination is essential to screen herbicides on shepherdspurse in the greenhouse. Field trials are also needed before accurate conclusions can be drawn.

Literature Cited

1. Crocker, W. 1906. Role of seed coats in delayed germination. Botanical Gazette 42: 265-291.
2. Kott, S. A. 1967. [The dormant period of seeds and morphogenesis of weeds.] Sel'.-khoz. 2: 270-276. (Weed Abstr. 17: 1784).
3. Mayer, A. M. and A. Poljakoff-Mayber. 1963. The germination of seeds. Pergamon Press Ltd. London. 236 p.
4. Muenscher, W. C. 1955. Weeds. 2nd Ed. The Macmillan Company, New York. 560 p.
5. Phillips, C. E. 1956. Weeds of the northeast. University of Delaware Agr. Expt. Sta. Field Manual No. 1. Newark Delaware. 80 p.
6. Toole, E. H. and W. L. Goss. 1925. Effect of light and potassium nitrate on germination. Assoc. Off. Seed Anal. Proc. 17: 31.
7. United States Department of Agriculture. Agriculture Research Service. 1970. Selected weeds of the United States. Agriculture Handbook No. 366. U.S. Govt. Printing Office, Washington, D.C. 463 p.
8. Walter, H. 1963. [On the nitrogen requirements of weeds of arable land and waste places]. (Paper read at) 5 Dtsch Arbeitsbesprechung über Fragen der Unkrautbiologie u-bekampfung, Hohenheim, [G] [Bot Inst, Hohenheim, W. Germany.] (Weed Abstr. 12: 547).

S-6176, A NEW HERBICIDE FOR CORN

R. A. Schwartzbeck, J. W. Pullen
E. R. Cozart 1/

"Prefox"* (a formulated, emulsifiable concentrate mixture containing 3/4 lb/gal of cyprazine plus 4 lb/gal of a thiolcarbamate) is a new herbicide combination discovered and developed by Gulf Research & Development Co. for pre-plant incorporated weed control in corn. This mixture has been tested under the code number of S-6176.

Most broadleaf and grassy weeds common to corn fields are susceptible to S-6176 with the exception of perennial weeds which usually are not killed.

Replicated small plot field tests were conducted in 9 locations in 1970 using different ratios of the components. Excellent control of most problem species was obtained using the ratio 3/4 lb. plus 4 lb. active of the triazine and thiolcarbamate component, respectively. In 1971 1/4 to 1/2 acre size tests were applied using farmer equipment for portions of all the tests. Results of these tests conducted on 19 different soil types in 7 states showed grass and weed control to be equal to or better than existing pre-emergence materials on any particular soil type. Yields taken from the field plots and analyzed statistically showed the same type of results.

Some of the more difficult to kill weeds and grasses controlled by S-6176 include shattercane (Sorghum bicolor), fall panicum (Panicum dichotomiflorum), velvet leaf (Abutilon theophrasti) and morning glory (Ipomea sp.). These are in addition to common annual broadleaves and grasses.

*Trademark of Gulf Oil Corporation

1/Gulf Research & Development Company, 9009 West 67th Street, Merriam, Kansas.

POSTEMERGENCE CHARACTERIZATION OF A NEW QUACKGRASS HERBICIDE

D. D. Baird and G. F. Begeman[1]

Introduction

Quackgrass (Agropyron repens, L.) is generally recognized as one of the widely spread noxious herbaceous perennial weeds in the temperate zone.

The evaluation of new compounds as potential herbicides is more complicated with herbaceous perennials than with annual weeds as the most important part (rhizome) is not readily accessible to periodic evaluation. Furthermore, a rhizome will behave in a differential manner to various environmental and agronomic forces. Thus, laboratory and field evaluations must simulate reality and the resulting information should reflect responses expected under natural and practical conditions.

Members of a new herbicidal class known as the N-(phosphonomethyl)glycines were extensively evaluated on quackgrass, other herbaceous perennials, and annual weeds. Selected evaluations with emphasis on quackgrass are presented herein for the monosodium salt of N-(phosphonomethyl)glycine (MON-0459) and the mono-(dimethylamine) salt of N-(phosphonomethyl)glycine (MON-0468). The former compound was formulated as a 2 lb/U.S. gal water soluble concentrate and the latter compound as a 5 lb/U.S. gal water soluble concentrate, both expressed as N-(phosphonomethyl)glycines on an ae basis. The chemistry and general properties were presented at the 1971 North Central Weed Control Conference (1).

Members of the new herbicidal class were found to be nonherbicidal when applied to mineral soils at normal use rates. They are generally nonselective except when applied on a directional basis in such a manner as to avoid foliar treatment. Such a directional application provides a wide margin of selectivity for crops with woody stems. Control of many broadleaf and narrowleaf perennials bearing underground propagules is achieved. A wide range of annual weeds is readily controlled at low rates.

Methods and Materials

Field tests on quackgrass were established during the fall and spring seasons when the grass was vigorously growing. Plots were 200 sq. ft. and were replicated three times. Treatments in the fall (September) were made by using an aqueous spray volume of 34 gpa while a volume of 30 gpa was used for spring (April and May) applications. A specific surfactant was used at a concentration of 10 ml ai/L in the volume sprayed. Tillage was performed in Wisconsin and Pennsylvania with a disk while in New York a plow was used. Tillage in Missouri was accomplished with a rotary cultivator. Assessment of activity was made at various intervals by visually rating herbicidal responses with a scale of 0 to 100 (100 indicating complete control).

---

[1]Monsanto Company, 800 N. Lindbergh Blvd., St. Louis, Missouri 63166

Results and Discussion

Treatments during fall or spring produced extremely high unit activity initially at one to four months after application (Table 1). Either fall or spring applications provided a level of control which substantially removed quackgrass as a severe deterrent to successful crop production. Rainfall shortly after application can reduce somewhat the generally excellent performance obtained on quackgrass treated in the fall. Such was the case at the Guelph location.

Various degrees of regrowth were apparent seven months after fall application indicating the possible desirability of application in both fall and spring. For fall applications up to 2 lb/A were generally required for maximum activity and more than this amount did not add to the activity in any appreciable amount.

In the spring 2 lb/A provided over 90% control for a period exceeding four months. The results for fall plus spring applications revealed no advantage over spring applications alone. However, in tests reported elsewhere, the advantage of fall plus spring applications was not revealed until rapid regeneration commenced under favorable fall conditions (1). In the experiments reported in Table 1, the rapid regeneration process had not commenced at the time of the last evaluation.

Tillage in the fall, three weeks after treatment, had no consistent major impact on the control observed during the subsequent 12 months.

A series of tests was established to characterize the impact of various cultural and environmental influences on the herbicidal performance of the N-(phosphonomethyl)glycines on quackgrass.

Stage of growth is one factor that has considerable influence on the postemergence activity of these new herbicides. When applied early in the spring to young emerging plants in the 1-1/2 to 2 leaf stage in the field at St. Charles, Missouri, ultimate activity was less than when applied later to plants having four or more leaves. A time lapse of about four to six weeks after treatment was required to observe maximum activity with all stages. In similar experiments, split applications (two week intervals) were slightly more effective on the younger stages of growth than on the more mature stages and this was most evident after about six months.

The time of tillage (with a Rotocultivator at a four-inch depth) after application was an important factor in the ultimate activity of this translocated herbicide (Table 2). Tillage three days after application reduced activity as did tillage at one week as shown in the Missouri test. However, it is not likely that the reduction in activity observed with the two and three week tillage interval is significant. In the Wisconsin test tillage at 7, 14 or 21 days after treatment did not materially reduce the control observed 22 weeks after treatment. Thus it would appear that seedbed preparation would be feasible within three weeks after application.

When the surfactant concentration was held constant, the volume of the diluent did not appear to influence activity as witnessed in two field tests (Table 3). However, when diluent volume was varied with surfactant applied on a poundage basis in ratio with the herbicide, subsequent postemergence activity was influenced. Activity under these conditions was generally greater at 10 and 30 gpa than at 90 gpa.

Rainfall soon after application of many postemergence herbicides is known to reduce activity. In tests where simulated rainfall was applied with a manual sprayer at specific time intervals after application, there was a reduction in activity noted when rainfall occurred within eight hours after herbicide application. It appears that a rain-free period of 4 to 8 hours or more is desired following application of MON-0468. The significance of rainfall within this period is probably a function of herbicidal rate, exact interval from treatment to rainfall, temperature, relative humidity, light conditions, density of sod and other factors.

Temperature is another environmental factor that influences herbicidal activity of MON-0468. Growth chamber tests at three temperature levels of 16, 24 and 32 C indicated that preconditioning for two weeks did not have an effect on postemergence activity. However, temperature after application did influence activity with the highest postemergence activity being observed at the cool temperature of 16 C and less activity at the warmer temperatures of 24 and 32 C.

Details of the stage of growth, rainfall and temperature studies will be presented elsewhere.

In conclusion, MON-0468 and MON-0459 proved to be effective postemergence herbicides for use against quackgrass. The subsequent activity of these new translocated compounds may be influenced by certain cultural aspects as stage of growth, season of application, interval between applications, tillage for seedbed preparation, and the filuent volume. Some of the environmental conditions discussed which influence postemergence activity were rainfall as related to occurrence after application and ambient temperature after application. The proper consideration of these cultural aspects and environmental conditions will lead to the development of maximum utility of the N-(phosphonomethyl)glycine herbicides.

Appropriate derivatives of N-(phosphonomethyl)glycine should be useful wherever quackgrass is a serious problem. For production of annual crops the compounds could be used between cropping seasons at any time the weed is actively growing. For crops with woody stems, quackgrass and other types of undesired vegetation, both perennial and annual, may be controlled as long as care is taken to avoid spraying the crop foliage.

Literature Cited

1. D. D. Baird, R. P. Upchurch, W. B. Homesley and J. E. Franz. 1971 Introduction of a new broadspectrum postemergence herbicide class with utility for herbaceous perennial weed control. Proc. North Centr. Weed Contr. Conf. 26 (In Press).

Table 1. Postemergence herbicidal activity of N-(phosphonomethyl)glycines on quackgrass at various field sites[1]

			Control (%) - Average 3 Replications																
			Monroe, Wisc.				Newburg, Pa.				Red Creek, NY			Ridgetown, Ont			Guelph, Ont.		
Lb/A	Season of Application	Fall Tillage	Oct 3[2] WAT	Apr 31 WAT	May 34/3 WAT	Oct 54/22 WAT	Oct 3 WAT	Apr 30 WAT	May 33/3 WAT	Oct 54/24 WAT	Oct 3 WAT	May 35 WAT	Oct 54 WAT	Oct 3 WAT	May 35 WAT	Oct 53 WAT	Oct 3 WAT	July 42/8 WAT	Oct 53/19 WAT
4	Fall	None	100	96	79	60	100	80	67	37	100	96	97	100	50	27	58	52	0
2			100	93	78	47	99	75	61	37	100	98	96	100	56	12	57	50	0
1			96	87	72	40	96	64	47	22	99	92	91	98	50	0	23	42	0
2+2	Fall+Spring	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93	88
1+1			-	-	89	82	-	-	93	73	-	-	-	-	-	-	-	88	78
1/2+1/2			-	-	73	58	-	-	84	67	-	-	-	-	-	-	-	77	50
2	Spring	None	-	-	98	99	-	-	98	93	-	-	-	-	-	-	-	99	95
1-1/2			-	-	98	97	-	-	95	94	-	-	-	-	-	-	-	-	-
1			-	-	92	89	-	-	93	75	-	-	-	-	-	-	-	89	82
4	Fall	Tillage	-	97	73	83	-	86	71	42	-	97	88	-	-	-	-	-	-
2			-	95	78	73	-	83	67	35	-	93	82	-	-	-	-	-	-
1			-	90	72	65	-	72	57	8	-	92	70	-	-	-	-	-	-
1+1	Fall	Tillage	-	-	88	68	-	81	57	-	-	-	-	-	-	-	-	-	-
1/2+1/2			-	-	62	67	-	58	0	-	-	-	-	-	-	-	-	-	-

[1]MON-0459 was applied in the fall and MON-0468 in the spring
[2]WAT = time in weeks after treatment at which estimate of % control was recorded, 34 over 3 indicates 34 weeks after fall treatment and three weeks after spring treatment.

Table 2. Influence of time of tillage on ultimate herbicidal activity of an N-(phosphonomethyl)glycine on quackgrass in the spring

MON-0468 lb/A	Interval between application and tillage	Control (%)-Avg 2 Replications			
		St. Charles, Mo.		Monroe, Wisc.	
		June[1] 7 WAT	Oct. 27 WAT	July 11 WAT	Oct. 22 WAT
4	No tillage	96	97	-	-
2		99	77	94	96
1		85	60	82	80
4	3 days	52	38	-	-
2		51	10	-	-
1		17	10	-	-
4	7 days	91	47	-	-
2		57	45	92	90
1		48	20	75	85
4	14 days	90	75	-	-
2		86	50	90	93
1		82	33	80	83
4	21 days	92	99	-	-
2		79	68	95	90
1		63	38	80	85

[1]WAT = time in weeks after treatment at which estimate of % control was recorded.

Table 3. Influence of diluent volume on postemergence herbicidal activity of MON-0468 on quackgrass in the spring

Volume Sprayed gpa[2]	Control (%)[1]				
	Monroe, Wisc.			Newburg, Pa.	
	3 WAT[3]	11 WAT	22 WAT	3 WAT	12 WAT
90	90	84	85	81	70
30	93	88	89	92	87
10	91	86	87	92	86

[1]Avg of 4 rates (2, 1-1/2, 1, 1/2 lb/A) and 3 replications

[2]Surfactant concentration constant at 10 g/L in the final spray volume

[3]WAT = time in weeks after treatment at which estimate of % control was recorded

CONTROL OF QUACKGRASS SOD BY 3,5-DICHLORO-N-(1,1-DIMETHYL-2-PROPYNYL)BENZAMIDE

K. L. Viste[1/]

Introduction

The herbicide 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)benzamide (Kerb [R]) controls quackgrass (*Agropyron repens*) and other perennial grasses effectively when applied in the fall (Duke 1970, Viste and Sanborn 1970). Duke and Hunt (1971) showed by bioassay that herbicidal activity of the compound disappears from the soil over winter from a fall application. Yih, et al (1970) reported the chemical mechanism by which this compound degrades in the soil.

The effectiveness from a fall application and the inactivation in the soil over winter are properties of Kerb that should permit it to be used in the fall to free a field of quackgrass for planting, the following spring, crops that may not be tolerant enough for selective control.

Materials and Methods

A sod of quackgrass was established in July 1970 by spreading rhizomes on a newly plowed field and immediately disking and irrigating. In September 2,4-D was used to remove dicot weeds. On October 7, when new growth was beginning to develop, the mature grass was mowed to about 5 inches. The population was predominately quackgrass but included some Kentucky bluegrass, (*Poa pratensis*), timothy (*Phleum pratensis*) and tall fescue, (*Festuca elatior*).

Kerb treatments were 1.0 and 2.0 lb per acre applied on October 14, 1970 and a split application of 1.0 lb on October 14, 1970 plus 1.0 lb on April 20, 1971. The field was rototilled on May 7, 1971.

Kerb treatments were main plots in a split plot design. The sub-plot treatments are listed in Table 1. Oats and alfalfa were sown together in plots 8

Table 1. Sub-plot treatments and crops.

Herbicide	Lb ai/A	Application	Date Applied	Crop	Variety
EPTC	4.0	Incorporated	May 7, 1971	Potatoes	Katahdin
Trifluralin	0.75	Incorporated	May 7, 1971	Tomatoes	Marglobe
Trifluralin	0.75	Incorporated	May 7, 1971	Cabbage	Golden Acre
Atrazine	2.0	Preemergence	May 19, 1971	Corn	Ind 654
Alachlor	2.0	Preemergence	May 19, 1971	Soybeans	Kent
2,4-DB	1.5	Postemergence	June 11, 1971	Oats	Clintford
				Alfalfa	Saranac

1/ Research Agronomist, AFTG, Rohm and Haas Company, Research Laboratories, Spring House, Pa.

R Kerb is a Trade Mark of Rohm and Haas Company, Philadelphia, Pa.

feet wide. Potatoes, corn, and soybeans were planted in 4 row plots of which 2 rows received the spring herbicide and 2 did not. Tomatoes and cabbage were planted with 1 row each in treated and untreated areas. Crops were planted on May 19 and 20, 1971.

Results and Discussion

Three weeks after rototilling the population of quackgrass was 25 to 30 shoots per square foot in the check plots. The 2.0 lb rate of Kerb and the split application gave nearly complete control of the heavy infestation. The 1.0 lb rate was only slightly less effective. (Table 2) This high degree of control evident before the soil was disturbed was also evident after rototilling.

Table 2. Quackgrass control in spring after application of Kerb without other herbicides.

Kerb Rate and Date		May 7, 1971 before rototilling	May 28, 1971 3 weeks after rototilling
0		0	0
1.0	10/14/70	87	90
2.0	10/14/70	92	99
1.0 plus 1.0	10/14/70 4/20/71	95	99

Of the herbicides used for annual weeds, only atrazine gave significant control of quackgrass (Table 3). Since Kerb gave such a high degree of control it was not possible to judge advantages on quackgrass control for combination with any of the herbicides.

Table 3. Quackgrass control by combinations of fall and spring herbicides (Rated 6/10/71)

Kerb Rate and Date		Spring Herbicide, Rate, and Application None	EPTC 4.0	Trifluralin 0.75	Alachlor 2.0	Atrazine 2.0	2,4-DB 1.5
0		0	40	30	10	70	0
1.0	10/14/70	95	97	95	96	95	95
2.0	10/14/70	99	99	98	99	98	98
1.0 plus 1.0	10/14/70 4/20/71	100	100	98	100	99	99

Annual grasses, primarily fall panicum (*Panicum dichotomiflorum*) and barnyardgrass (*Echinochloa crusgalli*), were not controlled by Kerb applied in the fall though the April treatment reduced infestation by about 50 percent (Table 4). All of the preemergence and preplant incorporated herbicides provided annual grass control. There was some indication that Kerb applied in the fall made a contribution to the control of annual grasses even though the fall treatment alone was not effective. For example without Kerb the control by Standard herbicides (other than 2,4-DB) ranged from 67 to 87 percent.

With Kerb the range was 87 to 100 percent.

Table 4. Annual grass control by combinations of fall and spring herbicides (Rated 6/10/71).

Kerb Rate and Date		None	EPTC 4.0	Trifluralin 0.75	Alachlor 2.0	Atrazine 2.0	2,4-DB 1.5
0		0	67	77	83	87	0
1.0	10/14/70	0	87	87	97	90	0
2.0	10/14/70	0	90	87	93	100	30
1.0 plus 1.0	10/14/70 4/20/71	55	97	100	100	97	80

All of the crops except oats were tolerant to the October Kerb treatment and were free of herbicide injury symptoms one month after planting (Table 5). Injury to oats was mild at 1.0 lb and moderate at 2.0 lb.

Table 5. Crop injury ratings in first month of crop growth.

Kerb Rate and Date		Crop and Spring Herbicide						
		EPTC Potato	Trifluralin Tomato	Trifluralin Cabbage	Alachlor Soybeans	Atrazine Corn	2,4-DB Oats	2,4-DB Alfalfa
0		0	0	0	0	0	0	0
1.0	10/14/70	0	0	0	0	0	2	0
2.0	10/14/70	0	0	0	0	0	4	1
1.0 plus 1.0	10/14/70 4/20/71	0	6	4	1	2	9	1

The split treatment, 1.0 lb in October plus 1.0 lb in April, caused injury to tomatoes, cabbage and corn and nearly eliminated oats. It is evident that most of the Kerb present was from the April application.

Crop yields were improved by control of quackgrass (Table 6). Maximum corn yields were obtained by the combination of Kerb applied in the fall for quackgrass and atrazine in the spring for annual weed control. The April application of Kerb was injurious to corn and reduced yield.

Table 6. Yield (CWT/A) of crops treated with Kerb with or without other herbicides.

Kerb Rate and Date		Soybeans Alachlor -	Soybeans Alachlor +	Tomatoes Trifluralin -	Tomatoes Trifluralin +	Corn Atrazine -	Corn Atrazine +
0		20.6 b*	27.4 a	86 b	86 b	64 c	89 b
1.0	10/14/70	18.9 b	24.8 ab	108 b	145 a	108 ab	114 a
2.0	10/14/70	17.5 b	21.4 b	86 b	118 b	99 ab	117 a
1.0 plus 1.0	10/14/70 4/20/71	30.9 a	30.4 a	5 c	16 c	80 b	84 b

* Yields within a crop followed by same letter are not significantly different.

In tomatoes control of annual weeds by trifluralin in the presence of uncontrolled quackgrass did not improve yields but when quackgrass was controlled by Kerb, the annual weeds by trifluralin, there was a large increase in yield. Phytotoxicity from the April application of Kerb drastically reduced tomato yield.

In a second experiment soybeans were planted without tillage after fall application of Kerb. Quackgrass control and the resultant benefit to soybean yield are shown in Table 7.

Table 7. Quackgrass control ratings during season from fall application of Kerb and final yield of no-till soybeans.

Kerb W.P. lb/A	Date of Rating			Soybean Yield
	4/19	5/12	7/12	CWT/A
1	83	59	60	21
2	90	77	60	25
3	90	83	65	27
0	0	0	0	16

Conclusion

Kerb applied in the fall of the year effectively controls quackgrass and the treated area can be safely planted to all but the most sensitive crops the following spring. Benefit from appropriate selective herbicides used in the spring is enhanced by the control of quackgrass provided by Kerb applied in the fall.

References

Duke, W. B. 1970. Proc. Northeastern Weed Control Conference. 24:220-226.

Duke, W. B. and Hunt, J. F. 1971. Proc. Northeastern Weed Science Society. 25:301-308.

Viste, K. L. and Sanborn, J. M. 1970. Proc. 24th Northeastern Weed Control Conference. 227-231.

Yih, R., Swithenbank, C. and McRae, D. H. 1970. Weed Science. 18:604-607.

HERBICIDE COMBINATIONS AND ADJUVANTS FOR RYE KILL IN NO-TILLAGE CORN

R. A. Peters [1]

Abstract Rye kill with paraquat was obtained with .5 lb/A of paraquat but not with the .25 lb/A rate unless 3 oz/A X-77 or Charger E adjuvants were added. Booster plus E oil at 1 qt in 40 gal of solution enhanced kill but was less effective than the former adjuvants. Inclusion of liquid nitrogen in the spray solution significantly reduced paraquat activity. Atrazine + Booster plus E (2+1 qt/A) gave very poor rye kill. Atrazine 1 lb/A, alachlor 2 lb/A or a combination of the two, enhanced the activity of paraquat but not as much as the adjuvants. Very little control of rye was obtained when using only atrazine, alachlor or a combination of the two.

Control of emerged (1-2 leaf stage) crabgrass by paraquat with or without X-77 or Charger plus E was only fair to poor. Atrazine with Booster plus E gave the best control (rating of 3) at the stage of growth applied. An increase in activity was obtained by adding 1 lb/A of atrazine to the paraquat treatments but the kill was not satisfactory. Alachlor at 2 lb/A combined with the paraquat treatments gave much better control.

Introduction

Direct seeding of corn into winter-rye cover crops is becoming a standard no-tillage practice in the Northeast. The following experiment was designed to evaluate materials which can be used to give rye kill prior to or at the time of seeding corn.

Materials and Methods

The experimental area was located at the Agronomy Research Farm, University of Connecticut, Storrs on a Paxton fine sandy loam soil. The area was in corn the previous year which had a heavy infestation of large crabgrass, *Digitaria sanguinalis* (L.) Scop. Rye (*Secale secale*, var. Balboa) was planted over the entire area in October, 1970.

The experimental design was a two-way whole plot with plots 10 feet by 112 feet in one direction and 10 feet by 40 feet in the other direction. Application of paraquat and adjuvants were made in one direction and residual herbicides across all plots in the other direction. There were three replications. All herbicides were applied in 40 gallons of solution per acre.

Herbicide applications were made on May 21, 1971 when the rye was 10-12 cm in height. Considerable large crabgrass had germinated and had grown to the 2-3 leaf stage. The stand of crabgrass, however, was not uniform throughout the experimental area.

Kill of ryegrass was evaluated by ratings made on June 23, 1971. A single rating of crabgrass kill was made on June 23. The rating scale used was: 1 - no effect; 9 - complete kill.

---

[1] Professor of Agronomy, University of Connecticut, Storrs, Connecticut

On June 23, 1971 field corn was planted in all plots. To kill any rye which had not been killed by previous treatments, an overall application of paraquat .5 lb/A + adjuvant was made on the same day. No corn yield data were obtained but visual observations indicated no influence on corn growth from any of the chemical treatments.

The chemical composition of the X-77 Spreader 1/ was a combination of alkylarylpolyoxethylene glycols, free fatty acids and isopropanol. The composition of Charger E was octylphenoxypolyethoxyethanol. The Booster plus E 2/ was formulated as a paraffine base oil (83%) + polyoxyethylene sorbitan fatty acid ester (16%). The recommended usage rate is 1 qt in 15 gal of water. In this experiment it was used at the rate of 1 qt in 40 gal of water. The liquid nitrogen was an urea and NH_4NO_3 solution which supplied 3.25 lb actual N per gallon.

The herbicides used are described in the Appendix.

Results and Discussion

A. Rye control

If paraquat alone was applied without an adjuvant, rye kill was obtained at the .5 lb/A rate but not at the .25 lb/A rate. Addition of X-77 or Charger E resulted in as good a kill with .25 lb/A as with the .50 lb/A rate without adjuvant. Addition of 1 qt/A of Booster plus E gave some enhancement but not as much as X-77 or Charger E. Inclusion of liquid nitrogen in the water carrier inhibited paraquat activity at both the .25 lb/A and .50 lb/A rates as compared to paraquat alone in water. Kill with paraquat at .50 lb/A in liquid nitrogen was not as good as .25 lb/A applied alone. Atrazine at 2 lb/A + Booster plus E 1 qt gave control comparable to paraquat without an adjuvant.

When atrazine at 1 lb was added to the treatments detailed above, kill with .25 lb/A of paraquat increased (rating of 7) but not as much as by the inclusion of X-77 or Charger E. The poor kill obtained with paraquat in liquid nitrogen was overcome to some extent by adding atrazine, but the kill even at the .5 lb/A rate of paraquat remained incomplete. When 1 lb of atrazine was added to the atrazine + Booster plus E to give a total of 3 lb of atrazine, rye injury was much less severe than with paraquat at .25 lb/A with X-77 or Charger E. As judged a month after application atrazine + oil was a very poor substitute for paraquat with adjuvant.

Additions of alachlor 2 lb/A or a combination of atrazine 1 lb/A + alachlor 2 lb/A gave essentially the same results as detailed above. In summary, atrazine and alachlor alone or in combination were a partial substitute for an adjuvant such as X-77 or Charger E when paraquat was used at the lower rate of .25 lb/A rate, but complete kill of rye was not obtained unless the adjuvant was used as well.

Very little control of rye was obtained when using only atrazine, alachlor or a combination of the two.

1/ Manufactured by Chevron Chemical Company

2/ Manufactured by Agway, Incorporated

KILL RATINGS [1] OF RYE COVER CROP AND CRABGRASS TREATED WITH VARIOUS COMBINATIONS OF HERBICIDES AND ADJUVANTS

Contact Herbicides	Residual Herbicides							
	Control		Atrazine 1 lb		Alachlor 2 lb		Atrazine 1 lb+ Alachlor 2 lb	
Chemical	Rye	Crab-grass	Rye	Crab-grass	Rye	Crab-grass	Rye	Crab-grass
Control	1.0	8.0	2.3	8.0	1.0	8.3	2.7	8.3
Paraquat .25 lb	4.7	3.7	7.0	5.7	6.3	7.0	6.0	6.0
Paraquat .25 lb + 3 oz + X-77	8.0	1.3	8.0	4.0	8.0	8.7	8.3	7.7
Paraquat .25 lb + 3 oz + Charger E	8.7	1.0	9.0	5.3	9.0	8.0	9.0	6.3
Paraquat .25 lb + 1 qt + Booster plus E	7.0	1.3	8.0	4.3	7.3	6.0	9.0	4.7
Paraquat .25 lb + 20 G + liquid N	2.0	6.0	5.3	6.0	6.7	8.7	6.7	6.0
Paraquat .50 lb	8.3	6.0	8.7	6.7	9.0	6.0	8.7	5.7
Paraquat .50 lb + 3 oz + X-77	9.0	3.3	9.0	5.0	9.0	5.7	9.0	5.7
Paraquat .50 lb + 3 oz + Charger E	9.0	6.3	9.0	6.3	9.0	5.3	9.0	7.7
Paraquat .50 lb + 1 qt + Booster plus E	9.0	1.0	9.0	3.7	9.0	5.7	8.3	4.7
Paraquat .50 lb + 20 G + liquid N	3.3	5.3	6.3	7.0	6.0	8.0	8.0	7.0
Atrazine 2 lb + 1 qt + Booster plus E	4.3	8.3	5.0	8.3	5.0	8.7	5.3	8.7
Overall mean	6.2	4.3	6.5	6.4	7.0	7.2	6.5	6.5

[1] Ratings were made on June 23, 1971. 1 - no effect; 9 - complete kill.

B. Crabgrass control

In general, control with paraquat was poor. This was attributed in part to the lack of residual effects on crabgrass which may have germinated after treatment. Poor control, compared with rye, was also related in the limited contact effects of paraquat on the many crabgrass plants that had germinated by the time of treatment. While the .5 lb/A rate gave more kill than the .25 lb/A rate, in no instance was complete kill obtained with or without an adjuvant. In contrast, atrazine 2 lb + Booster plus E gave good crabgrass control at the 1-2 leaf stage applied.

Control of crabgrass was actually decreased by adding Booster plus E to .5 lb/A of paraquat. This treatment killed rye but had virtually no effect on the crabgrass. Treatments resulting in poor control of rye, namely the control and the paraquat + liquid N treatment, displayed little crabgrass growth because of the severe shading from the rye.

The addition of atrazine to the paraquat solutions with or without X-77 or Booster plus E gave some increase in crabgrass control. For example, paraquat .25 lb/A with X-77 had a rating of 1.3 but with the addition of atrazine the rating was 4.0. In no instance was the kill as good as with atrazine with Booster plus E.

The addition of alachlor substantially increased crabgrass control compared to paraquat with or without adjuvants. Crabgrass control was better with alachlor at the .25 lb/A rate than at the .5 lb/A rate. No explanation for this trend can be given.

There was no advantage in combining both alachlor and atrazine as compared with alachlor only in combination with paraquat treatments. In fact, the crabgrass ratings corresponded more closely to the atrazine ratings than to the alachlor ratings when using the combination.

Appendix

Description of herbicides used

Common name	Formulation	
Paraquat	dichloride salt	1,1'-dimethyl-4, 4'-bipyridinium dichloride
Atrazine	80% WP	2-chloro-4-(ethylamino)-6-(isopropylamino) s-triazine
Alachlor	4 lb/G e.c.	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide

SELECTIVE PREPLANT INCORPORATED OR PREEMERGENT HERBICIDES PLUS POSTEMERGENT CHLOROXURON ON SOYBEANS[1/]

J. V. Parochetti, R. W. Feeny and S. R. Colby[2/]

Abstract. Greenhouse and field studies were conducted with 3-[p-(p-chlorophenoxy) phenyl]-1,1-dimethylurea (chloroxuron). Tolerant soybean (*Glycine max* (L.) Merr.) and susceptible annual morningglory (*Ipomea purpurea* (L.) Roth. and *I. hederacea* (L.) Jacq.) were studied using both root and foliar chloroxuron applications. Plant tolerance to chloroxuron was affected by physiological age. Soybean tolerance was reduced when treatments occurred in the unifoliate stage; greatest soybean tolerance was noted when treated in the cotyledonary, first or third trifoliate stage. Morningglory was susceptible to chloroxuron until about 3 weeks of age (five true leaves), after which resistance increased. Root applications of chloroxuron resulted in greater phytotoxicity than foliar applications for both species. In advanced studies in the field in 1968, 1969, and 1970, the following herbicides were applied singularly: (a) as preplant incorporated: a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin), 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylamiline (nitralin), S-propyl dipropylthiocarbamate (vernolate), (b) as preemergent: 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron), or (c) as topical postemergent treatments: chloroxuron. Other plots having herbicides applied at or before planting soybeans also received a postemergent application of chloroxuron. All sequential combinations with chloroxuron caused soybean injury. Soybean injury was greater when treated with chloroxuron in the first and second trifoliate stage than in the third trifoliate. Soybean injury decreased with new growth. Vernolate alone caused some injury in certain years. Giant foxtail (*Setaria faberii* Herrm.), ragweed (*Ambrosia artemisiifolia* L.) and yellow nutsedge (*Cyperus esculentus* L.) control was better with the sequential combinations. Soybean yields for all combinations for the 3 year average were higher than any single herbicide treatment.

1/ To be published in Weed Science.

2/ Assistant Professor, Former Research Assistant and Former Assistant Professor, Department of Agronomy, University of Maryland, College Park 20742.

Present address of R. W. Feeny is American Cyanamid Company, Agricultural Division, P. O. Box 400, Princeton, New Jersey 08540.

Present address of S. R. Colby is Crop Protection Institute, P. O. Drawer "S", Durham, New Hampshire 03824.

HERBICIDE COMBINATIONS FOR CONTROL OF PROBLEM WEEDS IN SOYBEANS[1]

T. S. Smith and E. M. Rahn[2]

INTRODUCTION

Several annual broadleaf weeds commonly escape certain herbicides used extensively on soybeans (Glycine max (L.) Merr.) in Delaware. The severity of this problem has increased due to the continued use of these herbicides. The problem weeds include jimsonweed (Datura stramonium L.), velvetleaf (Abutilon theophrasti Medic), and two species of morningglory (Ipomoea purpurea (L.) Roth and Ipomoca hederacea (L.) Jacq.). The experiments reported herein were conducted on two locations having varying weed populations to determine the best herbicide or herbicide combination to control these problem weeds.

MATERIALS AND METHODS

Two experiments were conducted at the University of Delaware Substation near Georgetown, Delaware, on a Sassafras sandy loam soil with an organic matter content of 1%. A completely randomized block design was used with three replications of 21 treatments (Tables 2 and 3). Plots were 4 rows, 20 ft. long with 3 ft. spacing between rows. Both experiments received the same treatments. All herbicides were applied as sprays at 50 gpa.

In both locations, Cutler variety soybeans were planted on June 9, 1971. Preplant incorporated treatments were applied June 8 except for Treatment 11 which was applied May 24, 15 days before planting. Preemergence treatments were applied June 9. Directed sprays were applied to the lower one third of soybean plants at plant heights indicated in Tables 2 and 3.

Experiment A was conducted in a field heavily infested with morningglory, velvetleaf, and pigweed (Amaranthus retroflexus L.). Experimental area B was primarily infested with pigweed. Both areas were seeded with jimsonweed on June 9, before the preemergence treatments were applied. Jimsonweed was seeded directly into one row of each treatment at 3 ft. intervals. In both locations, the infestation of annual grasses was so light that they were not rated.

---

[1] Published as Miscellaneous Paper No. 639 with the approval of the Director of the Delaware Agricultural Experiment Station. Contribution No. 22 of the Department of Plant Science.

[2] Graduate assistant and professor, Department of Plant Science, University of Delaware, Newark.

Experiment A received one rotary hoeing at emergence and four cultivations throughout the season as needed. Experiment B was not rotary hoed and was cultivated only twice due to less weed pressure. The common name and chemical name of the herbicides used are listed in Table 1.

Table 1. Herbicides used in Experiments A and B

Common Name	Chemical Name
Alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
BAY-94337	4-amino-6-t-butyl-3-(methylthio)-as-triazin-5-(4H)-one
Chloramben	3-amino-2,5-dichlorobenzoic acid
Chlorpropham	isopropyl m-chlorocarbanilate
Dinoseb	2-sec-butyl-4,6-dinitrophenol
Flurodiphen	p-nitrophenyl a,a,a-trifluoro-2-nitro-p-tolyl ether
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
Naptalam	N-1-naphthylphthalamic acid
Oryzalin	3,5-dinitro-N^4,N^4-dipropylsulfanilamide
Trifluralin	a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
2,4-DB	4-(2,4-dichlorophenoxy) butryic acid
Vernolate	S-propyl dipropylthiocarbamate

Early ratings for Experiment A were taken 10 days after rotary hoeing before the plots were cultivated. Early ratings for Experiment B were also taken before the first cultivation. Ratings for crop injury and weed control were made on a 0 to 10 basis where 0 = no effect and 10 = complete kill. The center two rows of each treatment were harvested on October 14.

RESULTS AND DISCUSSION

Under high weed pressure and full cultivation (Experiment A), considering all weed ratings as well as yields, excellent results were obtained with trifluralin, 1/2 lb/A PPI, followed by a directed spray of 2,4-DB at either 0.2 or 0.4 lb/A (Table 2). These treatments resulted in no apparent injury on September 21, and ratings on the same date for control of jimsonweed, morningglory and broadleaf weeds (primarily velvetleaf and pigweed) were 10, 9.3, and 9, respectively. A combination of alachlor, 1 lb/A, naptalam, 1.5 lb/A, and chlorpropham, 1.5 lb/A, PE was nearly as effective as the above combinations. Ratings on September 21 for jimsonweed, morningglory, and broadleaf weeds (primarily velvetleaf and pigweed) were 10, 7, and 9.3, respectively. Yields were not reduced by any of the above treatments.

Table 2. Weed control and crop injury ratings and yields of soybeans in Experiment A.

Treatments	Crop Injury[a]				Weed Control Ratings[a]					Yield
	6/24		9/21		Jimsonweed		V.L.[c]	M.G.	B.L.	bu/A.
lbs. of active material/A	S[b]	V	S	V	6/24	9/21	6/24	9/21	9/21	
1. Hoed check	0	0	0	0	10	10	10	10	10	48.6
2. Unhoed check	0	0	0	0	0	1.6	0	0	0	51.0
3. 1.0 lb. Oryzalin, PE[d]	0	0	0	0	0	4.3	4.0	6.3	7.3	51.0
4. 2.0 lb. Oryzalin, PE	0	1.0	0	0	0	7.0	5.3	8.3	10.0	52.6
5. 0.5 lb. Trifluralin, PPI	0	0	0	0	0	6.6	6.3	3.3	8.6	50.6
6. 0.5 lb. Trifluralin, PPI + 0.2 lb. 2,4-DB,DS (10" stage)	-	-	0	0	-	10.0	-	9.3	9.0	48.6
7. 0.5 lb. Trifluralin, PPI + 0.4 lb. 2,4-DB, DS (10" stage)	-	-	0	0	-	9.3	-	9.6	10.0	49.6
8. 0.5 lb. Trifluralin, PPI + 1.5 lb. Dinoseb, DS (8" stage)[e]	-	-	0.7	4.0	-	8.0	-	6.6	6.0	29.2
9. 0.5 lb. Trifluralin, PPI + 0.75 lb. Linuron, DS (12" stage)[e]	-	-	0	0	-	7.3	-	8.0	9.0	55.6
10. 0.5 lb. Trifluralin, PPI + 0.2 + 0.25 lb. 2,4-DB-Linuron, DS (12" stage)	-	-	0	0	-	6.6	-	8.0	10.0	51.8
11. 0.5 lb. Trifluralin, PPI + 0.5 lb. Linuron, PE[e,f]	0	0	0	0	0.3	6.6	5.6	7.6	10.0	53.6
12. 0.75 lb. Linuron, PE	0	0	0	0	0.3	8.6	7.0	7.3	8.6	49.0
13. 0.75 lb. Linuron Coarse, PE[g]	0	0	0	0	0	10.0	7.0	6.6	9.3	57.2
14. 1.5 lb. Alachlor + 0.5 lb. Linuron, PE (tank mix)	0	0	0	0	0	5.3	7.0	6.3	10.0	53.4
15. 1.5 lb. Chloramben + 0.5 lb. Linuron, PE	0	0	0	0	0	3.0	8.0	5.3	8.6	53.0

Table 2. Weed control and crop injury ratings and yields of soybeans in Experiment A (continued)

Treatments	Crop Injury[a]				Weed Control Ratings[a]					Yield
	6/24		9/21		Jimsonweed		V.L.[c]	M.G.	B.L.	bu/A.
Lbs. of active material/A	S[b]	V	S	V	6/24	9/21	6/24	9/21	9/21	
16. 2.5 lb. Vernolate, PPI, + 0.5 lb. Linuron, PE	.3	1.3	0	0	0	4.6	7.0	8.0	9.3	58.2
17. 2.5 lb. Vernolate, PPI	0	0.3	0	0	0.3	6.0	8.0	6.6	9.3	48.0
18. 4.0 lb. Flurodiphen, PE	0	0	0	0	0	7.0	4.3	8.3	8.6	53.0
19. 0.5 lb. BAY-94337, PE	1.0	3.3	0	0	4.0	9.0	8.6	7.0	9.3	46.1
20. 1.5 lb. Naptalam + 1.5 lb. Chlorpropham, PE	0	0	0	0	3.3	10.0	3.0	7.3	7.0	56.8
21. 1.0 lb. Alachlor + 1.5 lb. Naptalam + 1.5 lb. Chlorpropham, PE (tank mix)	1.0	0.6	0	0	4.6	10.0	6.6	7.0	9.3	54.6
LSD 5%	0.6	1.2	N.S.	0.4	2.4	5.0	3.0	1.5	1.8	7.2

[a] Crop injury and weed control ratings: 0 = no effect; 10 = complete kill.

[b] S = stand; V = vigor

[c] V.L. = Velvetleaf; M.G. = Morningglory; B.L. = Pigweed and Velvetleaf.

[d] PE = Applied preemergence to crop; PPI = preplant incorporated; DS = directed spray to lower 1/3 of soybean plants.

[e] Surfactant WK used at 1.5 pts/50 gal.

[f] Trifluralin PPI 15 days before planting. Seed-bed was not disturbed at planting. This is "stale seed-bed technique".

[g] Linuron coarse has a 35-40 μ particle size which is twice the particle size of regular linuron.

Table 3. Weed control and crop injury rating and yields of soybeans in Experiment B.

Treatments	Crop Injury[a]				Weed Control Ratings[a]			Yield
	7/1		9/21		Jimsonweed		B. L.[c]	bu/A.
Lbs. of active material/A	S[b]	V	S	V	7/21	9/21	9/21	
1. Hoed check	0	0	0	0	10	10	10.0	50.6
2. Unhoed check	0	0	0	0	0	2.0	0	51.6
3. 1.0 lb. Oryzalin, PE[d]	0	0	0	0	0	4.0	10.0	53.4
4. 2.0 lb. Oryzalin, PE	0	0	0	0	.3	10.0	10.0	53.4
5. 0.5 lb. Trifluralin, PPI	0	0	0	0	0	6.3	7.3	52.6
6. 0.5 lb. Trifluralin, PPI + 0.2 lb. 2,4-DB, DS (10" stage)	-	-	0	0	-	10.0	8.6	51.8
7. 0.5 lb. Trifluralin, PPI + 0.4 lb. 2,4-DB,DS (10" stage)	-	-	0	0	-	10.0	9.3	53.0
8. 0.5 lb. Trifluralin, PPI + 1.5 lb. Dinoseb, DS (8" stage)[e]	-	-	0	.6	-	10.0	9.0	50.2
9. 0.5 lb. Trifluralin, PPI + 0.75 lb. Linuron, DS (12" stage)[e]	-	-	0	.3	-	9.3	8.0	56.2
10. 0.5 lb. Trifluralin, PPI + 0.2 + 0.25 lb. 2,4-DB-Linuron, DS (12" stage)	-	-	0	0	-	8.6	7.3	52.6
11. 0.5 lb. Trifluralin, PPI + 0.5 lb. Linuron, PE[e,f]	0	0	0	0	0	8.3	9.0	57.2
12. 0.75 lb. Linuron, PE	0	0	0	0	0	10.0	8.6	50.6
13. 0.75 lb. Linuron Coarse, PE[g]	0	0	0	0	.33	9.3	9.3	55.8
14. 1.5 lb. Alachlor + 0.5 lb. Linuron, PE (tank mix)	0	0	0	0	3.6	10.0	9.6	54.2
15. 1.5 lb. Chloramben + 0.5 lb. Linuron, PE	0	0	0	0	0	7.0	9.3	48.4

Table 3. Weed control and crop injury rating and yields of soybeans in Experiment B (continued)

Treatments	Crop Injury[a]				Weed Control Ratings[a]			Yield
	7/1		9/21		Jimsonweed		B.L.[c]	bu/A
Lbs. of active material/A	S[b]	V	S	V	7/21	9/21	9/21	
16. 5 lb. Vernolate, PPI + 0.5 lb. Linuron, PE	0	.6	0	0	.3	9.6	10.0	53.0
17. 2.5 lb. Vernolate, PPI	0	0	0	0	0	9.3	8.6	53.4
18. 4.0 lb. Flurodiphen, PE	0	0	0	0	.6	10.0	10.0	55.6
19. 0.5 lb. BAY-94337, PE	0	.3	0	0	9.0	9.0	9.6	49.8
20. 1.5 lb. Naptalam + 1.5 lb. Chlorpropham, PE	0	0	0	0	.6	10.0	8.3	50.6
21. 1.0 lb. Alachlor + 1.5 lb. Naptalam + 1.5 lb. Chlorpropham, PE (tank mix)	0	.6	0	0	5.6	10.0	10.0	56.6
LSD 5%	N.S.	N.S.	N.S.	.3	2.7	2.2	1.1	N.S.

[a] Crop Injury and Weed Control Ratings: 0 = no effect; 10 = complete kill.

[b] S = stand; V = vigor.

[c] B.L. = Pigweed

[d] PE = applied preemergence to crop; PPI = preplant incorporated; DS = directed spray to lower 1/3 soybean plants.

[e] Surfactant WK used at 1.5 pts/50 gal.

[f] Trifluralin PPI 15 days before planting. Seed-bed was not disturbed at planting. This is "stale seed-bed technique".

[g] Linuran coarse has a 35-40 µ particle size which is twice the particle size of regular linuron.

Under low weed pressure and limited cultivation (Experiment B), where jimsonweed and pigweed were the primary weeds, a number of treatments in addition to the two mentioned above, were promising (Table 3). They were as follows: oryzalin, 2 lb/A PE; trifluralin 1/2 lb/A PPI followed by a directed spray of dinoseb, 1.5 lb/A; linuron, 3/4 lb/A PE; linuron coarse[3], 3/4 lb/A PE; a combination of alachlor 1 1/2 lb/A and linuron, 1/2 lb/A PE; vernolate, 2.5 lb/A PPI plus linuron, 1/2 lb/A PE; flurodiphen, 4 lb/A PE; and a combination of alachlor, 1 lb/A, naptalam, 1 1/2 lb/A, and chlorpropham, 1 1/2 lb/A PE.

Only a few treatments significantly reduced the stand of jimsonweed on June 21 and July 1 without causing crop injury or yield reduction (Tables 2 and 3). These were as follows: naptalam, 1.5 lb/A plus chlorpropham, 1.5 lb/A PE; alachlor, 1.5 lb/A, plus linuron, 1/2 lb/A PE; and a combination of alachlor, 1 lb/A, naptalam, 1-1/2 lb/A, and chlorpropham 1-1/2 lb/A PE. Due to the competition between the very vigorous Cutler variety of soybeans and jimsonweed, several treatments gave complete control of jimsonweed on ratings made September 21 (Tables 2 and 3). These were as follows: oryzalin, 2 lb/A PE; trifluralin, 1/2 lb/A PPI, plus a directed spray of 2,4-DB at eigher 0.2 or 0.4 lb/A; trifluralin 1/2 lb/A, plus a directed spray of dinoseb, 1-1/2 lb/A; linuron, 3/4 lb/A PE; linuron coarse, 3/4 lb/A PE; alachlor, 1-1/2 lb/A plus linuron, 1/2 lb/A PE; flurodiphen, 4 lb/A PE, naptalam, 1-1/2 lb/A plus chlorpropham, 1-1/2 lb/A PE; and a combination of alachlor, 1 lb/A, naptalam, 1-1/2 lb/A, and chlorpropham, 1-1/2 lb/A PE. Heavy and light cultivation used for the two experiments did not affect jimsonweed control since the jimsonweed was planted directly in the soybean row.

Early ratings for velvetleaf were made on June 24 for Experiment A (Table 2). Excellent control was obtained with BAY-94337, 1/2 lb/A PE, vernolate 2-1/2 lb/A PPI, and a combination of chloramben 1-1/2 lb/A plus linuron 1/2 lb/A PE. Broadleaf ratings were made on September 21 where the dominant weeds were velvetleaf and pigweed (Table 2). Excellent control of velvetleaf and pigweed was obtained with several treatments. Complete control was obtained with the following: oryzalin, 2 lb/A PE; trifluralin, 1/2 lb/A PPI, plus a directed spray of 2,4-DB, 0.4 lb/A; trifluralin, 1/2 lb/A PPI, plus a directed spray of 2,4-DB-linuron, 0.2 + 0.25 lb/A; trifluralin, 1/2 lb/A PPI, plus linuron, 1/2 lb/A PE; and alachlor, 1-1/2 lb/A, plus linuron 1/2 lb/A PE. Full cultivation and a vigorous variety of soybeans, plus any of the above treatments resulted in complete control of velvetleaf and pigweed.

The most outstanding treatment for morningglory control was trifluralin, 1/2 lb/A PPI plus a directed spray of 2,4-DB at either 0.2 or 0.4 lb/A.

[3] Linuron coarse has a 35-40 μ particle size which is twice the particle size of regular linuron.

CONCLUSION

For control of problem weeds (velvetleaf, morningglory, and jimsonweed), excellent results were obtained with trifluralin plus a directed spray of 2,4-DB, and a combination of alachlor, naptalam, and chlorpropham when used in conjunction with a vigorous variety of soybeans and a full cultivation program.

For control of morningglory, trifluralin plus a directed spray of 2,4-DB was excellent. Satisfactory early season jimsonweed control was achieved with the use of naptalam plus chlorpropham, alachlor plus linuron, and a combination of alachlor, naptalam and chlorpropham. Excellent early season velvetleaf control was obtained with vernolate, and a combination of chloramben plus linuron. All of these treatments plus the use of a vigorous variety of soybeans and a full cultivation program gave full season control of these weeds.

POSTEMERGENCE TIMING STUDIES WITH BAS 3512-H IN SOYBEANS

J. O. Pearson[1]

Abstract

Three-quarters, one and two lbs ai/A of 3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide (BAS 3512-H) were applied to soybeans [Glycine max (L.) Merr.] at various stages of development: unifoliate, first trifoliolate, two to four trifoliolate, full foliage, early bloom and one-third bloom. One pound ai/A was also applied at the two to four trifoliolate stage and again at one-third bloom. Soybeans at all stages were very tolerant to all rates of the chemical. At early stages of weed growth 3/4 lb ai/A of BAS 3512-H gave excellent control of Venice mallow (Hibiscus trionum L.), common cocklebur (Xanthium pensylvanicum Wallr.), prickly sida (Sida spinosa L.),common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), and Pennsylvania smartweed (Polygonum pensylvanicum L.). Differences in susceptibility were noted among the weed species as growth advanced and higher rates improved control. Common cocklebur, Venice mallow, prickly sida, and Pennsylvania smartweed were the most susceptible species. Redroot pigweed was more resistant than common lambsquarters. Since soybeans appear to be tolerant at all stages of development, application time should be determined by weed size.

Introduction

A promising new postemergence herbicide from BASF Wyandotte Corporation for controlling broadleaved weeds in grassy and some large seeded leguminous crops is 3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide (BAS 3512-H). BAS 3512-H is a 80% wettable powder and has previously been tested as a 50% wettable powder called BAS 3510-H. In 1970 BAS 3512-H (BAS 3510-H) was found to control many hard-to-kill broadleaved weeds in soybeans [Glycine max (L.) Merr.] which frequently escape preplant incorporated and preemergence treatments. To elucidate the efficacy of this chemical, thirteen detailed field trials, including two in New Jersey, were conducted by BASF Wyandotte personnel during 1971 in the U.S. The objective of these studies were to determine the soybean tolerance and the susceptibility of broadleaved weeds at different stages of growth to three rates of BAS 3512-H. Only the New Jersey data are presented in this report.

Methods and Materials

The two trials conducted in New Jersey were located at Cream Ridge (Experiment I) and Freehold (Experiment II) on loam soils. Plots were 6 x 30' (three rows wide) and were arranged in a randomized complete block design with three replications. Hawkeye soybeans were planted in Experiment I on May 27 and Perry soybeans in Experiment II on May 28. The test site in Experiment I was treated with 1/4 lb ai/A of a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) preplant incorporated. The 80% wettable powder formulation (BAS 3512-H) was used in these studies and applied with a hand operated plot sprayer using CO_2 pressure. Applications of 3/4,1, and 2 lbs ai/A of BAS 3512-H were made according to five stages of soybean growth:

[1] Technical Representative, BASF Wyandotte Corporation, Parsippany, New Jersey

unifoliate, first trifoliolate, two to four trifoliolate, full foliage (prior to flowering) or early bloom and one-third bloom. One lb ai/A was also applied at the two to four trifoliolate and again at the one-third bloom stage.

The application and evaluation dates and the environmental conditions at spraying are listed in Table 1.

Table 1: Application and evaluation dates and corresponding evironmental conditions.

	Dates		Temperature (°F)		Soil moisture		Sky
Stage Treated	Treated	Evaluated	Air	Soil (2")	Surface	Subsurface	
Experiment I							
Unifoliate	6/8	6/18	89	95	dry	moist	clear
First trifoliolate	6/11	6/18	74	88	moist	moist	partly cloudy
Two-four trifoliolate	6/22	6/28	87	100	moist	moist	partly cloudy
Early bloom	7/8	7/18	90	94	dry	dry	clear
One-third bloom	7/15	7/21	83	94	dry	dry	clear
Experiment II							
Unifoliate	6/11	6/18	73	85	dry	moist	partly cloudy
First trifoliolate	6/22	6/28	80	96	dry	moist	partly cloudy
Two-four trifoliolate	6/28	7/2	76	82	moist	moist	overcast
Full Foliage	7/8	7/18	84	85	dry	dry	clear
One-third bloom	7/23	8/3	78	78	dry	sl. moist	partly cloudy

The predominant weeds in Experiment I were Venice mallow (<u>Hibiscus trionum</u> L.), prickly sida (<u>Sida spinosa</u> L.), and common cocklebur (<u>Xanthium pensylvanicum</u> Wallr.). Weeds evaluated in Experiment II were common lambsquarters (<u>Chenopodium album</u> L.), redroot pigweed (<u>Amaranthus retroflexus</u> L.) and Pennsylvania smartweed (<u>Polygonum pensylvanicum</u> L.). The stage of development of the weeds at each application are listed in Table 2.

Table 2: Approximate number of leaves and height of weeds at application time.

Soybean Treatment Stage	Venice mallow	Common cocklebur	Prickly sida
Experiment I			
Unifoliate	cotyledon-1st leaf	2-3 leaves	
First trifoliolate	cotyledon-1st leaf	4 leaves	
Two-four trifoliolate	4-5 leaves	7+ leaves, 4-8"	4 leaves
Early bloom	8-10"	10-15"	8"
One-third bloom	8-10" flowering	1-2'	8-10"
Experiment II	Common lambsquarters	Redroot pigweed	Pensylvania smartweed
Unifoliate	2-4 leaves	2 leaves	2 leaves
First trifoliolate	8-10 leaves, 6-8"	4-8 leaves, 4-6"	8-10 leaves, 4-5"
Two-four trifoliolate	16+ leaves, 8-10"	10+ leaves, 4-6"	18 leaves, 6-8"
Full foliage	12-15"	10-15"	8-10"
One-third bloom	1-2'	10-18"	16-18"

Weed control and crop injury ratings were made using a scale of 1 to 10 where 1 represents no effect or plot covered with weeds and 10 complete kill or a weed free plot.

Results and Discussion

Soybean response to BAS 3512-H: Soybeans tolerated all rates of BAS 3512-H very well at all stages of development. The crop injury ratings in Table 3 and 4 were the first ratings made after treatment and reflect the most severe injury noted at any time during the season. Injury symptoms observed were very slight height reduction, faint chlorosis on all leaves and a few large necrotic areas on a small percentage of leaves (5-10% estimated). New growth was free of chlorosis and necrosis.

The ratings in Experiment I were confounded by wildlife damage; nevertheless, the degree of injury in both experiments was considered minor. Soybeans also tolerated well the double application of 1 lb of BAS 3512-H at two application times. In the first week of August both experiments were evaluated and essentially all herbicide injury symptoms in all plots had disappeared.

Weed species response to BAS 3512-H: Experiment I--The predominant weeds in this experiment were Venice mallow, common cocklebur, and prickly sida. All three species were very susceptible to 3/4, 1 and 2 lb ai/A of BAS 3512-H. There was little advantage of using the higher rates except when applied at the early bloom or one-third bloom stage. Excellent control of Venice mallow and common cocklebur was obtained up to and including the two to four trifoliolate leaf

Table 3. Effects of application time and rate of BAS 3512-H on soybeans and broadleaved weeds. Experiment I.

Stage treated	Rate lb ai/A	Soybeans	Venice mallow	Common cocklebur	Prickly sida
Unifoliate	3/4	1.5	10	9.7	
	1	1.5	9.9	9.7	
	2	1.4	9.8	9.7	
	Check	2.4	5.2	7.7	
First trifoliolate	3/4	1.5	9.8	9.7	
	1	2.1	9.9	9.5	
	2	2.7	9.5	9.8	
	Check	2.4	5.2	7.7	
Two to four trifoliolate	3/4	1.4	10	9.9	9.8
	1	2.2	10	9.9	9.9
	2	1.6	10	9.8	10
	Check	1.3	7.0	7.0	6.5
Early bloom	3/4	1.8	7.0	8.7	9.5
	1	1.8	8.6	8.7	9.7
	2	1.8	8.7	9.0	9.6
	Check	2.0	5.2	7.0	6.3
One-third bloom	3/4	1.4	6.7	8.0	7.8
	1	1.5	6.7	7.8	8.5
	2	1.3	8.2	7.5	8.8
	Check	1.1	8.7	7.8	8.2
Two-four trifoliolate & one-third bloom	1+1	1.1	10	10	10
Averages of stages for all rates (excluding check)					
Unifoliate		1.5	9.9	9.7	
First trifoliolate		2.1	9.7	9.7	
Two-four trifoliolate		1.7	10	9.9	9.9
Early bloom		1.8	8.1	8.8	9.6
One-third bloom		1.4	7.2	7.8	8.3
Averages of rates for all stages (excluding check)					
	3/4	1.5	8.7	9.2	9.0
	1	1.8	9.0	9.1	9.4
	2	1.8	9.2	9.1	9.5

Table 4. Effects of application time and rate of BAS 3512-H on soybeans and broadleaved weeds. Experiment II.

Stage treated	Rate lb ai/A	Soybeans	Common lambsquarters	Redroot pigweed	Pennsylvania smartweed
Unifoliate	3/4	1.3	9.6	9.9	10
	1	1.4	9.8	10	10
	2	1.5	10	10	10
	Check	1.2	5.8	4.3	8.8
First trifoliolate	3/4	1.3	8.1	8.3	10
	1	1.3	8.8	7.3	9.1
	2	1.8	9.4	9.1	10
	Check	1.0	7.0	3.7	8.5
Two-four trifoliolate	3/4	1.4	6.3	4.8	9.5
	1	1.5	7.3	6.0	9.1
	2	1.7	6.8	4.3	9.9
	Check	1.0	6.0	3.7	7.5
Full Foliage	3/4	1.3	6.1	3.7	8.2
	1	1.2	5.0	4.3	6.5
	2	1.3	4.5	4.5	6.2
	Check	1.2	5.8	2.3	7.0
One-third bloom	3/4	1.1	5.5	6.7	7.8
	1	1.1	5.5	6.5	6.7
	2	1.2	6.0	6.0	7.2
	Check	1.0	6.0	5.8	8.3
Two-four trifoliolate & one-third bloom	1+1	1.1	7.4	5.8	10
Averages for stages for all rates (excluding check)					
Unifoliate		1.4	9.8	10	10
First trifoliolate		1.5	8.8	8.3	9.7
Two-four trifoliolate		1.5	6.8	5.0	9.5
Full foliage		1.3	5.2	4.2	7.0
One-third bloom		1.1	5.7	6.4	7.2
Averages for rates for all stages (excluding check)					
	3/4	1.3	7.1	6.7	9.1
	1	1.3	7.3	6.8	8.3
	2	1.5	7.3	6.8	8.7

stage of the soybeans at which time Venice mallow had 4-5 leaves and cocklebur seven or more leaves and was 4-8" tall. As growth of these weeds advanced further, Venice mallow became slightly less susceptible while cocklebur remained more susceptible particularly at the 3/4 lb ai/A rate. It should be noted, however, that Venice mallow was maturing faster than cocklebur at this time. Fair to good control of cocklebur one to two feet tall was obtained at the late treatment stages.

Prickly sida emerged later than Venice mallow and common cocklebur and at the time of the two to four trifoliolate application stage it had four leaves. At this stage all three rates of BAS 3512-H gave excellent control. Control was still excellent with all rates at early bloom when the prickly sida was 8" tall; however, at one-third soybean bloom the 1 and 2 lb rates proved superior to the 3/4 lb rate. It should be pointed out that plots treated earlier than the two to four trifoliolate leaf stage of the soybeans remained free of this weed for the entire season, indicating some preemergence activity of BAS 3512-H on this species. One pound per acre applied at the two to four trifoliolate stage and also at one-third bloom gave perfect control of all weeds.

Experiment II: The predominant weeds in this experiment were common lambsquarters, redroot pigweed, and Pennsylvania smartweed. At the time of the unifoliate stage application all three weeds had two to four leaves and were very sensitive to 3/4 lb ai/A of BAS 3512-H. Following this treatment weed growth advanced very rapidly and differences in susceptibility were pronounced. Common lambsquarters and to a greater extent redroot pigweed became more resistant than Pennsylvania smartweed, which remained very susceptible at the two to four trifoliolate stage of the soybeans when it had approximately 18 leaves and was 6-8 inches tall. As in Experiment I the 2 lb rate improved control as the weeds advanced in development and became more resistant. Droughty soil conditions at later stages may have contributed to the resistance of these weeds.

The double application of 1 lb ai/A of BAS 3512-H did not improve weed control over the single 1 lb application at the two to four trifoliolate stage since the weeds had already progressed to a more resistant stage.

