CYPRAZINE, CYANAZINE AND ATRAZINE FOR WEED CONTROL IN CORN [1]

J. V. Parochetti [2]

ABSTRACT

Cyprazine (2-chloro-4-(cyclopropylamino)-6-(isopropylamino)-s-triazine), cyanazine (2-((4-chloro-6-(ethylamino)-s-triazin-2-yl)amino)-2-methyproprionitrile), and atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) were evaluated for annual weed control in corn (Zea mays L.) in field studies from 1971 to 1973. Cyanazine caused the most severe injury to corn when applied to corn in the seven leaf stage; earlier application caused little or no injury. Cyprazine and atrazine caused little or no corn injury. Cyanazine controlled fall panicum (Panicum dichotomifolium Michx.) effectively as preemergence and early postemergence treatments; in contrast fall panicum control from atrazine and cyprazine was variable.

Cyprazine affected the best giant green foxtail control (Setaria viridis var. major (Gaud) Posp.) as evidenced by the effectiveness of the late postemergence treatments.

INTRODUCTION

Two recently registered triazines, cyanazine and cyprazine are similar chemically to atrazine. Cyprazine has been used as a postemergence herbicide for foxtail control (5) but does not control fall panicum (4); cyprazine has possible use as a preemergence treatment. Cyanazine has been considered primarily as a preemergence herbicide (2, 3) but postemergence treatments are possible. The purpose of this three year study was to compare cyprazine, cyanazine and atrazine as preemergence or postemergence treatments.

MATERIAL AND METHODS

Six field experiments to evaluate atrazine, cyanazine and cyprazine were conducted at the Wye Institute, Queenstown, Maryland from 1971 through 1973. In each year, two experiments were established: atrazine and cyanazine were compared in one, and in the other, atrazine and cyprazine were evaluated. In each year, corn was planted in 30 inch rows with individual plots being 10 by 30 ft. All experiments were arranged in a randomized complete block design with four replications. Herbicides were applied with water at 30 gpa with an experimental bicycle sprayer. The cultivar '3369A' [3] was planted in 1971 and 1972 and 'XL 43' [4] was planted in 1973. The experiments were on a Mattapex silt loam with 1.5% organic matter.

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[1] Scientific Article No. A1953, and Contribution No. 4883 of the Maryland Agricultural Experiment Station, Department of Agronomy, College Park.

[2] Associate Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742.

[3] Obtained from Pioneer Seed Company, Des Moines, Ia.

[4] Obtained from DeKalb Agricultural Assoc., DeKalb, Illinois

A visual rating system was used to evaluate crop injury and the effectiveness of the weed control attained as previously described (1).

Cultivation was at five weeks after corn planting and was only in the cultivated control treatment in all experiments, except for the atrazine-cyanazine experiment in 1973 when all plots were cultivated.

In 1971, for both experiments, corn was planted May 6, followed by preemergence herbicides applications on the same day. For both experiments, early postemergence treatments were applied May 27 when corn was three inches tall and in the 4 leaf stage; giant green foxtail and fall panicum were in the 2 leaf stage. Late postemergence treatments were applied June 4 when corn was in the 7 leaf stage and 6 to 8 inches tall; giant green foxtail and fall panicum were in the 3 leaf stage and approximately 3 inches tall.

In 1972 for both experiments, corn was planted May 12 followed by preemergence herbicide applications on the same day. For the cyanazine-atrazine study, early postemergence treatments were made on May 24 when corn was in the 2 leaf stage and 1.5 inches tall; giant green foxtail and fall panicum were in the 2 leaf stage. For the cyprazine-atrazine study, early postemergence treatments were made on May 31 when corn was in the 4 leaf stage and 5.5 inches tall; fall panicum was in the 3 to 4 leaf stage and 1.25 inches tall. Late postemergence treatments were made on June 12 when corn was in the 7 leaf stage and 10 inches tall; fall panicum and giant green foxtail were in the 5 leaf stage and 4 inches tall.

In 1973, corn was planted May 2 followed by preemergence applications the same day. Early postemergence treatments for both experiments were applied on May 22 when corn was in 3 leaf stage; giant green foxtail was in the 2 leaf stage and 1.25 inches tall. Late postemergence treatments were applied on June 5 when corn was in the 7 leaf stage; giant green foxtail was in the 5 leaf stage and 3 inches tall.

RESULTS AND DISCUSSION

Giant green foxtail was prevalent in 1971 and 1972. In both years, good giant green foxtail control resulted from preemergence application of the wettable powder and water dispersable liquid formulations of atrazine and cyanazine each at 2 lb/A and the 1 lb/gal formulation of cyprazine at 1.5 lb/A (Table 1 and 2).

Both early and late postemergence applications of cyanazine affected excellent giant green foxtail control in 1971, except for the granular formulation as a late postemergence treatment (Table 1); this was in contrast to 1972 when only the early postemergence treatment, except the granular formulation, were effective. Similarily, atrazine as an early postemergence treatment resulted in excellent giant green foxtail control both in 1971 and 1972, but a late postemergence treatment of atrazine in 1972 resulted in poor control (Table 1 and 2).

Cyprazine applied either as an early or late postemergence treatments were very effective on giant green foxtail. Cyprazine is more effective in controlling taller giant green foxtail than atrazine (Table 2). One reason why cyanazine and atrazine , as late postemergence treatments, were not as effective in 1972 as in 1971 was that the giant green foxtail was taller in 1972, and thus, physiologically more resistant.

Fall panicum control with the triazines as preemergence treatments varied. Cyanazine affected excellent fall panicum control in 1971 and 1972 (Table 1). Fall panicum control resulting from preemergence treatments of atrazine varied from fair (4.5 rating) in 1971 to good (3.5 rating) in 1973 (Table 1). Preemergence treatments of cyprazine affected fair control of fall panicum in all 3 years (Table 2). Both early and late postemergence treatments of cyanazine resulted in excellent control of fall panicum in 1971, except the granular formulation, as a late postemergence treatment, but in 1972 only early postemergence treatments were effective (Table 1). Postemergence treatments of atrazine were not effective for fall panicum control except as an early postemergence treatment with oil (Table 1). Early postemergence treatment of cyprazine at 1.5 lb/A were effective for fall panicum control; the addition of oil at 1.5 lb/A did not enhance control (Table 2). Late postemergence treatments of cyprazine (1 lb/gal formulation) resulted in significantly less control than early postemergence treatments; in contrast the 4 lb/gal formulation of cyprazine affected similar fall panicum control as the early postemergence treatment of cyprazine at 1.5 lb/A.

Redroot pigweed (*Amaranthus retroflexus* L.) was controlled by atrazine and cyanazine as preemergence and early postemergence treatment. Late postemergence treatments of both cyanazine and atrazine, as well as early postemergence granular cyanazine, were not effective in controlling redroot pigweed (Table 1).

Corn injury was most severe with cyanazine as a late postemergence treatment as either the water dispensable liquid formulation or the 80% wettable powder formulation with oil (Table 1); injury ratings were as high as 8 in 1971. Early postemergence and preemergence treatments of cyanazine caused little or no corn injury. Corn injury from postemergence treatments of cyprazine was variable (Table 2), but it is difficult to ascertain what factors most important to manifest injury. Injury from cyprazine did not exceed a 5.5 rating. Postemergence treatments of atrazine caused the least amount of injury with ratings not exceeding 1.5 (Table 1 and 2).

Corn yields were not reduced by cyanazine induced corn injury as evidenced by the non-significant data for 1973 yields (Table 1); the 1973 experiment was the only study to be completely cultivated. Reduced yields in 1972 (Table 1) were due to the severe, uncontrolled fall panicum. Neither cyprazine nor atrazine reduced corn yields (Table 2).

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Table 1. The effect of atrazine and cyanazine applied in 1971, 1972, and 1973 under field conditions as either a preemergence or postemergence treatment on weed control, corn injury and corn yield.

Herbicide Formulation[a]	Time of Application[b]	CORN INJURY			CONTROL OF GIANT GREEN FOXTAIL		CONTROL OF FALL PANICUM		CONTROL OF RED-ROOT PIGWEED	CORN YIELD		
		6/11/71 (Rating) (%)[c]	6/15/72 (Rating) (%)[c]	6/11/73 (Rating) (%)[c]	7/1/71 (Rating) (%)[c]	6/15/72 (Rating) (%)[c]	7/1/71 (Rating) (%)[c]	6/15/72 (Rating) (%)[c]	6/15/72 (Rating) (%)[c]	1971 (Bu/A)	1972 (Bu/A)	1973 (Bu/A)
1. Control		1.0 (0)	1.0 (0)	--	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	7.0 (65)	37	25	--
2. Cult. Control		1.0 (0)	1.0 (0)	1.0 (0)	2.5 (96)	2.8 (95)	2.3 (97)	3.0 (95)	2.3 (96)	97	78	128
3. Cyanazine 80 WP	pre	1.0 (0)	1.0 (0)	1.3 (1)	2.5 (96)	1.3 (99)	3.0 (95)	2.8 (95)	1.8 (98)	117	78	150
4. Cyanazine WDL	pre	1.0 (0)	1.0 (0)	1.0 (0)	3.3 (94)	2.3 (96)	1.8 (98)	3.8 (91)	2.0 (97)	117	59	152
5. Cyanazine G	pre	1.0 (0)	1.0 (0)	1.3 (1)	5.0 (85)	1.0 (100)	4.0 (90)	3.5 (92)	3.3 (93)	97	83	147
6. Cyanazine 80 WP	early post	1.0 (0)	1.0 (0)	1.0 (0)	1.3 (99)	1.0 (100)	1.0 (100)	2.5 (96)	1.0 (100)	90	69	144
7. Cyanazine 80 WP	early post + oil[d]	-	-	1.0 (0)	-	-	-	-	-	-	-	165
8. Cyanazine WDL	early post	1.5 (2)	2.3 (4)	1.0 (0)	1.8 (98)	1.0 (100)	1.8 (98)	1.5 (98)	1.0 (100)	126	118	150
9. Cyanazine G	early post	1.5 (2)	1.0 (0)	1.0 (0)	1.0 (100)	4.3 (88)	1.0 (100)	7.0 (65)	5.0 (85)	111	55	151
10. Cyanazine 80 WP	late post	3.8 (9)	1.0 (0)	1.0 (0)	1.5 (98)	8.8 (6)	1.0 (100)	8.3 (22)	6.5 (70)	107	21	150
11. Cyanazine 80 WP	late post + oil[d]	-	3.3 (7)	7.8 (60)	-	8.8 (6)	-	8.8 (6)	5.0 (85)	-	31	133
12. Cyanazine WDL	late post	8.0 (70)	1.8 (2)	6.8 (33)	1.0 (100)	8.3 (22)	1.0 (100)	8.2 (26)	6.5 (70)	100	36	136
13. Cyanazine G	late post	2.8 (4)	1.0 (0)	1.0 (0)	4.0 (90)	8.5 (16)	4.3 (87)	9.0 (0)	7.8 (39)	109	61	122
14. Atrazine 80 WP	pre	1.0 (0)	1.0 (0)	1.0 (0)	2.0 (97)	1.5 (98)	3.5 (92)	5.5 (80)	1.0 (100)	119	48	144
15. Atrazine WDL	pre	1.0 (0)	1.0 (0)	1.0 (0)	2.5 (96)	1.3 (99)	3.8 (91)	3.3 (93)	1.0 (100)	101	73	154
16. Atrazine 80 WP	early post	-	1.0 (0)	1.0 (0)	-	1.5 (98)	-	8.5 (16)	1.0 (100)	-	37	144
17. Atrazine 80 WP	early post + oil[d]	-	1.8 (2)	-	-	1.8 (98)	-	4.8 (85)	1.0 (100)	-	71	149
18. Atrazine WDL	early post	1.0 (0)	1.0 (0)	1.0 (0)	1.3 (99)	1.5 (98)	3.0 (95)	7.5 (50)	1.0 (100)	84	40	154
19. Atrazine 80 WP	late post	-	-	1.0 (0)	-	-	-	-	-	-	-	150
20. Atrazine 80 WP	late post + oil[d]	-	1.0 (0)	-	-	7.5 (50)	-	8.3 (23)	5.5 (80)	-	27	-
21. Atrazine WDL	late post	-	-	1.0 (0)	-	-	-	-	-	-	-	152
	Bayes lsd 0.05 =	.39	.59	.18	1.5	1.7	1.8	1.6	2.3	25	35	n.s.

[a]Abbreviations used are: 80 WP = 80% wettable powder, WDL = water dispersible liquid at 4 lb/gal, and G = 15 or 20% granule.

[b]Abbreviations used are: pre = preemergence and post = postemergence.

[c]The % is an approximation.

[d]Oil is a nonparaffinic oil sold as Sun Oil 11E by Sun Oil Co.

ble 2. The effect of cyprazine and atrazine applied in 1971, 1972 and 1973 either as a preemergence or postemergence treatment for the control on giant green foxtail and fall panicum, and the effect on corn as measured by corn injury and corn grain yield.

	Treatments[a]	Rate (lb/A)	Time of Application[b]	CORN INJURY 6/11/71 (Rating) (%)[c]	CORN INJURY 6/5/72 (Rating) (%)[c]	CORN INJURY 6/25/73 (Rating) (%)[c]	CONTROL OF GIANT GREEN FOXTAIL 7/1/71 (Rating) (%)[c]	CONTROL OF GIANT GREEN FOXTAIL 6/25/72 (Rating) (%)[c]	CONTROL OF FALL PANICUM 7/1/71 (Rating) (%)[c]	CONTROL OF FALL PANICUM 7/2/72 (Rating) (%)[c]	CONTROL OF FALL PANICUM 6/25/73 (Rating) (%)[c]	CORN YIELD 1971 (Bu/A)	CORN YIELD 1972 (Bu/A)	CORN YIELD 1973 (Bu/A)
.	Control	--		1.0 (0)	1.3 (1)	1.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	9.0 (0)	56	104	86
.	Cult. Control	--		1.0 (0)	1.0 (0)	1.0 (0)	3.5 (93)	1.5 (98)	3.0 (95)	3.5 (92)	3.0 (95)	103	140	142
.	Cyprazine (1)	0.75	pre	1.0 (0)	1.0 (0)	1.0 (0)	6.3 (72)	4.5 (87)	5.8 (77)	5.5 (80)	5.5 (80)	92	141	136
.	Cyprazine (1)	1.5	pre	1.0 (0)	1.5 (1)	1.0 (0)	4.0 (90)	4.8 (86)	4.5 (87)	4.0 (90)	6.8 (67)	96	139	133
.	Cyprazine (4)	0.75	pre	-	2.0 (2)	1.0 (0)	-	4.4 (88)	-	3.0 (95)	5.0 (85)	--	124	131
.	Cyprazine (1)	0.75	early post	1.0 (0)	1.8 (2)	1.0 (0)	2.3 (97)	1.8 (98)	5.0 (85)	4.3 (88)	4.0 (90)	92	139	136
.	Cyprazine (1)	1.5	early post	1.0 (0)	3.5 (6)	1.3 (1)	1.8 (98)	1.0 (100)	2.3 (97)	2.0 (98)	1.8 (98)	100	140	149
.	Cyprazine (4)	0.75	early post	-	1.3 (1)	1.0 (0)	-	1.8 (98)	-	7.0 (65)	3.3 (97)	--	107	139
.	Cyprazine (4)	0.75	early post + oil[d]	-	1.8 (2)	1.0 (0)	-	3.5 (93)	-	5.0 (85)	2.3 (97)	--	121	119
0.	Cyprazine (4)	1.5	early post	-	1.5 (1)	1.3 (1)	-	1.8 (98)	-	3.0 (95)	3.0 (95)	--	111	139
1.	Cyprazine (4)	1.5	early post + oil[d]	-	3.3 (9)	1.0 (0)	-	1.5 (98)	-	3.0 (95)	3.8 (91)	--	125	148
2.	Cyprazine (1)	0.75	late post	1.3 (1)	1.3 (1)	-	3.5 (92)	-	4.3 (87)	8.8 (6)	-	105	118	--
3.	Cyprazine (1)	1.5	late post	5.5 (20)	1.0 (0)	1.8 (2)	1.8 (98)	1.5 (98)	1.8 (98)	5.3 (83)	5.0 (85)	101	120	149
4.	Cyprazine (4)	0.75	late post	-	1.0 (0)	1.0 (0)	-	4.8 (86)	-	5.0 (85)	5.8 (77)	--	143	144
5.	Cyprazine (4)	0.75	late post + oil[d]	-	1.0 (0)	1.0 (0)	-	4.0 (90)	-	5.5 (80)	6.3 (72)	--	101	144
6.	Cyprazine (4)	1.5	late post	-	1.3 (1)	1.8 (2)	-	2.0 (97)	-	4.8 (86)	4.3 (88)	--	111	145
7.	Cyprazine (4)	1.5	late post + oil[d]	-	1.0 (0)	3.0 (5)	-	2.8 (95)	-	3.5 (92)	3.8 (91)	--	133	146
8.	Atrazine (80 WP)	2	pre	1.0 (0)	2.3 (3)	1.3 (1)	2.8 (95)	1.5 (98)	4.5 (87)	3.3 (94)	3.5 (93)	100	115	150
9.	Atrazine (80 WP)	2	early post	1.0 (0)	1.3 (1)	1.0 (0)	2.0 (97)	1.5 (98)	3.8 (91)	5.5 (80)	3.8 (91)	126	129	136
0.	Atrazine (80 WP)	2	early post + oil[d]	1.0 (0)	1.0 (0)	1.3 (1)	1.5 (98)	1.0 (100)	2.0 (97)	3.8 (91)	4.8 (86)	133	142	148
1.	Atrazine (80 WP)	2	late post	1.0 (0)	1.0 (0)	1.0 (0)	5.0 (85)	5.3 (82)	6.5 (70)	5.3 (82)	6.8 (67)	102	127	129
2.	Atrazine (80 WP)	2	late post + oil[d]	1.0 (0)	1.5 (1)	1.0 (0)	1.3 (99)	6.5 (70)	6.0 (75)	6.5 (70)	4.8 (86)	103	101	143
			Bayes lsd 0.05	= 0.5	1.1	0.9	1.5	2.8	1.8	1.9	2.1	37	n.s.	27

[a] The numbers in parentheses refer to formulations: (1) = 1 lb/gal formulated in oil; (4) = 4 lb/gal; and (80 WP) = 80% wettable powder.
[b] Abbreviations are pre = preemergence and post = postemergence.
[c] The % is an approximation.
[d] Oil used at 2 gal/A was a nonparaffinic oil sold as Sun Oil 11E by Sun Oil Co.

ACTIVITIES OF BIFENOX AND H-22234 IN CORN[1/]

H. P. Wilson and T. E. Hines[2/]

Abstract. Control of lambsquarters (Chenopodium album L.) with methyl 5-(2',4-dichlorophenoxy)-2-nitrobenzoate (bifenox) at rates as low as 1.12 kg/ha was good but control of fall panicum (Panicum dichotomiflorum Michx.) was not satisfactory and extensive early injury to corn (Zea mays L. 'Pioneer 3369A') resulted. Combinations of bifenox with 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) effected excellent control of both weed species at rates of 1.12 plus 1.68 kg/ha respectively. The combination of bifenox with 2-chloro-N-isopropylacetanilide (propachlor) produced less injury to corn but control of fall panicum was not as good as from combinations of bifenox with alachlor. Differences between activities of the emulsifiable concentrate and wettable powder formulations of bifenox were small. All corn treated with bifenox, alone or in combinations, produced yields comparable to corn receiving the standard combination of 2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine (atrazine) with alachlor. Comparisons between N-chloroacetyl-N-(2,6,diethylphenyl)-glycine ethyl ester (H-22234) and alachlor showed that both provided good control of fall panicum and poor control of lambsquarters. Combinations of either H-22234 or alachlor with atrazine effected good control of both weed species. The margin of safety of H-22234 to corn was less than for alachlor. Control of yellow nutsedge (Cyperus esculentus L.) with H-22234 was equivalent to control of this species with alachlor.

Introduction

Bifenox has been reported to provide control of many annual broadleaf weeds and certain annual grasses in corn at rates of 1.68 to 2.24 kg/ha. Combinations of bifenox with herbicides specific for grasses have improved the spectrum of control when compared with applications of bifenox alone (1). However, in limited studies in 1971 it was found that crop injury resulted from preemergence applications; corn was not harvested so effects on yields were not determined.[3/]

Preliminary research with H-22234 indicated that this chemical may have potential for control of annual grasses in corn.[3/]

Investigations reported in this paper were conducted to determine the potential of bifenox and H-22234 alone and in combinations with other herbicides

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2/Plant Physiologist and Agricultural Research Assistant, respectively, Virginia Truck and Ornamentals Research Station, Painter, Virginia 23420.

3/Wilson, H. P., 1971. Unpublished data. Virginia Truck and Ornamentals Research Station, Painter, Virginia.

for controlling annual broadleaf weeds and grasses in corn. Considered of primary importance were comparisons of emulsifiable concentrate and wettable powder formulations of bifenox. The activity of H-22234 on yellow nutsedge was also investigated.

Materials and Methods

Research was conducted during 1972 and 1973 at the Virginia Truck and Ornamentals Research Station, Painter. Soil type was a Sassafras sandy loam with a pH of 6.0 and an organic matter content of approximately 1.5%. Herbicides were applied preemergence to plots measuring 1.8 m by 9.1 m containing two rows of corn. Experiments were designed as randomized complete blocks with 4 replications in 1972 and 3 replications in 1973. Planting dates were May 19, 1972 and May 10, 1973 and herbicides were applied 3 and 1 days later respectively. Soil was moist at the time of herbicide application in 1972 and 0.2 cm. rain followed immediately. In 1973, soil surface was dry but good subsurface moisture existed and 0.8 cm rain fell 4 days after herbicides were applied. Studies with bifenox were conducted both years while H-22234 was researched only in 1973.

Crop vigor and control of individual weed species were rated using the scale 0 to 10 where 0 represents no reduction in corn vigor or weed stand and 10 represents complete reduction in plant vigor or stand. Predominant weed species were lambsquarters and fall panicum.

Yields of corn were determined by weighing mature ears harvested at 18% moisture on October 5, 1972 and September 28, 1973. Data were analyzed statistically and means compared using Duncan's New Multiple Range Test.

In yellow nutsedge, preemergence applications of H-22234 at 2.24 and 4.48 were compared with applications of alachlor at the same rates. Soil type selected for the study was a Sassafras sandy loam with a pH of 5.0 and an organic matter content of approximately 2.0%. Soil was plowed in mid-March and disced twice immediately prior to herbicide applications on April 25, 1973. No crop was planted. Rain in the amount of 5.1 cm was received during the following 2 days. Nutsedge control was rated on June 20 and data were analyzed as above.

Results and Discussion

The activity of bifenox in 1972 is shown in Table 1. Alone and in combination with alachlor, bifenox caused injury to corn which was manifested as a reduction in vigor and the appearance of a chlorotic band across initial leaves, probably resulting from contact of the coleoptile with the treated soil surface during emergence. In severe instances, necrotic areas developed within the chlorotic band. This initial injury was quickly outgrown and had no effect on corn yields. Control of both lambsquarters and fall panicum was good with all treatments.

Table 1. Activity of preemergence applications of bifenox, bifenox with alachlor, and atrazine with alachlor in corn in 1972.[ab]

Herbicide and Formulation	Rate	Corn Vigor[c]	Weed Control[cd] L.Q.	Weed Control[cd] F.P.	Yield
	(kg/ha)	(6/12)	(7/3)	(7/3)	(kg/ha)
Bifenox	2.24	0.8 b	9.7 a	9.6 a	8171.9 a
(2 EC)	4.48	1.9 d	10.0 a	9.9 a	7684.0 a
Bifenox (2 EC) + Alachlor (4 EC)	1.12 + 1.68	1.1 c	10.0 a	9.9 a	8415.8 a
Atrazine (4L) + Alachlor (4 EC)	1.12 + 1.68	0.7 b	10.0 a	9.9 a	8171.9 a
Check (hoed)		0.0 a	10.0 a	10.0 a	6464.3 a
Check (hoed)		0.0 a	10.0 a	10.0 a	7562.0 a

a/Data are averages of 4 replications.
b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.
c/Scale: 0 to 10; 0 = no effect on plant stand or vigor and 10 = complete kill.
d/L.Q. = lambsquarters and F.P. = fall panicum.

Notwithstanding that both formulations of bifenox caused extensive crop injury in 1973, crop response diminished with time and yields were not affected by even the highest rates studied (Table 2). Injury from combinations of the emulsifiable concentrate formulation with alachlor lasted longer than injury from the combination of the wettable powder formulation with propachlor. With reference to weed control, both formulations of bifenox provided good control of lambsquarters but control of fall panicum was not satisfactory initially and further diminished with time. Combinations of the emulsifiable concentrate with alachlor provided better control of fall panicum than did the combination of the wettable powder formulation with propachlor.

Since even the low rates of 1.12 kg/ha bifenox provided good control of lambsquarters and satisfactory control of fall panicum resulted only from combinations with alachlor, it is suggested that acceptable broad-spectrum control with bifenox would consistently result only from combinations with alachlor or some other good grass herbicide. Because of the extensive initial crop injury resulting from bifenox, it is further suggested that the use rate should not exceed 1.12 kg/ha on sandy loam soils.

Table 2. Activity of two formulations of bifenox, alone and in combinations with other herbicides, applied preemergence in corn in 1973.[ab]

Herbicide and Formulation	Rate	Corn Vigor[c]		Weed Control[cd]			Yield
				L.Q.	F.P.	F.P.	
	(kg/ha)	(6/6)	(7/3)	(7/3)	(7/3)	(8/30)	(kg/ha)
Bifenox (80 WP)	1.12	4.0 c	2.3 abc	9.8 a	7.3 f	3.7 b	5529.2 ab
	1.40	4.7 cd	3.6 bcde	10.0 a	8.2 def	4.7 b	5976.4 a
	1.68	4.8 cd	4.0 bcdefg	9.6 a	8.7 bcde	4.7 b	6179.7 a
	2.24	5.7 def	3.6 bcde	9.7 a	9.1 abcd	4.9 b	6179.7 a
Bifenox (2 EC)	1.12	4.2 c	2.7 abcd	10.0 a	8.2 def	4.0 b	6179.7 a
	1.40	5.7 def	4.2 cdefgh	10.0 a	7.6 ef	3.5 b	5773.2 ab
	1.68	5.5 de	3.9 bcdef	9.7 a	8.5 cdef	4.3 b	5773.2 ab
	2.24	6.2 efg	5.0 efgh	9.8 a	9.3 abcd	5.6 b	6261.0 a
	4.48	6.8 fg	6.1 h	10.0 a	9.6 abc	8.0 a	6789.6 a
	6.72	7.2 g	5.9 gh	10.0 a	9.5 abc	8.4 a	6057.7 a
Bifenox (2 EC) + Alachlor (4 EC)	1.12 + 1.68	5.2 cde	4.3 defgh	9.8 a	9.7 abc	8.8 a	6789.6 a
	1.40 + 1.68	5.0 cde	4.8 efgh	10.0 a	10.0 a	9.3 a	7114.8 a
	2.24 + 3.36	7.0 g	4.6 defgh	10.0 a	10.0 a	9.5 a	7277.4 a
Bifenox (80 WP) + Propachlor (65 WP)	1.12 + 3.36	4.7 cd	2.2 ab	9.7 a	9.0 abcd	5.2 b	5976.4 ab
Alachlor (4E)	1.68	1.7 b	1.3 a	5.2 b	9.8 ab	9.4 a	5529.2 ab
Atrazine (4L)	1.12	1.2 ab	1.1 a	10.0 a	0.0 g	0.3 c	4268.9 b
Atrazine (4L) + Alachlor (4 EC)	1.12 + 1.68	1.5 b	1.0 a	10.0 a	9.9 ab	9.5 a	6179.7 a
Check		0.2 a	5.6 fgh	0.0 c	0.0 g	0.0 c	1301.0 c

a/Data are averages of 3 replications.
b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.
c/Scale: 0 to 10; 0 = no effect on plant stand or vigor and 10 = complete kill.
d/L.Q. = lambsquarters and F.P. = fall panicum.

Comparisons between the activities of H-22234 and alachlor in corn are presented in Table 3. Control of fall panicum with H-22234 and alachlor was good but neither herbicide provided satisfactory control of lambsquarters. Combinations of H-22234 or alachlor with atrazine effected good control of both lambsquarters and fall panicum and resulted in good yields. With reference to crop response, 3.36 and 4.48 kg/ha H-22234 caused greater reductions in vigor of corn than did the same rates of alachlor, indicating that the margin of crop safety with H-22234 may be less than with alachlor. However, since combinations of H-22234 with a herbicide specific for broad-leaf weeds will be needed to provide broad-spectrum control, rates of 1.12 to 1.68 would likely provide satisfactory control of annual grasses and result in little corn injury.

Table 3. Comparisons between preemergence applications of H-22234 and alachlor on weed control and crop response in corn in 1973.[ab]

Herbicide and Formulation	Rate	Corn Vigor[c]	Weed Control[cd] L.Q.	Weed Control[cd] F.P.	Yields
	(kg/ha)	(6/6)	(6/28)	(6/28)	(kg/ha)
H-22234	1.12	0.0 a	1.3 ef	9.7 bc	1829.5 e
(4 EC)	2.24	1.2 ab	3.3 de	9.7 bc	2764.6 de
	3.36	1.7 cd	3.2 de	9.8 abc	2480.0 de
	4.48	2.3 d	4.3 cd	9.9 ab	2561.3 de
Alachlor	1.12	0.8 abc	4.1 d	9.8 abc	3781.0 cd
(4 EC)	2.24	0.8 abc	6.5 bc	9.8 abc	4268.9 cd
	3.36	0.7 ab	3.0 de	10.0 a	5041.3 bc
	4.48	1.2 bc	6.8 b	10.0 a	5122.7 bc
H-22234 (4 EC) +	1.68 + 1.12	1.2 bc	10.0 a	9.6 c	7440.0 a
Atrazine (4L)	2.24 + 1.12	1.2 bc	10.0 a	9.8 abc	6667.6 ab
Alachlor (4 EC) +	1.68 + 1.12	0.6 ab	10.0 a	9.9 ab	7155.5 a
Atrazine (4L)	2.24 + 1.12	1.0 bc	10.0 a	10.0 a	8009.2 a
Check		0.0 a	0.0 f	0.0 d	1097.7 e

a/Data are averages of 3 replications.
b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.
c/Scale: 0 to 10; 0 = no effect on plant stand or vigor and 10 = complete kill.
d/L.Q. = lambsquarters and F.P. = fall panicum.

Good control of nutsedge resulted from both H-22234 and alachlor with no differences existing between rates (Table 4). Since previous work (2) indicated that effective yellow nutsedge control with alachlor could be obtained only when alachlor was incorporated, it is assumed that the heavy rainfall following herbicide application effected incorporation and that neither herbicide would likely provide satisfactory nutsedge control from preemergence applications in the absence of rain.

Table 4. Comparisons of H-22234 and alachlor for control of nutsedge in 1973.[abc]

Herbicide and Formulation	Rate (kg/ha)	Control (6/20)
H-22234	2.24	8.3 a
(4 EC)	4.48	9.3 a
Alachlor	2.24	8.6 a
(4 EC)	4.48	8.7 a
Check		0.0 b

a/Scale: 0 to 10; 0 represents no effect and 10 represents complete stand reduction.
b/Data are averages of 4 replications.
c/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

Acknowledgements

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Literature Cited

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2. Wilson, H. P., R. L. Waterfield, Jr., and C. P. Savage, Jr. 1971. Field investigations of the activities of several herbicides for control of yellow nutsedge. Proc. Northeast. Weed Sci. Soc. 25:255-262.

PREEMERGENCE CONTROL OF CRABGRASS AND CERTAIN ANNUAL BROADLEAF WEEDS IN FIELD CORN

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

ABSTRACT

Several preemergence herbicides were evaluated, singly and in combination, for control of annual grasses and broadleaf weeds in field corn (Zea mays L.) in 1972 and 1973. With the exception of some of the materials used alone, all of the treatments gave very satisfactory control, without any adverse effect on silage yields. From these results, it can be concluded that there is a wide variety of herbicide combinations that could provide the weed control needed for field corn production.

MATERIALS AND METHODS

Annual grass and broadleaf weed control treatments were applied preemergence to field corn and weeds on two different sites in 1972 and 1973. Treatments in 1972 were applied to a site on which the soil has been classified as a Swanton fine sandy loam, with an organic matter content of 6-7 percent. In 1973 the treatments were applied on an experimental plot located on soil classified as Charlton-Hollis fine sandy loam, with an organic matter content of 3-4 percent.

Herbicides were applied by use of a hand-held CO_2 small-plot sprayer which applied 24 gallons of water per acre at a pressure of 30 psi. A single coverage was made over each of the 12 x 25-foot plots.

Treatments were made within two days after the date of planting, June 18 in 1972 and May 12, 1973. Visual ratings of weed control were recorded on August 8 in 1972 and on June 4 and July 7 in 1973. Silage yields of 30 percent dry matter were harvested in September of 1973. In both years the experiments were designed as randomized complete blocks with three replications.

RESULTS

A. 1972

1. Annual Grasses - Smooth crabgrass (Digitaria ischaemum Schreb. Muhl), large crabgrass (Digitaria sanguinalis L. Scop.), yellow foxtail (Setaria glauca L. Beauv.), barnyard grass (Echinochloa crusgalli L. Beauv.) and witchgrass (Panicum capillare L.).

1/ Associate Professors, Department of Plant Science, University of New Hampshire, Durham, New Hampshire.

Herbicide combinations at low rates were generally more effective than single compounds, although cyanazine at 2.5 lbs./A and chlorbromuron at 4 lbs./A gave as good control as various combinations of cyanazine, alachlor, atrazine, simazine, chlorbromuron, and dinoseb (Table 1.).

2. Broadleaf Weeds - Lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), smartweed (*Polygonum pensylvanicum* L.) and ragweed (*Ambrosia artemisiifolia* L.).

As with grass control, it was generally the combination of materials at low rates that resulted in the best control, with the exception of chlorbromuron at 4 lbs./A which gave excellent control (Table 1). Atrazine at 2 lbs./A did not provide the satisfactory control that is usually experienced with this material.

B. 1973

1. Grasses - Smooth crabgrass (*Digitaria ischaemum* Schreb. Muhl), large crabgrass (*Digitaria sanguinalis* L. Scop.), yellow foxtail (*Setaria glauca* L. Beauv.), barnyard grass (*Echinochloa crusgalli* L. Beauv.) and witchgrass (*Panicum capillare* L.).

Combinations of herbicides at low rates gave the best control with the exception of cyanazine at 3 lbs./A, which also provided good control (Table 2.).

2. Broadleaf Weeds - Wild mustard (*Brassica kaber* DC. L. C. Wheeler), wild radish (*Raphomus raphanistrum* L.), redroot pigweed (*Amaranthus retroflexus* L.), and ragweed (*Ambrosia artemisiifolia* L.).

Atrazine at 2 lbs./A and cyanozine at 3 lbs./A gave very good control as well as several combination treatments. Cyanazine at 2.5 lbs./A was much less effective than the same material at 3 lbs./A (Table 2.).

3. Silage Yields - The yield of silage was unaffected by any herbicide treatment; only the yield in the check plots significantly differed from the yields in the herbicide treated plots (Table 2.).

SUMMARY AND CONCLUSIONS

The years of 1972 and 1973 followed about the same climatic pattern--wet in the early part of the season and dryer in the latter part. Of all the treatments applied, as single compounds and as combinations of materials, it is obvious that there are no one or two superior treatments. It must be concluded that there are many effective materials available and when combined in several various combinations and rates, very effective grass and broadleaf weed control is possible, and without reduction of corn silage yields.

Table 1. The effect of several preemergence herbicides on broadleaf weeds and grasses in field corn - 1972.

Treatment	Rate lbs. a.i./A	Weed Control a/	
		Broadleaf Weeds b/	Grasses b/
atrazine	2.0	9.7 AB	2.7 B
cyanazine	2.5	8.8 BC	8.8 A
chlorbromuron	2.0	9.7 AB	4.3 B
chlorbromuron	4.0	10.0 A	8.0 A
atrazine + simazine	1.0 + 1.0	8.2 C	8.3 A
atrazine + simazine	1.0 + 2.0	10.0 A	9.5 A
atrazine + simazine	2.0 + 2.0	10.0 A	10.0 A
atrazine + alachlor	1.0 + 1.5	9.8 A	9.8 A
cyanazine + alachlor	1.5 + 1.5	10.0 A	10.0 A
chlorbromuron + alachlor	1.5 + 1.5	10.0 A	10.0 A
alachlor + dinoseb	1.5 + 2.0	9.8 A	9.7 A
check		0.0 D	0.0 C

a/ 0 = No control; 10 = complete control

b/ Values followed by the same letter are not significantly different at 5% level (Duncans Multiple Range Test).

Table 2. The effect of several preemergence herbicides on broadleaf weeds and grasses in field corn - 1973.

Treatment	Rate lbs. a.i./A	Weed Control				Silage Yields[b] Tons/A
		Broadleaf Weeds[b]		Grasses[b]		
		6/4/73	7/3/73	6/4/73	7/3/73	
atrazine	2.0	10.0 A	10.0 A	4.5 C	0.0 D	13.4 A
cyanazine	2.5	8.5 CD	6.3 BC	9.0 AB	7.8 ABC	13.4 A
cyanazine	3.0	9.5 ABC	8.8 A	9.7 A	8.8 ABC	15.0 A
AC 92533	1.5	7.7 D	4.7 C	8.8 AB	7.5 BC	12.6 A
AC 92533	2.0	9.0 ABC	8.3 AB	9.3 A	8.7 ABC	17.2 A
atrazine + simazine	1.0 + 1.0	9.3 ABC	8.5 AB	8.5 AB	7.2 C	16.1 A
atrazine + simazine	1.0 + 2.0	9.8 A	9.5 A	9.3 A	8.8 ABC	18.1 A
atrazine + alachlor	1.0 + 1.5	9.7 AB	9.2 A	9.5 A	9.2 AB	17.6 A
cyanazine + alachlor	1.5 + 1.5	8.7 BCD	7.7 AB	9.7 A	9.0 ABC	17.0 A
AC 92533 + atrazine	1.0 + 1.0	9.2 ABC	8.5 A	7.7 B	8.0 ABC	16.8 A
AC 92533 + cyanazine	1.0 + 1.6	9.8 A	9.7 A	9.3 A	8.0 ABC	15.6 A
chlorbromuron + alachlor	1.5 + 1.5	9.7 A	9.0 A	9.8 A	9.5 A	17.5 A
check		0.0 E	0.0 D	0.0 D	0.0 D	2.1 B

[a] 0 = No control; 10 = complete control

[b] Values followed by the same letter are not significantly different at 5% level (Duncans Multiple Range Test).

ANNUAL WEED CONTROL IN FIELD CORN - 1973

W. M. Dest, R. A. Peters, A. C. Triolo[1/]

Abstract

Herbicides were applied alone and in combinations for evaluation of annual weed control in field corn. The experiment was conducted at the Agronomy Research Farm, University of Connecticut. The dominant weed species was large crabgrass (Digitaria sanguinalis (L.) Scop.).

All the preemergence herbicide treatments tested except dicamba and NIA 21844 at 1/2 lb/A gave good to excellent crabgrass control early in the season.

Alachlor in combination with simazine, simazine + atrazine, cyanazine, dicamba, chloropropham, or metribuzin provided season long control of crabgrass. Simazine 80W at 3 lb/A, Bay Kue 2236, and AC 92553 + atrazine 80W also gave good control over the duration of the growing season.

Postemergence treatments resulted in very poor control of crabgrass.

Both the 80W and 4L formulations of cyanazine applied postemergence injured the corn. The more severe injury resulted from the 4L formulation.

Butylate + atrazine (3 + 1 lb/A), EPTC + atrazine (3 + 1 lb/A), and vernolate + atrazine (3 + 1 lb/A) applied preplant incorporated gave full season control of crabgrass. Atrazine added to CGA 10832 increased herbicidal activity but did not result in crabgrass control over the duration of the growing season. All other herbicides applied preplant incorporated gave good control initially but failed to maintain crabgrass control through the growing season.

Experiment 1
Preemergence and Postemergence Treatments

Methods and Materials

The experiment was conducted at the Agronomy Research Farm of the Storrs Agricultural Experiment Station. The experimental design was a complete randomized block with 3 replications. Plot size was 8.5 feet by 30 feet. Penna 604 field corn was seeded in 34 inch rows (3 rows per plot) on May 17, 1973.

The soil type is a Paxton fine sandy loam. The field was fertilized at the rate of 1000 lb/A with a 15-15-15 fertilizer on April 16.

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

Large crabgrass was the major weed species with lesser amounts of redroot pigweed (Amaranthus retroflexus L.) and lambsquarters (Chenopodium album L.). No data was taken on broadleaf weeds due to the sparse population.

Preemergence applications of the herbicides were applied on May 22, 1973. Postemergence treatments were applied on June 5, 1973. Crabgrass was 2 to 3 inches tall with 1 to 3 tillers.

A total of 4.58 inches of precipitation was recorded in the five weeks following the preemergence applications. Rainfall was well distributed over this period.

All chemicals were applied in water at 40 gal/A with a small plot self-propelled sprayer. All herbicide rates are given in lb ai or ae/A.

A rating scale of 0-10 was used for weed control and corn injury. Zero indicates no effect and 10 indicates complete kill.

Results and Discussion

The herbicide treatments applied preemergence were more effective than postemergence treatments for controlling crabgrass (Table 1). The ample and evenly distributed rainfall in the five week period following the preemergence applications favored the herbicidal activity of these compounds.

Preemergence Treatments

Initially all the herbicides applied preemergence except dicamba and NIA 21844 at 1/2 lb/A gave good to excellent crabgrass control.

Some of the herbicides combined with alachlor gave full season crabgrass control. Simazine + alachlor, simazine + atrazine + alachlor, cyanazine + alachlor, dicamba + alachlor, and chlorpropham + alachlor all achieved residual control through the August 8th rating.

Atrazine 80W at 2 lb/A gave better control of crabgrass than the 4L formulation through the July 10th rating date. There was no difference in the degree of control with the 80W or 4L simazine formulations applied at 2 lb/A.

Simazine at 3 lb/A gave season long crabgrass control.

Cyanazine at either 2 or 3 lb/A gave good crabgrass control. There was no difference between the 80W and 4L formulations.

AC 92553 applied at 2 lb/A gave better control of crabgrass than the 1 1/2 lb/A rate. Addition of atrazine (1 1/2 lb/A) or cyanazine (2 lb/A) to the AC 92553 (1 1/2 lb/A) resulted in more effective control of crabgrass.

BAS 2903-H at 4 lb/A did not give full season control of crabgrass. The

addition of atrazine to BAS 2903-H at 1 + 2 lb/A, respectively, increased herbicidal activity. Similar results were recorded in 1972 (1).

NIA 21844 at 1 lb/A gave much better control of crabgrass than the 1/2 lb/A application. NIA 23486 (1 lb/A) gave excellent crabgrass control through the July 10th rating date. Neither of these two materials performed as well as in the previous year (1).

Bay Kue 2236 applied at 2 lb/A achieved full season crabgrass control. These same results were obtained in 1972 (1).

Postemergence Treatments

The postemergence treatments gave very poor crabgrass control. Due to the combined impact of the ideal growing conditions during the season and the advanced stage of growth of the crabgrass when the chemicals were applied, these treatments were relatively ineffective in the control of crabgrass.

Corn Response

No injury to the corn was noted with any of the preemergence treatments (Table 1). Some of the postemergence applications did cause injury to the corn, particularly the cyanazine. The 4L formulation of cyanazine at 1 1/2 lb/A was more phytotoxic to the corn than the 80W formulation at 2 lb/A.

Silage yield samples were taken on September 28 from selected treatments. There was no significant difference in silage yields, therefore yield data is not reported in this paper.

Experiment 2
Preplant Incorporated Treatments

Methods and Materials

Most of the methods used in this experiment are the same as used in Experiment 1. Only those methods that differ will be mentioned in this section.

Plot size was 8.5 feet by 25 feet.

The chemical treatments were applied on May 17, 1973. All the materials were incorporated immediately with a power driven roto-tiller.

Samples for silage yield determinations were harvested on September 20, 1973. Twelve feet of the center row was harvested from each plot. Yield is expressed as tons/A on a 30% dry matter basis.

Results and Discussion

At the June 21 rating, all chemical treatments gave good to excellent crabgrass control (Table 2).

Addition of atrazine to the butylate 6E formulation, EPTC, and CGA 10832 increased herbicidal activity. The butylate + atrazine (3 lb/A + 1 lb/A) and EPTC + atrazine (3 lb/A + 1 lb/A) gave full season control of crabgrass.

Vernolate + atrazine (3 lb/A + 1 lb/A) also resulted in full season control of crabgrass. All other treatments failed to maintain good control over the duration of the growing season.

The CGA 10832 compound at 2 lb/A injured the corn resulting in stunting and thinning of the stand. The decrease in plant population plus lack of full season control accounts for the significant reduction in silage yield when compared with the majority of chemical treatments. The plants that remained recovered from the injury.

The butylate 6E formulation also injured the corn but it later recovered.

All chemical treatments gave significantly higher silage yields than the check (Table 2).

Literature Cited

1. Dest, W. M., R. A. Peters and A. C. Triolo. 1973. Annual weed control in field corn. Proc. NEWSS 27:31-40.

Table 1. Evaluation of Herbicides for Crabgrass Control and Corn Injury in Field Corn.

Treatment	Rate lb ai/A	Crabgrass control ratings[1] 6/21	7/10	8/8	Corn injury ratings[1] 6/21	7/10
Atrazine 80W + alachlor	1 + 2 pre	9.0	9.3	6.7	0	0
Atrazine 4L	2 pre	7.3	5.3	3.7	0	0
Atrazine 80W	2 pre	8.6	8.0	3.3	0	0
Simazine 4L	2 pre	8.6	8.7	6.3	0	0
Simazine 80W	2 pre	9.0	8.0	5.7	0	0
Simazine 80W + alachlor	2 + 1 pre	9.7	9.3	8.3	0	0
Atrazine 4L + simazine 4L	1 + 2 pre	9.3	9.0	7.0	0	0
Atrazine 80W + simazine 80W	1 + 2 pre	9.3	9.2	7.3	0	0
Simazine 80W	3 pre	9.3	9.7	8.0	0	0
Simazine 80W + atrazine 80W + alachlor	1 + 1 + 1 pre	9.0	9.2	8.3	0	0
Cyanazine 80W	2 pre	9.3	9.0	7.3	0	0
Cyanazine 80W	3 pre	9.0	8.3	6.3	0	0
Cyanazine 4L	3 pre	9.0	8.2	6.0	0	0
Cyanazine 80W + alachlor	2 + 2 pre	9.7	9.5	9.0	0	0
Cyprazine + alachlor	3/4 + 2 pre	7.6	6.2	4.3	0	0
Dicamba	1/4 pre	6.3	3.0	2.3	0	0
Dicamba	1/2 pre	2.7	0.2	0.0	0	0
Dicamba + alachlor	1/2 + 2 pre	9.3	9.8	8.7	0	0
Chlorpropham + alachlor	2 + 2 pre	9.7	9.7	8.0	0	0
AC 92553	1 1/2 pre	9.0	7.8	5.0	0	0
AC 92553	2 pre	9.7	9.0	7.0	0	0
AC 92553 + atrazine 80W	1½ + 1½ pre	9.0	9.7	8.7	0	0
AC 92553 + cyanazine 4L	1½ + 2 pre	9.0	8.7	7.0	0	0
BAS 2903-H	4 pre	8.6	6.8	3.3	0	0
BAS 2903-H + atrazine 80W	2 + 1 pre	9.0	8.0	5.7	0	0
NIA 21844	1/2 pre	6.7	3.2	0.3	0	0
NIA 21844	1 pre	8.6	7.7	4.0	0	0
NIA 23486	1 pre	9.3	9.3	4.0	0	0
Bay Kue 2236 70W	2 pre	9.7	8.3	9.0	0	0
Metribuzin	1/2 pre	9.3	8.8	6.3	0	0
Metribuzin + alachlor	1/2 + 1½ pre	9.7	9.7	8.0	0	0
Atrazine 80W + alachlor	1 + 1½ post	5.0	4.8	2.0	0.3	0.3
Atrazine 80W + oil	2 + 1 qt post	3.0	3.8	1.0	0.3	1.3
Simazine 80W + oil	2 + 1 qt post	0.3	0.8	1.0	0	0
Dicamba + alachlor	1/2 + 1½ post	0.0	0.0	0.0	0	0
Cyanazine 80W	2 post	3.3	3.7	0.0	0.7	2.0
Cyanazine 4L	1½ post	4.0	2.3	0.7	3.3	3.5
Cyanazine 80W + oil	1½ + 1 qt post	2.0	2.2	0.0	0.7	1.7
Check		0.0	0.0	0.0	0	0

[1] Rating scale 0 = no effect 10 = complete kill

Table 2. Evaluation of Preplant Incorporation of Herbicides for Crabgrass Control, Corn Injury, and Silage Yields.

Treatment	Rate lb ai/A	Crabgrass Control[1] 6/21	7/10	8/8	Corn Injury 6/21	Silage Yield T/A[2]
Butylate 6E + atrazine	3 + 1	8.6	8.0	6.0	0	18.4ab[3]
Butylate 6E	4	6.7	5.3	3.3	3.0	15.5bc
Butylate 4F	4	7.0	3.3	3.0	0	15.9bc
Butylate 4F + atrazine	3 + 1	6.3	4.7	3.3	0	18.0ab
EPTC 6E	4	7.3	6.0	4.0	0	19.8ab
EPTC 6E + R-25788	4	7.7	5.7	3.3	0	19.3ab
EPTC 4F	4	8.0	6.7	4.3	0	18.8ab
EPTC 6E + R-25788 + atrazine	3 + 1	9.0	8.3	6.0	0	23.4a
Vernolate + R-25788 + atrazine	3 + 1	8.3	7.0	6.3	0	18.9ab
S-6176	4 3/4	6.3	5.0	1.7	0	15.8bc
CGA 10832	2	7.3	5.7	1.7	4.7	11.1c
CGA 10832 + atrazine	2 + 1	8.0	6.7	2.7	3.0	16.7abc
Check		0	0	0	0	4.1d

1/ Rating scale: 0 = no effect 10 = complete kill

2/ Silage yield: 30% dry matter basis

3/ Means not followed by the same letter are significantly different at the 5% level using Duncan's Multiple Range Test.

Appendix

Common Name	Formulation	Chemical Name
AC 92553	3 lb/gal EC	N-(1-Ethylpropyl)-2,6-dinitro-3,4-xylidine
NIA 23486	80% WP	6-tert-Butyl-3-isopropylisoxazolo-[3,4-d] pyrimidin-4(5H)-one
NIA 21844	80% WP	6-tert-Butyl-3-isopropylisoxazolo-[5,4-d] pyrimidin-4(5H)-one
Bay Kue 2236	70% WP	trifluoromethoxyphenyl urea
BAS 2903-H	4 lb/gal EC	2-chloro-N-(1-methyl-2-propynyl acetanilide
Dicamba	4 lb/gal EC	3,6-dichloro-o-anisic acid
Alachlor	4 lb/gal EC	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
Atrazine	80% WP 4 lb/gal EC	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
Simazine	80% WP 4 lb/gal EC	2-chloro-4,6,bis(ethylamino)-s-triazine
Cyanazine	80% WP 4 lb/gal EC	2-[[4 chloro-6-(ethylamino)-s-triazin-2-yl]amino]-2-methyl-propionitrile
Cyprazine	1 lb/gal EC	2-chloro-4-(cyclopropylamino)-6-(isopropylamino)-s-triazine
Chloropropham	4 lb/gal EC	isopropyl-m-chlorocarbanilate
Metribuzin	70% WP	4-amino-6-tert-butyl-3-(methylthio)-triazin-5(4H)-one
CGA 10832	4 lb/gal EC	N-n-propyl-N-cyclopropylmethyl-4-trifluromethyl-2,6-dinitroaniline
S-6176	4 3/4 lb/gal EC	ethyl N, N-diethylthiolcarbamate plus 2-chloro-4-cyclopropylamino-6-isopropylamino-s-triazine
EPTC	6 lb/gal EC	S-ethyl dipropylthiocarbamate
Butylate	6 lb/gal EC	S-ethyl diisobutylthiocarbamate
Protectant (R-25788)		unknown
Vernolate	6 lb/gal EC	S-propyl dipropylthiocarbamate

EVALUATION OF BUTYLATE, VERNOLATE AND EPTC FORMULATIONS WITH ANTIDOTES IN FIELD CORN

D. J. Herman, W. F. Smith and R. D. Ilnicki 1/

Abstract

No reduction in stand or vigor of field corn (Zea mays L.) was noted with butylate either this year or in 1972; however, severe weed competition from lambsquarters (Chenopodium album L.) and pigweed (Amaranthus retroflexus L.) significantly reduced yields of all butylate and butylate + R-25788 treatments. This competition far outshadowed any reduction in yield due to physiologic injury. A beneficial effect of R-25788 was shown, however, in combination with butylate (6E) + atrazine 8 + 2 lb/A over butylate (6E) + atrazine 8 + 2 lb/A alone.

EPTC 10G at 6 and 8 lb/A caused greater reductions of stand and vigor of the corn than the 6E formulation. However, the 10G formulation also gave better control of lambsquarters and pigweed. While R-25788 in combination with the emulsifiable or granular formulations of EPTC reduced or eliminated visual injury symptoms no significant effects on yield could be discerned. This concurs with our 1972 findings.

Injury caused by vernolate 6E and 10G at 8 lb/A was not as severe as that caused by comparable rates of EPTC. Yields of all vernolate treatments were not significantly different from the cultivated check; however, vernolate + R-25788, 6E + atrazine 6 + 2 lb/A was the highest yielding treatment in the entire trial.

Introduction

The thiocarbamate herbicides do have a place in field corn production as they are effective against nutsedge and other grassy weeds. However, since corn is also a member of the grass family, it may also be subject to some injury. This injury can express itself in stand reductions, stunting and formative effects.

1/Research Intern, Ph D. recipient and Research Professor of Weed Science, Department of Soils and Crops, Rutgers University New Brunswick, New Jersey 08903.

Chemicals which would prevent this injury, yet permit application rates to be high enough to control difficult weed species, have a definite place in thiocarbamate weed control programs. The objective of this experiment was to evaluate some different formulations of some thiocarbamate herbicides with the comparable commercially prepared herbicide-antidote formulations with respect to weed control and corn tolerance.

Methods and Materials

Field corn, variety Midstates 818, was planted on May 15, 1973, in a Freehold sandy loam at the Adelphia Research Station of Rutgers University, Adelphia, New Jersey. Preplant incorporated treatments of butylate, EPTC and vernolate with and without the antidote R-25788 and some combinations with atrazine, were applied on May 14, 1973, a day prior to planting and incorporated immediately after application.

The area chosen for the experiment was primarily infested with lambsquarters, pigweed, ragweed (Ambrosia artemisifolia L.) velvet leaf (Abutilon theophrasti Medic.) and fall panicum (Panicum dichotomiflorum Michx.)

Visual ratings on reduction of stand (S) and vigor (V) were made on July 12, 1973. A scale of 0 to 10 was used in which 0 = no effect on stand or vigor and 10 = complete control or elimination of stand. The corn was harvested on October 15, 1973, and yield data are expressed in Bu/A. The experiment was designed as a randomized complete block with three replications. Plot size was 14' x 19' with each plot containing four rows. Only the two center rows were harvested for yield. Comparisons between treatment means were made using Duncan's Multiple Range Test at the .05 level of probability. The data presented in Table 1 are a summary of three experiments. The statistical analysis included other treatments not presented here. Treatment means were compared to the mean of the cultivated check in each experiment.

Results and Discussion

Weed control and yield data for the three experiments are summarized in Table 1.

Because of the unusually dry conditions during the critical period of ear formation yields were very low. However, we were still able to show statistically valid differences between treatment means.

Antidote-herbicide combinations of butylate, vernolate and EPTC with R-25788 did not alter weed control when compared with the herbicides alone at comparable rates. The yield reductions measured from all rates of butylate alone or in combination with R-25788 must have come mainly from severe weed competition with lambsquarters because the combination of butylate + atrazine 6 + 2 lb/A, which gave virtually complete control of the entire weed spectrum did not yield significantly different than the cultivated check but did yield significantly better than any treatment of butylate alone. There may have been some physiological injury from the 8 lb/A rate of butylate in combination with 2 lb/A of atrazine, as the addition of the antidote at this rate produced significantly better yields than the comparable unantidoted treatment.

Rates of EPTC at 6 and 8 lb/A of both the emulsifiable and the granular formulations reduced the stand of the corn from 6 to about 20% and reduced vigor up to about 13%. While not evident from this table, early injury symptoms were a knurling of leaves within the whorl. However, as the season progressed the corn was able to grow out of this condition and recover most of its loss in vigor. R-25788 served as an effective protectant in combination with EPTC at all rates up to 8 lb/A. The 10G formulation of EPTC while causing more injury to the corn than the 6E formulation also provided much better control of lambsquarters and pigweed. As in 1972, crop injury from the higher rates of EPTC was not translated into significant yield reductions.

Vernolate did cause some slight injury at the 8 lb/A. rate of both the 6E and 10G formulations, but not enough to significantly reduce yields when compared to the cultivated check or to comparable rates of vernolate + R-25788.

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TABLE 1. The effects of the thiocarbamate herbicides butylate, EPTC and vernolate alone and in combination with the antidote R-25788 on field corn in New Jersey, 1973.