CHEMICAL WEED CONTROL IN DIRECT SEEDED CABBAGE AND METHODS OF EVALUATION OF WEEDING RESULTS

Charles J. Noll[1]

ABSTRACT

Seeded cabbage (Brassica oleracea ver. capitata) was successfully weeded in a preemergence application with BAS 2903-H (2-chloro-N-(1-methyl-2-propymyl)acetanilide), propachlor (2-chloro-N-isopropylacetanilide and alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide). A conventional weed rating system was employed based on number of weeds present in the plots. In addition the four most prevalent weeds in the field were rated without regard to their numbers. Under this system record taking was simplified and resulting data clearly showed what weeds were controlled or not controlled by each treatment.

INTRODUCTION

Seeded cabbage was chemically weeded with both preplant incorporated treatments and preemergent treatments. Successful treatments from last year's trials (2) were included in the experiment. Furrer (1) reported that A-820 had been successfully used last year and this herbicide was included in the test.

MATERIAL AND METHODS

This study was conducted at the Rock Springs Experimental Farm located 10 miles west of University Park. The soil, a Hagerstown silt loam, was plowed in the fall of 1970 and the seedbed prepared May 4, 1971. The preplant treatments were applied and incorporated the next day. Immediately following incorporation the field was seeded to the variety Golden Acre. The preemergent treatments were applied 4 days later.

Single row plots were 26 feet long and 2 feet wide. Treatments were randomized in each of 8 blocks. The entire area of the plot was treated with the herbicide. The field was cultivated twice. Weeds although present in large numbers were not uniformly distributed in the plots. Weeds present were lambsquarters (Chenopodium album L.); ragweed (Ambrosia artemisiifolia L.) shepherdspurse (Casella bursa-pastoris (L.) Medic.); and black medic (Medicago lupulina L.). The plot was harvested August 13.

A rating of 1 to 9 was used to evaluate weed control June 7 and again July 23. Under this system 1 is no weed control and 9 is complete weed control. It would be expected that all major weeds were controlled if the resulting rating were 9 or somewhat below this number. Most investigations use similar methods to evaluate weed control.

[1]Associate Professor of Olericulture, Department of Horticulture, The Pennsylvania State University, University Park, Pennsylvania, 16802.

In the evaluation of individual weeds with the weed not uniformly distributed in the field the above systems of evaluation based on weed numbers did not result in an accurate picture of the result of herbicide treatments. A weed rating based on their presence or absence or degree of stunting without regard to their numbers was used. Under this system the following rating was used:

1 One or more healthy weeds in the plot
2 One or more stunted weeds in the plot
3 One or more severely stunted weeds in the plot
4 No weeds in the plot

With this rating system record taking was simplified and an accurate picture was obtained of the weeds killed by each herbicide.

RESULTS

The results are presented in table 1. All herbicides significantly reduced the weed population as a whole Where individual weeds were rated it is clearly shown what weeds are controlled by each herbicide.

LITERATURE CITED

(1) Furrer, A. H. Jr., G. R. Starke and S. R. McLane. 1971. A-820 Selectivity and Biological Performance on Vegetable Crops. Proc. of the Northeastern Weed Science Soc 25:167-171.

(2) Noll, C. J. 1971. Chemical Weeding of Direct Seeded Cabbage. Proc. of the Northeastern Weed Science Soc. 25:7-8.

Table 1. Weed control, stand of plants, and weight of heads of cabbage under chemical treatments.

Treatment	Lbs. AIA	Application Days From Planting	Weed Control[a] (1-9) June 7	Weed Control[a] (1-9) July 23	Weed Control[b] (1-4) July 13. Rag-weed	Lambs-quarters	Shepherds-purse	Black Medic	Stand of Plants	Wt. Mkt. Heads lbs.
1. Check	---	----	2.3	1.0	1.1	1.0	2.3	2.4	31	15.7
2. A-820 (70-25)	3	PPI-0	5.3	5.1	1.1	3.3	2.1	1.9	9	7.1
3. A-820	6	"	6.8	6.3	1.4	3.8	2.0	2.3	6	6.7
4. BAS 2903-H	1½	"	5.5	4.6	1.8	1.4	2.4	2.5	34	18.2
5. BAS 2903-H	3	"	7.0	6.9	2.9	1.8	3.1	2.9	30	15.6
6. R7465	1	"	5.9	6.4	1.5	2.4	2.5	2.6	27	23.2
7. R7465	2	"	7.6	7.9	2.9	3.1	3.1	3.0	17	20.4
8. Nitralin	1	"	5.3	6.4	2.3	3.4	2.4	1.5	13	11.2
9. Nitralin	2	"	6.5	7.4	2.0	4.0	2.6	2.0	7	7.7
10. BAS 2903-H	4	PRE + 4	8.8	8.3	3.5	3.0	4.0	4.0	29	41.3
11. BAS 2903-H	6	"	8.9	8.0	3.9	2.9	4.0	4.0	24	23.6
12. R7465	1	"	6.3	7.5	1.8	2.9	3.4	2.5	33	33.0
13. R7465	2	"	8.1	7.5	1.6	3.4	3.9	3.5	32	34.2
14. Bitralin	1	"	6.3	7.1	1.3	3.4	2.6	3.0	20	26.1
15. Nitralin	1	"	6.8	6.9	1.1	4.0	3.3	2.5	22	27.2
16. Nitrofen	4	"	6.5	5.9	1.1	3.6	3.9	3.3	17	22.7
17. Nitrofen	6	"	8.1	8.3	1.1	3.5	4.0	3.6	21	28.0
18. Propachlor	4	"	8.1	7.4	2.3	2.4	3.8	3.5	34	36.9
19. Propachlor	6	"	8.8	8.6	3.5	2.5	4.0	3.9	34	33.4
20. Alachlor	2	"	8.8	8.3	2.6	3.0	4.0	4.0	29	31.7
21. Alachlor	3	"	8.9	8.6	3.1	3.3	4.0	4.0	23	31.5
22. Alachlor & Nitrofen	2 & 4	POST + 14	8.9	8.6	3.1	3.3	4.0	4.0	23	18.1
Least Significant Difference 5%			1.1	1.2	0.6	0.5	0.5	0.6	5	9.5
Least Significant Difference 1%			1.3	1.4	0.7	0.6	0.6	0.7	7	11.5

a/ Weed Control 1-9: 1 no weed control, 9 full weed control.

b/ Weed Control 1-4: 1 weeds present, 4 weeds absent.

EVALUATION OF SEVERAL HERBICIDES AND HERBICIDE COMBINATIONS FOR WEED CONTROL AND CROP INJURY IN TRANSPLANTED CABBAGE

R. A. Ashley[1]

Abstract

Excellent full season control of common ragweed, Pennsylvania smartweed, lambsquarters, redroot pigweed, large crabgrass and witchgrass was obtained from preplant incorporated applications of Amchem 70-25 at 2 lbs ai/A and trifluralin + alachlor at ½ + 4 lbs ai/A, and post transplant applications of alachlor at 2, 3 or 4 lbs ai/A and DCPA at 9 lbs ai/A.

Significant crop injury and consequent yield reductions were obtained from trifluralin + alachlor at ½ + 4 lbs and DCPA at 9 lbs ai/A post transplant.

Introduction

Experiments were conducted on the University of Connecticut Vegetable Research Farm in North Coventry, Connecticut to evaluate several herbicides and herbicide combinations with regard to weed control and crop injury in transplanted cabbage.

Materials and Methods

Cabbage (<u>Brassica</u> <u>oleracca</u> var. <u>capitata</u>) cv. C-C Cross was field set on May 19 and 20, 1971, 15 inches apart in 36-inch rows. Treatments were arranged in a randomized block design with treated plots consisting of a single row 10 feet long. Treatments were replicated three times. Soil was a Merrimac fine sandy loam. Diazinon 4EC was applied in the transplant water for cabbage maggot control at a rate of 5 oz./50 gal. of water.

Preplant incorporated applications of trifluralin 4EC, Amchem 70-25 (N-secondary-butyl-4-tertiary-butyl-2,6-dinitroaniline) 4EC, BAS 3870H (N-allyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluoramethyl-aniline) 4EC, and a tank mix of trifluralin + alachlor 4EC were made on May 20, 1971 and incorporated to a depth of approximately 3 inches within 5 minutes of application using a garden tractor mounted rotiller. Maximum temperature the day of application was 77°F. The last significant rainfall before application was 0.82 inches on May 15-17, 1971. Significant rainfall following application was 0.12 inches on May 22 and 0.19 inches on May 26, 1971.

Post transplant applications of alachlor 4EC and DCPA 75W were made to clean cultivated plots on June 3, 1971. Maximum temperature the day of application was 73°F. The last significant rainfall before application was 0.42 inches on May 26-31. Significant rainfall following application was 1.14 inches on June 3 and 4 and 1.16 inches on June 9, 1971.

1. Assistant Professor of Horticulture, University of Connecticut, Storrs, Connecticut.

Predominant weed species present in the experimental area were: common ragweed (Ambrosia artemisifolia L.), lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), large crabgrass (Digitaria sanguinalis (L.) Scop.), Pennsylvania smartweed (Polygonum pensylvanicum L.) and witchgrass (Panicum capillare L.).

Weed control ratings were taken for each of the above mentioned species using a 0 to 10 scale with 0 indicating no effect and 10 representing complete kill. Similar ratings were taken for crop stand and vigor.

Yield data were taken on July 19, 1971 to determine the effect of herbicide treatments on yield.

Results and Discussion

Good full season weed control was obtained from alachlor at 2, 3 or 4 lbs ai/A and DCPA at 9 lbs ai/A post transplant and Amchem 70-25 at 2 lbs ai/A ppi (Table 1). DCPA and trifluralin + alachlor at ½ + 4 lbs ai/A produced severe early stunting which resulted in significantly reduced yields.

Amchem 70-25 4EC at 1½ or 2 lbs ai/A ppi and alachlor 4EC at 2, 3 or 4 lbs ai/A post transplant gave significantly improved control of common ragweed as compared to the control treatment of trifluralin at ½ or 1 lb ai/A ppi. On July 19, 1971 control of common ragweed by Amchem 70-25 at 1½ lbs/A was rated at 7.7 and for Amchem 70-25 at 2 lbs/A at 8.0. Comparable figures of alachlor at 2, 3 and 4 lbs/A or 8.0, 9.0 and 9.3 respectively. Trifluralin at ½ and 1 lb/A showed ratings of 2.7 and 4.3 respectively. DCPA gave unexpectedly good control of common ragweed with a control rating of 8.7. BAS 3870H at 1 or 2 lbs/A ppi showed no improvement in control of common ragweed when compared to trifluralin at 1 lb/A but was significantly better than trifluralin at ½ lb/A. Combinations of trifluralin at ½ lb/A and alachlor at 2 or 4 lbs/A did not improve full season control of common ragweed as compared to trifluralin alone.

Full season control of Pennsylvania smartweed was obtained with preplant incorporated treatments of trifluralin at 1 lb ai/A, Amchem 70-25 at 1½ or 2 lbs ai/A, and trifluralin + alachlor at ½ + 4 lbs ai/A, and post transplant applications of alachlor at 2, 3 or 4 lbs ai/A and DCPA at 9 lbs ai/A. Control ratings on July 19, 1971 for these treatments were as follows: Trifluralin at 1 lb ai/A 8.3, Amchem 70-25 at 1½ and 2 lbs ai/A 8.3 and 8.3, trifluralin + alachlor at ½ + 4 lbs ai/A 6.7, alachlor at 2, 3 and 4 lbs ai/A 8.3, 9.3 and 9.3 respectively and DCPA at 9 lbs ai/A 9.0. BAS 3870H at 1 and 2 lbs ai/A ppi and trifluralin + alachlor at ½ + 2 lbs ai/A ppi gave poor control of Pennsylvania smartweed. Ratings for these treatments on July 19, 1971 were 2.3, 4.0 and 5.0 respectively.

All treatments gave excellent full season control of redroot pigweed and lambsquarters except trifluralin + alachlor at ½ + 2 lbs ai/A ppi.

Excellent control of large crabgrass was obtained with all treatments except Amchem 70-25 at 1½ or 2 lbs ai/A and trifluralin + alachlor at ½ + 2 lbs ai/A. The July 19, 1971 weed control rating showed the control treatments of trifluralin at ½ ai/A ppi and DCPA at 9 lbs ai/A post transplant to have control ratings of 9 and 9.3 respectively. Comparable figures for Amchem 70-25 at 1½ and 2 lbs ai/A were 6.3 and 7.3 while trifluralin + alachlor at ½ + 2 lbs ai/A was rated only 5.7.

Witchgrass was satisfactorily controlled by preplant incorporated applications of trifluralin at 1 lb ai/A, Amchem 70-25 at 2 lbs ai/A, BAS 3870H at 2 lbs ai/A and trifluralin + alachlor at ½ + 4 lbs ai/A. Trifluralin at ½ lb ai/A, Amchem 70-25 at 1½ lbs ai/A, BAS 3870H at 1 lb ai/A and trifluralin + alachlor at ½ + 2 lbs ai/A gave significantly less control of witchgrass than trifluralin at 1 lb ai/A. All post transplant applications tested gave complete control of witchgrass.

Significant yield reductions were recorded for trifluralin + alachlor at ½ + 4 lbs ai/A ppi and DCPA at 9 lbs ai/A post transplant. Yields for these treatments were 13.7 and 9.7 lbs per plot respectively as compared to 18.1 lbs for trifluralin at 1 lb ai/A ppi. These reductions were attributed to severe early stunting resulting from these treatments.

Alachlor at 2, 3 or 4 lbs ai/A post transplant resulted in significant yield increases as compared to trifluralin at 1 lb ai/A ppi. These increases were attributed to improved weed control. Amchem 70-25 at 1½ lbs ai/A ppi also showed increased crop yield as compared to trifluralin at 1 lb ai/A.

Table 1. Evaluation of several herbicides and herbicide combinations for weed control in transplanted cabbage.[a] 1971

Treatment[b] Rate ai/A	Weed Control Ratings[c]												Yield Lbs/Plot
	Ragweed		Lambs-quarters		Pigweed		Penn. Smartweed		Crabgrass		Witchgrass		
	6/28	7/19	6/28	7/19	6/28	7/19	6/28	7/19	6/28	7/19	6/28	7/19	
Alachlor 4EC 2 lbs Post	8.7	8.0	9.7	9.7	10.0	10.0	8.3	8.3	10.0	8.7	—	10.0	21.6
Alachlor 4EC 3 lbs Post	9.7	9.0	10.0	9.7	10.0	9.3	9.3	9.3	10.0	9.3	—	10.0	21.9
Alachlor 4EC 4 lbs Post	9.7	9.3	9.7	9.3	10.0	10.0	9.7	9.3	10.0	9.0	—	10.0	23.5
Trifluralin 4EC ½ lb ppi	3.7	2.7	9.3	9.3	9.3	9.3	1.7	5.7	8.7	9.0	—	5.0	15.7
Trifluralin 4EC 1 lb ppi	3.7	4.3	9.7	9.7	10.0	9.7	9.3	8.3	9.7	8.0	—	10.0	18.1
Amchem 70-25 4EC 1½ lbs ppi	9.0	7.7	9.7	10.0	9.7	9.7	8.3	8.3	7.7	6.3	—	6.0	21.0
Amchem 70-25 4EC 2 lbs ppi	9.0	8.0	10.0	9.7	10.0	9.7	9.3	8.3	8.0	7.3	—	8.3	15.5
BAS 3870H 4EC 1 lb ppi	1.7	5.0	9.3	8.7	10.0	10.0	0	2.3	7.7	8.0	—	6.0	14.2
BAS 3870H 4EC 2 lbs ppi	5.0	6.0	9.0	9.7	10.0	10.0	3.0	4.0	7.7	8.3	—	7.0	19.4
Trifluralin 4EC + Alachlor 4EC ½+2 lbs ppi	2.0	1.7	7.3	6.7	8.0	7.3	4.3	5.0	3.3	5.7	—	0	16.6
Trifluralin 4EC + Alachlor 4EC ½+4 lbs ppi	6.7	3.7	9.3	9.7	9.3	9.0	5.3	6.7	10.0	9.0	—	9.7	13.7
DCPA 75W 9 lbs Post	9.3	8.7	10.0	10.0	10.0	10.0	9.7	9.0	10.0	9.3	—	10.0	9.7
LSD 1%	4.0	3.1	NS	NS	NS	NS	3.0	3.0	3.5	2.6	—	3.1	2.6
LSD 5%	2.9	2.3	2.5	1.7	NS	1.8	2.2	2.2	2.6	1.9	—	2.3	1.9

a. Cabbage variety C-C Cross Hybrid, field set 5/19-20/71.
b. ppi applied 5/20/71. Post applied to clean cultivated plots 6/30/71.
c. Rated on 0 to 10 scale with 0 = no effect and 10 = complete kill.

YELLOW NUTSEDGE CONTROL AS INFLUENCED BY TIME OF TREATMENT[1/]

C. H. Doty and R. D. Sweet[2/]

Abstract

Three years of field experimentation showed that 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) controlled yellow nutsedge (Cyperus esculentus L.) better if part or all of the herbicide was applied postemergence with oil rather than incorporated. Incorporated applications of atrazine, S-ethyl dipropylthiocarbamate (EPTC) and S-ethyl diisobutylthiocarbamate (butylate) controlled nutsedge better if applied during or after, rather than before, germination. Shallow subsurface placement of EPTC or butylate effectively controlled nutsedge.

Introduction

For several years 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) and selected thiocarbamates have been tested for controlling yellow nutsedge (Cyperus esculentus L.) (1, 9). A newer herbicide, 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) has given some control of nutsedge (11, 14). Recent emphasis has been on timing of herbicide applications for maximum nutsedge control. This latter factor may be especially important in reducing rates of some persistant herbicides to a level satisfactory for vegetable crop production.

Kuratle and Rahn (10) obtained better control of yellow nutsedge in potatoes by incorporating S-ethyl dipropylthiocarbamate (EPTC) preplant rather than at drag-off or shoot emergence. Hauser et al (7, 8) found that shallow, subsurface injection of EPTC gave better control than either disc or rototilled incorporation. More recently, Wilson et al (14) reported good control with S-ethyl diisobutylthiocarbamate (butylate) preplant incorporated (PPI). The following year, however, the same treatment gave only partial control. Reports on the effectiveness of atrazine for yellow nutsedge control are quite variable. Several workers (2, 3, 5, 6, 11, 12, 14) have reported postemergence applications to be equal, and sometimes superior, to preplant incorporated or preemergence applications. Other reports (2, 13) show atrazine applied preplant incorporated or preemergence is better than postemergence. The addition of oil to atrazine has been shown to increase postemergence activity (4, 11). Alachlor, alachlor-atrazine and butylate-atrazine combinations have given some control of nutsedge (11, 14).

The purpose of the studies reported herein were to evaluate selected herbicides and herbicide combinations, applied at various growth stages, for control of yellow nutsedge.

1/ Paper No. 632 of the Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

2/ Graduate Assistant and Professor, respectively, Vegetable Crops Department, Cornell University, Ithaca, New York, 14850.

Materials and Methods

Research was conducted during 1969, 1970 and 1971 on a silt loam soil at Genoa, New York. The area has been maintained to a heavy infestation of yellow nutsedge for several years. In 1970 and 1971 a heavy stand of mustard (Brassica kaber DC.) L. C. Wheeler var. and redroot pigweed (Amaranthus retroflexus L.) was also present. Each year the land was prepared by plowing, followed by double discing. Treatments, except subsurface placement, were applied with a hand-held, CO_2 pressurized, small plot sprayer in a total volume equivalent to 35-40 gallons per acre (gpa). Table 1 gives methods and dates of treating, stage of nutsedge, and the date ratings were taken for all experiments.

Table 1. Information applicable to treatments for 1969, 1970 and 1971.

Year	Treatment	Date Applied	Nutsedge Stage	Incorporation	Date Rated	
1969	Spike	5/22	Spike 1/2-2 inch	Disc 3-5 inch	7/3	
	Post	6/14	3-6 inch	-	7/3	
1970	Injection	5/12	Shoot emergence	-	7/17	
	Germination	5/1	Germination	Disc 3-5 inch	7/17	
	Spike	5/19	Spike 1-3 inch	Disc 3-5 inch	7/17	
	Post	6/25	3-6 inch	-	7/17	
1971	Dormant	5/15	Dormant	Disc or spring-tooth harrow 3-5 inch	7/16	
					Experiment	
					4	5
	Spike	5/28	Spike 1/2-2 inch	Same as above	7/16	7/21
	Post	6/25	4-10 inch	-	7/16	7/21

Experiment one (1969) compared atrazine, EPTC, and butylate, incorporated (Inc.) alone and in combination, for nutsedge control. Also, three rates of atrazine were tested as split applications, part of the herbicide being incorporated and the remainder applied postemergence with or without oil. Incorporation was done by discing once each direction the length of the plot. Plots were 5 by 15 ft with two replications in a randomized complete block design.

Experiment two (1970) evaluated subsurface placement of selected herbicides for nutsedge control. This particular application technique is not in general use in New York State. Treatments were applied using a 10 inch, triangular injector built from an ordinary V-shaped cultivating shoe. A nozzle containing a 15003 spraying tip was mounted horizontally beneath the top cover plate of the shoe and the herbicide solution was fed to the nozzle from a CO_2 pressurized tank. A 10 inch band of herbicide was placed 2 inches below the soil surface by adjusting the shoe depth. Three adjacent passes per plot gave a 30 inch by 40 ft treated area. Plots were 5 by 40 ft with three replications in a randomized complete block design.

Experiment three (1970) compared incorporation of selected herbicides at separate stages of nutsedge growth. A set of seven herbicide treatments were applied when tubers were germinating, when nutsedge was in the spike stage, and one half of the total herbicide at each of the aforementioned stages. A check plot was included with each set of seven treatments. Incorporation was done by discing once each direction the length of the plots. Six feet of the 8 ft wide plot was treated leaving a 2 ft buffer zone between plots. One of the seven treatments at each stage received an additional atrazine plus oil post-emergence application. The 8 by 15 ft herbicide treatments were considered subplots and the stage of nutsedge growth at application time were the main plots of a split plot design. There were two replications.

Experiment four (1971) was similar to experiment three except there were twelve herbicide treatments and tubers were dormant rather than germinating at the earliest incorporated application. A comparison was made between applying atrazine incorporated with butylate or with oil postemergence following butylate. Incorporation was done by traveling once each direction across the plots using the spring-tooth harrow on the front half and the disc on the back half. Herbicide subplots were 8 by 18 ft and arranged in a split plot design with two replications as described for experiment three.

Experiment five (1971) was designed to evaluate the effect of incorporating spike stage treatments of alachlor and atrazine. A comparison of nutsedge control was made between applying part, or all, of the atrazine with oil postemergence rather than incorporated with alachlor. Following the spike application, the back half of the plots were incorporated by discing once each direction across the plots. Six feet of the 8 ft wide plot was treated. Plots were 8 by 18 ft with two replications in a randomized complete block design.

Figure 1 shows the mean daily temperature, total daily rainfall, and application dates of the incorporated treatments in timing experiments three and four for 1970 and 1971.

Results

Results of experiment one are presented in Table 2. Four lb/A of atrazine was necessary to give satisfactory nutsedge control when applied incorporated. Equal control was obtained with split applications of 1 lb/A incorporated plus 1 lb/A postemergence. Increasing the postemergence applications to 2 lb/A gave somewhat more control but addition of oil to postemergence atrazine did not improve control. Butylate and combinations of butylate-atrazine and EPTC-atrazine applied incorporated gave mediocre control.

Data from the subsurface placement experiment, number two, are given in Table 3. Any treatments containing butylate or EPTC gave good control and atrazine at 3 lb/A gave satisfactory control. Alachlor was not satisfactory as a subsurface application.

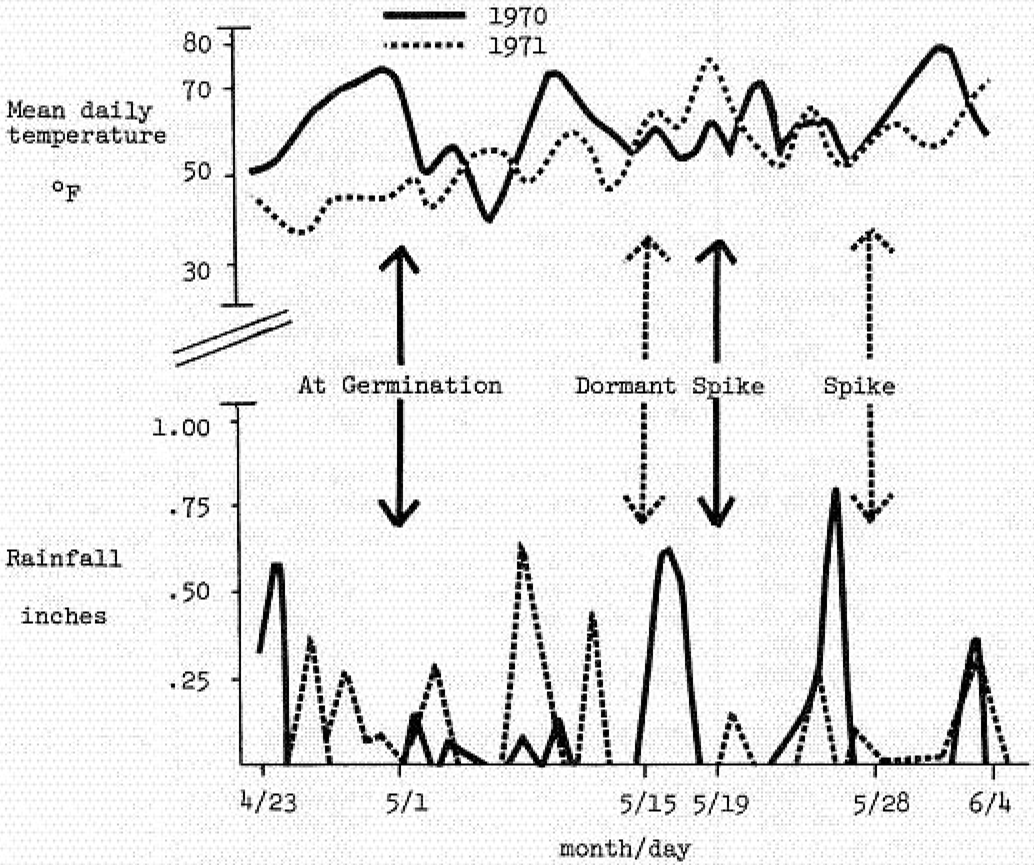


Figure 1. Mean daily temperature (°F), total rainfall (inches), and dates of incorporated applications of timing experiments three and four for 1970 and 1971.

Differences due to timing of incorporated treatments in 1970 were small with most herbicides (Table 4). EPTC appeared to give less control when applied to germinating tubers than at later stages. Atrazine-alachlor combination was slightly better when the incorporated application was split between "at germination" and spike stage. The best treatment, regardless of incorporation timing, was 2 lb/A atrazine incorporated followed by 1 lb/A atrazine plus oil postemergence.

Separate ratingswere taken for spring-tooth harrow and disc incorporation in 1971 but the data in Table 5 are a mean of the two. The difference in incorporation tools was especially evident when atrazine was applied with butylate rather than postemergence. Streaks of healthy nutsedge were growing parallel to the direction the spring-tooth harrow traveled. Differences due to timing of incorporated treatments in 1971 were more pronounced than in 1970. Butylate and atrazine, applied singly or in combination, gave less control when incorporated while tubers were dormant than when incorporated at the spike

Table 2. Visual ratings[a] of yellow nutsedge response to atrazine applied at different growth stages and selected thiocarbamates applied alone and combined with atrazine. Experiment 1 (1969).

Herbicide	lb/A Inc.	Rating	lb/A Inc.	lb/A Post	Rating	lb/A Inc.	lb/A Post[b]	Rating
Atrazine	2	3.5	1	1	7.0	1	1	7.5
Atrazine	3	5.0	1	2	8.5	1	2	8.0
Atrazine	4	7.0	2	2	8.0	2	2	8.0
Butylate	3	6.0						
Butylate	4	6.0						
Atrazine +Butylate	1 3	6.0						
Atrazine +Butylate	1 4	6.5						
Atrazine +EPTC	1 3	6.0						
Check		1.5						

[a] 1=no control; 7=commercial control; 9=complete control.
[b] These treatments had 1 gpa of Sunoco 11N oil plus X207 emulsifier.

Table 3. Visual ratings[a] of yellow nutsedge response to subsurface placement of atrazine, alachlor and selected thiocarbamates. Experiment 2 (1970).

Herbicide:lb/A	Rating[a]
Atrazine 3	7.3
Alachlor 4	2.3
EPTC 4	8.0
Butylate 4	8.0
Atrazine 2 + alachlor 3	4.3
Atrazine 2 + butylate 3	8.0
Alachlor 3 + butylate 3	8.0
Check	1.3

[a] 1=no control; 7=commercial control; 9=complete control.

Table 4. Ratings[a] of yellow nutsedge response to EPTC, butylate, atrazine and alachlor applied at different growth stages. Experiment 3 (1970).

Herbicide:lb/A	Applied	Stage at Incorporated Application: Germinating	Spike	Germinating and Spike[b]	Herbicide Means
Atrazine 3	Inc.	7.0	7.0	7.5	7.2
Atrazine 2 +Atrazine 1 +Booster+E 1 gpa	Inc. Post Post	8.5	8.5	8.0	8.3
Alachlor 4	Inc.	6.5	6.0	6.5	6.3
EPTC 4	Inc.	5.5	7.0	6.5	6.3
Butylate 4	Inc.	7.0	7.0	6.5	6.8
Atrazine 2 +Butylate 3	Inc. Inc.	7.5	7.0	7.5	7.3
Atrazine 2 +Alachlor 3	Inc. Inc.	6.0	6.0	7.0	6.3
Cultivated check		1.5	2.0	1.0	1.5
Mean for application stage		6.2	6.3	6.3	Hsd.05 Herb.=0.91

[a] 1=no control; 7=commercial control; 9=complete control.
[b] This was a split application, one half the total herbicide applied when tubers were germinating and the remainder at the spike stage.

stage or split between the two stages. Comparing butylate-atrazine combinations, atrazine applied postemergence, rather than incorporated with butylate, gave much better control. The difference is particularly evident where the incorporated applications were made while tubers were dormant.

It may be worth noting that tubers were germinating in 1970 at the early incorporated application whereas in 1971 they were dormant. Figure 1 shows the mean temperature was high prior to, but low following, the 1970 "at germination" application. However, conditions were more or less opposite before and after the 1971 dormant application. This suggests rapid tuber sprouting prior to treatment and slow growth following treatment in 1970. The reverse of this probably occurred in 1971.

Atrazine applied postemergence following spike stage applications is more effective than if applied with the spike stage application (Table 6). Several treatments at the spike stage were better when incorporated than when left undisturbed on the surface.

Table 5. Ratings[a] of yellow nutsedge response to butylate and atrazine incorporated at different growth stages, and combinations of atrazine incorporated with butylate or applied postemergence with oil[b] following butylate. Experiment 4 (1971).

	Stage at Incorporated Application						Herbicide Means	
	Dormant		Spike		Dormant and Spike[c]			
	Atrazine		Atrazine		Atrazine		Atrazine	
Herbicide:lb/A	Inc.	Post	Inc.	Post	Inc.	Post	Inc.	Post
Butylate 4	5.5[d]		7.0[d]		6.8[d]		6.4	
Atrazine 2	2.5	7.0[e]	6.3	8.0[e]	6.5	8.3[e]	5.0	7.8
Butylate 4 +Atrazine 1	5.3	7.8	7.3	8.0	7.0	8.5	6.5	8.1
Butylate 3 +Atrazine 2	5.0	8.3	6.3	8.8	6.8	9.0	6.0	8.7
Butylate 3 +Atrazine 1	5.0	7.5	6.8	8.5	6.0	8.5	5.9	8.2
Butylate 2 +Atrazine 2	5.3	8.3	6.5	9.0	5.8	9.0	5.8	8.8
Cultivated check	1.3		3.8		1.5		2.2	
Mean for application stage	5.7		7.2		7.0			
Lsd .05 = 1.1	Hsd .05 application stage = 0.5						Hsd.05 Herb.=1.1	

[a] 1=no control; 7=commercial control; 9=complete control.
[b] Agway Booster+E 1/2 gpa.
[c] This was a split application, one half the total herbicide applied when tubers were dormant and the remainder at the spike stage.
[d] No atrazine applied.
[e] No incorporated chemical applied but plots were cultivated at the indicated times with incorporation equipment.

Discussion

The results on subsurface placement of EPTC agree with that of Hauser et al (7, 8) that shallow placement gives good control of yellow nutsedge. Butylate was equally effective. Preplant incorporated EPTC and butylate appear more effective when applied after tubers have germinated, which seems to disagree with work by Kuratle and Rahn (10) who found early PPI application of EPTC most effective. However, they incorporated preplant applications by double discing and used the spike-tooth harrow or cultivator for later applications, which could account for the difference in control. Some tubers may have

Table 6. Ratings[a] of yellow nutsedge response to atrazine and alachlor applied alone and in various combinations. Experiment 5 (1971).

Herbicide	lb/A	Applied	Spike Stage Incorporated	Spike Stage Not Incorporated
Atrazine	2 1/4	Spike	6.5	6.0
Alachlor	2	Spike	5.0	1.0
Alachlor	4	Spike	6.5	3.0
Alachlor + atrazine	2 + 1 1/4	Spike	5.5	4.0
Alachlor Atrazine+Booster+E	2 1 1/4 + 1/2 gpa	Spike Post	7.0	5.5
Alachlor+atrazine Atrazine+Booster+E	2 + 1 1/4 1 1/4 + 1/2 gpa	Spike Post	8.0	9.0
Check			3.5	2.0

[a] 1=no control; 7=commercial control; 9=complete control.

started to germinate when the early PPI applications were made, but this seems unlikely since it was approximately one month prior to nutsedge emergence.

Incorporated applications of atrazine were less effective when tubers were dormant than at later stages. There appears to be no advantage of split incorporated herbicide applications. The most outstanding difference in all experiments with atrazine or atrazine combinations was the increased control obtained by applying all, or part, of the atrazine postemergence with oil. Very good control was obtained with total rates less than 4 lb/A.

Wilson (14) reported good nutsedge control in 1968 with atrazine applied incorporated or split between incorporated and postemergence. Incorporated treatments were made to germinating tubers and postemergence treatments to 4 to 6 inch nutsedge. In 1970, however, the same treatments gave little control. It should be noted that in the latter experiment less than one percent of the tubers had germinated at the time the incorporated treatments were applied and postemergence treatments were made to 1.5 inch nutsedge. Some of the best nutsedge control obtained by the authors has been when herbicides were applied at stages similar to those in Wilson's 1968 experiment.

When comparing results of different times of herbicide application, especially between years, environmental factors may be responsible for differences in control. The cultivation effect due to incorporation can also produce differences. However, in addition to these effects, the stage of nutsedge at the time of herbicide application is important in obtaining good control. Actively growing nutsedge is controlled more readily than that which is dormant or slowly growing.

Literature Cited

1. Bell, R. S., W. H. Lachman, E. M. Rahn and R. D. Sweet. 1962. Life history studies as related to weed control in the northeast. 1--Nutgrass. Rhode Island Agric. Expt. Bull. No. 364.
2. Bell, R. S. and P. B. Gardner. 1962. Nutgrass control studies in corn with atrazine and its residual effects on a forage seedling. Proc. NEWCC 16: 306-311.
3. Cole, R. H., C. D. Kessler and F. B. Springer, Jr. 1962. Nutgrass control in field corn. Proc. NEWCC 16: 316.
4. Dickerson, C. T. and R. D. Sweet. 1968. Atrazine, oil and 2,4-D for postemergence weed control in sweet corn. Proc. NEWCC 22: 64-74.
5. Fertig, S. N. 1961. Preliminary results on the use of chemicals for nutgrass control in field crops. Proc. NEWCC 15: 334-335.
6. Hargan, R. P., G. H. Bayer, J. C. Cialone and R. D. Sweet. 1963. Some factors influencing nutgrass response to chemicals. Proc. NEWCC 17: 333-338.
7. Hauser, E. W. and S. A. Parham. 1964. Preliminary report on methods for the control of yellow nutsedge (*Cyperus esculentus* L.) in peanuts. Proc. SWC 17: 158-159.
8. Hauser, E. W., J. L. Butler, J. L. Shepard and S. A. Parham. 1966. Response of yellow nutsedge, Florida pusley and peanuts to thiocarbamate herbicides as affected by method of placement in soil. Weed Res. 6: 338-345.
9. Hauser, E. W. 1968. Yellow nutsedge -- problems, research, trends and outlook. Proc. NEWCC 22: 37-48.
10. Kuratle, H. and E. M. Rahn. 1968. Time of application of EPTC for nutgrass control in potatoes. Proc. NEWCC 22: 424-428.
11. Parochetti, J. V. 1971. Yellow nutsedge control in corn with butylate, atrazine, alachlor and combinations. Proc. NEWCC 25: 322.
12. Santlemann, P. W. and J. A. Meade. 1962. The response of nutgrass to herbicides applied at varying stages of growth. Proc. NEWCC 16: 321-326.
13. Vengris, J. 1963. Nutgrass control in field corn. Proc. NEWCC 17: 308-311.
14. Wilson, H. P., R. L. Waterfield and C. P. Savage, Jr. 1971. Field investigations of the activities of several herbicides for control of yellow nutsedge. Proc. NEWCC 25: 255-262.

WEED CONTROL IN SEEDED ONIONS GROWN ON MINERAL SOILS

Charles J. Noll[1]

ABSTRACT

Twenty-one treatments including an untreated check plot were included in the seeded onion (Allium cepa) experiment. Nine herbicides, alone or in combination, were included in the trial. Weeds present were lambsquarters (Chenopodium album L.), yellow foxtail (Setaria glauca (L) Beauv.), ragweed (Ambrosia artemisiifolia (L) and shepherdspurse (Capella bursa pastoris (L) Medic). Taking into consideration weed control, stand of onion plants and yield the best treatments were DCPA in a preemergent application followed by chloroxuron in a postemergent application 30 days later and propachlor applied three times during the season at 30 day intervals.

INTRODUCTION

Successful earlier work (1,2,3) on chemical weeding of onions grown from sets or transplants encouraged us to use herbicides to weed onions grown from seed. The chemicals successfully used by Sanak and Dallyn (4) in weeding of transplanted onions were similar to ones we had used.

MATERIALS AND METHODS

The weeding trials were conducted at the Horticultural Research Farm located 10 miles west of University Park. The soil, a Hagerstown silt loam, was plowed in the fall of 1970 and the seedbed prepared May 4, 1971. Preplant treatments were applied May 5. A rototiller was used to incorporate these herbicides to a depth of 1 to 2 inches immediately following the application. The field was seeded to the variety Downing Yellow Globe the same day. Preemergent treatments were applied 4 days later and postemergent treatments 30 and 60 days after seeding. An estimate of weed control was made July 14 using a 1 to 9 rating scale. One is no weed control and 9 complete weed control.

Single row plots were 26 feet long and 2 feet wide. The treatments were randomized in each of 8 blocks. The entire area of the plot was treated with the herbicide. The field was cultivated. The onions were harvested October 6.

[1] Associate Professor of Olericulture, Department of Horticulture, Pennsylvania State University, University Park, Pa.

RESULTS

The results of the trial are presented in Table 1. All herbicides significantly reduced the weed population. Many of the treatments reduced the stand of plants and yield of bulbs as compared to the untreated check plot. BAS 2903-H applied in a preemergent application at 4 pounds per acre looks promising but at 6 pounds per acre injured the onions. DCPA in combination with BAS 2903-H or propachlor in a preemergent application or followed by chloroxuron in a postemergent treatment were among the best treatments. Probably the best treatment was propachlor applied at 5 pounds per acre at 30 day intervals for a total of 3 treatments, the first treatment applied 4 days after seeding. At the time of harvest, five months after seeding the plot was completely free of weeds.

LITERATURE CITED

1. Noll, C. J. 1969. Chemical weeding of set and transplanted onions grown in mineral soils. Proc. of the Northeastern Weed Control Conference 23:50-53.
2. Noll, C. J. 1970. Chemical weeding of onions grown from transplants. Proc. of the Northeastern Weed Control Conference 24:155-156.
3. Noll, C. J. 1971. Chemical weeding of onions grown from transplants. Proc. of the Northeastern Weed Science Society 25:225-226.
4. Sanak, W. J. and S. L. Dallyn. 1971. Weed control in transplanted onions grown in mineral soils 1970. Proc. of the Northeastern Weed Science Society 25:221-224.

Table 1. Evaluation of several herbicides and herbicide combinations for weed control [a] in seeded onions.

Treatment	Lbs. ai/A	Application Days from planting	Weed Control [b] (1-9)	Harvest Record No. Plants	Harvest Record Wt. Bulbs (lb.)
1. Check	---	---	3.4	53.5	5.0
2. A-820	3	PPI-0	5.9	4.6	0.4
3. "	6	"	6.4	4.0	0.9
4. PPG 124 (Furloe)	2	"	5.4	1.0	0.3
5. "	4	"	5.4	0.0	0.0
6. PPG 124 & PPG 124	2 & 2	PPI-1 & POST + 60	5.9	3.3	0.7
7. BAS 2903 H (Basamaize)	4	PRE + 4	7.3	90.0	15.3
8. " "	6	"	8.4	40.0	7.9
9. DCPA + BAS 2903-H	6 + 4	"	8.5	51.0	14.5
10. DCPA + Propachlor	6 + 5	"	7.9	66.4	10.9
11. DCPA & Chloroxuron	10 & 4	PRE + 4 & POST + 30	8.9	65.5	17.2
12. DCPA & Nitrofen	10 & 4	"	5.3	68.9	6.8
13. RP 17623	4	PRE + 4	9.0	0.0	0.0
14. "	4	POST + 30	9.0	36.7	10.1
15. "	2 & 2	PRE + 4 & POST + 30	9.0	1.4	0.2
16. Propachlor	5 & 5 & 5	PRE + 4 & POST + 30 & + 60	9.0	56.4	17.2
17. Fluorodifen	2 & 1	PRE + 4 & POST + 30	8.8	22.4	5.6
18. Chloroxuron + Sunoil	1 + ½ gal.	POST + 30	7.3	66.5	12.5
19. "	2 + ½ gal.	"	8.4	41.1	7.7
20. Chloroxuron	1	"	6.5	69.5	9.5
21. "	2	"	7.9	71.6	13.2
Least Significant Difference 5%			1.0	20.2	4.8
" " " 1%			1.2	24.8	5.8

a/ Major weed present: lambsquarters, yellow foxtail, ragweed, shepherdspurse.
b/ Weed Control 1-9: 1 no weed control, 9 perfect weed control.

EVALUATION OF HERBICIDES AND HERBICIDE COMBINATIONS FOR WEED CONTROL IN TRANSPLANTED STRAWBERRIES

M. M. Lay and R. D. Ilnicki[1]

Abstract

Three varieties of strawberries, Sunrise (early season), Raritan (early mid-season), and Guardian (mid-season) were used in this study. Sunrise was the least, Guardian the most, and Raritan intermediate in sensitivity to herbicide applications. RH 315 and RH 892 were more effective on grasses than on broadleaf weeds. The best treatments included EPTC incorporated with alachlor surface applied, DCPA plus sesone, chloroxuron plus diphenamid, fluorodifen plus chloroxuron, and chloroxuron plus alachlor for broad spectrum weed control. The applications of single herbicides often did not provide acceptable weed control.

Introduction

Single herbicides or herbicide combination treatments still have not provided effective weed control in strawberry fields in New Jersey. It is necessary to establish dependable herbicide treatments for weed control for profitable strawberry production. The objective of the present study was: (1) to evaluate herbicides and herbicide combinations for weed control in transplanted strawberries; and (2) to investigate the effect of herbicide treatments on the growth and development of three different and popular varieties grown in New Jersey and the Northeast.

Materials and Methods

Three varieties, Sunrise (early season), Raritan (early mid-season), and Guardian (mid-season) were used in this study. The experimental site was located at the Rutgers University Soils and Crops Research Center at Adelphia, New Jersey. The strawberries were transplanted in Freehold sandy loam soil. Predominant weed species were common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), fall panicum (Panicum dichotomiflorum Michx.), and crabgrass (Digitaria sanguinalis (L.) Scop.). A randomized block design with 3 replications was used for each variety. Plot size was 1 row x 25' with 48" row spacings and 10 plants per row.

---

[1] Graduate Assistant and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

The treatments included the following: single herbicides -- RH 315, RH 892, sesone, DCPA, fluorodifen, chloroxuron, diphenamid, alachlor, and EPTC; herbicide combinations -- chloroxuron with fluorodifen, diphenamid, alachlor; alachlor with EPTC in various combinations of incorporation; and DCPA plus sesone. The formulations as well as the chemical identities of herbicides are presented in the Appendix. Specific rates of combinations are indicated in the summary tables.

All treatments were applied as sprays, 40 gpa, on May 24 approximately one month after transplanting. Weed control and crop injury ratings were made on June 22 using the scale 0 to 10 in which 0 = no effect on stand or vigor and 10 = complete control or elimination of stand. In addition, runner numbers and development were used as a measure of response to treatment.

Results and Discussion

Effects of Treatments on Growth and Runner Development

In order to ascertain whether varietal differences existed with regard to herbicide tolerance the effects of all treatments on runner development and injury for each variety were summarized and are presented graphically in Figure 1. The data presented are the average injury ratings and average number of runners per treatment. With regard to injury, it is evident from the figure that Sunrise was the least injured, Raritan the most, and Guardian intermediate. Furthermore, using total number of runners per variety it is also obvious that Sunrise was the least sensitive, Guardian the most, and Raritan intermediate. Taking into consideration the overall effects of all treatments on these two parameters, it may be concluded that Sunrise was the least sensitive, Guardian the most, and Raritan intermediate.

Specific responses of the three varieties to single herbicides and herbicide combinations are presented in Tables 1 through 6.

Effects of Treatments on Control of Broadleaf and Grassy Weeds

Although responses of weeds to all herbicides and herbicide combinations were recorded on an individual species basis, for ease of discussion these were summarized in two categories, broadleaf and grassy weed control. Since the responses of the two prominent broadleaf weeds and two grassy weeds to the herbicide treatments were similar this summary makes it that much more convenient for discussion.

Weed control and varietal responses data are presented in Tables 1 through 6. From these tables it can be seen that applications of single herbicides often did not provide acceptable weed control. The two experimental herbicides, RH 315 and RH 892, were more effective on grasses than on broadleaf weeds. No combinations of these herbicides were made with other herbicides.

The effects of alachlor, EPTC, and combinations of the two with various schedules of incorporation are summarized in Table 2. Alachlor was effective on grassy weeds as was EPTC. The latter was also good on broadleaf weeds. Combinations of the two were somewhat better than each alone. One interesting effect was that when the combination was incorporated better weed control resulted but with slight injury increases to the strawberry plants. The best treatment included EPTC incorporated with alachlor surface-applied.

In Table 3 are summarized weed control data for sesone, DCPA, diphenamid, chloroxuron, diphenamid, and various combinations of these herbicides. The combination of DCPA plus sesone, the combination that has proved successful in many previous experiments, again proved to be an effective treatment. The combination was more efficient for weed control than either herbicide applied alone with no detrimental effect on any of the varieties. On the other hand, the combination of diphenamid plus sesone was not more effective than either herbicide applied alone. Chloroxuron, at the two rates evaluated, was more effective on broadleaf than on grassy weeds. Increases in grassy weed control with some increases in broadleaf control were realized when this herbicide was combined with diphenamid and the degree of control was comparable to the DCPA plus sesone combination.

From Table 4 it can be seen that fluorodifen by itself was not particularly good on broadleaf weeds and not much better on grasses. It effected general weed control comparable to chloroxuron; however, the combination of two herbicides complemented each other and may be a treatment worthy of additional study.

That alachlor is more efficient for grassy weeds than broadleaf control was also demonstrated in this study (Table 5). Additions of chloroxuron to alachlor applications increased the degree of broadleaf weed control with little or no increases in grassy weed control. Combinations of each at 3 lb/A proved effective and possibly serve as an excellent treatment since no appreciable injury to any of the varieties was realized.

Combinations of diphenamid with alachlor increased the degree of weed control of diphenamid applied alone; however, this combination was not much more effective than that of alachlor applied alone (Table 6).

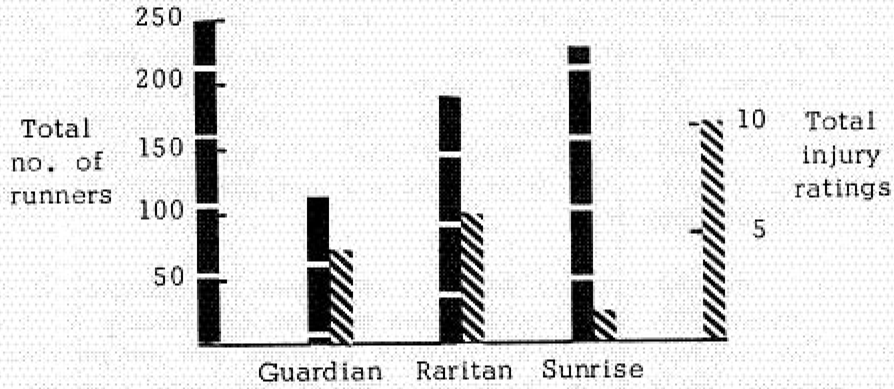


Fig. 1. Varietal response to herbicides and herbicide combinations.

Table 1. Varietal response and weed control to RH 315 and RH 892.*

Herbicide	Rate, lb a.i./A	Weed Control Broadleaf	Weed Control Grass	Varietal Response Guardian	Varietal Response Raritan	Varietal Response Sunrise
RH 315	3/4	6.1	7.8	0.0	0.2	0.0
	$1\frac{1}{2}$	6.9	8.5	0.5	0.2	0.4
RH 892	1	7.0	8.7	0.0	0.4	0.0
	2	7.7	9.1	0.2	0.5	0.0

Table 2. Varietal response and weed control to alachlor, EPTC and combinations.*

Herbicide	Rate, lb a.i./A	Weed Control Broadleaf	Weed Control Grass	Varietal Response Guardian	Varietal Response Raritan	Varietal Response Sunrise
alachlor	2	6.3	9.6	0.2	0.4	0.0
	3	7.1	8.6	0.2	0.2	0.5
EPTC	3 inc.	8.2	9.1	0.5	0.0	0.0
EPTC + alachlor	2 + 2 inc.	8.0	9.3	0.0	0.3	0.0
	3 + 2 inc.	9.1	9.5	0.6	0.2	0.0
	3 + 2 surf.	8.0	8.6	0.0	0.2	0.0
	2 inc. + 2 surf.	9.0	9.6	0.2	0.0	0.0

*Based on a scale of 0 to 10 where 0 = no effect on stand or vigor and 10 = complete control or elimination of stand.

Table 3. Varietal response and weed control to sesone, DCPA, chloroxuron, diphenamid and combinations.*

Herbicide	lb a.i./A	Weed Control Broadleaf	Weed Control Grass	Varietal Response Guardian	Varietal Response Raritan	Varietal Response Sunrise
sesone	2-7/10	6.2	8.5	0.0	0.5	0.2
DCPA	9	8.0	8.4	0.5	0.2	0.3
DCPA + sesone	9 + 2-7/10	8.9	9.1	0.2	0.2	0.0
diphenamid	3	4.0	7.6	0.0	0.0	0.0
diphenamid + sesone	3 + 3	5.6	7.6	0.0	0.2	0.0
chloroxuron	3	7.2	6.6	0.0	0.2	0.0
	4	7.9	6.8	0.0	0.0	0.0
chloroxuron + diphenamid	3 + 3	8.7	8.7	0.2	0.0	0.0

Table 4. Varietal response and weed control to chloroxuron, fluorodifen and combinations.*

Herbicide	lb a.i./A	Weed Control Broadleaf	Weed Control Grass	Varietal Response Guardian	Varietal Response Raritan	Varietal Response Sunrise
chloroxuron	3	7.2	6.6	0.0	0.0	0.0
fluorodifen	3	6.2	7.8	0.2	0.2	0.2
fluorodifen +	2 + 2	8.0	8.6	0.1	0.4	0.2
chloroxuron	3 + 3	9.2	8.9	0.0	0.2	0.0

*Based on a scale of 0 to 10 where 0 = no effect on stand or vigor and 10 = complete control or elimination of stand.

Table 5. Varietal response and weed control to alachlor, chloroxuron, and combinations.*

Herbicide	lb a.i./A	Weed Control		Varietal Response		
		Broadleaf	Grass	Guardian	Raritan	Sunrise
alachlor	2	6.3	9.6	0.2	0.4	0.0
	3	7.1	8.6	0.2	0.2	0.5
chloroxuron	3	7.2	6.6	0.0	0.2	0.0
	4	7.9	6.8	0.0	0.0	0.0
chloroxuron +	3 + 2	9.0	8.1	0.0	0.2	0.0
alachlor	3 + 3	9.0	9.4	0.0	0.4	0.0

Table 6. Varietal response and weed control to alachlor, diphenamid, and combinations.*

Herbicide	lb a.i./A	Weed Control		Varietal Response		
		Broadleaf	Grass	Guardian	Raritan	Sunrise
alachlor	2	6.3	9.6	0.2	0.4	0.0
	3	7.1	8.6	0.2	0.2	0.5
diphenamid	3	4.0	7.6	0.0	0.0	0.0
diphenamid +	3 + 2	7.1	9.1	0.5	0.4	0.0
alachlor	3 + 3	7.1	8.2	0.4	0.3	0.0

*Based on a scale of 0 to 10 where 0 = no effect on stand or vigor and 10 = complete control or elimination of stand.

Appendix

Common Name	Chemical Name
RH 315, WP	N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide
RH 892, WP	chemistry undisclosed
sesone, salt	2-(2,4-Dichlorophenoxy) ethyl sodium sulfate
DCPA, WP	Dimethyl 2,3,5,6-tetrachloroterephthalate
fluorodifen, WP	p-Nitrophenyl α,α,α-trifluoro-2-nitro-p-tolyl ether
chloroxuron, WP	3-[p,(p'-Chlorophenoxy)phenyl]-1,1-dimethylurea
diphenamid, WP	N,N-dimethyl-2,2-diphenylacetamide
alachlor, EC	2,6-Diethyl-N-(methoxymethyl) acetanilide
EPTC, EC	S-ethyl dipropylthiocarbamate

WEED CONTROL IN CUCUMBERS

Charles J. Noll[1]

ABSTRACT

The most promosing herbicides used to weed cucumbers (Cucumis sativa L.) were usually applied in combination or in a sequence. When single chemicals were used at rates in amounts large enough to control weeds the cucumbers were injured. The best preplant incorporation treatment was the combination of bensulide and naptalam. Equally good results were obtained when bensulide was incorporated followed by Dynap in a preemergence treatment. The best preemergence treatments were naptalam in combination with dinoseb, nitralin or chloramben. Chloramben applied as a preemergence application was promosing at 2 pounds per acre but injured cucumbers at 3 pounds.

The stand of cucumbers improved when seeding was delayed following seedbed preparation. The best treatment in the delayed seeding plot was the combination of dinoseb and chloramben applied the day of seeding.

INTRODUCTION

Cucumber is a difficult crop to weed with herbicides. Most herbicides when applied in amounts large enough to control weeds injure the crop. Cialone and Braden (1) reported that the combinations of naptalam and bensulide applied as preplant incorporation treatments were used successfully to weed cucumbers. In our own trials (2) various combinations of chemicals resulted in good weed control and good crop yield.

In an unpublished report F. D. Hess and A. R. Putnam describe a successful system of delayed planting and herbicide application following seedbed preparation. This looked like a promising line of investigation and had been including in some of our earier trials (2).

MATERIALS AND METHODS

The weeding trials were conducted at the Horticultural research farm located 10 miles west of University Park. The soil a Hagerstown silt loam was plowed in the fall of 1970 and the seedbed prepared June 7. The next day the preplant incorporation treatments were applied. A rototiller set to a depth of 1 to 2 inches was used to incorporate the herbicide. The plot was seeded to the variety Pioneer Hybrid that same day in the area where no delay in seeding was practised. Five treatments were seeded to the same variety 10 days after the seedbed was prepared. An estimate of weed control was made July 21 on a 1 to 9 scale. One is no weed control and 9 full weed control.

[1] Associate Professor of Olericulture, Department of Horticulture, Pennsylvania State University, University Park, Pa.

Single row plots were 38 feet long and 5 feet wide and randomized in each of 6 blocks. The herbicide was applied in a 2 foot wide band over the row. Between the rows cultivation was practiced. Weeds present in the field were purslane (Portulaca oleracea L.), redroot pigweed (<u>Amaranthup</u> <u>retrofletus</u> L.), sheperdspurse (<u>Capella</u> <u>bursa</u> <u>pastoris</u> (L.) Medic.) and yellow foxtail (<u>Setavia</u> <u>lutescens</u> (Weigel) Hubb). Cucumbers were harvested August 10.

RESULTS

The results of the preplant incorporation treatments and the preemergence treatments are presented in Table 1. In general, a combination of chemicals was superior to a single chemical. Cucumbers in the delay in seeding plots had significantly better stands than where no delay was practiced.

LITERATURE CITED

1. Cialone J. C. and D. A. Braden. 1971. Combination of natalam and bensulide for weed control in cucumber. Proc. of the Northeastern Weed Science Society. 25:400.

2. Noll, C. J. 1969. Chemical weeding of cucumbers. Proc. of the Northeastern Weed Control Conference. 23:8-11.

Table 1. Effect of various herbicides and combinations of herbicides on cucumbers.

Treatment	lbs. AIA	Application Days From Planting	Weed a/ Control (1-9)	Average Per Plot: Stand of Plants	Fruit-One Harvest No.	Fruit-One Harvest Wt. lb.
1. Check	---	---	1.3	48.2	55.1	26.1
2. EL 179	1	PPI-0	7.7	39.2	79.5	28.8
3. "	2	"	7.8	25.7	48.5	23.3
4. A-820	3	"	8.5	23.8	43.0	19.2
5. "	6	"	9.0	19.0	26.2	11.7
6. M & B 9057	4	"	5.2	43.8	69.0	26.3
7. "	6	"	5.8	44.0	71.0	27.1
8. Bensulide	6	"	6.0	47.5	83.5	32.1
9. Bensulide + Naptalam	6 + 4	"	8.0	46.2	97.8	39.4
10. Bensulide & Chloramben	6 & 2	PPI-0 & PRE + 1	9.0	33.2	72.7	31.0
11. Bensulide & Dynap	6 & 4½	" "	8.7	50.2	89.0	38.4
12. Bensulide & Dinsoseb	6 & 1½	" "	7.0	56.3	86.7	37.8
13. Chloramben	2	PRE + 1	8.8	38.3	81.0	33.7
14. "	3	"	9.0	27.7	55.8	21.7
15. Nitralin	2	"	6.0	40.3	63.8	22.9
16. "	3	"	6.5	49.5	89.0	32.1
17. Nitralin + Naptalam	2 + 3	"	8.8	50.2	87.7	35.4
18. "	2 + 6	"	8.8	47.1	104.0	38.6
19. ER 5461	2	"	7.8	43.5	66.7	26.1
20. "	3	"	8.3	41.0	64.3	19.1
21. Chloramben + Naptalam	1 + 3	"	9.0	49.8	105.8	44.7
22. "	2 + 6	"	9.0	38.8	73.7	26.8
23. Dinoseb + Naptalam	1½ + 3	"	8.0	41.5	90.7	38.2
24. Dinoseb (Premerge)	1½	"	3.5	39.0	58.5	20.2
Least Significant Difference		5%	1.0	13.0	20.2	9.8
" " "		1%	1.1	15.3	23.8	11.5

a/Weed Control 1-9: 1 no weed control, 9 perfect weed control
Major weed present: purslane, redroot pigweed, shepherdspurse, yellow foxtail.

Table 1 con'd.

Treatment	lbs. AIA	Application Days From Planting	Average Per Plot: Weed a/ Control (1-9)	Stand of Plants	Fruit-One Harvest No.	Wt. lb.
25. Check	---	10 Day Seeding Delay	2.3	55.7	58.3	19.5
26. Dinoseb (Dow General)	1½	" PRE + 0	6.3	65.5	88.3	32.4
27. Dinoseb (Pre-merge)	1½	" PRE + 0	6.5	71.5	96.8	31.2
28. Dinoseb + Naptalam (Dynap)	1½ + 3 "	"	5.5	66.0	87.0	29.8
29. Dinoseb + Chloramben	1½ + 2 "	"	8.2	65.5	106.0	37.5
Least Significant Difference 5%			1.0	13.0	20.2	9.8
" " " 1%			1.1	15.3	23.8	11.5

a/ Weed Control 1-9; 1 no weed control, 9 perfect weed control
Major weed present; purslane, redroot pigweed, shepherdspurse, yellow foxtail.

WEED CONTROL AND DRIFT REDUCTION WITH THE DIRECTA-SPRAY™ ROADSIDE SPRAYER

R. R. Johnson, R. J. Messinger and A. H. Furrer, Jr.[1]

Abstract[2]

Applications of water-soluble amines, oil-soluble amines and low-volatile esters of (2,4-dichlorophenoxy) acetic acid (2,4-D) at 2 lb/A were made through a Directa-Spra rotating nozzle roadside sprayer and a DOC 72 broadcast nozzle. Goldenrod, (Solidago spp.), heath aster, (Aster ericoides), wild carrot, (Daucus carota) and other weeds were controlled.

2,4-D oil-soluble amine and 2,4-D low-volatile ester controlled weeds better than 2,4-D water-soluble amine. 2,4-D oil-soluble amine applied through the Directa-Spra was more effective than when applied through a DOC 72 broadcast nozzle.

The Directa-Spra is equipped with removable tips which break up the spray stream to make smaller droplets and increase coverage. Removal of the spray tips did not decrease weed control, but did increase swath width. At 30 psi nozzle pressure, the average swath width was 7.3 meters with tips and 9.15 meters with tips removed.

Calibration studies indicate that the Directa-Spra should be calibrated using a herbicide mixture rather than water, since swath width is greater with water than with most herbicide solutions or emulsions.

A drift study using snapbeans, (Phaseolus vulgaris cultivar Black Valentine), as bioassay plants showed no biological evidence of drift beyond 7.6 meters from the downwind edge of the spray swath. Winds during the study blew directly across the spray swath at velocities of 5 to 18 mph.

FOOTNOTES

1. Research Department, Agricultural Chemical Division.
2. Complete paper to be printed in 1971 Proceedings, North Central Weed Control Conference.