Herbicide	Rate lb a.i./A	Corn S	Corn V	Lambs-quarters S	Lambs-quarters V	Pigweed S	Pigweed V	Ragweed S	Ragweed V	Velvet Leaf S	Velvet Leaf V	Fall Panicum S	Fall Panicum V	Yield (bu./A.)
butylate	4	0.0	0.3	0.0	0.3	10.0	10.0	8.6	2.6	9.0	8.0	9.3	8.0	14.3 fgh
SUTAN 6E	6	0.0	0.0	1.0	1.3	10.0	10.0	9.0	4.3	8.6	7.0	10.0	10.0	25.7 defg
	8	0.0	0.0	0.6	2.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	12.8 fgh
butylate + R-25788	4	0.0	0.0	0.3	1.0	9.6	8.0	7.0	5.3	9.6	9.3	10.0	10.0	12.6 fgh
SUTAN A, 6 lb/gal	6	0.0	0.3	0.0	0.3	10.0	10.0	9.0	6.0	10.0	10.0	10.0	10.0	17.1 fgh
(6 + 0.25 lb/gal)	8	0.0	0.0	1.3	1.0	10.0	10.0	9.3	7.3	9.3	8.0	10.0	10.0	11.6 fgh
butylate	4	0.0	0.0	0.6	0.6	10.0	10.0	8.3	6.3	10.0	10.0	9.6	9.6	12.2 fgh
SUTAN 10G	6	0.0	0.3	0.0	1.3	10.0	10.0	10.0	10.0	10.0	10.0	9.6	9.0	12.3 fgh
	8	0.0	0.6	0.0	2.0	9.6	6.2	9.2	8.6	10.0	10.0	10.0	10.0	15.4 fgh
butylate + R-25788	4	0.0	0.0	0.6	2.6	9.6	7.0	9.6	8.3	9.6	7.3	9.6	9.3	13.3 fgh
SUTANA, 10 G	6	0.0	0.0	3.6	4.3	10.0	10.0	9.0	8.0	9.6	8.3	9.0	9.0	16.3 fgh
(10 + 0.42 G)	8	0.0	0.3	1.6	3.3	10.0	10.0	9.3	8.0	10.0	10.0	10.0	10.0	19.8 fgh
butylate (6E) +	6 + 2	0.0	0.0	9.6	8.0	10.0	10.0	10.0	10.0	10.0	10.0	7.6	8.6	39.8 abc
atrazine (80W)	8 + 2	0.0	0.3	9.3	9.3	10.0	10.0	10.0	10.0	10.0	10.0	8.3	8.3	26.4 cdef
butylate + R-25788	6 + 2	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	7.6	7.0	37.1 abcd
6 lb/gal +atrazine	8 + 2	0.0	0.0	10.0	10.0	10.0	10.0	9.3	8.3	10.0	10.0	8.6	8.3	47.9 ab
check - cult.		0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	50.9 a
check - uncult.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8 fgh
EPTC	3	0.3	0.6	2.0	1.3	5.6	0.6	9.6	8.3	-	-	10.0	10.0	28.7 BCD
EPTAM 6E	4	0.0	0.3	1.3	0.3	6.3	0.0	10.0	10.0	-	-	10.0	10.0	40.2 ABCD
	6	0.6	0.3	3.0	1.3	7.6	2.0	9.3	8.3	-	-	9.3	8.3	47.3 ABCD
	8	0.6	1.0	5.3	3.6	8.3	2.0	9.6	6.6	-	-	10.0	10.0	26.3 BCD
EPTC + R-25788	4	0.6	0.0	1.0	0.0	6.0	1.3	9.3	6.6	-	-	10.0	10.0	19.9 D
ERADICANE 6E	6	0.3	0.3	3.6	1.6	9.0	5.6	8.6	3.3	-	-	10.0	10.0	47.2 ABCD
(6 + 0.5 lb/gal)	8	0.0	0.3	5.0	2.6	9.0	4.6	10.0	10.0	-	-	10.0	10.0	41.8 ABCD
EPTC	4	0.0	0.6	3.6	1.3	8.6	1.0	9.6	6.6	-	-	10.0	10.0	31.1 BCD
EPTAM 10G	6	2.0	1.3	7.0	4.6	9.0	5.3	10.0	10.0	-	-	10.0	10.0	41.7 ABCD
	8	2.0	1.0	7.0	3.3	9.3	5.6	8.6	6.3	-	-	10.0	10.0	46.6 ABCD
EPTC + R-25788	4	0.0	0.3	3.6	2.3	8.3	0.0	7.6	2.3	-	-	0.0	0.0	30.9 BCD
ERADICANE 10G	6	0.0	0.0	7.0	3.3	8.0	5.0	9.6	8.3	-	-	10.0	10.0	35.1 ABCD
	8	0.3	0.0	7.6	2.6	9.0	4.0	10.0	10.0	-	-	10.0	10.0	51.6 AB
check - Cult.		0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	-	-	0.0	0.0	62.8 A
check - not cult.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	0.0	0.0	22.4 CD
vernolate	3	0.3	0.3	3.0	2.7	5.3	2.7	9.0	6.7	6.3	4.7	8.7	7.0	43.6 23
VERNAM 6E	4	0.0	0.0	2.3	3.0	9.3	4.0	7.7	4.0	8.3	3.7	8.7	5.3	46.0 23
	6	0.0	0.3	5.7	4.7	5.7	8.7	7.3	5.7	8.3	4.3	8.3	5.0	58.6 12
	8	1.0	0.7	7.0	5.3	10.0	10.0	8.3	7.7	9.0	8.7	8.7	5.7	49.5 23
vernolate +	4	1.0	2.0	4.7	4.3	9.7	9.0	8.3	5.3	7.3	5.3	8.7	5.0	53.6 12
R-25788, 6E	6	0.0	1.0	6.7	5.7	9.0	5.7	7.3	5.0	8.7	7.0	8.3	4.3	50.2 23
(6 + 0.5 lb/gal)	8	0.0	0.7	8.3	5.3	10.0	10.0	8.7	5.7	8.3	6.7	9.0	7.0	59.8 12
vernolate	4	0.0	0.0	5.3	3.0	7.7	5.3	8.3	4.3	6.0	4.3	8.3	4.7	43.1 23
VERNAM 10G	8	0.3	1.3	8.7	6.0	9.7	8.0	9.3	7.3	10.0	10.0	9.3	8.0	52.7 12
vernolate +	4	0.3	1.0	6.7	3.3	9.0	6.0	10.0	10.0	8.0	6.3	8.3	4.7	41.5 23
R-25788 10G	8	0.7	1.3	5.3	3.0	6.7	6.7	6.0	4.0	6.3	5.0	6.0	5.7	46.9 23
(10 + 0.83 G)														
atrazine	2	0.0	1.0	9.7	8.0	10.0	10.0	10.0	10.0	9.7	8.0	1.0	3.7	63.8 12
AATREX 80W														
vernolate +	6 + 2	0.0	0.3	10.0	10.0	10.0	10.0	7.0	9.3	8.7	7.0	8.3	6.3	76.6 1
R-25788, 6E +	8 + 2	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	8.7	6.7	66.9 12
Atrazine														
check - cultivated		0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	66.6 12
check - uncultivated		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.3 3

Appendix

Material & Formulation	Chemical Name	Manufacturer
atrazine	2-chloro-4-ethylamino-6-isopropylamino-s-triazine	CIBA-GEIGY
butylate (6E & 10G)	s-ethyl diisobutylthiocarbamate	Stauffer
EPTC (6E & 10G)	ethyl-N, N-dipropylthiocarbamate	Stauffer
vernolate (6E & 10G)	s-propyl dipropylthiocarbamate	Stauffer
R-25788	N, N-dially-2, 2-dichloroacetamide	Stauffer

FOXTAIL AND FALL PANICUM CONTROL IN NO-TILLAGE CORN [1/]

J. V. Parochetti [2/]

ABSTRACT

Kill of the rye (Secale cereale L.) cover crop and control of annual weeds was studied in no-tillage corn (Zea mays L.) for 3 years. Of the two non-residual herbicides studied, glyphosate (N-(phosphonomethyl)glycine)) resulted in slower rye kill than paraquat (1,1'-dimethyl-4,4'-bipyridium, chloride); after one month, the rye was completely dead. Of the residual herbicides and combinations, simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) resulted in 90% or better control of giant green foxtail (Setaria viridis var. major (Gaud.) Posp.) and fall panicum (Panicum dichotomiflorum Michx.) in 2 out of the 3 years. All residual herbicides affected excellent control of redroot pigweed (Amaranthus retroflexus L.).

INTRODUCTION

Herbicides that are effective in conventional tillage corn do not necessarily affect the same degree of weed control when applied in no-tillage conditions. Specifically, many researchers have reported excellent fall panicum control with alachlor(2-chloro2',6'-diethyl-N-(methoxymethyl)acetanilide) and combinations with other herbicides such as cyanazine (2-((4-chloro-6-(ethylamino)-s-triazin-2-yl)amino)-2-methylpropiontrile) and atrazine(2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) in conventional corn; however, Parochetti (2) and Shear and Moschler (5) reported that alachlor does not affect satisfactory fall panicum control in no-tillage corn planted in a rye cover crop.

Glyphosate has been used to kill the existing vegetative cover crop for no-tillage production (3,4,6,7). The purpose of this research was to evaluate glyphosate and paraquat for the kill of a rye cover crop and to determine the effect of glyphosate or paraquat in combination with various residual herbicides.

MATERIAL AND METHODS

Three similar experiments were conducted in 1971, 1972 and 1973, at the Plant Research Farm, Fairland, Maryland. No-tillage seeding was planted in a cover crop of rye. All experiments were randomized complete block designs with four replications. Treatments are listed on Tables 2, 3, and 4. Herbicides were applied at 30 gpa. Plot size was 10 by 30 ft with 30 inch row spacing.

The percentage rye kill was visually rated on a scale of 0 to 100% . Weed control was rated visually using the a scale of 1 to 9 (1); an approximate percentage weed control are present in Tables 2, 3, and 4. A Bayes lsd at the 5% level of probability was calculated when there was a significant F test.

1/ Scientific Article No. A1952 , and Contribution No. 4882 of the Maryland Agricultural Experiment Station, Department of Agronomy, College Park.

2/ Associate Professor, Department of Agronomy, University of Maryland, College

Corn '3369A [3/] was planted May 4, 1971, May 8, 1972 and May 4, 1973. Herbicides were applied on May 5, 1971, May 8, 1972 and May 4, 1973. The soil was Chillum silt loam.

Rain fall and the maximum and the minimum air temperatures within two weeks following preemergence treatments are present in Table 1.

Table 1. Maximum and minimum air temperature and rainfall 2 weeks after application of the residual herbicides.

	1971			1972			1973		
May	Max. (F)	Min. (F)	Rain (Inches)	Max. (F)	Min. (F)	Rain (Inches)	Max. (F)	Min. (F)	Rain (Inches)
4	64	40	0.04				64	48	0.28
5	76	37					--	--	
6	75	53					--	--	
7	71	53					70	35	
8	61	51	0.49	83	42	0.65	72	51	
9	69	42		74	53	0.20	75	54	0.37
10	73	42		71	41		77	51	
11	79	52		--	--		81	55	
12	78	45	0.01	--	--		--	--	
13	70	40		--	--		--	--	
15	73	51		80	40	0.35	69	52	0.10
16	62	54	1.31	77	48	0.78	64	38	
17	76	52		76	50		67	39	
18	83	51		77	51		69	35	0.10
19				76	46	1.00			
20				--	--				
21				78	55				
22				78	52				

RESULTS AND DISCUSSION

Rye Cover Crop Kill. Glyphosate affected a slower kill of the rye cover crop than paraquat (Table 4). When observed three days after treatment, all glyphosate treatments affected low rye kill (57.5% or less) as compared to 90% or greater rye kill from paraquat treatments (Table 4). When observed 14 days after treatment in 1972, rye kill resulting from glyphosate combinations with residual herbicides was 60 to 95% compared to 75 to 100% from paraquat plus residual herbicides (Table 3). Rye was completely dead one month after either paraquat or glyphosate treatments.

Fall Panicum and Giant Green Foxtail Control. When evaluated at the end of the season in 1971, best control of fall panicum occurred with paraquat plus simazine alone or in combination with atrazine (Table 2). Combinations of paraquat in 1971 and 1973 or glyphosate in 1973 with simazine alone or in combination

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3/ This cultivar obtained from Pioneer Seed Co., Des Moines, Ia.

with other residual herbicides resulted in greater than 90% control of giant green foxtail and fall panicum (Tables 2 and 4). In 1972, control of fall panicum resulting from most treatments when observed in October, was lower than similar treatments in 1971 (Tables 2 and 3). The lower control cannot be attributed to the lack of rainfall (Table 1), but probably because the experiment was treated prior to planting; subsequent planting moved the treated soil out of the row allowing weeds to germinate and gradually encroach in the plots.

The experimental herbicides, NIA 23486 (6-tert-butyl-3-isopropylisoxazolo (3,4-d)pyrimidin-4(5H)-one) plus NIA 21844 (6-tert-butyl-3-isopylisoxazolo(5,4-d) pyrimidin-4(5H)-one) each when in combination exceeding 1.25 lb/A with paraquat resulted in excellent (95.5% or greater) control of giant green foxtail when observed at the end of the season (Table 4).

Redroot Pigweed Control. All herbicides, except glyphosate and paraquat applied alone resulted in excellent control of redroot pigweed (Table 3).

Corn Yields. Highest corn yields occurred in 1973 (Table 4) and lowest yields in 1971 (Table 2). Variability in yields for each year is difficult to attribute to lack of or degree of weed control.

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Table 2. The effect of paraquat and several residual herbicides on weed control and corn yields planted under no-tillage production in a rye cover crop, 1971.

Treatment[a]	Rate (lb/A)	July 29 Giant Green Foxtail (Rating)	July 29 Giant Green Foxtail (%)[b]	July 29 Fall Panicum (Rating)	July 29 Fall Panicum (%)[b]	October 12 Giant Green Foxtail (Rating)	October 12 Giant Green Foxtail (%)[b]	October 12 Fall Panicum (Rating)	October 12 Fall Panicum (%)[b]	Corn Yield (Bu/A)
1. Plow and disk -		9.0	(0)	9.0	(0)	9.0	(0)	8.8	(8)	4
2. Plow and disk -										
+ Atrazine	2.0	1.3	(99)	6.8	(66)	1.0	(100)	7.3	(56)	67
3. Cover removed		1.0	(100)	6.8	(67)	1.0	(100)	6.5	(70)	28
+ Paraquat	0.25									
+ Atrazine	2.0									
4. Paraquat	0.25	1.0	(100)	7.3	(56)	1.0	(100)	8.3	(24)	9
5. Paraquat	0.25	1.0	(100)	7.3	(56)	1.5	(98)	8.0	(32)	12
6. Atrazine	2.0	1.0	(100)	2.1	(97)	1.0	(100)	2.5	(96)	67
+ Simazine	2.0									
7. Paraquat	0.25	1.0	(100)	5.8	(77)	1.0	(100)	7.3	(56)	39
+ Atrazine	2.0									
8. Paraquat	0.25	1.0	(100)	6.0	(75)	1.0	(100)	6.3	(72)	50
+ Alachlor	1.5									
+ Atrazine	1.5									
9. Paraquat	0.25	1.0	(100)	1.3	(99)	1.0	(100)	1.3	(99)	65
+ Simazine	2.0									
10. Paraquat	0.25	1.0	(100)	2.5	(96)	1.0	(100)	1.3	(99)	71
+ Atrazine	1.0									
+ Simazine	1.0									
11. Paraquat	0.5	1.0	(100)	1.3	(99)	1.0	(100)	1.3	(99)	75
+ Atrazine	2.0									
+ Simazine	2.0									
12. Paraquat	0.25	1.0	(100)	4.3	(88)	1.0	(100)	3.8	(91)	45
+ Cyanazine	2.0									
13. Paraquat	0.25	1.0	(100)	4.5	(87)	1.0	(100)	5.3	(82)	50
+ Alachlor	2.25									
+ Atrazine	1.5									
Bayes lsd 0.05 =		0.2		1.3		0.4		1.4		19

[a]Treatments 3 through 13 were not plowed. All paraquat treatments included 1 pint of Ortho X-77/ 100 gal water.

[b]The % is an approximation.

Table 3. The effect of paraquat or glyphosate alone or in combination with several residual herbicides on weed control and corn yields under no-tillage production in a rye cover crop, 1972.

Treatment[a]	Rate (lb/A)	May 19 Rye Kill (%)	June 24 Fall Panicum (Rating)	June 24 Fall Panicum (%)[b]	June 24 Redroot Pigweed (Rating)	June 24 Redroot Pigweed (%)	July 13 Fall Panicum (Rating)	July 13 Fall Panicum (%)[b]	July 13 Fall Panicum (Rating)	July 13 Fall Panicum (%)[b]	Corn Yield (Bu/A)
1. Paraquat	0.25	97	8.8	(7)	7.5	(49)	9.0	(0)	6.8	(65)	43
2. Paraquat	0.25	75	3.3	(93)	1.0	(100)	5.5	(80)	6.5	((70)	82
+ Simazine	1.25										
+ Alachlor	2.0										
3. Paraquat	0.25	97	3.5	(92)	1.8	(90)	4.3	(88)	5.8	(77)	98
+ Simazine	1.25										
+ Atrazine	;.25										
4. Paraquat	0.25	97	3.0	(95)	1.0	(100)	3.8	(91)	6.5	(70)	94
+ Alachlor	2.0										
+ Atrazine	1.25										
5. paraquat	0.25	100	5.8	(77)	2.3	(97)	7.3	(56)	7.3	(56)	55
+Cyanazine	1.25										
+ Simazine	1.25										
6. Glyphosate	1.0	97	7.8	(41)	4.0	(90)	7.8	(41)	7.5	(49)	35
7. Glyphosate	2.0	87	7.5	(49)	7.3	(56)	8.3	(24)	7.3	(56)	60
8. Glyphosate	3.0	95	7.5	(49)	4.5	(87)	7.8	(41)	7.5	(50)	71
9. Glyphosate	1.0	85	2.0	(97)	1.0	(100)	2.8	(95)	5.0	(85)	127
+ Alachlor	2.0										
+ Simazine	1.5										
10. Glyphosate	1.0	95	2.3	(97)	1.0	(100)	3.3	(93)	4.3	(88)	125
+ Alachlor	2.0										
+ Atrazine	1.5										
11. Glyphosate	2.0	82	3.8	(91)	1.0	(100)	4.8	(88)	6.8	(67)	100
+Alachlor	2.0										
+Atrazine	1.5										
12. Glyphosate	3.0	85	4.0	(90)	1.0	(100)	6.0	(75)	4.5	(87)	94
+ Alachlor	2.0										
+ Atrazine	1.5										
13. Glyphosate	1.0	77	2.0	(97)	1.0	(100)	2.8	(95)	3.8	(91)	122
+ Simazine	2.5										
14. Glyphosate	1.0	62	7.0	(65)	1.0	(100)	7.8	(41)	7.8	(49)	60
+Atrazine	2.5										
15. Glyphosate	1.0	60	2.8	(95)	1.0	(100)	4.0	(90)	5.3	(82)	91
+ Atrazine	1.25										
+ Simazine	1.25										
Bayes lsd 0.05 = 9			1.9		2.3		1.9		6.0		n.s.

[a]The surfactant Ortho X-77 at 1 pint/100 gal water was used with all paraquat treatments.

[b]The % is an approximation.

Table 4. Giant green foxtail control and corn yields under no-tillage production planted in a rye cover crop using paraquat or glyphosate alone or in combination with several residual herbicides, 1973.

Treatment[a]	Rate (lb/A)	May 7 Rye Kill (%)	June 4 Giant Green Foxtail Control (Rating)	(%)[b]	August 14 Giant Green Foxtail Control (Rating)	(%)[b]	Corn Yields (Bu/A)
1. Control	-	18	5.3	(82)	8.8	(8)	59
2. Atrazine	2.5	25	2.8	(95)	4.3	(89)	128
3. Paraquat	0.25	94	3.0	(95)	4.3	(89)	106
+ Atrazine	2.5						
4. Paraquat	0.25	90	1.8	(98)	2.0	(98)	103
+ Atrazine	1.25						
+ Simazine	1.25						
5. Paraquat	0.25	94	1.0	(100)	3.0	(95)	113
+ Atrazine	0.85						
+ Simazine	1.65						
6. Paraquat	0.25	96	1.0	(100)	1.3	(99)	121
+ Simazine	2.5						
7. Paraquat	0.25	96	3.0	(95)	4.3	(88)	82
+ Cyanazine	2.5						
8. Paraquat	0.25	96	1.8	(98)	4.0	(90)	116
+Cyanazine	1.25						
+Simazine	1.25						
9. Paraquat	97	97	3.8	(91)	5.0	(85)	108
+ NIA 23486	0.33						
+ NIA 21844	0.67						
10. Paraquat	0.25	97	1.0	(100)	2.0	(97)	105
+ NIA 23486	0.67						
+ NIA 21844	1.33						
11. Paraquat	0.25	97	1.5	(98)	2.8	(95)	96
+ NIA23486	0.31						
+ NIA21844	0.94						
12. Paraquat	0.25	93	1.5	(98)	2.8	(95)	102
+ NIA 23486	0.62						
+ NIA 21844	1.88						
13. Paraquat	0.25	91	4.3	(88)	8.0	(32)	73
+ Alachlor	2.0						
+ Atrazine	1.5						
14. Glyphosate	0.5	50	4.0	(90)	4.8	(85)	84
+ Alachlor	2.0						
+ Atrazine	1.5						
15. Glyphosate	1.0	52	3.8	(91)	6.8	(66)	104
+ Alachlor	2.0						
+ Atrazine	1.5						
16. Glyphosate	1.5	55	4.5	(87)	6.3	(72)	105
+ Alachlor	2.0						
+ Atrazine	1.5						
17. Glyphosate	0.5	40	1.0	(100)	1.0	(100)	90
+ Atrazine	1.25						
+ Simazine	1.25						
18. Glyphosate	1.0	42	1.3	(99)	1.8	(98)	113
+ Atrazine	1.25						
+ Simazine	1.25						
19. Glyphosate	1.5	48	1.3	(99)	2.8	(95)	97
+ Atrazine	1.25						
+ Simazine	1.25						
20. Glyphosate	0.5	35	8.3	(24)	8.8	(7)	42
21. Glyphosate	1.0	43	7.8	(41)	8.8	(7)	87
22. Glyphosate	1.5	57	8.3	(24)	9.0	(0)	94
23. Paraquat	0.25	93	9.0	(0)	8.8	(7)	70
Bayes lsd 0.05 =		6	1.5		2.0		36

[a]The surfactant Ortho X-77 at 1 pint/100 gal water was used with all paraquat treatments.

[b]The % is an approximation.

PRELIMINARY REPORT ON THE EFFECT OF MIXING LIQUID FERTILIZERS AND RESIDUAL HERBICIDES WITH PARAQUAT AND GLYPHOSATE

R. A. Peters, W. M. Dest and A. C. Triolo[1/]

Abstract

Liquid N as a carrier for paraquat (1,1-dimethyl-4,4'-bipyridinium ion, dichloride salt) at a rate of 260 lb of N/A in 80 gal of solution, or glyphosate (N-phosonomethyl glycine, isopropylamine salt) gave enhanced kill of winter rye (Secale cereale var. Balboa). On perennial sod species, however, only the initial injury was enhanced with complete recovery occurring within six weeks. If complete fertilizer solutions were used as a carrier there was a reduction in activity of glyphosate on both rye and perennial sods as compared to an application in a water carrier except with 1.5 lb ai/A of glyphosate in a Poly P based carrier. Paraquat activity on rye was significantly decreased when applied in the phosphorus based complete fertilizer solutions.

As rated six weeks after treatment, addition of a triazine to paraquat in a water carrier resulted in good control of the perennial sod species. Good control was obtained from glyphosate in water with or without the addition of a triazine.

Introduction

The use of a liquid fertilizer as a carrier for herbicides required in no-tillage crop production could further decrease the labor input of the no-tillage method.

Previous work has indicated that liquid nitrogen and complete liquid fertilizer carriers may decrease the activity of paraquat on orchardgrass (1). Other work indicates that liquid nitrogen cannot be used to replace a surfactant in paraquat applications applied on rye (2). Glyphosate has proven to be very toxic on perennial sod species (3) but little information is available on the effect of applying it in fertilizer carriers.

Materials and Methods

Experiment 1 - Rye Cover Crop

The experimental area was located at the Agronomy Research Farm, University of Connecticut, Storrs on a Paxton fine sandy loam soil. A cover crop of rye had been seeded on the area the previous fall.

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

The experimental design was a randomized block design with plots 12 by 16 feet replicated three times. At the time of treatment on June 2, 1973 the rye was fully headed averaging 3 1/2 feet in height. Corn (Zea mays L. var. Penna 604) was planted with a Bridger No-Tillage planter on June 4, 1973.

Paraquat at 1/2 lb ai/A and glyphosate at 3/4 and 1 1/2 lb ai/A were applied in water and three liquid fertilizer carriers. A surfactant was included with all paraquat applications. The liquid fertilizers used for carriers were 1) liquid nitrogen from a mixture of urea and NH_4NO_3 supplying 3.25 lb actual N per gallon 2) a complete liquid fertilizer, 12-7-10, with a polyphosphoric acid base and 3) a complete liquid fertilizer, 12-7-10, with an orthophosphoric acid base. The polyphosphoric acid based formulation was a cold process mixture containing 2% attaclay to keep the potassium in suspension. The carrier rate was 80 gal/A which gave a rate of 260 lb N/A from the liquid nitrogen and 100 lb, 58 lb and 80 lb/A of N, P_2O_5 and K_2O equivalent, respectively, from both the polyphosphoric acid and orthophosphoric acid based fertilizers.

Results and Discussion

The rye injury ratings are given in Table 1.

Initial injury was greatest when liquid N was used as a carrier with all herbicides. At the final rating the nitrogen carrier gave significantly greater kill than any other carrier when using either paraquat or the lower rate of glyphosate.

The initial kill from paraquat was greater than from the lower rate of glyphosate in all carriers and from the higher rate of glyphosate in the water and liquid N carriers. Within 2 weeks, however, injury from glyphosate was as great or greater.

There was little difference in rye kill with paraquat in comparing water and the orthophosphate based carrier. When the polyphosphate based carrier was used with paraquat, however, there was a pronounced reduction in activity. This can probably be related to the attaclay in the Poly P carrier which adsorbed some of the paraquat.

With glyphosate at the 3/4 lb/A rate there was some early enhancement of kill with either complete fertilizer but by July 7 kill was significantly less than with the water carrier.

At the greater glyphosate rate (1 1/2 lb) there was initially little difference between the water carrier and the complete fertilizer carriers. As rated a month later there was no significant difference between the Poly P based carrier and water but a distinct reduction in activity from the Ortho P based material. This reaction was the reverse of the response obtained with paraquat and the lower rate of glyphosate.

Experiment 2 - Established Sod
Materials and Methods

The experimental area was located on a Woodbridge fine sandy loam. The area had been seeded to alfalfa in 1965 but had not been disturbed since. The sod grasses included quackgrass (Agropyron repens (L.) Beauv.), orchardgrass (Dactylis glomerata L.), Kentucky bluegrass (Poa pratensis L.), Colonial Bent (Agrostis tenuis), and meadow fescue (Festuca elaitor L.). The principal broadleaf species were dandelion (Taraxacum officinale Weber) and common white clover (Trifolium repens L.). The area had been mowed over once in early summer and had regrown to an average of 12 inches when the treatments were applied on August 8, 1973.

The experimental design was a randomized block design with plots 10 by 20 feet replicated four times. The liquid fertilizer carriers were liquid nitrogen, an orthophosphoric acid based complete fertilizer and a polyphosphoric acid based solution (Poly N) containing only N and P. The application rate was 260 N/A from the liquid nitrogen, 88 lb N and 320 lb P_2O_5/A equivalent, respectively from the Poly N (10-34-0) carrier and 100 lb, 58 lb and 80 lb/A of N, P_2O_5 and K_2O equivalent, respectively from the orthophosphoric acid based carrier. All carriers were applied at 80 gal/A except for water which was applied at the rate of 40 gal/A. Treatments were applied on August 8, 1973 using a self-propelled small plot sprayer. The chemical identity of the residual herbicides used are given in the Appendix.

Results and Discussion

As rated one week after treatment (Table 2) toxicity of paraquat was much greater than from glyphosate. By the second week, however, there was relatively little difference in foliage injury.

The initial activity was maximized with paraquat when using liquid nitrogen as a carrier or any of the three liquid fertilizer carriers with glyphosate. By the second week, however, there was a reversal since the two complete fertilizer carriers with paraquat or with the Poly N with glyphosate resulted in the least injury of any of the mixtures.

By the sixth week (September 21) after treatment there was essentially complete recovery of a l the grass species in the sod from all treatments involving liquid fertilizer carriers with either herbicide.

Both paraquat and glyphosate in water combined with atrazine, simazine or cyanazine gave good (over 70%) control of the perennial grasses as rated on the sixth week (September 21). Poor control, however, was noted from paraquat with alachlor. When applied alone in water good control was obtained with glyphosate but the sod had recovered when treated with paraquat.

Dandelion and white clover were similar in response. As rated September 21 there was very little injury from either chemical applied in any of the fertilizer solutions. When applied in water, glyphosate gave good control

Table 1. Liquid Fertilizers as Carriers for Paraquat and Glyphosate for Killing Rye Cover for No-Tillage Corn.

Herbicide	Rate lb ai/A	Carrier[1/]	Rye Injury Ratings (0 - no kill); (10 - complete kill)		
			June 7	June 15	July 7
Paraquat	0.50	Water	6.3	7.0	8.0bc[3/]
		12-7-10 (Ortho P base)	6.0	6.0	7.0c
		12-7-10 (Poly P base)[2]	3.0	5.0	5.3d
		Liquid nitrogen	8.7	9.7	10.0a
Glyphosate	0.75	Water	1.7	6.0	7.7bc
		12-7-10 (Ortho P base)	4.0	5.0	5.3d
		12-7-10 (Poly P base)[2]	2.3	4.0	4.0d
		Liquid nitrogen	7.7	9.7	10.0a
Glyphosate	1.50	Water	4.3	8.0	10.0a
		12-7-10 (Ortho P base)	4.7	5.0	5.3d
		12-7-10 (Poly P base)[2]	5.7	8.3	9.7ab
		Liquid nitrogen	7.3	10.0	10.0a

1/ All carriers applied at rate of 80 G/A

2/ Contained 2% attaclay in suspension

3/ Ratings followed by the same letter are not significantly different at the 5% level as determined by the Duncan's Multiple Range Test.

Table 2. Influence of Carriers and Residual Herbicides on the Toxicity of Paraquat and Glyphosate on Established Sod.

Herbicide	Rate lb ai/A	Carrier	Injury Ratings - (0 - no kill; 10 - complete kill) Perennial grasses			Dandelion	Ladino clover
			Aug 16	Aug 27	Sept 21	Sept 21	Sept 21
Paraquat[1]	0.5	Liquid N	5.8	6.7	0.8	0.0	0.0
Paraquat	0.5	Poly N (10-34-0)	2.9	4.0	0.3	0.0	0.9
Paraquat	0.5	Ortho P (12-7-10)	3.5	4.4	2.2	0.8	1.0
Paraquat	0.5	Water	-	-	0.0	0.0	0.0
Paraquat + atrazine	0.5, 2	Water	3.4	7.6	7.7	4.8	-
Paraquat + simazine	0.5, 2	Water	3.0	7.6	7.2	4.5	7.0
Paraquat + cyanazine	0.5, 2	Water	3.5	7.3	7.5	6.0	6.0
Paraquat + alachlor	0.5, 2	Water	3.4	7.2	4.8	1.8	2.6
Glyphosate	1.5	Liquid N	4.0	7.0	1.8	0.5	2.0
Glyphosate	1.5	Poly N (10-34-0)	1.2	2.9	1.3	1.5	0.0
Glyphosate	1.5	Ortho P (12-7-10)	2.8	6.3	2.0	1.3	2.1
Glyphosate	1.5	Water	-	-	8.0	8.0	8.0
Glyphosate + atrazine	1.5, 2	Water	0.0	6.9	8.2	8.8	8.1
Glyphosate + simazine	1.5, 2	Water	0.3	5.4	8.5	8.3	7.8
Glyphosate + cyanazine	1.5, 2	Water	0.9	7.3	7.5	7.0	-
Glyphosate + alachlor	1.5, 2	Water	1.4	6.5	8.3	7.5	5.6

[1] All paraquat treatments included X-77 surfactant at a rate of 8 oz/100 gal of carrier.

(over 70%) alone or if combined with a residual herbicide. Fair control (50%) was obtained from paraquat if combined in water with a triazine. Control was poor if applied alone or with alachlor.

Literature Cited

1. Parochetti, J. V. (Abs.) 1973. Orchardgrass kill with paraquat as influenced by surfactant, liquid carriers, and residual herbicides. Proceed. NEWSS 27:7.

2. Peters, R. A. 1972. Herbicide combinations and adjuvants for rye kill in no-tillage corn. Proceed. NEWSS 26:111-114.

3. Peters, R. A. and W. M. Dest. 1973. Glyphosate for perennial sod kill in no-tillage corn. Proceed. NEWSS 27:1-6.

Appendix

Common Name	Formulation	Chemical Name
Alachlor	E.C.	2-chloro-2',6'-diethyl-*N*-(methoxymethyl acetanilide
Atrazine	W.P.	2-chloro-4-(ethylamino)-6-(isopropylami *s*-triazine
Simazine	W.P.	2-chloro-4,6-bis(ethylamino)-*s*-triazine
Cyanazine	W.P.	2-[[4-chloro-6-(ethylamino)-*s*-triazin-2-yl]amino]-2-methylpropionitrile

NUTSEDGE CONTROL IN NO-TILL CORN

Larry R. Hawf[1/]

Abstract

Several herbicide treatments were applied to corn planted in corn stalks, rye cover or conventionally prepared land. Nutsedge (Cyperus esculentus L.) heavily infested the test area. Granular butylate with a light discing gave satisfactory control of nutsedge but was weak on broadleaf weed control. Preplant incorporated application of granular butylate-atrazine increased broadleaf weed control over butylate alone. However, in rye cover and corn stalk land less effective nutsedge control was obtained with the combination than with butylate alone. A preemergence application of atrazine + simazine, 1.1 + 1.1 kg/ha effectively controlled grass and broadleaf weeds but gave little control of nutsedge. Applying directed postemergence treatments of atrazine, ametryne, cyanizine, cyprazine or MBR 8251 with crop oil, in addition to preemergence atrazine-simazine, increased nutsedge control but to a level which was still unsatisfactory. S-21634 applied directed postemergence gave excellent nutsedge control with only slight injury to corn.

Introduction

Nutsedge control has proved to be a problem in no-till corn. In conventionally cultivated fields butylate has been used effectively for control of nutsedge, however, butylate must be incorporated for consistent control. This study has been conducted to evaluate the comparative performance of butylate applied preplant incorporated to corn planted in rye cover, corn stalks and conventionally cultivated soil. Several other compounds were evaluated as directed postemergence sprays for control of nutsedge in corn.

Materials and Methods

The study was conducted at the University of Delaware substation located near Georgetown, Delaware. The soil was an Evesboro loamy sand which had been fertilized with 336 kg/ha of 0-15-30 and 420 kg/ha of ammonium nitrate. Clark 777 corn was planted on April 16 in plots three rows 76.2 cm apart and 9.9 m long. Preplant incorporated treatments of granular butylate and granular butylate-atrazine were made on April 12 in undisturbed corn stalks, rye cover, and conventionally plowed land. The preplant materials were lightly incorporated with a tandem disc once over the plot. One-half of the remaining plots were treated with a preemergence application of atrazine + simazine (1.1 + 1.1 kg/ha). The other plots received no preemergence treatment. Vegetation in the rye cover plots was killed on April 20 with an application of paraquat at 1.1 kg/ha. Directed postemergence treatments were applied on June 4 to all plots except checks or those treated with butylate. The directed postemergence treatments were applied when nutsedge was in the 7 to 9 leaf stage (20 to 25 cm tall) and corn was 30 to 33 cm tall. Spray applications were made with a hand sprayer using CO_2 as a

1/ Asst. Professor, Plant Science Department, College of Agricultural Sciences, University of Delaware, Newark, Delaware, 19711.

propellant and delivering 379 l/ha. Each treatment was replicated 4 times. Rainfall one week after preplant and preemergence applications totaled 0.05 and 2.5 cm, respectively. The field contained a heavy infestation of nutsedge. Nutsedge populations in the atrazine + simazine treated plots ranged from 226 to 1359 plants per sq. m. More nutsedge plants were present in the conventionally tilled plots than those of rye cover or corn stalks. Other weeds common to the plots were: redroot pigweed (Amaranthus retroflexus L.), lambsquarter (Chenopodium album L.), common ragweed (Ambrosia artemisiifolia L.) and crabgrass (Digitaria sanguinalis (L.) Scop.). Those plots planted in corn stalks contained several weeds in addition to those listed above: marestail (Erigeron canadensis L.), chickweed (Stellaria media (L.) cyrillo), and storksbill (Erodium cicutarium (L.) L'her.

Crop tolerance and weed control ratings were made on a 0 to 10 scale where 0 represented no plant injury and 10 represented complete kill.

Results and Discussion

Tables 1, 2, and 3 depict results of rating data obtained on June 29, 1973. The granular application of butylate generally gave satisfactory control of nutsedge. However, the weakest control was found in the rye cover plots. Butylate was applied to rye shortly after a light precipitation. Perhaps some of the granules adhered to the wet foliage and were not incorporated well by the light discing. Butylate gave satisfactory grass control but was expectedly weak on broadleaf weed control. The butylate and atrazine granular combination increased the extent of broadleaf weed control over butylate alone. Nutsedge control in corn stalks and rye cover was not as effective with the combination as it was with butylate alone. Perhaps this is due to a formulation difference.

The triazine herbicides (atrazine, ametryne, cyanizine, and cyprazine) and MBR 8251 generally gave only 45 to 70% control of nutsedge. The least control of nutsedge was found on the conventionally tilled soils where higher populations were present. With the triazines and with MBR 8251 only slight differences were found in weed control among the systems of land preparation. The greatest difference in weed control was found between the inclusion of a preemergence combination application of atrazine and simazine versus no preemergence treatment. Overall weed control was much poorer where only a directed postemergence application was made. Weed control with directed postemergence applications were particularly difficult in corn planted directly in corn stalks with no preemergence treatment. With no preemergence treatment, marestail, chickweed and storksbill severely competed with corn. This competition also caused more herbicide spray to contact the corn, resulting in injury.

S-21634 proved to be a very effective material for postemergence control of nutsedge. In combination with the preemergence application of atrazine + simazine excellent broad spectrum weed control was obtained. S-21634 was quite specific for nutsedge but did not control other weed species. Some slight foliar chlorosis was obtained where S-21634 contacted corn foliage.

Table 1. Crop tolerance and weed control ratings taken from corn planted on conventionally tilled soil.[1/]

Treatment	Rate (kg ai/ha)	Crop Tolerance: Stand	Crop Tolerance: Vigor	Weed Control: Nutsedge	Weed Control: Grass	Weed Control: Broadleaf
Preplant incorporated:						
butylate	3.4	0.0	0.0	9.3	9.5	5.8
butylate + atrazine	4.5	0.0	0.0	9.0	9.5	7.8
A preemergence treatment[2/] + directed postemergence treatments of:						
atrazine + crop oil[3/]	2.2	0.0	0.0	5.8	10.0	10.0
ametryne + crop oil	2.2	0.0	2.5	4.5	10.0	10.0
cyanizine + crop oil	2.2	0.0	0.0	6.3	9.5	10.0
cyprazine + crop oil	1.1	0.0	0.5	4.3	10.0	10.0
MBR 8251 + crop oil	3.4	0.0	0.0	6.5	10.0	10.0
S-21634	4.5	0.0	0.3	10.0	9.3	9.3
Check	-	0.0	1.5	0.0	10.0	10.0
hoed check	-	0.0	0.0	9.0	9.8	9.8
Directed postemergence treatments only:						
atrazine + crop oil	2.2	0.0	1.3	3.5	5.8	10.0
ametryne + crop oil	2.2	0.0	2.5	6.0	10.0	10.0
cyanizine + crop oil	2.2	0.0	2.0	5.0	7.5	8.5
cyprazine + crop oil	1.1	0.0	0.5	3.3	8.8	9.5
MBR 8251 + crop oil	3.4	0.0	2.5	4.5	2.3	3.3
S-21634	4.5	0.0	1.3	9.3	0.0	0.8
Weedy Check	-					
Hoed Check	-					

1/ Ratings made on June 29, 1973. 0 = no injury, 10 = complete kill
2/ Atrazine + simazine, 1.1 + 1.1 kg ai/ha
3/ 10% Sun Oil 11E.

Table 2: Crop tolerance and weed control ratings taken from corn planted in a rye cover crop[1/]

Treatment	Rate (kg ai/ha)	Crop Tolerance Stand	Crop Tolerance Vigor	Weed Control Nutsedge	Weed Control Grass	Weed Control Broadleaf
Preplant incorporated:						
butylate	3.4	0.0	0.0	7.5	9.5	8.0
butylate + atrazine	4.5	0.0	0.0	6.3	9.3	8.8
A preemergence treatment[2/] + directed postemergence treatments of:						
atrazine + crop oil[3/]	2.2	0.0	0.0	6.5	10.0	10.0
ametryne + crop oil	2.2	0.0	0.3	7.8	10.0	9.5
cyanizine + crop oil	2.2	0.0	0.0	7.3	10.0	10.0
cyprazine + crop oil	1.1	0.0	0.0	6.3	10.0	10.0
MBR 8251 + crop oil	3.4	0.0	0.8	6.8	10.0	10.0
S-21634	4.5	0.0	0.0	9.8	9.3	10.0
Check	-	0.0	0.0	0.5	9.5	10.0
Hoed check	-	0.0	0.0	9.0	9.3	9.8
Directed postemergence treatments only:						
atrazine + crop oil	2.2	0.0	0.3	3.5	5.5	10.0
ametryne + crop oil	2.2	0.0	3.3	3.0	9.5	9.5
cyanizine + crop oil	2.2	0.0	2.0	6.3	5.0	10.0
cyprazine + crop oil	1.1	0.0	0.0	3.5	4.5	10.0
MBR 8251 + crop oil	3.4	0.0	2.3	4.8	5.0	6.3
S-21634	4.5	0.0	3.0	9.8	2.8	2.8
Weedy Check	-	0.0	2.0	0.0	0.0	0.0
Hoed Check	-	0.0	0.0	9.0	9.0	9.0

1/ Ratings made on June 29, 1973. 0 = no injury, 10 = complete kill.
2/ atrazine + simazine, 1.1 + 1.1 kg ai/ha
3/ 10% Sun Oil 11E

Table 3: Crop tolerance and weed control ratings taken from corn planted in corn stalk land.[1/]

Treatment	Rate (kg ai/ha)	Crop Tolerance Stand	Crop Tolerance Vigor	Weed Control Nutsedge	Weed Control Grass	Weed Control Broadleaf
Preplant Incorporated:						
butylate	3.4	0.0	0.5	9.5	7.5	6.8
butylate + atrazine	4.5	0.0	0.5	7.5	8.8	8.5
A preemergence treatment[2/] + directed postemergence treatments of:						
atrazine + crop oil[3/]	2.2	0.0	0.8	6.0	9.5	10.0
ametryne + crop oil	2.2	0.0	1.0	5.8	10.0	9.8
cyanizine + crop oil	2.2	0.0	0.8	5.8	9.3	9.3
cyprazine + crop oil	1.1	0.0	0.0	6.5	10.0	10.0
MBR 8251 + crop oil	3.4	0.0	1.8	5.5	9.5	9.3
S-21634	4.5	0.0	0.8	9.3	6.8	9.3
Check	-	0.0	1.5	0.0	10.0	9.3
Hoed check	-	0.0	0.0	8.8	9.5	9.8
Directed postemergence treatments only:						
atrazine + crop oil	2.2	0.0	3.5	3.8	7.5	5.5
ametryne + crop oil	2.2	1.3	6.5	3.5	9.5	8.3
cyanizine + crop oil	2.2	0.0	3.8	5.0	6.5	8.8
cyprazine + crop oil	1.1	0.0	4.5	3.3	7.3	7.0
MBR 8251 + crop oil	3.4	0.0	4.8	5.3	4.5	7.0
S-21634	4.5	0.0	5.3	8.3	0.0	1.3
Weedy Check	-	0.0	5.3	0.0	0.0	0.0
Hoed check	-	0.0	0.5	9.0	8.5	9.0

1/ Ratings made on June 29, 1973. 0 = no injury, 10 = complete kill.
2/ atrazine + simazine, 1.1 + 1.1 kg ai/ha
3/ 10% Sun Oil 11E

S-21634, 1-METHYL-4-PHENYLPYRIDINIUM CHLORIDE, FOR THE CONTROL OF NUTSEDGE

R. A. Schwartzbeck and J. W. Pullen[1]

S-21634, 1-methyl-4-phenylpyridinium chloride, is a new postemergent herbicide discovered and developed by Gulf Oil specifically for the purpose of controlling both purple and yellow nutsedge (*Cyperus rotundus* and *C. esculentus*). Control of weeds other than nutsedges has not been observed.

Foliar sprays at rates of 2-6 lbs/acre in a volume of water no less than 20 gal/acre have killed the top growth and severely inhibited or prevented regrowth from the underground nutlets. The low rates are effective under good growing conditions and the higher rates necessary when conditions are not optimum. S-21634 is not active as a preemergent spray.

When sprayed postemergently at the 6-9 leaf stage and in an active growth condition the foliage becomes chlorotic in 3-5 days, then necrotic several days later, and may take up to 4 weeks to die. Regrowth from the nutlets, both active and dormant, is severely retarded by the treatment and, may or may not appear above ground depending on growing conditions. Combinations with other herbicides or growth regulators such as 2,4-D, 2,4-DB or silvex improve the basipetal translocation and thus the effectiveness. Plants which are cut at the soil surface within 4 days after spraying or plants receiving a heavy rain within 4 hours after spraying are controlled less effectively.

Species showing the most tolerance to S-21634 are peanuts, soybeans, rice, potatoes, strawberries, various turf grasses and ornamental crops such as juniper, privet, forsythia, Japanese holly and Japanese yew. Directed sprays are effective in corn and cotton.

AN EVALUATION OF HERBICIDES FOR CRABGRASS CONTROL IN A NEW SEEDING OF ALFALFA

W. M. Dest, R. A. Peters, and A. C. Triolo[1/]

Abstract

Several new experimental compounds applied on a new spring seeding of alfalfa looked promising for the control of crabgrass (Digitaria sanguinalis (L.) Scop.).

S-6044 applied at 3 lb/A and 4 lb/A, CGA 10832 at 1 1/2 lb/A and 3 lb/A, A-820 at 1 1/2 lb/A and 3 lb/A, and BAS 3921-H at 1 1/2/A and 3 lb/A gave good to excellent crabgrass control with little or no injury to the alfalfa. EPTC, used as the standard treatment, gave excellent control. Benefin applied at 1 lb/A preplant incorporated and methazole at 2 lb/A preemergence resulted in good control.

BAS 3921-H applied at the rate of 3 lb/A and the combination of S-6044 plus alachlor at a rate of 3 lb/A + 1 lb/A moderately injured the alfalfa with a slight reduction in yield. The metribuzin plus benefin combination (1/4 lb/A + 1/2 lb/A) severely injured the alfalfa, reducing yields significantly below all treatments including the check.

An increase in alfalfa yield was associated with an increase in crabgrass control.

Methods and Materials

The experiment was conducted at the Agronomy Research Farm of the Storrs Agricultural Experiment Station. The experimental design was a complete randomized block with 3 replications. Plot size was 10 feet by 20 feet.

The soil type is a Paxton fine sandy loam. The field was fertilized on April 23, 1973 at a rate of 500 lb/A of 0-20-20 fertilizer. The fertilizer was incorporated with a disk harrow. Alfalfa (Medicago sativa L. var. Saranac) was seeded on May 3, 1973 at a rate of 12 lb/A.

The major weed species was large crabgrass with only small amounts of lambsquarters (Chenopodium album L.) and Pennsylvania smartweed (Polygonum pennsylvanicum L.). The experiment was planned originally to also evaluate broadleaf weed control, hence the addition of 2,4-DB to some of the treatments. However, the population of broadleaf weeds was so scant and variable throughout the field that no data was taken.

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

Preplant and preemergence treatments were applied on May 3, 1973. The preplant treatments were incorporated immediately by cross disking. Postemergence treatments were applied on June 5, 1973. All applications were applied in water at a rate of 40 gal/A, with a small plot self-propelled sprayer. Herbicide rates are given in lb ai or ae/A.

Crabgrass control and alfalfa injury ratings were taken on June 21, 1973. A rating scale of 0-10 was used, 0 indicating no crabgrass control or alfalfa injury and 10 indicating complete kill.

Yield samples were taken on July 17, 1973 from a 3 feet by 14 feet area from each plot and the green weight recorded. The total yield per plot was fractionated into alfalfa and crabgrass components by hand separation of subsamples. Yields are reported as lb/A on a dry matter basis.

Results and Discussion

EPTC, used as the reference herbicide treatment, resulted in excellent control of crabgrass (Table I). There was temporary injury to alfalfa caused principally by the contact effect of 2,4-DB on the alfalfa.

The control of crabgrass with benefin at the 1/2 lb/A rate was marginal. Increasing the rate to 1 lb/A improved its effectiveness.

As the herbicide rates of CGA 10832 increased from 3/4 lb/A to 3 lb/A, there was a corresponding increase in crabgrass control as noted by both the ratings and grass yield. There was slight injury to alfalfa at the higher rate but this did not affect alfalfa yield.

BAS 3921-H at the 3/4 lb/A rate gave only fair crabgrass control. At the 1 1/2 lb/A and 3 lb/A rates, good control was achieved. Alfalfa was injured by the two higher rates. The 3 lb/A treatment reduced alfalfa yield, although not significantly.

A-820 gave good crabgrass control at both rates with no injury to alfalfa.

The addition of metribuzin with benefin caused severe injury to the alfalfa which reduced yields significantly below the check. Crabgrass control was poor.

AC 92390 gave only marginal control of crabgrass when used alone at a 1 1/2 lb/A and 2 lb/A rate. When AC 92390 (1 lb/A) was combined with EPTC (2 lb/A), crabgrass control was excellent. However, control with this combination was no more effective than EPTC used alone at the 3 lb/A rate. The addition of a post treatment of 2,4-DB with AC 92390 injured the alfalfa slightly and can be attributed primarily to the contact effect on the alfalfa seedlings by the 2,4-DB.

Poor crabgrass control was experienced with methazole at the 1 lb/A rate. Increasing the rate to 2 lb/A achieved good control. Alfalfa yield increased with an increase in weed control. The absence of injury to alfalfa differs with results from previous years at the Storrs Station (1).

S-6044 applied preemergence at rates of 3 lb/A and 4 lb/A resulted in good to excellent crabgrass control. The 4 lb/A treatment injured the alfalfa but it recovered. The addition of alachlor in combination with the S-6044 was phytotoxic to the alfalfa without accomplishing significantly better grass control.

Alfalfa yields tended to increase with a corresponding decrease in crabgrass yields. The correlation coefficient for alfalfa yield and crabgrass control was $r = -.67$ with a 1% level of significance.

Only treatments A-820 at 3 lb/A + 2,4-DB at 1 lb/A and S-6044 at 4 lb/A resulted in significantly greater alfalfa yields than the check.

All treatments except metribuzin + benefin had significantly reduced crabgrass yield below the check.

Literature Cited

1. Dest, W. M., R. A. Peters, and A. C. Triolo. 1972. Annual weed control in new seedings of alfalfa. Proc. NEWSS 26:239-242.

Table 1. The Effect of Herbicide Treatments on Crabgrass Control, Injury Ratings, and Yields of Alfalfa and Crabgrass Components in a New Seeding of Alfalfa.

Treatment			Alfalfa Injury and Crabgrass Control		Yield lb/A Dry Matter[1]	
			Ratings[2] - June 21, 1973			
Herbicide	Lb ai or ae/A	Type of Application	Alfalfa	Crabgrass	Alfalfa	Crabgrass
Check			0	2.9	1776b	1240a
EPTC + 2,4-DB	3 + 1	ppi + post	1.6	9.9	2516ab	3d
Benefin	1/2	ppi	0	6.4	2210ab	557bcd
Benefin	1	ppi	0	8.0	2451ab	182bcd
CGA 10832	3/4	ppi	0	7.5	2395ab	349bcd
CGA 10832	1 1/2	ppi	0	8.9	2482ab	62cd
CGA 10832	3	ppi	2.0	9.2	2573ab	20cd
BAS 3921-H	3/4	ppi	0	6.9	2463ab	349bcd
BAS 3921-H	1 1/2	ppi	1.0	9.1	2483ab	35cd
BAS 3921-H	3	ppi	4.3	8.6	2208ab	75cd
A-820	1 1/2	ppi	0	9.3	2476ab	5d
A-820	3	ppi	0	8.8	2522ab	70cd
A-820 + 2,4-DB	1 1/2 + 1	ppi + post	0	8.4	2432ab	218bcd
A-820 + 2,4-DB	3 + 1	ppi + post	0	9.0	2729a	34cd
Metribuzin + benefin	1/4 + 1/2	ppi	8.7	7.7	692c	736ab
AC 92390	2	ppi	0	7.3	2196ab	409bcd
AC 92390 + 2,4-DB	1 1/2 + 1	ppi + post	1.3	8.1	2242ab	406bcd
AC 92390 + EPTC	1 + 2	ppi	0	10.0	2573ab	6d
Methazole	1	pre	0	5.8	2329ab	671abc
Methazole	2	pre	0	8.8	2503ab	90bcd
S-6044	3	pre	0	8.4	2561ab	36cd
S-6044	4	pre	2.3	9.6	2679a	56cd
S-6044 + alachlor	3 + 1	pre	5.7	10.0	2377ab	8d

1/ Means not followed by the same letter are significantly different at the 5% level using Duncan's Multiple Range Test.

2/ Ratings 0 - no effect 10 = complete kill

Appendix

Common Name	Formulation	Chemical Name
EPTC	6 lb/gal EC	s-ethyl dipropylthiocarbamate
2,4-DB	2 lb/gal EC	4-(2,4-dichlorophenoxy) butyric ester
Benefin	1.5 lb/gal EC	N-butyl-N-ethyl-a,a,a-trifluoro-2-6-dinitro-P-toluidine
CGA 10832	4 lb/gal EC	N-n-propyl-N-cyclopropylmethyl-4-trifluoromethyl-2,6-dinitroaniline
BAS 3921-H	3 lb/gal EC	N-propyl-N-(2-chloroethyl)-a,a,a,-trifluoro-2,6-dinitro-p-toluidine
A-820	4 lb/gal EC	N-secondary-butyl-4-teriary-butyl-2,6-dinitroaniline
Metribuzin	70% WP	4-amino-6-t-butyl-3-(methylthio) -1,2,4-triazin-5(4H)-one
AC 92390	3 lb/gal EC	N-sec-butyl-2,6-dinitro-3,4-xylidine
Methazole	75% WP	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,4-dione
S-6044	3 lb/gal EC	Unknown
Alachlor	4 lb/gal EC	2-chloro-2',6'-diethyl-N-(emthoxymethyl)acetotoluidide

Sod Seeding Legumes for Pasture Renovation[1/]

L. D. Hoffman and W. L. McClellan[2/]

(Abstract)

Successful plantings of alfalfa (Medicago sativa), crownvetch (Coronilla varia), birdsfoot trefoil (Lotus corniculatus), and red clover (Trifolium repens) have been made into all grass swards (permanent pasture) without conventional tillage techniques. To date various planting implements and herbicides have been tested. In all trials attempts were made to suppress existing grass but not eradicate it.

July 27, 1971 a grass sward was sprayed with 0.5 and 1.0 lb ai. per acre of paraquat, 1,1-dimethyl 4,4-bipyridinium plus surfactant. Three days later alfalfa, birdsfoot trefoil, and crownvetch were seeded in nineteen inch rows using an Allis Chalmers no-till corn planter. Seed was placed in the insecticide boxes and dropped immediately in front of the large rubber press wheel. All three species were successfully established with no significant differences between herbicide treatments.

On August 2, 1972 a pasture sward containing primarily Kentucky bluegrass (Poa pratense) and fescue (Festuca rubra) was sprayed with 0.5 lb paraquat ai. per acre plus surfactant. Again using the A.C. corn planter, Viking and Empire birdsfoot trefoil was seeded at 12 lb. per acre in 10 and 20 inch rows immediately after spraying. A successful stand was obtained. Yields up to 2 tons dry matter per acre were harvested in late May 1973 before cattle were permitted to graze.

Alfalfa, birdsfoot trefoil, and crownvetch was planted May 16, 1973 to evaluate the performance of two herbicides and four planting implements. The herbicide treatments included: glyphosate [N-(phosphonomethyl)glycine] at 0.25 and 0.5 lb ai., paraquat at 0.25 and 0.5 lb ai. and split applications of paraquat at the .5 and 1 lb ai. rates. The first half of the split application rates were applied April 16. All other treatments were applied May 10. Evaluation of planting devices included: conventional tillage and a press wheel grain drill; herbicides using the grain drill; herbicides and the Allis Chalmers no-till corn planter; and herbicide and a zero tillage seeder manufactured by Midland Mfg. Co. Results in this trial was little less than complete failure. A second planting 12 days later produced only slightly better stands. Failure probably occurred due to residue from dicamba applied for broadleaf control five weeks prior to planting and/or insect damage. Further tests are being established to evaluate this hypothesis.

1/ This abstract is a progress report and summarization of three years research.

2/ Assistant Professor of Agronomy and Associate Professor of Agronomy Extension respectively at The Pennsylvania State University.

EFFECTIVENESS OF SOYBEAN HERBICIDES IN NEW YORK AND NEW JERSEY

G. H. Bayer and N. A. Ferrant 1/

ABSTRACT

Nineteen herbicides singly, in combination as tank mixes or as sequential treatments were field tested for soybean weed control in New York and New Jersey during 1972 and 1973.

These experiments indicated that there are numerous herbicide treatments which are effective depending on the weed species present.

Combinations or sequential treatments provided the best broad spectrum control.

Soybean injury was more serious on the lighter soils of New Jersey than in the New York location.

Of the newer materials HOE 22870 (chemistry unknown) and HOE 23408 (chemistry unknown) were most promising as postemergent grass killers.

INTRODUCTION

For many years soybean acreage in the Northeast has been largely concentrated on the Del-Mar-Va peninsula. However, due to the protein shortage and higher prices, soybean acreage is increasing in New Jersey and is moving northward into Pennsylvania and New York.

Soybean herbicides which have proven successful in Del-Mar-Va would be subject to the effect of soil type, weed spectrum and climate variation as one moved north. Therefore, a large number of materials were evaluated in N.Y. and N.J. in 1972 and 1973.

MATERIALS AND METHODS

The N.Y. experiments were run both years at Lafayette, N.Y. on a gravelly silt loam with 4% organic matter. The variety Harosoy was planted in 1972 on July 11 and in 1973 on June 8. Preplant incorporated and preemergent treatments were made on the day of planting. Timing of

1/ Product Development Manager, Agway Inc., Syracuse, N.Y. and Crop Specialist, Agway Inc., Yardville, N.J.

postemergent treatments are noted in the tables. Experimental design was a randomized complete block with four replications. Materials were applied with a hand carried, CO_2 sprayer at 30 psi and 60 gallons per acre volume.

The New Jersey tests were non-replicated plots on numerous farms scattered throughout the central part of the state. Fields were selected with known heavy infestations of weeds. Varieties of beans varied with farms. Soil type also varied but most were loams or sandy loams with 1%-2% organic matter. In both years beans were planted and treatments applied in early June. The data in tables 3 and 4 represent the average of ratings on at least three farms or locations for each weed species.