RESPONSES OF WOODY SPECIES TO RATES, FORMULATIONS, PLACEMENTS AND TIMES OF APPLICATION OF KARBUTILATE

P. M. Grehlinger[1/]

Introduction

For a period of seven years karbutilate has been under development by the Niagara Chemical Division, FMC Corporation, for the non-selective control of vegetation. Karbutilate, m-(3,3-dimethylureido)phenyl tert-butylcarbamate, is the active ingredient of all TANDEX® formulations. Based upon its capability of eliciting favorable broad spectrum weed and brush controls over a season or more, coupled with a favorable mammalian toxicity, karbutilate formulations have received commercial acceptance in broadcast applications at dosages of 2.4 to 24.0 lb/acre. Rates within these dosage ranges control most annual, perennial and woody species.

The present study compares rates, formulations, placements and times of application of karbutilate in the control of woody species. It is often desirable to remove woody species to prevent them from (1) fouling wires, (2) obstructing vision, (3) serving as tinder for forest fires, and (4) shading or competing with desirable, low-growing herbaceous species. A selective placement of karbutilate should allow the low-growing herbaceous species to remain to prevent erosion and to afford a green cover.

Materials and Methods

A forested site in southern New Jersey was selected. The woody species ranged up to 12 years of age and are listed as follows:

quaking aspen	- Populus tremuloides
red maple	- Acer rubrum
pitch pine	- Pinus rigida
pignut hickory	- Carya glabra
sassafras	- Sassafrass albidum
black cherry	- Prunus serotina
sweetgum	- Liquidambar styraciflua
blackgum	- Nyssa sylvatica
tulip poplar	- Liriodendron tulipifera
red oak	- Quercus borealis
black oak	- Quercus velutina
scrub oak	- Quercus ilicifolia
pin oak	- Quercus palustris
white oak	- Quercus alba
chestnut oak	- Quercus prinus

[1/] Industrials Chemicals Department, Niagara Chemical Division, Middleport, New York

* TANDEX®, registered trademark of FMC products containing karbutilate.

post oak - *Quercus stellata*
white mulberry - *Morus alba*

Wettable powder basal sprays were applied by means of a back-pack sprayer during either June or November 1970. Tandex 4 Granules and Tandex 10 Granules were applied by tossing the selected rates by hand at the base of the tree. Tandex 4 Granules and Tandex 10 Granules were applied during March 1970 and May 1971, respectively. Four 60% tablets per inch of tree diameter were tossed within the dripline of the tree during June or November 1970. The 10% pellets were applied broadcast in June 1971 by means of a cyclone seeder.

Evaluations of brush and tree kills were made several times to determine rapidity of action and time of kill. Prior data (2 and 3) indicate that within one month of treatments, applied during the growing season, the trees became partially defoliated. The remaining leaves were partially chlorotic and necrotic. Treated defoliated trees produced a second flush of leaves which were small and partially chlorotic and necrotic. The exact time of tree death is difficult to determine but is best identified by the death of the cambium. It is the latter readings (fall 1971) which are important and are recorded in the table although the interval required for defoliation is also recorded.

Results and Discussion

Data presented in the table indicate that certain species are more susceptible and are killed quicker than others. Conifers were found to be most susceptible. Sassafras, on the other hand, was a more tolerant deciduous species. Treated species varied in their ability to initiate new foliage. Considering all species, formulations and rates, the intervals required for defoliation and death were as follows:

Time of Application	Average Time of Defoliation	Months Required for Cambium Death
Fall (Oct, Nov)	Spring (Apr, May)	12 months +
Winter (Jan, Feb)	Spring (Apr, May)	15 months
Spring (Mar, Apr)	Spring (May, June)	12 months +
Summer (June, July)	Summer (July, Aug)	14 months
Summer (Aug, Sept)	Fall (Sept, Oct)	14 months

The data, as presented in the table, indicate that all rates, formulations, placements and time of application killed the woody species. Karbutilate's action follows movement into the soil, root absorption, and the systemic translocation of the material throughout the tree. Conditions, such as frozen soils, may retard the entry and subsequent movement. Heavy soil types might delay the time required to produce plant injury or kill while woody vegetation growing in sandy soils is killed most rapidly.

Basal applications of karbutilate were found to be an effective, selective means of controlling undesirable brush and trees. These application procedures will selectively remove the unwanted woody species which will prevent the fouling of wires but, at the same time, maintain a green understory to prevent erosion and provide cover for wildlife. The selective removal of brush and trees also eliminates tinder which supports forest fires in drier climates and, in addition, improves the field of vision on roadway curves and at intersections.

2. Hagood, Edward S. 1969. The effectiveness of M-(3,3-dimethylureido)phenyl tert-butylcarbamate, various herbicides and their combinations as soil sterilants in the northeast. Proc. NEWCC 23: 303-319.

3. Hagood, Edward S. 1970. The effectiveness of maintenance programs of m-(3,3-dimethylureido)phenyl tert-butylcarbamate, various herbicides and their combinations as soil sterilants in the northeast. Proc. NEWCC 24: 87-101.

RESPONSES OF WOODY SPECIES TO RATES, FORMULATIONS, PLACEMENTS AND TIMES OF APPLICATION OF KARBUTILATE

Placement -	Basal Spray		Basal Granular	Basal Granular	Basal Tablet		Basal Pellet
Formulations -	80 WP		4% Granular	10% Granular	60% Tablets		10% Pellet
Rate active -	0.71 gm/inch		0.74 gm/inch	0.92 gm/inch	1.0 gm/inch		15 lb/acre Broadcast
Date applied -	6/70	11/70	3/70	5/71	6/70	11/70	6/71
Woody species responses*							
Pitch pine	-	10c	10c	10c	10c	10c	-
Pignut hickory	-	10c	-	8	-	-	10
Quaking aspen	-	10c	10c	-	10	10	8
Red maple	10c	10c	10c	10c	10c	10c	10
Sassafras	10	8	-	10c	10c	10	10
Black cherry	10c	10c	10c	10c	-	10	10
Sweet gum	-	10c	-	-	-	10	-
Black gum	10c	-	-	-	-	10	10
Tulip poplar	-	10c	-	-	-	-	-
Red oak**	10c	10c	10c	10c	10c	10c	10
White oak***	-	10	-	10c	10	10c	10
White mulberry	-	-	10c	-	-	-	-

*0 = None, 10 = Complete defoliation with no regrowth.
C = Death of cambium
**Includes red oak, black oak, scrub oak, pin oak, willow oak
***White oak, chestnut oak and post oak

PHYTOTOXICITY AND PERSISTENCE OF SIMAZINE IN A SHALLOW LAKE

(Abstract)

John F. Ahrens and Philip M. Block[1/]

Growth of aquatic vegetation in shallow bodies of water can be so dense as to preclude any recreational uses. Such was the case of the 1860 Reservoir, a former marsh with a man-made dike constructed over a century ago in Wethersfield, Connecticut. This 33 acre lake with a 100 acre watershed gradually had filled to an average depth of 2.4 feet in 1971. In recent years it was completely covered with aquatic vegetation during the summer months.

In an attempt to achieve broad spectrum control of aquatic vegetation, simazine (2-chloro-4,6-bisethylamino-s-triazine) was applied on June 1, 1971 at a level of 1.9 ppm. Effects on the aquatic and shoreline vegetation were observed and water samples were taken in the lake and downstream at varying times after treatment to determine levels of simazine in the water and toxicity of the water to plants.

While kill of certain weeds took 4 to 6 weeks, the lake was essentially clean and navigable all season. The following species were controlled to a high degree: duckweed (Lemna minor L.), filamentous algae (Rhizoclonium), coontail (Certatophyllum spp), flatleaf pondweed (Potamogeton robbinsii Oakes), large-leaf pondweed (P. amplifolius Tuckerm.), small pondweed (P. pusillus), spatterdock (Nuphar advena (Ait.) Ait.f.) and white waterlily (Nymphaea tuberosa Paine). Coontail, white waterlily and spatterdock slowly declined over a period of 6 weeks whereas duckweed and the algae were controlled in 2 weeks and did not reinvade in quantity during the season. While many large willows and other deciduous trees lined the banks, only four willows (Salix spp) growing in the spillway of the earthen dam, and a few deciduous shrubs within 2 feet of the bank were visibly affected by the treatment.

To determine phytotoxicity, one inch of sample water was poured over oats seeded in a sandy loam soil. Phytotoxicity of the lake water started to decline between 4 and 6 weeks after treatment so that after 2 months little was detected and at 11 weeks none was detected. At a point 1200 feet downstream from the dam levels of phytotoxic residues were considerably less than those in the lake, but a trace was detected 2 months after treatment. Further downstream, with dilution of the water from other streams, no phytotoxicity was detected at any date of sampling. This study will be carried to completion with chemical analyses of frozen water samples and observations on the lake during 1972.

1/ Plant Physiologist, The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor, and Sanitarian, Town of Wethersfield, Connecticut.

A STUDY OF ORGANISMS LIVING IN THE HEATED EFFLUENT OF A POWER PLANT

Madelene E. Pierce 1/ and Denise Alessandrello 2/

INTRODUCTION

The purpose of this study was to compare the flora and fauna living in the heated effluent of a power plant with that of two controls at undisturbed reaches of the river. The study was made possible by grants from Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y. Two grants were made to colleges in Poughkeepsie for environmental studies on the Hudson River. One was given to Robert Rehwoldt, Professor of Environmental Studies at Marist College, the other to Albert Feldman, Associate Professor of Biology at Dutchess Community College. In both studies the work was carried out by local faculty and their student assistants. This paper is concerned only with one aspect of the program at Marist College. Credit is given for specific data supplied by the Dutchess group.

The region of the heated effluent was Danskammer Point, the site of the power plant of Central Hudson which has been in operation for twenty years. This is located seven miles south of Poughkeepsie on the west shore of the Hudson River. Howland's Point, five miles south of Poughkeepsie on the east shore, was selected as the control by both groups. In addition, Marist College chose a second control one mile north of the city on the west shore.

The duration of the study was from spring to fall 1971, and the exact dates were: May 28; June 14, 23; July 7, 27; August 4, 12, 24; Spetember 24; October 9.

MATERIALS AND METHODS

On each date records of the following physico-chemical parameters were kept; air temperature, ambient temperature of river, outlet temperature of the plant. At selected stations the following observations were recorded: surface and bottom temperature, dissolved oxygen at surface and bottom, depth of water, substrate, name and number of animals dredged, aquatic weeds, and plankton forms. At the control only one station sixteen feet in depth was established. At Danskammer two stations were chosen. They were located on a perpendicular about seven hundred feet south of the outlet. The shallow station, five to ten feet deep, was close to shore; while the deeper station, twenty to thirty feet deep, was off shore some three hundred feet. Usually the sampling was carried out between 9:30 A.M. and 1:00 P.M.

1/ Emeritus professor of Biology, Vassar College, Poughkeepsie, N.Y.
2/ Biology major, Marist College, Poughkeepsie, N.Y.

Water temperatures were obtained by using an F T 3 marine hydrographic thermometer. Salinities were recorded with a Solu Conductivity Bridge. A Kemmerer sampling bottle was used to collect water samples which were analyzed by the Winkler method for oxygen determination. The plankton net was a number 12 standard. For dredging a modified Ekman grab was used, and the screening on the sieve was regular window screen.

SUMMARY OF RESULTS

The air temperature varied with the season, starting at 17°C, reaching a high in August of 30°C, and falling to 18°C in October.

The ambient temperature of the Hudson River followed that of the air, starting at 16°C, reaching 25°C in August, and falling to 21°C in October.

Physico-chemical data from Danskammer Point

The salinity was constant at 0.1 ppt over the entire period. The pH varied only from 7.2 - 7.7 (A. Feldman).

The temperature at the outlet changed from 26°C in May, 34.8°C in August, to 27.5°C in October. Surface and bottom temperatures of the shallow station followed the pattern of the outlet, usually being the same or one or two degrees less. Surface and bottom temperatures of the deeper station were usually five to eight degrees cooler than the outlet, and bottom temperatures were often decreased by two additional degrees. A typical example taken from the record of September 24 reads as follows: outlet 30°C; shallow station surface 28°C, bottom 27°C; deep station surface 24°C, bottom 21.8°C; ambient near surface 23°C.

The dissolved oxygen, at both surface and bottom of the shallow station, varied considerably between 5.1 ppm and 10.4 ppm, but no seasonal pattern was observed. The dissolved oxygen at the deeper station, both surface and bottom, was consistently higher. At the surface readings were usually 10.1 - 10.9 ppm, and at the bottom 7.2 - 9.4 ppm.

Physico-chemical data from Howland's Point

The salinity was consistent over the period, varying only from 0.09 ppt - 0.15 ppt. The pH as recorded at the surface varied from 6.9 - 7.7, and at the bottom remained a steady 7 (A. Feldman).

The surface temperatures showed a gradual rise and fall reflecting closely the seasonal cycle, beginning at 16°C, rising slowly to 25.9°C, and falling to 19.5°C.

The dissolved oxygen also followed a definite pattern of gradual decrease from spring to autumn. This was especially noticeable at the surface with a fall from 15.6 - 5.16 ppm, and less so at the bottom with a decrease from 13.6 - 5.9 ppm.

Dredging

Within the area sampled the substrate was comprised largely of mud and silt. Near the shore occasional sand was found. The unit of sampling for benthic forms consisted of three grabs with a modified Ekman dredge. This material was immediately sieved, and the organisms identified and counted. At both the control and the heated area few benthic species were found. It is also true that few individuals of any one species were present. At Danskammer the following species were observed: Chironomus, Annelids, Amphipoda (scuds), Odonata (damselfly larvae). Often the total of three dredges yielded nothing, while a high count might total as high as twelve specimens. A typical count was, one Chironomus and two Annelid worms. At Howland's Point the record was similar. In addition to the forms found at Danskammer, there were present Amnicola and Cyathura. Again, three grabs might yield nothing, but a more typical count was two Chironomids, three Annelids, and one Amnicola. The highest count per three grabs was twenty-five specimens.

Aquatic Weeds

At Danskammer Point the stand of weeds was limited in size and restricted to an area close to the shore. Potamogeton perfoliatus was the dominant species but Heteranthera sp. also occurred.

At Howland's Point a wide border of aquatic weeds fringed the shore line extending for miles both north and south. Six species were identified: Potamogeton perfoliatus, P.foliosus, Naja guadalupensis, Ceratophyllum demersum, Vallisneria americana, and Myriophyllum spicatum. At least three other species were present but unidentified.

The organisms living upon the weeds were also studied, and the following were found and identified: Nematoda; Annelida (bristle worms); Ostracoda; Amphipoda (scuds); Insecta (Diptera, Odonata, Trichoptera); Arachnida(mites); Mollusca (Amnicola, Ferrissia, Helisoma). Each species was represented by several individuals, and some species were present literally by the hundreds (scuds, Dipteran larvae, Amnicola).

Plankton

One plankton haul consisted of dragging a standard plankton net through the water for five minutes at a depth of three feet. The samples were taken to the laboratory where they were identified, while living, under the low power of a compound microscope. Only a qualitative study was made. The same big groups were constantly present throughout the period. A single genus might rise and fall conspicuously. For example, Asterionella was dominant during May and June, but Pediastrum took its place during the late summer. However, most organisms were present throughout the season with almost monotonous regularity. Both a large number of species and a large number of individuals within a single species was present. As an example of the more common forms of a single haul, the organisms identified from Danskammer Point on August 12 are shown below. The forms from the control would be similar.

Myxophyceae

- Anacystis
- Agmenellum
- Oscillatoria
- Gomphosphaeria
- Aphanizomenon

Chlorophyceae

- Mougeotia
- Ulothrix
- Pleodorina
- Actinastrum
- Closterium
- Pediastrum
- Scenedesmus
- Staurastrum

Bacillariophyceae

- Campylodiscus
- Cyclotella
- Fragilaria
- Gyrosigma
- Melosira
- Surirella
- Synedra

Protozoa

- Ceratium
- Euglena

Rotifera

- Brachionus
- Keratella
- Ploesoma
- Unidentified (1)

Annelida

- Bristle worm

Crustacea

- Nauplius
- Cyclops vernalis
- Limnocaulus
- Bosmina
- Ostracoda

DISCUSSION AND CONCLUSIONS

Certain parameters need no special comment. Both the air temperature and ambient temperature of the river obviously changed with the season. The salinity and pH of the river varied slightly but can be considered constant for purposes of this report.

The outlet temperature also reflects the seasonal change, usually five to ten degrees above the ambient temperature. It must be remembered however, that man is tampering with the circulating water, using more or less of it as demanded for cooling the plant.

Temperatures at the shallow station, 700 feet south of the inlet, were equal to or slightly less (2-3°C) than the outlet.

However, at the deeper offshore station, temperatures fell to within 2°C of the ambient.

The rapid cooling of the heated plume could be due to several factors. The volume of river water flowing by the plant is large; the basin of the river is deep; the current is swift; the power plant is isolated from other similar discharges.

The temperature of the control followed closely the ambient temperature of the river. In both areas the amount of dissolved oxygen at all times was adequate. Although temperatures at Danskammer reached 34°C, the dissolved oxygen ranged from 5.1 ppm - 9.3 ppm. At the control, since temperature never rose above 25.9°C, the dissolved oxygen also remained high, 8-10 ppm.

A study of the organisms shows little if any difference in the species occurring in the heated and control area. Throughout the sampling the same large groups were present, although often represented at any one time by different species.

The plankton hauls produced a variety of interesting forms which prove that the river is far from "dead", at least in this portion.

The organisms from the grabs were few and strictly limited to crustacea, annelids, insect larvae, and an occasional snail.

One of the most striking differences between the two areas is the plant growth. At the control a wide border of aquatic weeds extends along the shore for miles in either direction. This is typical of that part of the shore which has not been disturbed by development. Upon the weeds live large populations of diatoms and invertebrates, the commonest being scuds, insect larvae, and snails. In brief this is an area of high biological productivity. At the heated area only two species of weeds are present and these are somewhat limited in distribution. This may be the result of a rough substrate, as well as the presence of strong currents which occur. Even though the fauna living here consist of the same species as the control, the absence of large beds of aquatic weeds must necessarily result in lowered productivity.

In addition to Howland's Point another control was selected at a point eight miles north of the heated area where no industrial development has occurred. The data obtained compare favorably with that from Howland's Point. Temperatures and salinities are similar. The plankton, the benthic forms, the aquatic weeds and their clinging populations, are identical. This area is also one of high biological productivity.

If a conclusion can be drawn from the observations of the summer, it is this. In general the same species are living in both the heated effluent and the controls. Because of the rapid cooling of the effluent, this relatively unfavorable region is restricted to a very small area of the river. Therefore any adverse effect upon the river as a whole is minimal. However, should several power plants be located so closely that the heated plumes joined to from a relatively large area, the present rapid cooling effect might well be reduced.

SUMMARY

1. An ecological study of the fauna and flora living in the heated effluent of a power plant was made.

2. The study was conducted at Danskammer Point, at Howland's Point, and at a spot eight miles north of Danskammer Point, on the Hudson River, from May 28 to October 9, 1971.

3. Records on the following physico-chemical parameters were kept: air temperature, ambient temperature of water, outlet temperature of the plant; and at selected stations water temperatures, pH, salinity, and dissolved oxygen.

4. The aquatic weeds as well as the organisms living on them were identified.

5. Organisms from dredging samples and plankton hauls were identified.

6. A comparison of the organisms found indicate little difference in the number of species present in the control and heated area.

7. Commonly occurring forms numbered about seventy-five. The total count for the season may be twice that figure.

EXCHANGE OF PHOSPHATE BETWEEN SEDIMENT AND WATER IN THREE CONNECTICUT LAKES

W.A. Norvell [1]

Abstract

A combination of factors including shallow depth, very weak thermal stratification, ineffective sorption of P by bottom sediments, and low dissolved oxygen at the bottom during both winter and summer permit Bantam Lake sediments to contribute P to the overlying water where it may stimulate algal growth. Limitation of P availability in this lake would be difficult to accomplish. The contribution of P by sediments in Lake Zoar and Lillinonah is lower because of their greater depth, better thermal stratification, and shorter retention times. Although P concentrations in the water and sediment of these lakes are already relatively high, the opportunity to reduce P availability by controlling P inputs appears better than in Bantam Lake.

Introduction

Phosphorus is recognized as one of the nutrients that most frequently limit the growth of algae and other aquatic weeds in lakes. Phosphorus receives special attention because some of the sources that contribute significant amounts of P to our waters can be controlled at reasonable cost. However, attempts to reduce obnoxious algal blooms by reducing the availability of P may be effectively resisted by release of P from bottom sediments to overlying waters.

In most productive lakes various chemical, biological, and physical processes favor the net removal of P from the water and its eventual accumulation in organic and inorganic forms in bottom sediments (4). Nevertheless, very significant amounts of P may be cycled between sediments and waters under various conditions. Consequently, very adequate supplies of P may remain available to algae even when external inputs of P are reduced or even largely eliminated. This paper reports on some aspects of water and sediment chemistry that control the sorption and release of P by sediments in three Connecticut Lakes.

Materials and Methods

Three eutrophic lakes, previously studied by Frink (1,2,3) were selected for this investigation of the exchange of P between sediments and waters. Bantam Lake is a moderately eutrophic shallow lake (mean depth 4.4 m, maximum 7 m) while Lakes Zoar (mean depth 7.5 m, maximum 25 m) and Lillinonah (mean depth 11.8 m, maximum 30 m) are highly eutrophic impoundments of the Housatonic River.

The distribution of dissolved oxygen and water temperature in the three lakes was measured intermittently throughout 1970 and 1971 with a Yellow Springs Instrument Company oxygen-temperature meter equipped with a 30 m probe. Surficial sediment samples were collected with an Ekman dredge and stored in sealed glass bottles at approximately 4° C.

Sediments were analyzed for total P, total Fe, extractable ferrous iron, and pH. Samples of the interstitial water were obtained by dialysis or centrifugation-filtration and analyzed for soluble Fe and P. The capacity of sediments

1/ Assistant Soil Chemist, The Connecticut Agricultural Experiment Station, New Haven, Connecticut.

to sorb P in response to increases in the concentration of P in interstitial waters was studied in the laboratory using undiluted sediment samples. Soluble P concentrations were determined on samples of interstitial water obtained at selected times during reactions between sediments and added P.

Results

Lakes Zoar and Lillinonah were well mixed from late fall until the onset of thermal stratification in early summer. During late fall, winter, and spring flow rates are high enough to keep these impoundments well mixed with uniform distributions of dissolved oxygen and temperature throughout the water column. As flow rates begin to decline in early summer these lakes develop weak thermal stratification which persists until turnover in the fall. During the summer, these productive waters become completely depleted of oxygen in most of the hypolimnion.

In Bantam Lake weak thermal stratification was observed in the summer and under ice-cover in the winter. During the summer, oxygen was depleted near the sediment-water interface at all depths, and less than 0.1 ppm could be detected in the lower one to two meters of water in the deeper areas of the lake. However, the remainder of the water column was well supplied with oxygen. Oxygen was also depleted in water close to bottom sediments during the winter.

Analysis of sediment samples from this study and from earlier work by Frink (2, and unpublished data) show that sediments from the deeper regions of all three lakes are reasonably similar in pH (6.8-7.0), clay content (30-40%) and organic matter content (20-25%). However, sediments from Zoar and Lillinonah are markedly higher than sediments from Bantam in total iron, easily extractable ferrous iron, total P and inorganic P. Sediments from Zoar and Lillinonah are colored dark brown to black by amorphous iron sulfides whereas sediments from Bantam are lighter in color and contain little or no iron sulfide. Sediments from the three lakes also differ in the concentration of soluble Fe and inorganic P in the interstitial water. Lillinonah and Zoar have soluble ferrous iron concentrations of approximately 25 to 75 ppm and soluble inorganic P concentrations of 0.2 to 0.3 ppm. Sediments from Bantam usually have only 1/10 the concentration of soluble ferrous iron and 1/3 the concentration of soluble inorganic P found in the other sediments.

Preliminary results from our studies of the P sorbing capacity of these sediments show that fresh, non-oxidized sediments from Bantam have relatively little ability to sorb inorganic P from solution. On the other hand, sediments from Zoar and Lillinonah sorb added inorganic P rapidly and very effectively, despite their higher existing contents of soluble and total P.

Discussion

Sediments in Bantam Lake are sufficiently close to the photic zone to have a major influence on the solubility and availability of P throughout the year. Anoxic conditions at the sediment-water interface during the summer are coupled with relatively high concentrations of soluble P. This P comes in part from decomposition of sedimented organic materials and in part from reduction of oxidized compounds of Fe which contain some P. Much of the soluble P released at the sediment-water interface should become available to algae because turbulent mixing of the bottom water with the remainder of the water column is probable in this weakly stratified shallow lake. Furthermore, the inability of Bantam sediments to effectively sorb soluble P should contribute to continued high P solubility at the sediment-water interface. Low dissolved oxygen observed in the bottom waters during late winter increases the likelihood of abundant available P during the late spring and early summer. These conditions, combined with an average P concentration of 37 ppb in the inflowing waters of the Bantam River (1) are sufficient to provide adequate P for abundant growth of algae. In addition to the factors discussed above, the diffuse nature of nutrient sources in the watershed (1) would severely hamper any attempt to control algal problems by reducing P inputs into Bantam Lake.

The great majority of sediments in Lake Zoar and especially in Lake Lillinonah lie in deep water. Although much of the hypolimnia in these lakes becomes completely anoxic during the summer, the P released at or near the bottom is unlikely to be readily available to algae or other weeds. Thermal stratification of these deep impoundments effectively prevents mixing of the cooler hypolimnetic water with the warmer surface waters. Furthermore, even in their reduced condition the iron-rich sediments from these lakes sorb P quite effectively. During the late fall, winter, and spring these lakes are well oxygenated which should further impede release of P by these sediments. In any case the flow rate of the Housatonic River is too great during this period for P released by sediments to remain within these impoundments until summer. For these reasons, the contribution of sediment P to algal blooms in Lakes Zoar and Lillinonah appears small.

The major cause of excessive algal growth in these impoundments is the abundance of nutrients in the Housatonic River and its tributaries. Frink (3) found that the average total P concentration of the water entering these lakes was 65 ppm, well in excess of the P required for obnoxious growth of algae. Despite this higher P concentration, the opportunity for reducing algal blooms in these lakes by limiting P availability appears greater than in the case of Bantam Lake. A significant reduction of the P load entering the Housatonic River, especially during the late spring and summer, should also reduce the supplies of P available to algae in Lakes Zoar and Lillinonah.

Literature Cited

(1) Frink, C.R. 1967. Nutrient budget: Rational Analysis of Eutrophication in a Connecticut Lake. Environ. Sci. Tech. 1:425-428.

(2) Frink, C.R. 1969. Chemical and Mineralogical Characteristics of Eutrophic Lake Sediments. Soil Sci. Soc. Amer. Proc. 33:369-372.

(3) Frink, C.R. 1970. Nutrient Budgets in Reservoirs. NEWSS Proc. 24:284-286.

(4) Hutchinson, G.E. 1957. The Phosphorus Cycle in Lakes, p. 727-752. In G.E. Hutchinson, A Treatise on Limnology. Vol 1. John Wiley and Sons, Inc. New York.

Influence of Mineral Deficiencies in Potamogeton pectinatus and Their Influence on Naptalam Uptake and Accumulation

by

R.M. Devlin, R.W. Yaklich, and S.J. Karczmarczyk [1/]

INTRODUCTION

In cranberry culture good water management is of major importance and this can only be achieved if drainage ditches, irrigation canals, and reservoirs are kept relatively free of aquatic weeds. The typical cranberry bog, for example, contains from 750 to 1200 linear feet of ditch per acre (4). The purpose of the ditches is to allow rapid and free access of water to all sections of a bog for flooding and good drainage. Occasional flooding of bogs is necessary for frost protection in the spring and fall and for the elimination of trash after harvest. Also, flooding to check certain insect pests and protect against winterkill during the winter months is common. Finally, the unimpeded flow of clean water is necessary for the operation of low-gallonage sprinkler systems now found on most cranberry bogs.

Aquatic weeds, especially of the genus Potamogeton, flourish to such an extent in bog ditches as to render them useless before half of the growing season has been completed. The primary means of control for ditch weeds is their removal with hand potato-diggers and shovels in the spring or fall, a safe but very tedious practice. The easier and more efficient chemical control methods should be approached with great care. A grower must remember that the water in which the aquatic weed herbicide is being applied may be used to flood or irrigate his cranberry bog.

Because of the importance of aquatic weeds and because of the difficult ies their control presents to the cranberry grower, more information should be obtained on the chemical and physical factors controlling their growth and development. In the present study the influence of calcium, potassium, and magnesium deficiencies on the growth and development of the sago pond plant (Potamogeton pectinatus L.) was observed. In addition, the effect of these deficiencies on the uptake and accumulation of naptalam was studied. This aspect of the work was undertaken because naptalam is the major herbicide present in Morcran, a formulated mixture that also includes isopropyl m-chlorocarbanilate (Chlorpropham). Morcran is the herbicide used in greatest amount by the Massachusetts cranberry grower.

1/ Associate Professor of Plant Physiology and Research Associates, respectively, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts.

MATERIALS AND METHODS

Sago pond plant tubers were grown in 5-gallon battery jars containing either a complete inorganic medium (Hoagland No. 1) or inorganic media lacking calcium, potassium, or magnesium. In order to keep the plants on the floor of the battery jar, each tuber was weighed down with a small metal washer. All solutions were aerated for 1 hr before the tubers were planted and for 2 hr daily thereafter. Also before planting the tubers were weighed and their lengths measured. Temperature ($22 \pm 1^{\circ}C$), light intensity (400 ft-c), and light duration (continuous) were controlled by growing the plants in a growth chamber (Precision Model 806). A constant pH of 5.0 ± 0.2 was maintained in all growth media. Algal growth was controlled with the addition of 1 ppm $CuSO_4$ and twice during the test growth period the plants were transferred to fresh media. Deficiency symptoms were observed and recorded during the length of the 20-day test period.

After 20 days the sago pond plants were removed and immersed in a 25 ppm solution of naptalam. Temperature, light, and pH were controlled as before. After 24 hr exposure to naptalam the plants were removed, washed thoroughly with distilled water, weighed and their lengths measured. The plant tissues were then cut into small pieces and dried at $45^{\circ}C$ for 48 hr in preparation for extraction of naptalam. Before being extracted the dried plant tissues were ground into a fine powder by a Wiley mill. Each experiment was replicated four times.

Naptalam content of the plant tissues was determined, with only slight modification, by the method of Smith and Stone (5). Their method relies on the basic hydrolysis of naptalam in boiling 30% sodium hydroxide and the steam distillation of 1-napthylamine. Under the conditions of this study, steam distillation of the amine was complete when 15 ml of distillate had been collected.

In preparation for color development 5 ml of glacial acetic acid and 5 ml of distilled water were added to the 15 ml of distillate. Ten drops of freshly prepared diazonium reagent were then added to the diluted distillate. The diazonium reagent is composed of equal volumes of 1% sulfanilic acid and 0.12% sodium nitrite that have been allowed to react for about 4 min. The amine present in the distillate couples with diazotized sulfanilic acid to give an azo dye. After 30 min the intensity of the red color formed is read at 534 nm with a Beckman DU spectrophotometer. A linear relationship exists between the intensity of color and the amount of 1-napthylamine present.

RESULTS AND DISCUSSION

Slight marginal paling of several leaves was observed 12 days following planting of sago pond plant tubers in calcium deficient medium. This first observed symptom of calcium deficiency did not effect the tips of the leaves. More pronounced chlorosis and some marginal curvature was noted 15 days after planting along with a number of small black spots on the leaves and stems. This was rapidly followed by extensive necrotic spotting in the leaf blade and stem. By the 19th day after planting most of the leaves and stems had become gelatinous indicating collapse or physiological breakdown of the tissues.

The adverse physiological influence of calcium deficiency was reflected in the large differences in growth (as measured by growth in length and wet weight) between calcium deficient plants and control plants. The average growth of the control plant over a 20-day period was 24.03 cm while that of the calcium deficient plant was 7.41 cm. Difference in wet weight was even greater, the average control plant having a wet weight of 0.584 g compared to 0.075 g the average wet weight of the calcium deficient plant (Table 1).

The extensive necrosis and eventual breakdown of tissues found in calcium deficient sago pond plants may be explained by the function of calcium as a constituent of cell walls in the form of calcium pectate. It has been suggested that lipids such as lecithin might be involved as calcium salts in membrane formation or organization (1), a circumstance that also implicates calcium in tissue stability.

Sago pond plants in magnesium deficient medium demonstrated only a slight chlorosis at the end of the 20-day growth period. It is apparent that the tuber tissues contained enough magnesium to sustain the plant for most of this period. The slight chlorosis at the end of 20 days obviously reflects the function of magnesium as a constituent of the chlorophyll molecule. A shortage of magnesium did, however, quite noticeably inhibit growth in length and wet weight. On an average, control plants exhibited 39% more growth in length and 143% more wet weight (Table 1).

Table 1. The average lengths and wet weights of sago pond plant tubers 20 days after planting in complete inorganic medium (control), and in media lacking calcium, magnesium, or potassium. The uptake of naptalam on a per gram dry weight basis by calcium, magnesium, and potassium deficient plants and control plants is also included. Ten tubers per battery jar were planted and each experiment was replicated four times.

Treatment	Length cm	Wet weight, g	Naptalam uptake, ug/g
Control	24.03	0.584	130.4
Minus Ca	7.41	0.075	157.2
Minus Mg	17.54	0.240	108.5
Minus K	17.99	0.362	109.3

Sago pond plants responded to a lack of potassium by turning a darker green and by demonstrating an inhibition of growth. Darker green coloration is also exhibited by the foliage of potatoes that are deficient in potassium (3). This symptom generally precedes necrotic spotting, although necrosis was not observed in this study. Lack of potassium commonly causes marked shortening of internodes (3), a symptom readily observed in this study. Control plants averaged 34% more growth in length and 61% more wet weight than potassium deficient plants (Table 1).

Sago pond plants deficient in calcium take up and accumulate over 20% more naptalam than control plants (Table 1). This may be due, however, to the breakdown of tissues caused by a lack of calcium rather than to any acceleration of naptalam uptake. Devlin and Yaklich (2) found that sago pond plants slightly deficient in nitrogen or phosphorus take up over 45% more naptalam than plants grown in a complete inorganic medium. Unlike calcium, phosphorus, and nitrogen deficient plants, sago pond plants deficient in magnesium or potassium took up less naptalam than control plants (Table 1).

LITERATURE CITED

1. T.A. Bennett-Clark. 1956. Salt accumulation and mode of action of auxin; a preliminary hypothesis. In Chemistry and Mode of Action of Plant Growth Substances (R.L. Wain and F. Wightman, eds.), pp. 284-291. Butterworth, London.

2. R.M. Devlin and R.W. Yaklich. 1971. Mineral deficiency in Potamogeton and its influence on naptalam uptake and accumulation. Proc. Northeast. Weed Contr. Conf. 25:79-82.

3. E.J. Hewitt. 1963. The essential nutrient elements: requirements and interactions in plants. In Plant Physiology (F.C. Steward, ed.), Academic Press, New York. 3:137-360.

4. J.S. Norton. 1962. Cleaning cranberry bog ditches. Expt. Station Bull. 527, Univ. of Mass. Press, Amherst, Mass., pp. 1-9.

5. A.E. Smith and G.M. Stone. 1953. Microdeterminations of N-1-naphthylphthalamic acid residues in plant tissues. Anal. Chem. 25:1397-1399.

BIOLOGICAL CONTROL OF AQUATIC WEEDS - RECENT PROGRESS

R. I. Sailer[1]

During 1971, there was perceptible progress toward alleviation of aquatic weed problems in Southeastern United States. From South Carolina through Florida and west along the Gulf Coast well into East Texas alligatorweed, _Alternanthera philoxeroides_ (Mart.) Griseb. was under attack by the flea beetle, _Agasicles hygrophila_ Selman and Vogt. Although first introduced from Argentina in 1965 and actively distributed through a cooperative effort of Agricultural Research Service and the Army Corps of Engineers, only in the past year has the flea beetle become established throughout most of the region infested by alligatorweed.

Perhaps the most noteworthy development occurred in Louisiana where large acreages of alligatorweed came under beetle attack for the first time. Preliminary reports indicate that floating mats of the weed were destroyed over extensive areas. Rice growers were at first alarmed by enormous numbers of beetles entering rice fields adjacent to the canals where the floating alligatorweed had been destroyed. The grower's alarm soon subsided when they found that the beetles fed only on alligatorweed growing in the rice fields. Needless to say, they are now sold on biological control.

A further development of the past year was the introduction and colonization of a moth, _Vogtia malloi_ Pastrana. This stem boring moth is also a native of South America. It was imported from Argentina where studies conducted by an ARS entomologist showed that it would feed only on alligatorweed. Two field colonies were established in Florida and at last account, both were thriving. Laboratory studies show that the feeding damage caused by the moth larvae is more injurious than that of the flea beetle. The moth will also attack the weed where it grows in rooted mats or terrestrial sites. Neither of these habitats are favorable to the beetle. The moth may also be an effective enemy of alligatorweed in more northern areas where the beetle has failed to overwinter. Prospects that the moth will supplement and extend biological control of alligatorweed, therefore, appear favorable.

A disturbing note is accumulating evidence that as alligatorweed is suppressed by the flea beetle it is replaced by other aquatic plants. In many areas, the replacing plant is waterhyacinth, _Eichhornia crassipes_ (Mart.) Solms, which creates an equal or worse problem. This was not unexpected since waterhyacinth was known to be competively superior to alligatorweed (U.S. Army Corps of Engineers 1965). Alligatorweed originally became a problem because it was resistant to herbicides that were highly effective against waterhyacinth (U.S. Army Corps of Engineers 1965). The ability of alligatorweed to withstand chemical action was in fact responsible for the decision to seek biological

[1]Entomology Research Division, Agricultural Research Service, USDA, Beltsville, Maryland.

means of control. Now that the flea beetle has tipped the scales in favor of waterhyacinth, questions will be raised as to the utility of biologically controlling alligatorweed. Fortunately, waterhyacinth is also an introduced plant with an array of insect enemies in its native South America. These are not found in the United States.

As a result of research conducted by ARS scientists in Argentina and earlier work in Uruguay, supported by the ARS PL 480 program, several of the water-hyacinth feeding insects have already been intensively studied. Two species of weevils have in fact been cleared for introduction into the ARS Biological Control of Weeds Laboratory at Albany, California, where final tests are being conducted in quarantine to determine that they may safely be released in Florida. These weevils belong to the genus Neochetina. The adults of both species feed on waterhyacinth leaves and the larvae tunnel in the stem and root crown. We expect results of the tests at Albany to be favorable and hope to start colonizing the weevils in Florida during the summer of 1972.

How well the weevils will perform is difficult to predict. While the damage caused by an individual weevil is not impressive when compared with the growth potential of its host, we suspect that the feeding injury may expose the plant to invasion by fungi or bacteria. These secondary invaders could cause quick collapse and death of weevil attacked plants.

However, if the weevils should prove ineffective, a stem boring moth, Acigona infusella (Walker) and an acridid grasshopper, Cornops aquaticum Bruner are "waiting in the wings" and research on other insects is progressing favorably. In India, where the ART PL 480 program has also supported research on biological control of waterhyacinth, a fungus has been found that is pathogenic to this plant. In addition, a metabolite of the fungus has been shown to be highly toxic to waterhyacinth. Further research is in progress to determine whether either the fungus or its metabolite can be used for control purposes.

In addition to the work on alligatorweed and waterhyacinth, ARS through its PL 480 program is also sponsoring research on Eurasian watermilfoil, Myriophylum spicatum (1.) and Florida elodea, Hydrilla verticillata (L.F.) Casp. In Yugoslavia, further information has been obtained on the life history and feeding behavior of the moth Paropoynx stratiotata (L.) and the weevil Litodactylus leucogaster (Marsham). The larvae of the moth clearly prefer to feed on Myriophylum, but have been found to also feed in varying degrees on other submerged aquatic plants. The picture has been complicated by discovery of Parapoynx allionalis (Walker) in Florida. To date this native species has been found only in outdoor tanks at Ft. Lauderdale where Eurasian watermilfoil was being grown for experimental purposes. Since allionalis appears to have habits similar to the European stratiotata studies must now be undertaken to determine in what ways the two species differ and whether stratiotata can be expected to perform better in the United States than allionalis.

The research in Pakistan on Hydrilla verticellata has been in progress only a little more than a year; however, several promising insects have already been found. Among these are two weevils of the genus Bagous. One species feeds on the emersed stems in both the larval and adult stage. Only adults of the second species were found and they appeared to feed exclusively on emergent stems. A leaf and stem mining fly and larvae of a moth were also found feeding on submerged stems and leaves. Further studies are in progress on host plant specificity of these insects.

Thus, while not spectacular, it would appear that some considerable progress can be claimed in both research on biological control of aquatic weeds, and on operational control of alligatorweed. The fact that some progress has been made does not mean that we have solutions at hand for all weed problems nor that the total problem has been alleviated in a marked degree. Rather, the significant progress is in the evidence that the aquatic ecosystem containing alligatorweed has been modified in the direction of increased diversity and improved balance between the producer and the consumer organisms. This has been accomplished with a minimal input of effort because the energy stores of alligatorweed itself were utilized to produce the flea beetle populations responsible for the change. The fact that this gain has to some extent been offset by an increased waterhyacinth problem should not be regarded as a set back. Rather it is a challenge to proceed with the introduction of insects that will in a similar way utilize the energy stores of waterhyacinth. In a very real sense the research on biological control of aquatic weeds is a problem in environmental engineering at the ecosystem level. While we cannot expect quick results, we can, with some confidence, look forward to the day when both alligatorweed and waterhyacinth will be normal, even desirable elements of the aquatic plant community.

In closing, it should be noted that the progress I have reported is the result of the cooperative efforts of many people associated with many agencies. Within Agricultural Research Service, five Divisions (Entomology, Plant Science, International Programs, Personnel and the Technical Services Staff of the Finance Division) are involved either in conduct of the research or in a supporting role. Personnel of Foreign Agricultural Service and of the American Embassy at Buenos Aires provide support services for ARS personnel in Argentina. Most of the funds have been provided by the Army Corp of Engineers, and ARS International Programs Division. The Florida State Department of Natural Resources is making funds available to support much of the domestic phase of work on waterhyacinth, and finally the Commonwealth Institute's West Indian Station in Trinidad and Indian Station in India is making a valuable contribution to the total effort.

However, the number of agencies that in one way or other contribute to this effort should not leave the impression of a large well funded program. Actually, no more than 5 scientists will be working full time on biological control of aquatic weeds during the coming year. Their work will be supplemented by the part time efforts of perhaps as many as 4 other entomologists. Despite the fact that these scientists are scattered among 3 domestic and 5 foreign locations their work is closely coordinated. Each is engaged in research that contributes in a sequential manner to the common objective. At present, the principle target weed is waterhyacinth and if I were to place a bet, it would be on the insects to win.

References

U.S. Army Corps of Engineers, 1965. Expanded project for aquatic plant contol. 89th Congress, <u>1st</u> Session, House Document No. 251, 145 p.

SEED GERMINATION IN ARROWARUM (PELTANDRA VIRGINICA (L.) KUNTH)

D. N. Riemer and W. W. MacMillan[1]

Abstract. Seed germination studies with arrowarum (Peltandra virginica) showed that no after-ripening is necessary in this species. Germination occurs rapidly following removal of the leathery pericarp from the fruit. Freezing for one week kills the seed.

INTRODUCTION

Arrowarum (Peltandra virginica (L.) Kunth) is common in the shallow waters of lakes, ponds, and slow moving bodies of water along much of the east coast. It belongs to the family Araceae and bears numerous berry-like fruits on a narrow green spathe. The fruits are green, mottled brown, or black and each contains one, or occasionally two, seeds embedded in a gelatinous mass within a leathery pericarp. This study was conducted to investigate some of the factors affecting the germination of arrowarum seeds.

REVIEW OF LITERATURE

Most work on seed germination has been concerned with terrestrial plants but certain principles derived from these studies can also be applied to aquatic plants. Considerable importance has been given to the existence of a hard seed coat or ovary wall (Crocker, 1906). It is felt that the seed coat can prevent or delay germination by excluding oxygen or water from the seed or by mechanically restraining the embryo. Evanari (1949) feels that chemical germination inhibitors in plants are a widespread phenomenon and can be found in all parts of plants including fruit pulp, fruit coats, endosperm and seed coats.

Two workers have reported research concerned specifically with the germination of arrowarum seeds. Muenscher (1936) contested the view stated by Arber (1920) and others, that the seeds of aquatic plants, in general, require a long dormant period before germination and that drying favors germination. He showed that drying kills arrowarum seeds but observed that seeds stored for 5 to 7 months in cold tap water germinated well when exposed to favorable conditions. Edwards (1933) reported that seeds of this species germinated well after several months storage at room temperature. He also proved that seeds would germinate in an atmosphere devoid of oxygen and were able to elongate their plumules two to three times their original length under these conditions.

[1]Assoc. Prof. and former student, Department of Soils and Crops, Rutgers Univ., New Brunswick, N. J. 08903.

EXPERIMENT I

Methods and Materials - In this experiment fruits were subjected to five storage conditions following harvest:

A. no storage - placed in water in petri dishes at room temperature with 16 hour photoperiod.

B. refrigerated in water at approximately 3°C for one week.

C. frozen in water for one week.

D. frozen in water for four months.

E. refrigerated in water at approximately 3°C for four months.

Within each treatment, fruits were separated into equal numbers by color, (black, brown, and green), to determine if pericarp color indicated a particular stage of maturity or influenced germination in any way.

At the end of the storage period, fruits were placed in petri dishes, (30 per dish), and placed on a laboratory bench under the conditions described in A, above. Observations were made at 3 to 7 day intervals for the next 328 days and on each observation date, germinated seeds were counted and removed. Water was added to the dishes to replace evaporation loss but no attempt was made to control the growth of bacteria, algae, or fungus in the dishes.

Results - No differences in germination due to pericarp color were observed and all data below refer to averages of the three color groups. Throughout the course of the experiment, there appeared to be little difference in the per cent germination between the untreated fruits (A) and those refrigerated for one week (B), as shown graphically in Figure I. The fruits refrigerated for four months (E) were delayed approximately 30 days in germination but once they began, the rate of germination was similar to those refrigerated for one week and those receiving no treatment. By the end of the experiment, seeds refrigerated for four months reached 71% germination as compared to 80% for those refrigerated one week and 85% for those exposed to "favorable" germination conditions immediately.

Seeds frozen for one week and for four months appeared to have been killed. They decomposed rapidly when thawed and not a single germina-

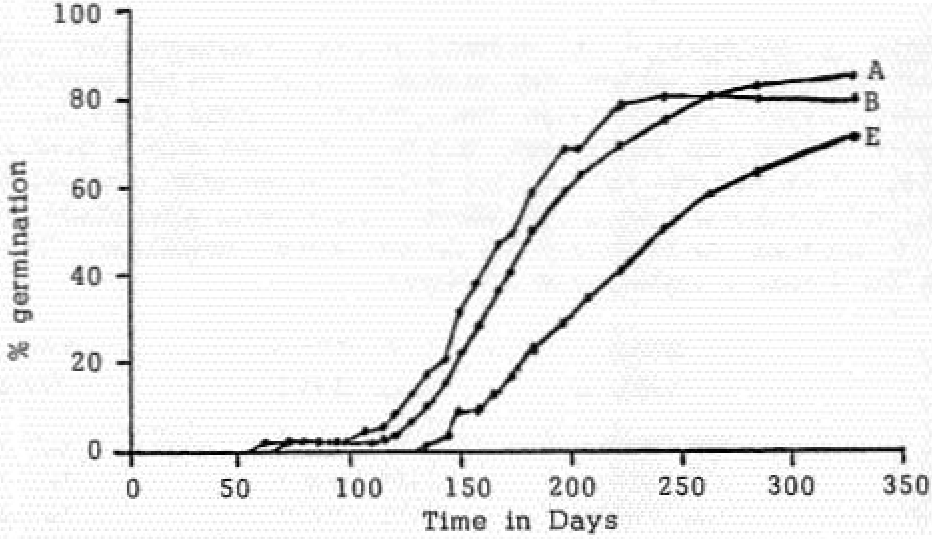


Fig. 1. Effects of cold treatment on germination in arrowarum. There was no germination of frozen seeds.

A = no treatment

B = refrigerated 1 week

E = refrigerated 4 months

tion was recorded from either of these groups.

EXPERIMENT II

Methods and Materials - The purpose of this experiment was to determine the effects of water volume and pericarp treatment on the germination of arrowarum seed. Twenty seeds were placed in either 75 ml, 3 l, or 36 l of water. Some had the pericarp punctured 8 times with a dissecting needle, others had the pericarp and gelatinous material removed from the seed, and some fruits were left intact. There were nine treatments with five replications per treatment and 20 seeds per replication. The following table illustrates the treatments involved:

	Intact fruit	Punctured pericarp	Pericarp removed
36 l	100 seeds	100 seeds	100 seeds
3 l	100 seeds	100 seeds	100 seeds
75 ml	100 seeds	100 seeds	100 seeds

The different water volumes were used to determine if any existing germination inhibitors could be diluted sufficiently to permit germination.

Seeds were observed periodically for the next 61 days with germinated seeds recorded and removed as in experiment I.

Results - An analysis of variance for each observation date and an overall analysis of variance for the 14 observation dates combined, showed that the volume of water in which the seeds were placed had no significant effect at any time. This variable will, therefore, not be discussed further and the results discussed below will refer to the effects of the three pericarp treatments averaged across all water volumes.

Figure II is a graphic representation of the accumulative percent germination of seeds receiving the three pericarp treatments at each of the 14 observation dates. Seeds with pericarps removed reached 55 to 65% germination after six days, attained 90% germination in 14 days, and 98% germination by the end of the experiment (61 days). Seeds from punctured berries were much slower to begin germination and reached only 18% by the end of the experiment. Seeds from intact berries attained an accumulative germination of only 5% by the end of the experiment.

Analyses of variance run for each observation date individually showed that pericarp treatment was significant at the 1% level for all 14 observations. An overall analysis of variance using all 14 dates and considering time as a variable, also showed pericarp treatment to be

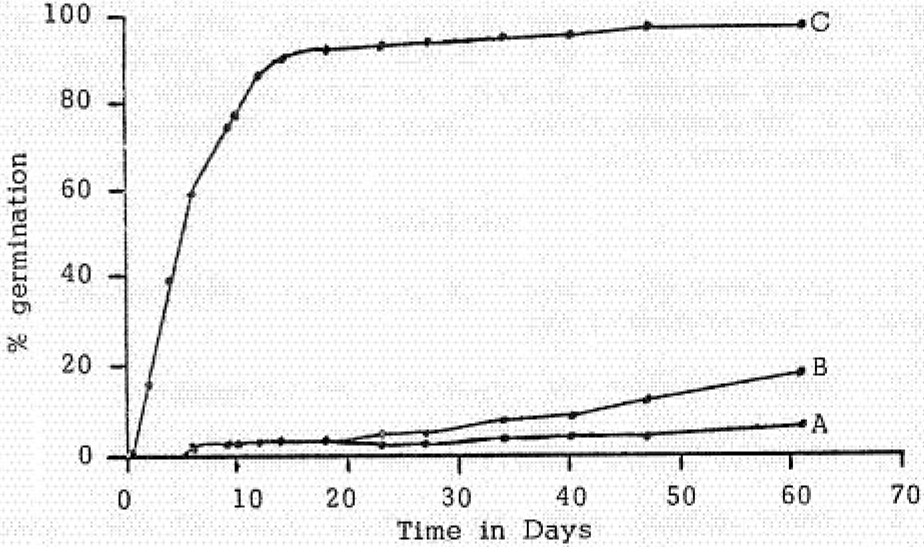


Fig. 2. Effects of pericarp treatment on germination in arrowarum.

A = intact pericarp

B = punctured pericarp

C = pericarp removed

significant at the 1% level.

Duncan's new multiple range test, run for all 14 dates, showed a significant difference between pericarp removal and the other two treatments at each observation date. It also showed a significant difference in accumulative germination between punctured pericarps and intact pericarps at observations 10-14. There was no difference between them at observations 1-9.

SUMMARY

1. The seeds of arrowarum do not require after-ripening or cold-treatment to induce germination.

2. Fruit color does not influence seed germination.

3. Freezing for one week kills the seeds.

4. Water volume, within broad limits, does not affect germination.

5. The presence of an intact pericarp inhibits germination markedly for at least a two-month period.

Literature Cited

1. Arber, A. 1920. Water plants. Cambridge Univ. Press, London.
2. Crocker, W. 1906. Role of seed coats in dalayed germination. Bot. Gaz. 42:265-291.
3. Edwards, T.I. 1933. The germination and growth of *Peltandra virginica* in the absence of oxygen. Torrey Bot. Club Bull. 60:573-581.
4. Evanari, M. 1949. Germination inhibitors. Bot. Rev. 15:153-194.
5. Muenscher, W. C. 1936. Storage and germination of seeds of aquatic plants. Bull. 652. Cornell Univ. Agric. Expt. Sta., Ithaca, N. Y.

"AQUATIC VEGETATION CONTROL IN PENNSYLVANIA STATE PARK LAKES - A PROGRESS REPORT"

William J. Harmon[1/]

INTRODUCTION

The Pennsylvania State Park Lake System comprises 46 lakes, ranging in size from 7 to 16,420 acres. These lakes, totalling 34,709 acres, are located in the 44 State Parks and spread throughout 38 of the Commonwealth's 67 counties.

At the present time two new parks are under construction, one park is under design, and four parks are in the land acquisition stage. These seven new parks, all located in eastern Pennsylvania, will add an additional 5,104 acres to our State Park Lake System.

The nearly 40,000 acres of recreational waters are made up entirely of artificial impoundments and are relatively shallow (average maximum depth less than 30 feet).

Ownership of these lakes is divided between the U.S. Army Corps of Engineers (6,417 acres), the Pennsylvania Fish Commission (255 acres), and the Pennsylvania Department of Environmental Resources (33,141 acres). In all these lakes, the Pennsylvania Fish Commission is responsible for stocking and fishery management and the Pennsylvania Department of Environmental Resources is responsible for multiple use management. Water uses, in addition to recreational and aesthetic uses, include domestic, industrial and agricultural water supplies, and irrigation.

BACKGROUND

The earliest recorded aquatic weed problem in our State Park lakes was reported in Conewago Lake in Gifford Pinchot State Park during 1961. This resulted in several futile attempts for weed control using a drawdown during late fall and early winter months of 1961, 1963, 1965, 1966, 1967 and 1968. Copper Sulfate was applied during the summer of 1964 and again in 1966. A mechanical underwater weed cutter was utilized during July, 1965, with 634 manhours expended on this operation during a two-week period.

The first endeavor at chemical weed control was planned for 1967. A contract was awarded to a private applicator but was subsequently cancelled due to adverse weather conditions during late May and early June. Finally in the spring of 1968, two State Park lakes were treated by private applicators.

1/ Chief, Environmental Section, Bureau of State Parks, Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.

PROGRAM DEVELOPMENT

In the spring of 1969 a study was funded by our Department for an "Evaluation of Aquatic Nuisance Control Projects at Selected Bureau of State Parks Recreation Lakes" **(Appendix A).** This study was completed by the U.S. Geological Survey and the report is currently in Washington for final review. 2/

During 1969 a total of 598 acres in nine lakes were treated by contract applicators at a cost of $37,197.83 (Table 1). The following year, 1970, a contractor treated 485 acres in eight lakes at a cost of $19,660.80 (Table 1).

As an integral part of our lake management program we decided to initiate a treatment program utilizing Department personnel and equipment. The main factors in this decision were (1) reduced costs; (2) greater flexibility in timing of treatment and selection of herbicides; and (3) application techniques.

Initial purchase of equipment included:

1. 17' Boston Whaler with 25 H.P. Evinrude Motor
2. K.W.H. Duster - Granular Applicator
3. 12 volt Cyclone Seeder
4. 150 g.p.m. Portable Pump
5. Hoses, tubing and fittings
6. Safety equipment
7. Testing equipment

Our first treatments were made during the summer of 1970 (Table 2). Subsequently, our entire weed control program for 1971 was completed using our own equipment and personnel (Table 2).

Additional purchases of equipment included:

1. 17' Boston Whaler with 25 H.P. Evinrude Motor
2. two airboat engines, props, mounts and accessories
3. Thuron Spray Unit
4. Tee Nee boat trailer
5. Testing and safety equipment

Concurrent with the chemical treatments we have initiated winter drawdowns for several lakes. In two lakes we have programmed a series of bottom discharges during the summer season.

DISCUSSION

Results to date have exceeded our expectations. The management tools with which we have to work are limited - and each one in itself is not the solution. We have only begun to treat the effect. Our real goal is to define and attack the causal agents and develop a management program for the entire watershed.

2/ An Evaluation of The Use of Herbicides to Control Aquatic Weeds in Six Pennsylvania Lakes. (44 pages) by James L. Barker

APPENDIX A

EVALUATION OF AQUATIC NUISANCE CONTROL PROJECTS AT SELECTED BUREAU OF STATE PARKS RECREATION LAKES

This proposed study is designed to document the ecological succession of an impoundment following the application of herbicides to control nuisance growths of algae and/or aquatic plants. To our knowledge, aquatic plant succession has not been recorded for Pennsylvania waters. Documentation is believed important since it is possible that in eradicating one particular nuisance growth another nuisance may develop that is more problematic than that originally treated.for.

In disrupting the plant community by the application of an herbicide, there are associated physical and chemical alterations of the environment that result in a temporary imbalance of nutrients and plant life. This imbalance quite often results in populations of algae that generally increase the turbidity of the water. There are recorded instances where the resultant algae reached nuisance proportions and caused more damage to the recreation and aesthetic values of the impoundment than previously existed with the rooted vegetation. Destruction of fish habitat is yet another reason to exercise knowledgeable judgment in disturbing the delicate balance of nature which exists in an aquatic ecological system.

Location of Study Lakes:

	Lake	Location	Acres
1.	Gifford Pinchot	York County	340
2.	Gouldsboro	Monroe & Wayne Counties	255
3.	Tobyhanna	Monroe & Wayne Counties	170
4.	Promised Land - lower	Pike County	173
5.	Promised Land - upper	Pike County	420
6.	Lake Jean (Ricketts Glen)	Luzerne County	254
7.	Black Moshannon	Centre County	250

Objectives - to determine:

1. Species composition and distribution of major rooted aquatic plants and phytoplankton before and after treatment of lake.
2. Physical and chemical parameters, including nutrient levels, of lake before and after treatment.
3. Evaluate effectiveness of treatment in controlling problem growth.
4. Plant succession or invasion into treated areas.

Schedule of sampling:

1. Prior to active growing season to achieve objective 2.
2. Immediately prior to treatment to achieve objective 1.
3. Lake will be visited on or about the day following treatment and on or about the 7th, 14th, 28th, and 90th day following treatment to achieve objectives 2, 3 and 4.

TABLE 1

LAKES TREATED BY CONTRACT APPLICATORS

Year	No. Lakes	Acres Treated	Herbicides	Total Cost
1968	2	150	Diquat Potassium Endothal	8,900.00
1969	9	598	Diquat Aquathol Plus Kuron Potassium Endothal 2, 4-D	37,197.83
1970	8	485	Diquat Potassium Endothal Hydrothol 47 Aqua-Vex Aquathol Plus 2, 4-D	19,660.80
Total	19	1,233		$65,758.63

Average Cost Per Acre for three (3) year period: $53.33

TABLE 2

LAKES TREATED BY DEPARTMENT PERSONNEL

Year	No. Lakes	Acres Treated	Herbicide
1970	5	195	Copper Sulfate Hydrothol 47 Diquat Potassium Endothal
1971	14	795	Diquat Aquathol Plus Aqua-Vex Aquathol K 2, 4-D

REMOVAL OF RHIZOCLONIUM FROM A POND AND ITS RELATIONSHIP TO DISSOLVED NUTRIENTS

A. Fekete, D. Riemer, and H. Motto[1]

Abstract. Rhizoclonium was raked from a small pond 4 times in one growing season and its dry weight and N and P contents determined. The dry weight yield was 4115 lb/A. The range of N was 3.64 to 3.87%. The range of P was 0.14 to 0.17%. The total amount of N and P removed from the pond in algae tissue was far greater than that found dissolved in the pond at any one time.

INTRODUCTION

During the course of preparing a small pond for another experiment, it became necessary to remove large amounts of Rhizoclonium from that pond by hand. Certain data regarding the Rhizoclonium and water chemistry were gathered at that time and these data have made it possible to draw some conclusions concerning the growth of this filamentous alga and the effects of its removal on dissolved N and P. These conclusions are pertinent to the problem of mechanical removal of aquatic vegetation and its resultant effects.

The pond is a man made, earth bottomed body of water having a surface area of .07 acres and a volume of .175 acre ft. It is seven years old and the water source is primarily ground water with some run-off from a watershed of less than .02 acres which is grassed and unfertilized.

Algae was removed by hand-raking 4 times during the growing season. No data were collected from the first raking because this study was only incidental to the main research objective. At the time of all subsequent rakings, algae was piled on the shore and permitted to drain for several days after which total green weight was recorded. At the same time sub-samples were taken for moisture, nitrogen, and phosphorus determinations. From this data dry weight yields were calculated.

Water samples were collected periodically during the growing season. Nitrate and ammonia nitrogen and ortho-phosphate phosphorus were determined by standard methods in filtered aliquots of the samples.

---

[1] Research Intern and Associate Research Professors, Department of Soils and Crops, Rutgers University, New Brunswick, N. J. 08903.

RESULTS

The dry-weight yields of Rhizoclonium are presented in Table 1. From visual observation of the first raking, including per cent cover of the pond and the bulk of material removed, it was estimated that the first raking was similar in yield to the second raking and thus identical values have been used for each.

Table 1. Dry Weight of Algae Removed

Date	lb	lb/A	lb/Acre Ft.
16 June	110*	1571*	628*
16 July	110	1571	628
28 July	42	600	240
16 Aug.	26	373	148
Total	288	4115	1644

*estimated

The results of the nitrogen and phosphorus analyses of the algae are presented in Table 2.

Table 2. N and P Contents of Rhizoclonium.