In tables 1-4 the treatments were rated visually on a 0 - 10 scale with 0 = no effect on weeds or crop and 10 = complete kill of weeds or crop. Observation ratings represent the resulting control near or at harvest. Where abbreviations were necessary: W. Mus. = Wild Mustard (Brassica kaber), Pig = Redroot Pigweed (Armaranthus retroflexus), Rag = Common Ragweed (Ambrosia artemisiifolia), BYG = Barnyardgrass (Echinochloa crusgalli), Vel = Velvetleaf (Abutilon theophrasti), F.P. = Fall Panicum (Panicum dichotomiflorum), L.Q. = Lambsquarters (Chenopodium album), Gi. Fox = Giant Foxtail (Setaria faberii) and L. Crab = Large Crabgrass (Digitaria sanguinalis).

RESULTS AND DISCUSSION

On an overall basis most of the treatments effected good weed control. However, differences were apparent on a species basis.

The substituted dinitroanilines including trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), fluchloralin (N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl)aniline), dibutalin (N-sec-butyl-4-tert-butyl-2,6-dinitroaniline), CGA 10832 (N-n-propyl-N-cyclopropylmethyl-4-trifluoromethyl-2-6-dinitroaniline), oryzalin (3,5-dinitro-N^4,N^4-dipropylsulfanilamide), and AC 92390 (chemistry unknown) were very weak on ragweed and mustard but excellent on large crabgrass, giant foxtail, fall panicum, lambsquarters and pigweed.

The thiocarbamate, vernolate (S-propyl dipropylthiocarbamate), gave results similar to the dinitroanilines except that it gave a little better control of velvetleaf and ragweed.

Combinations of a dinitroaniline with a broadleaf herbicide generally produced excellent results. These combinations included dibutalin plus metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one), trifluralin plus bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2 dioxide), trifluralin plus linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) and oryzalin plus metribuzin.

Single treatments of dinoseb (2-sec-butyl-4,6-dinitrophenol) (alkanolamine salt) were far more effective applied at the crook stage than preemergent. The oil soluble dinitro phenol used at label rates was not effective at either timing.

At the New York location the single most effective treatment was metribuzin. No soybean injury was noted in New York; however, in combination with alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide) it caused considerable injury on the lighter soils of New Jersey.

MC 4379 (methyl 5-(2',4-dichlorophenoxy)-2-nitrobenzoate), another preemergent material, was promising in the New York tests. However, in combination with alachlor it also caused considerable injury in New Jersey.

The postemergent materials, chloroxuron (3-[p-(p-chlorophenoxyl) phenyl]) and bentazon were quite effective on the broadleaf weeds present. HOE 22870 and HOE 23408 gave fair control of crabgrass and good control of fall panicum. The combination of Bentazon and HOE 22870 gave good control of broadleaf and grassy weeds with no injury to the beans.

The preemergent combinations which performed best were alachlor plus linuron, alachlor plus metribuzin, alachlor plus chlorbromuron and alachlor plus dinoseb.

Overlay or sequential treatments which were effective included combinations of trifluralin or vernolate followed by bentazon.

The results of these tests indicate that there are numerous herbicide treatments which are effective in these soybean growing areas. The correct program should be based on the weed spectrum present. Combinations, or sequential treatments provide the best broad spectrum control. Soybean injury is more likely to occur in the lighter soils of New Jersey than in New York.

Table 1. The effect of selected herbicide treatments on soybeans and weeds at Lafayette, N.Y. - 1972

Treatment	Rate (ai/A)	Timing	Crop Injury	Weed Control Pig	Rag	BYG
AC 92390	3.0	Pre	t	10.0	-	9.3
Fluchloralin	.75	PPI	.7	4.3	6.3	7.5
Fluchloralin	1.5	PPI	1.0	7.7	7.0	9.5
Trifluralin +	1.0	PPI				
Bentazon	.75	EP[a]	.7	9.3	9.0	9.3
Trifluralin +	1.5	PPI				
Bentazon	1.5	EP	2.0	9.7	9.3	9.5
Vernolate +	3.0	PPI				
Bentazon	.75	EP	.7	8.7	10.0	9.0
Vernolate +	3.0	PPI				
Bentazon	1.5	EP	1.7	8.3	9.7	9.7
Dibutalin +	2.0	PPI				
Bentazon	.75	EP	0	8.3	9.0	9.3
Dibutalin +	3.0	PPI				
Bentazon	.75	EP	1.3	9.0	9.3	10.0
Trifluralin	1.5	PPI	1.0	9.7	-	10.0
Vernolate	3.0	PPI	1.0	8.0	8.7	9.3
Dibutalin	1.5	PPI	0	6.0	-	9.0
Alachlor + Linuron	1.5+.5	Pre	0	10.0	10.0	10.0
Alachlor + Metribuzin	1.5+.38	Pre	t	10.0	10.0	10.0
Alachlor + Dinoseb	2.0+4.0	Pre	1.0	10.0	10.0	9.5
Chloroxuron + Adj.T	2.0+5% v/v	EP	3.0	10.0	10.0	-
Oryzalin	1.0	Pre	0	10.0	-	10.0
Oryzalin	2.0	Pre	2.3	10.0	-	10.0
CGA 10832 +	1.5	PPI				
Chlorbromuron	1.5	Pre	0	7.7	7.7	9.0
Alachlor +	1.5	Pre				
Chlorbromuron	1.5	Pre	.7	10.0	10.0	10.0

a/ EP = Early post - Beans had 2 true leaves and broadleaf weed 2 - 4 true leaves

Table 2. The effect of selected herbicide treatments on soybeans and weeds at Lafayette, N.Y. - 1973

Treatment	Rate (ai/A)	Timing	Crop Injury	Weed Control W.Mus	L.Q.	Pig	L.Crab
Dibutalin	2.0	PPI	0	0	10.0	6.5	10.0
Dibutalin +	2.0	PPI					
Metribuzin	.38	Pre	0	10.0	10.0	10.0	10.0
Metribuzin	.25	Pre	0	10.0	9.6	9.3	9.5
Metribuzin	.38	Pre	0	10.0	10.0	9.8	9.7
MC 4379	1.0	Pre	0	8.5	10.0	10.0	7.3
MC 4379	1.5	Pre	.3	9.0	10.0	10.0	8.0
MC 4379 +	1.0	Pre					
Alachlor	1.5	Pre	1.3	10.0	10.0	10.0	10.0
Dinoseb a/	3.0	Pre	0	-	-	2.8	3.5
Dinoseb	6.0	Pre	0	-	-	4.5	3.5
Dinoseb	1.5	Crook c/	.3	-	-	7.0	3.7
Dinoseb	3.0	Crook	0	-	-	7.8	7.7
Dinoseb b/ +	.95	Pre					
Booster Plus E e/	1.7% v/v	Pre	0	-	-	0	2.0
Dinoseb +	.5	Crook					
Booster Plus E	1.7% v/v	Crook	0	-	7.5	3.5	4.3
Bentazon	.75	Post d/	0	-	-	9.5	0
Bentazon +	.75	Post					
Spreader Sticker	.5% v/v	Post	0	-	-	8.3	0
HOE 22870	1.5	Post	0	1.0	0	2.8	7.7
HOE 23408	1.5	Post	0	0	1.7	1.5	5.3

a/ Dow Premerge 3E (alkanolamine salt)
b/ Dow General 5E (oil soluble dinitro phenol)
c/ Crook = Pig and L.Q. 1", grass 2"
d/ Post = Beans in first trifoliate, mustard 3 leaf, lambsquarters and pigweed 6 leaf, crabgrass 2 - 4 leaf.
e/ A blend of 100 sec non-phytotoxic oil plus a nonionic emulsifier

Table 3. The effect of selective herbicide treatments on soybeans and weeds in New Jersey - 1972

Treatment	Rate (ai/A)	Timing	Crop Injury	Weed Control Rag	L.Q.	Pig	Vel	Gi.Fox
Trifluralin	1.0	PPI	-	.8	8.0	9.3	5.0	10.0
Vernolate	2.0	PPI	2.7	1.0	9.0	10.0	5.8	10.0
Trifluralin +	1.0	PPI						
Linuron	0.5	Pre	-	9.5	10.0	10.0	8.2	10.0
Trifluralin +	1.0	PPI						
Dinoseb	1.5	Pre	-	5.9	6.6	10.0	6.5	10.0
Linuron +	.75	Pre						
Alachlor	1.5	Pre	-	10.0	9.8	10.0	10.0	9.0
Dinoseb +	2.0	Pre						
Alachlor	1.5	Pre	.2	7.0	7.8	9.8	7.5	9.0
Chlorbromuron +	1.5	Pre						
Alachlor	1.5	Pre	1.8	9.8	10.0	9.8	9.6	9.9
Dibutalin +	1.5	PPI						
Metribuzin	.25	PPI	.5	4.3	8.8	10.0	7.0	9.3
Metribuzin	.38	Pre	1.2	4.5	8.0	7.7	7.5	6.8
Oryzalin +	1.0	Pre						
Metribuzin	.38	Pre	2.2	7.9	9.8	10.0	8.9	7.9
Alachlor +	1.5	Pre						
Metribuzin	.38	Pre	1.5	7.0	10.0	10.0	7.4	9.9
Bentazon	.5	Post a/	-	4.3	-	7.3	10.0	2.5
Bentazon	1.0	Post	-	9.8	-	7.3	-	0

a/ Post - Soybeans 6" - 8", broadleaf weeds 4" - 8"

Table 4. The effect of selective herbicide treatments on soybeans and weeds in New Jersey - 1973

Treatment	Rate (ai/A)	Timing	Crop Injury	Vel	Rag	F.P.
Trifluralin + Linuron	.75+.5	PPI	0	8.1	6.3	10.0
Vernolate + Linuron	2.0+.5	PPI+Pre	0	9.7	8.9	9.7
Vernolate	2.0	PPI	0	9.6	1.2	9.2
Dibutalin + Metribuzin	1.5+2.5	PPI+Pre	tr	7.8	7.9	9.7
CGA 10832	.75	PPI	tr	5.8	2.8	9.3
Linuron + Alachlor	.75+1.5	Pre	tr	9.0	9.0	9.6
Chlorbromuron + Alachlor	1.0+1.5	Pre	tr	8.3	9.7	9.5
Cyanazine + Alachlor	1.5+1.5	Pre	1.6	8.5	10.0	9.8
Dinoseb + Alachlor	3.0+1.5	Pre	1.4	8.6	9.4	9.8
MC 4379 + Alachlor	1.5+1.5	Pre	4.2	9.8	6.8	9.6
Chloramben + Linuron	1.5+.5	Pre	0	8.5	7.9	8.3
Oryzalin + Metribuzin	1.25+.25	Pre	1.0	10.0	8.2	9.2
Metribuzin	.25	Pre	tr	8.8	5.8	7.3
AC 92390	1.5	Pre	tr	7.0	1.8	9.2
Bentazon	1.0	Post a/	0	10.0	10.0	0
HOE 23408	1.5	Post	0	5.3	1.0	9.5
HOE 22870	1.5	Post	0	3.8	1.2	9.0
Bentazon + HOE 22870	1.0+1.5	Post	0	9.8	9.4	8.5

a/ Post - soybeans 2 - 6 trifoliate and fall panicum was 6" - 10" high.

EVALUATION OF SOME PREPLANT INCORPORATED HERBICIDE TREATMENTS ON SOYBEANS

D. J. Herman and R. D. Ilnicki[1/]

Abstract

Preplant incorporated treatments of some dinitroaniline, an asymetrical triazine, thiocarbamates, and substituted urea herbicides and some combinations thereof were evaluated for weed control and crop injury in soybeans (*Glycine max* (L.) Merr.), variety, Williams. Crop injury was elicited from treatments of dibutalin at rates above 2 lb/A, metribuzin at rates above $\frac{1}{4}$ lb/A and the combination of trifluralin + chlorbromuron at rates above 3 + 2 lb/A. Broadleaf weeds were controlled by all treatments except vernolate at 3 lb/A, and dibutalin was ineffective on corn chamomile (*Anthemis arvensis* L.). Good control of fall panicum (*Panicum dichotomiflorum* (L.) Michx.) was effected by the combination of dibutalin + metribuzin at $1\frac{1}{2}$ + $\frac{1}{2}$ lb/A, vernolate + metribuzin at rates above 2 + $\frac{1}{4}$ lb/A and trifluralin at rates above 3/4 lb/A. Yields for all treatments were low due to a poor stand and droughty summer conditions.

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

RESULTS OF SOME PREEMERGENCE HERBICIDE TREATMENTS ON SOYBEANS

D. J. Herman and R. D. Ilnicki[1/]

Abstract

Various preemergence herbicides were evaluated in three experiments for weed control and crop tolerance in soybeans (Glycine max (L.) Merr.). Major weed species present in all three experimental areas were: lambsquarters (Chenopodium album L.), pigweed (Amaranthus retroflexus L.), carpetweed (Mollugo verticilliata L.), fall panicum (Panicum dichitomiflorum (L.) Michx.), crabgrass (Digitaria ishchaemum (Schreb.) Muhl.), and yellow foxtail (Setaria glauca (L.) Beauv.). Outstanding treatments were R-17623, 4 lb/A; MBR 8251, 6 lb/A; chloramben + linuron, $2\frac{1}{4}$ + 3/4 lb/A; and alachlor in combinations with linuron, chlorbromuron, metribuzin, and cyanazine at rates of 2 + 3/4, 2 + $1\frac{1}{2}$, $1\frac{1}{2}$ + 3/8, and 2 + 2 lb/A, respectively. The combination of alachlor + MC 4379 was an excellent treatment but slightly ineffective on crabgrass.

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

PREEMERGENCE WEED CONTROL IN SOYBEANS WITH ORYZALIN

W. E. Rogers, S. Addink, M. L. Jones, G. J. Shoop,
D. H. Lade and C. D. Christensen[1/]

ABSTRACT

Oryzalin (3,5-dinitro-N^4,N^4-dipropylsulfanilamide) was surface applied preemergence to weeds and soybeans (Glycine max) alone and in combination with metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one], linuron [3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea], and dinoseb [2-sec-butyl-4,6-dinitrophenol], to evaluate crop response and herbicidal efficacy.

Oryzalin alone provided acceptable control of foxtails (Setaria spp.), large crabgrass (Digitaria sanguinalis), common lambsquarters (Chenopodium album) and redroot pigweed (Amaranthus retroflexus). The combinations resulted in commercially acceptable control of those weeds controlled by oryzalin alone. In addition, oryzalin+metribuzin combinations effectively controlled common ragweed (Ambrosia artemisiifolia), velvetleaf (Abutilon theophrasti), jimsonweed (Datura stramonium), ivyleaf morningglory (Ipomoea hederacea), Venice mallow (Hibiscus trionum), common cocklebur (Xanthium pensylvanicum), prickly sida (Sida spinosa), and Pennsylvania smartweed (Polygonum pensylvanicum). Tank-mixed oryzalin+linuron effectively controlled the following oryzalin-resistant weeds: common ragweed, ivyleaf morningglory, jimsonweed, Pennsylvania smartweed and Venice mallow. Tank-mixed oryzalin+dinoseb effectively controlled the oryzalin-resistant common cocklebur, ivyleaf morningglory and Pennsylvania smartweed. Slight early injury occurred in some trials but the soybean plants recovered by midseason. Improved weed control resulted in higher yields in plots treated with the herbicide combinations than in nontreated controls.

INTRODUCTION

The soybean grower has a great need to control a wide variety of problem weeds. No single herbicide plus normal cultivation controls all weeds; therefore, many attempts have been made to combine herbicides that have complimentary weed control spectra.

Oryzalin has been found to be herbicidally active on most annual grasses and certain broadleaf weeds. In an attempt to extend the broadleaf weed control spectrum of oryzalin, the herbicide was applied in combination with metribuzin, linuron, and dinoseb. These compounds have been shown to be herbicidally

1/ Eli Lilly and Company, Greenfield, Indiana.

active against a variety of broadleaf weeds, but they often fail to provide adequate control of annual grasses. The research reported here is a compilation of data from field trials that were established to determine the herbicidal efficacy, weed control spectrum and crop tolerance of combinations of oryzalin and the herbicides listed above.

MATERIALS AND METHODS

This report includes data from 16 small plot trials and 36 nonreplicated large plot trials conducted on private farms in Kentucky, Indiana, Michigan, Ohio, Maryland, Delaware and New York in 1971, 1972 and 1973.

Oryzalin and metribuzin alone and in tank-mix combination were evaluated in 8 of the small plot replicated trials. Tank-mix combinations of oryzalin+linuron were evaluated in 9 small plot trials and oryzalin+dinoseb in 3 small plot trials. Plots were 2 to 4 rows, 50 to 100 feet long and were replicated three times. All treated areas received at least one normal cultivation.

Oryzalin+metribuzin tank-mixed was evaluated in over 100 locations in the Northeast on an Experimental Permit Program in 5 to 10 acre plots. Results are reported here from 30 of these Experimental Permit trials from which individual weed control data were recorded.

The field trials were established on a wide variety of soil types ranging from loamy sands to clay and silt loams with organic matter from 1.5 to 4.3 percent. Herbicides were surface applied alone or in combination preemergence to the crop and weeds, usually within 1 to 2 days after planting. The various types of spray apparatus were similar to typical equipment commercially available to growers. Although in many experiments several rates of each herbicide were evaluated, results are presented only for levels considered optimum for weed control and crop safety. Rates of oryzalin and metribuzin for the soil type alone and in combination are presented in Table 1. Results with linuron and dinoseb are reported at the label rates for the soil type in combination with the rates of oryzalin as listed in Table 1.

Soybean varieties used were representative of each area. Weed control and crop injury evaluations were made early and midway through the growing season at 3 to 4 weeks and 6 to 9 weeks after planting. Final weed control evaluations were made at harvest and yield data obtained from as many of the small plot trials as possible in 1971 and 1972. Since mid-season weed control data are the latest available for 1973 experiments, this rating is used for all weed control evaluations presented in this report.

RESULTS AND DISCUSSION

Table 1. Rates in pounds of active ingredient per acre of oryzalin and metribuzin applied alone or in combination.

Compound	Soil Type Coarse	Medium	Fine
oryzalin	0.75-1	1.25-1.5	1.5-2
metribuzin	0.25	0.38	0.5
oryzalin+metribuzin	0.75+0.25	1+0.33	1.5+0.5

I. Herbicidal Efficacy - Replicated Trials with Oryzalin+ Metribuzin: Oryzalin surface applied alone and in combination with metribuzin at the rates listed in Table 1 provided 89 to 98 percent control of foxtail and large crabgrass (Table 2). Control of fall panicum (*Panicum dichotomiflorum*) by oryzalin was less than acceptable (65 percent) but improved (79 percent) with the combination of oryzalin and metribuzin. Metribuzin applied alone at the rates indicated in Table 1 failed to provide acceptable control of grasses.

Oryzalin provided 93 to 95 percent control of common lambsquarters and redroot pigweed. Control of these weeds was improved by the combination of oryzalin and metribuzin that also provided 85+ percent control of the oryzalin resistant weeds, jimsonweed, common ragweed and ivyleaf morningglory. Metribuzin surface applied alone provided 93 to 99 percent control of redroot pigweed and ragweed, 70 to 75 percent control of common lambsquarters and jimsonweed and poor control (38 percent) of ivyleaf morningglory. Neither oryzalin nor metribuzin alone or in combination provided acceptable control of horsenettle (*Solanum carolinense*).

Table 2. Percent control of grasses and broadleaf weeds with oryzalin and metribuzin alone and in combination.

Weed Species	Number of Locations	Oryzalin	Oryzalin + Metribuzin	Metribuzin
Grasses				
Foxtails	8	89	94	70
Large crabgrass	2	89	98	74
Fall panicum	2	65	79	48
Broadleaf Weeds				
Common lambsquarters	5	93	97	75
Redroot pigweed	4	95	98	99
Jimsonweed	4	40	85	70
Common ragweed	6	59	88	93
Ivyleaf morningglory	2	57	85	38
Horsenettle	1	49	0	19

II. Herbicidal Efficacy - Replicated Trials with Oryzalin+Linuron and Dinoseb: Additional tank-mix combinations of herbicides with oryzalin provided a broad spectrum of weed control (Table 3). The tank-mix combination of oryzalin+linuron provided 90+ percent control of foxtail, large crabgrass and redroot pigweed, 80+ percent control of fall panicum, ivyleaf morningglory, Pennsylvania smartweed and 70+ percent control of common ragweed, jimsonweed and Venice mallow, but failed to control common cocklebur and horsenettle. Oryzalin+dinoseb provided 90+ percent control of common cocklebur and Pennsylvania smartweed and 67 to 79 percent control of foxtail, ragweed and ivyleaf morningglory.

Table 3. Percent control of grasses and broadleaf weeds with tank-mixed surface applications of oryzalin+linuron and dinoseb.

Weed Species	Oryzalin + Linuron[a/]	Oryzalin + Dinoseb[a/]
Foxtails	92(6)	73(2)
Large crabgrass	94(2)	
Fall panicum	83(1)	
Redroot pigweed	98(3)	
Common ragweed	79(4)	67(1)
Common cocklebur	23(1)	93(1)
Ivyleaf morningglory	84(1)	79(1)
Jimsonweed	73(1)	
Pennsylvania smartweed	87(2)	100(1)
Venice mallow	73(1)	
Horsenettle	35(1)	

a/ Oryazlin rates used were those for the soil type listed in Table 1; linuron and dinoseb were used at label recommended rates for the soil type. Numbers in parentheses represent number of locations where weed species were present.

III. Herbicidal Efficacy - Nonreplicated Trials with Oryzalin+Metribuzin: In nonreplicated trials (Table 4) established on representative soybean varieties in a 7-state area of the northeastern United States, oryzalin+metribuzin provided 90+ percent control of foxtail, large crabgrass, barnyardgrass (*Echinochloa crus-galli*), common lambsquarters, redroot pigweed, common ragweed, velvetleaf, common purslane (*Portulaca oleracea*), ivyleaf morningglory, Venice mallow and Pennsylvania smartweed, and 80+ percent control of fall panicum, jimsonweed, common cocklebur and prickly sida.

Table 4. Summary of weeds controlled with oryzalin+metribuzin in large plot nonreplicated trials.[a]

Weed Species	Number of Locations	Average Percent Weed Control
Foxtails	33	96
Large crabgrass	1	100
Barnyardgrass	1	95
Fall panicum	3	88
Common lambsquarters	8	94
Redroot pigweed	6	97
Common ragweed	12	94
Velvetleaf	16	93
Jimsonweed	12	85
Common purslane	2	100
Ivyleaf morningglory	1	98
Venice mallow	6	94
Common cocklebur	4	84
Pennsylvania smartweed	5	97
Prickly sida	5	88

a/ Data represent average weed control evaluations from 36 nonreplicated trials with oryzalin+metribuzin at rates listed in Table.

IV. Crop Response: Table 5 summarizes crop response data. Average crop injury ratings for oryzalin (0.6 early to 0.2 midseason), oryzalin+metribuzin (1.2 early to 0.3 midseason), and metribuzin (0.4 early to 0 midseason) indicated that these compounds applied alone or in combination resulted in only minor injury to a representative sample of soybean varieties. Observations of crop emergence and yield expressed as a percent of results from control plots indicated that oryzalin and metribuzin applied alone or in combination had little effect on crop emergence and resulted in increased yields due to weed suppression.

Crop injury observations at early and midseason indicated that early injury with tank-mix combinations of oryzalin with linuron and dinoseb was slight, affecting only the early leaves, and that by midseason most plants had recovered and were of normal stature. Weed control in herbicide treated plots resulted in yields (expressed as a percent of controls) greater than in the cultivated controls.

Table 5. Average crop injury ratings, percent emergence and percent yield with oryzalin alone and in combination.

Compound	Crop Injury Rating[a] Early Season	Mid-season	Crop Emergence[b] (% of Control)	Yield[c] (% of Control)
oryzalin	0.6	0.2	94	115
oryzalin+ metribuzin	1.2	0.3	96	141
metribuzin	0.4	0	97	128
oryzalin+ linuron	0.7	0.4	94	123
oryzalin+ dinoseb	1.1	0.3	87	146

a/ Average crop injury on a rating scale of 0-10: 0 = no injury; 1-3 = slight; 4-6 = moderate; 7-9 = severe and 10 = dead plants.

b/ Crop emergence expressed as percent of control based on number of plants emerged per 20 feet of row per plot.

c/ Yield expressed as percent of control. Average of 8 locations with oryzalin alone, 5 locations with oryzalin+metribuzin and metribuzin alone, 7 locations with oryzalin+linuron and 3 locations with oryzalin+dinoseb.

Results presented here demonstrate that the combinations of oryzalin+metribuzin, linuron or dinoseb preemergence surface applied, provide broad spectrum control of weeds in soybeans at rates that have adequate crop safety. In these experiments, oryzalin+metribuzin provided the broadest spectrum of weed control followed by oryzalin+linuron and oryzalin+dinoseb in that order.

BROAD SPECTRUM WEED CONTROL IN SOYBEANS WITH TRIFLURALIN+METRIBUZIN

S. Addink, M. L. Jones, W. E. Rogers, G. J. Shoop, D. H. Lade and C. D. Christensen[1/]

ABSTRACT

Trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) plus metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one] was applied preplant soil incorporated for broad spectrum weed control in soybeans (Glycine max). Trifluralin+metribuzin applied at 0.5+0.25, 0.75+0.38 and 1+0.5 lb/A on coarse, medium and fine textured soils, respectively, provided commercially acceptable control of the same weeds that are now controlled by trifluralin alone. In addition, trifluralin+metribuzin effectively controlled the problem weeds velvetleaf (Abutilon theophrasti), jimsonweed (Datura stramonium), prickly sida (Sida spinosa), Pennsylvania smartweed (Polygonum pensylvanicum), common ragweed (Ambrosia artemisiifolia), ivyleaf morningglory (Ipomoea hederacea), Venice mallow (Hibiscus trionum), and wild mustard (Brassica kaber). Partial control of common cocklebur (Xanthium pensylvanicum) was observed. Soybeans exhibited adequate tolerance to trifluralin+metribuzin at rates indicated above. In addition, trifluralin+metribuzin did not affect emergence and resulted in increased soybean yield compared to cultivated controls.

INTRODUCTION

Control of weeds is essential to successful soybean production. Weeds reduce yields by competing directly with the soybean plants for nutrients, water and light. According to the 1971 National Soybean Weed Loss Survey, the average yield loss of soybeans in the United States due to weeds was 11.5 percent in 1970 and 12 percent in 1971. In addition to direct losses, weeds may delay harvest, interfere with combine efficiency and slow operation of the harvester. Therefore, farmers are interested in herbicides to supplement cultural methods for broad spectrum weed control. No single herbicide on the market today plus normal cultivation consistently provides broad spectrum weed control; whereas, a well chosen combination of herbicides plus cultivation may provide effective control.

1/ Eli Lilly and Company, Greenfield, Indiana.

Trifluralin is herbicidally active on most annual grasses and several broadleaf weeds. Metribuzin is herbicidally active against several trifluralin resistant broadleaf weeds but at rates adequate for broadleaf weed control is sometimes weak on annual grasses. Therefore, research was initiated to determine the herbicidal efficacy and crop tolerance when tank-mixed trifluralin+metribuzin is preplant soil incorporated for weed control in soybeans.

MATERIALS AND METHODS

Research trials and Experimental Permit trials with trifluralin and metribuzin were established in 1972 and 1973 on privately owned farms in Kentucky, Indiana, Michigan, Ohio, Maryland, Delaware and New York. In research trials, trifluralin and metribuzin were applied at several different rates alone and in tank-mix combination. Only the rates of trifluralin and metribuzin in combination that provided effective weed control and had adequate crop safety are presented in this paper as well as each herbicide applied alone at the same rates (Table 1). Results are presented from six research trials replicated three times with plot size ranging from 8 x 50 feet to 13 x 100 feet and five non-replicated research trials with 0.5 acre plots. There were several non-replicated trials established with only the trifluralin+metribuzin combination in an Experimental Permit Program. This report includes 36 trials from the Experimental Permit Program in which control of each weed species was evaluated separately, although several more trials were established throughout the region. Soil texture ranged from a sandy loam to a clay loam and organic matter from 1.9 to 6.8 percent. Trifluralin and metribuzin either alone or as a tank-mix combination were applied preplant with several types of research, grower, and commercial spray equipment. Treatments were soil incorporated within eight hours of application with various incorporation implements including the tandem disc, power driven rotary tiller and field cultivator. The speed and depth of operation varied with the incorporation implement with the guide line being the label recommendations for soil incorporation of trifluralin alone. Most applications were made within one day of planting but a few applications were made one to two weeks prior to planting. The major soybean varieties for the areas monitored were represented in these trials.

Visual evaluations of weed control and crop injury were made either early or midway through the growing season and in many cases at both times. The first visual rating occurred from 22 to 47 days after application and generally before the first cultivation. The midseason rating was made from 48 to 86 days after application. Yield was taken on two trials in 1972 and will be taken on several trials established in 1973.

RESULTS AND DISCUSSION

Data from research trials indicated that trifluralin and trifluralin+metribuzin applied at the rates listed in Table 1 provided 85 to 96 percent control of foxtails (*Setaria* spp.), large crabgrass (*Digitaria sanguinalis*), and barnyardgrass (*Echinochloa crus-galli*) (Table 2).

Table 1. Rates in pounds of active ingredient per acre of trifluralin and metribuzin applied alone or in a tank-mix combination.

	Soil Type		
	Coarse	Medium	Fine
Trifluralin	0.5	0.75	1
Metribuzin	0.25	0.38	0.5

Table 2. Average percent control of annual grasses in research trials when trifluralin and metribuzin, alone and in a tank-mix combination, are preplant soil incorporated.

Annual Grasses	Number of Locations	Trifluralin	Trifluralin + Metribuzin	Metribuzin
Foxtails[a/]	8	91	93	75
Large crabgrass	1	85	92	62
Barnyardgrass	3	96	94	77

a/ Giant foxtail (*Setaria faberi*) and green foxtail (*Setaria viridis*).

Metribuzin applied at the rates listed in Table 1 was weak on annual grasses, providing 62 to 77 percent control (Table 2).

Data from research trials indicated only slight differences between the three treatments in control of trifluralin susceptible broadleaf weeds (Table 3).

Table 3. Average percent control of trifluralin susceptible broadleaf weeds in research trials when trifluralin and metribuzin, alone and in a tank-mix combination, are preplant soil incorporated.

Trifluralin Susceptible Broadleaf Weeds	Number of Locations	Trifluralin	Trifluralin + Metribuzin	Metribuzin
Redroot pigweed	5	88	89	90
Common lambsquarters	3	97	98	98
Common purslane	1	98	95	85

Trifluralin and metribuzin applied alone and as a tank-mix combination provided 85 to 93 percent control of redroot pigweed (*Amaranthus retroflexus*), common lambsquarters (*Chenopodium album*), and common purslane (*Portulaca oleracea*).

Metribuzin and trifluralin+metribuzin provided similar control of trifluralin resistant broadleaf weeds except for ivyleaf morningglory (Table 4).

Table 4. Average percent control of trifluralin resistant broadleaf weeds in research trials when trifluralin and metribuzin, alone and in a tank-mix combination, are preplant soil incorporated.

Trifluralin Resistant Broadleaf Weeds	Locations	Trifluralin	Trifluralin + Metribuzin	Metribuzin
Pennsylvania smartweed	1	70	100	100
Velvetleaf	2	41	92	95
Prickly sida	1	40	90	95
Ivyleaf morningglory	2	37	90	56
Common ragweed	9	24	84	82
Jimsonweed	3	39	73	76

The combination treatment provided 90 percent ivyleaf morningglory control compared with 56 percent control with metribuzin applied alone. Metribuzin alone or in a tank-mix combination with trifluralin provided greater than 80 percent control of Pennsylvania smartweed, velvetleaf, prickly sida, and common ragweed. Control of jimsonweed was marginal at 73 and 76 percent for trifluralin+metribuzin and metribuzin, respectively.

Table 5 summarizes weed control data obtained with the trifluralin+metribuzin tank-mix combination in all eleven research trials combined with the 36 Experimental Permit Trials (Table 5).

Table 5. Average percent control in research and Experimental Permit trials when trifluralin+metribuzin as a tank-mix combination is preplant soil incorporated.

Weed Species	Number of Locations	Percent Control[a]
Foxtails	19	96[b]
Large crabgrass	3	96
Barnyardgrass	5	93
Fall panicum	3	95
Redroot pigweed	9	92
Common lambsquarters	5	98
Common purslane	2	98
Pennsylvania smartweed	4	96
Velvetleaf	7	96
Prickly sida	1	90
Ivyleaf morningglory	4	88
Common ragweed	27	85
Jimsonweed	7	84
Venice mallow*	8	97
Common cocklebur	5	66
Wild mustard*	1	100
Quackgrass*	3	27
Perennial sowthistle*	2	25
Yellow nutsedge*	8	9
Horsenettle*	2	0
Common milkweed*	3	0
Black nightshade*	2	0

a/ Trifluralin+metribuzin was applied at rates indicated in Table 1.

b/ Data represent weed control evaluations made at midseason except for the species designated by an asterisk which had only early ratings.

When all trials were combined and averaged, trifluralin+metribuzin provided commercially acceptable midseason control of the following weed species: foxtails, large crabgrass, barnyardgrass, fall panicum (*Panicum dichotomiflorum*), redroot pigweed, common lambsquarters, common purslane, Pennsylvania smartweed, velvetleaf, prickly sida, ivyleaf morningglory, common ragweed, and jimsonweed.

Venice mallow and wild mustard were controlled based on early season ratings. The average control of common cocklebur was 66 percent with trifluralin+metribuzin at midseason. Weed species not controlled by the combination were: quackgrass (Agropyron repens), perennial sowthistle (Sonchus arvensis), yellow nutsedge (Cyperus esculentus), horsenettle (Solanum carolinense), common milkweed (Asclepias syriaca), and black nightshade (Solanum nigrum).

Soybean injury was less than four percent with the three treatments (Table 6). Less injury was evident at midseason than early in the season with trifluralin+metribuzin and metribuzin treatments. Less injury was also observed in several experiments with tank-mixed trifluralin+metribuzin than with metribuzin alone.

Table 6. Average percent soybean injury, emergence and yield in research trials when trifluralin and metribuzin[a], alone and in a tank-mix combination, are preplant soil incorporated.

	Crop Injury		Crop Emergence[b]	Yield[c]
	Early Season	Mid-Season	(% of Control)	(% of Control)
Trifluralin	0.3	0.6	100	96
Trifluralin+ Metribuzin	3	1	100	121
Metribuzin	3.6	0.8	100	120

a/ Trifluralin and metribuzin were applied at the rates indicated in Table 1.

b/ Percent crop emergence was calculated as follows: emergence in treated plots divided by emergence in control plots x 100.

c/ Yield data were collected from only two trials established in 1972 and calculations are the same as with emergence data.

Trifluralin or metribuzin either alone or in a combination did not affect crop emergence. An increase in soybean yield occurred in the plots treated with trifluralin+metribuzin or metribuzin compared with yield in cultivated control plots. The yield in the trifluralin treated plot was similar to the yield in the control plots.

Results presented here demonstrate that the tank-mix combination of trifluralin+metribuzin preplant soil incorporated provides broad spectrum control of weeds in soybeans at rates that have adequate crop safety.

WEED CONTROL IN DOUBLE CROPPED SOYBEANS

J. V. Parochetti [1]

ABSTRACT

Weed control in double cropped soybeans (Glycine max L.) following barley (Hordeum vulgare L.) was evaluated in field studies conducted from 1970 to 1973. Best control of weeds present after barley harvest occurred with herbicide combination containing the foliar active herbicide paraquat (1,1'-dimethyl-4,4'bipyridium, chloride) or glyphosate (N-(phosphonomethyl)glycine). Weeds present after barley harvest were horseweed (Conyza candensis (L.) Cronq.), common ragweed (Ambrosia artemisfolia L.) and fall panicum (Panicum dichotomifolium Michx.). Fall panicum 12 inches tall was not controlled by paraquat, but 3 inch fall panicum was controlled by paraquat. Best control of weeds emerging after soybean planting occurred with a combination of a foliar herbicide plus residual herbicides. Soybean injury occurred in some years from metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one), chlorbromuron (3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea) and linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea), but where there was adequate weed control yields were not reduced.

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[1] Associate Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742

INFLUENCE OF PREEMERGENCE HERBICIDES, NITROGEN, SOD DENSITY, AND MOWING ON POSTEMERGENCE ACTIVITY OF GLYPHOSATE FOR QUACKGRASS CONTROL

D. D. Baird[1], R. H. Brown[2], and S. C. Phatak[3]

Abstract

Various field investigations utilizing glyphosate [N-(phosphonomethyl)glycine] on Agropyron repens (L.) Beau. during 1973 have defined additional factors to be considered in a herbicidal management program. Combinations (tank mixed) of glyphosate with various preemergence herbicides for residual weed control can substantially influence the amount of regrowth control achieved. Applications of nitrogen prior to applying glyphosate may significantly improve the ultimate activity under sod conditions. The significance of rhizome density and/or previous cultural history as influencing glyphosate activity on Agropyron repens is discussed.

Introduction

During 1971 and 1972, presentations were made concerning the characterization (1, 2, 3) and agronomic factors (4) influencing the effectiveness of glyphosate as a postemergence herbicide for the control of quackgrass (Agropyron repens) (L.). This new class of herbicide has also exhibited high unit activity on a broad spectrum of plants in worldwide testing programs.

Due to the different conditions that may exist when a herbaceous perennial weed system is encountered, further studies utilizing glyphosate were initiated to define the response of quackgrass to various management and cultural systems. The specific studies entailed evaluating the response of quackgrass to postemergence applications of glyphosate after prior fertilization with various levels of nitrogen. Zero tillage tests in field corn were established to determine the influence of tank mixing various preemergence herbicides with glyphosate for residual weed control and also to evaluate the influence of quackgrass rhizome density and mowing on postemergence activity and subsequent regrowth.

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[1]Monsanto Company, 800 North Lindbergh Boulevard, St. Louis, Missouri, 63166.

[2]Ridgetown College of Agricultural Technology, Ridgetown, Ontario.

[3]Horticultural Research Institute of Ontario, Box 246, Simcoe, Ontario, N3Y 4L1.

Methods and Materials

Field studies with glyphosate were initiated at several sites throughout Ontario, Pennsylvania, and New York during 1973. The formulation used contained the Mono(Monoisopropylamine) salt of glyphosate N-(phosphonomethyl)glycine and a specific surfactant (MON 0818) at a fixed ratio. This formulation was given the trademark, Roundup*, and contained 3 lb/U.S. gal. of glyphosate. This was the same formulation used during 1972 under the code designation MON 2139. A different formulation was used during 1971, MON 0468, Mono(Dimethylamine) salt of glyphosate supplemented with a different surfactant, MON 0027.

Field studies were conducted at Lebanon and Aldenville, Pennsylvania; Hilton, New York; Ridgetown and Simcoe, Ontario on vigorously growing quackgrass having at least four leaves. The Pennsylvania and New York plots were 4.2 X 9.3 meters, while the Simcoe and Ridgetown, Ontario field plots were 1.2 X 2.5 meters and 2.8 X 9.3 meters respectively. Glyphosate was applied in water at 180 liters/hectare at New York and Pennsylvania sites and at 337 liters/hectare in Ontario. Three replications were used in New York, Pennsylvania, and Simcoe, Ontario, while four replications were utilized at the Ridgetown, Ontario test sites. Nitrogen treatments were made with NH_4NO_3 (33% nitrogen) at rates of 0, 84.5, and 169 kilograms per hectare of actual nitrogen; and applications were made to quackgrass 30 days or more prior to glyphosate applications. Preemergence herbicides used in tank mixes with glyphosate were the available commercial formulations such as:

atrazine	- 80% W.P.
cyanazine	- 80% W.P.
alachlor	- 4 lb/U.S. gal E.C.
simazine	- 80% W.P.
dicamba	- 4 lb/U.S. gal E.C.
chlorbromuron	- 50% W.P.

Rhizome and shoot counts were made prior to the establishment of the quackgrass density studies.

Quackgrass	Hilton, New York			Simcoe, Ontario	
Per 929 sq. c.m.	Corn Stubble	Sod	Fallow	Sod-low density	Sod-high density
Number shoots	74	88	70		
Shoot Fresh Wgt. in grams	72	96	62		
Number of Rhizomes	60	85	55	186	253
Rhizome Fresh Wgt. in grams	87	271	84		

*Registered Trademark of Monsanto Company, St. Louis, Missouri. for herbicide.

At Simcoe, Ontario, mowing was accomplished with a rotary mower set at 7.5 cm in height, and the clippings were not removed.

Assessment of activity was made at various intervals by plant counts or by visually rating herbicidal response by use of a scale of 0-100 with 100 indicating complete control.

Results and Discussion

Treatments of quackgrass under zero tillage conditions using tank mixes of glyphosate and various preemergence herbicides for residual control produced differential activity (Table 1). Relatively high unit activity was achieved when glyphosate was combinated with alachlor plus atrazine or simazine, atrazine plus simazine, or atrazine alone. Substantially less activity was evident when regrowth observations were made on treatments of glyphosate in combination with alachlor plus cyanazine, alachlor plus chlorbromuron, alachlor plus dicamba plus atrazine, and alachlor plus Modown. The greatest decrease in postemergence activity was observed when dicamba and Modown were used in combination with glyphosate at the Hilton site. Reduced activity was not as evident initially as during late season observations. Higher unit activity was generally achieved at the Hilton site in comparison to that at the Lebanon site. Although the exact mechanism for reducing the activity of glyphosate is not currently known, it was surmized during these tests that there might have been translocation antagonism within the quackgrass rhizomes. This would partially explain the substantial regrowth after significant top or shoot destruction. This interaction confirms earlier work (2); and there continues to be a need to study formulation, application sequence, rates, and species involved. The use of preemergence residuals having phytotoxic properties on quackgrass would certainly be expected to have significant management advantages when in a program with glyphosate. Brockman et al. (4) found that EPTC in the overall program with glyphosate tended to increase the degree of quackgrass control as well as providing preemergence control.

The influence of previous nitrogen treatments (Tables 2, 3) on glyphosate activity on quackgrass was most noticeable at low threshold rates and/or under conditions of sod buildup. Where high fertility had been practiced during the immediate past (Table 2 - Hilton site), then additional amounts of nitrogen did not improve postemergence activity. It was noted at this site that extremely high unit activity was also obtained. The competitive capabilities of quackgrass was well illustrated by the reduced corn yields and the obvious yield increases by controlling this tenacious perennial with glyphosate.

Whether the differences in ultimate control of quackgrass by glyphosate after nitrogen treatments are due to initial stimulation

of growth and/or increase in lateral bud-shoot development or to a metabolitic change or expenditure in the rhizome system is only speculative at this time. The data on hand does support the supposition that quackgrass may be more susceptible to herbicides when in a vigorously growing state.

Prior cultural history or rhizome density may be an important consideration in the design of a management program for controlling quackgrass with glyphosate (Tables 4, 5). At both sites, there appears to be a trend towards higher unit activity with the lesser amounts of rhizomes. However, this is most noticeable at lower rates. Justification of an overall rate of 2.2 kg/ha is supported by the data obtained under the different existing conditions. The lack of substantial difference between the eight year sod and one year fallow-mixed vegetation in response to glyphosate would indicate that other as of yet unidentified factors may significantly influence postemergence activity of glyphosate.

This data indicates that the number of shoots produced does not always indicate the amount of rhizomes produced and confirms the findings of Williams(5). Williams(5) indicated that shoots and rhizomes may often be inversely correlated. There is also a definite clonal difference in the amount of rhizomes produced and in the overall morphological appearances of rhizomes(5).

Field studies indicate that mowing quackgrass at various intervals before treatment (DBT) and after treatment (DAT) influence the ultimate activity achieved with glyphosate (Table 6). Mowing immediately before and within one day after application of glyphosate reduces activity as witnessed by the substantial amount of regrowth. This confirms earlier results (1). Mowing three days or more after glyphosate applications did not appear to influence ultimate activity in comparison to the non-mowed treatment. This data would indicate that translocation is essentially completed from the leaf and/or shoot tissue after three days but not after one day.

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TABLE 1. GLYPHOSATE POSTEMERGENCE ACTIVITY ON QUACKGRASS IN COMBINATION WITH VARIOUS PREEMERGENCE HERBICIDES IN ZERO TILLAGE CORN AT TWO NORTHEASTERN NORTH AMERICAN FIELD SITES.

		Percent Inhibition Avg. 3 Reps						
		Lebanon, Pa.				Hilton, N.Y.		
		Quackgrass		Alfalfa		Quackgrass		
Herbicides	Rates kg/ha a.e./a.i.	28 DAT*	85 DAT	28 DAT	85 DAT	24 DAT	88 DAT	118 DAT
Glyphosate + alachlor + atrazine	2.2 + 2.8 + 1.7	83	75	94	77	98	96	97
" " "	1.7 + 2.8 + 1.7	78	63	87	75	80	87	88
" " + cyanazine	2.2 + 2.8 + 2.2	78	48	87	75	99	87	85
" " "	1.7 + 2.8 + 2.2	61	45	75	40	78	55	51
" " + chlorbromuron	2.2 + 2.8 + 2.2	68	53	63	50	96	72	65
" " "	1.7 + 2.8 + 2.2	53	23	65	--	74	56	55
" " + simazine	2.2 + 2.8 + 1.7	83	83	77	80	93	86	88
" " "	1.7 + 2.8 + 1.7	78	75	83	75	70	76	73
" + atrazine + simazine	2.2 + 1.7 + 1.7	58	72	83	68	96	86	89
" " "	1.7 + 1.7 + 1.7	70	70	82	55	80	80	82
" + atrazine	2.2 + 2.2	73	70	73	63	93	92	92
" "	1.7 + 2.2	57	55	63	50	68	77	79
" + alachlor + atrazine + dicamba	2.2 + 2.8 + 1.7 + 0.4	61	62	98	83	97	38	33
" " + Modown	2.2 + 2.8 + 2.2	80	53	95	45	95	30	23
Paraquat + alachlor + atrazine	1.1 + 2.8 + 1.7	71	20	47	--	97	69	65

*DAT - days after treatment.

TABLE 2. INFLUENCE OF NITROGEN LEVELS ON POSTEMERGENCE ACTIVITY OF GLYPHOSATE ON QUACKGRASS AT TWO NORTHEASTERN FIELD SITES.

		Percent Control Quackgrass Avg. 3 Reps				
		Aldenville, Pa.		Hilton, N. Y.		
Glyphosate kg/ha a.e.	kg/ha Nitrogen**	39 DAT*	95 DAT	14 DAT	51 DAT	88 DAT
1.65	0	89	72	68	97	94
1.10	0	63	17	70	94	92
0.55	0	50	7	62	91	89
1.65	82.5	96	89	72	95	98
1.10	"	80	35	66	97	97
0.55	"	63	8	61	93	90
1.65	165	98	91	72	98	97
1.10	"	90	67	65	95	97
0.55	"	68	7	60	92	89

*DAT - days after treatment.

**Nitrogen applied 30 days or more before glyphosate application.

TABLE 3. INTERACTION OF GLYPHOSATE AND NITROGEN FOR QUACKGRASS CONTROL UNDER TWO CULTURAL SYSTEMS AT RIDGETOWN, ONTARIO.

		Avg. 4 Reps			
		Sod - Fallow		Cultivated - Corn	
Glyphosate kg/ha a.e.	kg/ha Nitrogen*	# Regrowth** Shoots/3700 sq. cm.	% Control	# Regrowth Shoots/3700 sq. cm.	% Control
1.65	0	5	84	7	86
1.10	0	19	39	17	75
0.55	0	31	0	25	49
0.00	0	31	0	49	0
1.65	82.5	5	89	6	84
1.10	"	12	75	12	68
0.55	"	25	47	14	63
0.00	"	47	0	38	0
1.65	165	7	83	5	88
1.10	"	11	72	8	80
0.55	"	30	25	10	76
0.00	"	40	0	41	0

*Nitrogen applied 30 days before glyphosate application.

**Results taken 95 days after application.

TABLE 4. GLYPHOSATE POSTEMERGENCE ACTIVITY AS INFLUENCED BY QUACKGRASS DENSITY OR PRIOR HISTORY IN NO-TILL CORN AT HILTON, NEW YORK.

Glyphosate kg/ha a.e.	Quackgrass stand/history	Avg. 3 Reps. Quackgrass 14 DAT*	51 DAT	88 DAT
2.20	Moderate in	83**	95	95
1.10	no-till corn	73	91	93
0.55	for 1 year	61	90	90
2.20	Heavy sod	64	93	93
1.10	8 years old	55	91	88
0.55		42	80	63
2.20	Mixed veg.	64	94	83
1.10	fallow for	47	91	75
0.55	1 year	42	72	52

*DAT - days after treatment.

**Percent control.

TABLE 5. EFFECT OF QUACKGRASS RHIZOME CONCENTRATION ON POSTEMERGENCE ACTIVITY OF GLYPHOSATE AT SIMCOE, ONTARIO

Glyphosate kg/ha	Quackgrass rhizomes Density - #/929 sq cm	Avg. 3 Reps. Number of Shoots/929 sq cm	Percent Control
2.20	"High" - 253	1	98
1.70	"	8	83
1.10	"	4	91
0.55	"	40	13
0.00	"	46	0
2.20	"Low" - 186	0	100
1.70	"	0	100
1.10	"	0	100
0.55	"	7	91
0.00	"	74	0

TABLE 6. EFFECT OF MOWING QUACKGRASS BEFORE AND AFTER POSTEMERGENCE APPLICATION OF GLYPHOSATE ON QUACKGRASS UNDER FIELD CONDITIONS AT SIMCOE, ONTARIO DURING 1973.

	Quackgrass plants per 929 sq. cm.						
	Time of mowing before or after spraying						
Glyphosate kg/ha	Not mowed	1 day before	Immed. after	1 day after	3 days after	7 days after	10 days after
2.24	1	35	43	25	3	5	3
1.78	8	53	58	29	3	2	4
1.12	4	65	74	62	7	3	7
0.56	40	62	74	59	33	38	25
0	46	75	50	45	62	52	60

QUACKGRASS CONTROL THE SEASON AFTER GLYPHOSATE APPLICATION IN THREE AGRONOMIC CROPS

P. K. Fay, J. F. Hunt, W. B. Duke and R. F. Lucey 1/

ABSTRACT

N-(phosphonomethyl)glycine (glyphosate) provided excellent control of quackgrass (Agropyron repens (L.) Beauv.) in alfalfa (Medicago sativa L.), corn (Zea mays L.) and soybeans (Glycine max (L.) Merr.) the year after spring applications to dense quackgrass sods. In alfalfa, 1, 2 and 3 lb/A resulted in 90-95% control in the second season. In corn and soybeans, a definite rate response was observed the second year, in contrast to the results of the first season. At 1.5 lb/A, quackgrass control was only 40-50% but at 3 lb/A, 75% control was maintained through the second season.

INTRODUCTION

N-(phosphonomethyl)glycine (glyphosate) has been shown to give excellent control of quackgrass (Agropyron repens (L.) Beauv.) during the season of herbicide application (1,2,3). Quackgrass reinfestation in the season following application is a problem with several other herbicides which have provided good control initially (4). Information is therefore needed concerning the duration of control obtained with glyphosate. The studies reported here were conducted to determine the effectiveness of glyphosate in providing quackgrass control in the second season after applications in alfalfa (Medicago sativa L.), corn (Zea mays L.), and soybeans (Glycine max (L.) Merr.).

MATERIALS AND METHODS

Alfalfa: A study was initiated at Aurora, New York in the fall of 1971 to examine the effect of rate and season of application of glyphosate on quackgrass control in alfalfa. This experiment has been previously described and the results obtained in the first year reported (3). In 1973, harvests were made on June 13 and July 25. An area 3 x 27 feet was cut through the center of each plot for yield determination. A subsample was composited from four locations within each plot for determination of botanical composition. These samples were hand separated according to species, oven-dried to constant weight (75°C) and weighed.

Corn and Soybeans: Two studies located at Miner Institute, Chazy, New York were conducted to determine the effect of glyphosate applied with and without various recommended residual herbicides on quackgrass control in corn and soybeans. A split plot design replicated four times was utilized for the two experiments with glyphosate rates being assigned to the main plots and residual herbicides to the subplots. Subplot size was 12 x 20 feet. Glyphosate was applied to an established quackgrass sod in the 3 to 4 leaf stage on May 22, 1972 at rates of 0, 1.5, and 3 lb/A. Plowing was done one week later after which time the two crops were planted.

1/ Graduate Assistant, Experimentalist, Associate Professor and Professor, respectively, Agronomy Department, Cornell University, Ithaca, New York.

In 1973, the residual preemergence chemical treatments for annual weed control in corn consisted of the following: 1) 2 lb/A of 2-chloro-4(ethylamino)-6-(isopropylamino)-s-triazine (atrazine); 2) 1 lb/A of atrazine plus 2 lb/A of 2-(chloro-2',6'-diethyl-N-methoxymethyl) acetanilide (alachlor); 3) 2 lb/A of 2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile (cyanazine); and 4) 2 lb/A of cyanazine plus 2 lb/A of alachlor. Preemergence treatments for annual weed control in soybeans were as follows: 1) 3 lb/A of 3-amino-2,5-dichlorobenzoic acid (chloramben); 2) 1 lb/A of 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron) plus 2 lb/A of alachlor; 3) 2 lb/A of linuron; and 4) 2 lb/A of alachlor plus 0.25 lb/A of 4-amino-6-t-butyl-3-(methylthio)-2,2,4-triazin-5(4H)-one (metribuzin).

In 1973, the experimental area was plowed and replanted to the same crop. All the corn plots which had been treated with residual chemicals in 1972 were treated with 1 lb/A of atrazine plus 2 lb/A of alachlor. In the soybean experiment, 1 lb/A of linuron and 2 lb/A of alachlor were applied to those plots receiving a residual herbicide treatment in the previous year.

Quackgrass control was evaluated by making stand counts in August 1972 and September 1973. The number of plants per square yard was determined at two randomly selected locations within each plot.

RESULTS

Alfalfa: The spring application of glyphosate provided excellent quackgrass control in the second season while the fall applications resulted in a decidedly lower degree of control (Fig. 1). Furthermore, the same high degree of control was observed in both harvests indicating that the effectiveness of glyphosate was maintained at a consistently high level throughout the second season (Table 1). Control of quackgrass with the spring application of glyphosate

Table 1. Second year yield of alfalfa and quackgrass control as affected by glyphosate with or without EPTC in the seedling year. Aurora, N.Y. 1973.

Time of Application	EPTC b/	Yield c/, lbs/A dry matter			% Quack. Control		
		Harvest			Harvest		
		I d/	II	Total	I	II	Means
Fall, 1971	-	2309 bc	2669 bc	4978 bc	32	40	36.0 b
	+	2767 a	2896 ab	5663 ab	37	34	35.5 b
Spring, 1972	-	2560 ab	2981 ab	5541 ab	94	86	90.0 a
	+	2894 a	3163 a	6057 a	97	93	95.0 a
Control	-	2078 c	2460 c	4530 c	0	0	0.0 c
	+	2091 c	2777 abc	4868 bc	15	48	31.5 b

a/ Glyphosate was applied to sod at 1, 2, and 3 lb/A.
b/ EPTC was applied preplant incorporated on May 26, 1973.
c/ Yield values are means for the three rates of glyphosate applied, no statistical differences were found between rates within time.
d/ Yield values within a column followed by identical letters are not significant at the .05 level of significance.

resulted in an increased yield of alfalfa. The control of yellow foxtail (Setaria glauca (L.) Beauv.), which infested the experimental area in the seedling year by S-ethyl dipropyl thiocarbamate (EPTC) at 4 lb/A resulted in a further yield increase.

The results obtained in this experiment suggest that application of glyphosate at a rate as low as 1 lb/A provides highly effective quackgrass control in alfalfa for at least two seasons. There was no rate response for either the fall or spring treatment. EPTC (4 lb/A) resulted in no signficant increase in the degree of second season quackgrass control.

Corn and Soybeans: In 1972, 3 lb/A of glyphosate provided excellent control of quackgrass in both corn and soybeans. Control obtained at the 1.5 lb/A rate was slightly less effective. Of all the residual herbicide treatments in both experiments, only atrazine caused any additional reduction in quackgrass stand (Table 2). In both crops, the quackgrass control resulting from the 1972 application of 1.5 lb/A of glyphosate was less in the second year as compared with the first (Fig. 2). A similar, though less pronounced, trend was observed at the 3 lb/A rate.

Table 2. Quackgrass Stand as Affected by Glyphosate and Residual Chemicals. Chazy, New York.

1972 Corn and Soybean Residual Chemical	Rate lb/A	Stand Count, No. of Plants/yd^2					
		1972			1973		
		Rate of Glyphosate			Rate of Glyphosate		
		0	1.5	3	0	1.5	3
atrazine	2	16	3	2	20	16	2
atrazine + alachlor	2+1	18	6	2	26	18	6
cyanazine	2	59	11	5	37	21	6
cyanazine + alachlor	2+2	37	3	4	31	19	16
control	-	49	6	3	34	16	8
Corn means		36	6	3	29	18	8
chloramben	3	23	4	1	33	8	8
linuron + alachlor	1+2	14	4	1	23	15	4
linuron	2	26	3	0	24	14	4
alachlor + metribuzin	2+.25	24	6	1	27	17	6
control	-	21	4	5	31	10	10
Soybean means		22	4	2	28	13	6

DISCUSSION

Although precise comparisons cannot be made, there are apparent differences in duration of quackgrass control among these studies. In the alfalfa experiment, highly effective quackgrass control persisted through the second year. However in corn and soybeans, though a high degree of control was obtained the first year, it was noticeably reduced in the second. If these differences are due to a crop related factor, they might result from (1) superior competitive ability of second year alfalfa in comparison to corn or soybeans, (2) removal of quackgrass top growth several times during the season in forage harvesting or (3) tillage in ground preparation for the second year of corn and soybeans.

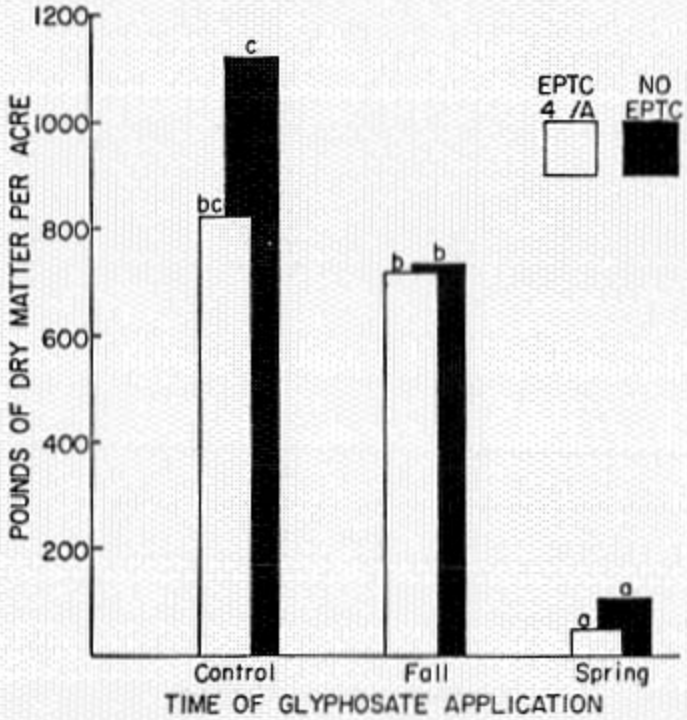

Fig. 1. Quackgrass yield in two cuttings of alfalfa as affected by glyphosate applied in fall or spring with or without a preplant incorporated treatment of EPTC. Aurora, N.Y. 1973
(Bars with the same letter do not differ significantly at the .05 level)

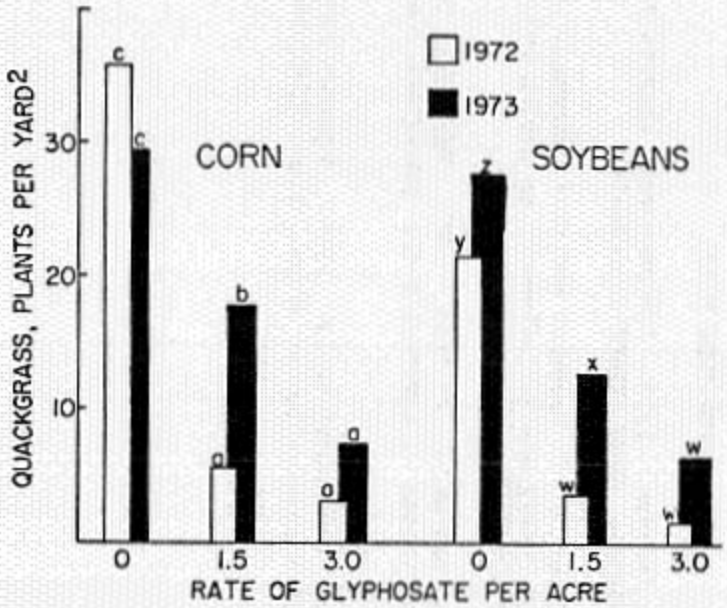

Fig. 2. Quackgrass stand in corn and soybeans in August 1972 and September 1973 as affected by glyphosate applied to sod on May 22, 1972.
(Bars with the same letter do not differ significantly at the .05 level)

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THE INFLUENCE OF SOD DENSITY AND TIME OF PLOWING ON QUACKGRASS CONTROL WITH GLYPHOSATE

B. J. Brecke, J. F. Hunt, P. K. Fay, and W. B. Duke [1/]

ABSTRACT

An experiment conducted during 1973 showed that quackgrass (Agropyron repens (L.) Beauv.) control with N-(phosphonomethyl)glycine (glyphosate) was not affected by tillage interval or initial sod density. There was also no difference in quackgrass control between 1.5 and 3.0 lb/A of glyphosate.

INTRODUCTION

Since the introduction of the N-(phosphonomethyl)glycine (glyphosate) as a potential herbicide for (Agropyron repens (L.) Beauv.) quackgrass, several studies have been conducted to determine the proper rate, time of application and interval between treatment and tillage to obtain maximum control (1,3). One factor that has not been studied to any great extent in the field is the influence of initial quackgrass sod density on the efficacy of glyphosate. This study was conducted to determine the effect of sod density and interval between application and tillage on the control of quackgrass with this herbicide.

MATERIALS AND METHODS

In the spring of 1973, an area near Etna, N. Y. with a non-uniform quackgrass infestation on an Erie channery silt loam was selected for this test. The factorial experiment included two sod densities, three intervals between herbicide application and plowing, and three rates of glyphosate. Each treatment was replicated four times.

The experimental area was initially divided into 8 x 25 ft plots. Since Proctor (4) had previously demonstrated that rhizome measurements were the most accurate for estimating quackgrass densities, this method was utilized. Soil cores 5.5 inches deep and 5.25 inches in diameter were obtained on May 8 from four randomly selected locations within each plot. The rhizomes in each core were separated from the soil and weighed. Each plot was also visually rated to estimate quackgrass density. From the original 120 plots, 36 high density and 36 of low density were chosen on the bases of total rhizome weights, least standard deviation between the fresh weights of the four rhizome samples and visual density ratings (Table 1).

1/ Graduate Assistant, Experimentalist, Graduate Assistant, and Associate Professor, respectively. Department of Agronomy, Cornell University, Ithaca, New York 14850.

Table 1. Quackgrass density estimates on May 8, 1973.

Density	Rhizome Fresh Wt. (lb/A)	Range of Fresh Wt. (lb/A)	Visual Rating % Ground Cover
Low	2552	575 to 3729	48.6
High	5161	3326 to 7573	61.0

Treatments were randomly assigned to plots within the high and low soil density classifications. Glyphosate, as the mono-(dimethylamine) salt of N-(phosphonomethyl)glycine formulated with surfactant, was applied at 0, 1.5 and 3 lb/A when the quackgrass was in the 5-6 leaf stage of growth (June 1, 1973). The herbicide was applied with a Mater plot sprayer calibrated to deliver 30 gpa with compressed air as a pressure source. Rainfall of approximately 0.1 inch occurred on June 2. The sod was plowed 1, 3 and 8 days after glyphosate application. All plots were disced after the final plowing.

Quackgrass topgrowth was harvested on November 2, 1973 from two 2 ft^2 areas chosen at random in each plot. The samples from each plot were combined, oven dried (75°C to a constant weight) and the dry weights were obtained. The data were subjected to analyses of variance and means were compared with the LSD test.

RESULTS AND DISCUSSION

Glyphosate reduced quackgrass regrowth by over 90% when tillage was performed as close as 1 day after application (Table 2). There was no difference in the amount of regrowth which occurred when tillage was performed 1, 3 or 8 days after glyphosate application. Later plowing with no herbicide did cause some reduction in regrowth. This data indicates that 1.5 lb/A of glyphosate controls quackgrass as effectively as 3 lb/A and that an interval between application and plowing of 1 day is adequate.

Table 2. Quackgrass regrowth as affected by rates of glyphosate and tillage intervals.

Glyphosate lb/A	Quackgrass Topgrowth (lb/A)			
	Time of Plowing			
	1 day	3 days	8 days	Mean
0	2125 a	1547 b	1418 b	1697 x
1.5	163 c	204 c	91 c	154 y
3	122 c	242 c	156 c	173 y

Values followed by the identical letters within a column or row are not significantly different at the 5% level.

Initial quackgrass density influenced the regrowth of quackgrass if the overall density means are compared (Table 3). But if the means for 1.5 and 3 lb/A of glyphosate are compared, there are no differences in quackgrass regrowth between treated plots regardless of initial infestation. The values for the untreated plots indicate that a difference in quackgrass density was still present in the areas not treated with glyphosate.

Table 3. Quackgrass regrowth as affected by glyphosate applied to quackgrass sods of different density.

Glyphosate lb/A	Quackgrass Topgrowth (lb/A) Low	High
0	1401 b	1993 a
1.5	127 c	180 c
3	125 c	223 c
Mean	551 y	799 z

Values followed by the identical letter within a row or column are not significantly different at the 5% level.

These findings indicate that sod density does not alter the effectiveness of glyphosate in controlling quackgrass when applied at 1.5 or 3 lb/A. Baird et. al (2) reported that in a greenhouse study, a high density of rhizomes resulted in more regrowth after treatment than did a low density. However, in their study the highest rate of glyphosate used was 0.25 lb/A which is much lower than the rates used in this study.

The results obtained from the comparison of tillage intervals after herbicide application confirm the report of Brockman et. al (3) that an interval of 1 day is adequate rather than a 3 week interval as reported by Baird et. al (1). This additional time period could be critical to the grower of many crops, since it would allow planting in time to assure crop maturity.

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EVALUATION OF A CONTROLLED RELEASE ALGAECIDE BY A GREENHOUSE METHOD

B. A. Schneider, W. V. Audia, and R. F. Thomas[1/]

A greenhouse method has been developed for evaluating the efficacy of algaecides at the Plant Biology Laboratory, Beltsville, Maryland. Polyethylene-lined pans (87.6 by 45.7 by 15.2 cm inside dimensions) are filled with 56.78 l of tap water. Ten g of a 23-19-17 fertilizer are added to each pan. Water levels are kept constant with a continuous-leveling device and the water pH is adjusted to 7.2-7.6. A motor-driven shaft is positioned above the pans. Four plastic panels (15.2 by 7.6 by 0.3 cm) are attached to the shaft above each pan. These panels dip into the water 4 times a minute. The test is conducted under greenhouse conditions with artificial lighting to extend the daylength to 16 hours. A 0.01 ml aliquot from a mixed algae suspension is transferred to each pan. The pans are arranged in a completely randomized design with 3 replications for each algaecide tested. Algaecides are applied according to their label rates to the pans and the test is conducted for a minimum of 4 weeks. Visual observations are recorded weekly and rated on a scale of 0 to 5 (0 = no growth, 5 = heavy growth). The product must provide at least 70% control of algae growth by the end of the test period.

An experimental encapsulated copper sulfate algaecide, designed to provide slow release of copper over a long period of time, was evaluated by the greenhouse method. Rates of 5.7, 11.4, and 22.7 kg/1233.5 m^3 were compared with a standard cupric sulfate pentahydrate (0.63 ppm). The capsules did not release copper fast enough or in adequate amounts to control algae growth. A new encapsulated formulation is also being investigated by the greenhouse method.

[1/] Plant Physiologists and Chemist, respectively, U.S. Environmental Protection Agency, Chemical and Biological Investigations Branch, Agricultural Research Center-East, Beltsville, Maryland 20705.

INFLUENCE OF PLANT GROWTH REGULATORS ON THE UPTAKE OF NAPTALAM BY POTAMOGETON

By

Robert M. Devlin 1/

INTRODUCTION

The transport of nutrients and metabolites in the growing plant and, particularly, to the developing seed and ripening fruit, are to a great extent under the direction of plant growth hormones. Early workers demonstrated that the movement of soluble carbohydrates, nitrogenous compounds, and ions to certain areas of the plant was enhanced when those areas were treated with indole-3-acetic acid (IAA). However, this enhancement extended over a prolonged period of time and no attempt was made to distinguish whether the influence of IAA was due to a stimulation of growth or to a direct effect of the hormone on the transport mechanisms. More recent experiments have demonstrated that hormone-directed transport can occur in plants within a relatively short period of time following application of the hormone. This more recent interest in the hormone-directed transport of metabolites--their uptake, transport, and accumulation--originated with the work of Mothes and his co-workers in Germany (12,13,14,15,16) and Osborne and McCready (8,9,10,11,17, 18) in England. Their studies were supported and considerably extended by Wareing and his colleagues also from England (1,2, 19,21).

The stimulatory influence of growth hormones on the uptake of compounds commonly found in plants has led to the testing of this influence on compounds foreign to plants (e.g., herbicides). It has been demonstrated (3) that treatment of redtop grass (Agrostis alba) with IAA and gibberellic acid (GA) increases its sensitivity to the herbicide 2-chloro--4,6-bis (ethylamino)-s-triazine (simazine). Devlin et al. (5) found that simultaneous

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1/ Associate Professor of Plant Physiology, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts.

application of either IAA or GA with 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) enhanced the toxic efficiency of the herbicide on poison ivy (Rhus toxicodendron). Residue analyses of plants treated with the hormone-herbicide combinations and plants treated with only the herbicide were compared. More silvex was found in the plants treated with the hormone-herbicide combinations. Recently, Devlin and Yaklich (4,6,7) have shown that bean (Phaseolus vulgaris) and sago pond plants (Potamogeton pectinatus) treated with GA, 2,4-dichlorophenoxyacetic acid (2,4-D) and parachlorophenoxyacetic acid (PCPA) will take up considerably more N-1-naphthylphthalamic acid (naptalam) than untreated plants.

In the present paper the influence of GA, 2,4-D, PCPA, and 2,4,5-trichlorophenoxypropionic acid (2,4,5-TP) on the uptake of naptalam by the American pond weed (P. nodosus) and sago pond plants is described.

MATERIALS AND METHODS

P. nodosus buds and P. pectinatus tubers were grown in one-gallon battery jars containing a complete inorganic medium (Hoagland No. 1--half strength). All solutions were aerated for 1 hr before the tubers and buds were planted and for 2 hr daily thereafter. Temperature (22 $\pm$ 1°C), light intensity (800 ft-c), and light duration (continuous)were controlled by growing the plants in a growth chamber (Percival E-54U model). A constant pH of 6.0 $\pm$ 0.2 was maintained. Algal growth was controlled with the addition of 1 ppm $CuSO_4$ and twice during the growth period the plants were transferred to fresh media.

Sago pond plants were allowed to grow for 20 days and American pond plants for 30 days under the above conditions, after which they were removed and immersed in solutions containing combinations of naptalam and the plant growth hormone to be tested. The concentration of naptalam when used alone (control) and in combinations with the growth hormones was 50 ppm. Temperature, light, and pH were controlled as before. After 24 hr. exposure to naptalam the plants were removed and washed thoroughly with distilled water. The plant tissues were cut into small pieces and dried at 45°C for 48 hr in preparation for extraction of naptalam. Before being extracted the dried plant tissue was ground into a fine powder by a Wiley mill. Each experiment was replicated four times.

Naptalam content was determined, with only slight modifica-

tions, by the method of Smith and Stone (20). 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 Perkin-Elmer double beam spectrophotometer. A linear relationship exists between the intensity of color and the amount of 1-napthylamine present.

RESULTS

Sago pond plants responded to 2,4-D and PCPA treatments with a significant increase in the uptake of naptalam. At the highest concentration of 2,4-D used (10^{-4}M), naptalam uptake was increased by 139% over the control (Figure 1). The acceleration of naptalam uptake decreased with decrease in the concentration of 2,4-D, the lowest concentration (10^{-7}M) causing only a 15% increase over control.

PCPA, on the other hand, had a more erratic influence on the uptake of naptalam by sago pond plants. At 10^{-4}M PCPA the plants contained 486% more herbicide than control plants (Figure 1). It is possible that with the use of such a high concentration of PCPA, some deterioration of membrane permeability properties may have occurred. However, at 10^{-5}M a sharp drop in the acceleration of naptalam uptake was observed, but still remained a substantial 190% over the control. At the lower concentration of PCPA (10^{-6} and 10^{-7}M) only small increases in herbicide uptake were noted (Figure 1).

The influence of 2,4,5-TP and GA on naptalam uptake by the American pond weed resembles that of 2,4-D and PCPA on the sago pond plant. American pond weeds treated with 100 ppm GA took up 337% more naptalam than untreated plants (Figure 2). When treated with 50 ppm GA, 62% more naptalam was absorbed.

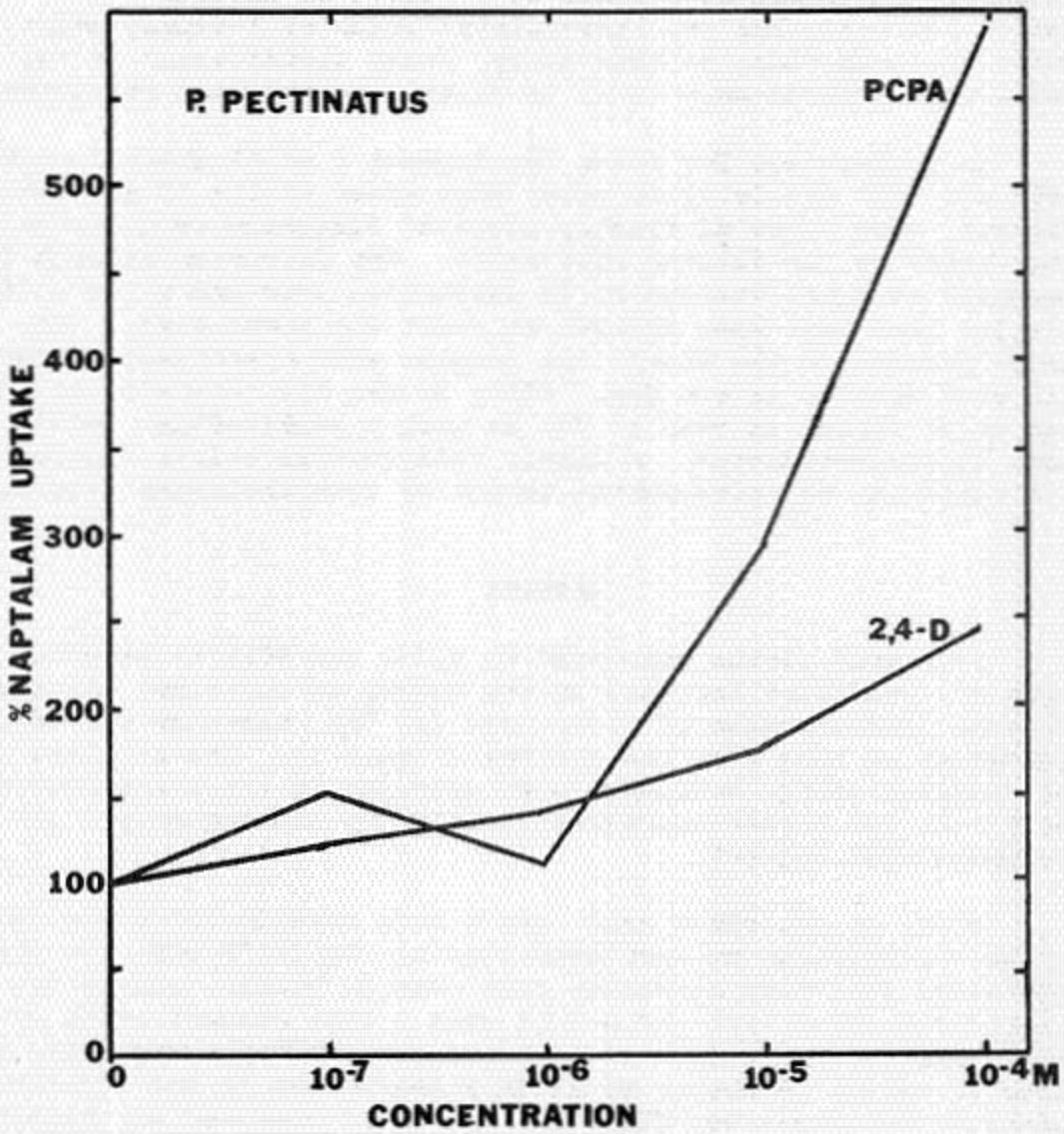

Figure 1. Uptake and accumulation of naptalam by sago pond plants treated with the phenoxy growth regulators 2,4-D and PCPA. The data are given as percents of the control.

At the highest concentration of 2,4,5-TP used (100 ppm), an increase in naptalam uptake by the American pond weed of over 500% was recorded (Figure 2). This dramatic increase in uptake suggests, as it did with the use of PCPA on sago pond plants, that membrane permeability properties may have been adversely

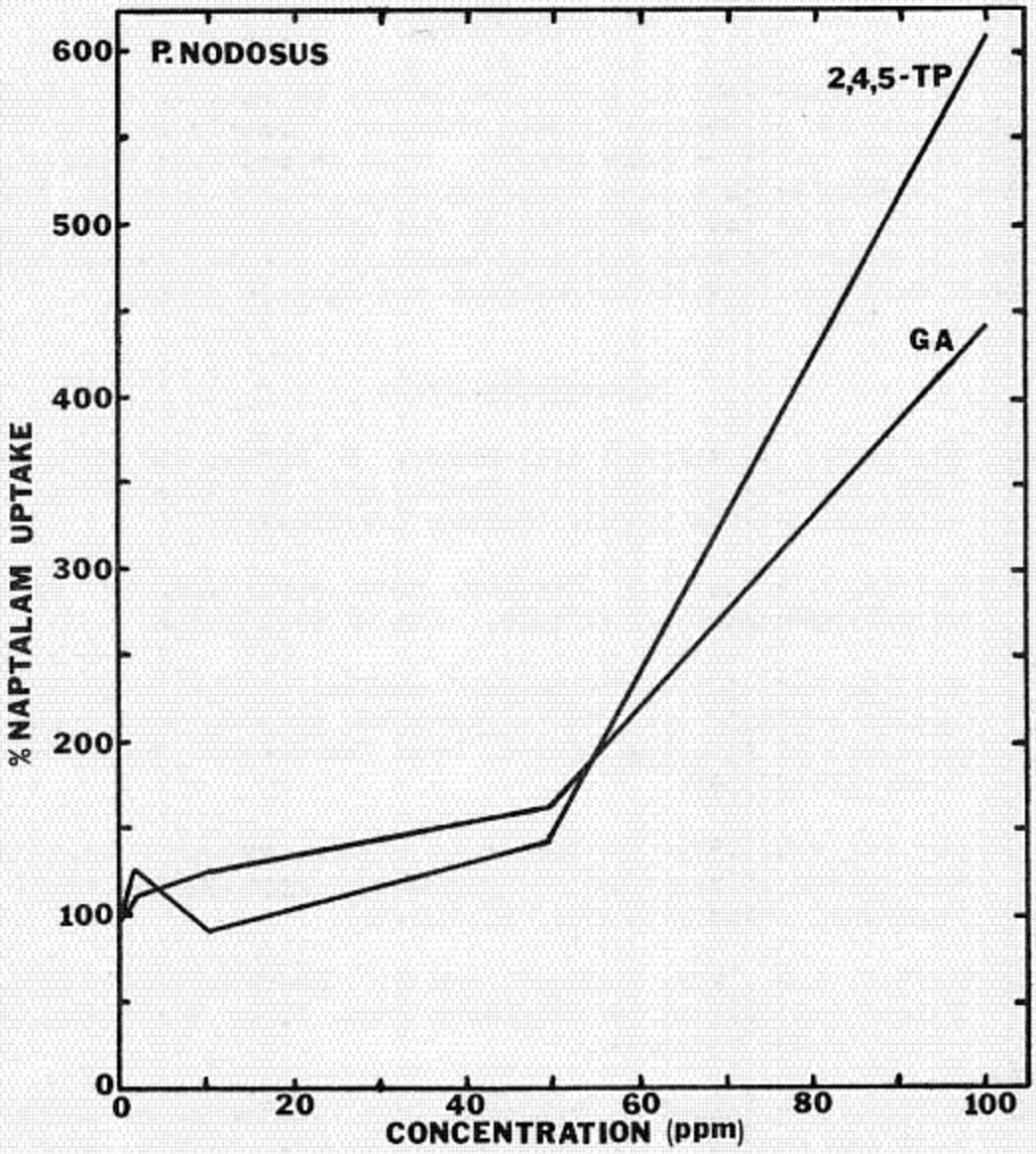

Figure 2. Influence of 2,4,5-TP and GA on the uptake and accumulation of naptalam by P. nodosus. The data are given as percents of the control.

affected by the high concentration of growth hormone used. When treated with 50 ppm 2,4,5-TP, American pond weeds responded with less than a 50% increase in naptalam uptake. No significant increase in uptake was observed when concentrations of 2,4,5-TP lower than 50 ppm were used (Figure 2).

DISCUSSION

The enhancement of herbicide uptake by species of Potamogeton with GA or phenoxy growth hormones supports work by Devlin and Yaklich (6,7) on bean plants. They showed that bean plants take up considerably more naptalam when treated with GA, PCPA, or 2,4-D. With the completion of the present study, the phenomenon of growth hormone enhanced herbicide uptake has now been shown to occur in both terrestrial and aquatic plants.

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EFFECT OF N-1-NAPHTHYLPHTHALAMIC ACID ON GROWTH OF EXCISED *PISUM SATIVUM* ROOT TIPS

Douglas H. Gaither[1,2]

ABSTRACT

Root growth is controlled by a multiplicity of factors not the least of which involves auxin. The molecular site of auxin action is reported to be coincident with the site of auxin transport. N-1-Naphthylphthalamic acid (NPA) is a potent auxin transport inhibitor. I have examined the effects of the sodium salt of NPA on the growth of excised pea root tips in order to gain information on how this important growth regulating chemical acts at the molecular level.

NPA inhibited length growth by about 52% at 10 μM. The NPA-induced growth cessation was immediate but reversible. NPA did not inhibit increase in fresh weight (water uptake) to as great an extent as length increase. Since the sections continued to grow transversely but not longitudinally, they appeared swollen. Root hairs were also induced. Besides inhibiting growth of the root sections, NPA also caused a distinct curling of the apex.

In roots a delicate balance exists between auxin and another natural plant growth hormone, ethylene. Auxin application inhibits root growth and causes an increase in their ethylene production. Indeed, ethylene causes growth inhibition in roots accompanied by swelling and root hair induction. Therefore, the gas has been proposed to be the mediator of auxin action in roots. A competitive inhibitor of ethylene action, carbon dioxide, overcame NPA-induced growth inhibition but did so noncompetitively. This plus the fact that additive growth inhibition occurred when roots were treated with NPA and ethylene simultaneously indicates that NPA and ethylene have different sites of action. Additive inhibition did not occur when roots were treated simultaneously with NPA and auxin. This suggests that NPA and auxin have similar sites of action. The implications of these experiments support the identical molecular-transport site concept for auxin. Also, at least two processes seem to be involved in NPA-induced root growth inhibition. First, if NPA interferes with auxin at its primary site of action, a disruption of the positive radial auxin gradient thought to be present in normally growing roots could result. This is a condition speculated to be a predominate growth inhibitory mechanism in roots. Second, the rearranged auxin distribution could allow some of the endogenous ethylene which is diffusing among the root cells not to be counterbalanced by its appropriate auxin titre. Thus, ethylene is free to act upon the root resulting in growth inhibition.

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[1]Plant Physiologist, Vegetation Control Division, Fort Detrick, Frederick, MD 21701

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EFFECT OF ALACHLOR ON WATER LOSS BY SWEET CORN (ZEA MAYS VAR. RUGOSA L.)

Richard A. Ashley[1/]

Abstract

Determinations were made in a controlled environment chamber of the rate of water loss from sweet corn (Zea Mays var. rugosa L.) treated with alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide) as compared to untreated plants. Sweet corn treated with alachlor was found to lose up to 13% more water in a 33-hour period than untreated plants. Porometer measurements indicated that stomatal resistance was less in leaves of treated plants than leaves of the control.

Introduction

Experiments were conducted in 1971 at the University of Connecticut Vegetable Research Farm in North Coventry to evaluate herbicides for weed control and crop injury on sweet corn grown under clear plastic mulch. During these trials, sweet corn treated with alachlor at 3 lb ai/A preplant incorporated or preemergence was observed to wilt during dry weather while corn treated with commercial rates of any of four other herbicides was unaffected. (1)

During the same year, field trials to evaluate varietal responses of 10 sweet corn varieties to alachlor and alachlor-atrazine combinations showed five varieties to suffer significant yield reductions when treated with alachlor alone or in combination with atrazine. (2) It is interesting to note that the five varieties not showing yield reduction were the five early varieties (65-67 days), while those showing yield reduction were mid to late season varieties (80-93 days). This, combined with the absence of detectable stand or vigor reduction, suggested the possibility of alteration of some physiological process by the herbicide alachlor.

Schales et al (3) reported reduced height and delayed tasseling of alachlor susceptible sweet corn varieties, but reported no decrease in yield. Thomson (4) reported no effect on plant height or ear weight of 10 sweet corn varieties when treated with alachlor. None of these workers, however, indicated the soil moisture levels under which the trials were run.

Materials and Methods

Sweet corn var. Seneca Scout was seeded October 3, 1972 in 10 cm plastic pots filled by weight with Merrimac fine sandy loam soil. Alachlor at rates of 3.3, 6.7 and 10 kg ai/ha were applied to three series of pots after seeding using an electrically driven pot sprayer calibrated to deliver the equivalent

1/ University of Connecticut, Storrs, Connecticut

of 375 l/ha at 2.8 kg/cm^2. Pressure was supplied from a compressed air tank. An additional series of pots were treated with 6.7 kg ai/ha of alachlor and the herbicide incorporated into the top 7.5 cm of soil before planting. Additional pots were left untreated. Treatments were arranged in a completely randomized design and were replicated 6 times.

After seeding, pots were placed in a controlled environment chamber. Temperature was maintained at 26.5 $\pm$ 1°C, and relative humidity at 70 $\pm$ 5%. The plants were illuminated for 18 hours per day with 2000 to 2500 footcandles with radiant energy of 0.7 to 0.8 gram calories cm^{-2} min^{-1} obtained from fluorescent and quartz iodide lamps.

The water-holding capacity of the soil was determined by thoroughly watering the pots, then allowing them to drain until water no longer dripped from the pots. The weight was then noted and uniform moisture levels maintained by bringing all the pots up to this constant weight. Plants were watered alternately with deionized water and half-strength Hoagland's nutrient solution.

On November 6, 1972 all treatments were brought up to maximum water capacity at the beginning of the light cycle. One hour later the pots were weighed to determine the amount of water lost and measurements of the rate of water loss through the stomates were made using an aspirated diffusion porometer. (5) Porometer measurements were made on the underside of the youngest fully expanded leaf on each plant. These determinations of rate and amount of water loss were repeated every three hours for the duration of the light period. Measurements were not taken during the dark period but resumed at the onset of the light period on November 7 and continued until plants in some treatments had wilted.

After the final readings on November 7, the pots were again brought up to maximum available moisture and maintained there for the next two days. On November 10, the measurement procedure was repeated beginning 2 hours after exposure of the plants to light and continuing for 6 hours.

At the conclusion of moisture loss measurements, the leaf area of each experimental plant was determined using a photometer and the moisture loss expressed as a function of leaf area.

Results and Discussion

Sweet corn treated with alachlor at 6.7 and 10 kg ai/ha preemergence lost more water per dm^2 of leaf area in a 33-hour period than untreated sweet corn (Table 1). Water loss from sweet corn treated with 3.3 kg ai/ha of alachlor preemergence or 6.7 kg ai/ha preplant incorporated was not significantly different than loss from untreated sweet corn. Water loss from untreated sweet corn was 26.1 grams per dm^2 as compared to 28.1 for sweet corn treated with alachlor at 6.7 kg ai/ha and 29.6 when treated with 10 kg ai/ha.

Table 1. Effect of alachlor on water loss per square decimeter of leaf area.

Treatment	Water Loss in Grams Per dm^2 of Leaf Area					
	2 hr.	11 hr.	24 hr.	27 hr.	30 hr.	33 hr.
Untreated	4.5	15.3	19.7	20.0	24.8	26.1
Alachlor 3.3 kg/ha Pre	4.2	14.1	18.5	20.7	23.5	24.8
Alachlor 6.7 kg/ha Pre	5.2	17.0	21.8	24.1	26.9	28.1
Alachlor 10 kg/ha Pre	4.5	16.3	21.5	24.6	27.9	29.6
Alachlor 6.7 kg/ha PPI	4.9	16.1	20.9	23.2	26.0	27.3
LSD 5%	NS	NS	NS	1.1	1.3	1.4

Stomatal resistance, as measured with an aspirated diffusion porometer, was generally less in leaves from plants treated with alachlor than from untreated plants. (Table 2) This was particularly evident in the 27, 30 and 33 hour observations as the plants began to approach wilting. Plants treated with alachlor at 3.3 kg ai/ha which were similar in rate of water loss to untreated plants during the first 24 hours of the experiment were losing water at a significantly higher rate at the end of 33 hours. Consequently, the plants treated with alachlor at 3.3 kg ai/ha wilted before untreated plants.

Table 2. Effect of alachlor on rate of water loss by sweet corn at various times after wetting.

Treatment	Porometer Readings in Seconds[a]				
	2 hr.	24 hr.	27 hr.	30 hr.	33 hr.
Untreated	44.4	83.9	75.9	108.8	129.2
Alachlor 3.3 kg/ha Pre	44.4	82.4	71.8	88.4	106.6[b]
Alachlor 6.7 kg/ha Pre	40.9	71.4	60.7	55.7[b]	59.6[b]
Alachlor 10 kg/ha Pre	50.5	77.1	98.8	76.2	66.4
Alachlor 6.7 kg/ha PPI	29.4	68.2	60.0	79.5[b]	90.8[b]
LSD 5%	5.4	10.1	12.2	23.6	21.9

a. The lower the porometer reading in seconds the lower the stomatal resistance and higher the rate of water loss. Measurements taken 11/6-7/73.

b. One or more plants showed signs of wilting.

Sweet corn treated with alachor at 6.7 kg ai/ha preemergence or preplant incorporated were observed at several points during the experiment to be losing water at rates greater than either untreated plants or plants treated with 3.3 kg of alachlor. Plants in both treatments wilted before untreated plants or plants treated at the 3.3 kg rate.

After rewetting these plants, the November 10 observations again indicated sweet corn treated with alachlor at 3.3 or 6.7 kg ai/ha preemergence or 6.7 kg ai/ha preplant incorporated to be losing water at a significantly greater rate than untreated plants. (Table 3) Two hours after wetting the soil, sweet corn treated with alachlor was losing water through the leaves 17 to 42% faster than untreated plants. Soil moisture levels at this time were approximately 90% of capacity. Eight hours after wetting with the available soil moisture at approximately 65%, alachlor treated sweet corn was still losing water 11 to 22% faster than untreated plants.

Increased rates of water loss in sweet corn treated with alachlor could result in yield reduction if soil moisture was limiting. This increased water loss could also explain the differential wilting and difference in plant size of sweet corn previously reported. (1, 2, 3, 4)

Table 3. Effect of alachlor on rate of water loss by sweet corn at various times after wetting.

Treatment	Porometer Readings in Seconds[a]		
	2 hr.	5 hr.	8 hr.
Untreated	50.6	54.0	45.6
Alachlor 3.3 kg/ha Pre	39.2	46.0	41.1
Alachlor 6.7 kg/ha Pre	43.1	34.1	39.6
Alachlor 10 kg/ha Pre	54.0	39.6	57.8
Alachlor 6.7 kg/ha PPI	35.6	38.0	37.2
LSD 5%	3.1	6.4	5.7

a. The lower the porometer reading in seconds the lower the stomatal resistance and higher the rate of water loss. Measurements taken 11/10/73.

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IODIDE INDUCTION OF ETHYLENE EVOLUTION BY ABSCISSION ZONE TISSUE

A. R. Templeton and E. D. Felix[1/]

ABSTRACT

The ability of various halides and halogenated compounds to induce ethylene evolution in excised bean abscission zone tissue was studied. Both organic and inorganic iodide salts were found to stimulate ethylene production. No ethylene evolution was observed when this plant system was treated with other halides or iodinated organic compounds.

INTRODUCTION

In the normal course of screening compounds for biological activity many iodide salts are encountered. Activity of these compounds is often manifested as defoliation of the lima bean plants (Phaseolus lunatus L. cv. Henderson Bush) in our test. Our objective in these experiments was to quantitate this response and to provide suitable benchmarks for future evaluation of such compounds.

Iodine, in small quantities, has been shown to be a necessary micronutrient for optimal growth of plants (5,8,15). At greater concentrations, however, iodine, particularly as the iodide ion, has a deleterious or phytotoxic effect (16). Plant species differ considerably in their ability to tolerate high concentrations of iodide. Selectivity appears to be based both on iodide accumulation in the plant and intracellular oxidation of iodide to iodine by peroxidase (11,12).

Although the precise role which ethylene plays in abscission is still unclear (1) it is generally recognized that ethylene evolution accompanying the abscission process is an indicator of potential defoliation. Many compounds cause defoliation either by release of ethylene from the compound (13) or stimulation of ethylene production by the plant (10). Iodide alone (3) or in combination with other chemicals (6) has been shown to be an effective defoliant of both woody (7,14) and herbaceous plants (3). For this reason the ability of various iodine-containing compounds to induce ethylene generation was investigated.

1/ Research Department, Agricultural Chemical Division, FMC Corporation, Middleport, NY 14105

MATERIALS AND METHODS

Lima beans (Phaseolus lunatus L. cv. Henderson Bush) were grown in a sand-peat moss mixture and maintained in the greenhouse until the plants were 15 to 20 cm tall. The primary leaf abscission zones were cut from the stem in such a manner as to include the abscission layer at the petiole base of both primary leaves. The tissue was weighed and placed in small vials. One ml of the treatment solution was then added and the vials were sealed with serum stoppers. The total volume of the sealed vials in 7.75 ml (the gas phase was considered as 6.75 ml with 1 ml of treatment solution). The tissue was incubated for 24 hr at 25°C with a light intensity of 2000 ft-c supplied by mixed incandescent and fluorescent lamps.

At the end of 24 hr 0.5 ml samples of the gases were withdrawn with an air tight syringe and analyzed via gas chromatography.

The gas samples were injected into a Hewlett Packard 700 gas chromatograph equipped with a flame ionization detector and an activated alumina column. The column temperature was held at 100°C, the injection port temperature at 125°C and the detector temperature at 265°C. Helium was used as the carrier gas at 50 psi.

Peaks were counted by a disc chart integrator for quantitation. Data were converted to total nanoliters ethylene/mg tissue. The instruments were calibrated using a standard containing 1000 ppm of pure ethylene.

RESULTS AND DISCUSSION

The ability of various inorganic halides to induce ethylene generation was studied (Table 1). Of the halides tested only iodide (either as KI or NaI) promoted ethylene generation in our system. These data were supported by greenhouse tests in which the compounds were sprayed on bean plants. Defoliation occurred in plants treated with iodide, but not in plants treated with the other halides.

Iodide stimulation of ethylene evolution was found to be dose dependent (Figure 1). Within the concentration range studied, there was a linear relationship between iodide concentration and ethylene evolution by excised bean abscission zone tissue. Response of bean plants to these concentrations of iodide was similar to that previously reported (3). At the higher concentrations (10-20 mM) leaves were rapidly desiccated and "frozen" onto the plant before abscission could occur. Median rates (0.1-0.5 mM) promoted abscission of primary leaves and a general stunting of the treated plants. Lower rates (<0.1 mM) had little or no effect on bean plants. Twenty-four hours after application

nastic responses were noted on plants treated with phytotoxic rates of iodide.

The ability of various organic iodides to promote ethylene evolution also was investigated (Table 2). Test chemicals were selected at random from iodo-compounds submitted for screening. When possible comparative studies were made of similar compounds which contained halogens other than iodide. In general organic iodide salts (compounds A-D, Table 2) promoted ethylene evolution while iodo compounds (compounds E-H) did not promote ethylene evolution. Previous reports (17) indicate that 2,3,5-triiodobenzoic acid induces defoliation of bean but no measurement of this compound's ability to promote ethylene evolution has been made. From the results of our study it would appear that the iodide ion alone is capable of stimulating ethylene production. It is possible that the iodine content of 2,3,5-triiodobenzoic acid or the particular nature of this compound's ability to make iodide readily available are responsible for the observed defoliation of bean plants.

In general the quantities of ethylene evolved in the presence of organic iodides were similar to those observed with KI (Figure

Table 1. The effect of various inorganic halide salts on ethylene evolution by excised bean abscission zone tissue.

Treatment	nl Ethylene/mg Tissue (Fresh Weight)		
Untreated Control	0.02a[1/]		
	Treatment Rate (mM)		
	0.1	1.0	10.0
KI	0.04 a	0.18 b	0.43 c
KBr	0.02 a	0.04 a	0.02 a
KCl	0 03 a	0.02 a	0.03 a
NaI	0.06 a	0.16 b	0.38 c
NaCl	0.02 a	0.01 a	0.02 a

[1/] Means followed by the same letter are not statistically different at p = 0.05. Values are the mean of three replicates.

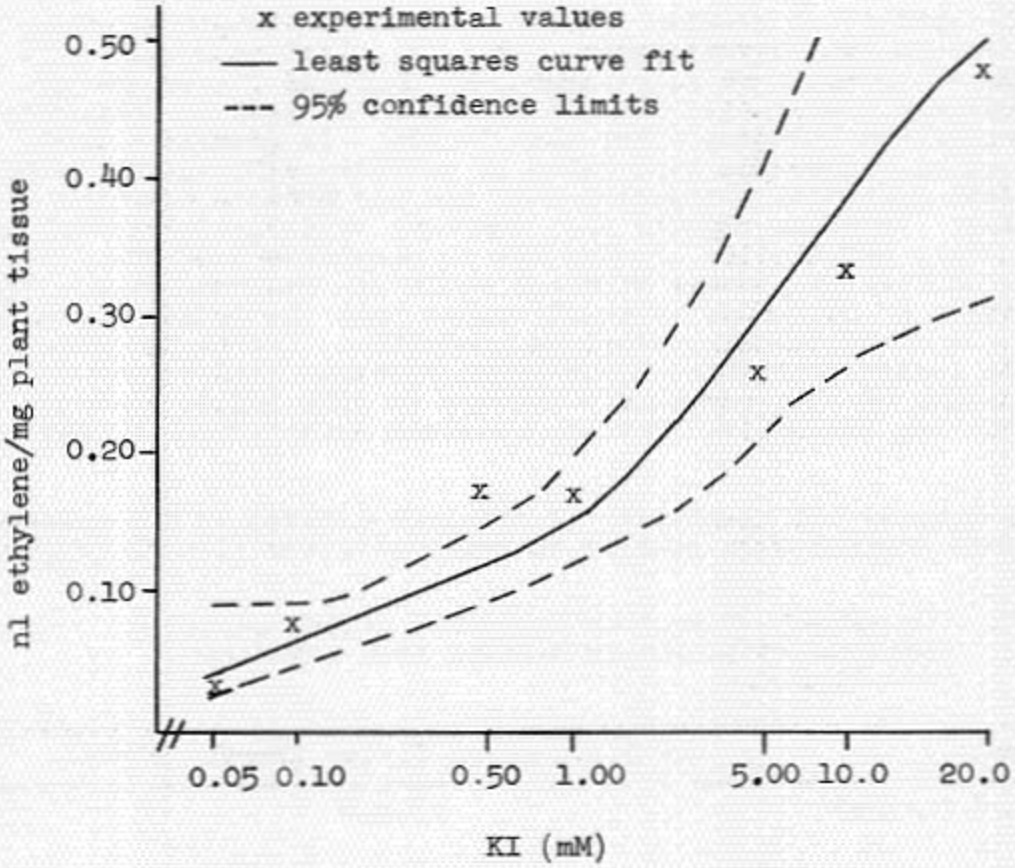

Figure 1. Ethylene evolution by excised bean abscission zone tissue treated with various concentrations of KI. Index of determination for least squares curve fit for the power function $Y = 0.15(X \uparrow 0.4)$ was 0.93.

1) when expressed on a molar basis. However compound "D", (Table 2), (2-(4-fluorophenacyl)isoquinolinium iodide), induced evolution of more ethylene than was expected. This compound is somewhat similar to compound "A" differing only in a portion of the organic cation. These observations would indicate that the organic moiety of the molecule may influence the availability of iodide to induce ethylene stimulated defoliation, perhaps by modifying entry and translocation in the plant. A similar case may be true for the previously mentioned 2,3,5-triiodobenzoic acid defoliation of bean (17), if this defoliation is due to iodide stimulation of ethylene

Table 2. Ability of various iodide organic compounds and their noniodated analogs to induce ethylene evolution in excised bean tissue.

Treatment		nl Ethylene/mg Tissue Fresh Weight		
Control		0.02[a]		
		Treatment Rate mM		
Compound	Identity	0.1	1.0	10.0
A	1-(4-Fluorophenacyl)pyridinium iodide	0.05	0.10	0
B	2-Methyl-1-(4-methylphenacyl)-quinolinium iodide	0.08	0.18	0.01
C	1,1-Dimethylpiperidinium iodide	0.04	0.25	0.02
D	2-(4-Fluorophenacyl)isoquinolinium iodide	0.03	1.47	0.03
E	N-(5-Iodo-2-methylphenyl)-4-methoxy-benzylideneimine	0.03	0.04	0.01
F	2-Iodobenzoic acid (3,4-dichloro-benzylidene)hydrazide	0.03	0.02	0.01
G	3',6'-Dihydroxy-4,5,6,7-tetraiodo-3-oxospiro[phthalan-1,9'-xanthene]	0.04	0.03	0.01
H	3-(Dimethylamino)-4'-iodopropiophenone hydrochloride	0.03	0.03	0.03
I	4-Chloro-2-nitrobenzenesulfonic acid (2-hydroxy-3,5-dinitrobenzylidene)-hydrazide	0.03	0.03	0.03
J	2-(Phenacyl)isoquinolinium chloride	0.02	0.04	0.05

[a] Each value represents the mean of three replicates.

production. Further evidence that the role of the organic cation is not entirely passive is shown by the lack of response of plants to the high treatment rate (10 mM). This concentration of the organic compounds tested was lethal to plant tissue in our system, while KI at this rate continued to promote ethylene evolution (Figure I).

Neither of the chloride salts tested (compounds "I-J", Table 2) promoted ethylene evolution. Compound "I" was selected for its similarity to compound "F", while compound "J" was selected for its similarity to compounds "B" and "D".

The precise mechanism of action of iodide phytotoxicity has received limited attention (11,12) Chlorides have been shown to be antagonistic to toxic effects of iodide on corn (9). Although iodide apparently does not inhibit chlorophyll synthesis it has marked inhibitory effects on the Hill reaction in isolated chloroplasts. Both chlorophyll content and photosynthesis are reduced in plants treated with iodide (12). Intracellular oxidation of iodide to iodine by peroxidase and iodination of cellular components has been demonstrated (11).

It is interesting to note that the iodide ion is highest in the Hofmeister (4) series which ranks ions as dehydrating agents (I, NO_3-, Br-, Cl, SO_4-). Although entirely speculative, the possibility that iodide exerts its influence by affecting hydration, and consequently conformation, of membrane macromolecules should be investigated. The effect of iodide on chloroplast morphology has not been studied; however the hypothesis that iodide may affect molecular hydration would be consistent with the observed loss of chlorophyll (12) in iodide-treated plants. It is also possible that a portion of the evolved ethylene may arise from disintegration of subcellular particles (2) brought about by iodide disruption of membranes.

Our studies have shown that the iodide ion, as either an organic or inorganic salt, stimulates ethylene production in excised bean abscission zone tissue. The stimulation of ethylene evolution is primarily related to the iodide ion alone, although in the case of organic iodides, the organic moiety may play a secondary role. Iodo compounds or halides other than iodide did not stimulate ethylene evolution. Defoliation of plants treated with iodide salts may be due to iodide-induced ethylene evolution.

ACKNOWLEDGEMENT

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THE EFFECT OF ULTRAVIOLET RADIATION AND DI-1-P-MENTHENE ON THE PHYTOTOXICITY OF 2,4-D APPLICATIONS TO BLACK VALENTINE BEAN PLANTS

W. Hurtt,[1/] A. R. Templeton,[2/] and R. M. See[1/]

ABSTRACT

Studies were conducted to determine the relationships, if any, between ultraviolet light, plant growth and plant response to di-1-p-menthene (a dimer of β-pinene), the dimethylamine salt of (2,4-dichlorophenoxy)acetic acid, and the combination of the latter two. Greenhouse-grown bean plants (*Phaseolus vulgaris* L. cv. Black Valentine) were exposed for various time periods to a mid-ultraviolet light source having a major emission peak at 254 nm. The energy level recorded at plant height was 350 ergs/cm^2/sec. Plants exposed to this light source for 1 hr had chlorotic, malformed leaves. Plants exposed for longer periods (2 hr) had desiccated, discolored leaves, while plants exposed for 3 hr died. An exposure time of 15 min was used as the maximum safe dose for the subsequent studies in which the plants were exposed to the light source 30 min after application of the herbicide treatments. Irradiation of the plants treated with 2,4-D did not result in a significant reduction in herbicide efficacy. The addition of di-1-p-menthene to the spray solution caused significant ($P \leq 0.05$) increases in the phytotoxicity of the herbicide. This was true irrespective of whether the herbicide application was followed by an exposure to ultraviolet light. The increase in effectiveness of the 2,4-D treatments from the addition of the β-pinene polymer appeared to be synergistic rather than additive.

INTRODUCTION

Previous investigations (13) established that the phytotoxicity of 2,4-D could be increased by combining the herbicide with di-1-p-menthene (a specific formulation of Pinolene^R containing dimers of β-pinene; marketed as Nu-Film 17, but hereafter referred to as Pinolene).[3/] Pinolene is a nontoxic, short-chain polymer which is derived from pine resins. When sprayed on the leaf surface and exposed to light and air, this compound undergoes a slow polymerization to form longer chain polymers (3). It has been studied for use as an antitranspirant (1,2) and has been shown to effectively block stomatal openings. Albrigio (1) reported that the polymer forms a film on older leaves but appears as droplets on younger leaves of orange trees. The droplet formation on the younger leaves was attributed to a low affinity of the polymer for the immature cuticle. Blazquez (5) has studied the ability of Pinolene to prevent decomposition of carbaryl. The addition of Pinolene to the spray mixture was reported to increase the initial deposition of the insecticide on tomato leaves and reduced the rate of decay on the foliage.

1/ Plant Physiologist and Biologist, Vegetation Control Division, Fort Detrick, Frederick, MD 21701.

2/ Biologist, FMC Corporation, Middleport, NY 14105.

3/ Distributed by Miller Chemical and Fertilizer Corp., Hanover, PA 17331.

Information supplied by the manufacturer (3) indicates that this reaction may be photocatalyzed by ultraviolet radiation.

Ordinary window glass admits light in the visible spectrum but prevents the entrance of radiation below 390 nm. Consequently, plants grown in the greenhouse receive little, if any, ultraviolet radiation. It has been known for some time that exposure to radiation of the ultraviolet wavelength may affect biological systems and pesticides. Many common herbicides exhibit their principal electronic absorption maxima in the ultraviolet region (200-400 nm) (7) and photodecomposition by ultraviolet light has been shown to occur in a number of pesticides (4,8,12) including 2,4-D (9). The latter was found to decompose rapidly in the presence of water and ultraviolet irradiation at a wavelength of 254 nm.

Plant growth has also been found to be affected by ultraviolet radiation (6,10,17,18). Dustin (11) noted a "bronzing" of green portions of apple fruits exposed to ultraviolet irradiation. This response is similar to the ultraviolet-induced destruction of chlorophyll noted by other investigations (15). Tranquillini (16) reviewed the work of several investigators on the growth of plants at high altitudes as affected by ultraviolet radiation. Supplemental ultraviolet radiation was found to adversely affect plants from low altitudes and caused death in some species. The plants found at high altitudes were resistant to ultraviolet. Since Pinolene was reported to require ultraviolet radiation for photopolymerization (3), experiments were conducted to determine the relationships, if any, between ultraviolet light, plant growth and plant response to Pinolene, 2,4-D, and Pinolene plus 2,4-D combinations.

MATERIALS AND METHODS

All plants used in these studies were grown from seed sown in 0.95-liter plastic containers filled with standard greenhouse soil. Plants were maintained in the greenhouse where temperatures ranged from 21 to 25 C and relative humidity from 30 to 40%. All treatments were applied to plants 18 days (Experiment I) or 20 days (Experiment II) after planting (14 or 16 days after emergence, respectively).

Ultraviolet radiation was supplied by a bank of mercury-line chromatographic lamps having a major emission peak of 254 nm (2540 Å). However, these lamps also provide some near-ultraviolet light in the 300 to 400 nm region. Photopolymerization of Pinolene has been reported to occur at 285 to 290 nm (3). The spectrum of natural sunlight does not extend below the mid-ultraviolet region at 286 nm (7). Consequently, the ultraviolet lamp source used in these experiments would be expected to supply radiation of the proper wavelength for photopolymerization of Pinolene and would also include particulate waves of a higher frequency than is normally encountered by the plant under natural condition. The light bank consisted of six Westinghouse Sterilamps (G-15T8) suspended 1 m above the bench top (40 cm from plant tops). This light source supplied 350 ergs per cm^2 per sec (0.35 mw per cm^2) of energy 40 cm above the bench top (plant height).

In Experiment I, bean plants, with and without Pinolene, were exposed for various time periods (1, 2 and 3 hr) to the described lamps to determine if ultraviolet radiation might adversely affect plant growth under the conditions specified. Each treatment consisted of two replications of two plants per pot. All plants were examined daily for visual symptoms of injury. The plants were harvested 7 days after treatment and fresh weights of tops were recorded.

In Experiment II, plants were treated with Pinolene (9.35 L/ha; 1 gal/A), 2,4-D (0.056 kg ae/ha; 0.05 lb ae/A) and a combination of Pinolene and 2,4-D (9.35 L/ha + 0.056 kg ae/ha). The formulation of 2,4-D contained an adjuvant prior to the addition of the Pinolene additive. Treatments were applied in a ventilated spray chamber with a DeVilbiss No. 163 sprayer at 0.1 g/sq cm. The total volume of aqueous spray was equivalent to 355 L/ha. All treated plants were returned to the greenhouse after spray applications. The average time for the droplets to visually dry on the surface of the leaves was 19 min. Approximately 30 min after treatment, one-half of each treatment group (seven replications of one plant per pot) including controls was moved into the room containing the ultraviolet light source and irradiated for 15 min. The plants were then returned to the greenhouse and randomized on the bench with the non-irradiated plants. Plant heights (distance from the cotyledonary node to the terminal bud) were immediately recorded for all plants. Seven and 12 days after treatment, plant heights were again recorded. After the final height measurements on the twelfth day, the plants were harvested as in Experiment I with fresh and dry weight determinations. We then obtained true growth in height over the treatment period for each plant by subtracting its height on the day of treatment.

RESULTS AND DISCUSSION

Under the conditions specified, ultraviolet radiation was found to significantly inhibit growth of Black Valentine bean plants (Figure 1). Symptoms of plants exposed to 60 min of ultraviolet radiation were manifested as malformed leaves with leaflets of unequal size and shape. There appeared to be considerable destruction of chlorophyll, particularly in cells surrounding the vascular tissue. Tissue near the veins was characterized by a light copper coloration extending 5 mm on either side of the major veins. Interveinal tissue did not appear to be affected in that it was normal in coloration and appearance. Since the interveinal tissue represents that part of the lamina which is laid down last in the ontogeny of the leaf, it is possible that this tissue was not present at the time of treatment and hence remained unaffected. Plants exposed to longer periods (120 min) had desiccated, discolored leaves, while leaves of plants exposed for 180 min were dead and overall plant growth was severely retarded (80% inhibition of fresh weight of tops, Figure 1).

Based on the results of Experiment I, it was concluded that long exposure of plants to this ultraviolet lamp system would be undesirable since any herbicidal effects on treated plants would be confounded by the deleterious effects of the ultraviolet radiation. Consequently, an exposure time of 15 min was selected as the maximum dose to use for photopolymerization of the Pinolene additive in the spray solution.

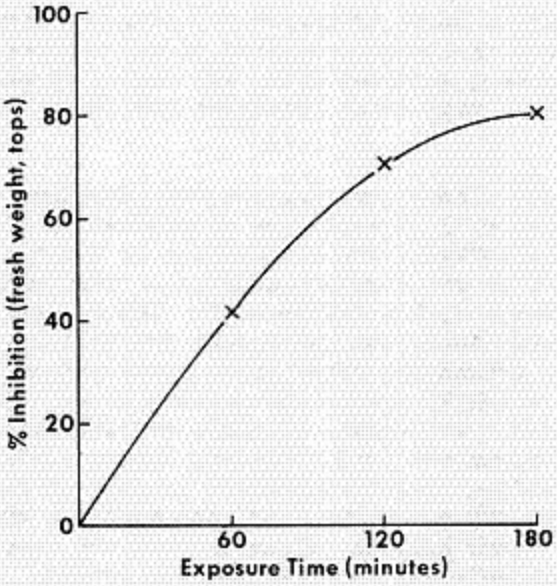

Figure 1. The effect of various exposure times of ultraviolet radiation (254 nm) on growth of Black Valentine bean plants. The radiation level was 350 erg per cm^2 per sec at plant height.

As we previously demonstrated (13), the addition of Pinolene to an aqueous formulation of the dimethylamine salt of 2,4-D increased the phytotoxicity of the herbicide when it was applied at a sublethal rate (Table 1). Application of 2,4-D alone caused a 16% inhibition of growth in height over the 12-day treatment period, but the combination of 2,4-D and Pinolene caused an 83% inhibition in growth. This was an approximate five-fold increase in phytotoxicity which was significant at $P \leq 0.05$. Using the dry weight data as a criterion of comparative effectiveness, the addition of Pinolene to the spray solution caused an approximate 40% increase in degree of growth suppression (20.2% vs 33.0%). This increase was significant at $P \leq 0.1$ but was not significant at $P \leq 0.05$.

In general, both nontreated and treated plants irradiated for 15 min with ultraviolet light appeared smaller than those not exposed to the ultraviolet light source. With one exception the differences in growth values in Table 1 between irradiated and nonirradiated plants were not significant. The significant difference in inhibition in growth due to exposure to ultraviolet light occurred in the height data for the plants treated with Pinolene alone. This anomaly, however, was not reflected by a corresponding significant difference in dry weight. Growth in height appeared to be a more sensitive criterion of ultraviolet light injury than did suppression of dry weight production, although this does not explain the apparent Pinolene-ultraviolet light interaction.

Table 1. Effect of presence or absence of supplemental ultraviolet light (254 nm)[1/] on response of Black Valentine bean plants to 9.35 L/ha of Pinolene, 0.056 kg ae/ha of 2,4-D and 2,4-D plus Pinolene. Treatments were foliarly-applied as aqueous sprays equivalent to a total volume of 355 L/ha.

Treatments	No ultraviolet light		Plus ultraviolet light	
	Measurement[2/]	% Inhib.	Measurement	% Inhib.
	12-Day growth in height (△ cm)			
Control	45.43 a	0	39.71 ab	0
Pinolene	45.64 a	- 0.5	35.71 b	10.1
2,4-D	38.21 ab	15.9	38.67 ab	2.6
2,4-D + Pinolene	7.86 c	82.7	5.90 c	85.2
	Dry wt of tops (g)			
Control	2.97 a	0	2.72 ab	0
Pinolene	2.85 ab	4.0	2.72 abc	0
2,4-D	2.37 abc	20.2	2.25 bc	17.3
2,4-D + Pinolene	1.99 c	33.0	1.94 c	28.7

[1/] One-half of the plants were exposed for 15 min at foliage level to 350 ergs/cm^2/sec of UV light following the chemical treatments. One-half of the controls were similarly exposed to the UV light. The nonultraviolet plants were placed in the greenhouse immediately following application of the chemical treatments.

[2/] Values are the means of seven replicates. Means followed by the same letters are not significantly different at $P \leq 0.05$, as computed by 95% confidence limits ($\bar{X} \pm t_{.05} S_{\bar{X}}$).