			Total lbs. removed	
Date	%N	%P	N	P
16 June	3.87*	.17 *	4.26*	.187*
16 July	3.87	.17	4.26	.187
28 July	3.83	.17	1.61	.071
16 Aug.	3.64	.14	.95	.036
			11.08	.481

*estimated

The results of the nitrate, ammonia, and phosphorus analyses on the water samples are presented in table 3

Table 3. Dissolved N and P in the Pond Water (ppm)

Date	NO_3-N	NH_3-N	PO_4-P
23 May	1.7	0.86	.02
7 June	1.5	2.6	.02
1st harvest 16 June			
23 June	0.81	0.80	.02
13 July	0.08	0.86	.02
2nd harvest 16 July			
27 July	0.02	0.75	.04
3rd harvest 28 July			
3 Aug.	0.03	0.73	.01
10 Aug.	0.03	0.44	.02
4th harvest 16 Aug.			
17 Aug.	0.04	0.34	.00
24 Aug.	0.04	1.00	.03
31 Aug.	0.01	1.14	.01
7 Sept.	0.01	.31	.00

DISCUSSION

Several pertinent facts are evident from the above tables. It can be seen from Table 1 that rather large dry-weight yields of filamentous algae can be obtained from ponds of this nature. The estimated yield of approximately 4000 pounds per acre is low, however, compared to yields of approximately 12,000 pounds dry matter per acre for fertilized corn. The amount of nitrogen removed, however is greater than that in the above-ground portion of a 100 bu/A corn crop. It is conceivable that higher algae yields might have been obtained if rakings had been more frequent, encouraging faster regrowth.

The amount of nitrogen and phosphorus removed from the pond in the tissue of the algae is also of interest. Altogether 11 pounds of nitrogen were removed. This 11 pounds represents slightly more than 23 ppm N in the volume of water contained in the pond. At no time did the soluble nitrogen concentration in the pond water even approach this value. The highest level ever recorded was on the second sampling date when total NO_3-N plus NH_3-N was 4.1 ppm. This indicates a continual addition of nitrogen to the water from bottom sediments, ammonia in rainwater or nitrogen fixation.

In the case of phosphorus, a total of .48 pounds were removed in the tissue of the algae. This represents slightly over 1 ppm P in the total water volume of the pond, which is much higher than the levels actually recorded in the water at any given time. The highest level recorded was 0.04 ppm on July 27. As with nitrogen, this indicates a continual addition of soluble P to the water, probably from bottom sediments.

Regrowth of Rhizoclonium continued throughout the season but the rate of regrowth became slower after each raking. The regrowth after the fourth raking resulted in less than a 10% cover of the pond. This reduced regrowth may have been due to the distinct downward trend of dissolved nitrogen in the water as the season progressed and algae was removed.

CONCLUSIONS

The primary conclusions to be drawn from this data are:

1. Large amounts of N and P can be removed from a pond by harvesting filamentous algae.
2. The effect on dissolved N and P levels in the water may be slight in relation to the amount removed due to a continuous resupply.
3. Continual removal of the algae may alter the condition of the pond so that only a limited amount of regrowth will occur.

THE EFFECT OF THREE EXPERIMENTAL HERBICIDES ON CONTROL OF CRABGRASS AND TURFGRASS SPECIES BALANCE

R. E. Engel and C. W. Bussey[1/]

Abstract

Three developmental chemicals, 2-tertiobutyl-4-(2,4-dichloro-5-isopropyloxphenyl)-5-oxo-1,3,4-oxadiazoline (RP 17623), N-sec-butyl-4-tertiary butyl-2,6-dinitroaniline (A-820), and 2-methylthio-4-isopropylamino-6-tert.butylamino-s-triazine (GS 13638), were applied for crabgrass (Digitaria ischaemum (Schreb.) and D. sanguinalis L.) control to a Kentucky bluegrass (Poa pratensis L.) lawn turf on April 30, 1971. Standard herbicide treatments of O,O-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) benzenesulfonamide (bensulide), dimethyl tetrachloroterephthalate (DCPA), and 1-(2-methylcyclohexyl)-3-phenylurea (siduron) were used for comparison. All herbicide treatments attained one or more ratings of 90% crabgrass control or higher except the GS 13638, which was applied at 6 and 9 lb/A from a wp formulation. Turfgrass population counts of Kentucky bluegrass and red fescue (Festuca rubra L.) in early October did not show any statistically significant differences (0.05) for chemical treatments. No turfgrass injury was observed from use of the several herbicides.

Introduction

Preemergence crabgrass control in turf has become an increasingly successful endeavor because of the new chemicals developed in the past 15 years. From this era, N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine (benefin), bensulide, DCPA, and siduron currently persist in applied use. The success of these chemicals over those used previously came from better crabgrass control with more safety to the turf. Additional improvements in efficiency and safety are continued goals in developing chemicals.

Previously, RP 17623 (1, 2, 3, 4) has demonstrated good crabgrass control and offers safety features. In 1971 A-820 and GS 13638 were introduced into developmental studies at several Experiment Stations. The purpose of this paper is to report crabgrass control and turfgrass species reaction to these chemicals for preemergence crabgrass control on lawn turf at the New Jersey Agricultural Experiment Station at New Brunswick, New Jersey.

1/ Research Professor of Turfgrass Management and Research Technician, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

Materials and Methods

The chemicals used for standards were bensulide, DCPA, and siduron. RP 17623, A-820, and GS 13638 were used as experimental chemicals.

The lawngrass test site was well-drained. The 8-year-old turf was predominantly Kentucky bluegrass with approximately 25% red fescue. In previous years the site had crabgrass, and it was overseeded with crabgrass in early April. The test had 3 replications and was of randomized block design. The test plots were 3 ft by 20 ft with check borders surrounding each plot.

The granular treatments were made with a 3 ft drop spreader and a CO_2 pack sprayer was used with water as a carrier at 40 gpa for spray applications. All applications were made on April 30, except for additional treatments of DCPA and RP 17623 on May 24.

Crabgrass germinated in late May and early June, but very dry weather in late June and early July delayed its development. On and off irrigation was used for a 2-day period in mid-July. Excessive rainfall occurred for the remainder of the summer. However, crabgrass did not develop a strong dominance over the turfgrasses because of the abundantly cloudy weather.

Crabgrass control was estimated by two persons in late August and averaged for individual plot readings. Later evaluation was not possible because of inadequate development of the crabgrass with the weather conditions. The percent Kentucky bluegrass and red fescue in treated and untreated plots were determined in early October by using the point quadrat for 100 identifications per plot.

Results and Discussion

Crabgrass control was apparent on some plots in late July. All three standard herbicides showed good control for their best treatments. The RP 17623 herbicide at rates of 2, 3, and 4 lb/A in granular formulation gave 88, 92, and 95% crabgrass control, which was equivalent to the best treatments with standard materials (Table 1). Application of 2 lb/A in granular preparation, on May 24, appeared less effective than the same rate of treatment applied 25 days earlier. The A-820 herbicide applied at 3, 6, and 9 lb/A in granular formulation gave 77, 93, and 91% crabgrass control. The ec preparation applied at 6 lb/A gave 16% less than its equivalent as a granular preparation. The GS 13638 preparation at rates of 6 and 9 lb/A gave 48 and 77% crabgrass control. No turf injury was observed with any of the chemicals as used. This is of special interest for GS 13638, the triazine compound. In contrast, triazines such as atrazine or simazine are very destructive to cool-season turfgrasses.

Kentucky bluegrass-red fescue population counts were taken in early October (Table 2). Four herbicide-treated plots ranked below the check in red fescue content, but the F values were not significant at .05.

Table 1. Crabgrass control in Kentucky bluegrass lawn turf from pre-emergence crabgrass herbicides. 1971. New Brunswick, New Jersey.

Chemical		Rate, lb a.i./A*	Crabgrass control (%)
DCPA	gr	12	80
	gr	12 (May)	94
	wp	12	92
siduron	gr	12	85
	wp	12	76
	gr	18	92
bensulide	gr	10	91
RP 17623	gr	2	88
	gr	2 (May)	73
	wp	2	88
	gr	3	92
	gr	4	95
A-820	gr	3	77
	gr	6	93
	gr	9	91
	ec	6	78
GS 13638	wp	6	48
		9	77

*All applications were made on April 30, 1971 except additional applications of DCPA and RP 17623 on May 23.

Table 2. Kentucky bluegrass and red fescue content of turfgrass in early October in plots treated with preemergence herbicides in April 1971.

Chemical	Rate, lb a.i./A	Kentucky bluegrass (%)*	Red fescue (%)*
check	-	59	26
DCPA	12	77	20
siduron	18	86	14
bensulide	10	60	40
RP 17623	4	63	37
A-820	9	76	23
GS 13638	6	70	18

*F values not significant at 0.05.

Literature Cited

1. Duich, J. M. and D. V. Waddington. 1971. Evaluation of experimental and commercial preemergence crabgrass chemicals for turf. Proc. NEWSS 25:97-99.

2. Engel, R. E. and R. D. Ilnicki. 1970. Preemergence crabgrass control in Merion Kentucky bluegrass turf with RP 17623 and other herbicides. NEWCC Proc. 24-375-378.

3. Engel, R. E. and K. J. McVeigh. 1971. Crabgrass and goosegrass control with several preemergence herbicides. Proc. NEWSS 25: 103-108.

4. Jagschitz, J. A. 1970. Pre and postemergence chemical crabgrass control studies in turfgrass 1968-1969. Proc. NEWCC 24:379-386.

EVALUATION OF PREEMERGENT CHEMICALS FOR CRABGRASS CONTROL IN 1971

T. L. Watschke, J. M. Duich, and D. V. Waddington[1]

ABSTRACT. Creeping red fescue was more susceptible to injury than Kentucky bluegrass when treated with one commercial and six experimental preemergence crabgrass control chemicals. 70-314B was the outstanding experimental chemical based on crabgrass control and turfgrass tolerance. All other chemicals varied in degree of control or injury to turfgrasses.

INTRODUCTION

Level of control and turfgrass response are the major criteria in evaluation of preemergence crabgrass chemicals. Past evidence has shown that control level often exceeds turfgrass tolerance, consequently, development and release of safer herbicides is essential if they are to be useful managerial tools. The objectives of this study were to evaluate the acceptibility of six experimentals and one commercial chemical for preemergence control on two turfgrass species.

MATERIALS AND METHODS

This research project was conducted at the Joseph Valentine Turfgrass Research Center, Pennsylvania State University. The soil type was Hagerstown silt loam and the two adjacent turf areas consisted of 8-year-old stands of a 'Delta' and 'Newport' Kentucky bluegrass (*Poa pratensis* L.) mixture, and 'Pennlawn' creeping red fescue (*Festuca rubra* L.). Turf was maintained at a 1.25-inch height of cut, and received supplemental irrigation to avoid any prolonged drying. Crabgrass species consisted of *Digitaria ischaemum* and *D. sanguinalis*. Mixed seed lots were seeded in previous years with subsequent natural reseeding providing this past year's stand.

Plots were 3 x 25 ft with two replications on each turf species. The commercial and five experimental chemicals were applied on May 5, 1971. On May 19, 1971, the experiment was expanded by applying another experimental chemical and two chemicals previously applied. Sprays were applied with a two-nozzle boom at 35 psi and 45 gpa, and dry formulations with a 3-foot drop spreader. Immediately following application, approximately 1-inch of water was applied by traveling sprinklers.

[1]Assistant Professor, Professor and Associate Professor, respectively, Department of Agronomy, Pennsylvania State University, University Park, Pa.

The commercial chemical applied was DCPA. Experimentals were 2-tertiobutyl-4-(2,4-dichloro-5-isopyloxphenyl)-5-oxo-1,3,4-oxadiazoline (RP-17623); NC-5651 (unrevealed); 13390 (unrevealed); S-14786 (unrevealed); N-secondary-butyl-4 tertiary-butyl-2,6-dinitroaniline (70-314B); 2-methylthio-4-isopropylamino-6 tert. butylamino-s-triazine (GS-13638).

Initial germination was observed May 20-22, and addition emergence was noted June 16-18, June 25-July12, and July 25-29. The major germination period was June 18-29. Temperature was believed to be the main factor controlling germination in this work since moisture was never limiting. Above normal temperatures in late May and throughout June triggered the majority of crabgrass germination observed. Each treatment plot had an adjacent 3 x 25 ft control plot for comparative purposes. Crabgrass control, turf discoloration, and thinning were estimated by two or three individuals throughout the season. Chemical treatment rates, crabgrass control, and turfgrass response are shown in table 1.

RESULTS

The DCPA applications used as standards resulted in control and turf response similar to those reported over past years. Some thinning was observed, but limited to red fescue. Slightly better control was obtained from the wettable powder than the granular formulation, however, control was near complete from both.

The RP-17623 formulation was inconsistent, having limited control, 30-50%, on both bluegrass and fescue at the 1 and 2 lb rate. Even at the 4 lb rate, control varied from 65% on fescue to 85% on bluegrass. Red fescue appears to be quite sensitive to RP-17623. Discoloration and thinning occurred at the low rates and at the 4 lb rate the fescue stand was thinned by as much as 20%. Temporary discoloration also occurred on the bluegrass at the 4 lb rate.

GS-13638 granular resulted in only 10% control on bluegrass and 20% on fescue at the high rate. At the two lower rates minimal control was observed. No discoloration or thinning of either turfgrass was noted. Higher rates should be tested in view of the apparent turf tolerance.

5651 gave excellent control at the 12 lb rate without causing injury to bluegrass or fescue. The lower rate was less effective with only moderate control, 55% on bluegrass to 80% on fescue, and no injury occurred.

13930 wettable powder was non-injurious to either turf, but the highest rate tested 4 lb, was limited to 20% control on bluegrass and 10% on fescue. The three lower rates resulted in insignificant control. Higher rates should possibly be tested to determine control at the limits of turf tolerance.

70-314B granular resulted in excellent control (99%) at the 8 lb rate on both bluegrass and fescue without discoloring or thinning either species. Near complete control (98%) was also obtained at the 4 and 6 lb rates. Even at the 2 lb rate 70% control was observed on bluegrass and 90% on fescue. This experimental was superior to all others tested.

S-14786 formulation was applied on May 14. Control was excellent and near complete (99%) at the 12 lb rate. However, a slight chlorosis of the turf occurred on both bluegrass and fescue proportional to rate. At the 4 lb. rate only very slight chlorosis occurred, however, control was limited to 40-55%. The control at 8 lb was intermediate (75%) between the low and high rate for bluegrass, however it was nearly complete (99%) on fescue.

DCPA granular applied on May 14 resulted in almost complete control (99%), however 20% thinning of fescue occurred. Bluegrass was relatively unaffected.

RP-17623 applied on May 14, controlled crabgrass approximately the same as on May 5. Control was limited to 80-85% at the high rate (4 lb), where 20% thinning of fescue occurred. Lower rates were less effective, particularly on bluegrass.

As often occurs, creeping red fescue was found to be more sensitive to chemical discoloration and thinning than Kentucky bluegrass. Injury from spray treatments was evident within 10 days of application, however, granular material injury was not always apparent within a month. No crabgrass species X chemical interactions were observed. Control from materials applied on both May 5 and 14 did not reveal any differences resulting from date of application.

CONCLUSIONS

Creeping red fescue was found to be more susceptible to injury than Kentucky bluegrass when treated with one commercial and six experimental preemergence crabgrass chemicals.

Near complete control of crabgrass was found for DCPA, however, 20% thinning of fescue resulted when the granular formulation was used. Only 10% thinning was noted for the spray formulation while control was near perfect.

70-314B was the outstanding experimental with near complete control and no turf injury at 8 lb. The 4 and 6 lb rates resulted in excellent control (98%), also without injury to turf. S-14786 ranked second best providing excellent control (99%) at the 12 lb rate, however, a chlorosis on both bluegrass and fescue resulted. 5651 at the high rate (12 lb) provided 98% control on both turf species without causing injury to turf. GS-13638, 17623, and 13930 experimentals rated appreciably lower due to poor crabgrass control and/or turfgrass injury.

Table 1. Effect of chemicals on preemergence crabgrass control, and discoloration and injury to Kentucky bluegrass and creeping red fescue turf. Applied May 5 and 14, 1971. University Park, Pa.

Treatment	lb. a.i./A	% Crabgrass control-August KBG	CRF	% Thinning KBG	CRF
May 5, 1971					
70-314B 2.3% g	2	70	90	0	0
	4	98	98	0	0
	6	98	99	0	0
	8	99+	99+	0	0
17623 g 2% g	1	30	40	0	<5
	2	40	50	0	5
	4	85	65	0	20
5651 20% w	8	55	80	0	0
	12	98	98	0	0
GS13638 2.5% g	2	5	15	0	0
	4	5	5	0	0
	6	10	20	0	0
13930 50% w	0.5	10	10	0	0
	1	10	10	0	0
	2	15	10	0	0
	4	20	10	0	0
DCPA 75 w	10	99+	99+	0	10
DCPA 6.14 g	10	98	92	0	20
May 19, 1971 Application					
S-14786 50% w	4	55	40	0*	0*
	8	75	99	0*	0*
	12	99	99	0*	0*
17623 2% g	1	25	40	0	5
	2	65	90	0	5
	4	85	80	0	20
DCPA 6.14 g	10	99+	99	0	20

*Chlorosis noted increasing with rate and bluegrass more susceptible than fescue.

PREEMERGENCE CRABGRASS AND GOOSEGRASS CONTROL IN TURFGRASS WITH HERBICIDES [1]

John A. Jagschitz [2]

Abstract. Experiments were conducted in lawn-type turfgrass to evaluate herbicides for preemergent control of crabgrass and goosegrass and to determine if half rates in the second year would give satisfactory control of crabgrass. Effective crabgrass control was obtained from bandane, benefin, bensulide, DCPA, nitralin, siduron, terbutol, tri-Ca-arsenate and from four newer materials - A-820, NC-5651, RP-17623, and S-14786. Results with DS-5328, IMC-3950 and 0-13930 were discouraging while GS-13638 deserves further study. Half rates of bandane, bensulide, DCPA, RP-17623 and terbutol in the second year provided excellent crabgrass control. Only fair control was provided by benefin, nitralin, siduron and NC-5651. Of the ten herbicides tested for goosegrass, good to excellent control was produced by nitralin, RP-17623, terbutol and tri-Ca-arsenate.

Introduction

Crabgrass (Digitaria ischaemum (Schreb.) Muhl.) in turfgrass areas is selectively controlled by preemergent herbicides (1,2,4). Although there are several materials available, new and experimental herbicides are released each year. One of the three studies reported in this paper evaluated some newer materials in an attempt to find chemicals that are more effective and less phytotoxic. A second study, to confirm earlier reports (3), investigated the effect of using half the amount of chemical to control crabgrass the second year. If successful, chemical residues in turfgrass areas could be reduced. In the third study various herbicides were evaluated for preemergent control of goosegrass (Eleusine indica (L.) Gaertn.) in turfgrass. In recent years this weed has become more prevalent and troublesome in R. I. It has been difficult to control and results with some standard herbicides have been disappointing (2).

Materials and Methods

The two crabgrass studies were initiated at the R. I. Agricultural Experiment Station in 1971. The turf was established in the fall of 1966 and contained Red fescue (Festuca rubra L.) and Kentucky bluegrass (Poa pratensis L.). It was maintained at one-inch height with weekly mowing. The area contained crabgrass seed from natural stands and from broadcast seeding. Water was applied during the test to enhance germination of crabgrass seed and to avert drought.

---

[1] Contribution No. 1419 , Agricultural Experiment Station, Kingston, R. I.

[2] Assistant Professor, Department of Plant and Soil Science.

Granular herbicide materials were applied by hand, and sprays were applied at 272 gpa with a pressure sprayer adjusted to 30 psi. These were applied to plots measuring 4 x 5 ft in three randomized complete blocks. A minimum of seven untreated plots were included in each block.

The herbicides, formulations, and pounds of active ingredient per acre used in test No. 1, "evaluation of new chemicals," are shown in Table 1. The treatments were applied on April 28th and 30th with the exception of S-14786 which was applied on May 13. In test No. 2, "the effectiveness of half rates of chemicals for controlling crabgrass in the second year," the treatments are shown in Table 2. The details and results from full rates in the first year (1970) were presented in a previous paper (3). On May 10, 1971 treatments were made to half of the area of certain plots. They received either half-rates or no chemical at all.

Visual estimates of turfgrass injury were made monthly through September. The scale used was 0 to 10, with 0 indicating no injury in comparison with check plots and 10, brown or dead turf. Crabgrass started to emerge about June 7 and reached 96% by June 23. Estimates of crabgrass cover in each plot were made in early September. Percent control was determined by comparing treated to untreated plots.

The goosegrass control study, test No. 3, was initiated on the seventh fairway of the Quidnessett Country Club in North Kingstown, R. I. on May 5, 1971. The turf was a mixture of Kentucky bluegrass and annual bluegrass (*Poa annua* L.). Herbicides were applied, in the manner described for the crabgrass tests, to plots measuring 5 x 5 ft in four randomized complete blocks. There were two untreated plots in each block. The herbicides, formulations and rates used are shown in Table 3. Estimates of goosegrass cover and bare exposed soil (indication of turfgrass injury) were made in each plot on September 21. Percent goosegrass control was determined by comparing treated to untreated plots.

Results and Discussion

Test No. 1 -- Evaluation of new herbicides

The effectiveness of new chemicals for preemergent control of crabgrass are shown in Table 1. The eight standard materials, bandane, benefin, bensulide, DCPA, nitralin, siduron, terbutol and tri-calcium arsenate, produced excellent control (90-100%) with only slight injury to the turfgrass (less than 2.0).

Of the eight newer materials tested, four provided good (80-89%) to excellent control with but slight injury to the turfgrass. These were A-820 at the 2 and 4 lb rate, NC-5651 at the 8 and 10 lb rate, RP-17623 at the 2 lb rate, and S-14786 at the 8 and 12 lb rate. Higher rates of A-820 and RP-17623 caused injury chiefly to fescue, rather than bluegrass, while with NC-5651 the injury was primarily to bluegrass.

Of the remaining four new materials, three failed to provide good control without causing moderate injury to turfgrass (2.0 to 3.9). These

Table 1. Crabgrass control in September and maximum turfgrass injury from preemergent herbicide treatments applied to bluegrass-fescue turfgrass in the spring of 1971.

Herbicide	Form-ulation	% ai	Rate lb ai/A	Percent crabgrass control	Maximum turfgrass injury [a]
bandane	(verm)	10	35	94	.3
benefin	(clay)	2.5	2	97	.6
bensulide	(clay)	12.5	10	94	.7
DCPA	(gran)	5	10	99	1.1
nitralin	(clay)	2	2	97	.7
siduron	(cob)	4.57	12	92	1.2
terbutol	(verm)	5	10	98	.8
tri-Ca-arsenate	(gran)	48	209	98	1.8
A-820	(verm)	2.3	2	98	.5
"	"	"	4	98	1.4
"	"	"	8	100	2.3 [c]
DS-5328	(WP)	65	2	0	.5
"	"	"	4	4	1.4
DS-5328	(cob)	1.5	2	9	1.3
"	"	"	4	0	4.8
"	"	"	8	0	9.1
GS-13638	(gran)	2.5	8	68	.7
"	"	"	12	61	1.1
IMC-3950	(EC)	7 lb/gal	5	2	2.6
"	"	"	10	75	3.1
NC-5651	(WP)	20	8	97	1.1
"	"	"	10	100	1.6
"	"	"	16	100	4.1 [b]
O-13930	(WP)	50	4	52	1.4
"	"	"	8	81	4.3
RP-17623	(clay)	2	2	86	1.4
"	"	"	4	97	2.4 [c]
"	"	"	6	99	3.7 [c]
"	"	"	8	99	3.7 [c]
S-14786	(WP)	50	4	27	.1
"	"	"	8	87	.3
"	"	"	12	97	.2

crabgrass cover in untreated plots = 84%

[a] turfgrass injury scale 0-10 (0 = none, 10 = complete brown or kill) from May through September.

[b] reduction in bluegrass

[c] reduction in fe[illegible]

were DS-5328, IMC-3950 and O-13930. The remaining chemical, GS-13638, gave no more than 68% control but since injury to the turf was slight, it should be investigated at higher rates.

Test No. 2 -- Effect of half rates in second year

The results from half rates applied to plots treated the previous year at full rates are presented in Table 2. None of the herbicides produced more than slight injury to the turfgrass but plots treated with RP-17623 showed a reduction in fescue. Control of crabgrass was less than 41% on plots that were not re-treated the second year indicating that residues were insufficient for control. Considering the evidence that most residues gave some control and on the increase in control where half rates were applied to plots that had been previously treated, rather than untreated, there is indication that bandane, bensulide, RP-17623, and possibly terbutol have residual activity. These four materials and DCPA provided excellent crabgrass control from half rates in the second year. Fair control (70-79%) was provided by benefin, nitralin, siduron and NC-5651. Based on the data in this report and the previous report (3) good crabgrass control might be expected from half rates of bandane, bensulide and DCPA in the second year.

Table 2. Percent crabgrass control in September from preemergent herbicides applied at half rates in the spring of the second year.

				Percent crabgrass control - 1971		
				Full rate 1970		None 1970
Herbicide	Form-ulation	% ai	Rate lb ai/A	None 1971	Half rate 1971	Half rate 1971
bandane	(vern)	10	35	27	92	68
benefin	(gran)	2.5	2	3	70	62
bensulide	(clay)	12.5	10	40	94	67
DCPA	(gran)	5	10	11	93	91
nitralin	(clay)	2	2	5	73	71
siduron	(cob)	4.57	12	17	75	74
terbutol	(verm)	5	10	21	95	86
NC-5651	(WP)	20	8	0	76	81
RP-17623	(gran)	2	4	29	97	81 [a]

crabgrass cover in check plots = 81%

[a] reduction in fescue

Although some herbicides applied at half rates in untreated plots provided good or even excellent crabgrass control this rate should not be considered sufficient for general use. All herbicides provided better control when applied at full rates (see Table 1). Had the period between herbicide application and 96% crabgrass emergence been greater than six weeks less favorable control might be expected, especially from herbicides with short residual activity.

Test No. 3 -- Goosegrass control

The data in Table 3 show that six of the ten herbicides evaluated provided less than 80% control of goosegrass. These materials were bandane, benefin, bensulide, DCPA, siduron and NC-5651. The data in Table 1 indicates that they were more effective in controlling crabgrass than goosegrass. Of the remaining four herbicides, good control was provided by terbutol and excellent control by nitralin, RP-17623 and tri-Ca-arsenate. There is some indication from the estimates of the percent bare soil that the nitralin, terbutol and RP-17623 treatments caused injury to the turfgrass. This evidence is not conclusive since (1) in the untreated plots, goosegrass may have covered bare soil areas (in the spring, turf cover was not complete) and (2) none of the plots without goosegrass showed complete turf cover.

Table 3. Percent goosegrass control and bare soil estimates in September from preemergent herbicide treatments applied in April 1971.

Herbicide	Formulation	% ai	Rate lb ai/A	Percent goosegrass control	Percent bare
bandane	(verm)	10	35	69	10
benefin	(clay)	2.5	2	41	5
bensulide	(clay)	12.5	10	52	6
DCPA	(gran)	5	10	63	3
nitralin	(clay)	2	2	90	23
siduron	(cob)	4.57	12	73	4
terbutol	(verm)	5	10	80	22
tri-Ca-arsenate	(gran)	48	209	100	10
NC-5651	(WP)	20	8	70	14
RP-17623	(gran)	2	4	100	26
checks	--	--	--	--	3

goosegrass cover in check plots = 65%

Literature Cited

1. Duich, J. M. and D. V. Waddington. 1971. Evaluation of experimental and commercial preemergence crabgrass chemicals for turf. Proc. Northeast Weed Sci. Soc. 25:97-101.

2. Engel, R. E. and K. J. McVeigh. 1971. Crabgrass and goosegrass control with several preemergence herbicides. Proc. Northeast Weed Sci. Soc. 25:103-108.

3. Jagschitz, J. A. 1970. Pre and postemergence chemical crabgrass control studies in turfgrass 1968-69. Proc. Northeast Weed Cont. Conf. 24:379-386.

4. Troutman, B. C. and J. A. Jagschitz. 1971. Evaluation of chemicals for crabgrass control in turfgrass - 1970. Proc. Northeast Weed Sci. Soc. 25:91-95.

Appendix

A list of the chemicals used and the company supplying them.

Herbicide	Company	Herbicide	Company
A-820	Amchem	NC-5651	Fisons
bandane	Velsicol	nitralin	Shell
benefin	Elanco	0-13930	Chevron
bensulide	Stauffer	RP-17623	Rhodia
DCPA	Diamond Shamrock	S-14786	Gulf
DS-5328	Diamond Shamrock	siduron	DuPont (Rockland)
GS-13638	Geigy	terbutol	Hercules
IMS-3950	International Minerals	tri-Ca-arsenate	Rhodia

EFFECT OF BENSULIDE ON *Poa annua* AND BENTGRASS CULTIVARS

J. M. Duich, T. L. Watschke and D. V. Waddington

ABSTRACT

Evaluation of bensulide in a program approach to *Poa annua* control was conducted for six continuous years utilizing 13 creeping bentgrass cultivars. Bensulide treatments resulted in near 100% control from consecutive late summer treatments, whereas *P. annua* infestations increased with biannual treatments. Control treatment populations ranged from 3-45% dependent on cultivar.

Herbicide induced turf injury was found to vary yearly with shifts in individual cultivar response. Variable winter conditions, root injury, and unknown factors were encountered. Greenhouse bioassay studies were conducted on field-treated samples to confirm root inhibition.

[1]Professor, Assistant Professor, Associate Professor, respectively. Agronomy Department, Pennsylvania State University.

SUMMARY OF PERFORMANCE OF A-820 ON ORNAMENTAL TURFGRASSES

John F. Koerwer, John E. Gallagher, and Armin H. Furrer[1]

Introduction

The potential of N-secondary-butyl-4-tertiary-butyl-2,6-dinitroaniline (A-820) for preemergence control of crabgrass (Digitaria spp.) became evident early in its investigation. The compound, discovered and field tested for various purposes by Amchem Products, Inc., research personnel, has performed well as a preemergence herbicide and is tolerated satisfactorily by ornamental turfgrasses. Results of test programs from 1969 through 1971 have confirmed the initial findings, and a petition for label registration was submitted to EPA in October, 1971.

The first formulation used (Amchem 69-41, a 2 lb/gal emulsifiable liquid) produced good crabgrass control but injured turfgrass objectionably. During the 1970 field trials Amchem 70-25, an improved liquid formulation, and Amchem 70-123, a 4% vermiculite granular formulation, were used. These retained the excellent crabgrass control properties while providing a three-fold safety factor over Amchem 69-41. The rate of 4 to 6 lb/A established earlier continued to appear reasonable in greenhouse and limited field tests. Normal germination of turfgrasses seeded the fall after spring application appeared probable.

Results in the 1970 test program indicated that the rate needed for cool-season turfgrass regions is 4 lb/A, and 6 lb/A for those of warm-season grasses. Encouraged by continued evidence of adequate turfgrass tolerance, 1971 test programs were planned to provide further data needed for label registration. Amchem 70-314-B, a 2.3% vermiculite granular formulation designed to provide adequate volume for good coverage when used in standard spreaders, was determined as the most suitable form, and was used in most of the 1971 field trials.

The 1971 test programs provided response information for cool- and warm-season turfgrass species tolerance, rates needed for crabgrass control in differing regions, and control of additional annual weed grasses which occasionally become lawn problems. Because of the greater importance of crabgrass in the Northeast and North Central part of the United States, more tests were established there. The South and Southwest were represented sufficiently to confirm the 6 lb/A rate for this area's warm-season turfgrasses.

---

[1] Specialist, Biological Screening; Technical Field Development Representative Southeastern U.S.; and Technical Field Development Representative Northeastern U.S., respectively; Amchem Products, Inc., Ambler, Pa., 19002

Crabgrass Control

All tests compared A-820 with either DCPA at 10 lb/A (15 lb/A in the West) or benefin at 2 lb/A (3 lb/A in the West). There were five separate test locations in the Northeast. Rates applied varied from 2 to 10 lb/A; the 4 lb/A rate provided an average of 95% control. The Midwest had two locations (Indiana and Iowa); at the 4 lb/A rate control averaged 96%. In the South (Georgia, North Carolina and Tennessee) at the 4 lb/A rate, control averaged 89%. In the single far West location (California), the 6 lb/A rate was needed to produce 82% control. Data is summarized in Table 1.

Table 1. Regional summary of A-820[a] crabgrass control

Herbicide	Rate lb/A	Northeast (5 tests)	North Central (2 tests)	South (3 tests)	Far West (1 test)
A-820	2.0	76 (3)[b]	92 (2)[b]		61 (1)[b]
A-820	3.0	68 (1)	93 (1)		
A-820	4.0	95 (4)	96 (2)	86 (3)	55 (1)
A-820	5.0	--	98 (1)		
A-820	6.0	97 (3)	99 (2)		82 (1)
A-820	8.0	98 (5)	99 (2)	100 (1)	
DCPA	10.0	96 (3)	94 (2)	93 (3)	
DCPA	15.0	--			80 (1)
benefin	2.0	92 (2)			
benefin	3.0	--		85 (2)	88 (1)

[a] Tested as Amchem 70-314-B, 2.3% vermiculite granular formulation.
[b] Number of tests in which rate was used.

Turfgrass Tolerance

Under the conditions of the 1971 field trials, A-820 tolerance by most common turfgrass species was excellent. Table 2 records the maximum injury by species regardless of the number of tests conducted. In all of the spring-applied tests, there was only one instance of slight injury to bentgrass. The single serious injury occurred in a fall test for annual grass control in a Penncross bentgrass fairway. Excessive rainfall (6.65 inches within 11 days) kept the fairway saturated for two weeks. No other fall application for crabgrass control in 1970 or 1971 produced any injury. Most cool-season grasses and the common turfgrasses of the South were included in the test program. In one test conducted on the Amchem Research Farm at Ambler, Pa., a split application of a fall and spring treatment totaling 16 lb/A provided excellent crabgrass control with no apparent effect on the mixture of common bluegrass, fineleaf fescue, and creeping bentgrass.

Turfgrass Seed Tolerance

In greenhouse trials, turfgrass seedlings were prevented from emerging up to 180 days when sterilized flats were treated at the 4 lb/A level. In a field test where the soil microbial population could be influential, the 4 lb/A rate allowed satisfactory germination of common bluegrass and Pennlawn red

Table 2. Summarized turfgrass tolerance of A-820

Species	Highest rate tested	Lb/A causing injury	Injury rating[a]
Cool-season grasses:			
Bentgrass, Highland Colonial	12 lb/A	None	0
Bentgrass, Penncross			
Bentgrass, red top	6	4, 6	2
Bentgrass, Seaside	12	12	Trace
Bluegrass, common Kentucky	12	None	0
Bluegrass, Merion Kentucky	12	None	0
Fescue, fineleaf	12	8	Trace
Fescue, K-31 tall	12	None	0
Fescue, Pennlawn	12	4	Trace
Warm-season grasses:			
Bahia, Argentina	8	None	0
Bahia, Pennsacola	8	None	0
Bermudagrass, common	8	None	0
Bermudagrass, Tif 419	8	None	0
Bermudagrass, Tifdwarf	12	None	0
Bermudagrass, Tifgreen	8	None	0
Bermudagrass, Tifway	12	None	0
Centipedegrass	12	None	0
St. Augustine, Bitter Blue	8	None	0
St. Augustine, Common	12	None	0
St. Augustine, Scott's 1081	8	None	0
Zoysia, Meyer	12	None	0

[a] 0 = no injury, 10 = complete kill

fescue 101 days following treatment, the time of fall seeding. In this same test, turfgrass seed germination in areas treated with 4 lb/A A-820 liquid or granular was equal to those treated with 1 to 2 lb/A benefin. All three materials controlled smooth crabgrass (Digitaria ischaemum).

In the previously mentioned fall and spring crabgrass control tests, May treatments of 0, 2, 4, 6 and 8 lb/A rates of A-820 were verticut and overseeded with a bluegrass/fescue mixture in August. Seedling counts were made two weeks later. Three 4" plugs were randomly removed from each of the six replications. Counts from these 18 plugs per treatment provided the averages presented in Table 3. The figures indicate successful fall overseeding of spring-treated turf at rates from 0 to 8 lb/A. All treated plots showed a greater stand establishment than the check, indicating that weed competition was more of a factor than chemical inhibition.

Control of Annual Grasses Other Than Digitaria spp.

Greenhouse persistence studies using Amchem 70-314-B and another experimental granular formulation of A-820 showed that for up to 120 days yellow foxtail (Setaria lutescens) and silver crabgrass (Eleusine indica)

Table 3. Response of fall turfgrass seeding[a] in lawns previously treated with A-820 (Amchem 70-314-B). Amchem Research Farm, Ambler, Pa.

Treatment date	Rate lb/A	Average number seedlings/4" plug[b]
October 28, 1970	8	25
May 7, 1971	0	15
May 7, 1971	2	19
May 7, 1971	4	18
May 7, 1971	6	33
May 7, 1971	8	24

[a] Plots overseeded August 19, 1971 with Kentucky bludgrass and fineleaf fescue.

[b] Three 4" plug samples each counted from 6 replications on September 2, 1971.

were prevented from emerging in flats of unsterilized soil treated at the 4 lb/A rate.

In field tests at Clinton, Iowa, conducted by Amchem personnel, plant counts were made at the conclusion of the test of three weed grasses: crabgrass, barnyardgrass (Echinochloa crusgalli) and witchgrass (Panicum capillare). The rates of Amchem 70-314-B used were 0, 2, 4, 6 and 8 lb/A; 10 lb/A DCPA was the standard for comparison. All A-820 treatments were more effective on all species than the 10 lb/A DCPA treatment (Table 4).

Table 4. Annual weed grass control with A-820 (Amchem 70-314-B). Amchem Research Farm, Clinton, Iowa

Treatment	Rate lb/A	% Control		
		Crabgrass	Barnyardgrass	Witchgrass
Check	0	0	0	0
A-820	2	94	68	25
A-820	4	95	75	43
A-820	6	99	75	53
A-820	8	99	94	82
DCPA	10	92	65	18

[a] Average of 4 replications; converted from number of crabgrass plants per plot. Treatments applied May 12, 1971; evaluated October 1.

Cooperators

Amchem acknowledges with appreciation the contributions of the following research workers whose data has been utilized in this report:

Dr. Lloyd M. Callahan, University of Tennessee, Knoxville, Tennessee 37901.
Dr. John F. Cornman, Cornell University, Ithaca, New York, and Herbert J. Kastyl, Nassau County Extension Service, Mineola, New York 11501.
Dr. William H. Daniel, Department of Agronomy, Purdue University, West Lafayette, Indiana 47907.
Dr. Joseph M. Duich, Department of Agronomy, The Pennsylvania State University, University Park, Pennsylvania 16802.
Dr. Clyde L. Elmore, Department of Botany, University of California, Davis, California 95616.
Dr. Ralph E. Engle, Department of Soils and Crops, Rutgers - The State University, New Brunswick, New Jersey 08903.
Mr. William J. Johnson, Griffin Experiment Station, University of Georgia, Griffin, Georgia 30223.
Mr. John A. Jagschitz, Department of Plants and Soil Science, University of Rhode Island, Kingston, Rhode Island 02881.
Dr. William M. Lewis, Department of Weed Science, North Carolina State University, Raleigh, North Carolina 27607.

EVALUATION OF HERBICIDES FOR THE CONTROL OF BROADLEAVED WEEDS IN SEEDLING AND MATURE TURFGRASS [1]

John A. Jagschitz [2]

Abstract. Several herbicides were evaluated for the selective control of weeds in mature and seedling turfgrass. In mature turfgrass effective control of white clover, mouseear chickweed and dandelion was obtained from 2,4-D or MCPA when combined with dicamba, mecoprop, or silvex. Results with bromoxynil, BAS-3483, and BAS-3510 indicate that they require testing at higher rates while results with chlorflurenol and DS-5328 appear discouraging because of injury to the turfgrass. Evaluation of herbicides for the control of carpetweed, ladysthumb, redroot pigweed and common purslane in seedling Kentucky bluegrass and red fescue indicate that the most promising herbicides were bromoxynil and dicamba, alone and in combination, and a newer material BAS-3510. These herbicides were less phytotoxic than 2,4-D or MCPA. In general, red fescue was more tolerant to herbicides than Kentucky bluegrass and seedlings treated in the 3 to 6-leaf stage were more tolerant than those treated in the 1-leaf stage. Bromoxynil treatments have an added advantage of reducing the weed canopy in a few days which could improve seedling growth and makes mechanical mowing operations easier.

Introduction

Research shows that herbicides can be used to selectively control broadleaved weeds in turfgrass (1, 2). With the present emphasis on pollution it is possible that some herbicides could be banned from use. One of five test reported in this paper evaluates substitute or newer chemicals, alone and in various combinations, for the control of white clover (*Trifolium repens* L.) mouseear chickweed (*Cerastium vulgatum* L.) and dandelion (*Taraxacum officinale Weber*.) in mature turfgrass.

At present, seedling grasses are usually left to compete with weeds until the turfgrasses mature and can tolerate herbicides. Research shows that bromoxynil may be an effective herbicide for use in seedling grasses (3,4). To further evaluate bromoxynil and other herbicides four tests were initiated to determine their phytotoxicity to grass seedlings of Kentucky bluegrass (*Poa pratensis* L.) and red fescue (*Festuca rubra* L.) and four weeds purslane (*Portulaca oleracea* L.), carpetweed (*Mollugo verticillata* L.), ladysthumb (*Polygonum persicaria* L.) and redroot pigweed (*Amaranthus retroflexus* L.).

---

[1] Contribution No. 1420, Agricultural Experiment Station, Kingston, R.I.

[2] Assistant Professor, Department of Plant and Soil Science

Materials and Methods

Weed control in mature turf

The turf was a mixture of Kentucky bluegrass, red fescue and Colonial bentgrass (*Agrostis tenuis* Sibth.) more than five years old and maintained at a height of one and one-half inch. The herbicide treatments, as presented in Table 1, were applied on May 28, 1971 as sprays in water at the rate of 43 gpa. These were applied to plots measuring 4 x 5 ft in four randomized complete blocks. There were ten untreated plots in each block. Dandelion counts and estimates of white clover and mouseear chickweed coverage were made at time of treatment and eight weeks later. Percentage control was determined by the changes in weed populations and the changes taking place in the untreated plots. Estimates of turf injury were recorded periodically during the test. The scale used was 0 to 10, with 0 indicating no injury and 10 being brown or dead turf.

Herbicide phytotoxicity to seedling grasses and weeds

Seedings of Park Kentucky bluegrass and Pennlawn red fescue were made on July 2, 1968. The herbicide treatments, as shown in Table 2, were applied 9 days and 21 days after seeding when the grasses were in the 1-leaf and 3 to 6-leaf stage, respectively. Herbicides were applied as sprays in water at the rate of 40 gpa to plots measuring 2 x 4 ft in two randomized complete blocks. There was one untreated plot in each block. Visual estimates of turfgrass cover were made five weeks after the 21 day treatments to indicate phytotoxicity.

An adjacent area seeded with Pennlawn red fescue on July 2 was also treated with herbicides 21 days later using the methods as described above. The herbicides and rates used are presented in Table 2. At the time of treatment there was a natural stand of purslane and carpetweed present with plants ranging in size from those with several leaves to those with several branches. Estimates of weed coverage were made at treatment and four weeks later. Control was based on the reduction in cover after considering the change in the untreated plots.

A test to control ladysthumb and redroot pigweed was initiated at the Tuckahoe Farms in Slocum, Rhode Island. The area was seeded May 23, 1971 with Merion Kentucky bluegrass and Highlite red fescue. The herbicide treatments, as presented in Table 3, were applied on July 14. They were applied as sprays in water at the rate of 43 gpa to plots measuring 5 x 5 ft in three randomized complete blocks. There were six untreated plots in each block. The turf had been mowed twice and was not mowed until seven days after treatment. At treatment the turf was up to two inches high with a canopy of ladysthumb and pigweed about six inches high. Weed coverage estimates were made three weeks after treatment and control was determined by comparing treated to untreated plots. Estimates of visual injury to the turfgrass was recorded during the test using the scale 0-10 as described earlier.

The final test, also at Tuckahoe Farms, was seeded to the same grasses as above but on August 11, 1971. The herbicides, as shown in Table 3, were applied on August 30 as sprays in water at the rate of 43 gpa to plots measuring 4 x 5 ft in three randomized complete blocks. There were three untreated plots in each block. At the time of treatment the grass had not been mowed and was in the 3 to 6-leaf stage. The pigweed at this time ranged in height up to three inches and had several leaves while some purslane plants had up to four branches with several leaves on each. Estimates of pigweed and purslane cover were made four weeks after treatment and control was determined by comparing treated to untreated plots. Observations of injury to the turf, similar to those described earlier, were made during the test period.

Results and Discussion

Control of weeds in mature turfgrass

The results of herbicides applied for the control of white clover, mouseear chickweed and dandelion in mature turfgrass are presented in Table 1. The data support previous research (1,2) that 2,4-D is effective for the control of dandelion but not for clover or chickweed. Certain combinations of 2,4-D with one or two of the following herbicides - dicamba, mecoprop, or silvex - produced excellent control (90% or better) of all three weeds with only slight turfgrass injury (2.0 or less). Mixtures containing silvex tended to produce the most injury. This data suggests that dicamba, mecoprop and silvex can be substituted for one another and be combined with 2,4-D to make an effective weed control mixture. Bromoxynil, chlorflurenol and BAS-3510 in combination with 2,4-D were not effective. Actually the mixtures of 2,4-D with bromoxynil or BAS-3510 appeared to be antagonistic for dandelion control and could be due to formulation difficulties.

The chemical MCPA produced results similar to those of 2,4-D - excellent control of dandelion and ineffective against clover and chickweed. Combining MCPA with either dicamba or mecoprop provided excellent control of the three weeds. It appears that MCPA could be used as a substitute for 2,4-D as a herbicide for use in turfgrass.

Chlorflurenol produced excellent control of the three weeds at the highest rate, but injury to the turfgrass was more than slight (moderate 2.1 to 4.0). This could limit its use for close-cut, lawn-type turfgrass. Lower rates might be tested for the specific control of clover.

BAS-3510 provided excellent control of chickweed but poor control of dandelion and clover. Bromoxynil and BAS-3483 were ineffective against all three weeds. Higher rates of these materials could be investigated since they produced only slight injury to the turfgrass. The remaining material, DS-5328, failed to provide effective weed control and success with higher rates appear limited due to its phytotoxicity.

Table 1. Effect of herbicides on weed control and turfgrass injury when applied to mature turfgrass in May 1971.

Herbicide	Rate lb ai/A	Percent control - July: clover	chick-weed	dan-delion	Maximum turfgrass injury [a]
2,4-D	1.0	38	1	90	.5
"	1.5	77	46	100	.8
" + dicamba	1.0 + .1	98	71	100	1.1
" + "	1.0 + .125	99	81	100	1.0
" + "	1.0 + .2	99	90	100	1.0
" + mecoprop	1.0 + 1.0	99	99	100	1.3
" + silvex	1.0 + .5	99	90	100	2.0
" + dicamba + mecoprop	1.0 + .1 + .5	99	99	100	1.3
" + " + "	1.0 + .125 + 0.5	99	99	100	1.0
" + " + "	1.0 + .0625 + .75	99	98	98	1.8
" + " + silvex	1.0 + .125 + .5	99	99	100	1.9
MCPA	1.0	46	61	92	.3
"	1.5	62	53	100	.3
" + dicamba	1.5 + .2	99	99	99	1.1
" + mecoprop	1.5 + 1.0	99	99	98	1.5
bromoxynil	2.0	31	11	0	.9
" + 2,4-D	1.0 + 1.0	48	24	27	.8
" + MCPA	1.0 + 1.0	43	66	42	.3
chlorflurenol	.5	99	37	78	2.1
"	1.0	99	74	89	2.5
"	2.0	99	97	100	3.1
" + 2,4-D	.5 + 1.0	99	63	91	1.9
BAS 3510 (WP)	2.0	7	84	0	.3
"	4.0	4	92	0	.3
" + 2,4-D	2.0 + 1.0	42	54	11	1.0
BAS-3483	4.0	24	46	0	.8
DS-5328 (WP)	2.0	59	17	0	3.0
checks	---	--	--	--	.1
weed cover in untreated plots		35%	7%	24 plants	

[a] turfgrass injury scale 0-10 (0 = none, 10 = complete brown or kill) from May through July.

Phytotoxicity of herbicides to seedling grasses

Percent turfgrass stand estimates of Kentucky bluegrass and red fescue, when treated with herbicides at the 1-leaf and 3 to 6-leaf stage of growth, are presented in Table 2. The data indicate that: (1) fescue was more tolerant to herbicide treatments than bluegrass, (2) seedlings in the 3 to 6-leaf stage of growth were more tolerant than those treated in the 1-leaf stage, and (3) in general, bromoxynil was less phytotoxic than dicamba and in turn dicamba was less phytotoxic than 2,4-D.

Table 2. Turfgrass establishment and weed control as influenced by herbicides applied to seedling turf in July 1968.

		Percent turfgrass stand					
		Treated 1-leaf stage		Treated 3 to 6-leaf stage		Percent control	
Herbicide	Rate lb ai/A	blue-grass	fes-cue	blue-grass	fes-cue	pur-slane	carpet-weed
2,4-D	.25	--	--	--	--	52	70
"	.5	60	80	77	91	99	87
"	1.0	33	53	50	88	--	--
bromoxynil	.5	86	95	87	97	63	100
"	1.0	82	95	86	96	57	100
dicamba	.0625	--	--	--	--	94	63
"	.125	78	88	84	96	100	91
"	.25	70	85	86	91	--	--
cover in check plots		93%	96%	93%	96%	23%	2%

Indications of injury to a mixture of bluegrass and fescue seedlings from herbicides applied in the summer of 1971 are presented in Table 3. Seven-week old seedlings (July treatments) were more tolerant to MCPA and 2,4-D at the .5 lb rate than seedlings three weeks old and in the 3 to 6-leaf stage (August treatments). This supports the conclusion that as seedlings mature they become more tolerant to herbicides. Bromoxynil, dicamba and a newer material, BAS-3510, appeared less phytotoxic to young seedlings than MCPA and 2,4-D at the rates evaluated. These rates were in general those needed for effective weed control. Of the treatments applied to seven-week old turf in July only the experimental material, BAS-3483, produced obvious turfgrass injury.

Weed control in seedling turfgrass

The control of carpetweed, ladysthumb, pigweed, and purslane in seedling turfgrass from herbicides is presented in Tables 2 and 3. Bromoxynil provided effective control of carpetweed and ladysthumb. It also provided excellent control of pigweed when treatments were applied to younger plants. As pigweed matures it apparently becomes resistant to bromoxynil. Poor control of purslane was provided by bromoxynil. This supports earlier research (3). When bromoxynil was applied to ladysthumb and pigweed the plants turned grey-brown and become shriveled and dry within a few days. Herbicides such as MCPA, 2,4-D and dicamba were slower acting and did not substantially reduce weed foliage for several weeks. Reduction in weed mass and canopy can improve seedling growth and make mechanical mowing operations easier.

Table 3. Control of ladysthumb, pigweed and purslane in seedling turfgrass from herbicides applied in the summer of 1971.

	Rate	Percent control			
		Treated July [a]		Treated August [b]	
Herbicide	lb ai/A	ladys-thumb	pig-weed	pig-weed	pur-slane
2,4-D	.25	61	62	92	18
"	.5	92	96	98[c]	88[c]
MCPA	.25	30	78	86	75
"	.5	47	95	99[c]	98[c]
dicamba	.1	91	79	98	90
"	.2	100	96	100	100
bromoxynil	.25	100	34	100	8
"	.5	100	18	100	0
BAS-3510	4.0	100	76	100	100
"	8.0	100	98	--	--
BAS-3483	4.0	88	28	--	--
"	8.0	99[c]	27[c]	--	--
bromoxynil + 2,4-D	.25 + .25	100	86	--	--
" + MCPA	.25 + .25	100	87	--	--
" + dicamba	.25 + .1	100	87	100	97
" + "	.25 + .2	100	95	--	--
cover in untreated plots		22%	22%	22%	29%

[a] 7 weeks after seeding

[b] 3 weeks after seeding

[c] moderate turfgrass injury (2.1 to 4.0), other had less injury

Dicamba provided effective control of all four weeds. The mixture of dicamba plus bromoxynil also was effective and could have the following advantages: (1) safety to seedling turfgrass, (2) more effective, broad-spectrum control of weeds, and (3) improved seedling growth and easier mechanical mowing due to the reduction in weed canopy. Combinations of bromoxynil with 2,4-D or MCPA provided effective weed control, but safety to seedlings appear questionable.

The data indicate that 2,4-D was more effective than MCPA for the control of ladysthumb, MCPA was more effective for purslane control and both were effective for pigweed control. The new material, BAS-3510, provided excellent control of ladysthumb, pigweed and purslane and deserves further study.

Literature Cited

1. Duich, J. M., D. V. Waddington and B. R. Fleming. 1966. Broadleaf weed control in turf. Proc. Northeast Weed Cont. Conf. 20:490-493.

2. Jagschitz, J. A. 1971. Response of turfgrasses and broadleaved weeds to various herbicides. Proc. Northeast Weed Sci. Soc. 25:115-122.

3. Jagschitz, J. A. and A. R. Mazur. 1967. Chemical control of purslane and other broadleaf weeds in seedling turf. Proc. Northeast Weed Cont. Conf. 21:520-523.

4. Shelley, C. H. and J. M. Duich. 1967. Effect of broadleaf herbicides on seedling turfgrasses. Proc. Northeast Weed Cont. Conf. 21:515-519.

Appendix

A list of the chemicals used and the companies supplying them.

Herbicide	Company
2,4-D	Amchem, Velsicol, Rhodia, Gordon, Mallinckrodt
BAS-3483	BASF
BAS-3510	BASF
bromoxynil	Rhodia, Amchem
chlorflurenol	U. S. Borax
dicamba	Velsicol, Amchem, Gordon, Mallinckrodt
DS-5328	Diamond Shamrock
MCPA	Amchem, Rhodia
mecoprop	Rhodia, Gordon, Mallinckrodt
silvex	Velsicol, Amchem

CHEMICAL GROWTH CONTROL OF A HIGHWAY TURF MIXTURE [1/], [2/]

A.T. Dore and R.C. Wakefield [3/]

Abstract

Three chemical growth retardants, MBR-6033, Maleic hydrazide (MH) and a combination of MH plus chlorflurenol (CF), successfully reduced growth of a highway turf mixture mowed at 2.5 inches and were especially effective at a 4-inch mowing height. Discoloration and thinning that resulted were overcome by a nitrogen increase from one pound to two pounds per 1000 square feet. MH plus CF and MH alone suppressed seedhead formation of Kentucky bluegrass, red fescue and Colonial bentgrass. MBR-6033, otherwise effective, did not control bentgrass seedheads.

Introduction

Chemical mowing still offers the most feasible way to economize and eliminate the hazards of operating mowers along highways (4). As a result, growth retardants have been widely investigated in many vegetation control programs (1, 2, 3) and numerous attempts have been made to develop more specialized and or varied uses for growth control chemicals (1, 3, 4, 5).

The objective of this test was to evaluate growth retardants under varying conditions of mowing height and nitrogen fertilization. Previous tests (1) have shown that thinning and discoloration of turf can occur following treatment. If these effects can be overcome by management then growth retardants should be more widely used.

1/ Contribution No. 1417, Agricultural Experiment Station, Kingston, R.I.

2/ This research was supported in part by the U.S. Dept. of Transportation, Federal Highway Administration, and the R.I. Dept. of Transportation. The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the respective Departments of Transportation.

3/ Research Assistant and Professor respectively, Department of Plant and Soil Science, Agricultural Experiment Station, Kingston, Rhode Island 02881.

Materials and Methods

The experiment was conducted on a mixture of Park Kentucky bluegrass (Poa pratensis L.), Exeter Colonial bentgrass (Agrostis tenuis Sibth), and Pennlawn red fescue (Festuca rubra L.) established in 1967 on a Bridgehampton silt loan at the University of Rhode Island and maintained at low fertility. The plots were fertilized with 1 or 2 pounds of nitrogen per 1000 square feet (lbs. N/M) as 10-6-4 fertilizer on April 22, 1971. The entire site was mowed to three inches on May 5, 1971.

Experimental treatments consisted of (1) three growth retardants applied at one or two rates (2) two nitrogen levels and (3) two mowing heights. In addition, a 3-foot section of each treated plot was not mowed as a check for dry weight and seedhead production.

On May 7, all growth retardants were applied in water with a bicycle sprayer delivering 50 gallons per acre. Chemicals with rates of active ingredient per acre (lbs. ai/A) are listed in Table 1. A surfactant, Ortho X-77, was added to MBR-6033. Additional information concerning the materials and manufacturers is presented in the Appendix

Nitrogen treatments consisted of 1 or 2 lbs. N/M for each growth retardant. Two mowing heights of 6.3 and 10 cm. (2.5 and 4.0 inches) were similarly maintained. The experiment involved a total of 13 treatments on 6 ft. x 18 ft. plots randomized in three complete blocks. Fifteen feet of each plot was referred to as the "mowed plots".

Height measurements, color (a visual rating of greenness on a basis of zero to a most desirable ten) and density (also a visual rating on a basis of zero to a most desirable ten, indicating thinness of the turf due to injury and or suppression of new tillers) were recorded weekly. When the grasses in at least two replicates measured 6 inches or more, the plots maintained at the low height were mowed. Likewise, grasses maintained at 4 inches were mowed when they measured at least 8 inches. A 21-inch Toro rotary mower with sample bag attached to chute was pushed twice the length of the plot harvesting an area of 52.5 square feet.

A 3-foot segment of each plot which was not mowed was investigated in the effect of the chemicals on uncut grass and the degree of seedhead suppression. Seedhead counts and dry weights of grasses exceeding 4 inches were taken from 2 square feet of each plot approximately 2 months after treatment (July 8).

All data were statistically analyzed and evaluated with Duncan's multiple range test.

TABLE 1. Effects of Growth Retardants on a Regularly Mowed Highway Turf Mixture

Chemical	Rate lbs. ai/A	Mow. Ht. (cm)	lbs. N/M	Accum. Growth Above, Mowing Ht. (7 wks) No. Cuts	Dry wt. kg/ha	Ht. cm	Color Ratings (0-10 best) 3 wks	6 wks	8 wks	Density Ratings (0-10 best) 3 wks	6 wks	8 wks
MBR-6033	4	6.3	1	2	920c**	18cd	6.3d	8.7b	8.3cd	6.0efg	7.8de	7.8ef
MBR-6033	6	6.3	1	1	595b	15ab	5.2e	5.7d	7.3e	5.2g	7.3e	7.3e
MH+CF	(3+1)*	6.3	1	1	929c	18cd	6.5d	5.8d	8.8bc	7.0cde	7.7e	7.8ef
MH	5	6.3	1	2	1115d	17bc	8.3bc	7.5c	7.7de	6.7c-f	7.7e	6.5f
Check		6.3	1	2	1710e	21ef	8.5abc	8.5bc	7.7de	8.7a	8.3cd	7.8ef
MBR-6033	4	10.0	1	1	334a	13a	6.5d	7.3c	8.0de	5.8fg	8.5c	9.1bc
MBR-6033	6	10.0	1	1	437a	13a	6.2d	7.3c	8.0de	6.3def	8.5c	9.3abc
MH+CF	(3+1)	10.0	1	1	325a	15a	6.2d	7.8bc	8.8bc	7.5bc	9.2ab	9.0c
MH	5	10.0	1	1	270a	14a	8.0bc	7.3c	9.2abc	7.3bcd	8.5c	8.3d
Check		10.0	1	2	725b	22ef	7.7c	8.0b	6.7f	8.3ab	9.3ab	9.8ab
MBR-6033	6	10.0	2	1	576b	15ab	8.3ab	9.8a	8.5bc	8.3ab	9.7a	9.5abc
MH+CF	(3+1)	10.0	2	2	1097cd	24f	8.7ab	8.7b	9.3ab	9.0a	9.5a	9.7abc
MH	5	10.0	2	1	353a	20de	9.3a	8.2b	9.8a	8.8a	8.8bc	9.5abc

* See Appendix

** Means followed by different letters indicate significant difference at Duncan's 5% level.

Results and Discussion

Mowed Plots

Presented in Table 1 are accumulated growth measurements (dry weights and heights) above the mowing height for a seven-week period and visual ratings of color and density at three, six and eight weeks after growth retardants were applied.

(1) Growth Measurements

Data for total dry weights and accumulated height measurements above either 2.5 inches or 4 inches for a period of seven weeks revealed that all chemical treatments resulted in growth suppression.

While 4 inches is considered to be a minimum mowing height for highway turf, a 2.5-inch height was included to obtain additional information on the effectiveness of the growth retardants tested. At 2.5 inches more frequent mowings were usually required and a much greater volume of plant growth was removed. A comparison of the dry matter produced by untreated check plots revealed that over 130 per cent more growth was mowed at 2.5 inches then at the 4-inch height.

At the 2.5-inch mowing height MBR-6033 and a combination of Maleic hydrazide and chlorflurenol (MH+CF) were particularly effective in reducing growth.

At the more conventional mowing height of 4 inches, all treatments were equally effective.

With the increase of nitrogen fertilizer from 1 to 2 lbs. N/M the effectiveness of MBR-6033 and MH+CF was reduced. Added nitrogen did not decrease the effectiveness of MH used alone in retarding dry weight although the height of growth was increased. Conversely added nitrogen increased the volume of growth but not the height when MBR-6033 was used at 6 pounds per acre (lbs./A).

Results indicated that growth retardants were generally more advantageous for turf mowed at 4 inches rather than 2.5 inches. Added nitrogen neither increased the volume of growth with MH nor the height of growth with MBR-6033.

(2) Color Ratings

Table 1 shows varying color ratings depending on the chemicals, mowing height and nitrogen rates.

MBR-6033 produced an initial temporary yellowing of grass blades tips. Similar observations were previously noted by Dore, et al (1). When nitrogen was increased to 2 lbs. N/M, not only did the yellowing disappear, but grass color was superior to the check.

Similarly, the combination of MH+CF showed an early temporary discoloration in the form of a whitish cast which was effectively overcome with the higher rate of nitrogen. MH at 5 lbs. ai/A produced some discoloration. Here again, supplemental nitrogen improved color.

All forms of discoloration disappeared after six weeks and by eight weeks, all treated plots were darker green than the check.

(3) Density Ratings

The extent of injury or tiller suppression by the chemicals and the effect of increased nitrogen are recorded in Table 1, as visual density ratings.

MBR-6033 at both 4 lbs. and 6 lbs. ai/A produced thin turf by suppressing new tiller growth. This effect decreased each week and was not noticed after six weeks. Two pounds of nitrogen with the higher rate of the chemical retained excellent turf density.