As shown in Table 1, plants treated with 2,4-D alone and subsequently exposed to ultraviolet light grew within less than one-half centimeter as much as the plants similarly treated but not irradiated (38.21 cm vs 38.67 cm). However, the respective percent inhibitions in growth for these two treatments suggest some loss in efficacy of 2,4-D attributable to ultraviolet light even though the differences are not significant. This apparent difference is a result of calculating these two percent inhibitions relative to their respective controls. The irradiated control was inhibited ca 13% in growth when compared to the nonirradiated control. Using the dry weight data in Table 1 to evaluate the effect of ultraviolet light on the phytotoxicity of the 2,4-D treatments, it can again be seen that there are no real differences in efficacy. Similarly, the presence or absence of ultraviolet light could not be shown to affect the plant's subsequent growth responses to the 2,4-D + Pinolene combination. Both sets of percent inhibition values for growth in height and dry weight were in extremely close agreement, i.e., 82.7% vs 85.2% and 33.0% vs 28.7%. As was found with the nonirradiated group of treatments, the addition of Pinolene to the spray solution markedly increased the phytotoxicity of the 2,4-D treatments.

Since these data show no significant effect on plant response attributable to ultraviolet light per se, it would appear that the photodegradation of 2,4-D by ultraviolet radiation in the literature (9) may be somewhat overstated. Our failure to find a significant loss in the activity of 2,4-D due to ultraviolet light is supported by the work of Penfound and Minyard (14) who studied the effects of 2,4-D on plants grown in sunlight and shade. Although they observed a variable response of water hyacinth plants to phenoxy herbicides attributed to sunlight, repetition of the experiment with potted Red Kidney beans revealed that 2,4-D caused a similar plant response that was independent of where the plants were grown, including darkness.

From these experiments it would appear that the potentiating effect of Pinolene on plant responses to sublethal concentrations of 2,4-D does not require the formation of ultraviolet-mediated polymerized di-1-p-menthene. No visual differences could be seen with a hand lens in the films and droplet residues on the leaves between the irradiated and nonirradiated plants. Since the 2,4-D formulation used in these studies contained a wetting agent, it seems unlikely that Pinolene acted simply as another surfactant. If this were, in fact, true, the increase in phytotoxicity should have been additive rather than synergistic. Pinolene may have simply acted as a sticker or extender, retaining the 2,4-D on the leaf surface for a longer period of time in a semi-liquid form, thereby allowing more time for foliar absorption.

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THE RELATIVE EFFECTIVENESS OF SEVERAL GROWTH RETARDANTS ON BLACK VALENTINE BEAN PLANTS

W. Hurtt and R. M. See[1]

ABSTRACT

Bean plants (*Phaseolus vulgaris* L. cv. Black Valentine) were used in a standardized test to determine the effectiveness of candidate growth retardants. Seeds were planted in 0.95-L pots containing a standard greenhouse soil. When the plants emerged they were transferred from the greenhouse to environmental growth chambers maintained at 25 ± 1.5 C and 50 ± 15% relative humidity. A 16-hr photoperiod of 1250 to 1450 ($\bar{X}$ ± S.D.) ft-c was supplied by a mixture of fluorescent and incandescent lamps. Treatments were foliarly-applied 9 to 11 days after emergence. Growth in height was obtained by subtracting height of plants on day of treatment from height measurements normally made at 1, 2, 3, 5, 7, and 9 days. Plants were usually harvested after the last height measurements for evaluation of any potential adverse inhibition in fresh or dry weight production. Growth in height was plotted against dose to obtain the concentration of retardant required for 50% reduction in growth, i.e., the GR_{50} value.

Some of the retardants tested were maleic hydrazide (MH), ethyl hydrogen-1-propylphosphonate (NIA-10637), ammonium ethyl carbamoylphosphonate (DPX-1108), α-cyclopropyl-α-(4-methyoxyphenyl)-5-pyrimidinemethanol (ancymidol), CHE-9064 (structure not yet released by Chemagro Corp.), and tributyl[(5-chloro-2-thienyl)methyl] phosphonium chloride (CHE-8728). Although we have not developed the dose response curves for all of the measured values, a number of generalizations can be made. Maleic hydrazide, the standard against which other compounds were compared, tended to injure or kill the terminal buds, even at concentrations less than the GR_{50} values. The GR_{50} for NIA-10637 was beteen 0.1 and 1.0 kg ai/ha and the corresponding value for DPX-1108 appears to be between 0.05 and 0.10 kg ai/ha. Both CHE-9064 and CHE-8728 caused 50% growth reductions at or near 0.01 kg ai/ha. The last two compounds are of particular interest because of their very low GR_{50} values. These comparative tests are continuing with a number of retardants. Other parameters are being explored to measure and numerically compare their effectiveness under these standardized test conditions.

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[1]Plant Physiologist and Biologist, respectively. Vegetation Control Division, Fort Detrick, Frederick, MD 21701

THE INFLUENCE OF ARTIFICIAL RAINFALL AND DI-1-P-MENTHENE ON KARBUTILATE MOVEMENT IN GREENHOUSE SOIL

R. M. See and W. Hurtt[1/]

ABSTRACT

Simulated rainfall was applied to flats of oats (Avena sativa L.) growing in greenhouse soil which had previously been treated with combinations of m-(3,3-dimethylureido)phenyl-tert-butyl-carbamate (karbutilate) and di-1-p-menthene (Vapor Gard).[2/] Aliquots of the runoff from each treatment were applied to the roots of bean plants (Phaseolus vulgaris L. cv. Black Valentine) grown in solution culture as a bioassay for the presence of the herbicide. The growth of the bean plants treated with runoff water from the karbutilate + Vapor Gard treatment was significantly less than the growth of the plants receiving runoff aliquots from the karbutilate treatment. The dry weight of oats clipped from flats treated with karbutilate was significantly less than the values obtained for the karbutilate + Vapor Gard treatment. These data suggest that Vapor Gard increased rather than decreased the amount of karbutilate in the surface runoff.

INTRODUCTION

The current emphasis on environmental quality and the danger posed by persistent pesticides has resulted in the removal of high-residue biocides from the agricultural market. The importance of pesticides to agriculture, combined with this growing environmental awareness, has accentuated the need for a method of increasing the efficacy of less toxic compounds by controlling residues, reducing movement from the target area, and temporarily protecting these compounds from degrading environmental factors.

Pinolene[3/] is a nontoxic polymer derived from pine resins consisting entirely of carbon and hydrogen. Several investigators have reported that the specific antitranspirant formulation of Pinolene (Vapor Gard) has successfully reduced damage due to water loss for several greenhouse and field crops (1,8).

Karbutilate is used as a soil-sterilant in noncrop areas. Optimum results are achieved with this compound when adequate rainfall is available to move the herbicide into the root zone. Although no specific information concerning the movement of karbutilate by surface runoff and subsequent distribution in aquatic ecosystems was found, the principles governing this diffusion and the impact of pesticides on aquatic populations have been reviewed by several investigators (2,3,9,10). The purpose of this investigation was to determine the effect of Vapor Gard on the movement of karbutilate in surface runoff under simulated rainfall conditions.

1/ Biologist and Plant Physiologist, respectively. Vegetation Control Division, Fort Detrick, Frederick, Md. 21701.

2/ Product of Miller Chemical and Fertilizer Corporation, Hanover, Pa. 17331

3/ Product of Miller Chemical and Fertilizer Corporation, Hanover, Pa. 17331

MATERIALS AND METHODS

Flats 1.92 sq. m were lined with polyethylene plastic, filled with a standard greenhouse soil (Table 1) and seeded with oats. Two small holes were located at one end of each flat to allow for drainage. The flats were then placed in the greenhouse at 22 ± 5 C. Treatments were applied 5 days later when the oats were approximately 2 cm tall in a ventilated spray booth with an atomizer-type sprayer at 0.4 kg/sq cm. The total volume of application was equivalent to 1895 L/ha. Deionized water was used as the diluent in all treatments. Five replications were made of treatments consisting of 6.72 kg ai/ha karbutilate, and 6.72 kg ai/ha karbutilate + 17.92 kg ai/ha Vapor Gard, and a treatment of Vapor Gard alone. All flats were returned to the greenhouse for a period of 24 hours. During this period the temperature within the greenhouse was maintained at 22 ± 5 C, and the light-intensity ranged from 1.6 klux to 2.7 klux.

Table 1. Characteristics of the greenhouse soil used in this study

Property	
Soil texture	Sandy loam
pH (1:1 suspension)	6.2
Organic matter %	2.1
Bulk density (g/cm^3)[a]	1.22

[a] Oven dry basis

The previously treated flats were placed on a 33% slope and subjected to 5.1 cm of artificial rainfall in 11 minutes. The device used for simulating rainfall consisted of three overhead #8010 Tee Jet nozzles located 154 cm above the surface of the test flat and operated at a line pressure of 0.7 kg/sq cm. The runoff from each flat was collected in a stainless steel trough located at the base of the flat (Fig. 1). The effluent was transferred to flasks, capped with a nonabsorbent material and stored at 4 C until analysis could be made. An unwashed flat of each treatment was maintained as a visual comparison of herbicide activity as affected by the artificial rainfall. When runoff collections were completed, the flats were returned to the greenhouse for a period of 14 days. Dry weight values were obtained after the oats from each flat had been clipped at the soil surface and placed in a force-draft oven at 95 C for 24 hours.

Due to the solubility of karbutilate, 325 ppm at 21 C (4), the water samples were transferred from the cold storage to the laboratory and allowed to equilibrate at room temperature. Each sample was then shaken for approximately 1 minute and filtered through Whatman #1 filter paper in a Buchner funnel. Proportionate volumes of the runoff water collected from each flat of the same treatment were pooled prior to dilution in the bioassay.

Black Valentine bean plants were used as bioassay indicator plants for the presence of karbutilate in the runoff. Seed were germinated in premoistened vermiculite. Five days after planting, the bean seedlings were

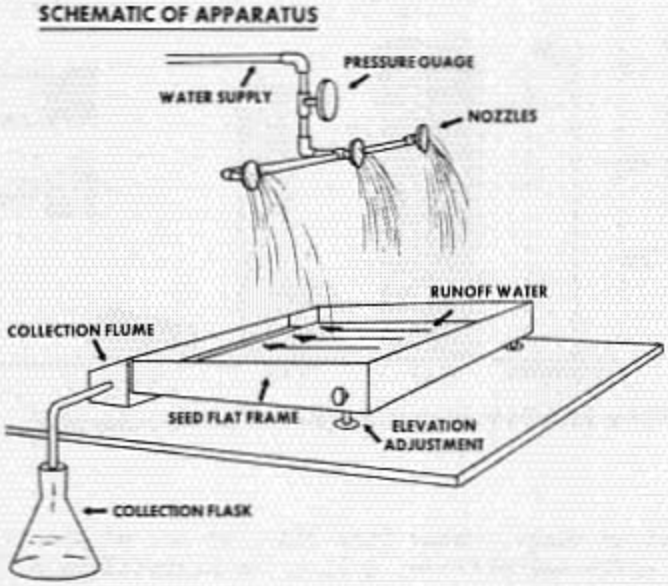

Figure 1. Schematic of apparatus used to simulate rainfall in the greenhouse.

transplanted into 0.5-strength aerated Hoagland's nutrient solution (7). The environment in the growth chamber throughout the growth period and subsequent bioassay was maintained at 25 ± 1 C and 50 ± 10% relative humidity. A 16-hr photoperiod of 1.3 ± 0.1 klux was supplied by a mixture of incandescent and fluorescent lamps.

Plants of uniform height were selected for experimental use 6 days after transplanting. Runoff aliquots were applied to the roots by adding the liquid directly to the nutrient solution. A completely randomized design with 10 replications was used. Initial plant heights were recorded on the day of treatment. Final heights and fresh weights of tops were recorded 10 days after treatment. Dry weights were obtained as before.

RESULTS AND DISCUSSION

Analysis of the growth parameters (change in height and dry weight of tops) from the bean bioassay indicates that the addition of Vapor Gard to the treatment solution significantly increased rather than decreased the quantity of karbutilate in the surface runoff (Fig. 2, 3). This increase in karbutilate did not result in growth inhibition until the second dilution level (2.5×10^{-5}) which exceeded the threshold level of the bean bioassay to karbutilate. The water samples collected from both treatments (karbutilate, karbutilate + Vapor Gard) significantly inhibited plant growth at the

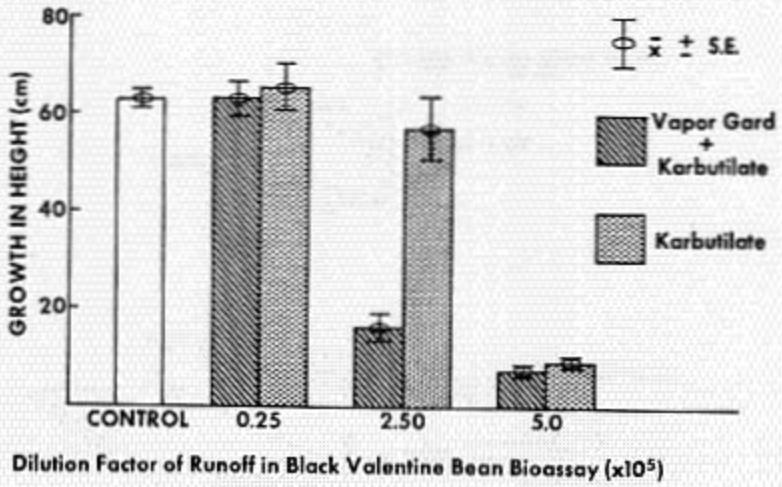

Figure 2. Effect of runoff water from flats of oat plants treated with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard on the growth of Black Valentine bean assay plants.

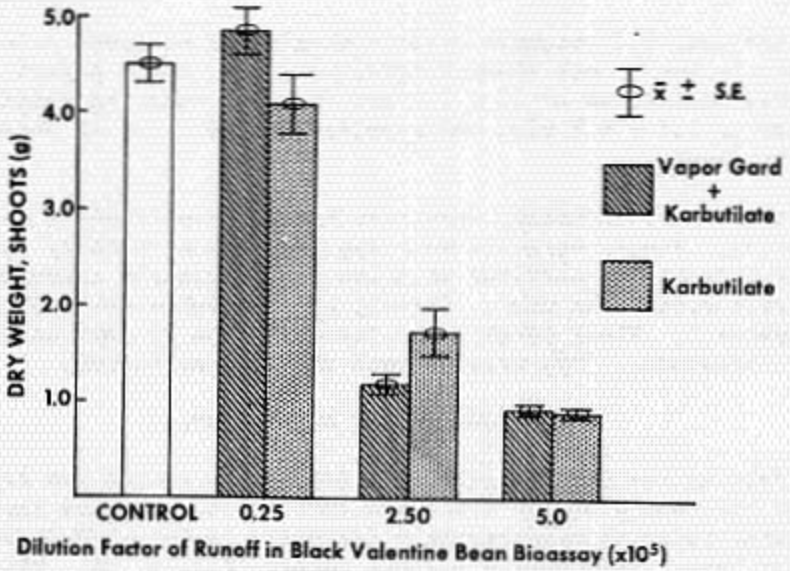

Figure 3. Effect of runoff water from flats of oat plants treated with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard on the dry weight of Black Valentine bean assay plants.

third dilution level (0.5×10^{-5}). Vapor Gard alone did not inhibit the growth of the oats in the test flats or the bean plants used in the bioassay.

The dry weight of oats clipped from treated flats also indicate that more herbicide was eroded from flats receiving the karbutilate + Vapor Gard treatment, as these values were not different from control values, but were significantly greater ($P \leq .05$) than the corresponding values from the karbutilate treatment (Table 2).

Table 2. Dry[a] weight of oats clipped from flats 14 days after treatment with 6.72 kg/ha karbutilate, 6.72 kg/ha karbutilate + 17.92 kg/ha Vapor Gard.

Treatment	Oven-Dry Weight, g[b]
Control	32.56 (28.83 - 36.29)
Karbutilate	20.96 (20.08 - 21.83)
Karbutilate + Vapor Gard	27.53 (25.82 - 29.24)

[a] 24 hrs following treatment all flats were placed on a 33% slope and subjected to 5.1 cm of artificial rainfall in 11 min.
[b] Values within parenthesis give upper and lower confidence limits at $P \leq .05$.

Several investigators have studied the movement of pesticides by surface runoff and soil erosion (6,7,12,13). Although these investigations involved different pesticides, application methods, soil types, topography, and environmental factors, it was conclusively shown that the amount of pesticide found in the sediment was up to 20 times greater than that quantity detected in the water portion of the runoff (6). Results from our investigation suggest that Vapor Gard may increase sorption of the herbicide on the soil surface particles. When rainfall occurs this increased adherence may temporarily reduce the vertical movement of the herbicide and therefore increase the karbutilate concentration of eroded soil particles.

The artificial rainfall system used in this investigation was designed to promote runoff and to an extent, soil erosion. The extreme slope (33%), volume and rate of rainfall (5.1 cm/11 min) was expected to cause excessive soil erosion. However, the 4 L of runoff contained only ca 2 g of eroded soil.[4/]

Although it would be difficult to attempt to accurately extrapolate the results of this investigation to field conditions, our results suggest that Vapor Gard temporarily retained karbutilate on the soil surface, thus making it more susceptible to movement from the target area when erosion occurred. Since eroded soils previously treated with pesticides are already a major source of surface water contamination (10), we feel considerable caution should be used when applying a pesticide in combination with any adjuvant of the spreader-sticker type which may retain the pesticide on the soil particles.

4/ Oven dry basis

These results emphasize the value of controlling sediment losses from agricultural areas as an important method of reducing any potentially disruptive effect that pesticides may have on the components of aquatic ecosystems.

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MOVEMENT AND DISTRIBUTION OF NIA 23486 IN VARIOUS SOIL TYPES

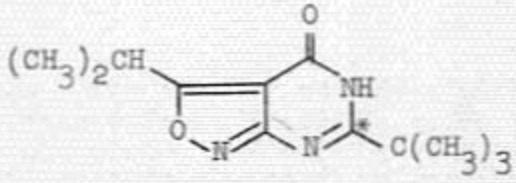
A. A. Nethery[1/]

ABSTRACT

The mobility of ^{14}C-NIA 23486 (6-tert-butyl-3-isopropyl-isoxazolo[3,4-d]pyrimidin-4(5H)-one) in eight soils was found to be correlated with the adsorption constant K of the herbicide in each soil type. The relative adsorption of ^{14}C-NIA 23486 in turn was correlated to the cation exchange capacity of the various samples.

INTRODUCTION

NIA 23486 (6-tert-butyl-3-isopropylisoxazolo[3,4-d]pyrimidin-4(5H)-one (I) is a particularly active member of a new class of broad spectrum herbicides (2,4). Corn and sorghum are crops which have shown tolerance in extended field trials. The present investigation was designed to examine the adsorption and mobility characteristics of this compound in several soil types.



I

The mobility of herbicides in soil is an important factor in their effectiveness and persistence. The extent to which a herbicide leaches in the soil is governed by its adsorption on the soil, its solubility in water and the quantity of water passing through the soil. Adsorption of herbicides by soils is largely reversible, linear with respect to dose and dependent on the physical characteristics of the soil and on the molecular

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1/ Research Department, Agricultural Chemical Division, FMC Corporation, Middleport, NY 14105

structure of the herbicide (7). Diffusion in the airspace of the soil is a mobility factor which generally is important only for compounds with a high vapor pressure (1). Percolating water appears to be the principal means of movement of the relatively non-volatile herbicides; diffusion in soil water is important only for transport over very small distances (1). Herbicide movement through a soil medium by water may be considered similar to the development of materials through chromatographic columns (1,5).

Several studies have shown that adsorption of pesticides most often correlates with the organic matter content of the soil, or with derived parameters related to the percentage of organic matter or of clay in the soil (3,7).

An inverse relationship between adsorption and water solubility of some herbicides has been shown (6,8).

MATERIALS AND METHODS

NIA 23486 was labeled with carbon-14 in the 6-position of the ring system (I). The specific activity of the sample was 4.45 millicuries/millimole. A stock solution in methanol was prepared to provide approximately 0.1 microcuries/microliter (5.3 micrograms NIA 23486/microliter).

Adsorption studies

One microliter aliquots of ^{14}C-NIA 23486 were added to vials containing 10 ml of water. One ml samples were removed from these vials and counted in a scintillation counter to establish the initial level of radioactivity per treatment. The soil sample to be tested was added to the remaining 9 ml of solution per vial. All vials were placed on a wrist-action shaker for 24 hours, after which the suspended soil was allowed to settle for 1 hour. Aliquots of 1 ml were withdrawn from the supernatant for scintillation counting.

Leaching studies

Plastic columns (6 mm x 20 cm) were filled with soil, which was further packed by placing the lower end of the columns in a shallow container of water and allowing the water to ascend to the soil surface. The columns were air dried overnight. One microliter of the labeled herbicide solution was added to the first 1.3 cm of water applied to each column. Leaching water was added as rapidly as permitted by the rate of water movement through the soil column. After leaching was completed, the columns were cut into 1 cm segments and placed into scintillation vials containing 0.5 ml of water and 18 ml of scintillation fluid. These vials were shaken for 1 hr, allowed to settle for 15 min, and counted.

RESULTS AND DISCUSSION

Adsorption of ^{14}C-NIA 23486 after 24 hr varied from 7.9 to 18.4 percent on the eight soils studied (Table 1). The adsorption constant, K, is a characteristic of a particular soil/herbicide combination.

$$K = \frac{\text{Concentration in soil}}{\text{Concentration in water}}$$

The K values for ^{14}C-NIA 23486 in combination with the eight soils also are listed in Table 1.

Table 1. Adsorption of ^{14}C-NIA 23486 by eight soils.

Soil	% Adsorption	K
#1 loam	10.7	1.08
#2 loam	7.9	0.77
#3 silt loam	8.0	0.78
#4 silt loam	9.7	0.97
#5 silt loam	9.0	0.89
#6 silt loam	9.5	0.94
#7 silty clay loam	18.4	2.03
#8 clay loam	16.7	1.80

The soils tested include those classified as loam, silt loam, silty clay loam and clay loam. The cation exchange capacity (CEC) and percentages of sand, silt, clay and organic matter (OM) are shown in Table 2.

A stepwise multiple regression analysis showed that the capacity of these soil samples to adsorb ^{14}C-NIA 23486 (as reflected by the K values) correlates most closely with the CEC of the soils. The regression equation determined was:

$$Y = 0.08\ X_{CEC} - 0.21 \qquad (R^2 = 0.824)$$

The multiple coefficient of determination, R^2, indicates that 82.4 percent of the variation in ^{14}C-NIA 23486 adsorption on these eight soils can be predicted from the CEC values of the soils. This regression equation is statistically significant at $P = 0.01$.

Table 2. Physical characteristics of soils leached.

Soil	CEC	Percent			
		Sand	Silt	Clay	OM
#1 loam	18.6	50.0	38.5	11.5	6.1
#2 loam	17.5	36.9	41.7	21.4	3.5
#3 silt loam	13.0	10.8	70.0	20.0	2.0
#4 silt loam	12.0	20.3	66.2	13.5	3.8
#5 silt loam	17.0	10.8	70.0	19.2	3.2
#6 silt loam	15.0	26.1	54.4	19.5	3.1
#7 silty clay loam	29.6	14.4	58.0	27.6	5.1
#8 clay loam	23.7	20.9	41.6	37.6	5.2

Table 3. Maximum depth of ^{14}C-NIA 23486 leaching by 10 cm water.

Soil	Maximum Depth (cm)
#1 loam	9.5
#2 loam	11.5
#3 silt loam	10.0
#4 silt loam	12.5
#5 silt loam	12.5
#6 silt loam	14.0
#7 silty clay loam	5.0
#8 clay loam	7.0

Leaching studies with 10 cm of water resulted in leaching depths of ^{14}C-NIA 23486 varying from 5 cm (#7 silty clay loam) to 14 cm (#6 silt loam)(Table 3). Multiple regression analysis also indicated that CEC was the most significant single factor correlated with the depth of penetration. Seventy four percent of the variation in mobility of ^{14}C-NIA 23486 was associated with the CEC values of the soils tested. The regression equation determined was:

$$Y = -0.45\ X_{CEC} + 18.4 \quad (R^2 = 0.736)$$

This equation is statistically significant at $P = 0.01$.

Leaching depth values were plotted versus the adsorption constant (K) for each soil type. A computer least-squares curve-fitting program fit a straight line to the data defined by the equation:

$$Y = 16.5 - 5.4\ X_K \quad (R^2 = 0.745)$$

All but two of the observed values fall within the 95 percent confidence limits of the estimated line (Figure 1).

By the use of a constant water volume and a single chemical, the variables of water flux and water solubility were eliminated. The mobility of ^{14}C-NIA 23486 was found to correlate inversely with adsorption by the soil, which in turn was highly dependent on the cation exchange capacity of the soil.

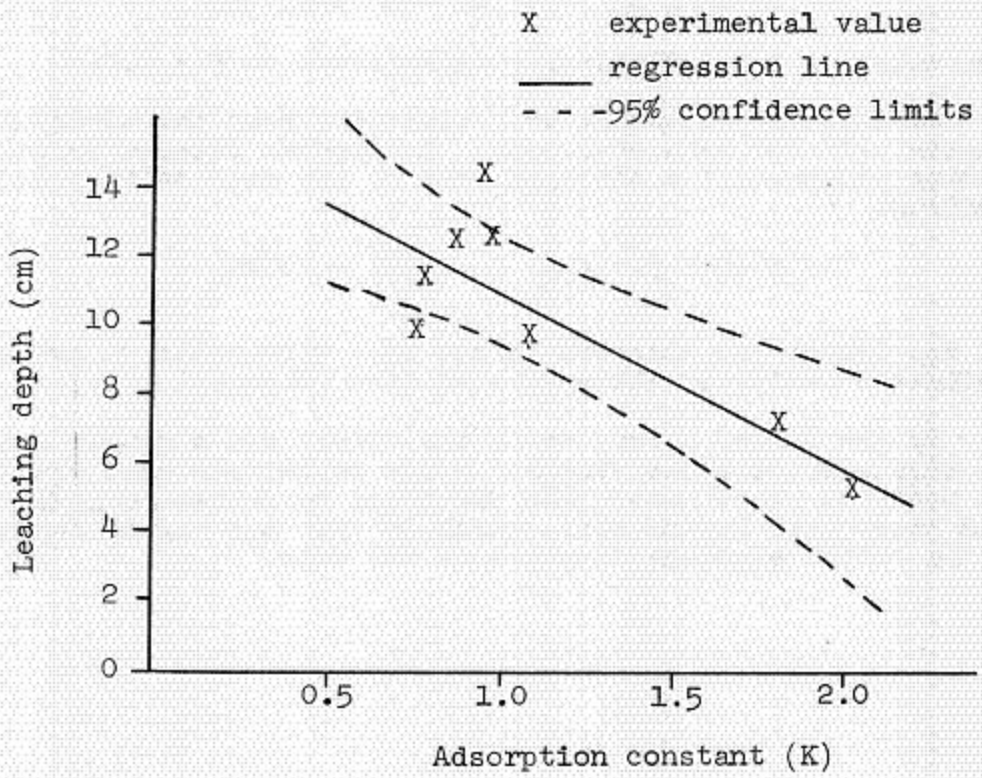

Figure 1. Leaching depth of ^{14}C-NIA 23486 versus adsorption constant (K) of several soils.
$K = \frac{\text{Concentration in soil}}{\text{Concentration in water}}$
Index of determination = 0.745 for regression line $Y = 16.5-5.4X_K$.

ACKNOWLEDGEMENTS

I wish to express my appreciation to Mrs. A. M. Schlaf for her assistance in these studies.

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PERSISTENCE OF NAPROPAMIDE AND U-27,267 IN A SANDY LOAM SOIL

R. C. Henne [1]

ABSTRACT

Napropamide (R-7465)(2-(alpha-naphthoxy)-N,N-diethylpropionamide) at rates of 1.12 and 2.24 kg/ha persisted in a sandy loam soil and adversely affected growth of a fall-seeded rye (Secale cereale) cover crop. Primary action was inhibition of root growth. U-27,267 (3,4,5-tribromo-N,N,a-trimethylpyracole-1-acetamide) persisted in the soil for 12 months and at rates above 1.12 kg/ha resulted in inhibition of secondary root growth of green peas (Pisum sativum). Plants remained alive but stunted and failed to produce a crop.

INTRODUCTION

Two experimental herbicides, napropamide (R 7465) and U-27,267, were included in tomato herbicide studies at Clayton, Delaware in 1972. Napropamide had been reported by Fricke (1,2) to persist in the soil and affect subsequent rye cover crop growth. There have been no reports of U-27,267 persisting in soils. This paper reports field observations and greenhouse bioassay data on crops grown in soil previously treated with the two herbicides.

MATERIALS AND METHODS

Procedures used in conducting the 1972 field trials have been reported (3). Rates, application methods and treatment dates are summarized in Table 1.

Tomatoes were disced under and rye was sown as a cover crop in November 1972. Because of late seeding and adverse fall weather, rye growth was minimal (no more than 5-6 cm tall) on January 13, 1973. In spite of this, areas previously treated with 2.24 kg/ha of napropamide could be visibly detected, but critical evaluation on degree of injury was not possible. Soil was sampled January 19, 1973 from herbicide plots treated May 8, 1972 with napropamide at 0, 1.12 and 2.24 kg/ha and with 1.78 and 3.36 kg/ha of U-27,267. Soil was collected from 4 replicates and samples from 0-7.5 cm depth ('A' zone = zone of incorporation) and from 7.5-15 cm depth ('B' zone). Soil was placed in 15 cm plastic greenhouse pots and seeded with rye and grown for 21 days. Root growth was examined and fresh plant weight determined.

By April 12, 1973 the rye cover crop had developed to the point where top growth was 28-30 cm tall. At this time napropamide-treated areas were quite distinct (although U-27,267 plots were not discernible). Stand counts were made in the napropamide plots, plants were carefully dug to determine plant height, root development and measure fresh plant weight. Only one replicate was sampled as visual observations indicated a very uniform growth pattern in all replicates. No rye plants were examined critically in U-27,267 plots.

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[1] Research Associate, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

In the spring of 1973 the rye cover crop on the 1972 herbicide trial plot area was plowed under, the land fertilized and disced, and Alaska peas (var. M-163) sown April 24. The seedling crop was carefully examined on May 17 and peas were found to be severely stunted in all plot areas treated the previous year with U-27,267 at rates above 1.12 kg/ha. Pea plants (10 plants/plot) were carefully dug, soil washed from their roots and fresh weight determined, from areas treated with 0, 0.84 (preemergence), 1.68 and 3.36 (preplanting) kg/ha of U-27,267 in 2 replications. No pea plants were examined from napropamide-treated areas as top and root growth appeared normal.

RESULTS

The soil in the test area is classified as a sandy loam with an organic matter content of 1%. Precipitation records at Clayton are presented in Table 2 and indicate ample rainfall during the 1972 growing season.

a. Greenhouse Study: Rye top growth appeared to develop normally and was comparable to controls under greenhouse conditions. However, when plants were harvested and root systems examined, severe inhibition had occurred with napropamide at 2.24 kg/ha in both soil zones (Table 3). While root elongation was inhibited, roots were highly branched and somewhat thickened, resulting in a fresh weight similar to controls. Under greenhouse conditions with daily watering this restricted root system was capable of supporting initial plant growth. There was a trend for rye plants grown in U-27,267 at 3.36 kg/ha to have somewhat restricted root development but not to the degree evident with napropamide at 2.24 kg/ha.

b. Spring Field Evaluation of Rye: Eleven months after the original applications ware made the rye cover crop was examined for herbicidal injury. Data are summarized in Table 4. Napropamide at 2.24 kg/ha had significantly thinned the rye stand and stunted growth by 84% compared to control or untreated plants. Response to the 1.12 kg/ha rate while not as great, was severe. The addition of pebulate (S-propyl butylethylthiocarbamate) did not appear to increase the adverse effects of napropamide residues. Rye growth in areas treated with U-27,267 appeared normal.

c. Spring Pea Crop: On May 17 the pea crop planted on the 1972 test area was 12-15 cm tall. The area was examined and sharply defined plot areas were observed that had been treated with U-27,267 at rates above 1.12 kg/ha the previous year. The area contained severely stunted pea plants which were blue-green in color compared to the yellow-green color of normal plants. At lower rates, i.e. at 0.84 and 1.12 kg/ha, treated areas were not easily discernible. Data in Table 5 summarize the extent of growth reduction obtained on this seedling pea crop. The prime area of activity was root inhibition as little or no secondary roots developed at the 1.68 and 3.36 kg/ha rates. Roots in the 0.84 kg/ha plots were well developed with normal branching. Only plants in plots treated with 1.68, 2.24 and 3.36 kg/ha (preplant or postplanting) remained stunted and failed to produce a crop. Pea growth was not adversely affected in areas treated with napropamide.

Lima beans (Phaseolus lunatus) planted in July 1973 (following the pea crop) did not show any phytotoxic symptoms to either herbicide. This could

mean beans were tolerant or that residue concentrations were below levels sensitive to plant growth.

DISCUSSION

Since rainfall was not a limiting factor during this period and normal temperatures prevailed it is evident that both napropamide and U-27,267 degrade very slowly and are very persistent compounds even in a low organic matter soil. Rye appears to be a good indicator crop for detecting napropamide residues (other grass species may be equally or more sensitive) while green peas are sensitive to U-27,267.

Weed control was optimum at the higher rates of both materials in our 1972 trials (3) but satisfactory control was obtained with napropamide at 1.12 kg/ha when combined with pebulate and from 0.84 kg/ha of U-27,267 applied preemergence. Even lower rates of napropamide, e.g. 0.58 kg/ha in combination with EPTC (S-ethyl dipropylthiocarbamate), were effective on weeds in potatoes according to Fricke (1,2). However, his observation in two separate experiments indicated that rye injury was greater from the 0.58 kg/ha rate than from 1.12 kg/ha (when combined with 4.48 kg/ha EPTC). Our data indicate less injury from 1.12 than 2.24 kg and no increased phytotoxicity when combined with pebulate (a compound closely related to EPTC). Since degradation of a herbicide is usually a first order reaction, the rate of disappearance is proportional to the concentration in the soil (4). Therefore, lower rates of napropamide in combination with pebulate (or EPTC) should be less injurious to cereal cover crops. The hazard of residual effects could be further reduced by banding napropamide or U-27,267 in tomatoes and possibly by fall plowing.

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Table 1. Rates and application methods used for U-27,267 and napropamide in 1972.

	Rate kg ai/ha	Application Method	Date Applied
U-27,267			
Direct-seeded tomatoes:	1.68	preplant incorporated	4/27/72
	3.36	preplant incorporated	4/27/72
	0.84	preemergence	4/28/72
	1.68	preemergence	4/28/72
	1.12	postemergence	6/5/72
	2.24	postemergence	6/5/72
Transplants:	1.68	preplant incorporated	5/8/72
	3.36	preplant incorporated	5/8/72
	1.68	postplanting	6/26/72
Napropamide			
Direct-seeded tomatoes:	1.12	preplant incorporated	4/27/72
	2.24	preplant incorporated	4/27/72
	1.12 + 3.36 pebulate	preplant incorporated	4/27/72
Transplants:	1.12	preplant incorporated	5/8/72
	2.24	preplant incorporated	5/8/72
	1.12 + 3.36 pebulate	preplant incorporated	5/8/72

Table 2. Precipitation record 1972-73 at Clayton, Delaware

Month	Precipitation cm	Comments
April 27-30, 1972	0	First application on 4/27/72
May	10.3	
June	30.3	
July	7.1	
August	2.3	
September	6.4	
October	14.6	
November	23.3	
December	14.3	
Jan. 1-19, 1973	1.8	
Subtotal	110.4	Soil sampled for greenhouse study 1/19/73
Jan. 20-31	7.6	
February	10.1	
March	11.0	
April 24	14.1	
Subtotal	153.2	Total to date of seeding peas
May 1-17	3.0	
Total	156.2	To date of field evaluation

Table 3. Response of rye plants grown in soil treated 9 months previously with napropamide and U-27,267.

Treatment	Rate kg ai/ha	Plant ht. cm	Root length cm	Fresh wt. (tops & roots) grams/plant
Control		14.2	8.2	0.39
Napropamide	1.12	15.7	7.6	0.41
Napropamide	2.24	15.2	3.8	0.42
U-27,267	1.68	14.2	11.4	0.42
U-27,267	3.36	15.2	7.0	0.34
LSD 5%		NSD	1.7	NSD

Note: Soil zones were not significantly different for any of the growth measurements.

Table 4. Influence of napropamide soil residues on rye cover crop growth 11 months after application.[1/]

Treatment rate kg ai/ha	Rye stand No. plants per 30.5 cm of row	Plant height cm	Fresh wt. (tops) grams/plant	% Reduction in growth
0	6.0	29.2	3.2	0
2.24	3.5	13.9	0.5	84
1.12	5.5	19.1	1.3	60
1.12 + pebulate @ 3.36	5.5	19.1	1.0	70

[1/] Means are for 5 plants/plot from a single replicate.

Table 5. Influence of U-27,267 soil residues on pea growth the year following application.

Treatment rate kg ai/ha (applied 1972)	Pea growth on May 17, 1973 (Plants 23 days old)* Height cm	Root length cm	Fresh weight grams/plant	% Reduction in growth
0	13.9[a]	17.0[a]	2.20[a]	0
0.84	8.9[b]	15.2[a]	1.81[ab]	18
1.68	6.4[b]	8.3[b]	1.24[bc]	44*
3.36	5.7[b]	7.6[b]	1.10[c]	50*

Means in columns followed by a common letter are not significantly different at 5% level DMR.

*No peas were produced on plants treated with these rates of U-27,267 in 1972.

PROBLEMS ENCOUNTERED BY ADDING FOAMING AGENTS TO PESTICIDE SPRAYS

Frank Black 1/

During the past four years, the use of foaming agents with pesticide sprays applied through foam nozzles for reducing drift has become quite popular. Their use for brush control sprays is an accepted practice to reduce the drift of these sprays into nearby fields. Two years ago a few reports at the weed and pesticide conventions were given demonstrating crop injury from a few specific foamed spray combinations. In 1972 ICI America decided to investigate the phytotoxicity of a number of pesticide-foaming agent combinations. We selected corn and tomatoes for our test. The University of Delaware agreed to plant the crops and allow us to apply our sprays at their Georgetown Research Station. Forty-one separate spray mixtures were applied. Twenty-seven were applied to corn and thirty-four were applied to tomatoes. Two commercial foaming agents were selected; they will be referred to as Agent A and Agent B. Four experimental foaming agents were added to investigate the effect from chemical type. The chemical types in this study were two nonionic foaming agents and four essentially anionic agents.

	Chemical Type
Agent A	Nonionic Ether
Agent B	Anionic Mixture
AL-1135	Nonionic Ester
AL-1172	Anionic
AL-1173	Anionic
AL-1174	Anionic

1/ Development Associate, Specialty Chemicals Division, ICI America, Wilmington, Delaware.

We selected standard insecticides and fungicides which are recommended for use on corn and tomatoes. They were Sevin 50W, Malathion 5E, Manzate and combinations. The 41 spray mixtures applied are shown in Table I.

Corn height: 11" to 14" at the time of spraying.
Tomato height: 13" to 15" at the time of spraying.
Sprayer: ICI America's Plot Sprayer with foam nozzle.
Dilution or gals spray per acre: 20 GPA.

The treatments were applied August 23 and 24. The timing was as follows:

August 23

36 to 41: 8-10:00 (Rear half of tomato plots sprayed twice (2X).)
Sprayer Cleanout
1 to 7: 10-12:00
Sprayer Cleanout
12:00-2:00 Lunch and rest:

During this time, field next to corn plots was irrigated and eight of the treated plots in the corn were washed off. It is questionable whether injury would occur with this short contact.

8 to 14: 2-3:30
Sprayer Cleanout
15 to 21: 3:30-5:00
Sprayer Cleanout

August 24

22 to 28: 9:00-10:30
Sprayer Cleanout
29 to 35: 10:30-12:00

Observations on August 24

Most of the sprays were causing definite injury to tomatoes, and there wasn't any apparent injury to the corn from the sprays applied on the 23rd.

September 12

35 mm color slides were taken of all the corn plots and 1/2 of the tomato plots. There was definite crop injury evident in the treatments on corn, but the damage to tomatoes had completely disappeared.

DISCUSSION

The study indicates that the combination of foaming agents with the insecticides Sevin or Malathion may be phytotoxic to corn or tomatoes under the conditions listed below:

Aged of Crop: Corn 11 to 14 inches high. Tomatoes less than 15 inches high. Gallons of Spray per Acre: 20 GPA with 1% Foaming Agent. The levels for the pesticides per acre: Malathion 5lb. per gallon emulsifiable 1 pint per acre. Sevin 50W 3 pounds per acre. Foam Nozzle height above crop 12 to 16 inches.

The injury to tomatoes disappears three weeks after spraying probably because only about 10 to 20% of the leaf surface had intercepted the spray. The injury to the corn was probably increased because the majority of the spray collected and drained into the whorl or growing point of the plant.

The pesticides are completely non phytotoxic when the sprays do not contain foaming agents at the 1% level. Foaming agents at 1% level sprayed at 20 gallons per acre without either Malathion or Sevin generally resulted in practically no injury to corn. We observed the second day of spraying that the plots in tomatoes and the one plot in corn that had been given a double spray (2X) in the rear half of each treatment that moderate to heavy damage to the crop was evident in both tomatoes and the one corn plot. This 2X treatment would be about 40 gallons per acre for these straight surfactant sprays.

It was noted on September 12 that the treatments which showed the greatest injury to the corn seemed to have stopped all growth but it still had green and yellow leaves which appeared to be alive. This suggests that Malathion or Sevin may have growth regulating properties for grasses when combined with the right surface active agent.

Compatibility studies were conducted in our formulation laboratory to investigate the effect of foaming agents upon the dispersion of the pesticides in water. In a few cases, we found that specific foaming agents would effect the emulsion performance of some emulsifiable concentrates. We also found that in a few mixtures that the following might effect the dispersion of foaming agent plus pesticide spray mixtures.

1. Percentage foaming agent

2. Gallons per acre or dilution

3. Order of addition to the spray tank of each formulation.

The majority of our thirty-five spray mixtures gave satisfactory spray tank dispersions for the time necessary to apply each treatment.

SUMMARY AND RECOMMENDATIONS

Caution is recommended when foaming agents are added to any pesticide spray; please test any new combination completely before recommendations are made to the grower. Test for spray tank compatibility and investigate the dilutions that the applicator might use and field test the combination for crop safety. Finally, determine the utility of the foaming agent to pesticide spray. Is it beneficial?

The commercial use of foaming agents with contact herbicides has demonstrated the utility of these adjuvants for reducing drift and improving deposit. Also, a study in Canada with a systemic insecticide and "Agent A" are looking very promising for controlling the Spruce Budworm.

There is a place for foaming agents in pesticide sprays but let us be certain that we find the areas and mixtures where this type of adjuvant is beneficial.

ACKNOWLEDGEMENT

We wish to express our appreciation to the University of Delaware for the planting of these crops and for allowing ICI America to use their Georgetown Substation for this study.

TABLE 1

FOAMING AGENT PESTICIDE TREATMENTS

Location: University of Delaware Georgetown Substation

No.	Pesticide	Amount/Acre	Foaming Agent	%	Crop
1	Sevin 50W	3 lbs	None	0	Corn & Tomatoes
2	Sevin 50W	3 lbs	Agent A	1%	Corn & Tomatoes
3	Sevin 50W	3 lbs	Agent B	1%	Corn & Tomatoes
4	Sevin 50W	3 lbs	AL 1135	1%	Corn & Tomatoes
5	Sevin 50W	3 lbs	AL 1172	1%	Corn & Tomatoes
6	Sevin 50W	3 lbs	AL 1173	1%	Corn & Tomatoes
7	Sevin 50W	3 lbs	AL 1174	1%	Corn & Tomatoes
8	Malathion 5E	1 pint	None	0	Corn & Tomatoes
9	Malathion 5E	1 pint	Agent A	1%	Corn & Tomatoes
10	Malathion 5E	1 pint	Agent B	1%	Corn & Tomatoes
11	Malathion 5E	1 pint	AL 1135	1%	Corn & Tomatoes
12	Malathion 5E	1 pint	AL 1172	1%	Corn & Tomatoes
13	Malathion 5E	1 pint	AL 1173	1%	Corn & Tomatoes
14	Malathion 5E	1 pint	AL 1174	1%	Corn & Tomatoes
15	Sevin + Malathion	3 + 1 pint	None	0	Corn
16	Sevin + Malathion	3 + 1 pint	Agent A	1%	Corn
17	Sevin + Malathion	3 + 1 pint	Agent B	1%	Corn
18	Sevin + Malathion	3 + 1 pint	AL 1135	1%	Corn
19	Sevin + Malathion	3 + 1 pint	AL 1172	1%	Corn
20	Sevin + Malathion	3 + 1 pint	AL 1173	1%	Corn
21	Sevin + Malathion	3 + 1 pint	AL 1174	1%	Corn
22	Manzate	4 lbs	None	0	Tomatoes
23	Manzate	4 lbs	Agent A	1%	Tomatoes
24	Manzate	4 lbs	Agent B	1%	Tomatoes
25	Manzate	4 lbs	AL 1135	1%	Tomatoes
26	Manzate	4 lbs	AL 1172	1%	Tomatoes
27	Manzate	4 lbs	AL 1173	1%	Tomatoes
28	Manzate	4 lbs	AL 1174	1%	Tomatoes
29	Sevin + Manzate + Malathion	3+4+1 pint	None	0	Tomatoes
30	"	3+4+1 pint	Agent A	1%	Tomatoes
31	"	3+4+1 pint	Agent B	1%	Tomatoes
32	"	3+4+1 pint	AL 1135	1%	Tomatoes
33	"	3+4+1 pint	AL 1172	1%	Tomatoes
34	"	3+4+1 pint	AL 1173	1%	Tomatoes
35	"	3+4+1 pint	AL 1174	1%	Tomatoes
36	None	0	Agent A	1%	Corn & Tomatoes
37	None	0	Agent B	1%	Corn & Tomatoes
38	None	0	AL 1135	1%	Corn & Tomatoes
39	None	0	AL 1172	1%	Corn & Tomatoes
40	None	0	AL 1173	1%	Corn & Tomato
41	None	0	AL 1174	1%	Corn & Tomatoes

Chart 1

PLOT DESIGN

GEORGETOWN SUBSTATION

CORN

	15	9	2	1	5	20	12
	3	18	36	11	40	13	4
	19	14	7	41	39	21	10
		6	38	16	37	17	8
		38	37	36	39	7	13
		17	4	10	1	12	9
2X 1X 37							
	16	8	15	3	6	19	40
41	21	14	11	20	2	5	18

Plots 20 ft. long - 1 row of corn 3.8 oz. of spray per plot. 50 psi.

◯ - Plots treated Wed. morning and irrigated Wed. noon for about 1½ hours.

▭ - Irrigated Area.

Chart 2

PLOT DESIGN

GEORGETOWN SUBSTATION

TOMATOES

11	36	29	21	24	40	27	25
34	33	4	8	6	28	26	3
9	12	7	22	23	5	39	31
13	35	10	14	41	1	30	2

38	11	32	37	12	24	29	1
25	32	8	9	21	33	35	22
4	34	26	23	2	27	31	10
28	7	13	5	14	30	6	3

◯ No duplicates: Upper half of each plot sprayed twice or at a 2X concentration. These plots were straight foaming agents with no pesticide plots - 20 ft. long one row of tomatoes 3.8 oz. spray per plot. 50 psi. - 1 - Delvan Foam Nozzle.

TABLE 2 PHYTOTOXICITY RATINGS ON CORN

Ratings Taken from Pictures Taken 9/12/72

Treatment	Remarks	Rating	Remarks	Rating	Rating Average
1. 3lbs/A Sevin 50W		1		1	1
2. +Agent A	Stunted	7	Twisted	3-5	5.5
3. +Agent B	Wilted & Twisted	5		2	3.5
4. +AL-1135	Irrigated Stunted	5		2	3.5
5. +AL-1172	Stunted	7	Stunted	3-6	5.75
6. +AL-1173	Stunted	7.5	Irrigated	4	5.75
7. +AL-1174	Irrigated	1		2	1.5
8. 1pt Malathion 5E		1		2	1.5
9. +Agent A	Wilted	7	Lodged	6.5	6.75
10. +Agent B	Wilted & Lodged	7	Stunted	6	6.5
11. +AL-1135	Wilted & Stunted	3	Twisted	4	3.5
12. +AL-1172	Wilted & Lodged	7.5	Stunted	5.5	6.5
13. +AL-1173	Wilted & Lodged	3-6	Wilted	2-5	4
14. +AL-1174	Lodged	9	Lodged	9	9
15. Mal. & Sevin		1		2	1.5
16. +Agent A	Young Plants Stunted	8	Burned Leaves	6	7
17. +Agent B	Wilted	7	Stunted	6	6.5
18. +AL-1135	Stunted	2-5	Twisted	2-5	3.5
19. +AL-1172	Stunted	7.5	Stunted	7	7.25
20. +AL-1173	Wilted & Lodged	7.5	Wilted	7	7.25
21. +AL-1174	Lodged	8.5	Lodged	8.5	8.5
36. 1% Agent A	Irrigated	1		1	1
37. 1% Agent B	Irrigated	1	Twisted	2	1.5
38. 1% AL-1135	Irrigated	2	Irrigated	2	2
39. 1% AL-1172		2	Stunted	3-5	3
40. 1% AL-1173		1	Stunted	3-5	2.5
41. 1% AL-1174	Irrigated	1	Young Plants Boarder Row	6	3.5

Ratings 2-5 or 3-5 or 3-6 Damage varied on plot.

Rating 1 - No Effect 2 - Slight Damage 3 to 5 - Moderate Damage 6 to 8 - Heavy 9 - Severe Damage

THE INFLUENCE OF TEMPERATURE AND SOIL MOISTURE ON THIOCARBAMATE INJURY IN CORN

Akin Akinsorotan and Gordon W. Burt[1]

ABSTRACT

Butylate (S-ethyl diisobutylthiocarbamate) and EPTC (S-ethyl dipropylthiocarbamate) control many annual and perennial grasses in corn in some seasons. Recently, protectants or antidotes have been found which can reduce thiocarbamate injury to corn while the herbicide remains toxic to other species. R 25788 (N,N-diallyl-2,2-dichloro-acetamide) is the protectant used in these studies. These studies were conducted (a) to determine the influence of temperature and soil moisture on thiocarbamate injury to corn and (b) to determine the influence of temperature and soil moisture on the protectant effect.

EPTC (3,9 lb/A), butylate (10,25 lb/A), EPTC (30,60 lb/A) plus R 25788 and butylate (60,90 lb/A) plus R 25788 were sprayed on soils with a laboratory sprayer at 30 gpa and thoroughly incorporated. R 25788 was commercially formulated with EPTC (½ lb per 6 lb EPTC) and butylate (1/4 lb per 6 lb butylate). Four plants per pot of Pioneer Variety 3369 A corn were planted. Soil moisture was maintained at a high (33%) and low (15%) level in growth chambers with temperatures maintained at 30 and 20 C in the light. Night temperatures were 5 C cooler than day temperatures. Other temperature regimes consisted of transferring the plants from the cool to the warm temperatures and from warm to cool temperatures at different time periods. The experimental period was 3 weeks during which time corn shoot height, shoot and root fresh weights and injury rating (morphological aberrations) were measured.

EPTC (60 lb/A) plus protectant caused severe morphological aberrations at high temperatures whereas, injury was slight in the cold. Butylate plus protectant injured corn less than EPTC plus protectant. No morphological aberrations were noted in corn grown in butylate plus protectant in the cold. Temperature effects on thiocarbamate injury were similar for herbicides alone as compared to herbicides with protectant; however, higher rates of herbicides were required before injury occurred in the treatments where protectant was used. Corn was more severely injured in dry than in moist soil with protectant; however, the opposite reaction occurred without protectant. Data of shoot height and shoot and root weight conform to the above results with visual rating of morphological aberrations.

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1 Graduate Student and Assistant Professor, respectively, Department of Agronomy, University of Maryland, College Park 20742

EVALUATION OF HERBICIDES ON DRY AND SNAP BEANS[1]

P. F. Boldt and R. D. Sweet[2]

Abstract

A series of field experiments were conducted evaluating various herbicides and herbicide combinations for control of redroot pigweed (Amaranthus retroflexus L.), lambsquarters (Chenopodium album L.), and galinsoga [Galinsoga ciliata (Raf.) Blake] in dry beans (Phaseolus vulgaris L. cv. California Light Red Kidney) and snap beans (Phaseolus vulgaris L. var humilus Alef. cv. Tendercrop). Three newer materials performed well. USB 3584, preplant incorporated at 0.25 to 0.50 kg/ha, gave good control of pigweed and lambsquarters. Preemergence treatments of metribuzin [4-amino-6-t-butyl-3-(methylthio)-as-triazin-5(4H)-one] at 0.25 kg/ha gave excellent control of redroot pigweed and galinsoga with little crop injury. Fluorodifen (2,4'-dinitro-4-trifluoromethyl-diphenylether dipropylaniline) at 2 kg/ha also gave good control, however, leaf symptoms were noted early in the season.

Studies were conducted with EPTC (ethyl N,N-dipropylthiocarbamate), trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), nitralin [4-2(2-methyl sulfonyl)-2,6-dinitro-N,N], chloramben (3-amino-2,5-dichlorobenzoic acid), alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)-acetanilide], fluorodifen, chlorbromuron [3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea], and dinoseb (2-sec-butyl-4,6-dinitrophenol) at recommended rates, alone and in combination. Fluorodifen, alachlor and chlorbromuron gave good weed control but caused toxicity to both beans. EPTC and trifluralin in combination provided better weed control than either applied alone. No crop injury occurred with either material alone or in combination.

Introduction

Dry beans and snap beans are an important portion of the New York State vegetable industry, comprising a total of 96,500 acres (estimate) in 1973. Both crops are almost totally mechanized, including harvest. Since harvesters do not perform well in crops with heavy weed growth, growers must have weed-free fields late in the season. At the present time many growers are not achieving full season control; also certain weed species such as galinsoga are not controlled by herbicide programs currently recommended.

The purpose of these studies were: a) to evaluate new herbicides for crop safety and weed control; b) secondary evaluation of newer bean herbicides specifically for galinsoga response and crop safety; and c) to evaluate established bean herbicides both alone and in combinations for crop tolerance and weed response.

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[1] Paper No. 660, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

[2] Research Technician and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

Experimental

General Materials and Methods

Four experiments were conducted in 1973. Location, planting dates and chemical application timings for these experiments are indicated in Table 1. Soil types for the various experiments were Howard gravelly loam - Experiment 1; Eel silt loam - Experiments 2 and 3; and a sandy loam - Experiment 4. Land preparation for all experiments consisted of plowing and disc harrowing in late April followed by reworking with a spring tooth and meeker harrow immediately before applying preplant incorporated treatments. Chemicals were incorporated with a spring tooth harrow set to a depth of 5 to 7 cm, and pulled down and back over the experimental area. Dates of planting and chemical application are given in Table 1.

In Experiment 1, chemical application was made with a small plot CO_2 powered logrithmic sprayer delivering four one-half rate doses. All other treatments were applied using a straight rate CO_2 powered small plot sprayer, delivering 460 l/ha at 2.46 kg/cm^2.

Plot sizes were 30 m^2 in Experiment 1, and 10 m^2 in all others. Complete randomized block designs with two replications were used for all experiments.

Rainfall for all experiments conducted at Freeville (Experiments 1, 2, and 3) was moderate throughout the growing period; consisting of light showers every three to five days. The experiment conducted at West Henrietta, New York, received heavy rains of over 2.5 cm soon after each application of preplant incorporated and preemergence treatments.

Visual ratings were made using a scale of 1 to 9; 1=no effect on weeds or crop completely killed; 7=commercially acceptable weed control or insignificant crop injury; 9=complete weed kill or no effect on crop.

Table 1. Location, dates of planting and of chemical application (1973).

			Chemical Application				
Expt.	Location	Planted	PPI	Pre	At Cracking	E.Post	L.Post
1	Freeville	5/25	5/25	5/25	--	--	--
2	Freeville	6/15	6/15	6/15	6/23	6/27	7/7
3	Freeville	6/23	6/23	6/26	--	--	--
4	W.Henrietta	6/13	6/11	6/16	--	--	--

New Herbicide Evaluation

One experiment was conducted in 1973 (Experiment 1), evaluating new compounds for crop tolerance and weed control. Only snap beans were used for crop evaluation, because of their greater sensitivity to herbicides. Dry beans are usually less sensitive to herbicides and will generally tolerate all

herbicides that snap beans tolerate. Chemicals tested along with the formulations, rates and timings are listed in Table 2. Visual ratings of the crop response (snap beans) and weed control (redroot pigweed, lambsquarters and ragweed) were taken on July 7, 1973, 42 days after treatment. Of the six chemicals tested, only USB 3584 at 0.25 to 0.50 kg/ha a.i. gave satisfactory crop tolerance with good control of pigweed and lambsquarters. Ragweed (Ambrosia artemisiifolia L.) was not controlled satisfactorily.

Table 2. Chemicals tested in Experiment 1.

Chemical	Formulation	kg/ha[a]	Timing
R-25823[b]	50WP	8 - 0.50	PPI, Pre
USB 3584[c]	2EC	2 - 0.12	PPI
ICS 3510[b]	50WP	5 - 0.40	PPI, Pre
R-31401[b]	4EC	8 - 0.50	Pre
S-6044[b]	3EC	8 - 0.50	Pre
MC-4379[b]	2EC	8 - 0.50	Pre

[a] Logarithmic dosage from highest to lowest rate as specified.
[b] Chemistry not disclosed.
[c] N^3,N^3-diethyl-2,4 dinitro-6-trifluoromethyl-m-phenylenediamine.

Secondary Evaluation of Newer Bean Herbicides

In Experiment 2, promising herbicides and herbicide combinations were tested for crop tolerance and weed control. Crops were snap beans and dry beans, principal weeds were galinsoga and redroot pigweed. Visual ratings of these treatments taken on July 12, 1973, 27 days after treatment, are recorded in Table 3.

Most treatments gave acceptable control of redroot pigweed, however, few controlled galinsoga. Effective galinsoga control with little or no crop injury was achieved with preplant incorporated treatments of EPTC (3F) at 3 kg/ha; preemergence treatments of metribuzin at 0.25 kg/ha or IMC 3950 at 6 kg/ha; at cracking treatments of dinoseb (3WS) at 3 kg/ha, or dinoseb (5EC) at 5 kg/ha; and late post treatments of bentazon at 0.50 to 1 kg/ha.

Fluorodifen applied preemergence at 2 kg/ha gave excellent weed control of both galinsoga and redroot pigweed. However, early stunting of the crops was evident. At the time of rating, the crop appeared to have grown out of the injury.