MH+CF gave turf density comparable to the check. A reverse trend by eight weeks was due to continuing drought. Two pounds N/M preserved good turf density when this combination was used.

MH at 5 lbs. ai/A produced some thinning of turf but it was effectively overcome with nitrogen at 2 lbs. N/M.

Unmowed Plots

In adjacent unmowed plots, the effects of growth retardants were evaluated nine weeks after treatment. Data for dry weights and height of vegetative growth above four inches and seedhead counts per square foot for Kentucky bluegrass, Colonial bentgrass and red fescue are summarized in Table 2.

(1) Growth Measurements

All chemical treatments applied to plots receiving 1 lb. N/M effectively suppressed unmowed turf in terms of dry weight and height of vegetative growth. Reduction in dry weights ranged as high as 80 per cent with MH alone and MBR-6033 at 6 lbs. ai/A.

At 2 lbs. N/M growth was considerably increased in weight and height although weight of grass sprayed with MBR-6033 and MH was significantly lower than the check plot at 1 lb. N/M.

TABLE 2. Effects of Growth Retardants on an Unmowed Highway Turf Mixture

Chemical	Rate lbs ai/A	lbs N/M	Total Growth (9 wks) Dry wts kg/ha	Ht cm	Seedheads per Sq ft Blue	Bent	Fescue	Total
MBR-6033	4	1	573ab**	24a	4.0b	24.8cd	11.8bc	40.6b
MBR-6033	6	1	342a	23a	2.5b	36.0bc	8.6bc	47.0b
MH+CF	(3+1)*	1	573ab	27b	.2b	8.8de	11.4bc	20.4c
MH	5	1	312a	24a	.1b	3.4e	4.8c	8.2c
Check		1	1765e	33c	15.8a	47.1ab	30.5a	93.4a
MBR-6033	6	2	1379cd	33c	4.4b	56.7a	15.5b	76.6a
MH+CF	(3+1)	2	1628de	37e	.2b	5.0e	4.3c	9.5c
MH	5	2	1002bc	32c	0b	.5e	2.5c	3.0c

* See Appendix

** Means followed by different letters indicate significant difference at Duncan's 5% level

(2) Seedhead Counts

Individual seedheads were counted in random two-square feet quadrats for each of the treatments.

Control of seedheads was most effective with MH and MH+CF. A considerable number of seedheads were not controlled with MBR-6033. However, most of these were seedheads of Colonial bentgrass. Results were similar at the higher rate of nitrogen although a greater number of seedheads were not suppressed by MBR-6033.

It is of interest to note that seedheads of Kentucky bluegrass were generally the easiest to control followed by red fescue and Colonial bentgrass.

Summary and Conclusions

A highway turfgrass mixture was treated with three growth retarding chemicals. Two rates of nitrogen fertilizer were used and plots were mowed at two cutting heights. In addition, a section of each plot was left unmowed to simulate unmowed roadside conditions. Chemicals were evaluated for suppression of dry weights and heights of growth, color, density and reduction of seedheads per unit area.

Conclusions may be summarized as follows:

(1) Satisfactory suppression of vegetative growth occurred with MBR-6033, MH and MH+CF.

(2) Control of seedhead growth was most effective with MH and the combination of MH+CF.

(3) MBR-6033 was most effective for growth control at 6 lbs. ai/A and at the higher nitrogen rate.

(4) MH+CF was generally effective and performed best at the lower rate of nitrogen.

(5) Discoloration of turf occurred temporarily with MBR-6033 and MH+CF. This was effectively overcome with increased nitrogen.

(6) MH used alone was equally effective in controlling growth at both nitrogen rates and caused little discoloration of turf.

(7) Results with growth retardants were substantially better at the higher (4-inch) mowing level.

References

1. Dore, A.T., R.C. Wakefield and J.A. Jagschitz. 1970. Effect of four growth retardants on Kentucky bluegrass and red fescue used for roadside turf. NEWSS Proc. 25: 123-130.

2. Engel, R.E. et al. 1970. The effect of growth regulators on turfgrass species. 1970. NEWSS Proc. 25: 131-140.

3. Gardner, M.R. 1970. Growth control in Trees. NEWSS Proc. 25: 332-339.

4. Garmhausen, W.J. 1963. Chemical mowing: a success in Ohio. Public works 94: (6): 117-118.

5. Zukel, J.W. 1956. Effect of some factors on rate of absorption of maleic hydrazide by several plants. Abstract in A Literature Summary on Maleic hydrazide, by J.W. Zukel for UniRoyal, pp. 165-166.

Appendix

Growth retardants used in this study were as follows (companies supplying materials are noted):

1. MBR-6033. Available as the diethanolamine salt. Formulated as a (21.80% w/w ai.) 2 lbs./gal. solution. Chemistry of material undisclosed. 3-M Company.

2. MH+CF refers to a combination of the following chemicals:

   a) Maleic hydrazide (MH) - A diethanolamine salt of 6-hydroxy-3-(2H)-pyridazinone. 3 lbs. ai/gal. U.S. Borax.

   b) Chlorflurenol (CF) (Maintain CF-125). - Methyl-2-chloro-9-hydroxyfluorene-9-carboxylate--8.8%; Methyl-9-hydroxyfluorene-9-carboxylate--2.1%; Methyl 2, 7 dichloro-9-hydroxyfluorene-9-carboxylate--1.6% 1 lb. ai/gal. U.S. Borax.

3. Maleic hydrazide (MH). Slo-Gro. 1, 2-dyhydro-3, 6-pyrida-zine-dione. 1.5 lbs. ai/gal. UniRoyal.

A STATUS REPORT ON THE NEW YORK STATE PESTICIDE REGULATORY PROGRAM

J. E. Dewey[1/]

Abstract

On January 1, 1971 the New York State Environmental Conservation Law, Section 15, Part 155, establishing lists of restricted use pesticides available only to permit holders became effective. There are three lists. The "A" list includes 55 highly toxic or hazardous pesticides which may be bought in any quantity by economic users holding an "A" permit. The 7 persistent and accumulative pesticides on the "B" list may be used only by permit in the quantities and for the specific uses designated. There are no permitted uses in New York State for the 10 pesticides on the "C" list. The law is intended to prohibit the homeowner from using highly hazardous pesticides, to restrict certain persistent and accumulative pesticides to a few essential uses, and to completely prohibit the more environmentally hazardous pesticides when effective alternatives are available. The lists are reviewed annually through public hearings held late in the year. Several revisions involving turf insecticides and herbicides have been proposed for 1972. Action taken on these proposals is discussed.

1/ Program, Leader, Chemicals-Pesticide Program, Cornell University.

CHICKWEED CONTROL IN SMALL GRAINS AS AFFECTED BY HERBICIDE-NITROGEN FERTILIZER COMBINATIONS APPLIED ON TWO DATES WITH THREE SCHEDULES

W. J. McAvoy, Jr., W. F. Smith III, and R. D. Ilnicki[1/]

Introduction

For the past two years research has been underway to investigate weed control with herbicides alone and in combination with liquid nitrogen fertilizer applied in the spring on winter wheat (Triticum aestivum, var. Redcoat) and barley (Hordeum vulgare, var. Wong). Differential injury responses of wheat and barley to herbicides were to be investigated since injury has been observed from some treatments in previous years. Common chickweed (Stellaria media (L.) Cyrillo) control was also investigated as affected by the three schedules of herbicide application.

Materials and Methods

The location for this research was at the Rutgers University Soils and Crops Research Station at Adelphia, New Jersey.

The seedbed was prepared on a Freehold sandy loam soil site in an area known to be infested with common chickweed. Barley and wheat were planted in the fall of 1970 and plots consisting of 5 drill bands, 13½ ft long, established the following spring.

The herbicides and combinations consisted of (2,4-dichlorophenoxy) acetic acid (2,4-D); 3,6-dichloro-o-anisic acid (dicamba); 3,5-dibromo-4-hydroxybenzonitrile (bromoxynil); 2,4-D + dicamba; 2,4-D + bromoxynil; and dicamba + bromoxynil. The three schedules followed were: (1) applying herbicide treatments alone; (2) applying the herbicides plus the liquid nitrogen fertilizer together; and (3) applying a split application of either the herbicide treatments alone or the liquid nitrogen fertilizer on the first date, March 26, and the other part of the split application on the second date of application (April 16). Two rates of fertilizer were used, 0 and 60 lb N/A. Four replications of each treatment were used in a randomized complete block design for both cereals.

[1/] Graduate Assistants and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey.

The treatments were applied with water as carrier with a two nozzle boom using 730616 TeeJet[2] spray tips at 30 psi, carbon dioxide serving as the pressure source delivering 40 gpa.

On March 26, both wheat and barley were in the late tillering stage. Barley was 4-6 inches tall with 3-14 tillers per plant, averaging 8. Wheat was 3-5 inches with 2-13 tillers per plant, averaging 7.

On April 16 both wheat and barley were in the early joint stage of development. Barley stood 10-11 inches tall with 6-16 tillers per plant, averaging 12. Wheat stood 9 inches tall with 8-16 tillers per plant, averaging 12. Common chickweed on March 26 was 1-2 inches tall, 1 foot in diameter, with a few flowers present and just starting active growth. On April 16 height was 2-3 inches tall and approximately one-quarter full flower.

Chickweed control and barley and wheat injury ratings were made on June 12 and 18, respectively. A rating scale of 0 to 10 was used in which 0 = essentially no reduction in stand or vigor of the species and 10 = complete kill or elimination of stand.

Wheat and barley tiller counts per 2 ft row were taken on June 21 and 22, respectively. Two center rows from each barley plot were harvested and threshed on June 29 and 30. In wheat the entire plot was harvested by a combine on July 7. All plot yields were converted to bushels per acre and subjected to standard statistical analyses.

Results and Discussion

Presented in Table 1 are the effects of herbicides and herbicide combinations with liquid nitrogen fertilizer on wheat and barley and on chickweed control.

Chickweed control in barley was better than in wheat. This was caused by the type of growing habit. Young barley plants are wider, fuller, and more leafy at the basal portion than wheat. This coupled with herbicides make barley better able to compete with chickweed and results in more effective control.

In wheat and barley the best chickweed control was obtained with the combination of 2,4-D + dicamba at the highest rate of 3/4 + 1/8 lb/A.

2/ Tradename of Spraying Systems Company, Bellwood, Illinois.

Generally, where herbicides followed fertilizer application, this treatment of 2,4-D + dicamba was most effective in barley. However, where 2,4-D + dicamba + nitrogen were applied on the same date, a reduction in chickweed control resulted, possibly due in part to the masking effect of the nitrogen component.

Dicamba at 1/8 lb/A and 2,4-D at 1 lb/A were not adequate for chickweed control at any schedule. It was observed, however, that those treatments containing dicamba applied in March prevented chickweed from flowering.

Barley vigor was reduced by 2,4-D + dicamba + nitrogen treatments applied in March. These treatments kept barley in a longer chlorotic state than did the other treatments.

In wheat, all herbicides + nitrogen treatments applied in March produced leaf tip burn and necrosis. Of these, 2,4-D + bromoxynil + nitrogen applied in April produced moderate leaf tip burn. When applied alone a very slight leaf tip burn resulted from nitrogen. It was thought that the effect of the herbicide and nitrogen fertilizer applied together is more than an additive effect of the two components applied separately. All wheat and barley injury effects were short-lived and outgrown.

Barley yields among replications were variable; consequently, no conclusions could be made concerning the effects of herbicide treatments, different schedules, or nitrogen levels on barley yield. The source of error can most probably be attributed to weather conditions and technique of harvest. A few days prior to harvest, strong winds and rain lodged the barley, resulting in extreme difficulty in the harvest of the two center rows from each plot. Wheat was not lodged and the entire plot was combine-harvested.

Wheat yields were more consistent and no treatment was significantly better than the check for the two dates and three schedules of application. However, when the two dates and three schedules were combined, resulting in six categories, herbicides applied in March followed by nitrogen fertilizer in April resulted in significantly higher yields than herbicides alone in either March or April.

Tiller counts taken as one of the components of yield were too variable among replications; no meaningful conclusions could be drawn.

Summary

Best common chickweed control resulted from 2,4-D + dicamba. Where the herbicide was applied with liquid nitrogen fertilizer on the

same date, a reduction in chickweed control was noted. Leaf tip burn and necrosis in barley resulted from 2,4-D + dicamba + 60 lb N/A applied in March and in wheat from 2,4-D + bromoxynil + 60 lb N/A. These injurious effects were short-lived and outgrown. Herbicide applied in March and 60 lb N/A applied in April resulted in significantly higher yields in wheat than treatments applied on either date with 0 lb N/A.

References

1. McAvoy, W. J., L. F. Hist, and R. D. Ilnicki. 1970. Weed control in barley and wheat with several herbicide treatments in combination with liquid nitrogen. Abstract. Northeastern Weed Control Conf. 24:241.

2. McAvoy, W. J. and R. D. Ilnicki. 1971. Chickweed control in barley and wheat with several herbicide-liquid nitrogen fertilizer mixtures. Northeastern Weed Science Society 25:212-219.

Table 1. The effects of herbicides and herbicide combinations in combination with liquid nitrogen fertilizer in wheat and barley and on control of common chickweed.

Treatment	Rate, lb a.i./A	In Barley: Chickweed S	Chickweed V	Barley vigor	Yield bu/A	In Wheat: Chickweed S	Chickweed V	Wheat vigor	Yield bu/A
0 lb/A nitrogen fertilizer + herbicide applied in March									
2,4-D	1	3.0	2.5	0.0	46.3	1.0	0.3	0.0	63.7
dicamba	1/8	0.0	0.0	0.5	42.8	0.3	0.0	0.0	67.1
2,4-D + dicamba	3/8 + 1/8	1.0	0.0	0.0	48.3	1.5	0.8	1.0	56.3
	½ + 1/8	1.3	0.0	0.0	49.3	0.3	0.0	1.3	54.6
	3/4 + 1/8	4.3	2.5	0.8	42.2	0.5	0.0	1.0	62.9
nitrogen	0	0.0	0.0	0.0	58.8	0.0	0.0	0.0	79.1
60 lb/A nitrogen fertilizer + herbicide applied in March									
2,4-D	1	1.0	0.0	0.0	34.9	0.0	0.0	0.5	65.5
dicamba	1/8	0.8	0.0	0.0	45.7	0.0	0.0	0.0	69.2
2,4-D + dicamba	3/8 + 1/8	2.0	0.3	0.0	48.2	0.3	0.0	0.0	61.8
	½ + 1/8	1.3	0.0	0.0	46.2	2.0	0.5	0.0	70.8
	3/4 + 1/8	7.0	1.5	0.0	43.1	0.3	0.3	0.0	75.3
nitrogen	60	0.0	0.0	0.0	54.1	0.0	0.0	0.3	70.3
Herbicide applied in March followed by 60 lb/A nitrogen fertilizer in April									
2,4-D	1	0.5	0.0	0.3	43.7	0.5	0.0	1.0	66.7
dicamba	1/8	2.0	0.5	0.0	49.0	0.3	0.0	0.0	76.1
2,4-D + dicamba	3/8 + 1/8	5.0	2.5	0.0	46.0	1.8	0.5	0.0	70.4
	½ + 1/8	3.8	0.0	0.0	47.3	3.0	2.3	0.0	75.0
	3/4 + 1/8	5.3	1.3	0.0	42.7	2.5	2.0	0.0	70.3
nitrogen	60	0.0	0.0	0.0	45.0	0.8	0.0	0.0	71.0
60 lb/A nitrogen fertilizer applied in March followed by herbicide in April									
2,4-D	1	1.5	0.0	0.0	43.0	0.3	0.0	0.3	63.0
dicamba	1/8	2.0	0.0	0.3	47.7	1.0	0.5	0.0	65.0
2,4-D + dicamba	3/8 + 1/8	4.0	0.0	0.0	46.1	1.3	0.3	0.3	70.4
	½ + 1/8	4.3	0.8	0.0	44.2	2.5	2.5	0.3	79.7
	3/4 + 1/8	9.5	7.0	0.8	40.9	1.8	1.3	1.0	69.5
nitrogen	60	0.0	0.0	0.0	51.5	0.5	0.0	0.0	70.6
0 lb/A nitrogen fertilizer + herbicide applied in April									
2,4-D	1	1.8	0.0	0.8	44.9	2.0	0.5	0.3	57.6
dicamba	1/8	0.8	0.0	0.0	48.3	1.5	0.5	0.3	62.7
2,4-D + dicamba	3/8 + 1/8	5.5	5.0	0.0	38.6	0.8	0.5	0.8	60.8
	½ + 1/8	0.5	0.0	0.5	48.1	1.8	0.5	0.0	67.2
	3/4 + 1/8	3.3	0.8	1.3	38.2	3.5	2.3	0.0	64.6
nitrogen	0	0.0	0.0	0.0	44.5	0.5	0.0	0.0	75.6

Table 1. Cont.

Treatment	Rate lb a.i./A	In Barley: Chickweed S	Chickweed V	Barley vigor	Yield bu/A	In Wheat: Chickweed S	Chickweed V	Wheat vigor	Yield bu/A
60 lb/A nitrogen fertilizer + herbicide applied in April									
2,4-D	1	1.3	0.3	0.0	46.6	1.8	1.0	0.5	60.8
dicamba	1/8	4.0	2.5	1.3	40.0	0.0	0.0	0.0	70.5
2,4-D + dicamba	3/8 + 1/8	5.5	3.3	0.5	48.8	2.0	0.5	0.0	74.0
	½ + 1/8	5.5	1.0	0.5	37.0	1.5	0.0	0.0	72.0
	3/4 + 1/8	2.5	1.0	0.3	49.1	1.8	0.5	0.0	66.4
nitrogen	60	0.0	0.0	0.0	42.2	0.0	0.0	0.0	69.2

ANNUAL WEED CONTROL IN NEW SEEDINGS OF ALFALFA

W. M. Dest, R. A. Peters and A. C. Triolo[1]

Abstract

Several herbicides alone and in combination were applied on a new spring seeding of alfalfa at the Agronomy Research Farm, University of Connecticut. The principal weeds were large crabgrass (Digitaria sanguinalis L.), redroot pigweed (Amaranthus retroflexus L.) and common lambsquarters (Chenopodium album L.).

The most effective single herbicide was S-6044 at 4 lb/A giving both grass and broadleaf weed control without injury to the alfalfa. The 2 lb/A rate gave good control of broadleaf weeds but only fair control of crabgrass. An herbicide quite active on broadleaf weeds was needed with EPTC to give broad spectrum weed control. 2,4-DB, or bromoxynil, at 1/4 and 3/8 lb/A gave good yields of alfalfa. Bromoxynil, 1/2 lb/A, and dinoseb gave good weed control but caused some injury to alfalfa. When bromoxynil was used alone, grasses proliferated. The combined effect of initial alfalfa injury and heavy grass competition resulted in complete suppression of alfalfa. By harvest time, VCS 438 caused alfalfa injury and very poor grass control. BAY 94337 caused severe injury to alfalfa and poor grass control.

Methods and Material

The location of the experiment was on the Agronomy Research Farm of the Storrs Agriculture Experiment Station, Storrs, Connecticut. The experimental design was a complete randomized block with 3 replications. Plot size was 10 feet by 25 feet.

The soil type was a Paxton fine sandy loam. One ton of agricultural ground limestone was applied on April 12, 1971 and plowed down. The field was fertilized on May 7, 1971 with 700 lb/A 0-15-30 and incorporated with a disk harrow. Alfalfa (Medicago sativa L. Var. Saranac) was seeded on June 4, 1971 at the rate of 12 lb/A.

The major weed species were redroot pigweed (Amaranthus retroflexus L.), common lambsquarters (Chenopodium album L.) and large crabgrass (Digitaria sanguinalis L.).

The times of treatments were: preplant June 4, preemergence June 5, and post emergence June 23, 1971, when the alfalfa was in the 2 leaf stage, the pigweed and the lambsquarters in the 3-5 leaf stage and the crabgrass in the 2-3 tiller stage. The temperature at the time of post emergence treatment was 82° F. Chemicals were applied in water at the rate of 40 gal/A with a

[1]Research Assistant III, Professor of Agronomy, and Research Assistant, respectively.

Table 1. Injury Ratings and Yields of Weed and Alfalfa Components Following Treatments of New Seedings

Treatments			Alfalfa injury and Weed Control			Yields T/A Dry Matter		
Herbicide	lb ai or ae/A	Type of application	Ratings 1/ - Aug. 6, 1971 Alfalfa	Crabgrass	Broadleaves	Alfalfa	Grass weeds	Broadleaf weeds
EPTC + 2,4-DB	3 + 3/4	PPI	1.3	8.0	9.0	3050 a	140 c	0 c
S-6044	4	PRE	1.3	8.0	6.8	2690 ab	290 c	290 bc
EPTC + bromoxynil	3 + 1/4	PPI + PRE	1.0	8.0	8.3	2470 ab	510 bc	140 c
EPTC + 2,4-DB	3 + 1 1/2	PPI + PRE	1.3	8.0	9.0	2400 ab	290 c	140 c
EPTC	2	PPI	1.3	8.3	5.0	2400 ab	360 bc	510 abc
VSC 438	1	PRE	4.3	5.6	6.0	2400 ab	1100 abc	290 bc
Diphenamide	3	PRE	3.3	7.3	5.6	2320 ab	140 c	700 ab
Diphenamide +2,4-DB	3 + 1	PRE + POST	3.3	5.8	9.0	2300 ab	1090 abc	0 c
EPTC	3	PPI	2.0	8.3	5.0	1960 abc	580 bc	510 abc
EPTC + bromoxynil	3 + 3/8	PPI + POST	2.0	7.3	8.7	1960 abc	650 bc	70 c
S-6044	2	PRE	3.3	6.3	6.3	1960 abc	1300 abc	140 c
EPTC + bromoxynil	3 + 1/2	PPI + POST	5.0	5.3	9.0	1450 abcd	1230 abc	140 c
EPTC + dinoseb	3+ 1	PPI + POST	4.0	8.3	9.0	1380 abcd	510 bc	70 c
VSC 438	1 1/2	PRE	6.3	4.0	6.0	1300 bcd	1800 abc	70 c
2,4-DB	1 1/2	POST	7.0	1.6	9.0	1300 bcd	2900 a	0 c
Control			6.8	3.6	2.8	2090 bcd	1380 abc	1020 a
Bay 94337	1/2	POST	6.0	3.0	6.9	580 cd	1380 abc	70 c
Control-mowed			3.3	4.3	9.0	510 cd	730 bc	220 c
Bay 94337	1.0	POST	8.3	2.6	5.6	70 d	2100 ab	140 c
VSC 438	3/4	POST	6.3	2.6	7.0	-	-	-
Bromoxynil	1/4	POST	7.0	1.6	9.0	-	-	-
Bromoxynil	3/8	POST	8.3	1.3	9.0	-	-	-
Bromoxynil	1/2	POST	7.3	1.6	9.0	-	-	-

1/ - Rating scale: 1-no injury; 9-complete kill small plot self propelled sprayer. EPTC was incorporated by cross disking. All herbicide rates were in lb ai or ae/A.

Weed control and alfalfa injury ratings were taken on August 6, 1971. Samples were taken from a 3' x 20' area from each plot and the green weight recorded. The total yield per plot was fractionated into alfalfa, grass weeds and broadleaf components by hand separations of sub-samples.

Results and Discussion

A. Early Observations

Ratings made within a few days of treatment indicated severe alfalfa injury from BAY 94337 at 1/2 and 1 lb/A. This injury persisted as shown by the injury ratings and yields in Table 1. The 3/8 and 1/2 lb/A rates of bromoxynil caused initial contact injury to alfalfa. Activity on broadleaf weeds was very marked but very limited in the grasses. An initial contact effect on alfalfa seedlings was attributed primarily to the dinoseb component of the EPTC-dinoseb treatment.

B. Observations At Time of First Cut

Mechanical control by a single mowing resulted in lower yields of alfalfa than did several of the herbicide treatments. While mowing did result in a significant decrease in yield of broadleaf weeds compared to the check, the grassy weeds were not significantly reduced. This is attributable to the greater recovery potential of the grasses. The mowing injured alfalfa since growth was less than in some of the herbicide treatments with significantly lower grass yields.

Herbicides controlling only broadleaf weeds resulted in a proliferation of grass weeds as evidenced by the grass yields when using 2,4-DB, bromoxynil. VCS 438 at 3/4 lb/A alone. The rank-grass growth so seriously reduced alfalfa yields, it was useless to sample the plots treated with bromoxynil or VCS 438 at 3/4 lb/A. While bromoxynil initially caused some injury to alfalfa, when combined with EPTC which gave grass control, the alfalfa recovered sufficiently except at the bromoxynil 1/2 lb/A rate to give satisfactory yields.

S-6044 at the 4 lb/A rate was the most promising material used. It gave both grass and broadleaf weed control without injury to alfalfa.

Diphenamid gave good grass weed control, but only fair broadleaf weed control. It gave better grass control alone than when combined with 2,4-DB which removed broadleaf weed competition.

EPTC alone gave fair to good grass control but poor broadleaf weed control. Inclusion of either 2,4-DB or bromoxynil (1/4 or 3/8 lb/A) resulted in control of both broadleaf and grass weeds producing satisfactory yields of alfalfa. When the combination included the 1/2 lb/A rate of bromoxynil, there was distinct evidence of alfalfa injury.

The VCS 438 treatments were unsatisfactory, giving limited grass control and some alfalfa injury. The least alfalfa was found at the lowest rate, 3/4 lb/A, because of the combined impact of injury and grass competition.

Appendix

Common Name	Formulation	Chemical Name
EPTC	6 lb/gal EC	S-ethyl dipropylthiocarbamate
Dinoseb	3 lb/gal EC	2-sec-butyl-4, 6-dinitrophenol (triethanolamine salt)
2,4-DB	2 lb/gal EC	4-(2,4-dichlorophenoxy) butyric ester
Bromoxynil	2 lb/gal EC	3-5-dibromo-4-hydroxybenzonitrile octanoic ester
VCS 438	75% WP	2-(3,4-Dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
Diphenamid	4 lb/gal Dis	N,N-dimethyl-2,2-diphenylacetamide
S-6044	3 lb/gal EC	Unknown
BAY 94337	70% WP	4 Amino-6t-butyl-3-(methylthio) as triazin 5(4H) one

SOME PROMISING HERBICIDE TREATMENTS FOR WEED CONTROL IN SPRING-SEEDED ALFALFA

M. M. Lay, W. F. Smith III and R. D. Ilnicki[1]

Abstract

Experiments were conducted in which herbicides were used to establish seedling alfalfa. Treatments included herbicides and herbicide combinations applied prior to planting, immediately after planting, and after alfalfa emerged. Included in the latter were evaluations of two surfactants. From these experiments several observations were made. EPTC, benefin, vernolate, trifluralin, BAS-3870-H, and A-820 were effective herbicides applied prior to planting and incorporated. Combinations of several of these improved general weed control. Alachlor applied preemergence was particularly effective on grasses; however, rates above 1.5 lb/A injured stand of alfalfa. Combining this herbicide with VCS-438 improved weed control. Another good combination included VCS-438 plus diphenamid. RH-315 was more effective on grasses than on broadleaf weeds. Weed control with broxoxynil was not improved by the additions of surfactants. Increased weed control resulted with 2,4-DB, amine and ester with surfactant additions.

Introduction

Several herbicides including 2-(3,4-dichlorophenyl)-4-methyl-1, 2,4-oxadiazolioline-3,5-dione (VCS-438), S-ethyl dipropylthiocarbamate (EPTC), 2-sec-butyl-4,6-dinitrophenol (dinoseb) and 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) are currently being used to control some annual and perennial weeds in seedling alfalfa (1,2). EPTC used preplant and incorporated controls most seedling grasses but is ineffective for many broadleaf weeds (2). The research reported herein was conducted to ascertain: (1) the effects of preplant incorporated and preemergence herbicides and herbicide combinations for broad spectrum weed control and (2) to investigate the effects on weed control of some surfactant additions to a postemergence herbicide.

[1] Graduate Assistants and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, The State University of New Jersey, New Brunswick, New Jersey.

Methods

Research was conducted at the Rutgers University Soils and Crops Research Center at Adelphia, New Jersey. Alfalfa (var. Saranac) was seeded on April 13 for the preemergence and postemergence experiments and on April 20 for the preplanted incorporated experiment on a Holmdel loam soil. Plots 5 x 20 feet were established to receive the herbicidal treatments. A complete randomized block design with 4 replications was used. Predominant weed species were common lambsquarter (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), velvetleaf (Abutilon theophrastic Medic.) and fall panicum (Panicum dichlotomiflorum Michx.). All treatments were applied as sprays in 40 gpa. 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 on June 17. Two harvests were taken and yields in fresh weight determined. Duncan's Multiple Range Test was used for the significance test among treatment means. The formulations and rates used as well as the chemical descriptions of the herbicides investigated are presented in the Appendix.

Results and Discussion

The responses of the three prominent broadleaf weeds to each herbicide treatment were essentially the same. These were averaged and summarized into broadleaf weeds for ease of discussion. The other category, grasses, included only fall panicum. The effect of the herbicides and herbicide combinations on crop response and weed control applied preplant incorporated are presented in Table 1.

From Table 1 it can be seen that A-820 was very effective on grasses at all rates investigated. Broadleaf control, however, was complete only at the highest rate of 6 lb/A. Broadleaf control was less at all rates below 6 lb/A with no apparent difference between the lower rates. The highest rate did produce some forage yield reductions.

EPTC at the two rates studied was effective on grassy weeds; however, only the higher rate, 4 lb/A, produced good broadleaf control. There appeared to be some advantage in combining EPTC and A-820. Excellent broad spectrum weed control was obtained with rates of each lower than what was ordinarily needed when applied alone.

BAS-3870-H was very effective on grasses but only fair on broadleaf weeds. A combination of this herbicide with EPTC did not increase the effectiveness on broadleaf weeds and had no detrimental effect on yield.

Benefin alone was effective on grasses with lesser control of broadleaf weeds. A combination with EPTC did retain its effect on grasses and produced control of broadleaf weeds greater than that produced by each applied alone. Futhermore, forage yield was also increased.

Vernolate and trifluralin were two effective herbicides providing excellent broad spectrum weed control with commensurate increases in forage yield. The low rate of each apparently was sufficient for commercial use. Notwithstanding, that preemergence applications of VCS-438 following preplant incorporated applications of trifluralin effected almost perfect weed control the added feature of another application method may not be economically desirable. Furthermore, this latter combination did not add much to the effectiveness of trifluralin; however, the combination did add to the effectiveness of VCS-438 (Table 2).

The effects of preemergence herbicides are summarized in Table 2. From this summary it is evident that the two higher rates of VCS-438 were more effective for weed control than the two lower rates. Generally, forage yields were related to weed control since no rate produced injury to alfalfa.

Combining VCS-438 with alachlor appeared to be a promising combination particularly at rates approximately 1.5 lb/A and 1 lb/A, respectively, for the two herbicides. It is worthy of note that alachlor was especially effective on grasses but injury to alfalfa resulted at rates near 2 lb/A whether applied singly or in combination.

That injury to alfalfa from alachlor above 1.5 lb/A is further evidenced when it was combined with RH-315. With regard to RH-315 this herbicide was not effective on broadleaf weeds when applied alone. Combinations with alachlor did improve grassy weed control with slight increase in broadleaf control.

Still another combination worthy of comment was that of VCS-438 + diphenamid which produced broad spectrum weed control with no injury to alfalfa. Although diphenamid was not evaluated alone, it did contribute to grassy weed control which certainly corroborates observations made in previous work.

Dinoseb, which served as a standard or reference herbicide in this experiment, was more effective on broadleaf weeds than on grasses, which was expected.

The effects of the postemergence herbicides bromoxynil, 2,4-DB amine, and 2,4-DB ester on weed control with added surfactants are presented graphically in Figures 1a, 1b, and 1c, respectively. From Figure 1a it can be seen that bromoxynil plus surfactants was not as effective as the herbicide applied alone either in weed control or forage yield. On the other hand, increases in weed control with 2,4-DB amine was realized with surfactant additions particularly on broadleaf weeds. Similar results were observed with 2,4-DB ester.

References

1. Duke, W. B., B. J. Brecke and P. E. Boldt. 1970. Comparative effects of EPTC, Butylate and VCS-438 on annual weeds and alfalfa. Proc. NEWCC 24: 213-219.

2. Linscott, D. L. and R. D. Hagin. 1968. Interaction of EPTC and DNBP on seedlings of alfalfa and birdsfoot trefoil. Weed Sci. 16: 182-184.

3. Ilnicki, R. D. and L. F. Hist. 1969. Some promising postemergence treatments in newly-seeded alfalfa. Proc. NEWCC 23: 233-234.

Table 1. Effect of preplant incorporated herbicides and herbicide combinations on weeds and alfalfa.

Herbicide	Rate lb/A	Weed Control[1/] Broadleaves	Grasses	Alfalfa Responses Vigor[1/]	Yield ton/A*
A-820	1.5	8.6	10	0.3	1.91 e
	2	8.6	10	0.0	1.83 f
	3	8.4	10	0.5	2.18 a
	4	9.1	10	0.5	1.82 fg
	6	10.0	10	0.5	1.69 hij
EPTC	3	6.5	10	0.8	1.70 hij
	4	9.7	10	1.3	1.66 ijk
A-820 + EPTC	3+3	10.0	10	0.8	1.81 fg
EPTC	3	6.5	10	0.8	1.70 hij
BAS-3870-H	0.5	5.2	10	0.8	1.63 jk
	1	7.6	10	0.5	1.69 hijk
	2	5.6	10	0.0	1.91 e
	3	8.8	10	1.0	1.74 ghi
Benefin	1	8.0	10	0.8	1.61 jk
	1.5	9.6	10	0.5	1.64 jk
EPTC + Benefin	3+1	9.9	10	0.8	1.76 fgh
EPTC +BAS-3870-H	3+2	7.1	10	0.5	1.63 jk
Vernolate	3	9.4	10	0.3	2.00 bcd
	4	9.8	10	0.5	1.93 de
Trifluralin	0.75	8.8	10	0.5	2.08 b
	1	9.8	10	0.0	2.03 bc
	1.5	9.7	10	1.3	1.97 cde
Trifluralin ppi	0.75+1	10.0	10	0.5	1.80 fg
+	0.75+1.5	9.1	10	0.5	2.04 bc
VCS-438 pre	0.75+2	9.2	10	1.0	1.75 fgh
	1 + 1	10.0	10	1.3	1.94 de
	1 + 1.5	10.0	10	0.5	1.96 cde
	1 + 2	10.0	10	1.5	1.73 hi
Check	--	0.0	0	0.9	1.36 l

1/ Based on scale 0 to 10; 0 = no effect, 10 = complete control or complete reduction in vigor.

*Means followed by identical letters are not significantly different at the 1% level (Duncan's Multiple Range Test).

Table 2. Effect of dinoseb, diphenamid and alachlor in combination with VCS-438 and RH-315 on crop response and weed control at pre-emergence application.

Herbicide	Rate lb/A	Weed Control[1]		Alfalfa Responses	
		Broadleaves	Grasses	Vigor[1]	Yield ton/A*
VCS-438	1	8.9	6.8	0.0	1.72 abcde
	1.5	8.2	8.5	0.3	1.90 ab
	2	9.7	9.8	0.0	2.00 ab
	2.5	10.0	7.5	0.3	1.90 ab
Alachlor	1	3.3	7.5	0.0	1.01 ghi
	1.5	5.0	10.0	0.0	1.18 defghi
	2	4.8	10.0	0.8	1.24 cdefghi
	2.5	6.7	10.0	0.8	0.92 hi
RH-315	1	1.6	7.5	0.8	1.57 bcdef
	1.5	3.3	10.0	0.8	1.31 cdefghi
	2	5.0	9.2	1.0	1.11 fghi
	2.5	5.6	8.2	2.5	0.87 i
VCS-438 + alachlor	1 + 1	7.6	7.6	0.0	1.70 abcde
	1 + 1.5	7.8	10.0	1.2	1.48 bcdefh
	1 + 2	7.6	10.0	1.8	1.76 abcd
	1.5 + 1	9.1	10.0	0.0	2.04 ab
	1.5 + 1.5	9.4	10.0	0.5	1.81 abc
	1.5 + 2	9.6	9.5	1.0	1.55 bcdefh
RH-315 + alachlor	1.5 + 1	4.1	10.0	1.0	1.05 fghi
	1.5 + 1.5	5.6	10.0	1.8	1.15 efghi
	1.5 + 2	6.3	10.0	1.5	1.24 cdefghi
Dinoseb	3	8.1	6.0	0.8	1.92 ab
	4.5	6.3	5.0	1.2	1.93 ab
VCS-438 + diphenamid	1.5 + 3	9.0	10.0	0.0	1.98 ab
	2 + 3	9.9	10.0	0.0	2.18 a
Check	--	0.0	0.0	0.0	0.87 i

[1] Based on scale 0 to 10; 0 = no effect, 10 = complete control or complete reduction in vigor.

*Means followed by identical letters are not significantly different at the 1% level (Duncan's Multiple Range Test).

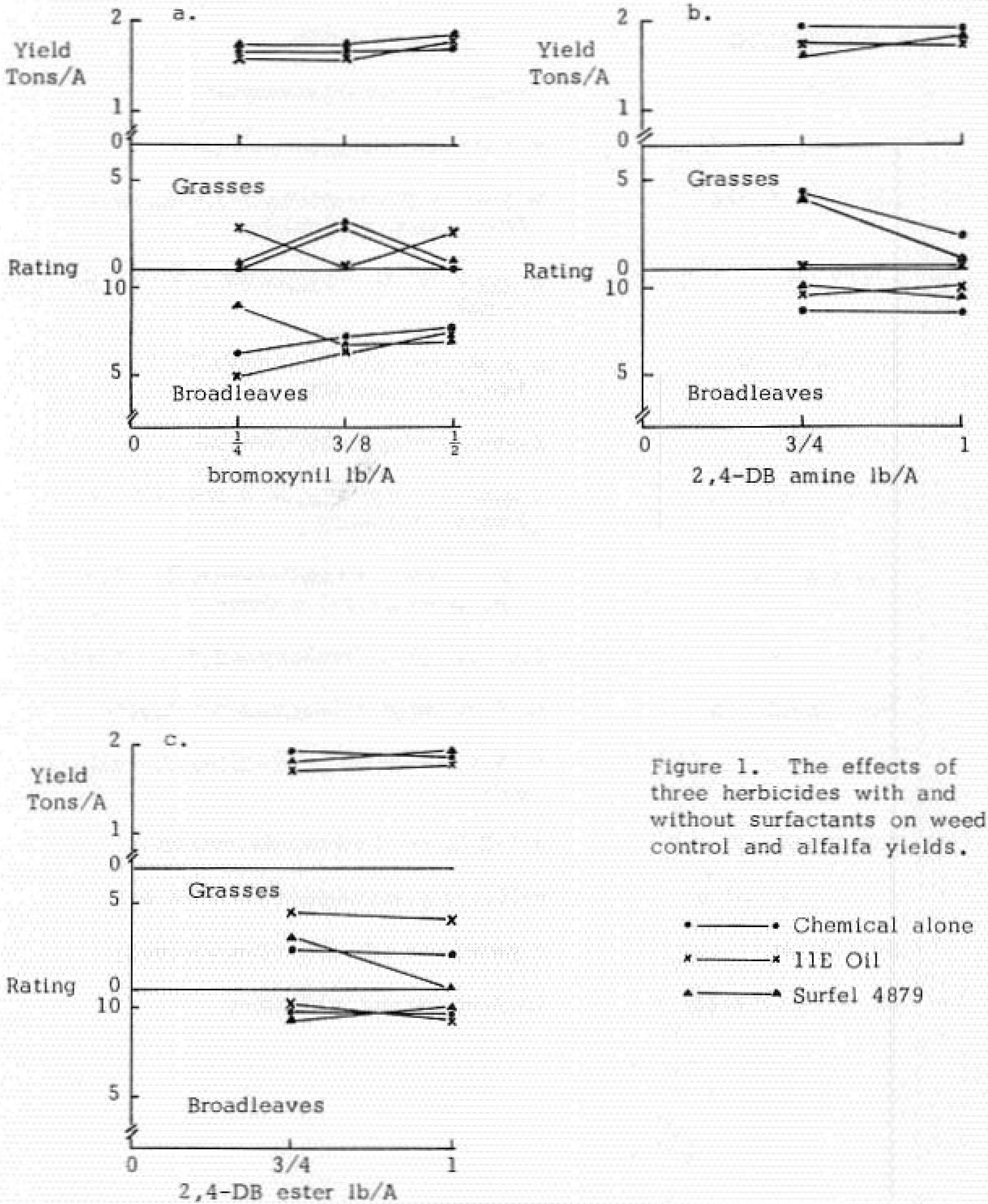


Figure 1. The effects of three herbicides with and without surfactants on weed control and alfalfa yields.

Appendix

Common Name	Chemical Name
Vernolate, ec	S-propyldipropylthiocarbamate
Dinoseb, ec	4,6-Dinitro-o-sec-butylphenol
BAS-3870-H, ec	N-allyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluoromethylaniline
A-820, ec	N-sec butyl-4-tertiarybutyl-2,6-dinitroaniline
Trifluralin, ec	α,α,α-Trifluoro-2-6-dinitro-N, N-dipropyl-p-toluidine
EPTC, ec	S-ethyl dipropylthiocarbamate
Benefin, ec	n-Butyl-N-ethyl α,α,α-trifluoro-2,6-dinitro-p-toluidine
VCS-438, wp	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazo=lioline-3,5-dione
Alachlor, ec	2,6-Diethyl-N-(methoxymethyl) acetanilide
Diphenamid, wp	N,N-Dimethyl-2,2-diphenylacetamide
RH-315, wp	N-(1-Dimethylpropynyl)-3,5-dichlorobenzamide
Bromoxynil, ec	3,5-Dibromo-4-hydroxybenzonitrile
2,4-DB, s and e	4-(2,4-dichlorophenoxy) butyric acid
No. 11 oil	A paraffinic oil of medium viscosity
UC 4879 (SURFEL)	An experimental surfactant

THE EFFECT OF SEEDING RATE AND HERBICIDE RATE ON PERFORMANCE OF VCS-438 IN ESTABLISHMENT OF ALFALFA.

Frank E. Brockman, William B. Duke and Julian F. Hunt[1]

ABSTRACT

Preemergence applications of 5 lb/A of 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione (VCS-438) for weed control in seedling alfalfa (Medicago sativa L.) compared favorably in most respects with the standard treatment of 3 lb/A of S-ethyl dipropylthiocarbamate (EPTC) applied preplant and incorporated plus 1 lb/A of 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) applied postemergence. There was no difference between these two treatments in the yield of alfalfa, redroot pigweed (Amaranthus retroflexus L.) and green foxtail (Setaria viridis (L.) Beauv.) at the time of first cutting. VCS-438, however, gave poorer control of barnyardgrass (Echinochloa crusgalli (L.) Beauv.). Alfalfa stand thinning occurred with VCS-438 treatment. Increasing seeding rate from 18 to 27 lb/A increased alfalfa stand but had no effect on forage yield.

INTRODUCTION

A need is felt in the Northeastern United States for a weed control treatment for the establishment of clear-seeded alfalfa (Medicago sativa L.) which does not require incorporation and/or two separate applications. Field trials conducted during 1968 and 1969 indicated that 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione (VCS-438) at rates of 2 to 4 lb/A might fulfill this need (1). However, in further studies carried out in 1970, it appeared that higher rates may be required to provide satisfactory weed control[2]. At these higher rates, an increase in crop injury could be anticipated. It was observed in growth chamber experiments that injury to alfalfa by high rates of VCS-438 consisted primarily of stand thinning and that plants which were not killed recovered and made good growth. In view of these observations, the study reported herein was conducted to determine if a higher seeding rate of alfalfa might compensate for the crop injury caused by VCS-438 when used at rates necessary for satisfactory weed control.

---

[1] Graduate Student, Assistant Professor and Experimentalist, respectively. Department of Agronomy, Cornell University, Ithaca, New York 14850.

[2] Brockman, F. E. 1971. Unpublished data.

MATERIALS AND METHODS

The study was conducted in 1971 at the Aurora Research Farm near Aurora, N. Y. on a Lima silt loam (OM = 3.5%). The experimental design was a split plot, replicated four times, with alfalfa seeding rates being assigned to the whole plots and herbicide treatments to the subplots. Subplot size was 6 x 20 ft.

Seeding rates of 18, 27 and 36 lb/A were used (18 lb/A being an average rate used with the standard herbicide treatments in New York state). Saranac alfalfa was planted on June 4 with a grain drill equipped for band seeding with press wheels and calibrated to deliver the required amount of seed. Fertilizer (300 lb of 10-10-10) was applied through the drill.

VCS-438 (75WP) was applied preemergence at rates of 0, 2, 3, 4, 5 and 6 lb/A. S-ethyl dipropylthiocarbamate (EPTC) at 3 lb/A, preplant incorporated, plus 4-(2,4-dichlorophenoxy) butyric acid (2,4-DB) at 1 lb/A, postemergence was included as a standard for comparison. Herbicides were applied with a Mater plot sprayer calibrated to deliver 30 gpa with compressed air as the pressure source. EPTC was incorporated by double discing immediately after spraying and just prior to planting. VCS-438 was applied the day after planting. The postemergence application of 2,4-DB was made 25 days after planting when alfalfa was in the four true-leaf stage and broadleaf weeds were in the four to six true-leaf stage. Redroot pigweed (Amaranthus retroflexus L.), barnyardgrass (Echinochloa crusgalli (L.) Beauv.) and green foxtail (Setaria viridis (L.) Beauv.) were the primary weed species present.

Crop response and weed control ratings on individual species were made 25 days after planting just prior to the application of 2,4-DB to EPTC treated plots. The rating scale used was 0 to 10 where 0 represents no control or crop injury and 10 represents complete reduction of plant stand and vigor. An area 3 x 16.75 ft. through the center of each subplot was cut for yield determination on August 18. A subsample composited from six locations within each subplot was taken for determination of botanical composition. These samples were weighed, separated according to species, oven-dried and reweighed. All yield data is expressed as lb/A on an oven dry basis (75C to a constant weight). An alfalfa stand count was made on August 31 by counting the number of plants per 50 cm of row at two locations chosen at random within each subplot. Plants were removed from the soil and the number of alfalfa taproots counted.

RESULTS AND DISCUSSION

Early control of all weed species was acceptable to excellent with rates of VCS-438 above 3 lb/A (Table 1). VCS-438 exhibited greater activity against redroot pigweed than against either of the grasses and did not provide as good grass control as EPTC. EPTC alone did not provide satisfactory control of redroot pigweed. (It should be noted that this rating was made just prior to application of 2,4-DB to the EPTC treated plots.) Higher

Table 1. Crop response and weed control ratings 25 days after planting as affected by VCS-438 and EPTC.

Herbicide Treatment	Rate lb/A	Ratings 1/ 2/ 3/ Alfalfa	Redroot Pigweed	Barnyard-grass	Green Foxtail
Control	-	0.3 a	0.0 a	0.0 a	0.0 a
VCS-438	2	1.6 b	8.0 c	6.7 b	6.1 b
	3	2.3 c	9.0 d	7.6 c	7.3 c
	4	2.5 c	9.1 d	7.9 c	7.8 d
	5	2.7 c	9.5 de	8.6 d	8.6 e
	6	3.5 d	9.7 e	8.8 d	8.6 e
EPTC	3	3.3 d	5.5 b	9.6 e	9.6 f

1/ Scale: 0 to 10; 0 = No effect and 10 = complete reduction of plant

2/ Stand and vigor ratings averaged across seeding rates

3/ Rating means followed by identical letters do not differ significantly at the 0.05 level.

rates of VCS-438 caused considerable thinning of the alfalfa stand. The high injury rating assigned to the EPTC treatment reflects observed symptoms of "leaf-cupping" and stunting. Seeding rate had no effect on weed control at this time.

Both seeding rate and chemical treatment affected the alfalfa stand at time of first cutting (Table 2). The 18 lb/A seeding rate resulted in

Table 2. Alfalfa stand count at time of first cutting as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate, lb/A	Stand Count, No. Plants/100 cm Row 1/ Seeding Rate, lb/A 18	27	36	Mean
Control	-	25	46	39	37 a
VCS-438	2	64	80	109	84 cd
	3	62	68	98	76 c
	4	60	70	86	72 bc
	5	52	60	69	60 b
	6	32	72	74	59 b
EPTC + 2,4-DB	3+1	66	107	102	92 d
Mean		51 a	72 b	82 b	

1/ Means followed by identical letters do not differ significantly at the 0.05 level.

fewer plants per 100 cm of row than the two higher seeding rates. The lowest stand count was found in the untreated control and can be ascribed to the effect of intense weed competition. Release from this competition by chemical treatment resulted in higher stand counts. However, with increasing rates of VCS-438, a definite thinning effect was observed.

The yield of redroot pigweed in the first cutting was affected by both seeding rate and chemical treatment (Table 3). The two higher seeding rates depressed pigweed yield as compared to the 18 lb/A rate. The

Table 3. Dry matter yield of redroot pigweed as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate, lb/A	Redroot Pigweed Yield, Dry Matter, lb/A[1/] Seeding Rate lb/A 18	27	36	Mean
Control	-	6222	4647	4523	5056 d
VCS-438	2	2181	867	2570	1719 c
	3	892	1460	1037	1130 bc
	4	2285	1327	831	1481 c
	5	334	296	939	523 ab
	6	760	617	532	636 ab
EPTC + 2,4-DB	3+1	68	211	273	184 a

[1/] Means followed by identical letters do not differ significantly at the 0.05 level.

correspondence between these results and those relating to the effect of seeding rate on alfalfa stand is noteworthy. A seeding rate higher than 18 lb/A provides a heavier stand which is more competitive with redroot pigweed. However, the stand and competitive ability of alfalfa is not increased beyond that achieved with a 27 lb/A seeding rate.

The yield of barnyardgrass as affected by herbicide treatment and seeding rate is shown in Table 4. VCS-438 did not significantly reduce the yield of this weed. This result confirms other observations[1/] that barnyardgrass has considerable tolerance for this chemical. Effective control was provided by EPTC plus 2,4-DB. Seeding rate had no effect on barnyardgrass yield.

[1/] Brockman, F. E., 1971. Unpublished data.

Table 4. Dry matter yield of barnyardgrass as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate lb/A	Barnyardgrass Yield, Dry Matter, lb/A[1/] Seeding Rate lb/A 18	27	36	Mean
Control	-	845	858	420	707 bc
VCS-438	2	837	776	1212	942 c
	3	1035	582	658	758 bc
	4	1130	685	638	817 bc
	5	249	854	536	546 b
	6	417	810	781	670 bc
EPTC + 2,4-DB	3+1	68	211	273	184 a

[1/] Means followed by identical letters do not differ significantly at the 0.05 level.

Herbicide treatment was the only factor which affected green foxtail yield (Table 5). Rates of VCS-438 from 2 to 5 lb/A gave as good control as the standard treatment of EPTC plus 2,4-DB. At 6 lb/A, VCS-438 provided better control than the standard treatment.

Table 5. Dry matter yield of green foxtail as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate lb/A	Green Foxtail Yield, Dry Matter, lb/A[1/] Seeding Rate, lb/A 18	27	36	Mean
Control	-	323	699	779	600 d
VCS-438	2	627	451	452	510 cd
	3	387	326	327	346 bc
	4	403	123	197	241 ab
	5	68	256	183	168 ab
	6	179	178	37	131 a
EPTC + 2,4-DB	3+1	207	418	384	336 bc

[1/] Means followed by identical letters do not differ significantly at the 0.05 level.

Table 6. Dry matter yield of alfalfa as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate lb/A	Alfalfa Yield, Dry Matter, lb/A[1/] Seeding Rate, lb/A 18	27	36	Mean
Control	-	61	472	107	213 a
VCS-438	2	1303	2710	1003	1672 b
	3	1857	1478	1871	1735 b
	4	1208	2241	2329	1926 b
	5	2861	3114	3077	3018 c
	6	1600	1999	2197	1932 b
EPTC + 2,4-DB	3+1	2858	2335	2655	2616 c

[1/] Means followed by identical letters do not differ significantly at the 0.05 level.

Results of the effects of herbicides and seeding rates on alfalfa yield are shown in Table 6. The yield of forage increased with increasing rates of VCS-438 to a maximum at 5 lb/A and then declined. The yield obtained with 5 lb/A of VCS-438 was comparable to that obtained with EPTC plus 2,4-DB. No effect of seeding rate on alfalfa yield was observed.

Relating the alfalfa yield results with the data obtained on weed yields and alfalfa stand count provides additional information on the factors controlling crop yield in this experiment. The differences in forage yield can be explained on the basis of two yield components: alfalfa stand and alfalfa vigor. A measure of the latter component is provided by values for weight per plant which were calculated from alfalfa yield and stand count data (Table 7). As rates of VCS-438 are increased from 2 to 5 lb/A, two yield

Table 7. Oven dry weight of alfalfa plants at time of first cutting as affected by alfalfa seeding rate and VCS-438 and EPTC + 2,4-DB.

Herbicide Treatment	Rate lb/A	Oven Dry Weight, gms/plant[1/] Seeding Rate, lb/A 18	27	36	Mean
Control	-	29	88	36	51 a
VCS-438	2	190	363	90	214 b
	3	308	208	191	236 bc
	4	194	310	277	260 bc
	5	553	568	431	517 e
	6	568	269	363	400 d
EPTC + 2,4-DB	3+1	455	204	277	312 cd

[1/] Means followed by identical letters do not differ significantly at the 0.10 level.

controlling factors are apparently operating in opposition to each other; a positive effect is exerted by a decrease in weed competition and a presumably negative effect is produced by a decrease in alfalfa stand. However, the release from weed competition has the greater influence and the increase in alfalfa vigor more than offsets the decrease in stand. A further increase in rate of VCS-438 from 5 to 6 lb/A has no effect on weed yield or stand count while alfalfa yield is decreased. The high rate of VCS-438 causes a reduction in crop vigor. Finally, it should be noted that, while the forage yield obtained with 5 lb/A of VCS-438 was comparable to that obtained with EPTC plus 2,4-DB, the stand count observed with the former treatment was significantly lower. Thus, it is seen that alfalfa vigor is reduced by the EPTC plus 2,4-DB treatment in comparison with the 5 lb/A VCS-438 treatment. This might be due to greater competition between alfalfa plants in the heavier stand or to a phytotoxic effect of the EPTC plus 2,4-DB treatment. Some support for the latter hypothesis is found in the data of Duke, et al. (2) which shows a significant reduction in weight per plant of 6 week old, greenhouse grown alfalfa treated with EPTC (3 lb/A, PPI) compared to an untreated, non-weedy control.

LITERATURE CITED

1. Duke, W. B., B. J. Brecke, and P. F. Boldt. 1970. Comparative effects of EPTC, Butylate and VCS-438 on annual weeds and alfalfa. Proc. NEWCC 24:213-219.

2. Duke, W. B., V. S. Rao, and J. F. Hunt. 1972. EPTC-Atrazine interaction effect on seedling alfalfa varieties. Proc. NEWCC 26. (In press).

EPTC - ATRAZINE RESIDUE INTERACTION EFFECT ON SEEDLING ALFALFA VARIETIES 1/

William B. Duke, V. S. Rao and Julian F. Hunt 2/

ABSTRACT

Experiments were conducted in the greenhouse during 1970 and 1971 to determine the effects of combinations of S-ethyl dipropylthiocarbamate (EPTC) and 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (atrazine) on the growth of seedling alfalfa (*Medicago sativa* L.). Atrazine incorporated through the soil contained in 6 in. pots reduced the final stand height and weight of alfalfa. When EPTC was mixed in the upper 2 in. of the triazine-treated soil, alfalfa injury was amplified. The effect of the combination was greater than the effect of either chemical alone. The reason for this is suggested to be due to an effect of EPTC on atrazine metabolism.

INTRODUCTION

Effects of 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (atrazine) residue on forage crop establishment have often been reported (1, 2, 4). Fink and Fletchall (2) reported that seedings of several forage crops including alfalfa (*Medicago sativa* L.) red clover (*Trifolium pratense*) and ladino clover (*Trifolium repens*) were severely injured 11 months following applications of 1 lb/A atrazine. Lucey *et al*. (4) reported that birdsfoot trefoil (*Lotus corniculatus*) seedings were severely damaged by triazine residue resulting from a split treatment of 3 and 2 lb/A atrazine applied 18 and 12 months, respectively, prior to legume establishment. In normal rotations used in the Northeast, clear-seeded alfalfa will often follow corn (*Zea mays* L.) which has been treated with similar rates of atrazine for the removal of quackgrass (3). Standard practices for establishing this clear-seeded alfalfa include the use of the herbicide S-ethyl dipropylthiocarbamate (EPTC) as a pre-plant incorporated treatment for grass and broadleaf control (3). Several recent reports have indicated that excessive EPTC injury to alfalfa occurs when seedings are made the year following corn. As a result, studies reported herein were designed to determine the possible influence of small quantities of atrazine on seedling alfalfa and if the use of EPTC rendered the young plants more susceptible to triazine injury.

MATERIALS AND METHODS

During 1970 and 1971, greenhouse studies were conducted to determine the effects of concentrations of atrazine and EPTC and their combinations on the growth of two alfalfa varieties, Iroquois and Narragansett. Honeoye

---

1/ Contribution from the Department of Agronomy, New York State College of Agriculture, Cornell University, Ithaca, New York.

2/ Assistant Professor, Research Assistant and Experimentalist, respectively, Department of Agronomy, Cornell University, Ithaca, New York.

silt loam soil with an organic matter of 3.8% was used in all studies. The experimental design was a randomized complete block with three replications.

Atrazine at 0, 1/16, 1/8, 1/4 and 1/2 ppm by weight (ppmw), on an air-dry basis, was thoroughly mixed with the soil by spraying the chemical onto the soil as it rotated in a 5 gal. small-batch mixer. Incorporation was considered complete after 5 min. After mixing, the treated soil was placed in 6 in. diameter pots sufficient to fill them to within 2 in. of the top. The remaining 2 in. of soil was treated with EPTC at 0 or 3 ppmw as described for atrazine i.e. incorporated thoroughly in the mixer for 10 min. After the second treatments, soil was added to the pots to fill them to capacity. Alfalfa seed were planted 1/4 in. deep and soil was brought to field capacity.

Data on seedling emergence was taken 7 days after planting. Seedlings were harvested six weeks after seeding by clipping at the soil surface.

RESULTS AND DISCUSSION

Germination and emergence of the two alfalfa varieties was unaffected by atrazine applied alone (Table 1) which agrees with the report of Fink and Fletchall (2) that alfalfa germinates equally well in soil containing up to 1.0 ppmw of this triazine herbicide. Similarly, EPTC was also ineffective against germination. However, when EPTC was combined with either

Table 1. Effect of atrazine and EPTC on emergence and final stand at harvest of Iroquois and Narragansett alfalfa.

Atrazine Rate, lb/A	EPTC Rate, lb/A	Seedling Emergence (%) 1/		Stand Reduction (%) 2/	
		Iroquois	Narragansett	Iroquois	Narragansett
0	0	75 ab 3/	90 a	3 g	2 g
	3	75 ab	85 ab	7 g	7 g
1/16	0	79 a	89 a	15 f	10 f
	3	76 ab	84 ab	18 f	11 f
1/8	0	74 ab	87 ab	23 e	18 e
	3	72 b	80 b	54 d	18 d
1/4	0	72 b	86 ab	76 c	62 c
	3	66 c	80 b	88 b	89 b
1/2	0	75 ab	85 ab	100 a	100 a
	3	61 c	82 b	100 a	100 a

1/ Emergence values are based on the number of plants emerging divided by the number of planted seeds.
2/ Stand reduction values are based on the number of plants at harvest (6 weeks) as a percent of those which emerged.
3/ Values in the same columns followed by identical letters are not significant at the 0.05 level.

1/4 or 1/2 ppmw atrazine, a significant reduction in emergence of one variety, Iroquois, was observed. Emergence of Narragansett seedlings was unaffected by the combination.

Results showing final stand counts in response to EPTC or atrazine treatments also indicated that the combination of EPTC with atrazine was more active than either chemical alone (Table 1). All rates of atrazine applied singularly significantly reduced the stand of both varieties by the time of harvest, while EPTC did not. When EPTC was, however, incorporated with the atrazine, stand reduction was significantly greater than when atrazine had been used alone. The significant interaction was observed with both 1/8 and 1/4 ppmw atrazine. Iroquois alfalfa seemed to be more responsive to the interaction than Narragansett.

The height of Iroquois and Narragansett at harvest was not affected by EPTC alone (Table 2). Iroquois was significantly shorted by all rates of atrazine while Narragansett was affected by only the 1/4 and 1/2 ppmw. This reduction in height caused by atrazine was amplified when EPTC was added to the soil. Seedlings of both varieties were significanly shorter when 1/4 ppmw atrazine and EPTC were combined while only Narragansett gave a significant response to 1/8 ppmw with EPTC. Differences between varieties were, however, not significant.

Table 2. Effects of EPTC and atrazine on the height and yield of Iroquois and Narragansett alfalfa 6 weeks after planting.

Atrazine Rate, lb/A	EPTC Rate, lb/A	Iroquois Height[1] (cm)	Iroquois % reduction	Narragansett Height (cm)	Narragansett % reduction	Iroquois Fr. Wt.[2] (mg)/plant	Iroquois % reduction	Narragansett Fr. Wt. (mg)/plant	Narragansett % reducti
0	0	35 a[3]	0	37 a	0	736 a	0	881 a	0
	3	34 a	3	34 ab	9	622 b	16	661 b	25
1/16	0	26 b	26	34 ab	9	562 b	24	655 b	26
	3	24 b	32	31 b	17	457 c	38	548 c	38
1/8	0	22 b	38	31 b	17	453 c	39	559 c	37
	3	23 b	35	24 c	36	309 d	59	402 d	55
1/4	0	0 d	100	0 e	100	0 f	100	0 f	100
	3	0 d	100	0 e	100	0 f	100	0 f	100

1/ Height values were taken the day of harvest of 6 weeks after planting.

2/ Fresh weight figures were obtained 6 weeks after planting.

3/ Values in the same column followed by identical letters are not significant at the 0.05 level.

Alfalfa yield was dramatically affected by both EPTC and atrazine (Table 2). Singular applications of EPTC and 1/16 ppmw atrazine equally reduced the yield of both varieties. When higher rates of atrazine were incorporated throughout the soil profile, a typical rate response was noted which was significant in all cases. The addition of 3 ppmw EPTC to the atrazine-treated soil caused an even greater weight reduction than had been noted with either chemical alone. This enhanced reduction was significant for all rates of atrazine. Both varieties responded similarly.