Combinations of Established Herbicides

Experiment 3 was conducted to evaluate eight herbicides alone and in combination with each other. These herbicides are either currently recommended or have shown promise for use on dry and snap beans. The treatments and visual ratings taken on July 12, 1973, 19 days after planting, are included in Table 4.

Table 3. Secondary evaluation of herbicides on dry and snap beans (Expt. 2).

Herbicide	kg/ha (ai)	Crop Response S.Beans	Crop Response D.Beans	Weed Control Galin.	Weed Control Pig.
CGA 10832 (ppi)[a]	0.75	7.5	8.0	4.5	7.0
CGA 10832 (ppi)	1.00	7.0	8.0	2.5	8.0
CGA 10832 (ppi)	1.50	7.5	7.5	4.0	9.0
BAS 3921-H (ppi)[b]	0.75	9.0	9.0	7.0	8.0
BAS 3921-H (ppi)	1.50	8.0	8.0	5.0	8.0
AC 92390 (ppi)[c]	1.50	8.0	7.5	3.5	6.5
AC 92553 (ppi)[c]	0.75	8.5	8.5	2.0	8.0
trifluralin (ppi)[d]	0.75	9.0	9.0	3.5	9.0
EPTC 6EC (ppi)[d]	1.50	9.0	9.0	5.0	6.5
EPTC 6EC (ppi)	3.00	8.0	7.5	6.0	8.5
EPTC 3F (ppi)	3.00	7.5	8.0	7.0	9.0
nitralin (ppi)[d]	1.00	9.0	9.0	5.5	8.5
fluorodifen (pre)[d]	2.00	8.0	8.0	8.5	9.0
fluorodifen (pre)	3.00	6.5	7.0	8.5	9.0
EL-119 (pre)[c]	1.00	7.5	7.5	7.0	8.0
metribuzin (pre)[d]	0.25	8.0	8.0	9.0	9.0
metribuzin (pre)	0.50	6.5	7.0	9.0	9.0
alachlor (pre)[d]	2.00	5.0	5.5	9.0	9.0
IMC-3950 (pre)[e]	3.00	8.0	9.0	6.5	7.5
IMC-3950 (pre)	6.00	7.0	8.0	8.5	9.0
chloramben, NH_3 salt (pre)[d]	3.00	7.0	7.0	5.0	9.0
trifluralin (ppi)+metribuzin (ppi)	0.75+0.50	5.0	4.5	9.0	9.0
AC 92390 (ppi)[c]+EPTC (ppi)	1.00+1.50	7.5	7.5	4.5	8.0
AC 92553 (ppi)[c]+EPTC (ppi)	0.75+1.50	7.0	7.5	2.0	6.0
CGA 10832 (ppi)+fluorodifen (pre)	0.75+2.00	7.0	8.0	8.5	9.0
CGA 10832 (ppi)+fluorodifen (pre)	1.00+2.00	7.0	8.0	9.0	9.0
EL-119 (pre)+metribuzin (pre)	1.00+0.25	7.0	7.5	9.0	9.0
dinoseb 3WS (crack)[d]	3.00	9.0	9.0	9.0	8.5
dinoseb 5EC (crack)	5.00	7.5	8.5	9.0	9.0
bentazon (crack)[f]	0.50	9.0	9.0	6.5	6.5
bentazon (crack)	1.00	9.0	9.0	7.5	6.5
bentazon (crack)	1.50	8.5	8.5	7.0	7.0
bentazon (e.post)	0.50	8.5	8.5	5.0	5.0
bentazon (e.post)	1.00	8.0	9.0	7.0	7.0
bentazon (e.post)	1.50	7.5	8.0	7.5	7.0
bentazon (l.post)	0.50	7.5	8.0	9.0	9.0
bentazon (l.post)	1.00	7.5	8.0	9.0	7.5
bentazon (l.post)	1.50	6.5	6.5	9.0	7.5
untreated		8.9	8.8	5.5	5.0

1=no effect on weeds, complete kill of crop; 7=commercially acceptable weed control and crop; 9=complete weed kill, no effect upon crop. Rated July 7, 1973.

[a] N-n-propyl-N cyclopropylmethyl-4-trifluromethyl-2,6-dinitroaniline
[b] N-propyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluoromethyl-aniline
[c] Chemistry not disclosed
[d] See first page of this paper for chemical identification
[e] S-(4 chlorobenzyl)-N,N-diethylthiol carbamate
[f] 3-isopropyl-H-2,1,3-benzothiadazin-(4) 3H-one 2,2-dioxide

Table 4. Evaluation of established herbicides alone and in combination (Expt. 3).

Herbicide	kg/ha (ai)	Crop Response S.Beans	Crop Response D.Beans	Weed Control Pigweed
EPTC (ppi)[a]	3.00	8.5	9.0	6.5
trifluralin (ppi)[a]	0.75	8.5	8.5	7.0
nitralin (ppi)[a]	1.00	9.0	9.0	8.0
chloramben, NH_3 salt (pre)[a]	3.00	8.5	8.5	6.5
alachlor (pre)[a]	2.00	5.0	6.0	9.0
fluorodifen (pre)[a]	3.00	5.5	6.0	9.0
chlorbromuron (pre)[a]	2.50	2.0	4.0	9.0
dinoseb (pre)[a]	3.00	7.5	8.0	5.5
EPTC (ppi)+trifluralin (ppi)	3.00+0.75	8.5	8.5	8.0
EPTC (ppi)+nitralin (ppi)	3.00+1.00	7.5	7.5	7.0
EPTC (ppi)+chloramben (pre)	3.00+2.00	7.0	7.0	9.0
EPTC (ppi)+alachlor (pre)	3.00+1.00	6.0	6.0	9.0
EPTC (ppi)+fluorodifen (pre)	3.00+2.00	6.5	6.5	9.0
EPTC (ppi)+chlorbromuron (pre)	3.00+1.25	3.5	4.5	9.0
EPTC (ppi)+dinoseb (pre)	3.00+3.00	7.0	7.0	9.0
trifluralin (ppi)+nitralin (ppi)	0.75+1.00	6.5	7.0	7.5
trifluralin (ppi)+chloramben (pre)	0.75+2.00	7.0	7.0	9.0
trifluralin (ppi)+alachlor (pre)	0.75+1.00	6.0	6.0	9.0
trifluralin (ppi)+fluorodifen (pre)	0.75+2.00	6.5	6.5	9.0
trifluralin (ppi)+chlorbromuron (pre)	0.75+1.25	3.5	5.0	9.0
trifluralin (ppi)+dinoseb (pre)	0.75+3.00	7.5	7.5	8.0
nitralin (ppi)+chloramben (pre)	1.00+2.00	7.5	7.5	8.0
nitralin (ppi)+alachlor (pre)	1.00+1.00	6.0	6.0	8.0
nitralin (ppi)+fluorodifen (pre)	1.00+2.00	6.0	6.5	9.0
nitralin (ppi)+chlorbromuron (pre)	1.00+1.25	4.0	5.0	9.0
nitralin (ppi)+dinoseb (pre)	1.00+3.00	8.5	8.5	8.5
chloramben (pre)+alachlor (pre)	2.00+1.00	6.0	6.5	9.0
chloramben (pre)+fluorodifen (pre)	2.00+2.00	6.5	5.5	9.0
chloramben (pre)+chlorbromuron (pre)	2.00+1.25	3.5	5.0	9.0
chloramben (pre)+dinoseb (pre)	2.00+3.00	7.5	7.5	9.0
alachlor (pre)+fluorodifen (pre)	1.00+2.00	6.0	6.0	9.0
alachlor (pre)+chlorbromuron (pre)	1.00+1.25	2.0	3.0	9.0
alachlor (pre)+dinoseb (pre)	1.00+3.00	6.5	7.0	9.0
fluorodifen (pre)+chlorbromuron (pre)	2.00+1.25	4.5	5.5	9.0
fluorodifen (pre)+dinoseb (pre)	2.00+3.00	6.0	6.0	9.0
chlorbromuron (pre)+dinoseb (pre)	1.25+3.00	3.5	5.0	9.0
untreated		8.7	8.8	1.6

1=no effect on weeds, complete kill of crop; 7=commercially acceptable crop and weed control; 9=complete weed kill, no effect upon crop. Rated July 12, 1973.

[a] See first page of this paper for chemical identification

It was observed that alachlor, fluorodifen and chlorbromuron caused stunting of both dry and snap beans, either alone or in combination. Later in the season it appeared that the beans in the fluorodifen treatments grew out of the injury; EPTC alone did not control redroot pigweed well. However, in combination with trifluralin better control was achieved than with either compound alone.

A duplicate of Experiment 3 was carried out with only dry beans, at West Henrietta, New York. Similar results were found, with one exception. Chloramben caused stunting to the beans. It is felt that heavy rains soon after chemical application contributed to this injury.

Summary

Many of the currently recommended bean herbicides do not provide full season weed control or do not control problem weeds such as galinsoga. Many herbicides which control galinsoga cause bean injury. Excellent weed control was achieved with the use of fluorodifen and metribuzin. Leaf symptoms were observed on the beans but after a few weeks the symptoms disappeared. The effect of these herbicides on bean yield, or the effect of lower rates on weed control and crop tolerance is not known and should be explored.

ACTIVITIES OF ALACHLOR AND FLUORODIPHEN IN SNAP BEANS[1]

H. P. Wilson, J. N. Belote III and T. E. Hines[2]

Abstract. Preemergence applications of p-nitrophenyl a,a,a-trifluoro-2-nitro-p-tolyl ether (fluorodiphen), 2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), and alachlor with 2-sec-butyl-4,6-dinitrophenol (dinoseb) effected good control of fall panicum (Panicum dichotomiflorum Michx.), large crabgrass (Digitaria sanguinalis L.) and redroot pigweed (Amaranthus retroflexus L.) in snap beans (Phaseolus vulgaris L. 'Harvester'). The combination of alachlor with dinoseb also provided good control of lambsquarters (Chenopodium album L.). Snap bean injury resulted from both fluorodiphen and alachlor and was influenced by preemergence rainfall. Fluorodiphen applications were more injurious when followed by heavy preemergence rainfall (7.5 cm) than when followed by low preemergence rainfall (1.2 cm) while alachlor effected more injury to snap beans with low preemergence rainfall.

Introduction

Several workers have reported excellent control of annual grasses in snap beans with alachlor while combinations of alachlor with dinoseb have provided good control of broadleaf weeds and grasses (1,3,5). Tolerance of snap beans to alachlor has varied from no injury (1,5) to reductions in crop vigor (2,3). Monaco and Weber (4) found that injury was more extensive on loamy sand soils than on sandy loams and that moisture in the form of rainfall or irrigation shortly after alachlor application resulted in increased crop injury when compared with treatments receiving no moisture. The authors concluded that the margin of safety of alachlor to snap beans was narrow.

Fluorodiphen has provided good control of annual grasses in snap beans and variable control of broadleaf weeds at rates between 2.24 and 6.72 kg/ha (1,3,5); however, Ashley (1) and Wilson et al. (5) have reported injury to snap beans at rates of 5.00 kg/ha and above.

The research reported herein was conducted to more fully investigate the activities of alachlor and fluorodiphen in snap beans.

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2/Plant Physiologist and Agricultural Research Assistants, respectively, Virginia Truck and Ornamentals Research Station, Painter, Virginia 23420.

Materials and Methods

A Sassafras sandy loam soil with an organic matter content of approximately 1.5% and a pH of 5.5 was selected for studies conducted during 1972 and 1973. Following normal soil preparation consisting of mold-board plowing and discing twice, snap beans were planted 1.2 to 1.8 cm deep on May 2, 1972 and May 3, 1973. Herbicides were applied immediately after planting both years at a delivery rate of 500 l/ha. Formulations of all herbicides used were emulsifiable concentrates. Soil moisture was good in 1972 when herbicides were applied and 8.1 cm rain was received during the 3 day period following applications. In 1973, soil moisture was again good when herbicides were applied and 1.2 cm rain was received 1 day after application. Plot size both years was 1.8 m x 9.1 m and plots contained 2 rows of snap beans. Experiments were designed as randomized complete blocks with 4 replications.

Weed control and crop responses were evaluated using the scale 0 to 10 where 0 represents no effect on plant stand or vigor and 10 represents complete reduction in stand or vigor. Weed species varied with years but included lambsquarters, redroot pigweed, large crabgrass and fall panicum. Snap beans were harvested in 1972 but not in 1973. All efficacy data and yields were analyzed statistically and means compared using Duncan's New Multiple Range Test.

Results and Discussion

Control of individual weed species varied with the herbicides and with the year (Tables 1 and 2). Fluorodiphen provided good control of all species present in 1972 and 1973. Control of lambsquarters with alachlor varied from good in 1972 to unsatisfactory in 1973 but control of annual grasses was good both years. Combinations of alachlor with dinoseb consistently resulted in good control of all species.

Fluorodiphen caused extensive injury to snap beans both years with the magnitude of response increasing with increases in herbicide rate. In 1972, when preemergence rainfall was heavy, injury was manifested as stand reductions resulting from stem breakage while snap beans were in the crook-neck stage of growth (Figure 1.). The fact that yields were not reduced probably resulted from a higher than optimum seeding rate causing a high population of snap bean plants. Where stand was reduced by fluorodiphen, remaining plants grew vigorously and likely produced more beans per plant than in uninjured check plots where the plant population was higher. It is suspected that at planting rates that would result in plant populations optimum for maximum yields, stand reductions would result in yield reductions. In 1973, when preemergence rainfall was light, fluorodiphen caused reductions in snap bean vigor which were soon outgrown and likely had no effect on yield.

Alachlor produced little crop injury under the heavy rainfall conditions of 1972 but alone and in combinations with dinoseb produced extensive reductions in snap bean growth in 1973. The 1.2 cm of preemergence rain in 1973 may have concentrated alachlor in the proximity of the seed as opposed to the previous year when heavy rainfall probably concentrated alachlor below the root zone. Eshel (2) showed that 5.1 cm water leached alachlor to a depth of 5.1 to 7.5 cm in sandy loam soil. He further showed that injury to cotton (Gossypium hirsutum L.) seedlings with a shoot length of 1 cm was greater when exposed to alachlor in the root zone than in the shoot zone.

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Table 1. Effects of fluorodiphen, alachlor and dinoseb applied preemergence in snap beans on crop response and weed control in 1972.[abc]

Herbicide	Rate	Crop Response	Weed Control[d] L.Q.	Pig	C.G.	Yields
	(kg/ha)	(6/8)	(6/8)	(6/8)	(6/8)	(kg/ha)
Fluorodiphen	2.24	1.8 c	9.7 a	9.6 ab	9.5 a	12705.0 abc
	3.36	3.1 d	9.6 a	10.0 a	9.8 a	10672.2 bc
	4.48	3.7 e	9.9 a	10.0 a	9.6 a	12196.8 abc
Alachlor	1.12	0.6 b	9.5 a	9.0 b	9.3 a	11398.2 abc
	1.68	0.6 b	8.9 a	9.8 ab	9.4 a	9801.0 c
	2.24	0.6 b	9.7 a	9.4 ab	9.7 a	12487.2 abc
	3.36	0.6 b	9.5 a	10.0 a	9.5 a	14011.8 a
Alachlor + Dinoseb	1.12 + 2.24	0.7 b	8.5 a	9.3 ab	9.1 a	13358.4 ab
	1.12 + 3.36	0.7 b	9.8 a	8.0 c	9.3 a	13068.0 ab
	1.68 + 3.36	0.5 ab	9.7 a	9.6 ab	9.6 a	13140.6 ab
Dinoseb	3.36	0.9 b	6.5 b	7.4 c	4.5 b	10381.8 bc
Check (hoed)		0.0 a	10.0 a	10.0 a	10.0 a	13358.4 ab
Check		0.0 a	0.0 c	0.0 d	0.0 c	10817.4 bc

a/Data are averages of 4 replications.
b/Scale: 0 to 10; 0 = no effect and 10 = complete stand reduction.
c/Means within columns followed by the same letter do not differ at the 5% level of significance.
d/L.Q. = lambsquarters; Pig = pigweed; and C.G. = crabgrass.

Table 2. Effects of fluorodiphen, alachlor, and dinoseb applied preemergence in snap beans on crop response and weed control in 1973.[abc]

Herbicide	Rate	Crop Response	Weed Control[d]		
			L.Q.	C.G.	F.P.
	(kg/ha)	(5/22)	(7/5)	(7/5)	(7/5)
Fluorodiphen	2.24	1.2 bc	7.1 cd	9.6 bc	8.9 b
	3.36	1.9 c	8.1 bc	9.8 ab	9.8 a
	4.48	2.1 cd	8.8 ab	9.9 a	9.6 ab
Alachlor	1.12	1.0 ab	5.1 e	10.0 a	9.9 a
	2.24	2.7 de	6.6 d	10.0 a	10.0 a
	3.36	3.6 e	7.2 cd	10.0 a	10.0 a
Alachlor + Dinoseb	1.12 + 3.36	1.4 bc	9.7 a	10.0 a	10.0 a
	2.24 + 3.36	2.7 de	9.7 a	10.0 a	10.0 a
Dinoseb	3.36	0.9 ab	9.1 ab	9.5 c	6.7 c
Check		0.0 a	0.0 f	0.0 d	0.0 d

a/Data are averages of 4 replications.

b/Scale: 0 to 10; 0 = no effect and 10 = complete reduction in crop vigor or weed stand.

c/Means within columns followed by the same letter do not differ at the 5% level of significance.

d/L.Q. = lambsquarters, C.G. = crabgrass and F.P. = fall panicum.

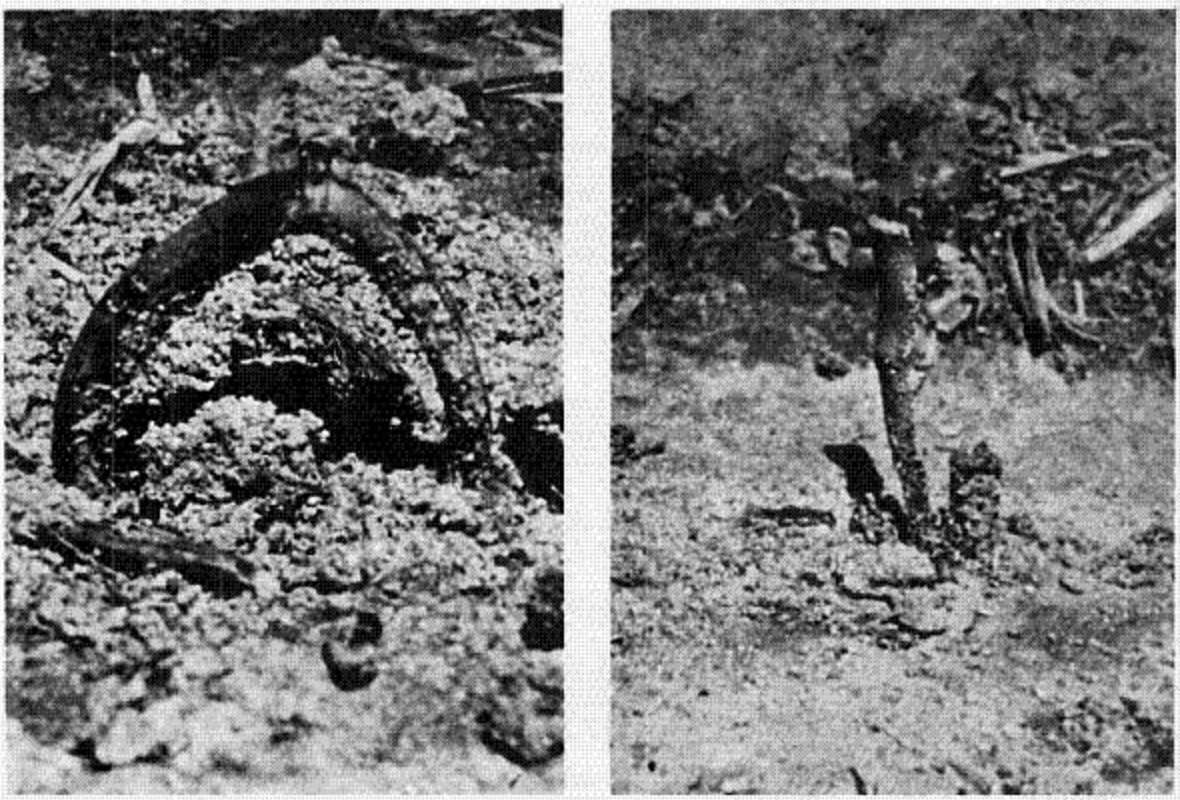

Figure 1. Effect of preemergence applications of fluorodiphen at 4.48 kg/ha on emergence of snap beans in 1972. Left: Partially expanded cotyledons failed to emerge from soil. Right: Stems broke while snap beans were in the crook-neck stage.

EVALUATION OF EIGHT HERBICIDES ALONE AND IN COMBINATION FOR WEED CONTROL IN CARROTS

Charles J. Noll[1]

Abstract

Carrots (*Daucus carota* var. *sativa*) were chemically weeded with six herbicides applied as preplant incorporation treatments and two herbicides applied as postemergence treatments and all combinations of the eight except the two postemergence treatments. The best single chemical treatments were A-820 (N-sec-butyl-4-tert-butyl-2,6-dinitroaniline) and nitralin (4-methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline) applied as preplant incorporation treatments. No combination of herbicides resulted in significant increases in yield as compared to A-820 and nitralin although weed control in a number of cases was significantly improved.

Introduction

Research was conducted to investigate eight herbicides and combinations of herbicides for the weeding of carrots. The possibility that combinations of chemicals would result in improved weed control and increased yield was investigated.

Materials and Methods

Eight herbicides each at a single rate were included in the carrot weed control trials this year. The six herbicides applied as preplant incorporation treatments were A-820, nitralin, trifluralin (a,a,a-trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine), BAS 3870 (N-allyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluoro-methyl-aniline), CGA 10832 (N-n-propyl-N-cyclopropylmethyl-4-trifluromethyl-2,6-dinitroaniline), and metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one. The two herbicides applied as postemergence chemicals were chloroxuron (3-[p-(p-chlorophenoxy)phenyl]-1,1-dimethylurea) and linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea).

The study was conducted at the Rock Springs Experimental farm located 10 miles west of University Park on a Hagerstown silt loam soil. The seedbed was prepared April 25 and preplant incorporation treatments applied the same day. Heavy rains packed the soil and delayed seeding. On May 2, the soil was rototilled again and the carrots, variety Royal Chautenay, seeded. The postemergence treatment with chloroxuron was applied 30 days after seeding and the linuron 55 days after seeding.

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

On July 5, two months after seeding, weed control was evaluated using a rating scale of 1 to 9. Under this system, 1 is no weed control and 9 is complete weed control. On August 2, in four replications, the weeds redroot pigweed and green foxtail were evaluated using a 1 to 3 rating scale. Under this system, 1 is one or more healthy weeds present, 2 shows injured weeds present, and 3 no weeds present. The remaining scattered weeds were recorded as being present or absent in each plot.

Six of the replications were harvested September 4th, 5th or 6th. Records were taken of number and weight of marketable roots.

Results and Discussion

The results are presented in Tables 1 and 2. In Table 1 all treatments except trifluralin were significantly superior to the check in overall weed control. Combination of chemicals resulted in improved weed control. The trifluralin and CGA 10832 did not control redroot pigweed and chloroxuron and linuron did not control green foxtail. There was no significant difference in the number of marketable roots but highly significant differences in weight of marketable roots. Based on weight of the roots, the best single herbicides were A-820 at 2 lbs per acre and nitralin at 1 lb per acre applied as preplant incorporation treatments.

Table 2 summarizes the weed control for each herbicide used alone or in combination. Redroot pigweed was completely eliminated by linuron. No herbicide completely eliminated green foxtail. Lambsquarters was completely controlled by metribuzin and chloroxuron. Pennsylvania smartweed was controlled by A-820 and ragweed was completely controlled by BAS 3870, metribuzin and linuron.

Table 1. The effects of eight herbicides alone and in combination on weed control and carrot responses.

Herbicide	Rate lb a.i./A	Application Days from Plant.	Average per plot: Weed Control: All Weeds (1-9)[1]	Red Root Pigweed (1-3)[2]	Green Foxtail (1-3)[2]	Marketable Yield: Number Roots	Weight lb.
1. Nothing	--	--	2.1	1.0	1.0	362	22.3
2. A-820	2	PPI-7	6.0	2.0	2.5	410	37.5
3. Trifluralin	1/2	PPI-7	2.4	1.0	1.8	383	23.0
4. Nitralin	1	PPI-7	7.1	1.8	1.8	467	37.4
5. BAS 3870	1½	PPI-7	5.8	1.8	2.5	335	32.4
6. CGA 10832	1	PPI-7	7.0	1.5	2.5	351	28.7
7. Metribuzin	1/2	PPI-7	4.0	1.8	2.0	422	31.4
8. Chloroxuron	4	POST+30	8.0	1.8	1.0	382	30.8
9. Linuron	1	POST+55	6.6	2.8	1.0	431	33.8
10. A-820 + Trifluralin	2+½	PPI-7	8.3	2.5	2.8	448	37.6
11. A-820 + Nitralin	2+1	PPI-7	7.9	2.8	2.8	405	38.1
12. A-820 + BAS 3870	2+1½	PPI-7	7.1	2.8	3.0	406	39.5
13. A-820 + CGA 10832	2+1	PPI-7	7.5	2.8	3.0	423	39.0
14. A-820 + Metribuzin	2+½	PPI-7	8.9	2.8	2.5	376	35.8
15. A-820 + Chloroxuron	2+4	PPI-7 & POST+30	8.5	2.5	2.5	411	36.9
16. A-820 & Linuron	2&1	PPI-7 & POST+55	8.8	3.0	2.8	432	32.6
17. Trifluralin + Nitralin	½+1	PPI-7	7.3	2.8	2.5	363	32.5
18. Trifluralin + BAS 3870	½+1½	PPI-7	7.0	2.0	2.0	378	35.9
19. Trifluralin + CGA 10832	½+1	PPI-7	5.9	2.0	2.3	404	33.2
20. Trifluralin + Metribuzin	½+½	PPI-7	7.1	2.3	2.5	333	29.2
21. Trifluralin & Chloroxuron	½&4	PPI-7 & POST+30	7.8	2.0	1.8	439	35.2
22. Trifluralin & Linuron	½&1	PPI-7 & POST+55	7.6	3.0	1.5	431	37.0
23. Nitralin + BAS 3870	1+1½	PPI-7	8.0	2.0	2.3	444	37.8
24. Nitralin + CGA 10832	1+1	PPI-7	7.6	3.0	2.5	399	34.8
25. Nitralin + Metribuzin	1+½	PPI-7	7.9	2.5	2.8	367	33.3
26. Nitralin & Chloroxuron	1&4	PPI-7 & POST+30	8.3	2.8	2.0	1146	38.9
27. Nitralin & Linuron	1&1	PPI-7 & POST+55	8.4	3.0	1.8	380	34.2
28. BAS 3870 + CGA 10832	1½+1	PPI-7	7.8	2.5	2.8	386	33.6
29. BAS 3870 + Metribuzin	1½ ½	PPI-7	8.0	2.3	2.8	363	30.5
30. BAS 3870 & Chloroxuron	1½&4	PPI-7 & POST+30	8.4	2.8	2.8	399	32.8

Herbicide	Rate lb ai/A	Application Days from Plant.	Average per plot: Weed Control: All Weeds (1-9)[1]	Red Root Pigweed (1-3)[2]	Green Foxtail (1-3)[2]	Marketable Yield: Number Roots	Weight lb.
31. BAS 3870 & Linuron	1½&1	PPI-7 & POST+55	8.4	3.0	2.3	399	36.8
32. CGA 10832 + Metribuzin	1+½	PPI-7	7.9	2.8	2.8	356	28.8
33. CGA 10832 & Chloroxuron	1&4	PPI-7 & POST+30	8.6	2.5	2.8	398	29.4
34. CGA 10832 & Linuron	1&1	PPI-7 & POST+55	8.6	3.0	2.3	384	32.7
35. Metribuzin & Chloroxuron	½&4	PPI-7 & POST+30	8.8	2.8	3.0	400	31.9
36. Metribuzin & Linuron	½&1	PPI-7 & POST+55	8.9	3.0	2.5	412	29.0
Least Significant Difference 5%			1.1	0.6	0.6	NSD	5.3
Least Significant Difference 1%			1.3	0.7	0.7	NSD	6.2

Weed Control Rating Scale

[1] (1-9) - 1 least desirable, 9 most desirable

[2] (1-3) - 1 least desirable, 3 most desirable

Table 2. A Summary of weed control in all plots where herbicides were applied.

	No. Plot	AVERAGE PER PLOT (1-3)[1] Redroot	Green Foxtail	% Weeds Present Lambsquarters	Pa.Smartweed	Ragweed
Untreated	4	1.0	1.0	75	75	50
1. Nothing & all single herbicides	36	1.7	1.8	36	14	25
2. A-820 alone & in combination	24	2.6	2.7	6	3	16
3. Trifluralin " " "	24	2.2	2.1	19	22	13
4. Nitralin " " "	24	2.6	2.3	6	16	6
5. BAS 3870 " " "	24	2.4	2.5	9	25	0
6. CGA 10832 " " "	24	2.5	2.6	16	9	6
7. Metribuzin " " "	24	2.5	2.6	0	6	0
8. Chloroxuron " " "	21	2.4	2.3	0	11	7
9. Linuron " " "	21	3.0	2.0	11	11	0

Weed Control Rating Scale

[1](1-3) - 1 least desirable, 3 most desirable

EFFECT OF DELAYED INCORPORATION ON PERFORMANCE OF TRIFLURALIN

Richard A. Ashley[1/]

Abstract

Incorporation of trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) was delayed 0, 1/4, 1/2, 1, 2, 4, 6 or 24 hours. Significant reductions in control of large crabgrass, redroot pigweed and lambsquarters resulted when the delay in incorporation exceeded 1 hour. No additional decrease in weed control was noted when the delay in incorporation was extended from 2 to 4 or 6 hours. A 24 hour delay in incorporation of trifluralin resulted in no control of pigweed or lambsquarters and only 20% control of crabgrass. No crop injury was observed. Significant yield reduction occurred only when incorporation was delayed 24 hours.

Introduction

An experiment was conducted on the University of Connecticut Agronomy Research Farm in Storrs, Connecticut to determine the effect of delayed incorporation of trifluralin on weed control.

Materials and Methods

Snap beans (*Phaseolus vulgaris* var. *humilis*) var. Bush Blue Lake were planted June 15, 1973 on the University of Connecticut Agronomy Research Farm. Soil type was a Woodbridge fine sandy loam with a pH of 6.4 and an organic matter content of 3 1/2%. Treatments were arranged in a randomized block design with treated plots consisting of a single row 10 feet long. Treatments were replicated three times.

Trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) was applied June 14, 1973 at 3/4 lb ai/A. One treatment was incorporated immediately while incorporation was delayed 1/4, 1/2, 1, 2, 4, 6 or 24 hours on others. Treatments were incorporated to a depth of approximately 3 inches using a garden tractor mounted rototiller. Soil surface was moist at the time of application. The last significant rainfall before application was 0.61 inches on June 14, 1973. The first measurable rainfall following treatment was 0.02 inches on June 17, 1973. Maximum and minimum temperatures on June 14, 1973 were 73° and 57°F. respectively.

Predominant weed species present in the experimental area were: Large crabgrass (*Digitaria sanguinalis* (L.) Scop.), lambsquarters (*Chenopodium album* L.), and redroot pigweed (*Amaranthus retroflexus* L.).

1/ University of Connecticut, Storrs, Conn.

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.

Yield data were taken on August 28, 1973 to determine the effect, if any, of the treatments on yield.

Results and Discussion

Significant reductions in control of large crabgrass, redroot pigweed and lambsquarters resulted when incorporation of trifluralin was delayed for more than 1 hour (Table 1). When trifluralin was incorporated immediately after application weed control ratings for large crabgrass, redroot pigweed and lambsquarters on August 14, 1973 were 8, 8 and 9 respectively. Corresponding ratings for trifluralin incorporated 2 hours after application were 4, 3 and 6.

Table 1. Effect of delayed incorporation of trifluralin on weed control, crop injury and yield of snap beans.

Herbicide[a]	Rate Lb ai/A	Delay in Incorporation	Crop[b] Injury	Weed Control[b] CG[c]	PW[d]	LQ[e]	Yields[f] Lbs/Plot
Trifluralin 4E	3/4	None	0	8	8	9	6.4
Trifluralin 4E	3/4	¼ hour	0	8	8	10	5.7
Trifluralin 4E	3/4	½ hour	0	7	6	9	4.8
Trifluralin 4E	3/4	1 hour	0	6	9	9	5.8
Trifluralin 4E	3/4	2 hours	0	4	3	6	4.2
Trifluralin 4E	3/4	4 hours	0	5	2	5	5.6
Trifluralin 4E	3/4	6 hours	0	5	4	6	4.7
Trifluralin 4E	3/4	24 hours	0	2	0	0	3.6
LSD 5%			NS	2	4	3	2.6

a. Applied 6/14/73
b. Rated 8/14/73 using a 0 to 10 scale with 0 = no effect and 10 = complete kill.
c. CG = Large Crabgrass (*Digitaria sanquinalis* (L.), Scop.)
d. PW = Redroot Pigweed (*Amaranthus retroflexus* L.)
e. LQ = Lambsquarters (*Chenopodium album* L.)
f. Harvested 8/28/73. Yields represent average of 3 replicates.

No differences in weed control were noted when incorporation was delayed 1/4, 1/2 or 1 hour. The August 14 rating for control of large crabgrass was 8, 8, 7 and 6 for treatments with 0, 1/4, 1/2 and 1 hour delay in incorporation respectively. Corresponding figures for control of redroot pigweed were 8, 8, 6, and 9, while ratings for lambsquarters control were 9, 10, 9 and 9.

Delay of incorporation of trifluralin for 4 or 6 hours did not result in any additional reduction in weed control as compared to the 2 hour delay in incorporation. Large crabgrass control ratings on August 14 were 4, 5 and 5 for delays in incorporation of 2, 4 and 6 hours respectively. Corresponding ratings for redroot pigweed control were 3, 2 and 4 and ratings for lambsquarters were 6, 5 and 6. Delay of incorporation of trifluralin for 24 hour resulted in no control of pigweed or lambsquarters and only 20% control of crabgrass.

No crop injury was noted. Significant yield reduction occurred only where incorporation of trifluralin was delayed for 24 hours. This reduction can be attributed to the poor weed control obtained with this treatment.

THE RESPONSE OF SEVERAL SWEET CORN VARIETIES TO VARIOUS HERBICIDES AND HERBICIDE COMBINATIONS

D. J. Herman, M. M. Lay and R. D. Ilnicki 1/

Abstract

Four sweet corn varieties, Gold Cup, Iochief, Seneca Chief, and Wonderful were studied to evaluate their responses to some promising herbicide treatments. Generally, the varieties responded from the most tolerant to the least tolerant in the order presented above; however, Seneca Chief was the most susceptible variety to yield reductions particularly from poorer herbicide treatments due to the poor competitive posture of the variety. All varieties did show injury from metribuzin ¼ and ½ lb/A. The best herbicide treatment was alachlor + MC 4379 80W 2 + 1½ lb/A. This treatment was the only one where a variety, Iochief, yielded significantly greater than the cultivated check. Other outstanding treatments included alachlor + cyanazine at 2 + 2 lb/A and alachlor + simazine 1¼ + 1½ lb/A.

Introduction

Whether or not good herbicide treatments for field corn can be used in sweet corn production has never been fully ascertained. Generally, it is known that sweet corn is more susceptible than field corn to herbicide treatments. The purpose of this experiment was to measure the response of popular sweet corn varieties grown in New Jersey to some accepted preemergence treatments and to some promising experimental herbicide treatments and combinations that proved successful in the growing of field corn.

Methods and Materials

The field chosen contained a fairly uniform stand of fall panicum (*Panicum dichotomiflorum* Michx.), smooth crabgrass

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1/ Research Intern, Ph.D. Recipient and Research Professor of Weed Science, respectively, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey 08903.

(Digitaria ischaemum (Schreb.) Muhl.), pigweed (Amaranthus retroflexus L.), lambsquarters (Chenopodium Album L.), nutsedge (Cyperus esculentus L.) and morning glory (Ipomea hederacea (L.) Jacq.).

Sweet corn was planted on May 18, 1973, in Freehold sandy loam soil at the Adelphia Research Station, Rutgers University, Adelphia, New Jersey. The field was divided into 4-row plots 14' x 22'. Treatments were applied preemergence to the crop on May 22, four days after planting. Treatments consisted of varying rates of atrazine, simazine, cyanazine, chlorbromuron, metribuzin, MC 4379 80W and MC 4379 2EC. All treatments were applied with a portable CO_2 knapsack sprayer at 40 gpa. Visual ratings on both stand and vigor of corn and weeds were made on July 18 and July 26 and averaged. Actual stand counts of corn plants were made for statistical analysis after harvest. A scale of 0 to 10 was used in which 0 = no effect on stand or vigor and 10 = complete control or elimination of stand. Corn was harvested by hand at maturity. A second harvest of the varieties Gold Cup and Wonderful was made one week after the respective first harvests; however, there seemed to be no significant treatment-maturity interactions. Yield data are expressed in cwt/A and stand and ears are in 1,000's/A. The experiment was designed as a split plot randomized complete block with four replications and comparisons between treatment means were made using Duncan's Multiple Range test at the 0.05 level of probability.

Results and Discussion

Weed control and yield data summaries are presented in Tables 1 and 2 respectively.

Alachlor at 2 and 2½ lb/A effected very good to excellent control of pigweed, crabgrass, and fall panicum but was not too effective on lambsquarters and morning glory. These weed control responses were reflected in yield particularly at the two lower rates of alachlor and especially on the variety Seneca Chief. No injury symptoms were noted on this variety even at the highest rate of 2½ lb/A. It goes without saying that yield reductions were due to the severe infestations of morning glory and lambsquarters. The competition of these two species was exaggerated by an unusually dry summer and the

unavailability of irrigation. One can assume from these data that Seneca Chief was probably the least competitive of the four varieties evaluated. Reductions in sweet corn vigor for the two lower rates of alachlor were a direct result of weed competition.

On the other hand, atrazine 1½ and 2 lb/A provided excellent control of lambsquarters and pigweed and very good control of morning glory. It was particularly weak on the grasses and nutsedge.

The combination of alachlor + atrazine each at 1½ lb/A was the best of the alachlor + atrazine combinations but did not provide sufficient control of the grasses. The combination of alachlor + atrazine at 1 + 1½ lb/A was inadequate for the vigorous growth of crabgrass and fall panicum in the plots.

As in other years and in other experiments, it was observed that simazine applied alone was weaker than atrazine on pigweed but was somewhat more effective on fall panicum. The comparable alachlor + simazine treatments were slightly more effective than the alachlor + atrazine treatments. Simazine at 2 lb/A ranked as the second highest yielding treatment for the varieties Goldcup, Iochief and Wonderful and the fifth highest on the variety Seneca Chief.

Chlorbromuron at 2 and 3 lb/A was somewhat weak on most weed species with the exception of lambsquarters and was one of the treatments which elicited a significantly reduced yield response from Seneca Chief. The combination of alachlor + chlorbromuron 1½ + 2 and 2 + 2 lb/A were similarly responsible for reduced yields of Seneca Chief and Wonderful. No major visual injury symptoms were noted with these varieties and the most probable cause of the yield reduction was the competition resulting from heavy infestations of morning glory.

Cyanazine was not too effective on pigweed and particularly weak on the grasses and morning glory; however, control of lambsquarters was more than adequate. The alachlor + cyanazine combination of 2 + 2 lb/A was better than the alachlor + atrazine 1½ + 1½ lb/A. Rates of 1½ and 2 lb/A of cyanazine significantly reduced the yield of Seneca Chief. However, these reductions in yield were not as a direct response to the herbicide but of

the inadequate control of the complete weed spectrum.

The combination of alachlor + cyanazine at all rates and cyanazine alone at 3 lb/A did not show similar yield reduction and it can be assumed that this was due to broader control of the weed spectrum especially the grasses.

All varieties were sensitive to metribuzin. The ¼ lb/A rate significantly reduced yields in all four varieites and the ½ lb/A rate significantly reduced both stand and yields. It is worthy of note that the combination of alachlor + metribuzin at 1½ + ¼ lb/A respectively, significantly reduced the yield of only the variety Seneca Chief while metribuzin alone at ¼ lb/A significantly reduced yields of all four varieties. It may be assumed that not only a physiological injury was involved but that weed competition was also a major factor in the response of these sweet corn varieties from metribuzin. Metribuzin at ½ lb/A was not too effective on crabgrass and morning glory; however, in combination with alachlor at 1½ + ½ lb/A it was effective on crabgrass but not on morning glory.

MC 4379 80W was comparable in its effects on weed control as 2EC. In this experiment the only situation in which a treatment outyielded the cultivated check was the combination of alachlor + MC 4379 80W 2 + 1½ lb/A on the variety Iochief. Interestingly enough, this treatment was the highest yielding treatment for Wonderful which was a full 25% above the cultivated check. Moreover, the slightly lower rate of alachlor + MC 4379 80W 2 + 1 lb/A respectively, was the highest yielding treatment on Goldcup. This was not significantly different from the cultivated check. Generally these treatments which included either formulation of MC 4379 tended to be distributed toward the high end of the non-significant yield range.

Under the conditions of this experiment, the performance of the four varieties may be found in Table 2 and can be ranked highest to lowest: Gold Cup, Iochief, Seneca Chief, and Wonderful. There was no instance where the stand mean of any treatment was significantly higher than that of the cultivated or non-cultivated check.

Table 1. The effects of varying rates of alachlor in combination with atrazine, simazine, cyanazine, chlorbromuron, metribuzin and MC 4379 on weed control in sweet corn. 1973 1/

Treatment		Sweet Corn Avg. of 4 Varieties2/		Lambs-quarters		Pigweed		Crabgrass		Fall Panicum		Nutsedge		Morning Glory	
		S	V	S	V	S	V	S	V	S	V	S	V	S	V
alachlor	1½	1.7	0.9	7.0	2.5	8.6	8.2	8.3	4.2	8.8	5.7	9.2	7.4	5.5	0.0
LASSO 4 EC	2	1.0	0.5	7.0	2.0	9.0	8.2	8.8	3.9	8.9	8.4	7.5	4.7	3.8	0.0
	2½	1.1	0.4	7.9	2.7	9.2	8.7	9.2	4.8	9.8	8.9	9.2	4.0	6.3	0.0
atrazin	1½	0.4	0.5	10.0	10.0	9.7	9.5	8.2	4.9	4.9	3.4	9.7	7.4	8.5	0.0
AATREX 80 W	2	0.9	0.4	10.0	10.0	9.8	9.7	7.7	3.6	6.3	2.9	6.9	3.7	9.0	0.0
alachlor +	1½ + 1½	0.9	0.5	9.9	9.7	8.2	7.3	7.3	2.6	8.4	4.1	8.4	4.8	5.8	2.5
atrazine	1½ + 1	0.7	0.5	9.9	8.4	9.1	7.6	8.3	2.0	8.5	4.0	8.0	3.3	5.8	0.0
	1 + 1½	1.0	0.5	9.8	9.7	9.0	8.4	6.7	1.9	7.6	3.4	8.7	6.5	5.3	0.0
simazine	1½	0.9	0.5	9.9	9.9	8.6	7.7	6.0	2.4	6.4	3.2	8.9	6.2	6.8	0.8
PRINCEP 80 W	2	1.0	0.4	9.9	8.8	8.8	7.2	8.1	3.2	7.3	2.8	8.4	6.8	7.5	4.5
alachlor +	1½ + 1½	0.8	0.5	9.9	9.9	9.2	9.2	9.2	5.2	8.8	4.0	9.4	8.2	5.5	0.0
simazine	1½ + 1	0.7	0.3	9.9	9.8	8.6	7.8	8.4	2.7	8.9	4.9	9.3	7.4	9.5	0.0
	1 + 1½	0.6	0.2	9.7	9.4	8.7	8.5	8.9	4.4	8.9	5.3	8.9	7.8	6.8	0.0
chlorbromuron	2	1.0	0.6	9.3	7.8	8.7	6.9	5.7	1.9	9.2	5.5	7.6	5.4	5.5	0.0
MALORAN 50 W	3	1.3	0.5	9.5	7.9	8.2	6.0	5.7	2.1	6.5	2.6	7.5	7.0	3.0	0.0
alachlor +	1½ + 1½	0.3	0.2	9.5	8.4	8.0	7.3	7.9	1.8	9.2	6.3	8.8	5.8	6.0	2.5
chlorbromuron	2 + 1½	0.5	0.4	9.4	7.5	9.1	7.8	8.5	1.7	9.5	6.9	8.0	5.1	3.0	0.0
	1½ + 2	1.5	0.9	9.7	9.4	9.0	8.9	8.7	2.3	9.2	6.0	9.8	8.6	3.5	2.5
	2 + 2	1.1	0.4	10.0	10.0	9.8	9.3	8.7	3.9	9.5	6.3	10.0	10.0	4.8	0.0
cyanazine	1½	1.5	0.5	8.7	8.1	5.3	3.8	6.2	2.4	6.3	1.6	5.9	3.8	5.3	0.0
BLADEX 80 W	2	1.5	0.5	9.6	8.6	5.1	5.9	6.9	2.7	7.7	4.9	8.2	6.8	7.3	3.8
	3	0.6	0.4	9.8	7.5	6.3	6.3	8.0	3.0	8.5	5.8	7.6	5.8	7.7	0.0
alachlor +	1½ + 1½	0.5	0.1	9.1	6.2	8.1	6.8	8.4	3.1	7.3	2.4	7.2	3.5	5.5	0.0
cyanazine	2 + 1½	0.8	0.3	9.8	9.7	8.0	6.3	8.2	2.9	8.6	6.7	6.7	2.7	4.0	0.0
	1½ + 2	1.6	0.5	9.2	7.7	8.1	7.1	7.3	2.4	8.1	5.6	6.7	1.8	5.0	0.0
	2 + 2	0.6	0.3	9.6	9.4	8.4	7.8	8.8	3.2	9.5	5.9	8.2	5.8	8.0	2.5
metribuzin	½	1.3	0.9	9.7	8.8	7.3	4.6	5.9	1.8	8.0	4.7	5.4	3.0	2.3	0.0
SENCOR 50 W	½	5.9	2.9	10.0	10.0	7.4	5.8	5.8	2.4	7.0	2.4	8.2	4.2	4.3	2.5
alachlor +	1½ + ½	1.2	0.6	9.9	8.3	9.3	8.7	8.6	3.0	9.7	7.0	8.4	5.7	4.3	2.5
metribuzin	1½ + ½	3.7	2.3	10.0	10.0	9.1	7.7	8.2	2.3	9.5	5.7	8.4	6.8	0.3	0.0
MC 4379	1½	0.7	0.3	9.6	7.9	8.7	6.3	4.9	2.9	7.2	3.9	6.4	0.8	7.0	0.0
MOWDOWN 80 W	2	1.0	0.5	9.3	8.2	9.2	9.2	3.7	1.0	5.8	2.4	8.8	7.2	4.0	0.0
MC 4379	1½	0.6	0.3	8.8	5.5	8.4	6.8	4.4	1.3	5.1	2.0	7.9	5.0	6.3	0.0
MOWDOWN 2 EC	2	0.7	0.3	8.8	7.4	9.2	8.4	4.3	1.4	6.8	1.9	6.0	3.4	6.8	2.5
alachlor +	2 + 1	0.6	0.4	9.4	7.2	9.0	8.2	8.4	2.3	8.2	4.3	8.5	5.5	6.3	0.0
MC 4379 80 W	2 + 1½	0.6	0.4	9.7	9.2	8.7	7.4	8.6	3.0	9.8	8.6	8.3	5.4	8.5	0.0
alachlor +	2 + 1	0.8	0.6	9.6	9.3	9.0	7.2	8.0	3.3	9.5	7.3	8.4	4.9	4.0	0.0
MC 4379 2 EC	2 + 1½	0.5	0.4	9.1	7.8	9.1	8.5	8.6	3.2	9.7	7.5	7.4	4.2	7.5	2.5
cult. - check		0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
uncult. - check		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1/ Average of 4 replications for each of two ratings.
2/ Gold Cup, Iochief, Seneca Chief, Wonderful

TABLE 2. Stand yield analysis for the sweet corn varieties Gold Cup (GC), Iochief (IC), Seneca Chief (SC) and Wonderful (WF)

Treatment		Stand				Yield				Ears			
		GC	IC	SC	WF	GC	IC	SC	WF	GC	IC	SC	WF
alachlor LASSO 4EC	1½							*			*		
	2							*			*	*	
	2½												
atrazine AATREX 80W	1½												
	2												
alachlor + atrazine	1½+1½												
	1½+1												
	1+1½												
simazine PRINCEP 80W	1½												
	2												
alachlor + simazine	1½+1½												
	1½+1												
	1+1½												
chlorbromuron MALORAN 50W	2							*					
	3							*					
alachlor + chlorbromuron	1½+1½												
	2+1½												
	1½+2							*					
	2+2							*	*		*		
cyanazine BLADEX 80W	1½							*					
	2							*					
	3												
alachlor + cyanazine	1½+1½												
	2+1½												
	1½+2												
	2+3												
metribuzin SEMCOR 50W	½					*	*	*	*	*	*	*	
	½	*	*	*	*	*	*	*	*	*	*	*	*
alachlor + metribuzin	1½+½							*			*		
	1½+½	*		*	*	*	*	*	*	*	*	*	*
MC 4379 MOWDOWN 80W	1½												
	2												
MC 4379 MOWDOWN 2EC	1½												
	2						$						
alachlor + MC 4379 80W	2+1												
	2+1½												
alachlor + MC 4379 2EC	2+1												
	2+1½												
check-cult.													
check-uncult.		*	*	*	*	*	*	*	*	*	*	*	*
Grand Mean(K/A or cwt/A)		13.3	10.4	12.0	8.3	87.0	68.0	58.0	30.0	11.6	7.0	9.8	3.9
Coeff.of Variation		17.4	26.9	13.8	21.9	31.2	32.1	32.4	48.1	-	-	-	-

* - Significantly poorer than the cultivated check - Duncan's .05
& - Significantly better than the cultivated check - Duncan's .05

Appendix

Material & Formulation	Chemical Name	Manufacturer
alachlor (4EC)	2-chloro-2', 6'-diethyl -N-(methoxymethyl) acetanilide	Monsanto
atrazine (80W)	2-chloro-4-ethylamino-6-isopropylamino-s-triazine	CIBA-GEIGY
chlorbromuron (50W)	3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea	CIBA-GEIGY
cyanazine (80W)	2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile	Shell
MC 4379(80W & 2EC)	Methyl 5-(2',4'-dichlorophenoxy)-2-nitrobenzoate	Mobil
metribuzin (50W)	4-amino-6-t-butyl-3-(methylthio)-as-triazin-5(4H)-one	Chemagro
simazine (80W)	2-chloro-4,6-bis(ethylamino)-S-triazine	GEIGY

RESPONSE OF SWEET CORN AND WEEDS TO SELECTED ADJUVANTS IN ATRAZINE SPRAYS[1/]

H. H. Hatfield, Jr. and R. D. Sweet[2/]

Abstract

Field studies were conducted in which selected adjuvants were evaluated in postemergence sprays of atrazine (2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine) on sweet corn (Zea mays var. rugosa L.) and weeds. Sweet corn was sprayed at heights of 10, 25 and 40 cm. The tallest corn was slightly more sensitive to injury.

Redroot pigweed (Amaranthus retroflexus L.), lambsquarters (Chenopodium album L.) and Japanese millet (Echinochloa crusgalli var. frumentacea L.) responded similarly regardless of the adjuvant included in the spray.

In the greenhouse, yellow nutsedge (Cyperus esculentus L.) was particularly sensitive to silicone adjuvants, by contrast, in the field, silicone surfactants were no more effective than an oil-surfactant blend.

Booster+E and Herbimax oil-surfactant blends were completely safe on corn; Dow Corning 470, a silicone surfactant caused moderate burning; and slight burning was caused by the silicone surfactants Union Carbide L-7607 and Dow Corning 195, as well as Soil Penetrant 80, Triton XA Special and Aqua Surf, surfactants formulated with isopropanol.

Introduction

It has been known for several years that adjuvants can enhance greatly the efficacy of postemergence herbicide sprays (1). Although a surfactant alone added to the spray tank can increase the level of weed control (2) in numerous field tests the authors have shown an adjuvant containing non-phytotoxic oil and surfactants, in the rates of 4-6 parts oil to 1 part surfactant can provide substantially more enhancement than surfactant alone. When an oil surfactant adjuvant is added at 0.5 or 1.0 percent to an atrazine spray the herbicide rate can be sharply reduced. A grower gains improved flexibility of land use from the lowered level of residual herbicide along with reduction in cost. Although adjuvants seldom cause crop injury when used as directed, severe permanent injury has been reported (3). Because the adjuvants were applied at a relatively late stage, the authors suggested that older, taller plants were more susceptible to injury than younger, shorter plants.

1/ Paper No. 658, Department of Vegetable Crops, Cornell University, Ithaca, N.Y., 14850.

2/ Experimentalist and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, N.Y., 14850

The purpose of the studies reported here was: 1) to evaluate the effect of size and age of sweet corn on its response to several adjuvants when used with atrazine sprays and, 2) to determine the efficiency of these adjuvants in enhancing the toxicity of atrazine sprays to yellow nutsedge, redroot pigweed, and Japanese millet.

Materials and Methods

Field plots were 1.8 x 5.5 m and were sprayed with a hand-held small plot sprayer using CO_2 at a pressure of 2.46 kg/cm^2 and a volume of 460 L/ha. Yellow nutsedge plants in Experiment 4 were sprayed with a belt sprayer equipped with a single 80015E TeeJet nozzle and using compressed air at 1.41 kg/cm^2. The nutsedge plants were grown in Cornell Peatlite Mix A* in fiber paks 6 cm deep.

In all experiments herbicide rates are in active ingredient by weight. Adjuvants were measured by volume and rates are expressed as v/v of final spray mix. All adjuvants were considered to be 100 percent active products except for Dow Corning 3560 which is labelled 50 percent active and was adjusted accordingly. Agway's Booster+E was included as a standard throughout. The adjuvants are described in Table 1. Crop cultivars, planting and application dates and plant heights are presented in Table 2.

Table 1. Designations and descriptions of adjuvants.

Adjuvant	Chemical	Source
Booster+E	83/17 oil surfactant blend	Agway
Herbimax	80/20 oil surfactant blend	Union Carbide
R&H 3736	85/15 oil surfactant blend	Rohm & Haas
Soil Penetrant 80	blend of alkyl poly(oxyethylene) ether type surfactants	Union Carbide
Triton XA Special	alkyl aryl polyethoxylate and potassium alkaroate with isopropanol	Rohm & Haas
Aqua Surf	surfactant blend with isopropanol	Agri Service
DC 3560	silicone oil	Dow Corning
UC L-77	organo modified silicone surfactant	Union Carbide
UC L-7607	organo modified silicone surfactant	Union Carbide
DC 193	silicone surfactant	Dow Corning
DC 195	silicone surfactant	Dow Corning
DC 470	silicone glycol polymer	Dow Corning

* Mix of equal volumes horticultural peat and vermiculite with plant nutrients added.

Table 2. Sweet corn cultivars, dates of planting and spraying, and plant heights at time of treating experiments.

Expt. No.	Species	Cultivar	Rows Per Plot	Planting Date	Application Date	Ht. (cm) at Applic.
1	sweet corn	Spring Gold	2	5/31/73	6/19/73	10.0
1	sweet corn	Spring Gold	2	5/31/73	6/25/73	25.0
1	sweet corn	Spring Gold	2	5/31/73	7/7/73	40.0
2	sweet corn	Gold Cup	1	7/23/73	8/1/73	7.5
2	sweet corn	Gold Cup	1	7/23/73	8/15/73	15.0
3	sweet corn	Gold Cup	2	6/14/73	7/2/73	15.0
3	sweet corn	Gold Cup	2	6/8/73	7/2/73	30.0
4	yellow nutsedge	-	*	4/17/73	5/8/73	15.0
4	yellow nutsedge	-	-	natural stand	6/15/73	10.0
5	yellow nutsedge	-	-	natural stand	6/29/73	20.0

* Six plants per pak

In Experiment 1, the following adjuvants were examined for their safety on sweet corn: Herbimax, Soil Penetrant 80 (SP80), Triton XA Special (XA Special), Aqua Surf, Union Carbide L-7607 (L-7607), Dow Corning 195 (DC 195), and Dow Corning 470 (DC 470). The rates of herbicides and adjuvants and dates of application are given in Table 3. The adjuvants were sprayed at either 0.25 or 0.50 percent and two formulations of atrazine were applied at 0.3 kg/ha. Visual ratings of foliage response 13 days after spraying were recorded. Silk counts were made three weeks after the last spraying.

In Experiments 2 and 3, three additional adjuvants were evaluated for safety to sweet corn and enhancement of activity of atrazine or atrazine + alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)-acetanilide] herbicide combination on Japanese millet, redroot pigweed and lambsquarters. Identity and rates of adjuvants as well as rates of herbicides, plant heights at application and treatment dates are given in Table 4. Visual ratings of sweet corn and the other test species were taken about two weeks following spraying.

In Experiment 4, two silicone-type adjuvants, L-7607 and L-77, were added at 0.25 and 0.50 percent to atrazine and glyphosate [N-(phosphomethyl) glycine] and sprayed on yellow nutsedge grown in flats in the greenhouse. Adjuvants tested and rates of adjuvants and herbicides and dates of application are given in Table 5. Visual ratings were made about two weeks after treatment.

In the field, experiment 5, nutsedge 10 and 20 cm tall was sprayed with atrazine and glyphosate sprays containing the silicone adjuvants

Table 3. Visual ratings of sweet corn[1] response to adjuvants in atrazine applications (Experiment 1).[2]

Adjuvant	Percent	Foliage Response[3,4] 13 Days After Spraying			Silk Counts[3,5] 21 Days After Spraying		
		No Herbicide	Atrazine 80WP 0.3 kg/ha	Atrazine 4L 0.3 kg/ha	No Herbicide	Atrazine 80WP 0.3 kg/ha	Atrazine 4L 0.3 kg/ha
Booster+E	0.50	9.0	9.0	9.0	12.7	18.7	13.3
Herbimax	0.50	9.0	9.0	9.0	19.3	17.3	9.7
Soil Penetrant 80	0.50	6.7	7.0	6.7	17.7	14.0	7.7
Triton XA Special	0.50	6.7	6.7	6.3	12.3	12.7	11.7
Aqua Surf	0.50	6.7	6.7	7.7	23.3	14.3	14.3
UC L-7607	0.25	6.7	6.7	6.7	10.0	12.0	10.0
DC 195	0.25	7.0	7.0	7.0	6.7	11.3	8.3
DC 470	0.25	6.0	6.7	6.3	18.3	15.7	10.0
No chemical	-	9.0	-	-	13.3	-	-

[1] Plants 35-45 cm tall sprayed July 7, 1973.
[2] Entire experimental area sprayed by tractor rig with 0.5 kg/ha atrazine + 0.75 kg/ha alachlor + 1.0% Booster+E on June 11, 1973, twelve days after planting when corn was in late spike stage and weeds were emerging. The area remained weed-free through harvest.
[3] Average of three replicates of plots of approximately 40 plants.
[4] Visual rating of crop response: 1=complete kill; 7=moderate injury but no yield reduction; 9=no crop injury.
[5] Total number of silks visible.

Table 4. Visual ratings of sweet corn, Japanese millet, redroot pigweed and lambsquarters response to adjuvants in atrazine sprays in Experiments 2 and 3.

Herbicide Formulation				Crop Response[1,2]					Weed Control[1,3]				
				Sweet Corn			Jap.Mil.		Redroot			Lambs.	
				cm Height at Time of Application									
Herbicide	kg/ha	Adjuvant	%	7.5	15	30	5	7.5	2.5	7.5	12.5	5	10
Data from Experiment 2													
Atrazine	0.50	DC 3560	0.5	9.0	8.7	-	4.3	6.7	9.0	8.7	-	-	-
Atrazine	0.50	DC 3560	1.0	9.0	8.3	-	4.7	6.7	9.0	9.0	-	-	-
Atrazine	0.50	R&H 3736	0.5	9.0	8.3	-	4.0	6.7	9.0	8.7	-	-	-
Atrazine	0.50	R&H 3736	1:0	9.0	8.7	-	4.7	6.0	9.0	8.7	-	-	-
Atrazine	0.50	Booster+E	1.0	9.0	8.7	-	3.3	6.3	9.0	9.0	-	-	-
Untreated				9.0	9.0	-	9.0	6.7	2.0	1.0	-	-	-
Data from Experiment 3													
Atrazine + Alachlor	1.00 0.75	Amway	0.5	-	9.0	9.0	-	-	-	8.5	9.0	9.0	9.0
Atrazine + Alachlor	1.00 0.75	Amway	1.0	-	9.0	9.0	-	-	-	8.5	9.0	9.0	9.0
Alachlor	0.75		-	-	-	-	-	-	-	-	-	-	-
Atrazine + Alachlor	1.0 0.75	Booster+E	0.5	-	9.0	9.0	-	-	-	8.0	8.0	9.0	9.0
Untreated				-	9.0	9.0	-	-	-	1.0	1.0	1.0	1.0

[1] Average of three replicates.
[2] Visual rating of crop response: 1=complete kill; 7=moderate injury but no yield reduction; and 9=no crop injury.
[3] Visual rating of weed control: 1=complete dense weed canopy; 7=a few weeds but no reduction in crop yield or quality; and 9=complete absence of all weeds.

Table 5. Visual ratings[1] of yellow nutsedge[2] response to adjuvants in atrazine and glyphosate applications (Experiment 4).

Adjuvant	Percent	Nutsedge Response[3] 14 Days After Spraying Herbicide (1 kg/ha) Atrazine	Glyphosate
L-77	0.25	8.0	6.0
L-77	0.50	8.0	6.0
L-7607	0.25	8.0	6.0
L-7607	0.50	8.0	6.0
Booster+E	0.50	7.0	5.5
None	-	1.5	5.5
Untreated		1.0	

[1] Visual rating of weed control: 1=no effect; 7=commercially acceptable control; and 9=complete kill.
[2] Plants 15 cm tall at application (3 weeks old).
[3] Average of twelve plants in two flats.

active in the greenhouse test and in addition three silicone adjuvants provided by Dow Corning. The Union Carbide surfactants were added at 0.25 percent and the Dow Corning silicones at 0.5 percent. Visual ratings were made two and four weeks after spraying. Spray application dates are given in Table 2.

Results

Visual ratings of foliage response and silk counts in Experiment 1 are presented in Table 3 for sweet corn 35-45 cm tall at treatment. DC 470 caused moderate foliage burn at 0.25 percent while DC 195 and UC L-7607 at 0.25 percent and Aqua Surf, SP 80 and XA Special caused slight burn at 0.5 percent. Typical injury included jagged holes in the midrib area near the bases of leaves which formed the top whorl of foliage when the treatment was applied. Booster+E and Herbimax were completely safe to foliage at 0.5 percent. There was no injury from any material in corn 10 or 25 cm tall at application.

Counts revealed fewer silks in DC 195 treatments and a trend toward fewer silks in atrazine 4L treatments than in atrazine 80WP treatments or in plots sprayed with adjuvants alone.

Visual ratings of crop response and weed control in Experiments 2 and 3 are given in Table 4. DC 3560, Rohm and Haas 3736 and Amway surfactant were safe on corn and enhanced weed control to a level equal to that of Booster+E in atrazine sprays.

In Experiment 4, 1 kg/ha of either atrazine or glyphosate without adjuvant did not kill yellow nutsedge plants 15 cm tall. However, most of the plants were killed by the addition of either L-77 or L-7607 at 0.25 or 0.50 percent

to atrazine. In contrast glyphosate-adjuvant treated plants were not killed. Visual ratings of the nutsedge response are given in Table 5.

In Experiment 5, in contrast with the high level of activity observed in the greenhouse evaluation of L-77 and L-7607 a commercially acceptable level of control of yellow nutsedge in the field did not occur. There was noticeable enhancement of atrazine activity from addition of silicone surfactants L-77 at 0.25 and 0.50 percent and DC 193 at 0.50 and 1.0 percent to 1.5 kg/ha of atrazine, but the control level was not commercially acceptable. In this field test, L-7607, DC 195 and DC 470 were also tested with 0.75 and 1.5 kg/ha of atrazine applied to nutsedge 10 and 20 cm tall. Booster+E treatments also were ineffective.

Discussion and Summary

Adjuvants in atrazine sprays on corn 35-45 cm tall were only moderately toxic to sweet corn. Leaf burn was confined to a few leaves and the effect on the plants was not comparable to the serious injury observed in the 1972 season. Although yields were not measured, the crop was allowed to mature and observations of plots indicated that yield probably had not been reduced.

It has been our experience that oil-surfactant blends are superior with respect to safety to the crop and enhancement of activity of atrazine sprays when compared with other types of adjuvant formulations evaluated on sweet corn.

It is possible that the decrease in activity of the standard adjuvant as well as the low level of enhancement of atrazine sprays by silicone surfactants in controlling yellow nutsedge in 1973 compared to former years was due to a decrease in rainfall in July and August, 1973.

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AN EVALUATION OF SWEET CORN VARIETIES WITH CYANAZINE[1/]

C. E. Beste[2/]

Abstract. Cyanazine (2-[[4-chloro-6-(ethylamino)-s-triazin-2-yl]amino]-2-methylpropionitrile) at 1.25 lb ai/A applied preemergence and postemergence at (a) spike to two leaf stage, (b) three to four leaf stage, and (c) seven leaf stage of sweet corn (Zea mays var. rugosa) growth reduced the vigor of NK-199, Buttersweet, Jubilee, Commander, and Silverqueen varieties 10 to 75 percent in a Norfolk loamy sand. Vigor reductions from postemergence cyanazine were unacceptable for all five varieties. Although not statistically significant, yield reductions occurred in NK-199 and Buttersweet with postemergence cyanazine at the spike to two leaf and three to four leaf stage of growth. Cyanazine applied at the seven-leaf stage of crop growth significantly reduced the yield of Buttersweet and Silverqueen, and although not significant, the yields of Commander, NK-199, and Jubilee were reduced. Preemergence treatments did not reduce yields and delayed maturity only in the variety NK-199. Postemergence treatments delayed the maturity of all five varieties, and, the least delay occurred with treatments at the seven leaf stage of growth. Crop and weed responses to the 80WP and 4WDL formulations of cyanazine were similar. The order of tolerance to cyanazine for the five varieties in Norfolk loamy sand was as follows: Silverqueen = Commander > Jubilee > NK-199 = Buttersweet.

INTRODUCTION

Several different varieties of sweet corn were grown on 20,000 acres in Maryland for processing and fresh market. The short residual soil activity of cyanazine is desirable for sweet corn; however, possible varietal interaction with cyanazine formulations should be evaluated. Ivany and Sweet (2) reported that cyanazine preemergence and postemergence at 1.0 and 2.0 lb/A in a gravelly loam caused slight injury but the crop was acceptable, and the variety Gold Cup was generally more tolerant than Deep Gold. Wilson and Waterfield (8) evaluated cyanazine at 1.0, 2.0, and 3.0 lb/A preemergence on a sandy loam with the variety NK-199 and reported that the 3.0 lb/A rate reduced yields. Sweet corn variety Iochief was not injured by cyanazine at 4.0 lb/A preemergence in a sandy loam and loam (4,7) and NK-199 was not injured by cyanazine at 2.0 lb/A in a silt loam (1). Cyanazine at 2.0 lb/A preemergence on a silt loam caused a slight reduction in ear count and weight in the variety Jubilee but not NK-199 (3). Peters et al. (6) reported severe injury to Iochief with cyanazine at 4.0 lb/A preemergence on a Merrimac fine sandy loam soil, however, injury did not occur on a Paxton fine sandy loam with a finer texture than Merrimac. This injury did not affect yields.

Since growers may need to apply herbicides postemergence, the two commercial formulations of cyanazine were evaluated postemergence at three stages of crop growth on five varieties of sweet corn. A preemergence treatment of cyanazine was also evaluated. Weed control, crop growth, and yields were determined.

1/ Scientific Article No. A1948, Contribution No. 4878, of the Maryland Agricultural Experiment Station, Department of Horticulture.
2/ Assistant Professor, University of Maryland.

MATERIALS AND METHODS

The following five varieties of sweet corn were planted in separate blocks on May 3, 1973: Commander (Asgrow), NK-199 (Northrup King), Silverqueen (Rogers Bros.), Buttersweet (Keystone), and Jubilee (Rogers Bros.). Seeding depth was 1.5 inches. Soil type was a Norfolk loamy sand with 0.6% organic matter. Herbicide treatment plot size was 9 ft by 18 ft with three rows spaced 36 inches apart. Herbicide treatments were replicated three times in a randomized complete block design with each sweet corn variety. Each variety block contained the following treatments: (a) handweeded control, (b) weedy control, (c) preemergence cyanazine treatment, and (d) six postemergence cyanazine treatments. Cyanazine was evaluated as an 80% wettable powder (80WP) and as a 4 lb/gal water dispersible liquid (4WDL). The cyanazine rate was 1.25 lb ai/A for all herbicide treatments.

Preemergence treatments were applied on May 5, 1973. Rainfall after planting was as follows: May 3 - 0.18 inch, May 4 - 0.72 inch, May 8 - 0.45 inch, and May 9 - 0.52 inch. Irrigation was applied when needed. Postemergence sprays were applied as follows: (a) spike to two leaf stage of crop growth - May 13, (b) three to four leaf stage of crop growth - May 22, and (c) seven leaf stage of crop growth - June 7. The weed growth at the time of postemergence treatments was as follows: (a) May 13 - grass and broadleaf weeds in the cotyledon stage, (b) May 22 - large crabgrass (Digitaria sanguinalis (L.) Scop.) and fall panicum (Panicum dichotomiflorum Michx.) were in the two true leaf stage and about 2 inches high, (c) June 7 - common purslane (Portulaca oleracea L.) was 4 to 5 inches tall, large crabgrass and fall panicum were in the four leaf stage and 4 to 5 inches tall, and common lambsquarters (Chenopodium album L.) were 10 to 12 inches tall.

A single cultivation was made on June 8 with the sidedress application of 50 lb/A nitrogen. Sweet corn vigor ratings were made on May 23 and June 19. Percent weed control was determined for large crabgrass, common purslane, and common lambsquarters on June 19 and for large crabgrass, common lambsquarters, and fall panicum on July 23. Due to the treatment effects on maturity, multiple harvests were made on the varieties NK-199, Buttersweet, and Jubilee to allow the sweet corn to reach full maturity prior to harvest. In this study, the term, full maturity, indicated that the kernals in the tip of the ear were completely filled. The maturity delay for each treatment was determined on July 20 for the varieties NK-199 and Jubilee. The varieties Commander and Silverqueen were harvested on 7-27 and 7-30, respectively, and the total ears per plot were counted. The number of fully mature ears were also counted for each plot in these two varieties. Ear weight and percent fully mature ears were calculated for each treatment with the varieties Commander and Silverqueen. Yield was expressed as tons per acre with the shuck intact (center row of 18 ft length was harvested from each plot).

RESULTS AND DISCUSSION

Postemergence applications of cyanazine reduced the vigor of the sweet corn varieties Buttersweet, NK-199, and Jubilee more than the varieties Commander and Silverqueen (Tables 1, 2, 3, 4, and 5). Vigor reductions from postemergence

cyanazine were unacceptable for all five varieties in Norfolk loamy sand. Generally, less vigor reduction occurred from postemergence treatments at the seven leaf stage of crop growth, but, this may be due to rating plant vigor only 11 days after the sprays were applied. Vigor ratings and yields indicated that the cyanazine formulation was not a significant factor in crop response to postemergence treatments, however, the 4WDL formulation, applied at the three to four leaf stage was less phytotoxic to NK-199, Jubilee, and Commander than the 80WP formulation.

The yields of NK-199 and Buttersweet treated with cyanazine at the spike to two leaf stage and three to four leaf stage of growth were generally lower than the handweeded control, however, Jubilee, Commander, and Silverqueen yields were approximately the same as the control. Cyanazine treatments at the seven leaf stage of crop growth significantly reduced yields of Buttersweet and Silverqueen (Tables 1 and 5), and suppressed yields of NK-199, Jubilee, and Commander (Tables 2, 3, and 4). The lack of significance in the yield data was partially due to yield variations within replicates which was caused by the erratic response of individual plants to herbicide treatments.

Cyanazine, postemergence, delayed the maturity of all five varieties, however, the least amount of delay was observed with the postemergence treatment at the seven leaf stage of growth. This delay of maturity required repeated harvest of Buttersweet, Jubilee, and NK-199 variety blocks (Tables 1, 2, and 3), and the maximum maturity delay was seven days with NK-199 (Table 2). Cyanazine treatments did not delay maturity sufficiently in Silverqueen and Commander to require multiple harvests. The percent fully mature ears for Silverqueen and Commander indicates that cyanazine, preemergence and postemergence, delayed maturity (Tables 4 and 5). Field observations on Silverqueen and Commander indicated that postemergence cyanazine caused slight differences in maturity delay when applied at different stages of crop growth, however, percent fully mature ear data in Tables 4 and 5 do not verify these observations. This was caused by including the second marketable ear (usually slightly immature) on each stalk in the harvest which reduced the accuracy of the fully mature ear count. Ear weight and ear count of Silverqueen and Commander indicated that postemergence cyanazine at the seven leaf stage reduced the number of marketable ears in Silverqueen (Tables 4 and 5).

Preemergence treatments of cyanazine reduced vigor in NK-199 and Buttersweet, however, no significant yield reduction occurred in any variety. Preemergence cyanazine caused a significant maturity delay only in the variety NK-199.

The order of tolerance to cyanazine for the five varieties tested was as follows: Silverqueen = Commander > Jubilee > NK-199 = Buttersweet (Table 6). Generally, the maturity delay of sweet corn from the stage of crop growth at the time of cyanazine treatment was as follows: spike to two leaf stage ≧ three to four leaf stage > seven leaf stage ≧ preemergence. Leng (5) reported that the shoot apex of corn began ear and tassel development when the seventh leaf could be seen in the whorl of the sixth leaf. Therefore, the development of ear and tassel shoots prior to cyanazine treatment appeared to reduce the maturity delay from the postemergence treatments.

Large crabgrass, common lambsquarters, common purslane, and fall panicum control were acceptable for all cyanazine treatments (Table 7).

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Table 1. Effect of cyanazine (1.25 lb ai/A) applied preemergence and postemergence at three stages of crop growth on the sweet corn variety Buttersweet in a Norfolk loamy sand.

Treatment		Vigor (% of Control)		Yield	
Herbicide	Method-Crop Growth Stage	5-23-73	6-19-73	Harvest Date	Ton/A 1/
none	----	100	58	7-25	1.91 c
weeded control	----	100	100	7-25	7.35 a
cyanazine 80WP	preemergence	78	68	7-25	6.72 ab
cyanazine 80WP	post - spike to 2 leaf	73	30	7-30	5.97 ab
cyanazine 4WDL	post - spike to 2 leaf	58	23	7-30	4.25 bc
cyanazine 80WP	post - 3 to 4 leaf	100	28	7-30	4.90 ab
cyanazine 4WDL	post - 3 to 4	100	23	7-30	5.43 ab
cyanazine 80WP	post - 7 leaf	100	45	7-25	4.22 bc
cyanazine 4WDL	post - 7 leaf	100	47	7-25	4.54 b

1/ Means followed by the same letter are not significantly different at the 5% level with Duncans Multiple Range Test.

Table 2. Effect of cyanazine (1.25 lb ai/A) applied preemergence and postemergence at three stages of crop growth on the sweet corn variety NK-199 in a Norfolk loamy sand.

Treatment		Variety NK-199				
		Vigor (% of Control)		Maturity Delay[1/]	Yield	
Herbicide	Method-Crop Growth Stage	5-23-73	6-19-73	Days	Harvest Date	Ton/A
none	----	100	92	0	7-20	3.27 n.s.[2/]
weeded control	----	100	100	0	7-20	5.26
cyanazine 80WP	preemergence	80	72	3.0	7-23	6.52
cyanazine 80WP	post - spike to 2 leaf	75	27	5.0	7-27	3.67
cyanazine 4WDL	post - spike to 2 leaf	53	33	6.7	7-27	3.42
cyanazine 80WP	post - 3 to 4 leaf	100	23	6.0	7-27	4.07
cyanazine 4WDL	post - 3 to 4 leaf	100	40	5.7	7-27	4.39
cyanazine 80WP	post - 7 leaf	100	57	3.7	7-23	4.89
cyanazine 4WDL	post - 7 leaf	100	57	3.0	7-23	4.55

1/ Estimated on 7-20-73.
2/ No significant difference between means at the 5% level with Duncans Multiple Range Test.

Table 3. Effect of cyanazine (1.25 lb ai/A) applied preemergence and postemergence at three stages of crop growth on the sweet corn variety Jubilee in a Norfolk loamy sand.

Treatment		Variety Jubilee				
		Vigor (% of Control)		Maturity Delay[1/]	Yield	
Herbicide	Method-Crop Growth Stage	5-23-73	6-19-73	Days	Harvest Date	Ton/A
none	----	100	97	0	7-20	4.15 n.s.[2/]
weeded control	----	100	100	0	7-20	5.99
cyanazine 80WP	preemergence	87	78	0	7-20	6.61
cyanazine 80WP	post - spike to 2 leaf	77	40	5	7-25	6.11
cyanazine 4WDL	post - spike to 2 leaf	72	33	4.3	7-25	6.26
cyanazine 80WP	post - 3 to 4 leaf	100	33	5	7-25	5.56
cyanazine 4WDL	post - 3 to 4 leaf	100	48	4.3	7-25	6.25
cyanazine 80WP	post - 7 leaf	100	63	1	7-20	3.43
cyanazine 4WDL	post - 7 leaf	100	60	0	7-20	4.27

1/ Estimated on 7-20-73.
2/ No significant difference between means at the 5% level with Duncans Multiple Range Test.

Table 4. Effect of cyanazine (1.25 lb ai/A) applied preemergence and postemergence at three stages of growth on the sweet corn variety Commander in a Norfolk loamy sand.

Treatment		Vigor (% of Control)		Yield		Ear Count		% Fully Mature
Herbicide	Method-Crop Growth Stage	5-23-73	6-19-73	Harvest Date	Ton/A	Ears/Plot	Lb/Ear	Ears
none	----	100	100	7-27	4.55 n.s.[1/]	18	0.63 n.s.	56
weeded control	----	100	100	7-27	8.12	27	0.77	75
cyanazine 80WP	preemergence	98	93	7-27	7.15	27	0.66	62
cyanazine 80WP	post - spike to 2 leaf	87	58	7-27	6.50	25	0.64	64
cyanazine 4WDL	post - spike to 2 leaf	77	52	7-27	6.34	23	0.66	42
cyanazine 80WP	post - 3 to 4 leaf	100	57	7-27	7.43	28	0.65	39
cyanazine 4WDL	post - 3 to 4 leaf	100	80	7-27	7.70	31	0.63	42
cyanazine 80WP	post - 7 leaf	100	87	7-27	6.25	24	0.65	51
cyanazine 4WDL	post - 7 leaf	100	82	7-27	6.10	25	0.69	57

1/ No significant difference between means at the 5% level with Duncans Multiple Range Test.

Table 5. Effect of cyanazine (1.25 lb ai/A) applied preemergence and postemergence at three stages of crop growth on the sweet corn variety Silverqueen in a Norfolk loamy sand.

Treatment		Vigor (% of Control)		Yield		Ear Count		% Fully Mature
Herbicide	Method-Crop Growth Stage	5-23-73	6-19-73	Harvest Date	Ton/A[1/]	Ears/Plot	Lb/Ear	Ears
none	----	100	83	7-30	4.60 c	19	0.60 n.s.[2/]	30
weeded control	----	100	100	7-30	7.57 a	25	0.76	76
cyanazine 80WP	preemergence	93	88	7-30	6.68 ab	26	0.64	47
cyanazine 80WP	post - spike to 2 leaf	95	77	7-30	6.55 ab	25	0.68	46
cyanazine 4WDL	post - spike to 2 leaf	87	62	7-30	7.31 ab	29	0.62	44
cyanazine 80WP	post - 3 to 4 leaf	100	73	7-30	7.87 a	31	0.62	57
cyanazine 4WDL	post - 3 to 4 leaf	100	70	7-30	8.12 a	32	0.63	46
cyanazine 80WP	post - 7 leaf	100	78	7-30	5.40 bc	22	0.61	53
cyanazine 4WDL	post - 7 leaf	100	80	7-30	5.42 bc	23	0.58	43

1/ Means followed by the same letter are not significantly different at the 5% level with Duncans Multiple Range Test.

2/ No significant difference at the 5% level with Duncans Multiple Range Test.

Table 6. A comparison of five sweet corn varieties with cyanazine preemergence and postemergence at two stages of crop growth in a Norfolk loamy sand (cyanazine - 1.25 lb ai/A).

	Vigor (% of Control) - June 19, 1973				
Variety	Cyanazine 80WP Preemergence % of Control	Cyanazine 80WP Post - Spike to 2 Leaf Stage % of Control	Cyanazine 4WDL Post - Spike to 2 Leaf Stage % of Control	Cyanazine 80WP Post - 3 to 4 Leaf Stage % of Control	Cyanazine 4WDL Post - 3 to 4 Leaf Stage % of Control
Commander	93 a	58 ab	52 ab	57 a	80 a
Silverqueen	88 ab	77 a	62 a	73 a	70 a
Jubilee	78 abc	40 bc	33 bc	33 b	48 b
NK-199	72 bc	27 c	33 bc	23 b	40 bc
Buttersweet	68 c	30 bc	23 c	28 b	23 c

Means followed by the same letter are not significantly different at the 5% level with Duncans Multiple Range Test.

Table 7. Weed control in sweet corn with cyanazine (1.25 lb ai/A) preemergence and postemergence in a Norfolk loamy sand.

Treatment		% Control 1/					
		June 9, 1973 2/			July 23, 1973 3/		
Herbicide	Method-Crop Growth Stage	Crab-grass	Lambs-quarters	Purs-lane	Crab-grass	Lambs-quarters	Fall panicum
none	----	0	0	0	0	0	0
handweeded control	----	100	100	100	100	100	100
cyanazine 80WP	preemergence	100	100	100	94	100	99
cyanazine 80WP	post - spike to 2 leaf	100	100	100	86	99	100
cyanazine 4WDL	post - spike to 2 leaf	100	100	100	74	100	96
cyanazine 80WP	post - 3 to 4 leaf	100	100	100	87	100	99
cyanazine 4WDL	post - 3 to 4 leaf	100	100	100	91	100	97
cyanazine 80WP	post - 7 leaf	89	100	100	82	96	85
cyanazine 4WDL	post - 7 leaf	87	100	100	88	100	87

1/ Average of 15 reps total with 5 varieties.
2/ Weed population: Crabgrass - 40%, Lambsquarters - 35%, and Purslane - 25%.
3/ Weed population: Crabgrass - 60%, Lambsquarters - 20%, and Fall Panicum - 20%.

GLYPHOSATE STUDIES ON YELLOW NUTSEDGE[1]

P. F. Boldt and R. D. Sweet[2]

Abstract

In a field experiment glyphosate [N-(phosphonomethyl)glycine] at 1, 2 and 3 kg/ha was applied to yellow nutsedge (Cyperus esculentus L.) 5-10 cm, 10-20 cm, 20-30 cm, and over 30 cm tall. Applications to small plants were not effective at any dosage and more than 1 kg/ha was needed for control at the 20-30 cm and over 30 cm heights.

In the greenhouse glyphosate at 0.5, 1 and 3 kg/ha was applied to yellow nutsedge when foliage was 5, 10, 15, 20, 25 and 30 cm tall. More than 1 kg/ha was needed for control. Applications made before the 20 cm height were less effective than later applications. Numbers of tubers formed in each treatment were lower than those from untreated plants. Percent germination of tubers from treated plants was not lowered except for those from plants treated at 25 cm. Shoots of tubers from treated plants were normal except that an increased number of shoots were formed by tubers from the 25 and 30 cm treatment.

Introduction

Yellow nutsedge is one of the most serious perennial weeds in New York State; each year encroaching upon more and more good agricultural land. Few herbicides are available for yellow nutsedge control in vegetable crops during the growing season. As a somewhat different approach to control, efforts have been made to find chemicals to inhibit tuber formation and germination when applied late postemergence to nutsedge, perhaps after the crop has been harvested. Among such compounds are MH (1,2-dihydro 3,6-pyridazideione) and amitrole (3-amino-s-triazole), both having been found to inhibit tuber germination and growth (4, 5).

Glyphosate is a non-selective, rapidly translocated herbicide which has shown promise against many perennial weed pests (1, 2). Few detailed studies with this chemical on yellow nutsedge have been reported.

The studies reported here were conducted to determine at what stage of yellow nutsedge growth various rates of glyphosate would give effective foliage control and what effect these treatments would have upon tuberization and subsequent tuber germination and growth.

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[1] Paper No. 657, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

[2] Research Technician and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

Experimental

Experiments were conducted in both the field and greenhouse. In the greenhouse chemical applications were made with a chain driven belt sprayer, utilizing one 8003 Teejet nozzle delivering 1380 L/ha at 2.46 kg/cm^2 pressure. Field applications were made with a CO_2 powered, hand held, backpack sprayer, delivering 460 L/ha at 2.46 kg/cm^2 pressure.

Nutsedge plants for the greenhouse experiments were propagated from tubers germinated in an incubator. Six germinated tubers were planted in a 15x22cm styrofoam flat filled with Cornell Peatlite Mix A as the growing media. Supplemental fluorescent lighting was provided; 16 hours during vegetative growth (8 weeks) and 10 hours during tuberization (6 weeks). Greenhouse temperatures were maintained at 20°C (N) and 30°C (D). Tap water was applied overhead as needed with weekly applications of a water soluble 20-20-20 fertilizer.

All experiments utilized the randomized complete block design with three replications. Visual ratings used to evaluate results were based upon a 1 to 9 system with 1=no effect; 7=commercial control; and 9=complete kill.

Experiment 1

In the summer of 1972 glyphosate was applied to nutsedge at 0.5 and 1 kg/ha when it was approximately 5-7 cm tall and although initial knockdown was good, regrowth occurred. On the other hand, similar treatments made when nutsedge was flowering gave good foliage control and appeared to cause more rapid deterioration of rhizomes as compared to untreated plants.

From these cursory observations, a greenhouse study of rates and time of application of glyphosate in relation to nutsedge foliage and tuber development was undertaken. Table 1 gives the times of application for three rates of glyphosate, 0.5, 1 and 3 kg/ha. Three months later visual ratings were made of foliage responses. About one week later flats were dismantled and all tubers counted and retained for additional studies.

As can be seen in Table 2, it required 3 kg/ha of glyphosate to give effective foliage control of yellow nutsedge. Those treatments which effected better foliage control reduced the tuber formation (Figure 1). Contrary to Linscott and Hagin (6) who reported increased tuber formation with low rates of glyphosate, no treatment increased tuber formation. The high numbers of tubers present when nutsedge foliage was treated at 25 and 30 cm is due to the fact that the tubers were already formed at the time of chemical application (See Table 1).

Table 1. Nutsedge growth at time of treatment (Experiment 1).

Foliage Height at Treatment	Range	Date Treated	Lighting
(cm)	(cm)		(hrs)
5	2-7	10/21/72	16 (LD)
10	7-12	11/2/72	16
15	14-16	11/9/72	16
20	18-22	11/27/72	16
25	25-35	12/22/72*	10 (SD)
30	25-35	1/3/73**	10

* 30-40 immature white tubers per flat initiated at time of treatment.
** 75% of tubers formed were tan colored; plants starting to senesce.

Table 2. Means of final visual ratings of nutsedge foliage treated with glyphosate at various times and rates (Experiment 1).

Foliage Height at Treatment	kg/ha (a.i.) 0.5	1	3
(cm)			
5	2.0	7.3	8.7
10	2.0	5.3	8.7
15	1.7	7.7	9.0
20	2.7	6.3	9.0
25	*	*	*
30	*	*	*
ck = 1.3			

* at time of rating (1/26/73) these treatments had senesced.

1=no effect; 7=commercially acceptable control; 9= complete kill.

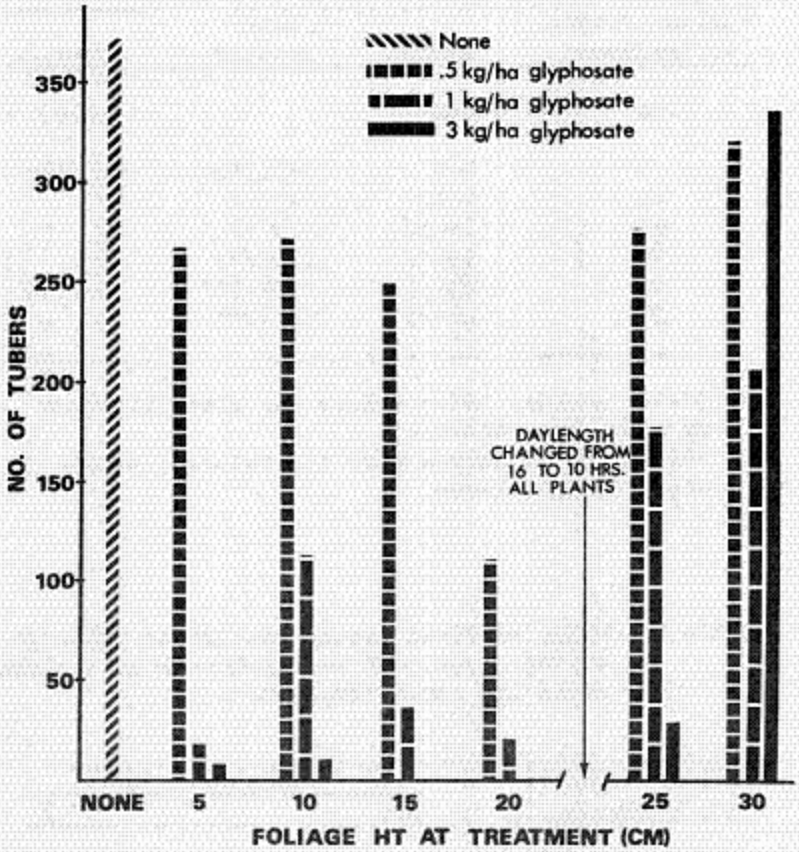

Figure 1. Number of tubers per flat(330 cm^2) formed by plants treated at various heights with three rates of glyphosate.

Experiment 2

Tubers collected from each of the treatments in Experiment 1 were wrapped in moist paper towels, sealed in plastic bags and stored in a refrigerator at 4°C for 4 weeks. Then a subsample of 100 tubers, if available, was placed in petri dishes in an incubator with 27/38°C alternating temperatures. Numbers of tubers germinated were counted every 7 days for a total of 4 weeks. From these counts a percent germination for each treatment was determined. These values are presented in Figure 2. No treatment appeared to reduce the percent germination except for those applied at the 25 cm height of nutsedge. Why this occurred is not known.

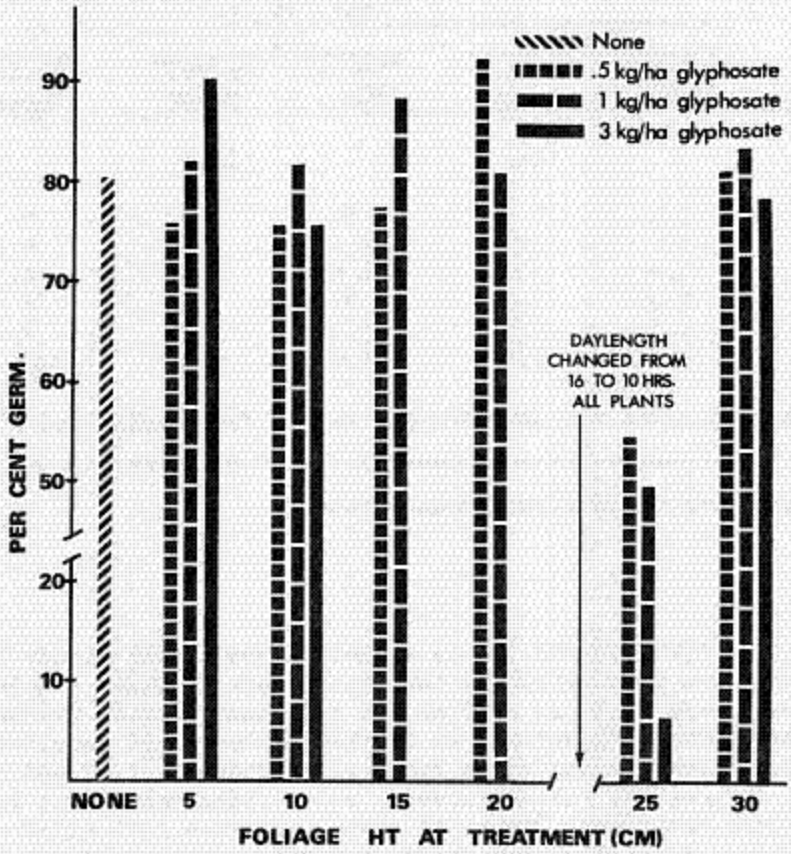

Figure 2. Per cent germination of tubers from plants treated at various heights with three rates of glyphosate.

Experiment 3

From those tubers germinated in Experiment 2, a random sample of six germinated tubers from each treatment was planted in the greenhouse. After six weeks the total number of shoots and the fresh weight of the shoots was obtained. The results are presented in Table 3. Treatments applied while the mother plant was vegetative did not appear to affect the growth characteristics of shoots from tubers formed by these plants. However, an increase in shoots per tuber and a corresponding decrease in fresh weight per shoot was found in those treatments applied during tuber formation.

Table 3. Shoot growth by tubers from plants treated at various heights with three rates of glyphosate (Experiment 3).

Foliage Ht. at Treatment	Rate (kg/ha) 0.5 Shoots/ Tuber	0.5 Fr.Wt./ Shoot	1 Shoots/ Tuber	1 Fr.Wt./ Shoot	3 Shoots/ Tuber	3 Fr.Wt./ Shoot
(cm)		(gm)		(gm)		(gm)
5	5.1	1.7	*	*	*	*
10	5.2	2.1	4.4	1.6	*	*
15	4.9	2.0	4.2	1.7	*	*
20	4.9	1.6	*	*	*	*
25	9.8	1.2	10.1	0.9	*	*
30	5.6	1.7	8.6	1.4	10.1	1.3

Untreated plants yielded 5.1 shoots/tuber with a fresh weight of 1.5 gm/shoot

* too few tubers for valid growth measurements.

Experiment 4

Reports from some workers (6, 7) suggested that applications to young nutsedge plants were more effective than those made to older plants. However, our preliminary field test, as well as the greenhouse tests, did not agree with those statements. Therefore, to further explore this question a field experiment was designed using three rates of glyphosate, 1, 2 and 3 kg/ha, to determine the response of yellow nutsedge under field conditions to this chemical. Results from this experiment (Table 4) again indicated that older plants were more susceptible. Initially treatments to young nutsedge reacted very well, giving control in approximately 2 weeks. However, within 4 weeks after treatment nutsedge treated at either the 5-10 cm and 10-20 cm height showed substantial regrowth regardless of dosage.

Applications of glyphosate to nutsedge 20 cm and higher provided good control particularly with the 3 kg/ha rate. This agrees with results obtained by other workers who made applications to well advanced, pre-bloom nutsedge and received excellent foliage control (2, 3).

This experiment is being continued in that tubers from treated plants have been harvested. Percent germination and shoot growth characteristics will be determined after an adequate cold storage period has elapsed.

Table 4. Visual ratings of yellow nutsedge foliage treated at various heights with three rates of glyphosate (Experiment 4). Each datum is the mean of three replications.

Foliage Height at Treatment (cm)	kg/ha (a.i.) 1	2	3
5-10 (6/10/73)	1.7	1.7	2.0
10-20 (6/19/73)	2.7	3.0	2.0
20-30 (6/29/73)	7.1	7.1	7.7
over 30 (7/17/73)	6.0	8.7	9.0
untreated plants = 1.0			

1=no effect; 7=commercially acceptable control; 9= complete kill

Summary

Studies with glyphosate on yellow nutsedge indicate that more than 1 kg/ha is needed for control. Early applications, before 20 cm of foliage growth, are less effective than later applications. It is not clear from these studies whether this is due to size of plant, stage of growth, or the effect of shorter days.

The chemical does not appear to have an effect upon germination of tubers collected from treated plants. Shoot growth appears to be normal, however, there is an increased number of shoots formed by tubers from plants treated under short daylength conditions. The cause of this is unknown.

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GLYPHOSATE FOR HERBACEOUS PERENNIAL WEED CONTROL IN NORTHEASTERN APPLE ORCHARDS AND VINEYARDS

D. D. Baird[1], N. J. Shaulis[2], and C. G. Waywell[3]

Abstract

Preliminary field investigations using glyphosate [N-(phosphonomethyl)glycine] for herbaceous perennial weed control in northeastern apple orchards and vineyards are discussed. Effective control of various grass and broadleaf herbaceous perennial weeds is achieved with directed postemergence applications of glyphosate to well established apple trees or grapevines. Various management practices and timing of spray applications in order to achieve selective control are discussed.

Introduction

Glyphosate has been shown to have a significant margin of safety on well established fruit trees for effective herbaceous perennial and annual weed control. The germination of annual weeds which occurs following glyphosate applications necessitated combinations with specific preemergence residual herbicides. However, the interaction, antagonisms, and application sequences required for a successful orchard or vineyard program warrant further, more clearly defined investigations. This report represents a portion of those studies required to identify the possible systems which could utilize glyphosate for weed control in orchards and vineyards.

Herbaceous perennial weeds are a problem in perennial plantings such as apple orchards or vineyards. This is due to the long-term use of the land by one tree or vine and particularly to the use of various selective herbicides. Control of the herbaceous perennial weed is desirable to avoid problems during harvest operations, to remove competition, and to aid in year-round management of the crop. Examples of serious perennial weeds in the region are:

1. *Convolulus sp.*
2. Perennial grasses
3. Any perennial weeds with seed heads higher than 15 inches
4. Other weeds such as Virginia creeper, poison ivy, brambles, and Indian hemp.

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[1]Monsanto Company, 800 North Lindbergh Boulevard, St. Louis, Missouri, 63166.

[2]New York State Agricultural Experiment Station, Geneva, New York, 14456.

[3]University of Guelph, Guelph, Ontario, Canada, N1G 2W1.

Methods and Materials

Field studies with glyphosate were initiated at several sites in New York and Ontario. The formulation used (MON 2139) contained the Mono(Monoisopropylamine) salt of glyphosate [N-(phosphonomethyl)glycine] and a specific surfactant at a fixed ratio.

Field studies conducted in New York on apples were on plots of 1.1 X 9.3 meters and on grapes on plots of 1 X 7.1 or 1 X 14.2 meters. The treatments in New York apples contained two trees per plot and three replicates. Six vine plots of six year old Aurore grapes with three replicates were used in the Ontario, New York test while three vine nonreplicated plots with numerous varieties and vine ages were in various tests in commercial vineyards throughout New York State.

Glyphosate was applied in water at 180 liters/hectare in all New York State tests.

Field studies conducted in Ontario, Canada on three apple varieties were on plots 1.6 X 9.6 meters, each plot containing at least three trees, and three replications were used. Glyphosate and glyphosate combinations were applied in water at 284 liters/hectare. Vineyard studies were conducted in the Niagara area of Ontario on well established Concord, Elvira, Canada Muscot, and other varieties. Three to four vines were used in each plot of 0.6 X 7.3 meters and with two to three replications.

All combinations in apples were tank mixed while those in grapes were applied separately. Assessment of postemergence and residual activity was made at various intervals by visual ratings of weed response using a scale of 0-100 with 100 indicating complete control.

Results and Discussion

Orchards

Glyphosate effectively controlled common orchard herbaceous perennial weeds as quackgrass, orchardgrass, common milkweed, and dandelion (Table 1). A program utilizing glyphosate alone at 2.2 kg/ha applied twice a year or glyphosate at 2.2 kg/ha in combination with a preemergence residual compound such as terbacil provided adequate control. Those growers preferring not to have residual control may elect to use glyphosate as a directed spray twice during the season. Those growers preferring a single application may elect to utilize simazine, terbacil, or diuron in combination with glyphosate. However, the single combination

treatment when applied early in the season (May) does not achieve adequate control of late emerging perennials such as common milkweed. Two applications of glyphosate, when applied at the proper stages of weed growth, effectively control both the early and late season herbaceous perennials. Seedling dandelion control (Table 2) is not achieved, reflecting the lack of preemergence activity of glyphosate.

In an Ontario, Canada trial, glyphosate was applied at rates of 1.1, 2.2, and 4.4 kg/ha alone and in combination with simazine at 2.2 kg/ha, terbacil at 1.1 kg/ha, and metribuzin at 1.1 kg/ha during 1972 and 1973 to young nonbearing apple varieties. No injury of any kind was observed on Idared, Spartan, or Red Delicious varieties during the two growing seasons. Growth, as measured by an increase in trunk diameter, was not affected. A broad spectrum of annual weeds, Agropyron repens (L.) Beau. and Veronica spp. were controlled.

Vineyards

Glyphosate has provided excellent weed control of herbaceous perennial weeds in vineyards in preliminary studies throughout the northeast. This is particularly significant when the weeds controlled are those which escape control of any of the commonly used residual herbicides. Grapevines were not injured by glyphosate sprays applied to the vine trunk or to the soil. When glyphosate was intentionally (or unintentionally) applied to leaves or shoots, injury occurred. The injury was observed as malformed leaves as well as contact injury as observed with fortified oil sprays. Young green shoots which are basally sprayed with glyphosate develop symptoms towards the shoot tip. Timing of glyphosate applications is critical in order to achieve maximum weed control of herbaceous perennials without incurring any injury to grapevines. Some of the conditions suggested to further insure the possible safe use of glyphosate in vineyards which may be required are:

a. the vine is trained and the spray application timing is such that shoot tips are not within 15 inches of the vineyard floor at application time.
b. suckers are removed from the vine or the spray is directed away from them.
c. an adequate application of a residual herbicide is made during the dormant season.

Further studies are required to define application techniques and to determine whether applications may be made with existing commercial equipment.

Control of herbaceous perennials as hedge bindweed and common milkweed were achieved in an Aurore vineyard with glyphosate (Table 3). Two applications of glyphosate at 2.2 kg/ha were

required for control of common milkweed due to the difference in their season of growth. Glyphosate may be applied as a directed postemergence treatment to control hedge bindweed which is in the bud stage during mid June. However, common milkweed appears to require later applications for elimination due to its later emergence. Single early applications at 4.4 kg/ha did reduce the amount of milkweed plant material that would be collectible by the harvester. The second application of glyphosate does require "tucking" (raising of the shoots) to avoid any contact of the spray material with green grape tissue, which may be commercially unacceptable in some situations. The total effectiveness of glyphosate as a herbicide for use in vineyards for herbaceous perennial weed control was illustrated in a series of tests in commercial vineyards in several major grape areas in New York State (Table 4). These small single application plots showed that field bindweed could be controlled with about 3.3-4.4 kg/ha a.e., hedge bindweed at 2.2 kg/ha a.e., Virginia creeper at 4.4 kg/ha a.e., and quackgrass at 1.1-2.2 kg/ha a.e.

No injury was observed from glyphosate treatments on any of the varieties in the Ontario, Canada tests. A rate of 2.2 kg/ha at grape bloom plus 5 days was necessary for control of field bindweed, but there was some regrowth on plots which received only one treatment. Late germinating annual grasses [*Echinochloa crusgalli* (L.) Beau.], (*Digitaria* spp.) were observed in all plots which received only one application of glyphosate without residual treatments of simazine or diuron. A 2.2 kg/ha rate of glyphosate also controlled *Agropyron repens* and *Veronica* spp.

The 1973 treatment of glyphosate did not have any adverse effect on the quality or quantity of the 1973 crop of grapes or apples. There also was no evidence of the glyphosate treatments adversely effecting maturity or fruit size of either crop.

TABLE 1. Glyphosate Postemergence Activity on Herbaceous Perennial Weeds in a First Year Bearing Idared Apple Orchard at Ontario, New York**

			Avg. 3 Reps							
			Quackgrass		Orchardgrass		Common Milkweed		Dandelion	
Herbicides	Rates kg/ha a.e./a.i.	Number Appl./Yr.	79 DAT*	123 DAT	79 DAT	123 DAT	79 DAT	123 DAT	79 DAT	123 DAT
Glyphosate	4.4 + 4.4	2	100	100	100	100	96	92	100	83
"	2.2 + 3.3	"	100	97	100	100	100	100	100	73
"	2.2 + 2.2	"	100	93	100	100	95	100	100	87
"	2.2 + 1.1	"	100	94	100	97	87	85	100	90
Glyphosate + diuron	2.2 + 5.3	1	95	94	95	100	30	23	100	88
Glyphosate + simazine	2.2 + 2.2	"	90	55	87	80	75	33	100	88
Glyphosate + terbacil	2.2 + 2.2	"	85	93	93	90	82	73	100	94
Paraquat + simazine	1.1 + 2.2	"	80	70	60	17	25	0	100	88

*DAT - observation in days after treatment - ratings are percent control. 1st application May 16, 1973.

**No injury was observed to the apple trees on either observation date.

TABLE 2. Postemergence Activity of Glyphosate on Various Herbaceous Perennial Weeds in Two Young Nonbearing Orchards (Northern Spy and Macoun) in New York**

Glyphosate kg/ha a.e.	# of Appl. Each Year ('72 & '73)	Quackgrass Oct. '72	Quackgrass May 16 '73	Quackgrass Sept. '73	Orchardgrass Oct. '72	Orchardgrass May 16 '73	Orchardgrass Sept. '73	Cm. Milkweed Aug. '72	Cm. Milkweed Sept. '73	Dandelion Oct. '72	Dandelion May 16 '73	Dandelion Sept. '73	Control of All Vegetation - % Bareground May 16 '73
4.4	1	96	90	100	100	90	100	0	0	85*	0	0*	20
2.2	"	80	80	100	100	100	100	0	0	80*	15	0*	17
1.1	"	85	65	100	80	50	100	0	0	80*	0	0*	30
4.4	2	99	97	100	95	95	100	75	100	100	90	85	82
2.2	"	99	88	100	100	95	100	70	100	100	80	85	70
1.1	"	97	70	100	100	70	100	70	50	100	82	70	77
4.4	3	97	93	100	95	100	100	100	100	90	80	100	80
2.2	"	96	90	100	100	90	100	100	100	100	90	100	82
1.1	"	96	65	100	100	80	100	95	90	94	75	100	55
Paraquat 0.8	1	0	0	20	75	0	50	0	0	0	0	0	7
" 0.8	2	0	0	0	85	0	10	0	0	5	0	0	6
DAT (From Initial Appl.)		170	371	495	170	371	495	456	495	170	371	495	371

*Seedlings
**No injury to the apple trees was observed either year.

1 Application - 1972 May 10 1973 May 16
2 " s - 1972 May 10, June 27 1973 May 16, July 5
3 " s - 1972 May 10, June 27, August 10 1973 May 16, July 5, August 9

TABLE 3. Glyphosate Postemergence Activity on Herbaceous Perennial Weeds in an Aurore Vineyard at Ontario, New York.

kg/ha Glyphosate	Number of Applications per year	Hedge Bindweed 10/0 DAT	Hedge Bindweed 53/0 DAT	Hedge Bindweed 79/26 DAT	Common Milkweed 10/0 DAT	Common Milkweed 53/0 DAT	Common Milkweed 79/26 DAT	Aurore Grapes*** % Trellis Fill	Aurore Grapes*** % Foliage Green
4.4	2**	95	94	100	80	82	98	53	58
3.3	"	85	92	100	83	90	100	62	59
2.2	"	85	94	100	83	80	97	58	55
8.8	1*	77	70	97	85	73	43	49	52
4.4	"	85	90	92	82	70	53	54	56
3.3	"	85	92	97	84	93	80	44	46
2.2	"	85	91	96	70	77	63	38	48
Paraquat 1.1	"	70	10	45	55	23	20	52	55
Check	--							29	41

*Applied June 12, 1973

**Applied June 12 and August 4, 1973

***Ratings on October 16, 1973

TABLE 4. Postemergence Activity of Glyphosate on Selected Herbaceous Perennials in Non-replicated Commercial Vineyard Tests Throughout New York State.

			% Control at 78 Days After Treatment					
Herbicide	Rate kg/ha	Time of Application	Field Bindweed Avg. 9 sites	Hedge Bindweed Avg. 4 sites	Hemp Dogbane Avg. 2 sites	Virginia Creeper Avg. 4 sites	Common Milkweed Avg. 2 sites	Quackgrass Avg. 2 sites
Glyphosate	4.4	Grape Bloom	88	96	60	93	82	100
	2.2	"	82	91	35	89	95	100
	1.1	"	82	80	40	55	87	89
	2.2	Mid May	17	0	0	--	--	--
Paraquat	1.1	Grape Bloom	10	52	--	--	50	70

WEED CONTROL IN PEACH NURSERIES WITH TERBACIL

O. F. Curtis, Jr.[1/]

ABSTRACT

Terbacil (3-tert-butyl-5-chloro-6-methyluracil) at 0.4 to 1.7 kg/ha and simazine [2-chloro-4,6-bis(ethylamino)-s-triazine] at 0.7 kg/ha were applied as seedlings were emerging from plantings of peach [Prunus persica (L.) Batsch] seed. Application was repeated at double rate next year as scion shoots grew from the budded seedlings. The problem of weed populations that emerge before and with the peaches was eliminated by all terbacil rates and reduced by simazine. The herbicides as a supplement to cultivation did not adversely affect emergence or the final stand of budded seedlings in the first year, or the growth from scion buds in the next year. Size attained by seedlings and by scion growth under herbicides was equal or greater than that under cultivation alone. Other herbicides observed in the first or second year of nursery growth were dipehnamid (N,N-dimethyl-2,2-diphenylacetamide), diuron [3-(3,4-dichlorophenyl)-1',1-dimethylurea], and paraquat (1,1-dimethyl-4,4'-bipyridinium ion).

INTRODUCTION

Peach tree production in the Northeast typically begins with seed planted in the spring. In late summer buds of the cultivar are inserted in the base of those seedling stems that have reached suitable size. Growth from these buds next year forms the tops of the nursery trees that are dug at the end of the year. Weeds offer severe competition in the early stage of peach growth. Later weed growth that screens the peach stems interferes with the operations of budding and removing unwanted lateral shoots. Hoeing and hand weeding is often a necessary preliminary to these operations. In some seasons peach seed germinate so slowly that the seedling rows are completely hidden by weeds.

Paraquat was considered as a possible remedy for weeds emerging before the peaches. However, peaches emerged rather promptly in the two plantings of this study. Among other potential herbicides, terbacil received attention because peach seedlings had been observed growing under mature trees treated with terbacil. Preliminary observation in this study has been reported (1).

[1/] Dept. of Pomology and Viticulture, New York State Agricultural Experiment Station, Geneva, N.Y. 14456.

MATERIALS AND METHODS

Experiments were conducted in the production plantings of the New York State Fruit Testing Cooperative Association, Geneva, N.Y. Herbicide regimes consisted of one application as peach seedlings were emerging about two weeks after planting and another in late spring of the next year as scion shoots were growing from buds inserted the previous August. Treatments were a supplement to the routine nursery operations of periodic cultivation plus hoeing and hand weeding when necessary. The soil was Berrian fine sandy loam.

Treatments were in a randomized complete block design of 5 blocks in 1969 and 8 blocks in the 1970 planting. Individual plots were 8 m lengths of row treated on a band one m wide. Herbicides were applied over emerging seedlings in sprays at 460 L/ha. In the year of scion growth sprays at 900 L/ha were directed on each side of the row, but did wet the lower leaves of the scions. Commercial formulations were used; rates are expressed as active ingredient.

Weed species encountered in the 1969 planting were common ragweed (*Ambrosia artemisiifolia* L.), yellow foxtail [*Setaria lutescens* (Weigel) Hubb.], red sorrel (*Rumex acetosella* L.), wild carrot (*Daucus carota* L.), and toad rush (*Juncus bufonis* L.). The 1970 planting included these plus a moderate population of corn spurry (*Spergula arvensis* L.) and common lambsquarters (*Chenopodium album* L.).

Stand of peach seedlings was recorded on the date of treatment and at intervals through the season, and a final count made of the number budded. Records in the second year of treatment concerned the number of seedlings from which scion growth started, the final number of nursery trees resulting, and their size. Data were analyzed by analysis of variance or covariance and means compared by Duncan's multiple range test. Weed counts were converted to logarithms for analysis then reconverted. Covariance analysis was used where appropriate to compare differences independent of previously observed differences.

RESULTS AND DISCUSSION

1969 PLANTING. Weeds were from the cotyledon stage to 2 cm high at the time the herbicide treatments of Table 1 were applied. Rainfall was 2.5 cm in the first 10 days after treatment and 5 cm in the next 10 days. Four weeks after treatment the weeds to be controlled by cultivation were almost eliminated by even the low 0.5 kg rate of terbacil and were markedly reduced by simazine.

Emergence of peach seedlings after treatment and the final stand at the end of the season showed no sign of adverse effect of herbicide. Compared on the basis of equal initial stand, final stand under herbicides averaged significantly greater than in the check; and the number of budded seedlings also tended to be greater under herbicides (Table 1).

Table 1. Weed control and peach seedling crop under herbicides as a supplement to cultivation. 1969 Planting.

Herbicide[x] June 6		Weeds / sq m July 3	No. peach plants per 8 m row length: June 6	July 3	Adjust for June 6 no.[y] July 3	Sept.	Budded
	(kg/ha)	(no.)	(no.)	(no.)	(no.)	(no.)	(no.)
1. Terbacil	1.7	<1 a[z]	15	47 a	49 a	48 a	27 ab
2. Terbacil	0.8	1 a	16	48 a	49 a	48 a	37 a
3. Terbacil	0.5	3 b	16	40 a	41 a	40 ab	27 ab
4. Simazine	0.7	12 c	17	49 a	48 a	49 a	31 ab
5. None		162 d	19	42 a	40 a	33 b	23 b
LSD (5%)		-	-	13	11	13	12

[x] All plots cultivated July 14 then hoed, cultivated Aug. 24, Sept.

[y] Adjusted by covariance analysis for differences in June 6 no.

[z] Means followed by the same letter do not differ significantly at the 5% level.

Table 2. Scion growth in 1970 after further herbicide treatment on the plots of Table 1.

Herbicide[a] May 25		No scions per 8 m row length: Budded (1969)	May	Oct	Adjust Oct for[y] June 1969	Budded 1969	Trunk diam Oct	Weeds / sq m Oct
	(kg/ha)	(no.)	(no.)	(no.)	(no.)	(no.)	(mm)	(no.)
1. Terbacil	3.4	26	18 a[z]	17 a	18 a	19 a	16.6 ab	1
2. Terbacil	1.8	37	22 a	21 a	22 a	18 a	17.9 a	1
3. Terbacil	0.8	27	15 a	15 a	15 a	16 a	17.6 a	2
4. Simazine	1.7	31	20 a	20 a	19 a	19 a	16.5 ab	6
5. None		25	18 a	17 a	15 a	19 a	15.4 b	44
LSD (5%)			9	8	6	5	2.0	-

[x] All cultivated June 11 then hoed, cultivated July 20, Sept.

[y] Adjusted by covariance analysis for differences in the indicated previous numbers.

[z] Means followed by the same letter do not differ significantly at 5%.

Application was repeated in 1970 on the same plots but at about double the 1969 rates. Weeds were up to 6 cm in height. Rainfall was 2 cm in the first 10 days and 8 cm in the next 20 days after treatment. When cultivated 17 days after treatment excellent weed control was noted for all terbacil rates and good control noted for simazine. Weeds remaining in the rows at the end of the season were clearly reduced by all herbicide treatments (Table 2).

The number of scion buds starting growth in 1970 did not differ significantly among treatments, and essentially all grew to form trees at the end of the season (Table 2). Differences in stand that were significant in favor of herbicides in 1969 became insignificant. Adjusting the final stand of trees to allow comparison on the basis of equal numbers of budded seedlings or equal numbers emerged when first treated did not reveal significant effects. Final tree size averaged larger under herbicides than in the check.

1970 PLANTING. Weeds were up to 2 cm high in the row band and up to 7 cm high in the longer undisturbed area between rows. Rainfall was 3 cm in the first 10 days and 2.5 cm in the next 10 days after treatment. Three weeks after treatment weed control was very good to complete under all treatments except simazine at 0.7 kg. On the larger weeds beside the row only terbacil at 0.8 kg or more gave a high degree of control. Survivors of the 0.4 kg rate of terbacil were largely foxtail and sorrel; control of these was improved by the addition of diphenamid at 3 kg.

Stand of peach seedlings in midsummer and final stand of budded seedlings showed no significant differences among treatments (Table 3). Herbicide treatment on the average increased final seedling size as compared with the checks.

An injury symptom from the 1.7 kg rate of terbacil showed 2 weeks after treatment in lighter color of the lower peach leaves and necrosis of their tips. This was soon screened by newer leaves and final size was equal or greater than that of any other treatment.