Interestingly, the yield reduction in response to 1/16 ppmw atrazine in combination with EPTC is similar to that obtained with 1/8 ppmw atrazine alone, and 1/8 ppmw in combination is similar to 1/4 ppmw atrazine alone. This would indicate that EPTC enhances the physiological effect of atrazine in the plant by 1) affecting the same biochemical mechanism as does atrazine or 2) preventing the metabolism of the triazine which would provide more phytotoxicant in the plant and at the low rates used in these studies, provide more activity. Two lines of reasoning would support the latter contention. First, the most recent evidence for the mode of action of EPTC indicates that it affects protein synthesis (5) rather than photosynthesis as does atrazine (6). Second, in this study plants treated with the combination of chemicals exhibited phytotoxic symptoms which were practically identical to those observed on seedlings treated with atrazine alone and which were dissimilar to those seen on seedlings treated with EPTC alone. For example, alfalfa seedlings exposed to 3 ppmw EPTC exhibited slight height reduction and cupping of the first and second trifoliate leaves which lasted for only one to three weeks and was followed by recovery. On the other hand, seedlings exposed to 1/2 ppmw atrazine exhibited a rapid spread of chlorosis from the margins of the first and second trifoliate leaves until the whole leaf area was affected and the plants died. When plants were treated with a lower rate of atrazine, such as 1/8 ppmw, a similar chlorosis occurred, but phytotoxic action was not as fast and many plants recovered and grew normally. Seedlings treated with EPTC and 1/8 ppmw atrazine not only showed short-lived leaf cupping, they exhibited chlorosis which spread more rapidly than noted for 1/8 ppmw alone and approximately as fast as 1/4 or 1/2 ppmw atrazine alone. Symptoms on all plants treated with the combinations of chemicals appeared to be due to a higher concentration of atrazine than that being used in the particular treatment.

If the observational data are coupled with the reports in the literature that 1) EPTC interfers with protein synthesis in plants (5) and that 2) atrazine metabolism in corn is dependent on the presence and activity of the enzyme glutathione S-transferase (7), it seems logical that enhanced seedling mortality which occurs when EPTC is used in soil containing low levels of atrazine is due to EPTC preventing the formation of a similar detoxifying enzyme in alfalfa which would then prevent the metabolism of atrazine and thereby allow more activity rather than inactivity.

In the soils of New York, where triazine herbicides are being used for weed control in corn, the year before triazine-sensitive crops are planted, crop injury may occur if a small level of triazine residue persists and if EPTC is used on the succeeding crop. This injury will likely not be evident if EPTC is not used. Other herbicides which are used on succeeding crops may also cause this effect. Accordingly, reports of herbicide injury on crops which are grown in soils previously treated with triazine herbicides may be due to an interaction effect rather than an effect of the individual herbicide.

LITERATURE CITED

1. Buchholtz, K. P. 1966. Factors influencing oat injury from triazine residues in soil. Weeds 14:362-367.

2. Fink, Rodney J. and O. Hale Fletchall. 1963. Forage crop establishment in soil containing atrazine or simazine residues. Weeds 11:81-83.

3. Linscott, D. L. and R. D. Hagin. 1968. Interaction of EPTC and DNBP on seedlings of alfalfa and birdsfoot trefoil. Weed Science 16:182-184.

4. Lucey, R. F., S. N. Fertig, and E. J. Czarnetzky. 1967. Herbicide injury to oats and birdsfoot trefoil following corn treated for the control of quackgrass. Proc. NEWCC 21:286-293.

5. Moreland, D. E., S. S. Malhotra, R. D. Gruenhagen, and E. H. Shokrah. 1969. Effects of herbicides on RNA and protein synthesis. Weed Science 17:556-563.

6. Moreland, D. E. and K. L. Hill. 1962. Interference of herbicides with the Hill reaction of isolated chloroplasts. Weeds 10:229-236.

7. Shimabukuro, L. H., D. S. Frear, H. R. Swanson and W. C. Walsh. 1971. Glutathione conjugation. An enzymatic basis for atrazine resistance in corn. Plant Physiol. 47:10-14.

THE EFFECTS OF 4-AMINO-6-T-BUTYL-3-(METHYLTHIO)-AS-TRIAZIN-5-(4H)-ONE (BAY 94337) ON WEEDS IN ESTABLISHED ALFALFA [1/]

William B. Duke and Julian F. Hunt [2/]

ABSTRACT

Experiments conducted at two locations during 1970 and 1971 revealed that 4-amino-6-t-butyl-3-(methylthio)-as-triazin-5-(4H)-one (BAY 94337) was effective for the control of common dandelion (Taraxacum officinale Weber) in established alfalfa. Applications of the herbicide in the spring were found to be more effective than the corresponding treatments in the fall. Even though treatments in the fall reduce the vigor of dandelion, the weed survives and spreads. Alfalfa was found to tolerate up to 2 lb/A of BAY 94337 but maximum levels for normal use are suggested to be in the range of 1.0 to 1.5 lb/A.

INTRODUCTION

The herbicide 4-amino-6-t-butyl-3-(methylthio)-as-triazin-5-(4H)-one (BAY 94337) has been reported to be effective for annual and perennial broadleaf and grass control in several crops (1, 2, 4). Murphy (4) reported that high rates of this chemical gave marginal control of quackgrass (Agropyron repens (L.) Beauv.) in potatoes (Solanum tuberosum). Hunt [3/] reported excellent control of quackgrass with similar rates. On the other hand, Rockwell [4/] noted that in corn (Zea mays L.) and soybeans (Glycine max (L.) Merr) volunteer alfalfa (Medicago sativa L.) was not removed by preemergence applications of BAY 94337. Studies reported herein were conducted to determine the tolerance of established alfalfa and common dandelion (Taraxacum officinale Weber) to BAY 94337 applied at different times during the year.

MATERIALS AND METHODS

During 1970 and 1971 experiments were conducted near Etna, New York on Lima channery silt loam (OM = 3.2%) and near Aurora, New York on Lima silt loam (OM = 3.9%). In all experiments, plots 6 x 20 ft. were established in an alfalfa stand predominately infested with dandelion. Herbicide applications in all cases were made with a Mater plot sprayer calibrated to deliver 30 gpa. Each experiment was a completely randomized block design with four replications.

In Experiment I, BAY 94337 at 0, 0.5 and 1.0 lb/A was applied to a two year old stand of Saranac alfalfa on April 13, 1970. Applications were made prior

---

1/ Contribution from the Department of Agronomy, New York State College of Agriculture, Cornell University, Ithaca, New York.

2/ Assistant Professor and Experimentalist, respectively, Department of Agronomy, Cornell University, Ithaca, New York 14850.

3/ Hunt, J. F. 1970. Personal Communication.

4/ Rockwell, L. F. 1970. Personal Communication.

to visible initiation of growth of buds on the alfalfa crowns. Dandelion plants, on the other hand, were completely green and appeared to be actively growing. Total forage yield was estimated from a 3.25 by 20 ft. swath taken from the center of each plot at each of three cutting dates during the 1970 growing season. All yield data are expressed as lb/A on an oven-dry basis (75 C to a constant weight). Botanical composition estimates were made on the standing forage by the visual weight estimation method described by Hunt (3).

In late 1970, Experiment II was initiated in a three year old stand of Naragansett alfalfa to compare BAY 94337 at 0, 0.5, 1.0, 1.5 and 2.0 lb/A applied in the fall with similar rates applied in the spring. Dates of application were November 3, 1970 and April 13, 1971. In November, the herbicide was applied immediately after the alfalfa had been mowed to a height of 4 to 5 in. At that time, dandelion rosettes were 10 to 12 in. in diameter and were actively growing. In the spring, BAY 94337 was applied prior to visible initiation of alfalfa growth. At the time of treatment dandelion rosettes averaged 3 to 6 in. in diameter at the time of spraying, and were actively growing.

In Experiment II, total forage yield estimations were taken as described for Experiment I. In this study, however, botanical composition was determined from hand separations of a random, subsample composited from five locations within each plot. Samples were separated into dandelion and alfalfa, weighed and oven-dried. All yield data are expressed as lb/A on an oven-dry basis.

RESULTS AND DISCUSSION

In Experiment I, BAY 94337 caused a dramatic reduction in dandelion growth by the time of first forage harvest (CT I) in 1970. (Table 1). Differences between rates of the herbicide were not found to be significant,

Table 1. Botanical composition and yield of forage as affected by BAY 94337 applied in the spring to established alfalfa, Etna, New York, 1970.

		Botanical Composition (%) 1/						Total Yield,
	Rate	Dandelion			Alfalfa			Dry Matter
Herbicide	lb/A	CT I	CT II	CT III 2/	CT I	CT II	CT III	lb/A
BAY 94337	1/2	8 a	7 ab	9 ab 3/	89 b	92	90 ab	8489
	1	2 a	2 a	4 a	98 a	98	96 a	8701
Control	0	15 b	9 b	16 b	81 b	90	82 b	8104

1/ Botanical composition figures obtained by the visual weight estimation method (3).

2/ CT I, CT II and CT III refer to forage harvests taken respectively on June 3, June 27 and September 21, 1970.

3/ Treatment means followed by identical letters are not significant at the 0.05 level.

however, there was a trend towards greater activity with the 1 lb/A rate. The effectiveness of the herbicide was lasting as evidenced by continued significant reduction in dandelion through the time of third cutting (CT III). The highest rate of BAY 94337 caused a small amount of marginal chlorosis on older alfalfa leaves prior to first cut but this phytotoxic symptom persisted for only a short time. The short-lived effect did not affect total forage yield.

The results of Experiment II indicated that dandelion plants treated in the fall with BAY 94337 responded quite differently to those treated in the spring (Table 2). One month after treatment in the fall, rosettes of treated dandelion plants were yellow, necrotic and were 2 to 3 times smaller in diameter than corresponding untreated plants. By June of the following year, however, these same plants had partially or fully recovered. On the other hand, plants treated in the early spring had similar phytotoxic symptoms and never recovered.

It is interesting that even though the size and vigor of the perennial broadleaf is reduced by BAY 94337 prior to winter, the plant fully recovers the following growing season. One possible reason for this incomplete kill could be related to the physiology of the dandelion plant and soil-chemical relationships. As fall progresses, carbohydrates produced by photosynthesis are translocated to the tap root for storage for winter survival and spring

Table 2. Common dandelion control with BAY 94337 applied in the fall or spring to established alfalfa, Aurora, New York, 1971.

Application	BAY 94337 Rate, lb/A	Plant Response Ratings 1/ 2/ Dandelion Dec. 9, 1970	Dandelion June 6, 1971
November, 1970	0.5	4.8 b	1.0 b
	1.0	6.8 ab	2.0 b
	1.5	6.5 ab	0.8 b
	2.0	7.3 a	2.0 b
April, 1971	0.5	0.0 c	8.5 a
	1.0	0.0 c	10.0 a
	1.5	0.0 c	10.0 a
	2.0	0.0 c	10.0 a
Control	--	0.0 c	0.0 b
Control	--	0.0 c	1.3 b

1/ Plant response ratings are based on the scale 0 to 10 where 0 represents no control and 10 represents a complete reduction in stand and vigor.

2/ Treatment means followed by the same letter do not differ significantly at the 0.05 level.

regrowth. The level of photosynthesis diminishes as temperatures near freezing. If BAY 94337 was applied after the time that sufficient carbohydrates had been stored but to cessation of photosynthesis through freezing, yellowing and marginal necrosis would occur with minimal effects on the ability of the plant to survive the winter. Any herbicide which might be in the plant storage organ during the winter might possibly be detoxified metabolically. In the early spring, the chemical present in the soil would be leached away from the dandelion root zone by melting snow. On the other hand, BAY 94337 applied to dandelion plants in the spring would affect photosynthesis needed for early growth which would be fatal for plant survival. Finally, leaching effects in the spring would be of a smaller magnitude.

Botanical composition data taken on each of three cutting dates confirmed the effectiveness of BAY 94337 for dandelion control (Table 3). All rates of this herbicide applied in the early spring significantly reduced the yield of this weed at each cutting date. No significant differences in rates were observed although the lowest rate did appear to be less active. At the last harvest (CT III) dandelion plants began to reappear in all treated plots as evidenced by increased weed yield. The significance of this slight regrowth will not be known until June of 1972 when yields of weeds and alfalfa will

Table 3. Yield of alfalfa and common dandelion as affected by BAY 94337 applied in the fall or spring to established alfalfa. Aurora, New York, 1971.

	BAY 94337	Alfalfa Yield 1/ Dry Matter lb/A			Dandelion Yield 1/ 3/ Dry Matter lb/A			
Application	Rate lb/A	CT I	CT II	CT III 2/	CT I	CT II	CT III	Ave.
Nov., 1970	0.5	3790	2355	904	141	226	183	183 bc
	1.0	3854	2174	548	65	222	229	172 cd
	1.5	3372	2172	813	127	220	288	212 abc
	2.0	3678	2369	968	13	149	171	111 d
April, 1971	0.5	3635	2667	1196	28	45	115	63 e
	1.0	3823	2714	1286	0	2	56	19 e
	1.5	3464	2688	1598	0	0	66	22 e
	2.0	2694	2523	1385	1	7	58	22 e
Control	0	3645	2156	704	245	287	249	260 a
Control	0	3974	2314	783	193	267	256	239 ab

1/ Yield values . re obtained from botanical separations of five random sub-samples from each plot

2/ CT I, CT II, and CT III refer to cutting dates taken on June 9, July 19 and August 31, 1971 respectively.

3/ Means followed by identical letters are not significant at the 0.25 level.

again be taken. The slight re-infestation at third cutting, however, may indicate that a retreatment with this herbicide is required. The highest rate of BAY 94337 applied in the fall effected a significant reduction in dandelion yield over the year but was less effective than the corresponding treatment in the spring. Rates less than 2 lb/A in the fall were, at best, erratic.

Alfalfa yields were not significantly reduced by BAY 94337 (Table 3). It is important to note, however, that two weeks prior to first cutting some discoloration of the margins of older alfalfa leaves was observed on plants treated with 1.5 and 2.0 lb/A in the fall or the spring. Plants treated with 2.0 lb/A were less vigorous at first cutting but recovered fully by second cutting. The most effective and safest concentration range appeared to be 1 to 1.5 lb/A.

BAY 94337 applied in the early spring is more effective for complete dandelion control than corresponding applications in the fall. This herbicide appears safe for use on alfalfa except at the higher rates.

LITERATURE CITED

1. Bayer, George H. 1971. A four year summary of weed control in white potatoes in upstate New York. Proc. NEWSS 25:181-185.

2. Cialone, J. C. and D. A. Braden. 1971. Evaluation of herbicides for weed control in transplanted and seeded tomatoes. Proc. NEWCC 25:401-402.

3. Hunt, O. J. 1964. An evaluation of the visual weight estimation method of determining botanical composition of forage plots. Agron. Jour. 56:73-76.

4. Murphy, H. J. and M. J. Goven. 1971. Weed Control in white potatoes in Maine. Proc. NEWSS 25:204-211.

A COMPUTERIZED CHEMICAL-HERBICIDAL SCREENING DATA BASE

R. A. Creager[1]

ABSTRACT

Very powerful searching capability with a small-to-medium-sized computer (CDC 3150) is provided in a set of FORTRAN IV programs, written to search a growing file of 25,000 compounds for chemical substructures and herbicidal activities. This Fort Detrick data base contains four kinds of chemical information for substructure searching; the biological details cover two dosage rates, four degrees of activity, and ten kinds of plant responses on the following six species: *Phaseolus vulgaris* var. Black Valentine, *Glycine max* var. Kanrich, *Ipomoea purpurea* var. Heavenly Blue, *Raphanus sativus* var. Scarlet Globe, *Avena sativa* var. Clintland, and *Oryza sativa* var. P.I. 8970.

The chemicals are applied as foliar sprays on 7-day-old plants. Visual effects are observed after 1, 5, and 10 to 14 days. The input biological data are based on these effects, which can be searched in a single pass of the total tape or disc file for up to 25 sets of queries. Each set may contain up to 15 criteria or search questions. One such criterion is a linear sequence of the four elementary variables: visual effect, dosage, plant species, and intensity of effect.

This paper elaborates on the biological aspects of the data base, and briefly mentions the chemical aspects, which were detailed in earlier papers.

[1]Horticulturist, Vegetation Control Laboratory, Fort Detrick, Frederick, Maryland 21701

STRUCTURE-ACTIVITY RELATIONSHIPS AMONG HERBICIDES RELATED TO ANILINE

D. L. Sirois [1]

ABSTRACT

Regressions of the physicochemical parameters (parachor and Hansch's π constant) on the pre-emergence herbicidal activity for 13 analogues of aniline were determined in greenhouse tests. The results show a marked correlation of herbicidal activity with both parachor and π. The results thus indicate that a strong relationship exists between the pre-emergence herbicidal activity of certain aniline analogues and their lipophilicity whether evaluated in terms of parachor or Hansch's π constant.

INTRODUCTION

During the past two decades, empirical screening programs have led to the discovery of a number of important herbicides. The success of the empirical approach is, however, highly dependent upon chance. A more rational approach, as suggested by Gabbott (5), encompassing structure-activity studies based upon an understanding of underlying biochemical and physiological phenomena appears to hold more promise for further enhancing the design and development of more efficient and safer herbicides.

A number of aromatic nitrogenous compounds possess pre-emergence herbicidal activity, particularly against grassy weed species. These compounds include amides, carbamates, chloroacetamides and dinitroanilines. The objective of the present study was to determine the absence or presence of a relationship between herbicidal activity and molecular structure in this heterogeneous group of pre-emergence herbicides.

If the full benefits of structure-activity studies of herbicides are to be realised, it is important that the derived structure-activity relationships be defined in mathematical terms. The recent trend has been to express the toxicity of biologically active molecules in terms of extra-thermodynamic substituent constants. In a number of biological systems, excellent correlations have been obtained between biological response and these substituent constants (6, 7, 8, 9, 13).

McGowan (13) has recently developed a theory of "physical toxicity" which relates biological activity to molar volume or parachor (P). Based on certain theories of solubility McGowan derived the equation

$$-\log_{10} C_t = -\log c'_t + k(P) \qquad (1)$$

to relate toxicity to parachor. In this expression, C_t and c'_t are the toxic concentrations in the aqueous phase and the biophase, respectively, and k is a constant.

---

[1] Boyce Thompson Institute for Plant Research, Yonkers, New York 10701

Parachor (P) is a physical constant derived from the physical properties of molecular weight, density and surface tension. Hence, the parachor for a liquid is defined

$$P = r^{\frac{1}{4}} \frac{M}{D-d} \quad (2)$$

where M is the molecular weight; r is the surface tension; D is the density of the liquid and d is the density of the vapor, respectively. When the vapor density is small compared to the density of the liquid:

$$P = Vm\, r^{\frac{1}{4}} \quad (3)$$

where Vm is the molar volume. When the surface tension equals unity:

$$P = Vm \quad (4)$$

The parachors of a wide variety of organic compounds may be calculated from a table, compiled by Quayle (15), of estimated parachor values for various group and bond contributions. Quayle also has catalogued empirically determined parachors for a number of compounds.

Hansch and coworkers (7, 8, 9) have introduced a theory of toxic action based on the substituent constant, π, a free energy related parameter which is a measure of the lipophilic character or hydrophobic bonding power of a substituent. They found that the biological activity of a series of substituted compounds can be related to π and the Hammett σ function as follows:

$$\text{Log } 1/C = -k\pi^2 + k'\pi + \rho\sigma + k'' \quad (5)$$

In the above equation C is the concentration of the organic compound producing an equivalent biological response, i.e. LD_{50}, ED_{50}, etc., ρ and σ are Hammett functions with σ being a substituent constant related to electronic effects, ρ a reaction constant peculiar to the system being studied, and k, k', and k'' are constants. π is defined as: $\pi = \log P_X/P_H$ where P_H is the partition coefficient of a parent compound and P_X that of a derivative in a 1-octanol-water system.

Parachor and Hansch's π constant are two of the substituent constants related to lipophilicity which have received wide acceptance in the study of structure-activity relationships. The present study was, therefore, limited to examining herbicidal activity in terms of these two physicochemical parameters. Undoubtedly, other parameters also could be found to relate phytotoxicity to lipophilicity equally as well as π and parachor. However, it is not our intent or purpose to evaluate all possible substituent constants which might be employed.

MATERIALS AND METHODS

The regression of physicochemical parameters on the pre-emergence herbicidal activity of a number of analogues of aniline was studied using ED_{50} values obtained from dosage-response curves contructed for each of the analogues. The compounds (technical grade) were dissolved in an acetone-surfactant solution, then made up to volume with distilled water. Serial dilutions of each preparation were made and 50 ml of each of the resulting dilutions were applied as a soil drench to individual 3½" X 3½" X 3" pots at concentrations of 4×10^{-1} to 2×10^{-7} moles/pot. The final aqueous solutions or suspensions contained, in addition to the active compound, 10% acetone and 0.1% Triton X151-X171 (1:1). Immediately prior to treatment the soil in the pots was planted with Japanese millet [Echinocloa frumentacea (Roxb.) Link] seeds at the rate of ½ teaspoon per pot. After the treated pots were held for two weeks in the greenhouse the above-ground parts of the emerging seedlings were harvested and the fresh weights recorded. The fresh weight data were transformed to percentages and a dosage-response curve for each of the test compounds was derived by plotting percent of control fresh weight versus the logarithm of the molar concentration. From these dosage-response curves an ED_{50} (median dose that reduces fresh weight to 50% of control fresh weight) was obtained graphically for each compound.

RESULTS AND DISCUSSION

Our results (Table 1) indicate a relationship between the pre-emergence herbicidal activity and the lipophilic characteristics of a number of organic compounds. Using the method of least squares the following equations were derived from the data presented in Table 1.

	n	r	s	
$\log 1/ED_{50} = 0.01087P - 0.281$	13	0.962	0.825	(6)
$\log 1/ED_{50} = 1.160\pi + 2.377$	13	0.899	0.680	(7)

In the above equations P is parachor, π is Hansch's constant, n is the number of points used in deriving the constants, r is the correlation coefficient and s is the standard deviation. F tests indicate that both of these equations are statistically significant at the 0.01 level. Comparison of the correlation coefficients reveals, however, that equation 6 fits the data better than equation 7. The fact that the herbicidal activity of the compounds appears to be more strongly correlated with parachor than with π is most likely explained by the unavailability of accurate estimates of the π values for some of the substituents involved in this system.

It is apparent that the data indicate a relationship between the pre-emergence herbicidal activity of certain aniline analogues and their lipophilicity whether evaluated by parachor or Hansch's π constant. The physical significance of this correlation is, however, not so apparent. It is quite possible that changes in the lipophilic character of these compounds, resulting from the addition or removal of substituents, may bring about changes in biological activity which may be manifested in a number of ways.

Hansch (9) suggested that lipophilicity may influence biological activity through an effect on the ease with which a compound can penetrate lipid barriers within an organism in transit to its target site. According to the theory, in a series of analogues, compounds with small partition coefficients will not be able to penetrate the lipid barriers presented by living cells but will be restricted to the aqueous phase. Therefore, as the partition coefficient of the parent molecule is increased by adding lipophilic substituents the molecule can more readily penetrate lipid barriers in gaining access to its site of action. It may well be then that a strong lipophilicity may be required by these herbicides to insure adequate transport into plant tissues.

Lambert (11) studied the effect of chemical structure on the sorption of certain dinitroaniline and phenylurea herbicides by soil and showed linear relationships between K (the partition coefficient between soil organic matter and water) and parachor. Apparently, an increase in parachor increases the sorption of these herbicides by the soil. Briggs (1) found similar relationships between soil sorption of these herbicides and their π values. It would then seem that as lipophilicity increases, soil sorption sites would compete for the herbicide molecules with active sites in the emerging plant seedlings. However, soil sorption also may stabilize the availability of the herbicide in the soil by preventing leaching and volatilization losses.

Phytotoxicity of the tested herbicides may be related to their lipophilic character in yet another way. Hansch and Anderson (6), using the data of Ostergren (14) have shown a relationship between π and c-mitosis (mitotic inhibition similar to that caused by colchicine) in onions. Similarly, McGowan (13) showed a direct relationship between parachor and mitotic inhibition in onion. Of the compounds considered in the present study those that are established or implied mitotic poisons include acetanilide (14), phenylurethane (12), propanil (10), propham (2, 3), chloropropham (3), and trifluralin (10). Thus it is suggested that these herbicides may have a common mode of action as disorganizers of mitosis and that their relative activity as mitotic poisons is governed, at least in part, by the lipophilic character of the molecules.

SUMMARY

Obviously the results presented in this paper pose more questions than answers. The results do, however, indicate that the pre-emergence herbicidal activity of structurally different molecules appears related to certain physicochemical parameters of these molecules. Further indicated is the need for a study of the structure-activity relationships of pre-emergence herbicides on simpler biological systems than entire plants. Cytological and biochemical studies of toxic action by these herbicides in relation to molecular structure offers promise of not only increasing our knowledge and understanding of the physiology and biochemistry of present herbicides, but enhancing the design and synthesis of active new compounds.

LITERATURE CITED

1. Briggs, G. G. Molecular structure of herbicides and their sorption by soils. Nature (London) 223: 1288. 1969.

2. Doxey, D. The effect of isopropyl phenyl carbamate on mitosis in rye (Secale cereale) and onion (Allium cepa). Ann. Bot. (London) 13: 329-335. 1949.

3. Ennis, W. B., Jr. Histological and cytological responses of certain plants to some aryl carbamic esters. (Abst.) Amer. J. Bot. 36: 823. 1949.

4. Fujita, Toshio, Junkichi Iwasa, and Corwin Hansch. A new substituent constant, π, derived from partition coefficients. J. Amer. Chem. Soc. 86: 5175-5180. 1964.

5. Gabbott, P. A. The design of herbicides: a rational approach. Proc. Biochem. Soc. 101: 1P. 1966.

6. Hansch, Corwin and Susan M. Anderson. The structure-activity relationship in barbiturates and its similarity to that in other narcotics. J. Med. Chem. 10: 745-753. 1967.

7. Hansch, Corwin and Toshio Fujita. ρ-σ-π analysis. A method for the correlation of biological activity and chemical structure. J. Amer. Chem. Soc. 86: 1616-1626. 1964.

8. Hansch, Corwin, Robert M. Muir, Toshio Fujita, Peyton P. Maloney, Fred Geiger and Margaret Streich. The correlation of biological activity of plant growth regulators and chloromycetin derivatives with Hammett constants and partition coefficients. J. Amer. Chem. Soc. 85: 2817-2824. 1963.

9. Hansch, Corwin, A. Ruth Steward, Junkichi Iwasa and Edna W. Deutsch. The use of a hydrophobic bonding constant for structure-activity correlations. Mol. Pharmacol. 1: 205-213. 1965.

10. Hull, Herbert M. Biocides. Part V. Herbicides. In "Metabolism" (P. L. Altman and D. S. Dittmer eds.) pp. 477-484. Fed. Amer. Soc. Exptl. Biol., Bethesda, Md. 1968.

11. Lambert, Sheldon M. Functional relationship between sorption in soil and chemical structure. J. Agr. Food Chem. 15: 572-576. 1967.

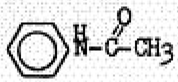
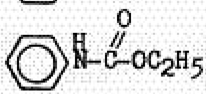
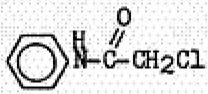
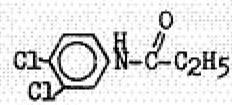
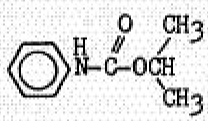
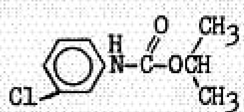
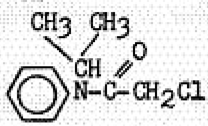
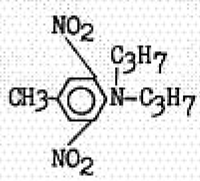
12. Lefèvre, Joseph. Similitude de actions cytologiques exercées par le phényluréthane et la colchicine sur des plantules végétales. C. R. Acad. Sci. 208: 301-304. 1939.

13. McGowan, J. C. The physical toxicity of chemicals. II. Factors affecting physical toxicity in aqueous solutions. J. Appl. Chem. 2: 323-328. 1952.

14. Östergren, G. Mecanisme de la Narcose. Centre National de la Recherche Scientifique, Paris. p. 77. 1950.

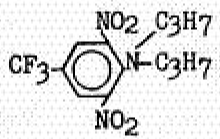
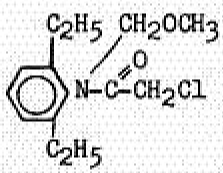
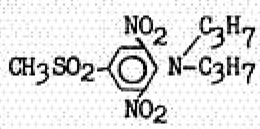
15. Quayle, Osborne R. The parachors of organic compounds: An interpretation and catalogue. Chem. Rev. 53: 439-589. 1953.

Table 1. Herbicidal activity of compounds of the type  against Japanese millet.

Compound	Structure	Parachor [a]	$\Sigma\pi$ [b]	ED_{50} [c]
Aniline		235.0	0.00	5.0×10^{-3}
Acetanilide		321.8	0.26	1.2×10^{-3}
Phenylurethane		375.6	1.40	3.1×10^{-4}
α-Chloroacetanilide		361.5	0.65	2.6×10^{-4}
Propanil		441.2	2.22	1.6×10^{-4}
Swep		415.0	2.36	3.5×10^{-5}
Propham		411.7	1.90	2.5×10^{-5}
Chloropropham		451.4	2.66	2.4×10^{-5}
Propachlor		480.8	2.15	1.2×10^{-6}
Dipropalin		586.4	3.06	6.2×10^{-7}

(continued)

Table 1. Continued

Compound	Structure	Parachor [a]	$\Sigma\pi$ [b]	ED_{50} [c]
Trifluralin		618.2	3.61	3.8×10^{-7}
Alachlor		624.3	3.12	2.8×10^{-7}
Nitralin		675.1	3.03	2.2×10^{-7}

[a] Parachor values calculated from tables compiled by Quayle (15).

[b] π values of ring substituents are those for the phenoxyacetic acid system (except the 4-CH_3SO_2 substituent which is a calculated value) given by Hansch (4). π values of the amino substituents are those calculated on the basis of the partition coefficient of aniline (log P = 0.90), acetanilide (log P = 1.16) and phenylurethane (log P = 2.30) using the equation $\pi = \log P_X - \log P_H$ where P_H is the partition coefficient of the of the parent compound aniline and P_X is the partition coefficient of derivative. In calculating the amino substituents the following π values were used, CH_3 = 50, OCH_3 = -47 and Cl = 39.

[c] Concentration required to reduce the fresh weight growth of Japanese millet seedlings by 50%.

EXUDATION OF C^{14}-CACODYLIC ACID FROM THE ROOTS OF BEAN PLANTS AND ASH SEEDLINGS

D. N. Sommerville,[1] W. A. Wells,[2] and F. B. Anastasia[3]

ABSTRACT

Bean plants (Phaseolus vulgaris L. var. Black Valentine) and green ash seedlings (Fraxinus pennsylvanica Marsh.) were treated with sublethal concentrations of C^{14}-cacodylic acid (hydroxydimethylarsine oxide) to determine if cacodylic acid is exuded from the roots of plants.

The bean plants were treated with 100 µl (.012 µCi) of cacodylic acid (spec. act. 17.4 µCi/mg) in 0.5% (v/v) Tween 20 applied in five 10-µl droplets to each primary leaf. Similarly, 100 µl of cacodylic acid/adjuvant mixture were applied to the ash seedlings on each leaf of the pair of leaves at the fourth node above the root collar. Plants were all grown in pots containing 0.5-strength Hoagland's nutrient solution under controlled environmental conditions.

The presence of C^{14} was detected in the nutrient solution of both bean plants and ash seedlings within 24 hours following treatment. The root exudation of radioactive material increased over the 9- and 16-day sampling periods for the bean plants and ash seedlings respectively. The root exudation studies in bean plants showed 6.9% and 12.8% of the total applied radioactivity was exuded 2 and 3 days after application respectively. For ash seedlings the comparable rate after 3 days was 2.7%. The cumulative root loss of the total applied radioactivity for the bean plants was 19.1% after 9 days compared to 9.6% for the ash seedlings after 16 days.

At the termination of the experiment, the nutrient solutions were spotted on Whatman 3MM chromatography paper and developed in two solvent systems (2-propanol:H_2O, 7:3; 1-propanol:NH_4OH, 7:3). The radioactive areas on the chromatograms of the nutrient solution concentrate from both the treated bean plants and ash seedlings closely coincided with the chromatogram of the C^{14}-cacodylic standard and the cochromatogram of the nutrient solution-standard mix. Therefore, it would appear that C^{14}-cacodylic acid is exuded as an unaltered molecule.

---

[1]Plant Physiologist, Vegetation Control Division, Fort Detrick, Frederick, Maryland 21701.

[2]Present address: Plant Physiologist, Environmental Protection Agency, Pesticide Regulation Division, Washington, D. C. 20250.

[3]Present address: Plant Physiologist, The Proctor & Gamble Company, Ivorydale Technical Center, Cincinnati, Ohio 45217.

EFFECT OF PRE-TREATMENT ENVIRONMENT ON HERBICIDAL RESPONSE AND MORPHOLOGICAL VARIATION OF THREE SPECIES

A. R. Templeton and W. Hurtt[1]

ABSTRACT

Three species of plants were grown under three common regimes (greenhouse, growth chamber and field conditions) and treated with sublethal applications of (2,4-dichlorophenoxy) acetic acid (2,4-D) at different stages of growth. Pre-treatment environment was found to affect growth habit and herbicide response in all species tested. Preliminary microscopic examinations indicate a possible relation between herbicide sensitivity and cuticle thickness as modified by environment. Investigators who cross-compare plant responses from different habitats should take such effects into consideration.

INTRODUCTION

In the past many investigators (1, 2) have given attention to the environmental factors affecting plant response to herbicides, but the majority of these investigations have been directed to conditions during and immediately following treatment. Little attention has been devoted to the possible relationship of pre-treatment history and herbicide response of such plants. By suitable manipulation of the environment individuals may be produced which differ morphologically and anatomically from other individuals of the same species grown under different conditions. Darwent and Behrens[2] have reported that velvetleaf pre-conditioned under sunlight responded 10 to 20% more to 2,4-D than when pre-conditioned under artificial lights. Low temperature (15 C) and low humidity (25-35%) had an opposite effect, i.e., reduction of the phytotoxicity of 2,4-D. In our studies it was found that when plants of three different species were grown in three common environments the pre-conditioning affected plant response to herbicide application.

MATERIALS AND METHODS

Seeds of bean (*Phaseolus vulgaris* L. var Black Valentine), morning glory (*Ipomoea purpurea* L. var Heavenly Blue) and radish (*Raphanus sativus* L. var. Scarlet Globe) were planted in one-quart plastic pots filled with standard greenhouse soil. Fifty pots of each species were placed in each of three locations: the growth chamber, the greenhouse, and outside the greenhouse on elevated benches. The later was used to simulate field conditions. After emergence (4-5 days after planting) all pots were thinned to two plants per pot. Normal care and maintenance were provided for all plants as indicated for their respective environments. Ten pots of each species were treated

---

[1]Plant Physiologists, Vegetation Control Division, Fort Detrick, Md. 21701

[2]Darwent, A. L. and R. Behrens. 1971. Influence of several pretreatment environmental factors on plant response to 2,4-D. Weed Sci. Soc. Amer. Abstract 98.

at 14, 21, and 28 days after planting with a rate equivalent to 0.056 L/ha (0.05 lb/A) of a commercial formulation of the dimethylamine salt of (2,4-dichlorophenoxy) acetic acid (2,4-D). The experiment was replicated three times over a two-month period. After treatment all plants were placed in a common environment (the greenhouse) to negate the possible effects that post-harvest conditions might have had on plant response to herbicides. Plants were harvested 14 days later. At the termination of the experiment growth in height and fresh weights of tops were recorded. Light intensity, temperature, and relative humidity were measured on a daily basis for each of the three environments investigated. Recording hygrothermographs, routinely compared to shielded mercury thermometers and a psychrometer, provided a permanent record of temperature and relative humidity. Light intensity was measured daily between 1300 and 1330 hours with a Weston Research Model 756 foot-candle meter. Environmental conditions in the greenhouse were monitored by a 3-channel Triptonic recorder which continuously plotted air temperature, relative humidity and light intensity. Cross-sections of leaves were made from representative plants in each environment using a cryostat microtome and the tertiary butyl alcohol-paraffin embedding procedure described by Sass (3).

RESULTS AND DISCUSSION

Climatic conditions for the three environments are shown in Table 1. In the controlled environment of the growth chamber, conditions were maintained at the constant levels indicated. In the greenhouse, plants were protected from wind, rain, and temperatures lower than 20 C. The average maximum temperatures of the field and greenhouse were found to differ only slightly. In actuality plants in the greenhouse were subjected to temperatures of 48 C on five occasions, while the greatest temperature to which field plants were subjected was 38 C. On cool or cloudy days temperatures in the greenhouse were similar to, or slightly lower than those in the field. Moisture (dew) condensed on the leaves of the field plants almost every night while this phenomenon occurred infrequently in the greenhouse (two occasions) and never in the growth chamber. Light intensity, as measured in foot candles, was markedly different in the three environments. In the greenhouse, readings were normally 3,000-4,000 ft-c lower than in the field except on cloudy days when light intensities were nearly identical.

The growth of Black Valentine bean plants as measured by height in the three environments is shown in Figure 1. The greatest increase in height occurred for plants grown in the greenhouse. Plants grown in the field were much smaller, while plants from the growth chamber were of medium height. Distinct ecotypical forms were produced as a result of growth in the different environments. Growth chamber plants had red stems, indicating greater anthocyanin production, and dark green foilage. Field plants were shorter and stouter with thicker leaves. Number of trifoliolate leaves per plant did not differ greatly for the three environments, the differences in height were primarily due to differences in internode elongation. Leaf area was affected, with markedly larger leaves being produced in the greenhouse (second trifoliolate leaf area = 339 cm^2) while leaves from the field (88 cm^2) were slightly larger than those from the growth chamber (69 cm^2).

TABLE 1. Comparison of climatic factors in controlled, natural, and protected environments.

Factor	Growth chamber (controlled)	Field (natural)	Greenhouse (protected)
Temperature (C)			
average high	23.6 ± 0.6[a]	32.9 ± 4.7	34.8 ± 6.1
average low	21.7 ± 1.0	14.0 ± 4.0	21.6 ± 0.1
Relative humidity (%)			
average high	56.7 ± 4.0	100.0 ± 0.0	92.4 ± 9.1
average low	48.6 ± 2.0	39.2 ± 19.0	43.2 ± 16.8
Light intensity (ft-c)[b]	1,470 ± 36	8,900 ± 3,000	5,100 ± 3,400

[a]means ± standard deviations

[b]means value for a series of daily readings 1300-1330 hrs.

Growth, in height, of morning glory plants is shown in Figure 2. During the early phase of the experiment plants from the growth chamber grew more rapidly, but by 21 days plants from the greenhouse had overtaken them and continued to grow at about the same rate. Plants from the field continued to grow slowly during the course of the experiment. Increase in height was primarily due to internode elongation; the number of leaves per plant for the three groups did not differ greatly until 28 days.

There was little apparent difference in growth of radish plants in the three environments. In general, field radishes were slightly larger than those from the greenhouse or growth chamber, but this difference was not statistically significant at $p \leq .05$.

Pre-treatment environment was found to affect plant response to sublethal herbicide applications in all three species. As indicated in Figure 3, individual mortality was higher in 14-day-old Black Valentine bean plants from the field. Greenhouse plants had the lowest level of mortality for 14-day-old plants. No 21-day-old plants from the greenhouse or growth chamber succumbed to treatment, but 20% of field plants from this age group died. No 28-day-old plants from any environment died.

Response, as measured by percent inhibition of fresh weight of tops, (Figure 4) and growth in height was similar to that expressed as percent kill (Figure 3). Differential response to herbicide treatment as affected by pre-

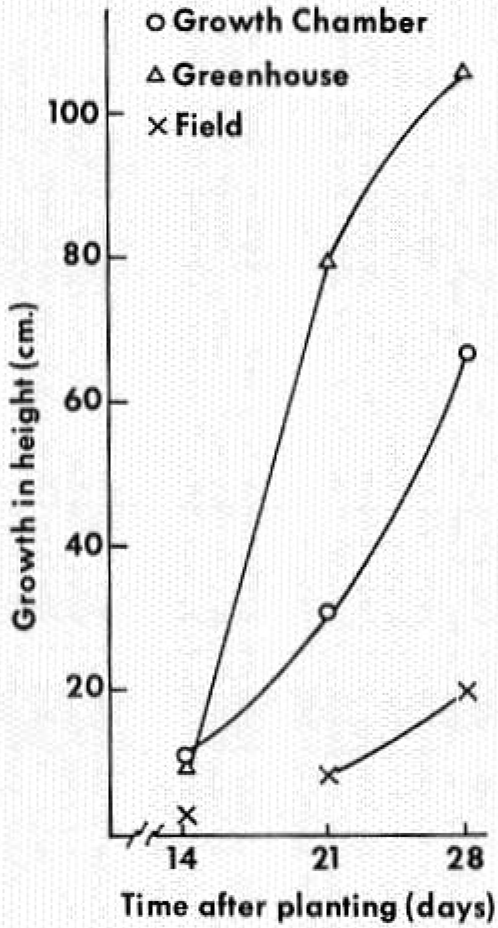


Figure 1. Influence of three enviornments on growth in height of Black Valentine bean plants.

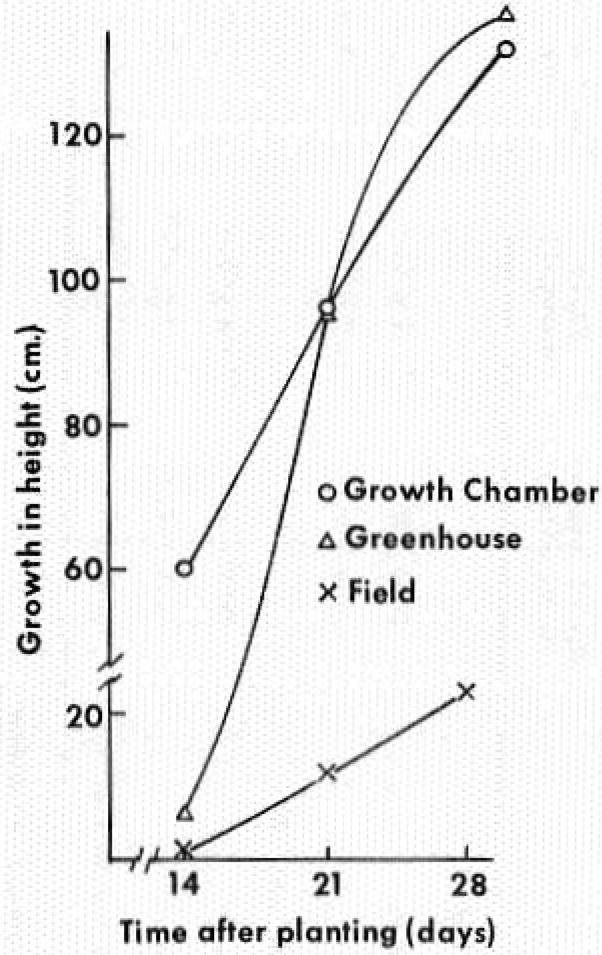


Figure 2. Influence of three enviornments on growth in height of morning glory plants.

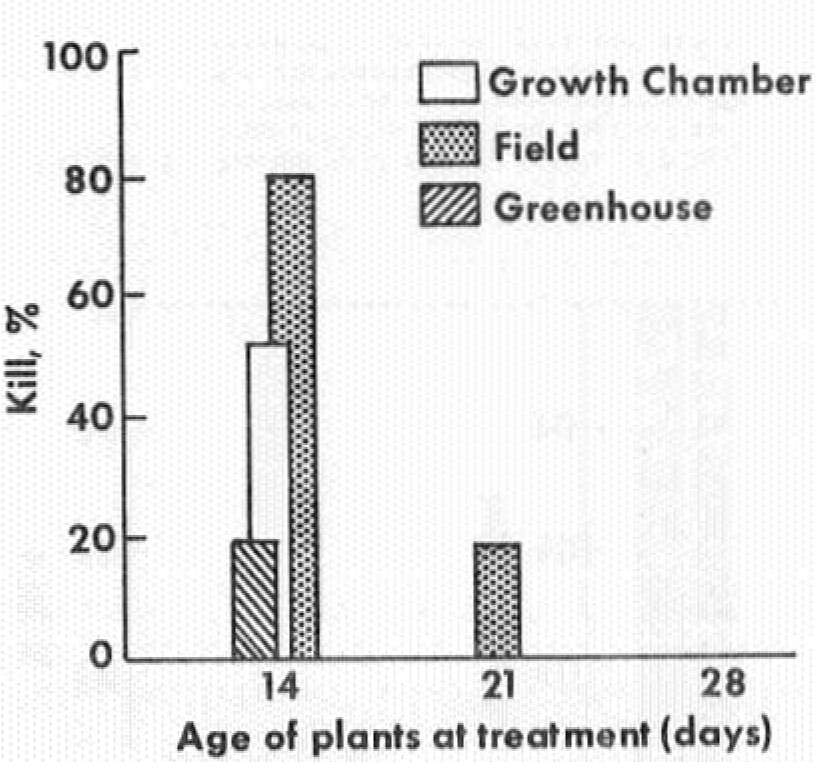


Figure 3. Percent kill of Black Valentine bean plants resulting from 2,4-D application at different plant ages as mediated by pre-treatment environment. No 28-day old plants were killed by this rate of 2,4-D.

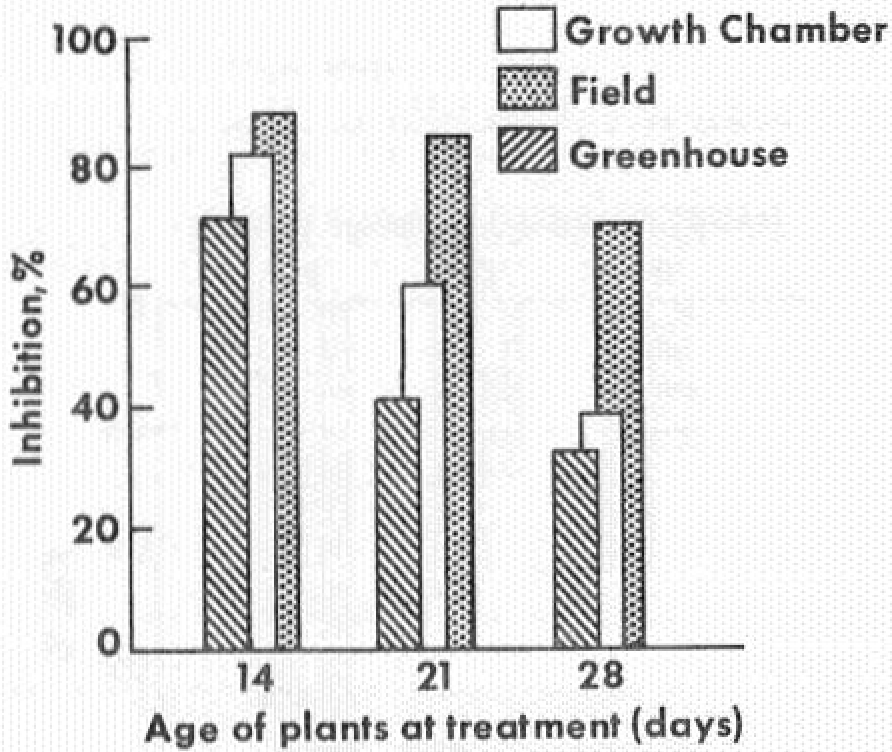


Figure 4. Percent inhibition by 2,4-D of Black Valentine bean plant growth in height as mediated by pre-treatment environment and age of plants.

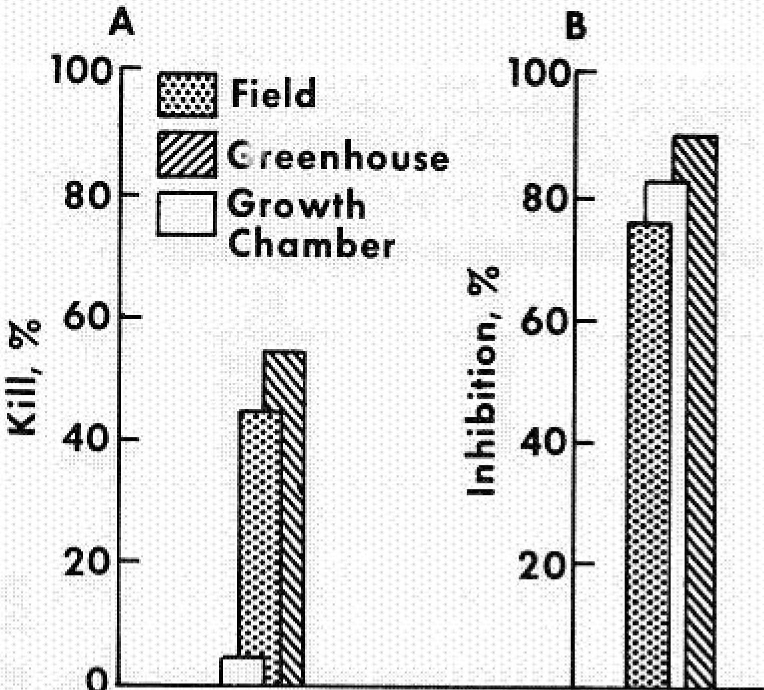


Figure 5. Percent kill (A) and percent inhibition of fresh weight of tops (B) resulting from 2,4-D application to 28-day old morning glory plants as mediated by pre-treatment enviornment.

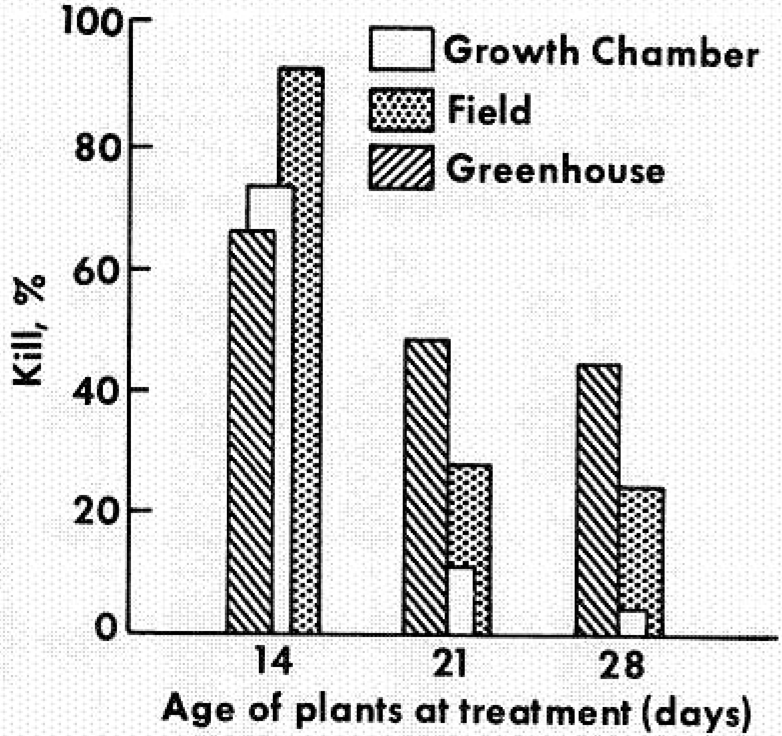


Figure 6. Percent kill of three ages of radish plants resulting from 2,4-D application to plants grown in three pre-treatment environments.

treatment environment would appear to be related to plant size in the case of Black Valentine bean.

Herbicide application at the rate used in this experiment was fatal to all 14- and 21-day-old morning glory plants. A differential response was observed in 28-day-old morning glories (Figure 5). Greenhouse plants were the most sensitive as measured by percent kill (Figure 5a) as well as inhibition of fresh weight of tops (Figure 5b). Although a relatively low percent kill was observed for growth chamber plants, growth as measured by fresh weight of tops, was greatly inhibited. There were no great differences in response of morning glory plants as affected by pre-treatment environment to herbicide application when expressed as percent inhibition of fresh weight of tops or growth in height.

As shown in Figure 6 field grown radishes were the most susceptible to treatment, followed by growth chamber and greenhouse grown plants for the 14-day-old group. At 21 days growth chamber and field plants appeared to increase in comparative resistance to treatment; this pattern continued through the 28 day period with greenhouse plants being the most sensitive to treatment. Results from these studies indicate that pre-treatment environment does affect plant response to herbicide application. The effect of pre-treatment environment should be taken into consideration when a cross comparison of results from herbicide application to different groups of plants is made. This is particularly true for the investigator who may conduct studies in a number of different environments. Results from field studies may have little relation to similar tests conducted in the greenhouse or growth chamber.

Microscopic examination of comparative leaf sections of plants are currently being completed. It is hoped that these examinations may elucidate the differential responses to herbicides observed in plants grown in separate environments.

ACKNOWLEDGEMENT

We gratefully acknowledge the assistance provided by Mr. Roger W. Hatcher, summer aide employed under the "Federal Summer Employment Program for Youth" and SP4 Duane N. Sommerville, Plant Physiologist, Vegetation Control Division, Fort Detrick, Maryland.

LITERATURE CITED

1. Åberg, Ewerto. 1964. Factors in the plant modifying the response of a given species to treatment, p 401-422. In L. J. Audus (ed). The Physiology and Biochemistry of Herbicides. Academic Press, New York.
2. Hilton, J. L., L. L. Jansen and H. M. Hull. 1963. Mechanisms of herbicidal action. Ann. Rev. Plant Physiol. 14:353-384.
3. Sass, John E. 1951. Botanical Microtechnique, 2nd Ed. Iowa State College Press, Ames, Iowa 228p.

THE MOVEMENT OF ^{14}C-ETHYL HYDROGEN PROPYLPHOSPHONATE (NIA 10637) IN SOIL AND ITS SUBSEQUENT UPTAKE BY LIMA BEANS

By E. F. Koldenhoven[1]

The movement of ^{14}C-ethyl hydrogen propylphosphonate (NIA 10637) in soil was examined by leaching water through columns of treated soil. The uptake of ^{14}C-NIA 10637 from the soil was determined by growing lima beans (*Phaseolus lunatus*) in the treated soil and analyzing the soil and the plants for the labeled compound. The extent of movement in the soil of this chemical is related to the quantity of water leached through the treated soil. Lima beans readily absorb ^{14}C-NIA 10637 from the treated soil.

1/ Senior Biologist, Niagara Chemical Division, FMC Corporation, Middleport, NY

UPTAKE AND TRANSLOCATION OF ^{14}C-ETHYL HYDROGEN PROPYLPHOSPHONATE (NIA 10637) BY MAPLE AND POPLAR TREES

By A. A. Nethery[1]

Applications of ^{14}C-ethyl hydrogen propylphosphonate (NIA 10637) were made to small silver maple (Acer saccharinum), Norway maple (Acer platanoides) and Androscoggin poplar (Populus maximowiczii x Populus trichocarpa) trees via nutrient solution, foliar treatments and lanolin- and asphalt-based wound dressings. Gross uptake and translocation patterns were observed autoradiographically; quantitation of radioactive label absorbed by the plants was accomplished through digestion and scintillation counting of dry, milled plant tissues. Appreciable levels of radioactivity were found in the roots after foliar treatments. More than 80% of the ^{14}C applied either in lanolin or asphalt wound dressing had been absorbed from the wound dressing after one month.

1/ Research Biologist, Niagara Chemical Division, FMC Corporation, Middleport, NY

EFFECT OF DIFFERENT METHODS OF HERBICIDE INCORPORATION

D. A. Braden and J. C. Cialone[1/]

Abstract. Two experiments were conducted on a Freehold sandy loam soil to compare several methods of herbicide incorporation. A double-disc, a power-driven tiller and a shallow incorporation tool constructed from a weighted piece of chain-link fence were used. Several herbicides were used: 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), dimethyl tetrachloroterephthalate (DCPA), S-ethyl dipropylthiocarbamate (EPTC), and a,a,a-trifluoro-2,6-dinitro-N,N,dipropyl-p-toluidine (trifluralin). In addition, plots were rolled to introduce compaction as a factor in herbicide performance. Cucumber (*Cucumis sativus* L., var. Ashley) stand counts, and weed control and cucumber vigor ratings were made. Compaction had little effect on herbicidal activity or crop growth. Surface-applied EPTC was the only treatment not consistent from experiment to experiment. This was probably due to variation in soil-surface moisture. There was little difference in EPTC or trifluralin activity due to the three incorporation methods. Phytotoxicity to crops and weeds was in the order trifluralin and EPTC > DCPA > alachlor > control. An effect due to the incorporation method x herbicide interaction was consistently significant.

INTRODUCTION

Parker (1966) investigated the optimum placement of various herbicides in relation to seed position in soil under greenhouse and laboratory conditions. He found that a,a,a,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) was more phytotoxic when incorporated, and, particularly, when placed just below the germinating seed. Also, soil incorporation of S-ethyl dipropylthiocarbamate (EPTC) is required for consistent field activity (Cialone, 1967). Wiese and Smith (1970), in field studies, found that the herbicidal activity of dimethyl tetrachloroterephthalate (DCPA) was greatest when incorporated, and that the incorporation of 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) had little effect on herbicidal activity.

Present methods of soil incorporation of herbicides in New Jersey vegetable areas are: discing with a double disc or rototilling with a power-driven rototiller (PDR). Bode and Gebhardt (1969) compared the incorporation

---

1/ Graduate Assistant and Associate Research Professor respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey 08903. The present address of the latter is Tropic Greenhouses, Inc., Hanover, New Jersey.

of trifluralin with a disc and a PDR. With the disc, non-uniform distribution of herbicide resulted and the greatest concentration of the trifluralin was found at the 3-in depth. With the PDR, trifluralin was concentrated in the top in of soil.

Orr et al. (1969) found that 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline (nitralin) and trifluralin were injurious to cotton (Gossypium hirsutum L.) when deeply incorporated (2-4 in). Smith and Hudspeth (1968) increased weed control with the shallow incorporation (1 in) of trifluralin and DCPA. Although weed seeds are capable of emerging from a range of depths, the majority of the weeds present on land used for vegetable production are shallow-germinating annuals. Conceivably the shallow incorporation of certain herbicides could provide increased weed control and a greater margin of crop safety.

A bed maker is often used in conjunction with the PDR and is sometimes included in the same piece of equipment. An important effect from such an operation is the slight compaction of the soil which results when forming the seed bed. Roberts and Hewson (1970) found little effect from compaction (by rolling) of seed beds on herbicide activity but found a general increase in the number of weeds.

It was our objective to compare 3 methods of herbicide incorporation, the double-disc, the PDR, and a shallow incorporation tool, particularly with respect to shallow incorporation, soil compaction, crop tolerance, and weed control.

METHODS AND MATERIALS

All experiments were conducted in the summer of 1971 at the Soils and Crops Research Center at Adelphia, New Jersey on a Freehold sandy loam soil containing 1.5% organic matter. Plots were 5x25 ft and were seeded with 3 rows of cucumbers (Cucumis sativus L., var. Ashley) at different depths: 0.5, 0.75, and 1.0 in. Herbicides were applied with a portable, CO_2-powered sprayer in a spray volume equivalent to 55 gpa.

The various kinds of incorporation equipment used were: a 6-ft double-disc, set to disc 6 in; a 5-ft Ferguson Tilrovator[R] (Norfolk, Virginia) set at a 3-in depth; and a shallow incorporation tool constructed from an 8x10 ft piece of chain-link fence, fixed in a cylindrical roll and weighted with 50 lbs of sheet-steel. Finger-like, 2-in long, projections were constructed from 18 gauge wire and fixed to the underside of the rolled, chain-link fence to disturb the soil surface as it was pulled behind a tractor. A 6-ft Brillion seeder was used as a roller for the compaction treatments.

Cucumber stand counts were made on 3-ft of row; visual ratings were made on weed control and cucumber vigor. The rating scale used was 1 to 9, where 1 equals no crop injury or weed control and 9 equals crop death or perfect weed control. All data were subjected to analysis of variance and the means were compared using Duncan's Multiple Range Method. All experimental designs were factorial with 3 or 4 replicates.

Experiment I

The herbicidal activity of alachlor (1 lb/A), EPTC (3 lb/A), trifluralin (.75 lb/A), and no chemical were compared when left on the soil surface and when incorporated by discing, rototilling, and chaining. The effect of compaction was examined by rolling the back-half of each plot. (All chemical rates are expressed as actual ingredient.) Cucumbers were planted and herbicide treatments were made on May 18, 1971.

Experiment II

Alachlor (1 lb/A), DCPA (10 lb/A), EPTC (3 lb/A), trifluralin (.75 lb/A), and no chemical were left on the soil surface and incorporated by rototilling and chaining. Half of each plot was compacted by rolling after herbicide-incorporation treatments were made. Cucumbers were planted and herbicide applications were made on June 26, 1971.

RESULTS AND DISCUSSION

Experiment I

In the analysis of counts of cucumbers present in the middle row of each plot, a highly significant effect ($p = 0.01$) was found due to herbicide and a significant effect ($p = 0.05$) due to the herbicide x incorporation method interaction. The number of cucumbers present in alachlor-treated or control plots did not differ greatly due to incorporation method. However, severe reduction of cucumber stand resulted from EPTC and trifluralin treatments. Reductions from the surface application of EPTC were similar to reductions from the chain-incorporated EPTC, while the surface application of trifluralin was significantly less toxic than chain incorporation (Figure 1).

The weather conditions at time of herbicide application were extremely unusual for that time of year. The day was sunny and warm (72 F) and the soil surface was dry. The activity from the surface-applied EPTC could have been due to retention of the herbicide on the dry soil surface. The lack of activity of the surface-applied trifluralin could have been due to relatively high temperature and bright sunlight which resulted in volatilization and photodecomposition. In addition, there was no significant rainfall for 2 weeks following herbicide application.

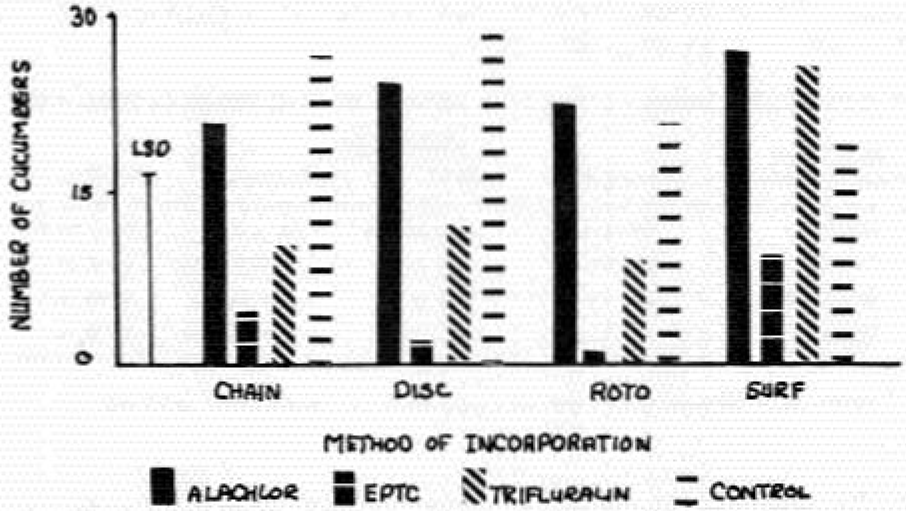


Figure 1. Effect of 3 methods of incorporation of 3 herbicides on the stand of cucumbers (3-ft of row) seeded at a 0.75 in depth on May 18, 1971.

In an analysis comparing cucumber stand counts at the three different depths of seeding, highly significant effects were found due to incorporation method, herbicides, depth of seeding, the compaction x herbicide interaction, the incorporation method x herbicide interaction, and the herbicide x depth of seeding interaction. The compaction x incorporation method x herbicide interaction was significant. Compaction reduced slightly the activity of EPTC and slightly increased the activity of trifluralin. Little difference existed between incorporation methods except that surface-applied trifluralin showed little herbicidal activity (Table 1).

Experiment II

Analysis of stand counts of cucumbers seeded at the middle depth showed a highly significant effect due to herbicide. The reduction in stand due to herbicides was in the following order: trifluralin > EPTC > DCPA > alachlor > control. Analysis of vigor ratings of middle seeded cucumbers indicated a highly significant incorporation method x herbicide interaction where severe injury resulted from all herbicides and all incorporation methods. Analysis of common lambsquarters (Chenopodium album L.) control ratings showed similar results: control of C. album was evident from all herbicides and all methods of incorporation.

Table 1. Effect of 3 methods of incorporation of 3 herbicides on the stand of cucumbers (3-ft of row) seeded at 3 depths (0.50, 0.75, and 1.00 in) on May 18, 1971.

METHOD OF INCORPORATION	HERBICIDE			
	ALACHLOR	EPTC	TRIFLURALIN	CONTROL
SURFACE	26.6 ab*	10.0 abcde	26.3 ab	19.1 abcd
CHAINED	20.6 abc	4.6 cde	9.8 abcde	25.4 ab
ROTOTILLED	21.7 ab	0.7 e	8.6 bcde	21.6 ab
DISCED	23.9 abc	2.1 de	12.3 abcde	28.3 a

*MEANS WITH COMMON LETTER ARE NOT SIGNIFICANTLY DIFFERENT P = 0.05.

In the analysis of cucumber stand counts over depths of seeding, all main effects were significant and the following interactions were highly significant: incorporation method x herbicide; incorporation method x depth of seeding; and herbicide x depth of seeding. Cucumber stand was significantly reduced by trifluralin as compared with the control. Stand reduction due to trifluralin was not significantly different from EPTC, DCPA, or alachlor.

Examination of the incorporation method x herbicide interaction indicated decreased activity from surface-applied EPTC (Figure 2). This could have been due to the loss of EPTC since soil-surface moisture was high at time of application. The herbicide x depth of seeding interaction showed a stand reduction at the shallow depth of seeding regardless of herbicide present.

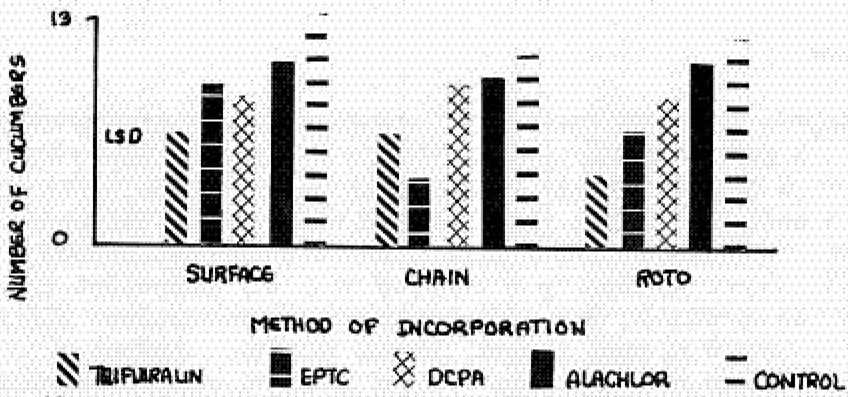


Figure 2. Effect of 2 methods of incorporation of 4 herbicides on the stand of cucumbers (3-ft of row) seeded at a 0.75 in depth on June 26, 1971.

Examination of the data presented in Table 2 provides an over-all view of the many possible interactions as measured by effect on cucumber stand. The activity of trifluralin and DCPA was increased by rototilling while EPTC had greatest activity when chain-incorporated. Alachlor exhibited the greatest activity on the shallow cucumber seeding whether incorporated or not.

Lower cucumber stand counts in this experiment were due to a decreased seeding rate.

Table 2. Effect of 2 methods of incorporation of 4 herbicides on the stand of cucumber (3-ft of row) seeded at 3 depths (0.50, 0.75, and 1.00 in) on June 26, 1971.

METHOD OF INCORPORATION	HERBICIDE	DEPTH OF SEEDING 0.5 IN	0.75 IN	1.0 IN
SURFACE	TRIFLURALIN	5.0	8.4	8.8
	EPTC	8.6	10.8	8.5
	ALACHLOR	6.9	11.4	13.8
	DCPA	8.9	8.9	8.8
	CONTROL	10.8	14.1	13.6
CHAINED	TRIFLURALIN	3.1	8.5	7.8
	EPTC	2.8	7.1	2.4
	ALACHLOR	5.3	12.9	11.1
	DCPA	5.3	12.1	9.9
	CONTROL	7.5	12.5	14.3
ROTOTILLED	TRIFLURALIN	2.5	2.5	7.6
	EPTC	8.0	7.3	4.5
	ALACHLOR	6.9	11.5	13.1
	DCPA	8.6	9.4	8.6
	CONTROL	8.4	14.1	13.1

SUMMARY AND CONCLUSIONS

Although the two experiments were established at different times and therefore under different environmental conditions, the results were remarkably similar. The exception to this was the surface-applied EPTC treatment; the differences here can reasonably be explained by the absence and presence of surface soil moisture which would affect the retention of EPTC.

Soil compaction had little effect on herbicide activity, weed growth, or crop vigor. There was no measurable difference between the three implements used for incorporation. Differences in herbicidal activity were measured by weed control, and crop stand and vigor. Phytotoxicity was in the general order: trifluralin and EPTC > DCPA > alachlor.

Consistently, an incorporation method x herbicide interaction appeared throughout the study; one method of incorporation was not necessarily beneficial for all herbicides. Herbicide incorporation should be considered specifically, based on herbicide, equipment available, weed species, and crop tolerances.

LITERATURE CITED

1. Bode, L. E. and M. R. Gebhardt. 1969. Equipment for incorporation of herbicides. Weed Sci. 17:551-555.
2. Cialone, J. C. 1967. Factors affecting the activity of EPTC. Ph.D. Thesis. Cornell Univ., Ithaca, N.Y.
3. Orr, J. E., R. E. Tabert, and R. E. Frans. 1969. The effect of incorporation procedure on nitralin activity. Proc. So. Weed Sci. Soc. 17:42.
4. Parker, C. 1966. The importance of shoot entry in the action of herbicides applied to soil. Weeds 14:117-121.
5. Roberts, H. A. and R. T. Hewson. 1971. Herbicide performance and soil surface conditions. Weed Res. 11:69-74.
6. Wiese, A. F., and E. B. Hudspeth, Jr. 1968. Subsurface application and shallow incorporation of herbicides in cotton. Weed Sci. 16:494-498.
7. Wiese, A. F. and D. T. Smith. 1970. Herbicidal activity as affected by soil incorporation and rainfall. Weed Sci. 18:515-517.

NAPTALAM ESTIMATION IN CRANBERRY BOG SOIL

by

Robert W. Yaklich, I.E. Demoranville and Robert M. Devlin 1/

ABSTRACT

The persistence of naptalam in cranberry bog soil that had received annual applications of 8, 10, and 12 lb a.i./A of the herbicide was studied. Soil samples at two depths, 0 to 4 inches and 4 to 8 inches, were analyzed. Most of the naptalam residue was found at the 0 to 4 inch depth and it appeared that for the two lower rates of naptalam applied a steady state between herbicide persistence and breakdown had been reached after two years.

INTRODUCTION

For the last four years the major herbicide for the cranberry-growing regions of southeastern Massachusetts has been morcran. Morcran is a commercial name for a formulated mixture of sodium N-1-naphtylphthalamate (naptalam) and isopropyl m-chlorocarbanilate (chlorpropham). In the mixture there is 62% more naptalam than chlorpropham.

Morcran is primarily used to control annuals as well as nutsedge (Cyperus dentatus Tort.) and cutgrass (Leersia oryzoides (L.) Sw.) on cranberry bogs. However, nutsedge and cutgrass are not eradicated but only suppressed for about 75% of the growing season. This necessitates annual applications of morcran, a circumstance that could lead to the gradual build-up of naptalam or chlorpropham in the soil and possible inhibition of root or vine growth.

The present study was undertaken to evaluate the persistence of naptalam in bog soil receiving annual applications of morcran. Also, the vertical movement of naptalam was checked.

MATERIALS AND METHODS

In the spring of 1969 plots 0.5 sq rods in area were staked out in a section of weed-free cranberry bog containing a relatively consistent stand of vines. Morcran was applied to the test plots at rates of 0, 100, 125, and 150 lb/A, which is equivalent to 0, 8, 10, and 12 lb a.i./A of naptalam.

1/ Research Associate, Associate Professor of Horticulture and Associate Professor of Plant Physiology, respectively, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts.

Each treatment was replicated three times and all treatments were repeated for three consecutive years. In October 1970 and 1971 soil samples were taken with a cylindrical soil probe at 0-4 and 4-8 inches in depth. The samples were then air-dried, filtered through a 2 mm sieve, and stored at room temperature.

A twenty five gram sample of air-dried soil was placed in a 250 ml round bottom flask with 1 gram of 10-mesh zinc, 50 ml of 30% NaOH and approximately 1 ml of Dow-Corning Antifoam A compound. The flasks were then placed in a heating mantle and 25 ml of distillate was collected. The distillate was transferred to a separatory funnel containing one g of salt and swirled till the salt dissolved. The condensor and connecting tube of the distilling apparatus were rinsed with 50 ml of hexane and the hexane rinse placed into the separatory funnel. The separatory funnel was shaken for one minute and then allowed a settling period of two minutes before the aqueous layer was drawn off and discarded. One drop of concentrated HCl and 5 ml of H_2O were added to the hexane layer and the mixture was again shaken for one minute. This process was repeated twice more and the total 15 ml were transferred quantitatively to a 25 ml erlenmeyer flask with the aid of 5 ml of H_2O. The above mixture then received 5 ml of concentrated acetic acid, 6 drops of 30% NaOH, and 10 drops of a diazonium reagent. The diazonium reagent was prepared fresh by mixing equal volumes of 1% sulfanilic acid solution and 0.12% sodium nitrite solution 3 minutes before use. After 30 minutes the color that developed was measured in a Beckman Model DU spectrophotometer at 534 nm. Fifty micrograms of naptalam was carried through the procedure and used as a standard. The above procedures have been modified from the methods of Lane et al. (1) and Smith and Stone (2).

RESULTS AND DISCUSSION

Cranberry bogs are generally built upon peat bogs, the layer of underlying peat varying with the particular bog. In the typical bog the underlying peat is covered by several successive layers of organic matter and sand. The depth of this strata is generally dependent on several factors with age about the most important. Bordering the bog are ditches that generally contain water throughout the season. The water table on a bog is, therefore, not too far below the surface and relatively stationary. In this respect, vertical penetration of pesticides to any great depth would not be expected.

The naptalam content detected in soil samples taken from plots treated with morcran for two and three successive years is shown in Table 1. If the averages for the highest values of naptalam detected are computed and compared a slight upward trend appears between years two and three. Soil samples were not taken after the first year of morcran application. Naptalam residues found in the 1 to 4 inch soil samples taken from plots that had received 8 lb a.i./A naptalam for two and three years ranged from 0.60 to 0.66 ppm. Under the same circumstances, soil samples at the 1 to 4 inch depth taken from plots treated with 10 and 12 lb a.i./A naptalam yielded residues of naptalam that ranged from 0.70 to 0.73 ppm and 0.96 to 1.13 ppm, respectively. The data in Table 1 suggests that at a 1 to 4 inch depth a plateau of herbicide persistence has been reached in plots treated at the 8 and 10 lb/A rate. However, in plots treated at the 12 lb/A rate it is apparent that the steady state of herbicide persistence has not been reached in the 1 to 4 inch depth after three consecutive annual applications.

Although much less naptalam was detected in the 4 to 8 inch soil samples, a similar upward trand in herbicid^e persistence was observed. That is, less naptalam was found in soil samples from plots treated for two consecutive years than in soil samples from plots receiving naptalam for three consecutive years. The average values for the highest amounts of naptalam found at the 4 to 8 inch depth from plots treated with 8, 10, and 12 lb a.i./A naptalam for two and three years were 0.03 to 0.06 ppm, 0.06 to 0.06 ppm, and 0.06 to 0.1 ppm, respectively (Table 1).

Table 1. Naptalam found in soil samples from plots receiving annual applications of 0, 8, 10 and 12 lb a.i./A naptalam for two and three successive years. The soil samples were taken from 0 to 4 inch and 4 to 8 inch depths.

Treatment (lb a.i./A)	Range of naptalam extracted (ppm)			
	0-4 inch depth		4-8 inch depth	
	Year 2	Year 3	Year 2	Year 3
0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0
	0.0	0.6*	0.0	0.0
8	0.5-0.6	0.5-0.7	0.0-0.1	0.0
	0.6-0.7	0.6-0.6	0.0	0.0
	0.4-0.5	0.6-0.7	0.0	0.0-0.2
10	0.6-0.7	0.8-0.9	0.0-0.1	0.0
	0.5-0.6	0.4-0.6	0.0	0.0
	0.6-0.8	0.6-0.7	0.0-0.1	0.0-0.2
12	1.0-1.3	1.1-1.3	0.0	0.0-0.1
	0.7-0.8	0.7-0.8	0.0-0.1	0.0
	0.7-0.8	1.0-1.3	0.0-0.1	0.0-0.2

* This control plot received 8 lb/acre in year 3 by mistake.

The data presented in this study suggest that annual applications of naptalam to cranberry bogs result in a build-up of the herbicide in the bog soil. This build-up persists until a steady state between herbicide persistence and breakdown is reached. The amounts of herbicide found at the plateau level is determined by the rate of naptalam applied.

LITERATURE CITED

1. Lane, J.R., D.K. Gullstrom, and J.E. Newell. 1958. Extension of the residue methods for 1,2-dihydro-3,6-pyridazinedione (maleic hydrazide) and N-1-naphthylphthalamic acid (alanap). J. Agr. Food Chem. 6:671-674.

2. Smith, A.E. and G.M. Stone. 1953. Microdetermination of N-1-naphthylphthalamic acid residues in plant tissues. Anal. Chem. 25:1397-1399.

POTATO VINE KILLING IN MAINE - 1970

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

Abstract

Several vine desiccants and adjuvants to increase their efficacy were tested for killing Katahdin potato vines in Maine during 1970. Paraquat, Des-I-Cate, and sodium arsenite plus nitrogen provided better vine desiccation than any of the DNBP products used as standards. Some vascular discoloration of tubers occurred when kill was rapid, but was not excessive. Emergence and yield results from follow up field emergence tests were not conclusive. There was some indication, however, that seed tubers used from Des-I-Cate plus #2 oil and C.I.P.C. treated plots did not yield as well as tubers from other desiccant treatments.

Introduction

The following paper reports the results of potato vine killing studies conducted in Maine during the 1970 growing season. Evaluation of harvested tubers was made during the 1970-71 storage period and emergence trials were conducted during the 1971 growing season.

Materials and Methods

All desiccant chemicals unless otherwise indicated were applied in 80 gallons of water per acre at 40 pounds pressure to actively growing Katahdin potato vines on the dates indicated in Table 2. A compressed air sprayer equipped with a two-nozzle brush type boom was used for foliar application of vine desiccants. Plots were single rows 25 feet long with buffer rows between each treatment. Plots were arranged in a randomized block design and each treatment replicated six times.

Using a five step rating system as listed in Table 1, vine kill ratings were made at weekly intervals following application of vine desiccants.

Table 1. Potato vine-kill rating code. Maine - 1970.

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

[1]Associate Professor of Agronomy and Technician, Grade II, Department of Plant and Soil Sciences, University of Maine, Orono, Maine 04473.

Approximately 15 pounds of tubers were collected at random from each plot at harvest time and stored at 50°F. for later examination during the winter storage season. Storage studies consisted of observing tubers from each treatment for storage disorders and examination of individual tubers for internal and possible external discolorations which might have been caused by use of chemical desiccants. From these storage samples tubers were also made available to chemical company cooperators for residue analysis when requested.

Tubers that were snipped in December, 1970, and examined for stem end vascular discoloration were bulked by treatment and stored at 38°F. In the spring of 1971 tubers from the high rate of each desiccant used were planted in replicated field emergence and yield trials. In addition these plots were observed at several growth stages to detect any side effects which might have been caused by desiccant treatments in 1970.

Data in Table 3 presents source and chemical names of compounds used in the 1970 potato vine killing tests in Maine.

Results and Discussion

Data presented in Table 2 indicate that Paraquat at all rates, alone or with adjuvants killed potato vines better than the Premerge or Dow General standards. The addition of adjuvant PM 4879 improved activity of Paraquat slightly. The addition of liquid nitrogen did not increase activity of Paraquat as compared to Paraquat alone.

In 1970 some carry-over sodium arsenite was used in Maine so was included in trial for comparative purposes. Although its activity was equal to the DNBP compounds, the addition of liquid nitrogen increased its activity significantly.

Des-I-Cate at the 2 gallon rate plus the addition of #2 oil gave excellent vine kill. The rapid killing action did, however, cause some tuber discoloration and a significant yield reduction when tubers were used to propagate new plants. The discoloration was understandable, but the yield reduction had no logical explanation. In this trial the data indicated that the two gallon rate was superior to the 1½ gallon rate and also that the addition of #2 oil improved the efficacy of Des-I-Cate.

Compound C-20546 and C.I.P.C. plus Petro Crop Oil as candidate desiccants did not show sufficient activity to warrant continued testing.

The use of Tronic or PM 4879 adjuvants as possible substitutes for #2 oil with Premerge or Dow General was demonstrated by the data presented in Table 2. Five gallons of #2 oil improved the efficacy of both DNBP products for vine killing much more than Tronic or PM 4879 used at either of two rates tested.

Vascular discoloration of tubers following application of vine desiccants was not a factor in 1970 because of adequate moisture during the killing period and directly after. Data in Table 2 indicate sodium arsenite plus nitrogen, Premerge plus #2 oil, and 2 gallons of Des-I-Cate plus #2 oil caused more vascular discoloration of tubers than all other treatments. These amounts of discoloration would not be considered of any consequence in commercial stocks.

None of the vine desiccation treatments used in 1970 affected emergence of plants significantly. In all three cases where emergence was not 100 percent, seedpiece examination indicated rotted seedpieces rather than sprout inhibited eyes were the cause.

The effect of vine desiccants on yield of potatoes propagated with tubers from vine killed plots is presented in Table 2. The data indicate that lower yields occurred where 2 gallons of Des-I-Cate plus oil and C.I.P.C. plus oil were used. There has been no previous indication that Des-I-Cate affected yielding ability of potatoes; therefore, this treatment should be rechecked in 1971.

Table 2. Effect of several chemicals on potato vine desiccation, discoloration of tubers, and emergence of plants from tubers used for seed. Katahdin Variety. Maine - 1970.

Treatments[1]			Vine kill ratings[2]		Percent vascular discoloration[3]			Percent emergence	Yield Cwt./A.
Material	Rate/Acre	Additive	8/25	8/31	Slight	Medium	Severe	1971	1971
No treatment			1.0	1.0	0.7			98.3	351ab
Paraquat	2 pts.	10 lbs. N.(Uran)	3.2	3.2	0.0			100.0	349ab
Paraquat	2 pts.	1 pt. PM 4879	4.0	3.6*	0.0			---	
Paraquat	2 pts.	2 pts. PM 4879	3.8	3.8*	0.0			100.0	352ab
Paraquat	2 pts.		3.4	3.3	0.0			100.0	352ab
Sodium Arsenite	4 lbs.(AS_2O_3)		2.3	2.2*	0.2			---	
Sodium Arsenite	8 lbs.(AS_2O_3)		2.8	2.8*	0.4	0.4		100.0	364a
Sodium Arsenite	4 lbs.(AS_2O_3)	10 lbs. N.(Uran)	3.2	3.6	3.8	1.2	0.3	100.0	342ab
Premerge	3 qts.	1 qt. Tronic	2.0	1.4	0.0			---	
Premerge	3 qts.	2 qts. Tronic	2.0	1.5	0.0			100.0	336b
Premerge	3 qts.	1 pt. PM 4879	2.0	1.3	0.3			---	
Premerge	3 qts.	2 pts. PM 4879	2.0	1.7	0.7			100.0	356ab
Premerge	3 qts.	5 gals #2 oil 1 pt. emulsifier	2.6	2.2	1.3	0.6	0.2	100.0	351ab
Dow General	2 pts.	5 gals. #2 oil	2.0	2.6	0.0			99.2	348ab
Dow General	2 pts.	1 qt. Tronic	2.0	1.1	0.5			---	
Dow General	2 pts.	2 qts. Tronic	2.0	1.6	0.3			100.0	352ab
C-20546	8 lbs.		1.0	1.0*	0.4			---	
C-20546	8 lbs.	8 oz. Surfactant WK	1.6	1.9*	0.4	0.6	0.3	94.2	346ab
Des-I-Cate	6 qts.		2.0	2.0*	0.4			---	
Des-I-Cate	6 qts.	5 gals. #2 oil	3.4	3.4*	0.4			100.0	345ab
Des-I-Cate	8 qts.		4.2	4.1*	0.1			98.8	342ab
Des-I-Cate	8 qts.	5 gals. #2 oil	4.8	4.6*	5.2	0.5	0.3	100.0	324c
C.I.P.C.	3 qts.	10 gals. Petro Crop Oil	1.0	1.5	0.0			100.0	316c

[1]Materials except C.I.P.C. applied August 19. Weather clear. Temperature 75-80°F. Soil conditions very dry. One acre inch of rain occurred August 22, and another inch on August 29. Vines were very vigorous at time of application. All materials except C.I.P.C. applied in 80 gallons of water at 40 P.S.I. C.I.P.C. applied August 24. C.I.P.C. plus petro oil was not diluted with water.

Table 2 (continued)

[2]Kill rating code presented in Table 1.

[3]Examinations made on 15 pound tuber samples from each of six replicates on December 29, 1970.

[4]New growth starting as rosette foliage at base of main stems and some axillary nodes on August 31.

Table 3. Chemical desiccants used for Maine potato vine killing studies - 1970.

Compound	Active Ingredient	Source
Paraquat	1,1-dimethyl-4, 4-bipyridium dichloride	Chevron Chemical Company
Sodium Arsenite	Arsenic trioxide	C.W. Staples Co., Inc.
Premerge	4,6-dinitro-O-sec-butyphenol	Dow Chemical Company
Dow General	4,6-dinitro-O-sec-butyphenol	Dow Chemical Company
Des-I-Cate	Mono-(N, N-dimethylathylanion salt of endothal)	Pennwalt Corporation
C.I.P.C.	Isopropyl N-(3-chlorophenyl) carbamate	
C-20546	Unknown	CIBA-Geigy Corporation
PM 4879	Spreader-sticker	Union-Carbide Corporation
Uran	Liquid nitrogen	Allied Chemical Corporation
Tronic	Spreader-activator	Colloidal Products Corporation
Surfactant WK	Polyethylene glycol	Dupont Company
Petro Crop Oil	Crop Oil	Esso Research Engineering Co.

EVALUATION OF HERBICIDES FOR ANNUAL WEED CONTROL IN WHITE POTATOES (1971)

D.H. Fricke[1]

Abstract

Fifteen chemical herbicides were applied alone or in combination at pre-emergence, post-emergence or as split treatments applied both pre and post-emergence. Several treatments resulted in good weed control, with no photo-toxic effect on the potatoes or fall planted rye cover crop.

Introduction

The following paper represents a progress report in evaluation of herbicides for annual weed control in white potatoes on Long Island. Four experiments conducted during 1971 are summarized below.

Procedure

The experiments were conducted on a commercial farm which had a history of high populations of annual grass weeds. The Katahdin variety was planted in 34 inch rows on April 20. Fertilization was 2,250 pounds of 8-16-8 banded at planting. During the growing season potatoes were irrigated on June 29 and July 9. A regular insect and disease spray program was followed.

Plot size in the first three experiments was 2 rows wide by 30 feet long and 1 row by 30 feet in the fourth. Experimental design was a randomized block with each treatment replicated five times. Herbicides used in the experiments are listed in Table 5. Spray formulations of herbicides in Experiment I, II and III were applied with a tractor mounted 2 row boom sprayer using a pressure of 35 p.s.i. and a volume of 38 gallons per acre. In Experiment IV spray formulations were applied with a 1½ gallon compressed air sprayer using a pressure of 20 p.s.i. and a volume of 55 gallons per acre. Granular materials were applied with a hand held, gravity flow, cone type applicator.

The planting ridges in Experiment 3 were harrowed down on May 18 and on May 19 the drag off incorporated treatments were applied and immediately incorporated with a tractor drawn finger weeder and followed up with a tractor mounted 2 row cultivator. The pre-emergence treatments in the other four experiments were applied on May 19, 20 and 21. Weather during these days was 70° F. + and partly sunny. Germinated grassy and broadleaf weeds were in the two leaf stage. A light shower of .15 inch fell in the evening of May 21, with no additional rain until May 31. Treatments applied at 50% emergence were made on May 27 and all plots were rated for phytotoxic effects on June 6.

---

1 Cooperative Extension Agent, Suffolk County, Riverhead, New York

All plots were cultivated on June 8 when the potato plants were 6 inches high. Except for the drag off incorporated treatment this was the first tillage since planting. Herbicide treatments indicated as applied at 6 inches were made during cultivation (incorporated treatments) or following the cultivation (without incorporation). The treatment in Experiment IV applied at 12 inches of potato heighth was made on June 16. All plots were hilled on June 19.

Weed control was rated on September 7. Potatoes were harvested on a single row in each plot on September 28 and 29. Rye cover crop was rated for stand and vigor on November 5.

Principle weed species present was barnyard grass (*Echinochloa crusgalli* [L.] Beauv).

Results

The treatments are listed in Tables 1-4. In Experiment I, Table 1, all treatments were applied pre-emergence to the potatoes. Experiment II, Table 2, compared a number of incorporated treatments applied at drag off. Experiment III, Table 3, compared combinations applied at different times and Experiment IV, Table 4 compared a number of post-emergence applications with pre-emergence treatments.

Experiment I

Shortly after emergence slight chlorosis, stunting and tip burn were observed on the potato plants with treatment No. 5 (alachlor at 6 lbs.) and treatment No. 8 (alachlor 4 lbs. plus linuron 1.5 lbs.). Moderate chlorosis was also observed with treatment No. 13,(VCS 438 at 3 lbs.).

Populations of weeds, primarily barnyard grass were relatively high in this experiment where a limited tillage program was followed. None of the treatments gave commercially acceptable levels of weed control - 7 or better. There were however, significant differences between treatments at the 1% level. Treatments with significantly better (1%) weed control of the grassy weeds present included No. 5, (alachlor at 6 lbs.), No. 8 (alachlor 4 lbs. plus linuron at 1.5 lbs.), and 16 and 17 (EL119 at 1.5 and 3.0 lbs.).

Significantly better at the 5% level were the above and No. 10 (DCPA 6.0 lbs. plus linuron 0.75 lbs., No. 11 (DCPA 6 lbs.), No. 13 (VCS 438 1.0 lbs.), No. 15 (EL119 1.0 lbs.), No. 20 (Am Chem 70-25 4 lbs.), No. 23 (chlorobromuron 50W 3 lbs.) and No. 29 (Norea 3.0 lbs.).

Significant differences in potato yields were found at the 5% level. Those treatments significantly lower than the check were No. 2 (linuron 50W at 1.5 lbs.), No. 8 (alachlor 4 lbs. plus linuron at 1.5 lbs.), and No. 13 (VCS 438 at 3.0 lbs.).

Treatment No. 17 (EL119 3.0 lbs.) was the only treatment in the experiment where growth of the rye cover crop was restricted.

Table 1 - Experiment I

Yield and Weed Control - Pre-Emergence Herbicide Treatments

	Material	Formulation	Lbs. Aia		Yield[a]	Weed Control[b]
1	linuron	50W	1.0		203	3.0
2	linuron	50W	1.5		175*	3.9
3	linuron	10G	1.5		193	4.1
4	dinoseb	3EC	4.5		214	4.2
5	alachlor	4EC	6.0		215	5.6**
6	alachlor linuron	4EC 50W	1 0.75	tank mix	240	4.3
7	alachlor linuron	4EC 50W	2 0.75	tank mix	231	3.9
8	alachlor linuron	4EC 50W	4 1.5	tank mix	173*	5.6**
9	DCPA metobromuron	75W 50W	6.0 1.0	tank mix	204	4.6
10	DCPA linuron	60W 7.5	6.0 0.75	formulated mix	231	5.3*
11	DCPA	75W	6		249	5.4*
12	VCS 438	75W	1.5		212	4.8
13	VCS 438	75W	3.0		146*	5.1*
14	VCS 438 alachlor	75W 4EC	1.5 1.5	tank mix	185	4.6
15	EL 119	75W	1.0		221	5.4*
16	EL 119	75W	1.5		208	5.9**
17	EL 119	75W	3.0		218	6.5**
18	EL 119 dinoseb	75W 3EC	1.0 3.0	tank mix	212	4.9
19	Amchem 70-25	4EC	2		213	4.6
20	Amchem 70-25	4EC	4		214	5.4*
21	chlorobromuron linuron	10G 10G	2 2	formulated mix	212	4.3
22	chlorobromuron	50W	2		200	4.4
23	chlorobromuron	50W	3		220	5.2*
24	metobromuron	50W	3		216	4.4
25	chlorobromuron	10G	2		216	3.7
26	chlorobromuron alachlor	50W 4EC	2 2	tank mix	194	4.9
27	Bay 94337	70W	0.75		217	4.1
28	Bay 94337	70W	1.0		203	4.7
29	norea	80W	3.0		206	5.5*
30	check				225	3.3
				LSD 5%	44	1.7
				1%	N.S.	2.3

* Significantly different from check at 5% probability level.
** Significantly different from check at 1% probability level.
a,b - See footnotes Table 2.

Experiment II

No phytotoxic effect on the growth of the potatoes was observed at emergence with any of the treatments. There were significant differences in weed control at the 1% level. In this experiment EPTC 6EC at 6 lbs. was the only treatment with weed control not significantly better than the check.

There was no significant effect on yield in this experiment. All three treatments with R7465 alone or in combination had a moderate to severe effect on the growth of the rye cover crop sown after harvest.

Table 2 - Experiment II

Yield, weed control & effect on cover crop - Drag off incorporated treatments

Material	Formulation	Lbs. Aia		Yield[a]	Weed Control[b]	Fall Cover Crop[b]
31 vernolate	6EC	6.0		190	6.6**	1.0
32 vernolate	10G	6.0		264	6.1**	1.0
33 EPTC	6EC	6.0		228	4.5	1.0
34 EPTC	6EC	4.5		239	6.0**	1.0
35 R7465	50W	2.0		231	7.6**	7.4
36 R7465 EPTC	50W 6EC	0.5 3.0	tank mix	206	5.8*	5.4
37 R7465 EPTC	50W 6EC	1.0 4.0	tank mix	202	6.7**	7.2
38 linuron EPTC	50W 6EC	1.0 4.0	tank mix	243	6.4**	1.0
39 trifluralin linuron	4EC 50W	0.75 1.0	tank mix	199	6.5**	1.0
40 trifluralin	4EC	1.0		226	6.8**	1.0
41 check				230	3.9	1.0
				N.S. LSD		
				5%	1.5	
				1%	2.0	

a - Potato yield, cwt. per acre, total harvested weight.
b - Weed control or crop damage rating scale, 1-9.
1= No crop injury or weed control.
9= Crop eliminated or 100% weed control.

* - Significantly different from check at 5% probability level.
**- Significantly different from check at 1% probability level.

Experiment III

No phytotoxic effect was observed at emergence on the potatoes in this experiment. Treatments which resulted in weed control significantly better than the check at the 1% level were No. 44 (dinoseb 3 lbs. PE plus EPTC 3.5 lbs.) incorporated at 6 inches, No. 45 (linuron 0.75 lbs. PE plus EPTC 3.5 lbs.) at 6 inches, No. 46 (EPTC 4.5 lbs.) at 6 inches, No. 48 (Bay 94337

0.75 lbs.) PE and repeated at 6 inches, No. 50 (VCS 438 1.5 lbs. PE plus alachlor 2 lbs.) at 6 inches and No. 55 (linuron 0.75 lbs. PE plus alachlor 6 lbs.) at 6 inches. Significantly better than the check at the 5% level of weed control were the above and No. 43 (EPTC 4.5 lbs.) drag off incorporated, No. 47 (Bay 94337 0.5 lbs.) PE repeated at 6 inches, and No. 54 (linuron 0.75 lbs. PE plus alachlor 2.0 lbs.) at 6 inches.

Table 3 - Experiment III

Yield and weed control - Split combination Treatments

Material	Formulation	Lbs. Aia	Timing	Yield[a]	Weed Control[b]
42 Check				201	3.2
43 EPTC	6E	4.5	D.O.Inc.	246*	5.1*
44 dinoseb	3 lbs./gal.	3.0	P.E.	214	5.5**
EPTC	10G	3.5	Inc. @ 6"		
45 linuron	50W	0.75	P.E.	182	6.2**
EPTC	10G	3.5	Inc. @ 6"		
46 EPTC	10G	4.5	Inc. @ 6"	238*	6.5**
47 Bay 94337	70W	0.5	P.E.	221	5.0*
Bay 94337	70W	0.5	Post 6"		
48 Bay 94337	70W	0.75	P.E.	188	6.1**
Bay 94337	70W	0.75	Post 6"		
49 chlorobromuron	50W	2.0	P.E.	214	3.5
alachlor	10G	2.0	Post 6"		
50 VCS 438	75W	1.5	P.E.	214	5.4**
alachlor	10G	2.0	Post 6"		
51 linuron	10G	1.5	Post 6"	182	4.4
52 linuron	50W	0.75	P.E.	225	2.1
linuron	10G	0.75	Post 6"		
53 linuron	50W	0.75	P.E.	191	4.2
alachlor	4EC	2.0	Post 6"		
54 linuron	50W	0.75	P.E.	206	4.9*
alachlor	10G	2.0	Post 6"		
55 linuron	50W	0.75	P.E.	228	5.3**
alachlor	4EC	6.0	Post 6"		
56 alachlor	4EC	6.0	Post 6"	217	4.6
57 linuron	50W	0.75	P.E.	212	3.9
alachlor	10G	6.0	Post 6"		
			LSD 5%	36	1.5
			1%	N.S.	2.0

a, b - See footnotes Table 2.

*, ** - See footnotes Table 2.

Two of the treatments resulted in yields significantly better than the check at the 5% level. These were No. 43 (EPTC 4.5 lbs.) drag off incorporated and No. 46 (EPTC 4.5 lbs.) incorporated at 6 inches. None of the treatments appeared to have any effect on the rye cover crop when examined on November 5.

Experiment IV

Two of the treatments applied early post-emergence caused phytotoxic effects on the potatoes when rated shortly after emergence. These were No. 61 (alachlor 2 lbs. plus linuron 0.75 lbs.) and No. 62 (alachlor 2 lbs. plus dinoseb 3 lbs.). No other phytotoxic effects were observed from the other treatments made later. Significant differences in weed control were found at both 5 and 1% levels. At the 1% level were the alachlor-linuron PE treatments and the four Bay 94337 treatments. At 5% was the alachlor-linuron early post-emergence treatment. There was no significant differences in yields. None of the treatments had any effect on the cover crop when examined on November 5.

Table 4 - Experiment IV

Yield and weed control - Pre vs. Post-Emergence

Material	Formulation	Lbs. Aia		Timing	Yield[a]	Weed Control[b]
60 alachlor	4EC	2.0	tank	P.E.	212	5.7**
linuron	50W	0.75	mix			
61 alachlor	4EC	2.0	tank	early	201	5.0*
linuron	50W	0.75	mix	post 2"		
62 alachlor	4EC	2.0	tank	early	225	4.1
dinoseb	3EC	3.0	mix	post 2"		
63 Bay 94337	70W	1.05		P.E.	195	5.5**
64 Bay 94337	70W	1.05		2"early post	202	6.4**
65 Bay 94337	70W	1.05		post 6"	176	6.7**
66 Bay 94337	70W	1.05		post 12"	183	7.5**
67 check					215	3.6
				LSD 5%	N.S.	1.3
				1%		1.8

a, b - See footnotes Table 2.

*, ** - See footnotes Table 2.

Discussion

An examination of weather records for the Riverhead area for May and June 1971 indicated these two months were unusually cool and dry. These conditions may have had some effect on performance of herbicides in these experiments.

Because of the relatively low populations of broadleaf weeds in this experiment it was not possible to determine effectiveness of the treatments for that purpose.

Under the conditions of these experiments where barnyard grass was the primary weed present and where season long weed control was evaluated by rating weed control in September, a month after potato vines had "gone down", very few of the pre-emergence treatments provided satisfactory weed control with no adverse effects on the potato or rye crop.

A number of drag off incorporated, post-emergence, and split treatments did provide satisfactory weed control. Drag off incorporated materials which performed well included vernolate, EPTC, trifluralin and combinations of EPTC with linuron, and trifluralin with linuron. R7465 gave good weed control with no noted phytotoxic effect on potatoes, but, either alone or in combination with EPTC did severely retard growth on the fall cover crop of rye.

Among the split treatments applied PE followed by another treatment post-emergence when potatoes were 6 inches high were dinoseb-EPTC, linuron-EPTC, Bay 94337 PE plus Post, VCS 438-alachlor and linuron-alachlor. Successful post emergence treatments included EPTC and Bay 94337. Post-emergence applications of Bay 94337 as late as with potatoes 12 inches in heighth did not appear to have any phytotoxic effect, with a trend toward improved weed control with delayed application. Higher rates of alachlor PE and early post-emergence spray treatments did result in some phytotoxic effects on the potato crop which were not observed with later applications.

Table 5 - Herbicides Used in 1971 Potato Herbicide Evaluations

Common Name	Trade Name	Chemical Name
alachlor	Lasso	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
Amchem 70-25		Unknown
Bay 94337	Sencor	4-amino-6 t-butyl-3-(methylthio)-as-triazin-5-(4H)-one
chlorobromuron	Maloran	3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea
DCPA	Dacthal	dimethyl tetra chloro terephthalate
dinoseb	Premerge	4,6-dinitro-o-sec butyl phenol
EL 119	Ryzelan	3,5 Dinitro-N, N-dipropylsulfanilamide
EPTC	Eptam	S-ethyl dipropylthiocarbamate
linuron	Lorox	3(3,4-dichlorophenyl-1-methoxy-1-methylurea
metobromuron	Patoran	3-(p-bromophenyl)-1-methyl-1-methoxyurea
norea	Herban	3-(hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea
R7465	Stauffer	Unknown
trifluralin	Treflan	a,a,a,-trifluro-2,6 dinitro-N,N-dipropyl-p-toluide
VCS 438	Probe	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiozolidine-3,5-dione
vernolate	Vernam	S,propyl dipropyl dithio carbamate
	Proprietory Mixtures	
chlorobromuron 10% linuron 10%	Shamrox	
DCPA 60W linuron 7.5W	20G formulation	

ALACHLOR IN COMBINATION WITH CHLORBROMURON, METOBROMURON, LINURON, DINOSEB, AND VCS-438 IN POTATOES

W. J. McAvoy, Jr., M. M. Lay, and R. D. Ilnicki[1/]

Abstract

Combinations of chlorbromuron, metobromuron, linuron, dinoseb, and VCS-438 with alachlor effected broad spectrum weed control. Applications of alachlor in combination with linuron, dinoseb, or VCS-438 approximately 20 days after planting were generally better than applications made immediately after planting. Yields of potatoes were highest for alachlor in combination with metobromuron, linuron, and dinoseb.

Introduction

White potatoes (Solanum tuberosum) is one of the many important crops in New Jersey's diversified agriculture. When several weed species are in a potato field and one herbicide is applied, there may be a few weed species which escape control. These weed species can impede harvest and very likely reduce yields. It was the purpose of this experiment to investigate several herbicides for weed control and their effects on yield.

Materials and Methods

This experiment was located at the Rutgers University Soils and Crops Research Station at Adelphia, New Jersey.

The seedbed was prepared on Freehold sandy loam soil in an area infested with common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), Pennsylvania smartweed (Polygonum pensylvanicum L.), prostrate knotweed (Polygonum aviculare L.), large crabgrass (Digitaria sanguinalis (L.) Scop.), and yellow foxtail (Setaria lutescens (Weigel) Hubb.). White potatoes (var. Katahdin) were planted on April 21, 1971 in plots consisting of 4 rows 12 ft wide and 20 ft long.

The herbicides 3-(p-bromophenyl)-1-methoxy-1-methylurea (metobromuron); 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorbromuron); 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron); 2-sec-butyl-4,6-dinitro=phenol (dinoseb); and 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione (VCS-438) were applied separately and in combination with

---

[1/] Graduate Assistants and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jer

2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor). There were three replications of each treatment in a randomized complete block design.

Most treatments were applied on the date of planting (April 21); a few treatment applications were purposely delayed until May 10. The treatments were applied with a four-nozzle boom using 730616 TeeJet[2/] spray tips at 30 psi, carbon dioxide serving as the pressure source. The spray volume was 40 gpa with water as the carrier.

Potato injury and weed control ratings by species were made on June 21. A scale of 0 to 10 was used in which 0 = essentially no effect on stand or vigor and 10 = complete kill or elimination of stand.

Potatoes were harvested on September 7-8 using the center two rows of each plot for yield determination. The potatoes were graded into No. 1, No. 2, and culls and weighed. Field weights were then converted to cwt/A. Yields were statistically analyzed and Duncan's Multiple Range Test used for comparison of treatment means.

Results and Discussion

There was essentially no injury to the potatoes from any treatment (Table 1).

Lambsquarters control was excellent from all treatments except dinoseb at 3 and 4½ lb/A rates. Alachlor at 1½, 2, 3, and 4 lb/A rates effected variable lambsquarters control. Dinoseb was weak on pigweed with all other treatments giving excellent control.

Smartweed was not controlled at all by VCS-438 at 2 and 2½ lb/A. Alachlor at all rates was again variable in controlling smartweed. Alachlor + VCS-438 at 1½ + 1½ lb/A applied on the day of planting was ineffective but the delayed treatment at the same rates enhanced considerably the degree of smartweed control. Effective smartweed control was not realized by chlorbromuron at 2 lb/A or dinoseb at 3 lb/A or dinoseb + alachlor at 3 + 2 or 6 + 4 lb/A.

Alachlor was ineffective against knotweed. Treatments that partially controlled knotweed were chlorbromuron at 2 lb/A, chlorbromuron + alachlor at 2 + 1½ lb/A, linuron at 1 and 1½ lb/A, dinoseb at 3 lb/A, and linuron and VCS-438 applied in combination on the planting dates. Again, enhancement of control of knotweed was evident for those treatments applied at a later date.

2/ Tradename of Spraying Systems Company, Bellwood, Illinois.

Most treatments were effective for crabgrass control with the exception of chlorbromuron at 2 and 3 lb/A, metobromuron at 2 lb/A, and dinoseb at 3 and $4\frac{1}{2}$ lb/A.

Excellent yellow foxtail control was produced by many treatments. Metobromuron and chlorbromuron at 2 lb/A and dinoseb at 3 and $4\frac{1}{2}$ lb/A were ineffective in controlling this species.

The best treatments for total weed species control in this experiment were chlorbromuron + alachlor at 3 + $1\frac{1}{2}$ lb/A, metobromuron + alachlor at all rates, and linuron, dinoseb, and VCS-438 in combination with alachlor applied at the later date.

Total potato yields ranged from 100.67 to 258.09 cwt/A. Treatments yielding above 220 cwt/A were significantly different from the cultivated check. These treatments included metobromuron, linuron, and dinoseb in combination with alachlor.

Table 1. The response of potatoes and some weeds to preemergence applications of herbicides and herbicide combinations.

Trmt. No.	Herbicide	Rate, lb a.i./A	Weed Control Lbsq	Pig	Smt	Ktw	Cbg	Yf	Yield cwt/A No. 1's	culls	Total**
1.	VCS-438	2	9.9	9.9	0.0	10.0	10.0	6.7	143.75	13.55	157.30 c-h
2.		2½	10.0	10.0	0.0	10.0	10.0	6.7	189.73	9.68	199.41 a-g
3.	alachlor	1½	4.3	9.3	6.0	0.0	10.0	10.0	146.90	4.96	151.86 e-h
4.		2	8.7	9.7	6.7	1.7	10.0	10.0	163.95	11.74	175.69 a-h
5.		3	4.5	10.0	10.0	0.0	10.0	9.7	151.01	10.41	161.42 b-h
6.		4	7.0	10.0	3.0	0.0	10.0	10.0	178.23	11.13	189.36 a-g
7.	VCS-438 +	1½ + 1½	9.5	9.7	4.2	6.7	10.0	8.0	182.10	8.59	190.70 a-g
8.	alachlor	1½ + 2	9.7	9.8	9.7	6.7	9.9	9.5	187.91	6.78	194.69 a-g
* 9.	(later)	1½ + 1½	10.0	10.0	9.5	10.0	9.9	10.0	203.40	8.95	212.35 a-g
*10.		1½ + 2	10.0	10.0	9.9	10.0	10.0	10.0	196.74	6.05	202.79 a-g
11.	chlorbromuron	2	10.0	10.0	6.7	6.7	6.7	4.7	183.44	9.68	193.12 a-g
12.		3	10.0	10.0	9.5	6.0	6.3	8.0	197.95	8.35	206.30 a-g
13.	chlorbromuron +	2 + 1½	10.0	10.0	10.0	2.7	10.0	9.9	178.35	10.41	188.76 a-g
14.	alachlor	3 + 1½	10.0	10.0	9.8	9.7	10.0	9.7	185.85	5.69	191.54 a-g
15.	metobromuron	2	10.0	9.8	10.0	5.0	2.7	1.0	134.31	7.99	142.30 f-h
16.		4	10.0	10.0	9.8	10.0	10.0	9.0	203.04	8.59	211.63 a-g
17.	metobromuron +	2 + 1½	9.9	9.9	9.8	10.0	10.0	9.2	246.84	9.68	256.52 a
18.	alachlor	2 + 2	10.0	10.0	9.4	6.7	10.0	9.9	212.59	11.62	224.21 a-f
19.		4 + 3	10.0	10.0	9.7	10.0	10.0	9.2	236.43	6.78	243.21 a-c

Table 1. Cont.

Trmt. No.	Herbicide	Rate, lb a.i./A	Weed Control lbsq	Pig	Smt	Ktw	Cbg	Yf	Yield cwt/A No. 1's	culls	Total**
20.	linuron	1	9.8	9.3	9.2	6.7	10.0	5.3	191.79	8.10	199.89 a-g
21.		1½	10.0	10.0	8.8	6.7	9.7	8.5	193.85	10.16	204.01 a-g
22.	linuron +	3/4 + 2	9.9	10.0	9.9	3.3	10.0	9.8	206.42	14.41	220.83 a-f
23.	alachlor	1½ + 4	10.0	10.0	9.9	5.0	10.0	10.0	247.32	10.77	258.09 a
*24.	(later)	3/4 + 2	10.0	10.0	10.0	10.0	10.0	10.0	225.42	7.99	233.41 a-e
*25.		1½ + 4	10.0	10.0	10.0	10.0	10.0	10.0	223.97	6.05	230.02 a-e
26.	dinoseb	3	3.0	3.0	6.0	0.0	0.0	2.3	146.65	9.08	155.73 d-h
27.		4½	6.5	4.3	8.7	10.0	0.0	2.7	188.04	10.16	198.20 a-g
28.	dinoseb +	3 + 2	9.8	9.7	6.5	10.0	9.8	9.3	229.18	12.82	242.00 a-d
29.	alachlor	6 + 4	10.0	9.9	6.9	9.3	10.0	6.9	235.34	9.93	245.27 ab
*30.	(later)	3 + 2	9.9	9.9	9.7	10.0	10.0	9.3	223.37	8.10	231.47 a-e
*31.		6 + 4	10.0	10.0	10.0	10.0	10.0	10.0	224.34	12.82	237.16 a-e
32.	check-cult.	-	10.0	10.0	10.0	10.0	10.0	10.0	119.06	11.62	130.68 gh
33.	check-not cult.	-	0.0	0.0	0.0	0.0	0.0	0.0	89.17	11.50	100.67 h

*Treatments applied on May 10, 1971.
**Means having the same letter in common are not significantly different at the 0.01 level.

Lbsq = lambsquarters; Pig = pigweed, Smt = smartweed; Ktw = knotweed; Cbg = crabgrass; Yf = Yellow foxtail.

WEED CONTROL IN WHITE POTATOES IN MAINE - 1971

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

Abstract

In Maine during the 1971 season, seventeen herbicides at various dosage levels and combinations were tested for control of broadleaved weeds, annual grass, and quackgrass growing in white potatoes. In general, the recommended herbicides such as DNBP, EPTC, Linuron, and Paraquat gave satisfactory broadleaf weed and grass control.

Of the newer candidate compounds, Sencor, Tunic, Alachlor, Bay Kue 2236, S-6044, and BAS 2903-H were also effective for broad spectrum weed control in white potatoes during the 1971 growing season.

Introduction

Seventeen herbicides were tested in Maine during the 1971 season for control of broadleaved weeds, annual grasses, and quackgrass *(Agropyron repens)* growing in white potatoes. In Maine, we are looking for herbicides which have broad spectrum weed control, are flexible as to time of application, and not have adverse effects on vine characteristics or affect quality of tubers when used for seed purposes.

Rainfall during the 1971 growing season as presented in Table 1 was normal during May and June, and above normal during July and August. Soil moisture and temperature was favorable for germination and rapid growth of both weeds and potatoes during the entire season.

Materials and Methods

Two blocks of Katahdin potatoes were planted on May 21 and June 2, 1971, at Aroostook Farm, Presque Isle, Maine. All plots were fertilized with 1300 pounds of 10-10-10 placed in conventional row sidebands. Seedpieces were spaced 8 inches apart in 34 inch rows and uniformly covered with 1½ inches of soil. Soil type at both test locations was Caribou gravelly sandy loam with an organic matter content of 4.54 percent. Plot areas were fall plowed and harrowed twice before planting in 1971. Previous crop on test Block I was Japanese millet and potatoes followed by

[1]Associate Professor of Agronomy and Technician, Grade II, Department of Plant and Soil Sciences, University of Maine, Orono, Maine 04473

winter rye on test Block II. No herbicides were used to control weeds growing in the Japanese green manure crop or winter rye cover crop in 1970.

Experimental designs for both tests reported in this paper were randomized blocks with each treatment replicated six times. Plot size was two 20-foot rows with untreated buffer rows between 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 mixture per acre. Herbicides were applied on the following dates:

	Block I	Block II
Preemergence (P.E.)	June 9	June 22
Preplant Inc. (P.P.)		June 2
Early preemergence (E.P.E.)		June 10

Weed control ratings were made on dates indicated in Tables 3 and 4 which also note the weed species present in each Block. Yield of tubers was measured and 25 pounds of tubers from each plot were saved for storage studies and residue analysis.

Samples will be examined after four months in 50F storage for possible internal and external tuber discoloration. Replicates of treatments will be bulked and stored at 38F. Tubers from the highest rates of each herbicide will be planted the following year to determine possible side effects of the herbicides on tubers used for seed purposes.

Common names and chemical designation of herbicides used in Maine trials are presented in Table 2.

Results and Discussion

Block I: Data presented in Table 3 show the effect of several herbicides applied preemergence to potatoes on broadleaved weeds, annual barnyard grass, and quackgrass. All of the herbicide treatments gave excellent early control of broadleaved weeds, but several treatments, namely, Alachlor in combination with 0.75, 1.25, and 1.50 pounds of Linuron did not effectively control (less than 4.0 rating) late emerging weeds. All combinations of EL119 with DNBP except the 2.25 rate of EL119 controlled early weeds but missed late emerging weeds. Paraquat at both rates used was also weak on late emerging weeds.

With the exception of the 2.25 pounds of Alachlor plus 1.5 pound DNBP treatment, all treatments were effective (3.5 rating or higher) for controlling early emerged annual grasses. Later emerging annual grasses were missed by DNBP applied alone, by the 2.25 pounds Alachlor plus 1.5 pounds DNBP treatment, by the one pound of Paraquat, and by the combination of 1.875 pounds EL119 and 3.0 pounds DNBP.

Paraquat at 2.0 pounds per acre provided good full season control of quackgrass. Yield data presented in Table 3 indicate that chemical weed control prevented yield declines as compared to no treatment. None of the herbicides used in Block I, applied preemergence, caused any phytotoxic symptoms on emerging or growing potato plants in 1971.

Block II: Data presented in Table 4 indicate the effect of several herbicide treatments tested for weed control in potatoes. Amchem A-820 at 1.5 pounds per acre and 1.0 pound of R7465 applied preplant did not control early broadleaved weeds, but developed sufficient activity to control later emerging weeds. Paraquat applied early preemergence also increased in activity as the season progressed. Two pounds of NIA 20439, and most of the herbicides applied preemergence to the potatoes showed activity on broadleaved weeds until late August.

Most herbicides tested in Block II except DNBP and Paraquat applied early preemergence, 2.0 pounds NIA 20439, and BAS 3510-H applied preemergence provided good kill of annual grasses. These same herbicides were not effective in holding annual grasses that emerged during mid and late season.

Many of the herbicides tested in Block II showed very slow initial kill of quackgrass. By late August, however, as shown in Table 4 all materials except Linuron and Paraquat applied early preemergence and BAS 3510-H applied preemergence had increased activity enough to provide good commercial control of quackgrass.

Weeds in Block II were apparently not detrimental to yield of potatoes as indicated by the untreated check plot with a yield of 351 hundredweight. In Block II none of the herbicides had any adverse effect on yield of tubers and none of the herbicides used showed any phytotoxic effects on growing potato plants.

Table 1. 1971 Rainfall - Presque Isle, Maine

May	3	0.28		July	1	0.27	
	4	0.61			2	T	
	5	0.28			4	0.07	
	6	T			6	0.11	
	7	0.13			7	0.04	
	13	0.05			8	0.05	
	14	T			9	0.03	
	15	0.03			11	T	
	16	T			14	0.32	
	17	T			15	0.35	
	22	0.23			18	1.35	
	23	0.59			19	T	
	25	0.04			20	0.21	
	26	0.39			21	T	
	27	0.07			24	0.02	
			2.70		25	0.10	
					27	0.33	
June	3	0.10			31	0.05	
	4	T					3.30
	7	T					
	8	0.07		Aug.	3	0.02	
	9	T			4	0.83	
	10	T			9	0.52	
	13	T			10	0.40	
	16	0.55			11	0.46	
	17	0.10			12	0.60	
	20	T			13	0.05	
	21	0.52			15	T	
	24	0.04			21	0.15	
	25	T			23	0.44	
	26	0.40			24	0.03	
	29	T			25	0.52	
	30	0.25			29	0.80	
			2.03		30	0.26	
							5.08

Table 2. Herbicides used on white potatoes in Maine - 1971

Trade Name	Common Name	Chemical Name
Dowpon	Dalapon	2, 2-dichloropropionic acid
Eptam 6E	EPTC	S-ethyl dipropylthiocarbamate
Lasso 4E	Alachlor	2-chloro-2, 6-diethyl-N(methyoxy-methyl) acetonilide
Lorox 50W	Linuron	3-(3, 4-dichlorophenyl)-1-methoxy-1-methyl-urea
Paraquat CL		1, 1'-dimethyl-4, 4'bipyridium dichloride
Premerge	DNBP	2-sec-butyl-4, 6-dinitrophenol
Amchem A-820 4E		N-secondary-butyl-4-tertiary-butyl-2, 6-dinitroaniline
BAS 2903-H 4E	Basamaize	
BAS 3510-H 50W		
Bay Dic 1897 70W		
Bay Kue 2236 70W		1, 1-dimethyl-3-(m-chloro-p-trifluoro-methoxyphenyl) urea
Bay 94337 70W	Sencor	4-Amino-6-T-butyl-3-(methylthio)-1,2, 4-triazin-5(4H)-one
EL119 75W		4-Isopropyl-2, 6-dinitro-N, N-dipropyl-aniline
NIA 20439 50W		3-(2-methylphenoxy) pyridazine
R7465 50W	Waylay	2-(napthoxy)-N, N-diethylpropionamide
S-6044 3E		
U-27,267 75W		
VCS438 75W	Tunic	2-(3,4-dichlorophenyl)-4-methyl-1,2, 4-oxadiozalidine 3, 5-dione

Block I

Table 3. Yield and weed control ratings for white potatoes following application of various herbicides. Maine - 1971

Pounds of active material per acre	Treatments	Yield Cwt./acre	Weed control ratings[1] Broadleaf[2] 6/22	Broadleaf[2] 8/27	Annual Grass[3] 6/22	Annual Grass[3] 8/27	Qucakgrass[4] 6/22	Qucakgrass[4] 8/27
	Check - no treatment	172d	1.0	1.0	1.0	1.0	1.0	1.0
4.5#	DNBP	349ab	5.0	4.0	3.8	2.5	2.7	1.8
4.5#	DNBP + 5# Dalapon	346ab	5.0	4.0	4.8	4.3	4.0	3.0
1.5#	Tunic	329ab	5.0	4.2	4.8	4.3	2.8	2.8
2.0#	Tunic	338ab	5.0	4.0	5.0	3.7	2.7	2.5
3.0#	Tunic	310bc	5.0	4.5	5.0	4.0	2.7	2.5
3.5#	Tunic	315b	5.0	4.2	5.0	4.0	3.0	3.3
2.25#	Alachlor + 0.75# Linuron	337ab	5.0	3.7	5.0	3.8	2.8	2.3
2.25#	Alachlor + 1.0# Linuron	331ab	5.0	4.3	5.0	3.7	3.2	3.0
2.25#	Alachlor + 1.25# Linuron	333ab	5.0	3.8	5.0	4.0	3.5	2.8
2.25#	Alachlor + 1.50# Linuron	332ab	5.0	3.7	5.0	3.8	2.8	3.2
4.5#	Alachlor + 1.50# Linuron	336ab	5.0	4.0	5.0	3.5	3.7	3.2
2.25#	Alachlor + 3.0# DNBP	348ab	5.0	4.2	4.7	3.7	2.7	2.7
4.5#	Alachlor + 6.0# DNBP	337ab	5.0	4.3	5.0	4.0	3.5	3.3
2.25#	Alachlor + 1.5# DNBP	337ab	5.0	4.2	3.2	2.7	1.7	2.7
0.75#	EL119 + 3.0# DNBP	319ab	5.0	3.3	4.8	4.3	2.2	2.7
1.125#	EL119 + 3.0# DNBP	344ab	5.0	3.8	3.8	4.3	2.0	3.0
1.50#	EL119 + 3.0# DNBP	332ab	5.0	3.8	3.8	3.7	2.2	2.8
1.875#	EL119 + 3.0# DNBP	334ab	5.0	3.7	3.8	3.0	2.3	2.7
2.25#	EL119 + 3.0# DNBP	323ab	5.0	4.2	4.8	4.0	2.8	2.5
1.0#	Paraquat	350ab	4.2	3.5	4.2	2.8	3.5	2.8
2.0#	Paraquat	360ab	4.7	3.0	5.0	3.8	4.3	3.8

[1]Weed control ratings: 1 = no control; 5 = excellent control.

[2]Broadleaf weed species: *Chenopodium album*, *Brassica campestris*, *Brassica rapa*, *Amaranthus retroflexus*, and *Polygonum persicaria*.

[3]Annual Grass: *Echinochloa crusgalli* and *Setaria viridis*.

[4]Quackgrass: *Agropyron repens*.

Block II

Table 4. Yield and weed control ratings for white potatoes following application of various herbicides. Maine - 1971

Pounds of active material per acre	Treatments	Yield Cwt./acre	Weed control ratings[1] Broadleaf[2] 7/19	Broadleaf[2] 8/30	Annual Grass[3] 7/19	Annual Grass[3] 8/30	Quackgrass[4] 7/19	Quackgrass[4] 8/30
	Check - no treatment	351ab	0.8	2.2	1.0	1.4	1.0	1.4
0.5#	R7465 (50W), P.P.[5]	367ab	4.6	4.8	4.2	4.8	3.8	4.6
1.0#	R7465 (50W), P.P.	374ab	3.2	4.2	4.0	3.8	1.8	3.8
2.0#	R7465 (50W), P.P.	352ab	4.2	4.4	3.8	4.6	2.8	4.6
3.0#	EPTC + ½# R7465 (50W), P.P.	345ab	4.8	5.0	5.0	4.4	4.2	4.8
3.0#	EPTC + 1# R7465 (50W), P.P.	370ab	4.2	5.0	4.8	4.8	4.2	5.0
3.0#	EPTC + 2# R7465 (50W), P.P.	324ab	4.4	5.0	4.2	4.2	3.6	5.0
3.0#	EPTC + 4# Dyfonate, P.P.	372ab	3.8	5.0	4.6	4.2	3.6	4.6
1.5#	U-27,267 (75W), P.P.	367ab	4.4	5.0	4.0	4.4	1.4	4.8
2.75#	U-27,267 (75W), P.P.	345ab	4.2	4.6	4.6	5.0	3.0	5.0
1.5#	Amchem A-820 (4E), P.P.	328ab	3.0	3.8	3.4	3.8	2.8	4.0
3.0#	Amchem A-820 (4E), P.P.	317ab	4.2	4.8	4.6	4.2	3.8	4.4
2.25#	Alachlor + 0.75# Linuron, E.P.E.	369ab	5.0	5.0	5.0	4.6	3.8	4.2
2.25#	Alachlor + 3.0# DNBP, E.P.E.	353ab	5.0	5.0	4.8	4.4	4.0	4.8
3.0#	DNBP, E.P.E.	323ab	4.8	3.8	3.0	3.4	3.0	4.0
0.75#	Linuron, E.P.E.	365ab	4.2	4.8	4.2	3.4	3.0	2.8
0.50#	Paraquat, E.P.E.	350ab	3.2	4.0	2.2	2.4	1.4	2.8
1.0#	Bay Kue 2236 (70W), E.P.E.	384a	4.8	4.8	3.4	2.6	2.4	5.0
2.0#	Bay Kue 2236 (70W), E.P.E.	310b	5.0	4.8	4.4	4.6	3.4	4.0
1.0#	Sencor (70W), E.P.E.	355ab	4.8	4.8	4.4	3.8	3.0	4.8
2.0#	Sencor (70W), E.P.E.	348ab	5.0	5.0	4.8	4.6	3.0	4.2
1.0#	Bay Dic 1897 (70W), E.P.E.	370ab	4.8	4.8	4.2	2.6	3.0	4.6
2.0#	Bay Dic 1897 (70W), E.P.E.	351ab	5.0	5.0	5.0	4.6	3.8	4.2
4.5#	DNBP, P.E.	337ab	5.0	5.0	4.8	4.2	4.0	4.8
1.0#	Linuron, P.E.	386a	5.0	4.6	5.0	4.2	4.6	5.0
1.0#	Paraquat, P.E.	386a	4.0	4.6	3.6	3.4	2.6	5.0
2.0#	Paraquat, P.E.	350ab	3.8	5.0	3.6	4.0	2.4	4.8

Table 4 - continued

Pounds of active material per acre	Treatments	Yield Cwt./acre	Weed control ratings[1] Broadleaf[2] 7/19	Broadleaf 8/30	Annual Grass[3] 7/19	Annual Grass 8/30	Quackgrass[4] 7/19	Quackgrass 8/30
2.25#	DNBP + 0.5# Linuron, P.E.	339ab	5.0	5.0	4.8	4.8	2.4	3.8
2.0#	NIA 20439 (50W), P.E.	376ab	3.2	4.2	2.2	3.2	1.6	4.2
4.0#	NIA 20439 (50W), P.E.	337ab	3.6	5.0	3.6	3.6	1.6	3.4
6.0#	NIA 20439 (50W), P.E.	324ab	4.0	5.0	4.0	3.2	2.6	3.4
2.25#	U-27,267 (75W), P.E.	331ab	3.4	4.4	4.2	4.4	2.2	4.4
3.0#	U-27,267 (75W), P.E.	347ab	4.6	5.0	4.8	5.0	3.4	3.8
1.0#	Bay Kue 2236 (70W), P.E.	358ab	5.0	5.0	5.0	4.2	3.8	5.0
2.0#	Bay Kue 2236 (70W), P.E.	324ab	5.0	5.0	5.0	4.8	3.2	4.2
1.0#	Sencor (70W), P.E.	335ab	4.8	5.0	4.6	4.8	2.8	4.8
2.0#	Sencor (70W), P.E.	362ab	5.0	5.0	5.0	4.4	4.6	5.0
1.0#	Bay Dic 1897 (70W), P.E.	369ab	5.0	5.0	5.0	4.6	3.8	4.6
2.0#	Bay Dic 1897 (70W), P.E.	344ab	5.0	4.8	5.0	4.4	4.6	4.4
1.5#	S-6044 (3E), P.E.	375ab	4.8	5.0	3.8	4.2	2.4	5.0
3.0#	S-6044 (3E), P.E.	348ab	4.8	5.0	4.2	4.4	2.0	4.4
4.0#	S-6044 (3E), P.E.	337ab	5.0	5.0	4.0	4.2	1.8	3.8
4.0#	BAS 2903-H (4EC), P.E.	354ab	4.8	4.8	5.0	4.6	3.8	4.6
3.0#	BAS 2903-H + 1.0# Linuron, P.E.	338ab	5.0	4.8	5.0	4.4	4.2	4.4
1.0#	BAS 3510-H (50W), P.E.	356ab	4.4	5.0	2.0	3.0	1.2	2.2

[1]Weed control ratings: 1 = no control; 5 = excellent control.

[2]Broadleaf weed species: *Chenopodium album*, *Brassica compestris*, *Brassica rapa*, *Amaranthus retroflexus*, and *Polygonum persicaria*.

[3]Annual grass: *Echinochloa crusgalli* and *Setaria viridis*.

[4]Quackgrass: *Agropyron repens*.

[5]P.P. - Pre-plant; E.P.E. - Early Preemergence; P.E. - Preemergence.

CONTROL OF ANNUAL WEEDS AND GRASSES IN POTATOES WITH PREEMERGENCE AND LAYBY HERBICIDE APPLICATIONS [1/]

H. P. Wilson, B. C. Frey and J. N. Belote III [2/]

Abstract

Granular formulations of 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron) and 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) applied after the layby cultivation provided late-season control of annual broadleaf weeds and grasses in potatoes (Solanum tuberosum L.). Both herbicides were effective only if preceded by good preemergence weed control. Potatoes were not injured by either herbicide; however, control of late-season weeds did not result in higher yields of potatoes since the crop was mature when these weeds became competitive.

Introduction

As outlined by Cialone (1), most potatoes in Virginia are planted in March and harvested as a summer crop. In recent years, unfavorable weather conditions and changes in varieties have caused a trend towards later harvest dates. This trend has intensified the problem of annual grass control. Much of the acreage is treated preemergence with 4,6-dinitro-o-sec. butylphenol (dinoseb) but the characteristic short residual activity and the fact that it is weak on annual grasses limits the desirability of this herbicide. Linuron and 3-(p-bromophenyl)-1-methoxy-1-methylurea (metobromuron) have provided good initial control of annual broadleaf weeds and grasses (1,2,3), but observations made late in the season indicate that growth of annual grasses can be extensive by harvest time (1,2). Because of the relatively long period that weed control is needed in potatoes, it was hypothesized that herbicides should be applied later in the season subsequent to preemergence treatments. The research reported herein was conducted to determine if granular formulations of linuron and alachlor would provide satisfactory control of broadleaf weeds and grasses for the remainder of the crop season if applied following the last (layby) cultivation. The need for a preemergence herbicide preceding the layby treatment was also studied.

Materials and Methods

Research was conducted at the Eastern Shore Branch, Virginia Truck and Ornamentals Research Station near Painter during 1970 and 1971. Soils were Sassafras sandy loams having an organic matter content of approximately 1.5%, a pH of 5.5 and a cation exchange capacity of 4.5. Potatoes (var. Pungo) were planted in 36-inch rows and plots 9 ft x 20 ft containing 3 rows were established to receive herbicide treatments. The experimental design was a randomized block with 3 replications in 1970 and 4 replications in 1971. In order that results would be applicable to commercial production practices, normal cultural practices

---

1/ Contribution from the Plant Physiology Department, Virginia Truck and Ornamentals Research Station. Paper No. 153, Journal Series. Approved for publication November 23, 1971.

2/ Plant Physiologist and Agricultural Research Technicians, respectively, Virginia Truck and Ornamentals Research Station, Painter, Va.

were simulated as much as possible. Prior to application of preemergence herbicides, potatoes were cultivated and the hills dragged off. Linuron (50% wettable powder formulation) was then applied to selected plots on April 24 in 1970 and April 12 in 1971. Applications were made using small plot sprayers. All potatoes were cultivated and hoed twice before layby applications were made with the layby cultivation and hoeing immediately preceding herbicide application in 1970 and being 5 days prior to herbicide treatment in 1971. At this time potatoes were in the early bloom stage with the vines extending 10 in to 12 in on either side of the rows. The formulations of linuron and alachlor applied at layby were 10% granulars; application was accomplished using hand shakers held above the potato foliage.

Rainfall patterns differed during the two years of the study. In 1970, preemergence herbicides were applied to moist soil and approximately 0.50 in rain was received within 3 days. Although precipitation during May was below normal, distribution was good, as it was for the entire season (Table 1).

Table 1. Rainfall distribution and amounts in inches received by potatoes in 1970 and 1971, Painter, Va.

	March	April	May	June	July	August
1970	4.93	3.17	2.23	4.72	5.65	0.22
1971	3.14	2.41	6.24	1.26	2.02	0.72

Layby applications were made to a dry soil surface and 0.50 in rainfall was received later the same day. Contrary to the desirable moisture conditions encountered in 1970, rainfall was below normal in 1971 and the distribution pattern was poor. The only month during which adequate moisture was received was May. Preemergence treatments were applied to a dry soil surface, and less than 0.10 in rainfall was recorded for the following 3 weeks. Layby herbicides were applied to wet soil but no further precipitation occurred for 6 days when 0.46 in was received.

Effectiveness of the various treatments was determined by rating control of annual broadleaf weeds and grasses in mid-August using the scale 0 to 10 where 0 represents no effect and 10 represents complete reduction of plant stand. Predominant weeds were lambsquarters (Chenopodium album L.), pigweed (Amaranthus retroflexus L.), large crabgrass (Digitaria sanguinalis (L.) Scop.), fall panicum (Panicum dichotomiflorum Michx.) and barnyardgrass (Echinochloa crusgalli (L.) Beauv.). After rating, potatoes were harvested to permit yield determinations; yields were analyzed statistically.

Results and Discussion

Linuron applied preemergence in 1970 provided season-long control of annual broadleaf weeds although grass control diminished by harvest time (Table 2). Poor control of lambsquarters and pigweed with layby applications is indicative that weeds may already have been established when linuron or linuron plus alachlor were applied, despite the fact that care was taken to provide mechanical control until layby treatment. This is further emphasized by the outstanding response from combinations of 0.75 lb/A linuron applied preemergence followed by another application at layby.

Table 2. Control of annual broadleaf weeds and grasses in potatoes with linuron and alachlor applied preemergence and at layby in 1970.[1/]

Preemergence Herbicide	Rate, lb/A ai	Layby Herbicide	Rate, lb/A ai	Weed Control[2/] Grasses[3/]	Pig-weed	Lambs-quarters	Yield, cwt/A
Linuron	0.75	None		8.6	10.0	9.5	231.6
None		Linuron	0.75	8.8	7.7	5.3	202.6
None		Linuron	1.50	9.1	8.7	9.2	234.5
Linuron	0.75	Linuron	0.75	9.5	10.0	10.0	241.8
Linuron	0.75	Linuron	1.50	9.5	10.0	10.0	218.5
None		Alachlor	1.50	7.8	9.0	6.0	158.3
None		Alachlor	3.00	9.5	10.0	7.2	222.9
Linuron	0.75	Alachlor	1.50	9.2	10.0	9.2	227.2
Linuron	0.75	Alachlor	3.00	9.5	10.0	9.5	217.1
None		Linuron + Alachlor	0.75 + 1.50	9.7	9.7	8.2	209.8
None		None		7.0	4.7	0.0	201.8
LSD 0.05							N.S.

[1/]All potatoes were cultivated and hoed twice.

[2/]Scale: 0 to 10; 0 = no effect and 10 = complete control.

[3/]Grasses were crabgrass, fall panicum and barnyardgrass.

Results with alachlor parallel those obtained with linuron. When layby applications of alachlor were preceded by linuron preemergence, control was superior to that obtained when the preceding treatments were cultivation only. As might be expected, alachlor was most effective for control of annual grasses and pigweed whereas linuron provided better control of broadleaf weeds than of grasses. From these results it was surmised that effective layby use rates of linuron would be 0.75 lb/A and alachlor would be 2.00 lb/A.

Differences among treatments in 1971 were greater than in 1970 (Table 3). Control with preemergence applications of linuron, alone or in combinations with alachlor, was initially good but did not last until harvest time. Neither linuron nor alachlor applied at layby gave satisfactory control unless preceded by linuron preemergence. It is interesting to note that linuron did not provide complete control of annual grasses in 1971 even when the preemergence and layby rates were a total of 3.00 lb/A. Although layby applications of alachlor provided good grass control when preceded by linuron preemergence, the rate required was 4.00 lb/A and even then, control of lambsquarters was not satisfactory.

Table 3. Control of annual broadleaf weeds and grasses in potatoes with linuron and alachlor applied preemergence and at layby in 1971.[1/]

Preemergence Herbicide	Rate, lb/A ai	Layby Herbicide	Rate, lb/A ai	Weed Control[2/] Grasses[3/]	Lambs-quarters	Yield, cwt/A
Linuron	0.75	None		0.0	5.4	151.0
Linuron	1.50	None		1.1	6.2	165.2
None		Linuron	0.75	2.9	6.5	136.5
None		Linuron	1.50	4.5	8.0	175.7
Linuron	0.75	Linuron	0.75	6.0	7.2	167.3
Linuron	1.50	Linuron	1.50	7.3	9.8	155.0
None		Alachlor	1.50	7.4	2.6	176.1
None		Alachlor	2.00	7.9	2.2	152.1
None		Alachlor	4.00	9.4	3.8	169.9
None		Alachlor	6.00	9.3	3.8	144.1
Linuron	0.75	Alachlor	1.50	7.0	5.2	177.5
Linuron	0.75	Alachlor	2.00	7.9	5.6	174.6
Linuron	0.75	Alachlor	4.00	9.4	6.5	169.5
Linuron	0.75	Alachlor	6.00	9.2	6.2	193.8
Linuron + Alachlor	0.75 + 1.50	None		1.5	0.6	172.1
	0.50 + 2.00	None		1.4	1.2	168.4
None		None		0.4	0.8	157.2
LSD 0.05						N.S.

[1/]All potatoes were cultivated and hoed twice.

[2/]Scale: 0 to 10; 0 = no effect and 10 = complete control.

[3/]Grasses were fall panicum and crabgrass.

Between the time potatoes were cultivated on May 27 and were treated with layby herbicides on June 1, the crop received 2.51 in rain. It is likely that under these excellent growing conditions, many weeds germinated and emerged prior to the rainfall which occurred 6 days following application of layby herbicides. This would seem especially applicable where no linuron was applied preemergence. However, it will be recalled that in 1971 3 weeks elapsed before any significant precipitation occurred following the time linuron was applied preemergence. It seems probable, therefore, that linuron provided less control preemergence than would normally be expected under more favorable moisture conditions.

Potatoes were not injured by any treatments. However, since layby herbicides were applied as broadcast treatments above potato foliage, it is suspected that a wet plant surface could retain some granules with the likelihood of slight foliar injury, especially from linuron.

With reference to potato yields, no significant differences existed during the two years of this study; two major assumptions can be made from this. First, since potatoes receiving high total amounts of herbicides yielded as well as other treatments, it is believed that good crop tolerance existed. And second, despite the fact that weed growth was extensive where no herbicides were applied at layby, these late season weeds had no adverse effect on yield. Since the Pungo variety is an early maturing potato, growth may have been complete when weeds were most competitive. Late season weeds could cause yield reductions in a longer season or later maturing crop. Even though yields were not influenced, layby herbicides did facilitate harvesting.

In conclusion, it is believed that granular formulations of linuron and alachlor can be safely used at layby to extend the period of weed control beyond that normally provided by preemergence herbicides. The success of the layby treatment depends largely on good preemergence weed control. There is currently no reason to believe that the preemergence herbicide must be limited to linuron or the layby herbicides limited to linuron and alachlor. As long as the preemergence herbicide does not predispose the crop to injury from the layby herbicide and control is satisfactory, numerous treatments could be appropriate.

Literature Cited

1. Cialone, J. C. 1967. Weed control in Irish potatoes in eastern Virginia. Proc. NEWCC 21:137-144.

2. Kuratle, H., E. M. Rahn and R. L. Feulner. 1967. Comparison of several herbicides for weed control in potatoes. Proc. NEWCC 21:148-155.

3. Wilson, H. P. and R. D. Ilnicki. 1968. Weed and crop responses to herbicides applied with various cultural practices and at different stages of potato growth. Proc. NEWCC 22:429-438.

CHEMICAL WEED CONTROL IN POTATOES WITH BAY 94337 AND TRIFLURALIN IN CONNECTICUT, 1971

Arthur Hawkins[1]

Abstract

Bay 94337 (Sencor)* at 1.0 lb ai/A applied preemergence to potatoes was compared at three locations with standard treatments. Satisfactory control of broadleafed weeds and grassy weeds, primarily large crabgrass (D. Sanguinalis) and barnyardgrass (Echinochloa crusgalli) was obtained in heavy vines of an early variety until chemically killed early; and in a later variety where crabgrass had not been a serious problem. At a location heavily infested with weed seed, good weed control was obtained from either Bay 94337 or metabromuron until three inches of rain occurred in late August following which crabgrass growth was quite heavy. Bay 94337 was also effective in killing rye and quackgrass.

Trifluralin at 1.0 lb ai/A incorporated with a standard cultivator and weeder gave satisfactory season-long weed control equal to EPTC EC at 5 lb ai/A incorporated, both applied 10 days before emergence of potatoes. Following treatment at this heavily weed-infested location dinitro had been applied preemergence to potatoes to kill a flush of early weeds. In a rate test trifluralin at 0.75 lb ai/A, after dinitro was applied to kill the first flush of weeds, controlled barnyardgrass and crabgrass but did not provide satisfactory control of smartweed (Polygonium pensylvanicum). Trifluralin at 1.0 lb ai/A, however, gave acceptable control of smartweed in addition to control of the grasses. Dinitro was used to kill a flush of weeds which developed under wet conditions before trifluralin could be applied. The trifluralin was incorporated twice with a standard spring tooth cultivator with weeder attached.

Introduction

Season-long chemical weed control has become a common practice on most of the potato acreage in Connecticut during the past eight years (2,3,4,5). EPTC is used either preplant or at ridge-off for nutsedge control and/or for season-long weed control; or EPTC is incorporated when potato plants are 10-12 inches high or later for control of late germinating weeds, especially grasses, following early weed control with dinitro.

For season-long weed control where nutsedge is not a problem, some growers are trying metabromuron applied preemergence to potatoes (1). Some follow metabromuron with a later application of EPTC.

There is continued interest in trying promising new materials which may be more effective or less costly. Following are observations made in field comparisons of Bay 94337 (Sencor)* and trifluralin as compared with standard

---

[1]Agronomist and Potato Specialist, University of Connecticut, Storrs, Conn.
* Tradename, Chemagro Corporation

materials such as metabromuron, EPTC or a combination of both. The effect of rates of trifluralin on weed and control was made in replicated plots.

Materials and Methods

Bay 94337 at 1.0 lb ai/A preemergence: Bay 94337 (70 WP) at 1.0 lb ai/A applied preemergence to potatoes was compared at 3 locations with either metabromuron preemergence or EPTC incorporated preemergence, or with a combination of metabromuron followed by EPTC later. Comparisons were made in commercial potato fields in the Connecticut River Valley on soils ranging from silt loam to fine sandy loam. Experimental treatments were applied to blocks of 2 to 4 acres with a comparison of a standard treatment on one or on either side. The methods of application are given in Results and Discussion.

Trifluralin: On a relatively low-lying to wet field (DH) heavily infested with weed seed, trifluralin at 1.0 lb ai/A was sprayed in 18 gallons water/A with 2-row boom, low pressure T-jet nozzles in front of a tractor and simultaneously incorporated with standard spring tooth cultivator with weeder attached 10 days after planting. It was compared with EPTC (EC) at 5.0 lb ai/A applied and incorporated with the same equipment. Dinitro was applied just before emergence of potatoes to control a flush of weeds on both treated areas; and kale in the trifluralin-treated block. Within a week crusting of the silt loam soil, which occurred as a result of heavy rains, was broken up with two cultivations two days apart. The cultivations provided further incorporation of the materials.

Rates of trifluralin at 0.5, 0.75 and 1.0 lb ai/A were compared in plots 9 ft x 12 ft replicated twice in randomized blocks at a location with silt loam soil heavily infested with weed seed. The material was applied just before emergence of potatoes following dinitro control of emerged weeds, and incorporated by two cultivations with a standard spring tooth cultivator with weeder attached. The spray formulation was applied with a 1 gallon hand sprayer equipped with a fan-type nozzle at 100 gallons of solution per acre rate.

Season: Following 1" of rain July 1, there were 12 consecutive days with little or no rainfall until 1.3" fell during the last 3 days of July and 1.2" on August 1-4. Rainfall was low until 3.12" on August 27-28.

Results and Discussion

With early-planted Chippewa potatoes at Farm DS, Bay 94337 and/or heavy vine growth provided ample weed control until the potatoes were vinekilled on August 31. Young crabgrass seedlings were noted on August 20 in Bay 94337 sections but none were noted on sections with metabromuron at 2.0 lb ai/A applied preemergence to potatoes, followed with EPTC EC at 4½ lb ai/A applied in 18 gals water as a directed spray and cultivated in simultaneously when potatoes were at the 10-12 inch stage. It was noted that Bay 94337 controlled both annual weeds and quackgrass (*Agropyron repens*).

At Farm G on a field where crabgrass had not been a severe problem, EPTC (10 G) at 3.8 lb ai/A incorporated a week prior to potato emergence and Bay 94337 at 1.0 lb ai/A applied in 100 gals/A 2 to 3 days prior to emergence gave equal control of weeds including crabgrass. In addition, Bay 94337 killed any rye which survived plowing and harrowing.

At field HP with a history of heavy weed infestation, Bay 94337 at 1.0 lb ai/A, was compared with metabromuron at 2.5 lb ai/A, both applied in 30 gals solution/A preemergence to potatoes on June 1 with grass and broadleaf weeds 2 inches in height. Following treatment weeds died faster with Bay 94337 than with metabromuron, but final kill was equal. Both materials gave complete weed control until about September 1. Following heavy rains of 3.0 inches on August 27-28 a considerable growth of crabgrass developed on both treated areas, with slightly less on the area treated with Bay 94337. Since the development of crabgrass was late, produced only a small root system, and was chemically killed along with vines September 15, there was little effect of this growth on yield and harvesting.

Rates of trifluralin: In replicated plots on a field heavily infested with weed seeds, trifluralin at .75 lb ai/A fully controlled barnyardgrass and crabgrass but not smartweed, the primary broadleaf weed. Acceptable control of smartweed was obtained in addition to the grasses with trifluralin at 1.0 lb ai/A. At this location dinitro was applied to control a flush of weeds which resulted during a wet spell before the trifluralin could be applied. The trifluralin was incorporated by two cultivations with a standard spring tooth cultivator with weeder attached. The equipment incorporated the material to about 3" between rows and about 2" in depth on top of the row.

References

1. Hawkins, Arthur. 1970. The Effect of Rates of Diphenamid-DNBP, Metabromuron, and Linuron Applied at Preemergence on Weed Control in Potatoes. NEWCC 24:417-420.

2. Hawkins, Arthur. 1963. Lay-by Chemical Weed Control in Potatoes With Granular and Spray Applications. NEWCC 17:140-144.

3. Hawkins, Arthur. 1963. Spraying Chemicals for Soil Incorporation While Cultivating for Lay-by Weed Control in Potatoes. NEWCC 17:129.

4. Hawkins, Arthur. 1962. Adapting Equipment for Applying Chemicals for Lay-by Weed Control in Potatoes. American Potato Journal, April 1962 Vol. 39, No. 4, pp. 162-163.

5. Hawkins, Arthur. 1961. Post-hill Chemical Weed Control in Potatoes with Granular Formulations. NEWCC 15:180-181.

THE EFFECT OF POTATO VINE KILLING WITH PARAQUAT ON STORABILITY OF POTATO TUBERS[1/]

Joseph B. Sieczka[2/]

ABSTRACT

Potato tubers from three vine killing trials were cut and placed in unsterilized soil or soil mix to evaluate their susceptibility to breakdown. The results of tests conducted in 1970-71 on one of the trials indicate that high rates of paraquat per acre applied to vigorous, immature potato vines increase tuber rot. Uncut tubers stored at 40°F. (4.4°C), 50°F. (10°C), and 60°F. (15.6°C) did not breakdown and produced normal sprouts at 50°F. and 60°F.

INTRODUCTION

The cancellation of the potato vine killing label for sodium arsenite has resulted in the usage of other desiccants by potato growers. Dinoseb (2-sec-butyl-4,6-dinitrophenol) and paraquat (1,1'dimethyl-4,4'-bipyridinium dichloride) are the only registered alternatives in the Northeastern United States. The suitability of paraquat as a potato vine desiccant has been demonstrated experimentally since 1965 (2,3,5,6,7,8). Grower usage of the material has for the most part also proven to be satisfactory. A report of increased susceptibility to tuber breakdown (4), however, prompted the initiation of the experiments which are being reported on in this paper.

MATERIALS AND METHODS

Three field trials were initiated in 1970 to investigate the effect of potato vine desiccation with paraquat on the storability of tubers. Soil studies were conducted to evaluate treatment effects on tuber susceptibility to breakdown. In these studies, tubers were cut longitudinally in half and placed in styrofoam flats containing unsterilized soil or soil mix[3/] which was kept moist at 50°F. or 60°F. for a period of approximately two to three weeks. Number of tubers having >90%, 89 to 50%, 49% to trace, and no decay were recorded for each test. In addition to the soil studies, data were collected on rate of vine kill, vascular discoloration, and sprouting.

Experiment 1. The Katahdin potato variety was planted in 34 inch rows on a Howard gravelly loam on May 19 and May 22, 1970. Plot size was 2 rows wide by 15 feet long. The experimental design was a randomized complete-block with four replications. Spray material was applied with a hand carried CO_2 pressurized sprayer which delivered approximately 40 gallons/A in two replications and approximately 100 gallons/A in the other two. Treatments consisted of two dates of application of two rates of each of the formulations of paraquat (Cl and Dual) and one rate of dinoseb plus diesel fuel. Tubers were collected

---

1/ Paper No. 634 of the Department of Vegetable Crops, Cornell University, Ithaca, New York.

2/ Extension Specialist, Department of Vegetable Crops, Cornell University, Ithaca, New York.

3/ A mixture of equal volumes of soil, sand, and sphagnum peat moss with nutrients added.

at harvest and divided into subsamples which were stored at 40°F. or 60°F. Two soil studies were conducted on tubers stored at 60°F. and one on tubers stored at 40°F.

Experiment 2. Single rows of Katahdin, Chippewa, Peconic, and Bake-King were planted in 34 inch rows on a Howard gravelly loam on May 19, 1970. Experimental design for chemical treatments was a randomized complete-block with three replications. Plot size was four rows wide by fifteen feet long. Soil studies were conducted on subsamples stored at 40°F. or 60°F.

Experiment 3. A logarithmic sprayer (1) was used to apply paraquat at rates ranging from 1 lb/A to 1/16 lb/A in four half dosages. Plots were two rows wide by 48 feet long. Four replications were used. Katahdins, planted on a Howard gravelly loam on May 19, 1970, were used for one replication. The remaining replications were planted on an Eel silt loam on June 1, 1970. Two of these replications were of the Katahdin variety. The other was Raritan. Potato tubers were collected from four, twelve-foot sections of each replication and stored at 50°F. The sections corresponded to the following rate ranges: 0 to 12' = 1 to 1/2 lb/A; 12 to 24' = 1/2 to 1/4 lb/A; 24 to 36' = 1/4 to 1/8 lb/A; and 36 to 48' = 1/8 to 1/16 lb/A.

RESULTS AND DISCUSSION

Experiment 1. Vine kill ratings taken eight, fourteen, and eighteen days after the first application date were not significantly different due to chemical treatments on any one date. The rate of vine kill was faster in the two replications where the higher gallonage was used. The high gallonage, however, did not have an effect on tuber decay or sprouting. Sprout weight and tuber decay were not affected by the treatments used in this experiment(See Table 1).

Experiment 2. Emergence data in Table 2 show that the two rates of paraquat did not have an affect on emergence of the four varieties in this experiment. Soil studies failed to show an association between rate of paraquat and amount of tuber decay.

Experiment 3. The vine kill ratings for the four replications in this experiment point out the differences in the maturity of the vines. The plants in the first twenty-four feet of replication I were 100% desiccated on September 7 while plants in a similar distance in the other three replications were singed slightly. The vigor of the vines in the last three replications is attributed to the later planting date, the better water supplying power of the soil, and the lack of Verticillium wilt. Symptoms of Verticillium wilt were observed in all the trials conducted on the Howard gravelly loam soil.

Results of the soil studies conducted in this trial indicate an association between the application rate of paraquat and the number of decayed tubers. Tuber decay was greatest in the samples taken from the three replications where paraquat had been applied to vigorous, immature vines. The amount of decay also corresponded to the residue analysis of tubers from each rate range of both replications of vigorously growing Katahdins. Residues of 0.05, 0.04, 0.01, and 0 ppm paraquat corresponded to the 1 to 1/2, 1/2 to 1/4, 1/4 to 1/8, and 1/8 to 1/16 pound/A rate ranges, respectively, in these two replications. Tubers from each rate range in replication I, which had the least amount of decay in the trial, and Katahdin tubers grown near replication I, but not sprayed with a vine killer, contained 0 ppm paraquat. Katahdin tubers from the unsprayed area were used in soil study 3 as a check on the method of evaluation. None of these tuber halves decayed.

Uncut tubers from each rate range of each replication did not breakdown and produced normal sprouts when stored at 50°F.

In conclusion, whole tubers from three vine killing trials in which paraquat had been applied did not break down and produced normal sprouts in storage. Soil studies in two experiments where paraquat was applied to senescing vines failed to show a correlation between decay and paraquat formulation, rate, time of application, or amount of spray material applied per acre. Similar studies from another field experiment, however, showed an association between paraquat rate and the number of decayed tuber halves in three replications which had vigorously growing vines at the time of paraquat application. Tuber halves from a fourth replication did not show the same susceptibility to decay. These results indicate that paraquat uptake and subsequent breakdown of tuber halves are associated with high application rates (1 to 1/4 lbs/A) of this material to vigorous vines. Studies are presently being conducted to investigate this further.

ACKNOWLEDGMENT

I wish to thank Dr. Elmer E. Ewing for his advice and assistance and Mr. Randy E. Schafer, Chevron Chemical Company, for providing the residue analysis.

LITERATURE CITED

1. Cialone, J. C. and D. W. Davis. May 1963, revised January 1965. Construction and uses for a hand operated logarithmic sprayer for small plots. VC-115. Department of Vegetable Crops, Cornell University.

2. Dallyn, S. L. and D. H. Fricke. 1968. Pre-harvest use of chemicals in potato production. NEWCC 22: 443-447.

3. ____________ and P. A. Schippers. 1971. Potato vine killing. NEWSS 25: 193-198.

4. Jones, E. O. 1970. Unpublished results. Department of Plant Pathology, Cornell University, Ithaca, New York.

5. Murphy, H. J. and M. J. Goven. 1971. Potato vine killing in Maine. 1969. NEWSS 25: 199-203.

6. ____________ and ____________. 1970. Potato vine killing in Maine. 1968. NEWCC 24: 193-198.

7. ____________ and ____________. 1969. Potato vine killing in Maine. 1967. NEWCC 23: 115-121.

8. ____________ and ____________. 1967. Potato vine killing in Maine. 1965. NEWCC 21: 156-162.

Table 1. Experiment 1. Effect of rate and formulation of paraquat and time of application on potato vine desiccation and sprouting.

Variety: Katahdin
Planted: Replications III and IV - 5/19/70
Replications I and II - 5/22/70
Spray Material Applied/A: 40 gal for replications I and II
100 gal for replications III and IV

Treatments (Rate/A)	Vine Kill Ratings 1/			Sprout Weight as % of Total Weight 2/
	9/1	9/7	9/11	
1) 2.5 lb dinoseb + 5 gal diesel fuel (8/24)	7.3	9.0	9.0	13.4
2) 0.5 lb paraquat (Dual) + X-77 (8/24)	7.0	9.0	9.0	16.2
3) 1.0 lb paraquat (Dual) + X-77 (8/24)	7.5	9.0	9.0	11.9
4) 0.5 lb paraquat (Cl) + X-77 (8/24)	7.5	9.0	9.0	14.8
5) 1.0 lb paraquat (Cl) + X-77 (8/24)	7.3	9.0	9.0	13.6
6) 2.5 lb dinoseb + 5 gal diesel fuel (9/2)		8.0	8.8	13.9
7) 0.5 lb paraquat (Dual) + X-77 (9/2)		7.8	8.8	12.4
8) 1.0 lb paraquat (Dual) + X-77 (9/2)		8.1	9.0	11.8
9) 0.5 lb paraquat (Cl) + X-77 (9/2)		7.9	8.8	10.9
10) 1.0 lb paraquat (Cl) + X-77 (9/2)		8.3	9.0	13.6
	ns 3/	ns	ns	ns

1/ Means of four replications. Ratings based on a scale of 1 to 9; 1 = green leaves and stems, 9 = leaves and stems desiccated

2/ Stored at 60°F. until 5/17/71

3/ Ratings for replications were significant. Average ratings for all treatments in replications I and II = 6.5, in replications III and IV = 8.1.

Table 2. Experiment 2. Effect of rate of paraquat on the emergence of plants from tubers of four varieties.

Planted: 5/19/70
Spray Material Applied/A: 62.5 gal
Date of Application: 9/2/70

Treatments	Average Number of tubers with sprouts 1"1/	
	5/4	5/14
0.5 lb paraquat (Cl) + X-77/A		
Katahdin	2.0	12.0
Bake-King	4.3	12.0
Chippewa	6.3	11.7
Peconic	1.7	12.0
1.0 lb paraquat (Cl) + X-77/A		
Katahdin	2.7	9.7
Bake-King	3.0	12.0
Chippewa	8.7	11.7
Peconic	1.7	12.0
2.5 lb dinoseb + 5 gal diesel fuel/A		
Katahdin	2.7	11.7
Bake-King	5.7	12.0
Chippewa	7.0	12.0
Peconic	0.7	11.3

1/ Twelve tubers were used in each treatment per replication. Samples were stored at 40°F. until cut and placed in soil on 4/22. Temperature after 4/22 was 60°F.

Table 3. Experiment 3. Results of soil studies conducted on a field experiment in which paraquat was applied with a logarithmic sprayer.

Variety and Date of Planting:
Rep I = Katahdin 5/19/70
Reps II and III = Katahdin 6/1/70
Rep IV = Raritan 6/1/70
Date of Application: 9/2/70
Vine Kill Rating:1/

9/7/70 -	Rep I	0-24' = 9, 24-48' = 7
	Reps II, III, & IV	0-12' = 2, 12-48' = 1
9/11/70 -	Rep I	0-27' = 9, 27-48' = 8
	Reps II, III, & IV	0-18' = 5, 18-48' = 4

Paraquat (Cl) Rate/A	Decay2/ Soil Studies4/ 1 (15)	2 (22)	3 (25)	Combined data	No. of tubers with sprouts >1"3/ Soil Study 34/ (15)	(25)
1 to 1/2 lb	7/24	11/24	23/48	41/96	3.0	8.5
1/2 to 1/4 lb	1/24	6/24	20/48	27/96	3.5	7.8
1/4 to 1/8 lb	0/24	1/24	3/48	4/96	6.0	11.5
1/8 to 1/16 lb	0/24	7/24	0/48	7/96	5.5	12.0
Untreated Katahdin			0/48	0/48	5.8	11.8

1/ Rating scale outlined in footnote 1, Table 1.
2/ Decay expressed as a fraction; numerator = number of tuber halves with more than 90% decay, denominator = total number of tuber halves observed.
3/ Means of four replications. Twelve tuber halves used for each treatment in each replication.
4/ Numbers in parentheses refer to total number of days the tuber halves had been in the soil media. Tubers were stored at 50°F. prior to soil studies. Temperature for soil study 1 was 50°F., soil studies 2 and 3 were conducted at 60°F.

EFFECT OF COMPETITION AND CONTROL OF GALINSOGA CILIATA (RAF.) BLAKE IN SNAP BEANS

R. A. Ashley[1]

Abstract

Alachlor 4EC and combinations of alachlor with dinoseb, chlorpropham or trifluralin gave excellent full season control of hairy galinsoga. MON-097 at rates from 3/4 to 2 lbs ai/A, dinoseb at 6 lbs ai/A and EPTC at 3 lbs ai/A also gave excellent control.

Trifluralin, Amchem 70-25, BAS 3510H, BAS 3870H, chloramben methyl ester, trifluralin + chlorpropham and diphenamid + dinoseb failed to give adequate full-season control at the rates tested.

Hairy galinsoga populations of 1/2 to 2 plants per square foot reduced yields of snap beans by nearly one-third while populations of 2 to 3 plants per square foot reduced yields by nearly one-half as compared to a weed-free control.

Introduction

Reports from Connecticut vegetable growers of increasing populations of hairy galinsoga (*Galinsoga ciliata* (Raf.) Blake), particularly in fields treated with trifluralin, prompted the establishment of a series of three experiments at the University of Connecticut Vegetable Research Farm in North Coventry, to evaluate several herbicides and herbicide combinations for control of hairy galinsoga and to determine the effect of hairy galinsoga competition on yield of snap beans.

Materials and Methods

Snap beans (*Phaseolus vulgaris* var. *humilis*) cv. Tendercrop were seeded June 4, 1971 (weed control experiment one) and June 30, 1971 (weed control experiment two and competition study) in 36-inch rows. Seeding was done by hand at a rate of 4 seeds per foot. Treated plots consisted of a single row 10 feet long. In the competition study, treatment rows were separated by guard rows. Treatments were replicated 3 times. Soil type was a Merrimac fine sandy loam with an organic matter content of 3%.

An area supporting a high population of hairy galinsoga was selected for the experimental area. In addition, approximately 3 ounces of hairy galinsoga seed was broadcast over the experimental area planted June 30, 1971.

1. Assistant Professor of Horticulture, University of Connecticut, Storrs, Connecticut.

Preplant incorporated and preemergent applications of the herbicides listed in Table 1 were made the day of planting. Postemergent applications of BAS 3510H (3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide) were made in experiment one to beans in the two trifoliate leaf stage and to weeds 2 to 4 inches high on June 25, 1971.

No herbicides were applied to snap beans in the competition study. Beans were thinned to a uniform stand of 20 plants per row. All weeds were hand pulled from the control treatment and all weeds other than hairy galinsoga were hand pulled from other rows. Populations of hairy galinsoga of less than 1 plant per square foot, 1 to 2 plants per square foot and 2 to 3 plants per square foot were established by thinning the natural stand present.

Significant rainfall during the establishment of these experiments included: 0.22 inches May 30-31, 1.14 inches June 3-4, 1.16 inches June 9, 0.37 inches June 25-26, and 1.02 inches July 2, 1971.

Ratings of hairy galinsoga control were made July 15 and August 2, 1971 in experiment one and August 19 and September 14, 1971 in experiment two. Ratings were made using a 0 to 10 scale with 0 representing no effect and 10 representing complete kill.

Yield data was taken August 2 and August 19, 1971 in experiment one and September 2 and September 7, 1971 in experiment two. Yields were taken in the competition study on August 26 and September 10, 1971.

Results and Discussion

Excellent full-season control of hairy galinsoga was obtained in both weed control experiments from all rates of alachlor tested and all combinations containing alachlor (Table 1). MON-097 gave complete control of hairy galinsoga in both experiments at rates as low as 3/4 lb ai/A.

In experiment one, control treatments of dinoseb 3EC at 6 lbs ai/A preemergence gave complete control of hairy galinsoga. EPTC 6E at 3 lbs ai/A and flurodipen 3EC 4½ lbs ai/A gave control ratings of 10 on July 15 and 8.3 on August 2, 1971. On the same dates, ratings for trifluralin 4EC at 3/4 lb ai/A preplant incorporated were 6.8 and 5.0 respectively. With trifluralin, weed control in general was not good and some of the apparent control of hairy galinsoga probably resulted from weed competition. Similar effects can be seen in other treatments where lower rates apparently gave better control of hairy galinsoga than higher rates, where in fact they gave inadequate control of other annual weeds. Combination treatments of trifluralin + chlorpropham at 3/4 + 2 lbs ai/A and diphenamid + dinoseb at 2 + 2 lbs ai/A failed to give adequate full-season control. The July 15 rating showed the diphenamid-dinoseb combination to be controlling hairy galinsoga at the 9.0 level as compared to 6.8 for the trifluralin-chlorpropham combination. By August 2, 1971 both were rated 6.8.

Table 1. Evaluation of several herbicides and herbicide combinations for control of hairy galinsoga in snap beans.

Herbicide[a]	Rate lbs ai/A		Control rating[b]				Total Yield	
			Expt 1		Expt 2		Expt 1	Expt 2
			7/15	8/2	8/19	9/14	Lbs/plot[c]	
Dinoseb 3EC	6	Pre	10.0	10.0	—	—	6.3	—
EPTC 6E	3	ppi	10.0	8.3	—	—	7.4	—
Trifluralin 4EC	3/4	ppi	6.8	5.0	—	—	3.9	—
Alachlor 4EC	1½	Pre	10.0	10.0	—	—	4.6	—
Alachlor 4EC	2	Pre	—	—	10.0	10.0	—	5.4
Alachlor 4EC	2¼	Pre	10.0	10.0	—	—	6.1	—
Alachlor 4EC	3	Pre	10.0	10.0	—	—	7.3	—
Alachlor 4EC	4	Pre	—	—	10.0	8.3	—	4.2
Amchem 70-25 4EC	1½	ppi	10.0	6.8	8.3	2.3	7.3	4.2
Amchem 70-25 4EC	3	ppi	10.0	5.0	1.3	0	5.0	5.5
BAS 3510H 50W	1	Post	8.3	8.3	—	—	7.2	—
BAS 3510H 50W	2	Post	6.8	6.8	—	—	3.6	—
BAS 3870H 4EC	1	ppi	5.0	5.0	—	—	4.9	—
BAS 3870H 4EC	1½	ppi	—	—	2.7	1.7	—	4.1
BAS 3870H 4EC	2	ppi	3.3	3.3	—	—	8.2	—
BAS 3870H 4EC	3	ppi	—	—	3.3	1.3	—	4.6
Chloramben ME 2E	2	Pre	—	—	3.3	1.3	—	5.0
Chloramben ME 2E	3	Pre	—	—	1.0	1.0	—	5.5
Flurodiphen 3EC	4½	Pre	10.0	8.3	—	—	7.7	—
MON-097 4EC	3/4	Pre	10.0	10.0	—	—	3.6	—
MON-097 4EC	1	Pre	—	—	10.0	10.0	—	0.2
MON-097 4EC	1½	Pre	10.0	10.0	—	—	7.2	—
MON-097 4EC	2	Pre	—	—	10.0	10.0	—	2.7
Alachlor 4EC+dinoseb 3EC	3/4+1½	Pre	—	—	9.0	8.0	—	4.4
Alachlor 4EC+dinoseb 3EC	1½+3	Pre	—	—	10.0	9.7	—	5.5
Alachlor 4EC+dinoseb 3EC	2+3	Pre	10.0	10.0	—	—	12.3	—
Alachlor 4EC+dinoseb 3EC	2½+4½	Pre	10.0	10.0	—	—	14.0	—
PPG126 3EC (Alachlor +	1½+	Pre						
Chlorpropham)	1½	Pre	—	—	10.0	7.3	—	5.6
PPG126 3EC (Alachlor +	3+	Pre						
Chlorpropham)	3	Pre	10.0	10.0	10.0	9.3	9.6	4.3
PPG127 3EC (Alachlor +	1½+	Pre						
Chlorpropham)	1½	Pre	—	—	10.0	9.0	—	4.0
PPG127 3EC (Alachlor +	3+	Pre						
Chlorpropham)	3	Pre	10.0	10.0	10.0	8.7	8.7	3.9
Diphenamid 50W +	2+	Pre						
Dinoseb 3EC	2	Pre	9.0	6.8	—	—	7.9	—
Trifluralin 4EC +	3/4+	ppi						
Alachlor 4EC	2½	ppi	10.0	10.0	—	—	8.6	—
Trifluralin 4EC +	3/4+	ppi						
Chlorpropham 4EC	2	Pre	6.8	6.8	—	—	5.5	—
LSD 5%			2.4	2.1	2.7	3.1	3.8	4.0

a. Herbicides applied (Expt 1) ppi and pre 6/4/71, post 6/25/71. (Expt 2) all treatments 6/30/71.

b. Average of 3 replicates. 0 = no effect, 10 = complete control.

c. Average of 3 replicates, each single row 10 feet long.

Amchem 70-25 (N-secondary-butyl-4-tertiary-butyl-2,6-dinitroaniline) gave adequate early control of hairy galinsoga under light weed pressure in experiment one but gave poor full-season control. In experiment two under heavy weed pressure, control was poor on both rating dates. Again the 1½ lb rate appeared to give adequate early control only because control of other weeds was poor.

BAS 3870H (N-allyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluoramethyl-aniline) at rates as high as 3 lbs ai/A and chloramben methyl ester at 2 or 3 lbs ai/A failed to give adequate control of hairy galinsoga in either experiment.

BAS 3510H at 1 and 2 lbs ai/A postemergence gave poor general weed control. Weed competition resulted in apparent high levels of hairy galinsoga control.

The competitive effects of hairy galinsoga on snap bean yields is considerable. The presence of 1/2 to 1 hairy galinsoga plant per square foot reduced yields of snap beans by nearly one-third (Table 2). Increasing hairy galinsoga populations to 1 to 2 plants per square foot did not result in additional yield reduction but when the population rose to 2 to 3 plants per square foot, yield dropped to nearly half that of the weed-free control.

Table 2. Effect of population of hairy galinsoga on yield of snap beans.

Hairy galinsoga population plants per sq. ft.	Yield of snap beans lb per 30 sq. ft.	Fresh weight of hairy galinsoga per 30 sq. ft.
0	15.1	0
½-1	10.4	9.6
1-2	10.3	17.9
2-3	7.6	21.4
LSD 5%	1.8	2.1

EVALUATION OF HERBICIDES FOR WEED CONTROL IN SNAP BEANS

Charles J. Noll[1]

ABSTRACT

Taking into consideration weed control, snap bean (Phaseolus vulgaris var. humilis) injury, stand of plants and weight of harvested fruit the best treatments were with the preplant incorporation treatments EPTC, A820 and ER 5461, and with the preemergence treatments ER 5461, propachlor, NIA 20439 (3-(2 Methylphenoxy) pyridazine) and alachlor or alachlor in combination with dinoseb.

INTRODUCTION

Most of the snap beans grown in Pennsylvania are grown for processing. Chemical weed control is used on most of the acreage usually with dinoseb herbicide. Furrer (1) reported that the chemical A820 was tolerated by beans and would control most of the weeds likely to be problems in our fields. Wilson (2) reported on his success with a number of herbicides and herbicide combinations that looked promising for our condition. These chemicals together with the best herbicide from our rather unsucessfully weeding experiment in 1970 were included in the trials. This research was designed to compare the most promising herbicides for weeding snap beans.

MATERIALS AND METHODS

The weeding trial was conducted at the Rock Springs research farm 10 miles west of University Park. The soil a Hagerstown silt loam was plowed in the fall of 1970 and the seedbed prepared June 21, 1971. On June 22 preplant herbicides were applied and incorporated in the soil to a depth of 1 to 2 inches. The field was seeded June 23 to the variety tendercrop and the preemergence treatments applied the next day or 5 days later. An estimate of injury to the beans was made July 20 and an estimate of weed control July 28. All estimates were on a 1 to 9 scale. One is no weed control and 9 is perfect weed control.

Single row plots were 28 feet long and 3 feet wide. Treatments were randomized in each of 8 blocks. The herbicides were applied in a 2 foot band over the row. The field was cultivated. Weeds present in the field were lambsquarters (chenopodium album L.), ragweed (Ambrosia artemisiifolia L.), redroot pigweed (Amaranthus retroflexus L.), yellow foxtail (Setaria lutescens (Weigel) Hubb.) and Purslane (Portulaca oleracea L.) Five of the eight replications were harvested August 19 and 20.

[1] Associate Professor of Olericulture, Department of Horticulture, Pennsylvania State University, University Park, Pa.

RESULTS

The results are presented in Table 1. All herbicides significantly reduced the weed population as compared to the untreated check plot. One chemical and one combination of chemicals injured the beans and reduced the stand and yield. Another chemical reduced the stand but yields were equal to the check. The best plots were free of weeds, the beans undamaged by the treatment and had a normal stand with double the yield of the untreated plots.

LITERATURE CITED

1. Furrer A. H. Jr., G. R. Stanke and S. R. McLane. 1971. A-820 Selectivity and biological performance on vegetable crops. Proc. Northeastern Weed Science Society. 25:167-170.

2. Wilson, H. P., H. J. Davis and J. Belate. 1971. Activities of several herbicides and herbicide combinations in snap beans. Proc. Northeastern Weed Science Society. 25:249-254.

Table 1. Effect of various herbicides and combination of herbicides on weed control and snapbeans.

Treatment	lbs. AIA	Application Days From Planting	Weed Control (1-9)	Injury a/ (1-9)	Stand of Plants	Wt. Fruit lb.
1. Check	---	---	1.9	8.3	56	5.7
2. BAS 3870-H	1	PPI-1	7.8	8.0	57	10.7
3. " "	2	"	7.9	7.9	58	11.0
4. BAS 3921-H	3/4	"	7.6	8.0	62	10.0
5. " "	1 1/2	"	8.3	7.0	58	8.2
6. EPTC	3	"	8.9	8.3	58	11.6
7. Nitralin	1	"	6.4	8.3	58	9.8
8. Trifluralin	3/4	"	7.8	7.9	54	10.3
9. A-820	2	"	8.1	8.4	58	10.1
10. "	4	"	9.0	8.3	56	10.3
11. R7465	2	"	7.6	6.9	43	7.6
12. "	4	"	8.6	6.8	44	8.3
13. U27267	2	"	6.0	7.9	62	11.2
14. "	4	"	7.1	7.5	51	9.8
15. ER5461	2	"	8.8	7.3	48	7.8
16. "	4	"	8.6	6.8	53	10.0
17. AC92390	3/4	"	7.0	8.3	55	9.3
18. "	1	"	6.6	8.5	64	10.8
19. U27267	2	PRE + 1	6.8	8.3	62	10.8
20. "	4	"	7.8	7.9	47	8.5
21. ER 5461	2	"	9.0	8.1	55	10.2
22. "	4	"	8.8	8.3	59	9.3
23. AC92390	3/4	"	5.0	8.0	57	8.5
24. "	1	"	6.3	8.1	57	8.7
25. Chloramben (Amiben Ester)	3	"	6.6	7.9	58	9.3
26. Propachlor	4	"	8.9	8.1	54	11.6
27. Alachlor	2	"	8.9	7.9	53	10.4
28. "	3	"	9.0	7.6	48	8.4
Least Significant Difference		5%	1.0	1.1	7.0	2.6
" " "		1%	1.2	1.3	8.2	3.0

a/ Weed Control and injury 1-9: 1 no weed control, 9 perfect weed control.

Table 1 con'd.

Treatment	lbs. AIA	Application Days From Planting	Weed a/ Control (1-9)	Injury (1-9)	Stand of Plants	Wt. Fruit lb.
29. Alachlor	4	PRE + 1	9.0	8.0	56	9.4
30. Alachlor + Dinoseb	2 + 3	"	8.9	8.5	52	11.0
31. "	3 + 4½	"	9.0	8.1	55	8.8
32. NIA 20439	2	"	8.0	8.3	60	8.6
33. "	4	"	8.6	8.1	53	10.7
34. BAY DIC 1897	1	"	8.6	8.4	32	3.2
35. "	1 1/2	"	8.6	3.1	11	0.4
36. Fluorodifen	3	"	5.6	7.8	54	8.7
37. "	4 1/2	"	7.4	8.4	58	9.8
38. PPG 124 (Furloe)	2	"	3.8	8.5	52	7.4
39. "	4	"	6.1	8.3	51	10.4
40. PPG 124 + Chloramben	2 + 2	"	7.1	7.9	60	10.9
41. Dinoseb + Chloramben	2 + 1	PRE + 5	6.3	8.9	49	8.8
42. "	4 + 2	"	7.6	8.0	54	9.4
43. Dinoseb + Nitrofen	1 + 2	"	6.6	6.0	37	5.4
44. "	2 + 4	"	7.1	3.4	31	3.0
45. Dinoseb	4	"	4.9	8.1	56	8.3
Least Significant Difference 5%			1.0	1.1	7.0	2.6
" " " 1%			1.2	1.3	8.2	3.0

a/ Weed control and injury 1-9: 1 no weed control, 9 perfect weed control.

Evaluation of Several Herbicides and Herbicide Combinations on Lima Beans and Snap Beans[1/]

E. M. Rahn, T. S. Smith, and J. E. Merrick[2/]

Abstract

For full-season weed control in Thaxter lima beans (*Phaseolus lunatus*) grown in close rows (18 in.) without cultivation, a combination of *a*, *a*, *a*-trifluoro-2,6-dinitro-*N*,*N*-dipropyl-p-toluidine (trifluralin) and 3-amino-2,5-dichlorobenzoic acid (amiben) was outstanding, except for control of jimsonweed (*Datura stramonium* L.). Trifluralin was pre-plant incorporated by discing at 1/2 lb./A. Amiben was applied just after seeding at 2 or 4 lb/A. The 4 lb/A rate of amiben increased control of annual grasses to a considerable degree when compared with the 2 lb/A rate. In snap beans (*Phaseolus vulgaris*), a combination of 2-chloro-2',6'diethyl-*N*-(methoxymethyl)-acetanilid (alachlor) and 2-sec-butyl-4,6-dinitrophenol (dinoseb) was outstanding for control of both annual grasses and broadleaf weeds. Alachlor plus dinoseb was applied just after seeding at either 1 + 3 lb/A or 2 + 3 lbs/A. Both rates resulted in over 90% weed control and maximum yields in the experiment.

INTRODUCTION

Lima beans (*Phaseolus lunatus*) and snap beans (*Phaseolus vulgaris*) are grown extensively for processing in Delaware. Both are mechanically harvested. Research in Wisconsin (2) and Delaware (1) indicate that yields of lima beans can be increased considerably by moving the rows as close as 1 to 2 ft. apart. The normal row spacing in Delaware is approximately 3 ft. When rows are as close as 1 to 2 ft., cultivation is difficult. Under these conditions, full season control of a wide spectrum of weeds is essential. Several new herbicides appear promising for these two crops. Therefore, the major objective of these experiments was to evaluate certain new herbicides and herbicide combinations for full season control in these crops.

1/ Published as Miscellaneous Paper No. 640 with the approval of the Director of the Delaware Agricultural Experiment Station. Contribution No. 21 of the Department of Plant Science.

2/ Professor and graduate assistants, Department of Plant Science, University of Delaware, Newark.

MATERIALS AND METHODS

Research was conducted at the Substation Division, Georgetown, Delaware, on a Sassafras sandy loam with an organic matter content of 1%. Fertilizer, 10-10-10, was drilled at 600 lb/A. Herbicides that were preplant incorporated were incorporated to a depth of 3 in. by two discings in the opposite direction. Thaxter lima beans and Harvester snap beans were planted on June 22, 1971. In-the-row spacing for lima beans was 3 in. and for snap beans 2 in. Three seeds of jimsonweed (Datura stramonium L.) were planted every three feet in the lima bean rows to evaluate control of this troublesome pest. Treatments were replicated four times. Lima bean plots consisted of 4 rows 20 ft. long with rows 1-1/2 ft. apart. These plots were never cultivated. Snap bean plots consisted of two rows 30 ft. long with rows 3 ft. apart. These plots were cultivated three times during the season. Herbicides were applied with an AZ CO_2 pressurized sprayer in 50 gpa of formulated spray. At the time herbicides were applied, soil moisture was near field capacity because during the week previous to planting there was 0.97 inches of rainfall, with 0.74 inches the day previous to planting. During the week following planting, there was 0.30 inches of rainfall. Lima bean plots were irrigated three times, and snap bean plots twice, during the season whenever moisture became limiting. Growth of both lima bean and snap bean plants was good, providing a fairly dense canopy of foliage.

Weed control and crop injury ratings were made using the scale 0 to 10 where 0 represents no effect and 10 complete reduction of plant stand and vigor. Predominant weed species were large crabgrass (Digitaria sanguinalis (L.) Scop.), goosegrass (Eleusine indica (L.) Gaertn.), redroot pigweed (Amaranthus retroflexus L.), common ragweed (Ambrosia artemisiifolia L.), and common purslane (Portulaca oleracea L.).

Lima beans were harvested on September 14 by pulling all the plants in each plot and running them through a Hamachek stationary viner. Weight of shelled beans as well as percent green beans was recorded. Snap beans were hand-pulled on two dates: August 16 and 26. Weight of marketable beans for each whole plot was recorded.

RESULTS AND DISCUSSION

In the lima bean experiment, only the combination of a,a,a-trifluoro-2, 6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) and 3-amino-2,5-dichlorobenzoic acid (amiben) resulted in no significant early crop injury (Table 1). The two combinations of 2-chloro-2',6'diethyl-N-(methoxymethyl)-acetanilide (alachlor) with amiben, and the combination of 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron) with amiben at the higher rate, 1 + 3 lb/A, resulted in significant early crop injury. The injury apparently was outgrown except at the higher rate of the alachlor-amiben combination, 2 + 3 lb/A, since yields were not reduced significantly. The linuron-amiben combination at the lower rate, 1/2 + 1 1/2 lb/A, caused no significant early crop injury, but resulted in a lower yield, presumably due to weed competition since only 47% of the annual grasses were controlled.

Table 1. Weed control and crop ratings, and yields of lima beans in 1971

Herbicide and Rate	Crop Rating[1] on 7/20		Weed Ratings[1] on 8/31						Shelled beans from 4 plots lb.	% green
			An. Grasses		Broadleaves		Jimsonweed			
	S[2]	V[2]	S	V	S	V	S	V		
Hoed check	0	0	10.0	10.0	10.0	10.0	10.0	10.0	62.9	76
Trifluralin[3] + amiben, 1/2 + 2 lb/A	0.5	0.7	6.0	0.7	9.7	7.5	1.5	1.5	60.0	68
Trifluralin[3] + amiben, 1/2 + 4 lb/A	0	0.7	8.2	0.7	9.7	7.5	1.0	2.2	60.1	74
Alachlor + amiben, 1 1/2 + 3 lb/A	0.5	2.0	6.2	2.2	9.7	7.5	7.5	7.0	60.7	73
Alachlor + amiben, 2 + 3 lb/A	0.5	3.5	6.7	0	10.0	10.0	10.0	10.0	57.7	77
Linuron + amiben, 1/2 + 1 1/2 lb/A	0.2	1.0	4.7	0	10.0	10.0	5.7	5.7	56.0	66
Linuron + amiben, 1 + 3 lb/A	1.0	3.7	8.0	2.7	10.0	10.0	8.5	7.5	61.4	73
LSD, 5%	0.7	1.2	2.6	3.5	0.5	4.8	3.6	4.5	5.2	--

1. Scale: 0 = no effect and 10 = complete reduction
2. S = stand; V = vigor
3. Trifluralin was pre-plant incorporated

Table 2. Weed control and crop ratings, and yields of snap beans in 1971

Herbicide and Rate	Crop Rating[1] on 7/20		Weed Ratings[1] on 8/13 An. Grasses		Weed Ratings[1] on 8/13 Broad leaves		Mkt. yield from 4 plots
	S[2]	V[2]	S	V	S	V	lb.
Hoed check	0	0	10.0	10.0	10.0	10.0	97.9
Alachlor, 1 lb/A	0	0	7.3	4.0	7.5	1.3	104.0
Alachlor, 1 1/2 lb/A	0	0.3	8.3	3.3	9.0	3.8	97.9
Alachlor, 2 lb/A	0	0.3	8.5	3.3	9.3	5.0	94.1
Alachlor + dinoseb, 1 + 3 lb/A	0	0	9.1	6.3	9.3	9.0	108.3
Alachlor + dinoseb, 2 + 3 lb/A	0	0	9.5	3.5	9.5	8.5	109.4
Dinoseb, 3 lb/A	0	0	7.3	4.5	6.5	4.0	95.2
EPTC, 3 lb/A, PPI[3]	0	0	6.8	1.0	7.5	5.3	87.0
Flurodiphen, 2 lb/A	0	0	7.0	1.0	8.5	3.8	81.7
Flurodiphen, 4 lb/A	0	0	7.8	5.5	8.8	6.3	90.9
LSD 5%	NS	NS	2.2	3.7	2.2	4.8	17.6

1. Scale: 0 = no effect and 10 = complete reduction
2. S = stand; V = vigor
3. PPI = pre-plant incorporated

The trifluralin-amiben combinations, however, gave poor control of jimsonweed, only 10 to 15% (Table 1). The alachlor-amiben and the linuron-amiben combinations, particularly at the higher rates, gave good control of jimsonweed, 85 to 100%. In fields where jimsonweed is a serious problem, it might be feasible to tolerate some early crop injury from these combinations if final yields are not affected adversely. The trifluralin-amiben combination at the higher rate, 1/2 + 4 lb/A, gave 82% control of annual grasses as compared to only 60% control at the lower rate, 1/2 + 2 lb/A. This 82% control of annual grasses was the highest for any herbicide combination used.

In the snap bean experiment, the two combinations of alachlor and 2-sec-butyl-4,6-dinitrophenol (dinoseb) gave the best overall weed control which resulted in the highest yields. Weed control from the alachlor-dinoseb combination, 1 + 3 lbs/A, and 2 + 3 lb/A, were essentially the same, 91 and 95% for annual grasses, and 93 and 95% for broadleaves, respectively. S-ethyl dipropylthiocarbamate (EPTC) 3 lb/A, pre-plant incorporated, which is the herbicide most used by growers, was not very effective, presumably because soil moisture was near field capacity when incorporated. EPTC has been quite effective when incorporated in dry soil.

Alachlor alone at the higher rates, 1 1/2 and 2 lb/A, resulted in good weed control and good yields. In fact, no treatment produced yields significantly different from those of the hoed check plots. However, weed control was somewhat less on plots treated with alachlor, 1 lb/A; dinoseb, 3 lb/A; EPTC, 3 lb/A; and flurodiphen, 2 and 4 lb/A.

LITERATURE CITED

1. Fisher, V. J. and E. L. Wisk. 1971. Lima bean spacing studies in 1971. Mimeo of Plant Science Department, University of Delaware.
2. Haltvick, E. T. 1971. High density lima bean trials in 1970. 1970 Processing Crops Manual. College of Agricultural and Life Sciences, University of Wisconsin.