Paraquat at 0.6 kg/ha (applied with 0.6 ml/L nonionic surfactant in 460 L/ha) injured emerged peach seedlings. Mortality was about 15%. Terminal buds of an additional 20% were killed, but renewed growth occurred from lateral buds. This effect was overshadowed in final observed stand (Table 3) by later emerged seedlings and variable losses from cultivation. Seedlings with leaves relfexed from the bud suffered more serious injury than those in earlier stages. Application made 4 days later in the emergence period on supplementary plots showed a more serious thinning and stunting of stand.

When herbicides were again applied in early June of 1971 annual weeds were up to 5 cm in height and red sorrel ranged from 2 to 20 cm high. Rainfall over the first 10 days after treatment was 6 cm. Three weeks after treatment diuron at 1.8 kg was observed to have given excellent control of sorrel.

Table 3. Weed control and peach seedling growth under herbicides as a supplement to cultivation. 1970 Planting.

Herbicide[w]		Weed cover June 19			No. peaches per plot				
		Rating		Count	May	June	June	Budded	Stem diam
		In row[x]	Beside[y]	in row	28	30	30 adj[z]	adj[z]	Oct
	(kg/ha)			(no./sq m)	(no./8 m row length)				(mm)
1. Terbacil	1.7	0.0	0.0	1 a	19	40 a	40 a	31 a	9.7 a
2. Terbacil	0.8	0.0	0.0	2 ab	19	40 a	40 a	33 a	9.0 abc
3. Terbacil	0.4	0.2	2/5	21 c	21	36 a	34 a	31 a	8.7 bc
4. Terbacil + diphenamid	3.8	0.0	0.8	4 b	16	33 a	36 a	32 a	9.1 abc
5. Simazine	0.8	3.5	7.0	75 d	17	34 a	36 a	31 a	9.3 ab
6. Paraquat	0.6	1.0	2.0	30 cd	16	34 a	36 a	29 a	9.1 abc
7. None		10	10	272 e	19	39 a	38 a	30 a	8.4 c
8. None		10	10	262 e	24	42 a	37 a	29 a	8.7 bc
LSD (5%)						9	7	7	0.8
Mean herbicide					18	36	37	31	9.2
Mean none					22	40	37	30	8.5**

[w] All cultivated June 19 then hoed, cultivated July, August.

[x] Weeds to 2 cm high when treated.

[y] Weeds to 7 cm high when treated.

[z] Adjusted by covariance analyses for differences in May 28 no.

** Significantly less than herbicide mean at 1% level.

Numbers of peach scions that started growth in 1971 and the numbers growing in midsummer showed no significant effects of treatment. Nor did any effect show when number growing in midsummer was related to the number starting growth in 1971, budded in 1970, or emerged at the time of first treatment in 1970. Height of scion growth in midsummer showed an insignificant trend for larger trees under herbicides than in the checks. Trees were dug before measurements were obtained at the end of the season.

The bulk of peach seedling emergence in both plantings occurred before rainfall had presumably carried herbicides into the soil. However, some emergence was noted after such rainfall. After June 16, 1969, following 2.5 cm of rain, emergence per plot averaged 7 for the two higher rates of terbacil, 5 for both the low rate and simazine, and 4 for the check. After June 4, 1970, following 3 cm of rain over a two-day period, emergence averaged 8.9 per plot for the two high rates of terbacil, compared with 8.4 for the checks and 1.8 as standard deviation of the difference.

Table 4. Scion growth in 1971 under further herbicide treatment on the plots of Table 3.

Herbicide[x] June 10		Weed cover July 26[y]	No. scions per 8 m row length: Budded (1970)	June 10	July 26	Adjust July 26 for[z]: May 1970	Budded 1970	June 10	Scion height July 26
	(Kg/ha)		(no.)	(no.)	(no.)	(no.)	(no.)	(no.)	(cm)
1. Terbacil	3.5	0.0	31	16	14	14	13	12	106
2. Terbacil	1.7	0.0	33	14	14	14	13	14	103
3. Terbacil	0.9	0.4	33	14	13	12	12	13	103
4. Terbacil	0.4	0.4							
+ diuron	0.9	0.4	30	16	15	16	15	14	107
5. Simazine	1.8	3.6	29	15	12	13	13	12	104
6. Diuron	1.8	2.0	26	12	11	12	13	13	103
7. Hoe		1.0	30	15	12	12	13	12	102
8. None		8.0	34	14	13	11	12	14	99
LSD (5%)			10	7	6	5	4	2	8
Mean herbicide			30	15	13	13.4	13.3	13.1	104
Mean no herbicide			32	14	13	12.0	12.2	13.0	101

[x] All plots cultivated July 5.

[y] Rating as a product of weed number and height in the tree row.

[z] Adjusted by covariance analysis for differences in the indicated previous counts.

The lowest terbacil rates used in this study were ample for commercial control of the weeds encountered. Yet quadruple such rates did not impair the successful production of nursery trees. This is not only evidence of usefulness in the nursery; it also has implications of low hazard to peaches in orchard plantings. Fisher and Price (2) have reported indications that peaches have more inherent tolerance of terbacil than do apples.

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APPLE RESPONSE TO LOCAL APPLICATION OF GLYPHOSATE ON FOLIAGE OR PRUNING WOUNDS.

O. F. Curtis, Jr.[1/]

ABSTRACT

Growing apple buds exposed to glyphosate [N-(phosphonomethyl)glycine] showed symptoms ranging in severity through:

1) Temporary suppression of growth with emerging leaves temporarily chlorotic and maturing to smaller size and more linear shape than normal. Later extension growth in the same year or the next year eventually produced normal leaves.
2) Cessation of terminal growth. Multiple short shoots, often with the symptom 1), grew from the bud in the same season or next year.
3) Abscission or death of the bud.

Such responses resulted from application to the bud itself, to mature foliage within one m distance of the bud, or to fresh pruning cuts within two m distance. Application to opening buds in the spring resulted in symptoms in other opening buds to 0.5 m distance distally.

Sprays on the tips of actively growing shoots caused symptoms 1) at concentrations of 0.06 to 0.2 gm/L, 2) at 0.2 to 0.6 gm/L, and 3) at 0.6 to 2 gm/L. Sprays at 2 to 6 gm/L killed apical stem tissue as well as the bud. Shoots treated at 0.2 gm/L or higher showed symptoms 1) and 2) next year in growth from the buds near the tip.

Sprays on the basal 20 cm of 40-60 cm growing shoots resulted in injury (1,2,3) or killing of the shoot tip at concentrations of 0.6 to 2 gm/L. At 2 to 6 gm/L the killing progressed from tip to the base of the shoot over a period of weeks. Next year, 9 to 10 months after treatment, injury showed on spurs up to one meter distant from the treated shoot. Systemic effects showed at a greater distance if more than one shoot in a tree sector had been treated at 2 to 6 gm/L.

Severe injury followed application to fresh pruning cuts in the period between bud opening and petal fall. Concentrations of 0.4 to 1.2 gm/L applied to cuts 0.6 to 2 m distant from branch terminals caused symptoms on spurs and terminals and marked reduction in length of terminal growth. Concentrations of 4 to 12 gm/L resulted in mortality of buds and stem tissue of spurs and terminals when applied to fresh cuts, but had negligible effects when applied to cuts made two weeks previously.

Application on fresh cuts later in the season had much less visible effect; buds that had ceased growth showed no visible response. It is possible, however, that visible expression of effects will appear in the next growing season.

[1/] Dept. of Pomology and Viticulture, New York State Agricultural Experiment Station, Geneva, N.Y. 14456.

POSTEMERGENCE HERBICIDES FOR SEEDED ONIONS IN MINERAL SOILS

C. E. Beste[1/]

Abstract. The purpose of this study was to determine the effect of several postemergence herbicides on onion (*Allium Cepa* L.) yields when weed competition was not a factor. Herbicide plots were 5 ft by 20 ft with four onion (var. Autumn spice) rows of 12 inch width. The onions were seeded on April 5, 1973 in a Norfolk loamy sand at the University of Maryland Vegetable Research Farm at Salisbury. DCPA (dimethyl tetrachloroterephthalate) at 6.0 lb/A was applied preemergence to all plots except the controls, and postemergence treatments were applied June 1 when 70% of the onions were in the three leaf stage and 30% were in the two leaf stage of growth. Postemergence treatments applied after DCPA preemergence were chlorpropham (isopropyl *m*-chlorocarbanilate)- 2 lb/A, chloroxuron (3-[*p*-(*p*-chlorophenoxy)phenyl]-1,1-dimethylurea)- 3 lb/A, nitrofen (2,4-dichlorophenyl-*p*-nitrophenyl ether)- 2 and 3 lb/A, and methazole (2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione)- 0.5, 1.0, 1.5, and 2.0 lb/A. The nitrofen treatment at 2.0 lb/A was repeated after 36 days. Weed control ratings for common purslane (*Portulaca oleracea* L.), carpetweed (*Mollugo verticillata* L.), and large crabgrass (*Digitaria sanguinalis* (L.) Scop.) were made when the weeds were small prior to cultivation and hand weeding. The center two rows in each plot were harvested on August 6, field dried, and stored until the tops were removed in October to determine the yield of bulbs.

Onion yields were not significantly reduced by the herbicide treatments and yields were in the 8 ton/A range. Leaf burning and vigor reduction were not observed with any treatment. All postemergence treatments improved the weed control compared to the preemergence treatment of DCPA alone. Nitrofen and chloroxuron provided 89% and 79% control of large crabgrass, respectively, at the time of harvest. Chlorpropham gave 79% large crabgrass control and 96% common purslane control at the time of harvest. Methazole at 0.5 lb/A provided acceptable full-season weed control, with only slightly better weed control at higher rates. Common purslane was effectively controlled by all the postemergence treatments.

1/ Assistant Professor, Department of Horticulture, University of Maryland Vegetable Research Farm, Salisbury.

EVALUATION OF HERBICIDES FOR WEED CONTROL IN SEEDED ONIONS GROWN IN MINERAL SOILS

Charles J. Noll[1]

Abstract

Seeded onions (Allium Cepa) grown in mineral soils were successfully weeded with a number of herbicides. Taking into consideration weed control and yield the best four treatments were: propachlor (2-chloro-N-isopropyl-acetanilide) applied in three treatments 30 days apart with the first application made 1 day after seeding; the combination of DCPA (dimethyl tetrachloroterephthalate) applied 1 day after seeding followed by methazole (2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione) applied 48 days later; a single application of methazole applied 48 days after seeding; and the combination of prynachlor(2-chloro-N-(1-methyl-2-propynyl) acetanilide) applied 1 day after seeding followed by methazole 48 days after seeding.

Introduction

Onions are grown in limited plantings by many of our vegetable growers in Pennsylvania. Most of the onions are grown from sets or transplants; few onions are grown from seed. Onions successfully grown from seed could be less costly to produce but weed control would have to be extended over many months.

Earlier studies identified a number of promising herbicides and combination of herbicides worthy of trial for the weeding of this crop. These herbicides and a number of other herbicides reported as being promising were included in this year's trial.

Materials 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 1972 and the seedbed prepared April 16, 1973. On April 17, the field was seeded to the variety Early Yellow Globe. The preemergence treatments were applied the next day and the postemergence treatments 30, 48 or 59 days after seeding.

Single row plots were 28 feet long and 3 feet wide. Treatments were randomized in each of 8 blocks. Herbicides were applied in a two foot band over the row. The field was cultivated and irrigation applied as needed.

Weeds present in the greatest numbers were redroot pigweed (Amaranthus retroflexus L.), lambsquarters (Chenopodium album L.) and green foxtail

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

(*Selaria vividis* (L.) Bleauv). A rating scale of 1 to 9 was used to evaluate the overall weed control June 27th, 71 days after seeding. Under this system, 1 is no weed control and 9 is complete weed control. On August 14th, 123 days after seeding, weeds were identified and rated on a 1 to 3 scale. Under this system, 1 is one or more healthy weeds present, 2 shows stunted or injured weeds present, and 3 no weeds present. The 1 to 3 rating scale for specific weeds partly eliminates the problem of uneven weed distribution in the field and simplifies the record taking.

Results and Discussion

The results are presented in Table 1. All herbicides significantly reduced the overall weed population when rated 71 days after seeding. One hundred twenty-three days after onion seeding, all herbicides significantly controlled lambsquarters, all but two controlled green foxtail and four of the 18 treatments controlled redroot pigweed.

The four best treatments were: propachlor applied three times at 30 days intervals with the first application 1 day after onion seeding; DCPA in a preemergence application followed by methazole 48 days later; methazole applied alone 48 days after onion seeding; and prynachlor applied as a preemergence treatment followed by methazole 48 days later.

Yield records were taken September 24 more than 5 months after seeding.

This year a good yield of onions was obtained on our heavy mineral soils where good weed control treatments were applied. Early planting and water supplied as needed by rain or irrigation were contributing factors.

TABLE 1. The effects of herbicides alone and in combination on weed control and onion responses.

Herbicide	Lbs. ai/A	Application Days from Planting	AVERAGE PER PLOT: Weed Control: All Weeds (1-9)[1/]	Redroot Pigweed (1-3)[2/]	Lambs-quarter (1-3)[2/]	Green Foxtail (1-3)[2/]	Marketable Yield: No. Bulbs	Wt. Bulb lbs.
1. Nothing	--	--	1.4	1.4	1.0	1.6	34	3.7
2. Prynachlor	4	PRE+1	6.0	1.0	2.6	3.0	86	13.0
3. Propachlor	5 & 5	PRE+1,Post +30/59	9.0	2.6	3.0	3.0	104	33.4
4. DCPA + Nitrofen	8 + 4	PRE+1	8.6	1.6	2.8	2.8	15	4.5
5. Prynachlor & Chloroxuron	4 & 2	PRE+1 & Post+30	7.9	1.0	3.0	3.0	35	8.3
6. Prynachlor & Methazole	4 & 1	PRE+1 & Post+48	8.6	1.8	3.0	3.0	85	22.0
7. Prynachlor & Bentazole	4 & 1	PRE+1 & Post+48	8.3	1.0	3.0	2.8	41	9.2
8. Propachlor & Chloroxuron	5 & 2	PRE+1 & Post+30	8.3	1.0	3.0	3.0	41	11.8
9. Propachlor & Methazole	5 & 1	PRE+1 & Post+48	8.8	1.6	3.0	2.8	97	19.6
10. Propachlor & Bentazole	5 & 1	PRE+1 & Post+48	8.3	1.2	3.0	3.0	57	10.6
11. DCPA & Chloroxuron	8 & 2	PRE+1 & Post+30	9.0	1.2	2.3	3.0	63	15.4
12. DCPA & Methazole	8 & 1	PRE+1 & Post+48	8.6	2.2	2.6	3.0	104	27.2
13. DCPA & Bentazole	8 & 1	PRE+1 & Post+48	8.6	2.0	3.0	3.0	75	21.7
14. Chloroxuron	2	Post+30	7.5	1.0	2.8	3.0	41	9.0
15. Chloroxuron	4	Post+30	8.0	1.4	2.8	3.0	44	11.4
16. Methazole	1	Post+48	7.0	1.6	3.0	1.4	71	11.1
17. Methazole	2	Post+48	8.0	1.6	2.8	1.6	107	24.0
18. Bentazole	1	Post+48	5.8	1.4	3.0	1.0	31	5.9
19. Bentazole	2	Post+48	6.0	1.6	3.0	1.0	46	9.2
Least Significant Difference		5%	1.7	0.5	0.3	0.5	21	4.7
" " "		1%	2.0	0.6	0.4	0.5	25	5.8

Weed Control Rating Scale:

1/ (1-9) 1 least desirable; 9 most desirable
2/ (1-3) 1 least desirable; 3 most desirable

SOME PROMISING HERBICIDES FOR WEED CONTROL IN SUMMER SQUASH

D. J. Herman, M. M. Lay and Richard D. Ilnicki 1/

Abstract

Some preplant incorporated and preemergence treatments were evaluated in two separate experiments. Lambsquarters (Chenopodium album L.), pigweed (Amaranthus retroflexus L.), fall panicum (Panicum dichotomiflorum Michx.) and smooth crabgrass (Digitaria ischaemum (Schreb.) Muhl.) were the major weed species present in the experimental area. The outstanding preplant incorporated treatment was bensulide 4 lb /A followed by chloramben, methyl ester 3 lb /A applied preemergence. The outstanding preemergence treatment for both weed control and yield was chloramben, methyl ester 1½ lb/A + asulam 3 lb/A. Crop injury was induced by the following preplant incorporated treatments: dibutalin at rates above 1½ lb/A, dinitramine (USB 3584)at rates above ¼ lb/A, nitralin at ½ lb/A and bensulide at 4 lb/A followed by naptalam applied preemergence at 3 lb/A.

Methods and Materials

A field was chosen containing a fairly uniform stand of lambsquarters, pigweed, fall panicum and crabgrass. Summer squash, variety Seneca Prolific, was planted in Freehold sandy loam soil on June 1, 1973, at the Adelphia Research Center of Rutgers University, Adelphia, New Jersey. The field was fitted into 5-foot beds and divided into plots which were 16½' in length. Each bed had 4 hills planted with 4 seeds. Treatments were applied on May 31 or June 1, 1973, with a portable knapsack CO_2 sprayer at 40 gpa for both the preplant incorporated and preemergence applications. Visual ratings on both stand (S) and vigor (V) were made on August 14 and 15, 1973. A scale of 0 to 10 was used in which 0= no effect on stand or vigor and 10 = complete control or elimination of stand. The squash was harvested 15 times throughout the growing season as required. Yield data are presented in cwt./A. The experiment was designed as a randomized complete block and comparisons between treatment means were made using Duncan's Multiple Range Test at the .05 level of probability.

1/ Research Intern, Ph.D. recipient and Research Professor of Weed Science, Department of Soils and Crops, respectively, Rutgers University, New Brunswick, N. J. 08903.

Results and Discussion

In general, the preplant incorporated herbicide treatments evaluated were not as good as the preemergence treatments. A summary of weed control and crop injury results can be found in Table 1.

One observation worthy of note was that dibutalin at 1½ lb/A and above effected a noticeable swelling of the stem at ground level. Often these swellings became brittle and resulted in loss of stand.

Dibutalin 1½ lb/A generally effected greater response on the grassy weeds than the broadleaf weeds; nevertheless, it was a high yielding treatment.

With regard to the swelling at ground level caused by dibutalin treatments, no satisfactory explanation can be offered at this time. It is possible, however, that as a result of this swelling, buildup of sugars resulted whereby their flow to the roots was restricted. This type of injury, if not too severe, may be beneficial for fruit production. If, in fact, this phenomenon occurs, it would be similar to the practice of girdling young fruit trees to bring them into production earlier.

Outstanding yields for preplant incorporated treatments resulted from bensulide 4 lb/A applied preplant incorporated + the methyl ester of chloramben 3 lb/A applied preemergence. This treatment also gave outstanding weed control.

Severe reductions in crop stand were also noted with dinitramine (USB 3584) ¼ and ½ lb/A, bensulide 4 lb/A applied preplant incorporated followed by naptalam 3 lb/A applied preemergence and with nitralin applied preplant and incorporated at ½ lb/A.

Injury to squash from preemergence treatments were produced by nitralin at ½ lb/A and above and all rates of naptalam. The outstanding preemergence treatments were the methyl ester of chloramben + asulam and chloramben as the methyl ester or salt formulations. The highest yielding treatments were combinations of the methyl ester of chloramben + asulam with the 1½ lb + 3 lb/A being the highest followed by the 1½ lb + 2 lb/A rates

respectively. Both of these treatments were higher than the best preplant incorporated treatments. In addition, these treatments gave excellent control of lambsquarters, pigweed, fall panicum and crabgrass.

From a graphic analysis of the fifteen harvests not presented in this paper, the following comments can be made. The preemergence treatments of chloramben methyl ester + asulam at 1½ + 2 and 1½ + 3 lb/A produced two sharp yield peaks; the first 53 days after planting and the second peak 82 days after planting. The 3 + 2 lb/A treatment did not have the characteristic first peak but the second peak came about a week earlier (74 days). Yields from the preplant incorporated treatments were somewhat more erratic and there was only a second peak for the better treatments. The bensulide + chloramben methyl ester treatment at 4 + 3 lbs/A respectively produced a peak after 74 days while dibutalin + chloramben methyl ester applied 1½lb/A preplant incorporated followed by 3lb/A applied preemergence had a minor peak significantly higher than all other treatments at 63 days and a later peak comparable to the other best treatments at 82 days. These early and later peaks corresponded to our sixth and twelfth harvests. Our first harvest was made 41 days after planting.

Table 1. The effects of varying rates of herbicides and herbicide combinations on weed control in summer squash in New Jersey, 1973[1/]

Treatment	Rate	Squash S	Squash V	Lamb-quarters S	Lamb-quarters V	Pigweed S	Pigweed V	Crabgrass S	Crabgrass V	Fall Panicum S	Fall Panicum V	YIELDS (cwt./A)
PREPLANT INCORPORATED												
dibutalin	1½	0.0	0.3	6.7	1.3	8.2	2.3	7.0	2.7	9.0	3.3	290.2 abc
AMEX 820 4E	2	2.7	0.3	7.0	0.0	7.3	1.0	8.0	6.0	8.7	4.3	120.2 defg
	2½	4.3	5.0	5.3	0.0	9.2	3.0	9.7	7.3	9.3	6.7	92.5 efg
isopropalin (EL 179)	½	0.0	2.0	2.0	0.3	7.0	1.3	5.3	1.0	8.3	3.3	180.6 cdef
PAARLAN 6E	3/4	2.4	1.0	2.3	0.7	7.2	1.3	7.3	1.3	9.0	4.0	155.1 def
	1	1.9	0.7	5.3	0.0	8.7	1.7	5.0	0.7	9.0	2.3	174.2 def
	1¼	0.0	0.7	5.0	0.0	8.0	1.0	8.3	1.3	5.0	0.7	220.9 bcd
asulam	2	0.0	2.3	7.0	0.7	4.0	0.0	6.7	2.7	6.3	2.7	165.7 def
ASULOX 3.34lb/gal.	4	0.0	1.0	8.7	6.0	4.7	0.0	9.7	7.7	7.3	4.7	201.3 bcdef
	6	0.0	1.3	6.7	1.0	4.0	0.0	9.0	9.0	8.7	5.0	145.6 def
bensulide	4	0.0	2.3	5.0	2.0	2.7	0.0	8.7	3.7	6.3	0.7	111.9 defg
PREFAR 4E	6	0.0	2.0	4.0	0.0	6.3	0.0	7.0	3.3	9.3	5.0	208.0 bcde
dinitramine(USB 3584)	¼	2.4	0.3	7.0	0.0	8.0	0.0	6.3	4.0	8.7	6.3	191.1 bcdef
COBEX 2lb/gal.	½	9.5	7.0	4.3	0.0	9.0	1.0	8.7	4.3	9.0	6.7	13.9 g
bensulide (ppi) +	4 ppi	6.4	3.7	3.0	1.0	9.6	5.0	8.7	5.7	8.7	0.0	86.6 fg
naptalam (pre)	3 pre											
bensulide (ppi) +	4 ppi	0.0	0.0	9.3	8.0	9.9	9.3	9.7	9.0	9.9	8.3	396.7 a
chloramben CH_3	3 pre											
ester (pre)												
dibutalin(ppi) +	1½ppi	1.2	0.0	9.2	3.0	9.6	5.0	9.9	7.7	9.9	9.3	296.9 ab
chloramben CH_3	3 pre											
ester (pre)												
nitralin	½	2.4	3.7	4.7	0.0	6.3	0.3	7.7	0.0	8.7	0.0	112.8 defg
PLANAVIN 75W	3/4	0.0	1.0	5.7	0.0	9.0	1.3	8.3	2.3	9.0	6.7	154.2 def
check-uncultivated		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	83.6 fg
PREEMERGENCE												
chloramben, salt	2½	0.0	0.0	9.7	9.3	10.0	10.0	10.0	10.0	10.0	10.0	328.2 BC
AMIBEN 2lb/gal.	3	0.0	0.0	9.3	6.7	10.0	10.0	10.0	10.0	10.0	10.0	352.2 BC
chloramben CH_3 ester	2½	0.0	0.0	9.3	7.0	9.3	7.7	10.0	10.0	9.7	8.3	361.2 AB
VEGIBEN 2E	3	0.0	0.0	9.0	6.3	10.0	10.0	9.7	8.7	8.7	6.3	351.1 BC
dinoseb	2	0.0	0.0	8.3	5.7	8.3	6.3	4.0	3.3	8.7	4.7	187.4 DEFG
PREMERGE 3lb/gal.	3	0.0	0.0	8.0	6.3	8.3	6.0	5.0	3.7	9.0	7.3	206.6 DEF
	4	0.0	0.0	9.0	5.3	8.7	6.0	4.7	3.0	9.0	7.0	218.7 DE
nitralin	½	2.1	1.0	6.3	4.0	8.0	5.0	8.7	7.3	9.3	7.0	114.9 FGHI
PLANAVIN 75W	1	3.3	2.0	5.3	3.3	9.0	5.7	9.3	6.7	8.3	6.0	88.5 GHI
asulam	2	0.0	1.0	9.0	4.0	5.3	4.0	10.0	10.0	9.7	8.3	151.9 EFGH
ASULOX 3.34lb/gal.	4	0.0	0.0	9.7	9.0	7.0	4.7	10.0	10.0	10.0	10.0	252.2 CD
	6	0.0	0.0	9.7	9.0	5.3	3.7	10.0	10.0	10.0	10.0	182.3 DEFG
naptalam	3	3.7	1.3	5.7	4.0	7.7	4.7	6.7	4.3	6.7	4.0	49.6 I
ALANAP 2lb/gal.	4	2.1	0.7	5.3	3.3	8.3	6.0	5.3	3.3	7.0	4.3	65.3 HI
	5	5.3	1.7	5.3	3.7	8.0	5.0	7.0	4.7	6.0	4.0	19.4 I
chloramben CH_3 ester	1½+2	0.0	0.0	8.7	6.0	9.3	8.0	10.0	10.0	9.0	6.3	427.3 AB
+ asulam	1½+3	0.0	0.0	9.3	6.7	9.3	7.3	9.7	9.0	9.3	7.0	451.1 A
	3 +2	0.0	0.0	9.0	6.3	9.3	7.3	10.0	10.0	9.7	8.3	367.0 AB
check-cultivated		0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	181.6 DEFG
check-uncultivated		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0 I

1/ Average of 3 replications.

Appendix

Material & Formulation	Chemical Name	Manufacturer
asulam (4E)	methyl sulfonilycarbamate	Rhodia
bensulide (4E)	N-(beta-O, O-diisopropyldithiophosphonyl-ethyl) benzene sulfamide	Stauffer
dibutalin (4E)	N-secondary-4-butyl-4-tertiary-butyl-2,6-dinitroaniline	Amchem (Amex-820)
dinitramine 2lb/gal.	N^3, N^3-diethyl-2,4 dinitro-6-trifluormethyl-M-phenylenediamine	U.S. Borax (USB3584)
isopropalin (6E)	4-isopropyl-2, 6-dinitro-N, N-di-(n-propyl) aniline	Eli Lilly (EL 179)
nitralin (75W)	4-2(2-methylsulfonyl)-2, 6-dinitro-N, N-dipropylaniline	Shell

COMPETITION OF SQUASH CULTIVARS WITH WEEDS[1]

E. K. Stilwell and R. D. Sweet[2,3]

Abstract

The competitive ability of three field grown squash cultivars (Cucurbita pepo L. cvs. Table Queen Bush, Bush Ebony, Ebony Acorn) grown with redroot pigweed (Amaranthus retroflexus L.) and lambsquarters (Chenopodium album L.) or yellow nutsedge (Cyperus esculentus L.) were investigated. Ebony Acorn, a vine type, competed well with redroot pigweed and lambsquarters when planted early but did not when planted late. Table Queen Bush and Bush Ebony, a bush and semi-bush cultivar, respectively, when planted late competed with yellow nutsedge. However, highest yields were always obtained from squash cultivars grown weed-free.

Introduction

Redroot pigweed, lambsquarters and yellow nutsedge are among the most serious weeds found in vegetables, including squash, in New York State. Present control measures such as cultivation, plastic mulch and herbicides are often inadequate. Another possibility for control is that of growing vegetable crop cultivars with growth habits which would compete with weeds. Very little is known about the relative competitive ability of vegetable crop cultivars. In two recent studies (3, 4) seven potato (Solanum tuberosum L.) cultivars were investigated for their potential to compete with redroot pigweed and lambsquarters. Three of the cultivars were relatively weed-free, one had a severe infestation and the other three were intermediates. Sweet (2) in 1948 grew winter squash (Cucurbita maxima Duchesne cv. Blue Hubbard) in dense yellow nutsedge infestation to test its competitive nature. It competed successfully with nutsedge because the tight canopy of large leaves shaded the soil and allowed very little yellow nutsedge growth. If a crop specie can germinate, emerge and produce a dense ground cover faster than a certain weed specie then cultivars within a specie may also have this same potential. Munger (1) observed that three cultivars of Table Queen squash each had different growth habits which produced different ground covers that might enhance their ability to compete with weeds. A change in temperature or rainfall during this period of growth might also provide a cultivar with a competitive advantage.

The purpose of the studies reported here was to determine the relative ability of three Table Queen squash cultivars to compete with yellow nutsedge, redroot pigweed and lambsquarters at two planting dates.

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[1] Paper No. 659, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

[2] Research Assistant and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

[3] The authors wish to acknowledge the advice and assistance of Dr. H. M. Munger, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

Materials and Methods

Studies involving redroot pigweed and lambsquarters were conducted on a Howard gravelly loam at Freeville, New York. Three distinctly different Table Queen squash cultivars were evaluated. They were:

1) Table Queen Bush (Bush). A non-vining type that remains compact throughout the growing season.
2) Bush Ebony (Semi-bush). An intermediate type which is compact until time of flowering. It then rapidly becomes a vining type.
3) Ebony Acorn (Vine). A vining type which forms runners long before flowering and continues to vine throughout the season.

Two weed regimes were established, natural mixed stands of pigweed and lambsquarters and weed-free plots. To give squash seedlings a chance for survival during the first flush of weed growth, a single application of dinoseb (2-sec-butyl-4,6-dinitrophenol) at 2 kg/ha was made four days after planting, just prior to squash emergence. No further treatments were given. The weed-free plots were hand cultivated as needed.

An early and a late planting date was established. The second planting was made beside the first, with similar but not identical plot arrangements. Each planting consisted of 3 blocks, each containing only one of the three squash cultivars. Both weed treatments were replicated two times within each block. Treatments were confined to 10 m^2 plots which contained a single row of squash. The plots were arranged in a randomized incomplete block design. Seeding was with a "Planet Jr." seeder on May 29 and June 20, 1973, immediately after harrowing. The cultivars were thinned to 9 plants per plot two weeks after emergence.

On July 17, the 6, 7, and 8 petiole and corresponding leaf blade of three randomly selected plants in each weed treatment of the early planting date were measured. Petiole length was measured from the main stem to the point of leaf attachment. Leaf size was determined by measuring the length of the leaf from point of petiole attachment to the leaf tip. The width was measured across the leaf at its widest point. Also assessed was the relative height of squash in weedy and weed-free plots. Yields of marketable squash were recorded September 8, after the first frost.

Experiments involving nutsedge were established on a Kendaia silt loam at Aurora, New York. The same three squash cultivars described for the broadleaf tests were also used in these experiments. The plot design was also the same as that used in Freeville, but the arrangement of plots was not identical. The first planting was on June 8, five days after discing. Nutsedge was about 8 cm tall and in the 3-4 leaf stage at this time. On June 20, immediately after harrowing, the second planting was made. Natural stands of nutsedge were used for the weedy plots. They were maintained by hand pulling the annual grasses and by applying 2 kg/ha dinoseb just prior to squash emergence for broadleaf control. Nutsedge-free plots were established and maintained by two applications of Stoddard Solvent at 960 l/ha per application plus some hand weeding. The first application was made just prior

to squash emergence and the second when the squash was in the 3-4 leaf stage. The crop was protected from the spray by covering the young plants individually with an 8 ounce Dixie cup. Yields of marketable squash were obtained September 12.

Results and Discussion

The effects of broadleaf weeds on the growth of three squash cultivars planted early are shown in Table 1. Petiole lengths of all three cultivars were consistently longer in the weedy plots. Leaf blades of the bush and semi-bush type were always smaller in weedy plots. Broadleaf weeds did not influence size of leaf blade of the vine type. It was also noted that the average height of the squash cultivars in the weedy plots were 12-15 cm taller than those in the weed-free plots. Tendrils of the vine type were observed to be attached to the weeds and the main stem bearing the petioles was actually off the ground level 2-10 cm. Later at harvest the end of this same main stem was nearly 60 cm off the ground. Also the petioles were short and the weeds were bent over from the weight of fruit hanging from these vines.

Table 1. Influence of redroot pigweed and lambsquarters on petiole and leaf blade size of three squash cultivars.

	Petiole[a]		Leaf Blade[a]			
	Weeds	No Weeds	Weeds		No Weeds	
Cultivar	Length	Length	Length	Width	Length	Width
	cm	cm	cm	cm	cm	cm
Bush	45	37	27	19	32	25
Semi-bush	56	46	34	26	38	29
Vine	47	42	34	25	34	25

[a] Values shown represent the mean of 18 measurements. Planting date was May 29, 1973.

Broadleaf weeds consistently reduced squash yields (Table 2). Yields of weed-free plots were not appreciably affected by planting dates. However, all cultivars competing with weeds in the early planting produced higher yields than those planted late. In fact, the vine type planted early and competing with broadleaf weeds yielded 91% of that of weed-free squash.

Severe yellow nutsedge infestations significantly reduced yields of squash planted early as shown in Table 3. This drastic yield reduction was probably influenced by the presence of an established nutsedge infestation at planting time. There was little difference between yields of early and late planted squash in slight infestations of nutsedge. Bush and semi-bush types competing with severe infestations of nutsedge in the late planting yielded 84 and 86%, respectively of yields obtained from relatively nutsedge-free plots.

Table 2. Influence of redroot pigweed and lambsquarters on yields of three squash cultivars at two planting dates.

	May 29, 1973[a]				June 20, 1973[a]			
	Weeds		No Weeds		Weeds		No Weeds	
Cultivar	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.
Bush	9.5	3.0	33.0	18.9	10.5	3.6	42.0	18.9
Semi-bush	10.5	6.9	31.5	28.2	5.0	3.2	24.0	19.7
Vine	20.5	16.6	20.0	18.2	6.5	5.5	18.0	17.5

[a] Values shown represent the mean number and weight of fruit from 18 plants.

Table 3. Effect of yellow nutsedge on the yields of three squash cultivars at two planting dates.

	Nutsedge Infestation[a]							
	June 8, 1973				June 20, 1973			
	Severe[b]		Slight[c]		Severe[b]		Slight[c]	
Cultivar	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.
Bush	10.0	2.9	22.0	9.9	20.5	8.8	22.5	10.5
Semi-bush	7.0	4.2	15.0	12.3	13.0	11.0	14.5	12.7
Vine	9.0	5.7	18.0	14.4	12.0	10.5	18.0	15.4

[a] Values shown represent the mean number and weight of fruit from 18 plants.
[b] Severe = at least 200 shoots per m^2.
[c] Slight = less than 10 shoots per m^2.

Conclusions

Squash cultivars differed in their ability to compete with weeds. Time of planting influenced competitive ability. Bush and semi-bush cultivars competed reasonably well with severe infestations of yellow nutsedge when planted late, but the vine type did not. The latter did, however, compete fairly well with dense populations of redroot pigweed and lambsquarters when planted early. With one exception, date of planting had no effect on yields of weed-free squash.

Competitive potentials of vegetable cultivars warrants intensive investigations.

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CHEMICAL WEED CONTROL IN DIRECT-SEEDED ASPARAGUS

William V. Welker, Jr. 1/

Abstract

The effect of various herbicides upon the germination and establishment of asparagus (Asparagus officinalis L. Martha Washington) from seed was studied over a 4-year period. The studies were conducted at Adelphia, New Jersey, on a Freehold sandy loam. Herbicides that provided adequate preemergence weed control while exhibiting good crop tolerance were linuron [3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea] at 1 to 2 lb/A, VCS-438 [2-(3,4 dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione] at 2 to 4 lb/A, chloramben [3-amino-2,5-dichlorobenzoic acid] at 4 to 6 lb/A and DCPA [dimethyl tetrachloroterephthalate] at 6 to 8 lb/A. Combinations of these herbicides at lower rates of each were also studied. These combinations were more effective against a broader spectrum of weeds than the individual herbicides used alone. Split applications were also investigated and were more effective than one application of a single herbicide applied as a preemergence treatment. The cultural system used in planting and establishing asparagus from seed greatly influenced the effectiveness of the herbicides. A herbicide system must be tailored to the cultural system used. Weed competition was found to greatly reduce the growth of asparagus. The best asparagus growth was obtained when weeds were controlled for the entire growing season.

1/Horticulturist, Agricultural Research Service, U. S. Department of Agriculture, Rutgers University, New Brunswick, New Jersey 08903.

RELATIONSHIP BETWEEN ACTIVATED CARBON AND ATRAZINE ON CUCUMBERS AND SNAP BEANS[1]

H. P. Wilson, T. E. Hines and J. N. Belote III[2]

Abstract. In the greenhouse, fresh weight determinations indicated that 100 ppmw activated carbon provided considerable protection to cucumbers (Cucumis sativus L. 'Gemini') from as much as 0.50 ppmw atrazine (2-chloro-4-(ethylamino)-6-isopropylamino)-s-triazine). In field studies, 168 kg/ha activated carbon provided protection from 0.17 kg/ha atrazine but only when carbon was incorporated as deep as atrazine incorporation. Snap beans (Phaseolus vulgaris L. 'Harvester') had more tolerance than cucumbers to atrazine and 112 kg/ha activated carbon permitted snap beans to produce good yields in the presence of as much as 0.34 kg/ha atrazine.

Introduction

The relatively long growing season in eastern Virginia permits production of two successively grown vegetable crops the same year. Frequently practiced crop rotations include sweet corn followed by cucumbers or snap beans. Applications of atrazine to spring planted sweet corn can result in residual injury to either of these crops planted after sweet corn is harvested.

Activated carbon has been found to provide protection to vegetable and fruit crops from herbicides where selectivity was otherwise non-existent or marginal (1,2,3,5,6,7). Ahrens (1) reported that for atrazine rates of 1.12 kg/ha and below in a sandy loam soil, a ratio of 200 parts carbon to one part atrazine provided appreciable protection for snap beans from atrazine; yield reductions were less than 15% when compared to checks receiving no atrazine. The author further reported that the ability of activated carbon to protect plants from herbicide injury varies with plant species and with herbicide (2). Burr et al. (4) showed that soil type influenced the ability of carbon to protect Italian ryegrass (Lolium multiflorum Lam.) against 3-(3,4-dichlorophenyl)-1,1-dimethylurea (diuron) with a sandy loam soil requiring three times more activated carbon than a clay loam to obtain the same protection.

Research reported herein was conducted to determine if activated carbon would protect snap beans from simulated residues of atrazine in Virginia to the extent reported elsewhere and to determine the protective effect on cucumbers from the same herbicide.

1/ Contribution from the Plant Physiology Department, Virginia Truck and Ornamentals Research Station. Paper No. 158, Journal Series. Approved for publication November 9, 1973.

2/ Plant Physiologist and Agricultural Research Assistants, respectively, Virginia Truck and Ornamentals Research Station, Painter, Virginia 23420.

Materials and Methods

Greenhouse Study - To determine the amounts of activated carbon[3/] needed to protect cucumbers from low rates of atrazine, research was conducted in the greenhouse. A Sassafras sandy loam soil with a pH of 5.8 and an organic matter content of 1.5% was selected for the study. The experimental design used was completely randomized with factorial treatment combinations. Rates of atrazine were 0, 0.1, 0.2, 0.3, 0.4, and 0.5 ppmw and activated carbon rates were 0, 33, 67, and 100 ppmw. There were four repetitions.

Atrazine and carbon were each suspended in 200 ml water to facilitate application to soil. Treatments were established by adding the desired amounts of atrazine to air dry soil in a cement mixer and mixing for 15 minutes. Aliquots of atrazine-treated soil were then returned to the cement mixer and activated carbon was added in amounts needed to establish the desired treatment combinations. Soil was again mixed for 15 minutes, removed and placed in 10 cm plastic pots and planted to cucumbers. Soil moisture was maintained by surface watering on a daily basis. After 10 days, cucumbers were thinned to five plants per pot. Cucumber vigor was rated 4 weeks after establishment of the test and cucumbers were harvested to permit fresh weight determinations.

Field Studies - Two field studies were conducted on cucumbers during 1972 and one on snap beans. Differences in the cucumber studies were related to rates of activated carbon and depth of carbon incorporation. In Field Test I carbon was applied at rates of 0, 37, 75, and 112 kg/ha and incorporated to a depth of 7.5 cm. Cucumbers were planted August 2. In Field Test II, carbon rates were 0, 56, 112, and 168 kg/ha and incorporation depth was 12.5 to 15.0 cm with cucumbers being planted on August 17. Atrazine rates were 0, 0.17, 0.34, and 0.50 kg/ha for both cucumber studies and the chemical was incorporated to a depth of 12.5 to 15.0 cm. In snap beans, carbon rates were 0, 37, 75, and 112 kg/ha and atrazine rates were 0, 0.17, 0.34, 0.50, and 0.67 kg/ha with depth of atrazine incorporation being 12.5 to 15.0 cm and depth of carbon incorporation being 7.5 cm. The snap beans were planted on August 3. Assuming uniform incorporation, it was calculated that these rates of atrazine and carbon would approximate on a ppmw basis those used in greenhouse studies when incorporated to a depth of 7.5 cm and would be half the rates when incorporated 12.5 to 15.0 cm. The experimental designs were randomized complete blocks with factorial treatment combinations replicated four times. Plots measured 1.8 m by 9.1 m and contained 1 row of cucumbers or 2 rows of snap beans.

The experimental procedure was to apply atrazine to freshly tilled soil and incorporate twice in opposite directions of travel to prevent excessive soil movement in one direction. Activated carbon was then applied and incorporated twice in opposite directions of travel. Atrazine and carbon were applied in water suspensions at a delivery rate of 500 l/ha. Incorporation was with a tractor-mounted rotary tiller. Cucumbers or snap beans were planted immediately. Two weeks after emergence crops were rated for treatment effects on stand and vigor and cultivated to minimize weed effects on yields. Cucumbers were harveste four times and snap beans once to permit determination of treatment effects on yields.

3/Gro-Safe, ICI America Inc., Wilmington, Delaware.

Results and Discussion

Greenhouse Study - Atrazine and activated carbon interacted in their effects on cucumber vigor and fresh weights (Tables 1 and 2) with all rates of carbon providing good protection against atrazine injury at low rates of the herbicide but only the high rates of carbon providing protection against the high rate of atrazine. These data indicated that similar rates of activated carbon should be satisfactory for protecting cucumbers from atrazine injury in the field.

The cause of the reduction in cucumber fresh weight due to carbon applied in the absence of atrazine is not known. With its high adsorptive capacity, it is possible that some nutrients became unavailable for cucumber growth.

Table 1. Relationship between activated carbon and atrazine on cucumber vigor in greenhouse study.[abc]

Activated Carbon (ppmw)	Cucumber Vigor: Atrazine (ppmw) 0.0	0.1	0.2	0.3	0.4	0.5
0	0 a	3.0 b	10.0 c	10.0 c	10.0 c	10.0 c
33	0 a	0.2 a	4.1 b	10.0 c	10.0 c	10.0 c
67	0 a	0.3 a	0.5 a	2.5 b	4.1 b	6.0 b
100	0 a	0.4 a	0.3 a	0.6 a	0.4 a	1.1 a

a/Scale: 0 to 10; 0 = no effect and 10 = complete kill.
b/Data are averages of 4 repetitions.
c/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

Table 2. Relationship between activated carbon and atrazine on fresh weights of cucumbers in greenhouse study.[ab]

Activated Carbon (ppmw)	Cucumber Fresh Weight (g): Atrazine (ppmw) 0.0	0.1	0.2	0.3	0.4	0.5
0	20.3 a	9.3 b	0.0 c	0.0 c	0.0 c	0.0 c
33	15.2 b	12.6 a	7.4 b	0.0 c	0.0 c	0.0 c
67	16.7 b	14.4 a	14.1 a	8.5 b	10.6 b	5.5 b
100	16.3 b	12.2 a	14.9 a	13.0 a	14.9 a	12.4 a

a/Data are averages of 4 repetitions.
b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

Field Studies - The extensive cucumber injury resulting from atrazine in Field Study I (Table 3) indicated that higher rates of carbon were needed to provide protection. It was also suspected that cucumber roots were growing below the 7.5 cm depth of carbon and that carbon incorporation should more closely approximate the depth of atrazine incorporation.

Table 3. Relationship between activated carbon and atrazine on cucumber stand in Field Study I.[abc]

Activated Carbon (kg/ha)	Cucumber Stand Atrazine (kg/ha) 0	0.17	0.34	0.50
0	0.4 a	6.1 b	9.5 b	10.0 c
37	0.0 a	2.1 a	8.1 b	9.6 bc
75	0.1 a	1.2 a	3.4 a	7.5 ab
112	0.4 a	1.1 a	3.2 a	5.6 a

a/Scale 0 to 10; 0 = no effect and 10 = complete stand reduction.

b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

c/Activated carbon was incorporated to a depth of 7.5 cm and atrazine to a depth of 12.5 to 15.0 cm.

The effects on cucumber vigor and yield from incorporating higher rates of carbon to a depth of 12.5 to 15.0 cm in Field Study II are presented in Tables 4 and 5. Carbon had no effect on cucumber growth in the absence of atrazine but all rates provided protection at the low rate of atrazine (0.17 kg/ha) according to vigor ratings although 56 kg/ha carbon did not prevent yield reductions at that atrazine rate. As the rate of atrazine increased, the effects of carbon were still evident but were not sufficient to provide complete protection.

Table 4. Relationship between activated carbon and atrazine on cucumber vigor in Field Study II.[abc]

Activated Carbon (kg/ha)	Cucumber Vigor Atrazine (kg/ha) 0	0.17	0.34	0.50
0	0.1 a	6.2 b	8.6 c	9.5 b
56	0.0 a	0.7 a	5.5 b	8.5 b
112	0.5 a	0.5 a	5.0 b	5.8 a
168	0.4 a	0.0 a	0.8 a	5.3 a

a/Scale 0 to 10; 0 = no effect and 10 = complete vigor reduction.

b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

c/Activated carbon and atrazine were incorporated to a depth of 12.5 to 15.0 cm.

Table 5. Relationship between carbon and atrazine on cucumber yields in Field Study II.[ab]

Activated Carbon (kg/ha)	Cucumber Yields Atrazine (kg/ha) 0	0.17	0.34	0.50
	(1000 kg/ha)			
0	8.37 a	0.69 c	0.00 c	0.00 a
56	9.68 a	5.00 b	1.58 b	0.12 a
112	6.71 a	8.41 a	4.55 a	0.73 a
168	8.37 a	6.71 ab	5.00 a	2.48 a

a/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

b/Activated carbon and atrazine were incorporated to a depth of 12.5 to 15.0 cm.

Snap beans had more tolerance to atrazine than did cucumbers (Tables 6 and 7). Neither vigor nor yields of snap beans were reduced by atrazine at the rate of 0.17 kg/ha. Applications of 112 kg/ha of activated carbon in the presence of 0.50 kg/ha atrazine prevented extensive reductions in snap bean vigor and permitted snap beans to produce yields which approximated half the yield produced in the absence of atrazine.

Table 6. Relationship between carbon and atrazine on snap bean vigor.[abc]

Activated Carbon (kg/ha)	Snap Bean Vigor Atrazine (kg/ha) 0	0.17	0.34	0.50	0.67
0	0.0 a	1.0 a	5.6 b	8.8 c	9.6 c
37	0.0 a	0.4 a	2.4 a	6.1 b	7.9 bc
75	0.1 a	0.4 a	1.6 a	5.1 b	6.9 ab
112	0.0 a	0.2 a	0.8 a	3.0 a	5.9 a

a/Scale 0 to 10; 0 = no effect and 10 = complete vigor reduction.

b/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

c/Activated carbon was incorporated to a depth of 7.5 cm and atrazine to a depth of 12.5 to 15.0 cm.

Table 7. Relationship between carbon and atrazine on snap bean yields.[ab]

Activated Carbon (kg/ha)	Snap Bean Yields Atrazine (kg/ha) 0	0.17	0.34	0.50	0.67
	(1000 kg/ha)				
0	8.46 a	6.26 a	1.02 c	0.04 b	0.04 a
37	9.15 a	7.76 a	3.62 b	1.14 b	0.36 a
75	9.43 a	7.72 a	5.85 a	1.30 b	0.53 a
112	9.27 a	8.29 a	6.59 a	3.66 a	0.85 a

a/Means within columns followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

b/Activated carbon was incorporated to a depth of 7.5 cm and atrazine to a depth of 12.5 to 15.0 cm.

With reference to the ratio of activated carbon to atrazine needed to provide protection, these results are in partial agreement with Ahrens (1,2) in that the amount of carbon needed depends on plant species. To be more specific, the amount of carbon needed for protection depends on the tolerance of the species to the herbicide, in this instance, atrazine. These data suggest that with snap beans, a ratio of activated carbon to atrazine of 300 to 1 would provide adequate protection at atrazine rates of 0.34 kg/ha or less but that the ratio would likely increase at higher atrazine rates. However, the results with cucumbers, which required a carbon to atrazine ratio of approximately 600 to 1 for as little as 0.17 kg/ha, would suggest that the ratio might be reduced further for snap beans if depth of carbon incorporation were sufficient to prevent snap bean roots from penetrating below the zone of carbon protection.

The relative availability of atrazine for plant uptake in these studies as compared with residual atrazine is not known and would vary with the number and type of binding sites in the soil. However, it is suspected that the amount of atrazine activity remaining from a spring application following sweet corn harvest would generally approximate the lower rates of atrazine in these studies and that activated carbon would permit satisfactory growth of these two vegetables.

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ACTIVATED CARBON AS A METHOD OF REDUCING METRIBUZIN PHYTOTOXICITY TO SEEDED TOMATOES

R. C. Henne and R. T. Guest [1/]

ABSTRACT

Activated carbon was used to reduce the phytotoxicity of metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one) to direct-seeded tomatoes (*Lycopersicum esculentum*) in 3 greenhouse experiments and in 1 field trial. Metribuzin when applied preplanting and incorporated into the soil was not adequately adsorbed by activated carbon treatments and tomato seedlings were adversely affected, but preemergence applications were successfully detoxified and tomato seedlings survived. Initial greenhouse trials utilized 56 kg/ha of activated carbon applied in 2 cm bands over or in the seed row, but a subsequent trial suggested protection from metribuzin applied preemergence at 0.56 kg/ha could be achieved with 1/10th or 5.6 kg/ha of activated carbon. Activated carbon was effective when applied as a dry mixture with vermiculite or when applied alone as a surface spray, but less effective if applied directly with the seed. Greenhouse results were confirmed under field conditions.

INTRODUCTION

Metribuzin is an experimental herbicide with potential for use in tomatoes. Transplanted tomatoes have shown considerable tolerance to metribuzin but field results with seeded tomatoes have indicated varying degrees of crop phytotoxicity (2,4,6,7). Activated carbon has been used by several workers to reduce herbicide phytotoxicity on marginally tolerant crops (1,3,5). This paper reports greenhouse and field results using activated carbon as a tool to protect tomato seedlings from injury by metribuzin.

MATERIALS AND METHODS

Greenhouse trials - Experiment I: Sandy loam soil (fumigated with methyl bromide 2 months prior to use) with an organic matter content of approximately 1% was treated with metribuzin at 0.56 kg/ha, thoroughly hand mixed to simulate preplant incorporation, and placed into greenhouse flats 35.6 cm x 50.8 cm x 7 cm deep. A preemergence surface application at the same rate also was used. A deVilbus atomizer using compressed CO_2 as a propellent at 703 grams/cm^2 applied solutions at a rate of 467.5 l/ha. Untreated controls were included in a 3-replicate factorial trial.

The flats filled with soil were marked with 7 furrows, 0.9 cm deep, 6 cm apart. Campbell 28 tomatoes were planted at a rate of 50 seeds per row. Each row was randomly lettered from A to G according to the respective treatment: rows A and B = controls covered with soil (treated soil in the case of preplant

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[1/] Research Associate and Research Scientist, respectively, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

treatments); row C with vermiculite @ 54 cc/row; D and E seed covered with a dry mixture of vermiculite plus activated carbon (Norit 'A') @ 56 kg/ha in a 2 cm band over the row; rows F and G, the seed was directly covered with activated carbon (same rate as D and E) and the remaining portion of the furrow to the soil surface filled with soil (treated in the case of the pre-plant treatment).

Flats were surface watered, initially with a captan (N-trichloromethylthio-4-cyclohexene-1,2-dicarboximide) drench (1.2 kg/ha a.i.) and at 10-day intervals to prevent damping-off of tomato seedlings. Greenhouse temperatures ranged between 20-25° C, with natural lighting. Twenty-eight days after seeding the final number of surviving plants was determined along with total fresh plant weight (leaves and roots).

Experiment II: In the second trial a steam sterilized sandy loam soil was used and C-28 tomatoes were seeded as in trial I. Rows A and B were controls and received no carbon, C and D were covered with activated carbon + vermiculite, and in row G the activated carbon was applied dry directly over the seed. In rows E and F the furrow was closed and a water suspension of activated carbon (@ 56 kg/ha) was applied in a 2 cm band over these rows. Preemergence applications of metribuzin were made at 0, 0.56, and 1.12 kg/ha. Treatments were replicated 4 times and plants grown for 28 days.

Experiment III: The third experiment was similar to number II with the exception that activated carbon was used at a rate of 5.6 kg/ha, metribuzin was applied at 0 and 0.56 kg/ha and plants were grown for 24 days.

Field Trial: Land was prepared and C-28 tomatoes were seeded at Clayton, Delaware, on May 2, 1973. Activated carbon ("Gro-Safe", ICI America Inc.) was applied at 2.8 and 5.6 kg/ha in a 2.5 cm band either by mixing dry with vermiculite (1.0 m^3/ha) and distributed by hand in the seed furrow, or as a surface spray over the closed seed row (in 374 l/ha). The narrow spray band was achieved in the latter case by aligning a T-Jet 8002 fan nozzle with the seed row. Metribuzin was applied preemergence May 4 at 0, 0.56 and 1.12 kg/ha to a 4-replicate randomized block trial with single row plots 1.5 m x 6.1 m in size. Precipitation totaled 1.52 cm within the next 4 days. Stand counts were made on 3 occasions; on 5/21 before phytotoxicity was detectable, on 5/29 after a considerable number of plants died, and on 6/6 when seedlings had 2-3 true leaves and no more plants were observed dying. Weed control was rated and controls were hand weeded as required to prevent competition (with the exception of 1 unweeded control treatment). Yields were determined for a single destructive harvest on 9/13, when 63% of the fruit in control plots were ripe.

RESULTS AND DISCUSSION.

Greenhouse Trials. In the first greenhouse trial stands were thinned due to damping-off of tomato seedlings, particularly in rows receiving the activated carbon + vermiculite treatment. It is thought that the carbon may have tied up the captan that was applied and decreased control of this disease. Metribuzin treatments did not interfere with tomato seed germination or with seedling emergence. Seedlings produced two cotyledon leaves which became pale green and chlorotic in color. Fourteen to fifteen days

after seeding the cotyledon leaves appeared water-soaked and rapidly wilted with stems remaining erect.

Experiment I. Metribuzin when applied preplanting completely killed all seedlings in rows not receiving activated carbon (Table 1). A few plants survived where activated carbon was used but protection was not adequate since root growth was restricted, as is reflected in the reduction in fresh weight per plant (Table 2). Preemergence treatments also killed virtually all seedlings not protected by activated carbon. When protected with activated carbon + vermiculite, the number of tomato seedlings surviving the preemergence metribuzin treatment was similar to the number in untreated control flats. Fresh weight of plants also was comparable indicating complete protection from metribuzin. Activated carbon applied alone directly over the seed did not provide adequate protection as only about 12% of the seedlings survived and these had significantly reduced fresh weight indicating phytotoxicity.

Experiment II. Only a few seedlings survived metribuzin at 0.56 kg/ha and only 1/row on an average survived the 1.12 kg rate when no carbon was used. Activated carbon with vermiculite or as a surface spray gave good seedling protection at both rates as measured by survival and fresh plant weight, although growth at the 1.12 kg rate tended to be reduced compared to the control (Tables 1 and 2). Activated carbon with the seed was fairly effective at the 0.56 kg rate but a significant number of seedlings were killed at the 1.12 kg/ha level.

Experiment III. No tomato seedlings survived 0.56 kg/ha of metribuzin when no carbon was used, while 5.6 kg/ha activated carbon with vermiculite or as a surface spray protected tomato seedlings from injury. As in experiments I and II, application with the seed was only partially effective.

Field Experiment. Untreated and activated carbon control plots contained an average of 6.5 tomato seedlings per 30.5 cm of row while only 25% of this number survived metribuzin at 0.56 kg/ha and less than 8% of this number survived the 1.12 kg/ha rate (Table 3). Stands were not statistically different from controls when metribuzin was applied at 0.56 kg/ha and activated carbon had been applied at 5.6 kg/ha as a surface spray or as a combination treatment with vermiculite, or when the 2.8 kg/ha rate had been applied as a surface spray. The low rate of carbon, with vermiculite, was least effective. Although none of the activated carbon treatments provided complete protection against phytotoxic effects of metribuzin at 1.12 kg/ha, a 2x-5x increase in stand number was achieved over no carbon protection.

While not significant there was a trend for the 5.6 kg rate to provide better protection in terms of seedling survival than the low rate and for the surface spray application to be more effective than the vermiculite combination.

Phytotoxicity ratings of crop growth in early August indicated metribuzin injury still existed but that surviving plants, while lacking uniformity of growth compared to controls, were compensating for the thin stands. Yield data, from a single harvest when control plots had an

average of 63% ripe fruit, revealed that weeded control plots, with or without carbon, averaged 29.3 metric tons/ha. Metribuzin at 0.56 kg/ha produced an average of 22.4 metric tons/ha, statistically similar to the controls. This was achieved in spite of a 75% stand reduction which suggests surviving plants set more fruit per plant and these fruit were significantly larger than controls by over 40%. All activated carbon treatments with metribuzin at the 0.56 kg/ha rate produced yields comparable to the weeded controls and all were greater than when no carbon was applied.

Metribuzin at 1.12 kg/ha significantly reduced tomato yields. Activated carbon as a surface spray averaged 21.9 and 28.9 metric tons/ha for the 2.8 and 5.6 kg/ha rates respectively. Activated carbon with vermiculite was only partially effective in improving yields over metribuzin alone at 1.12 kg/ha.

It is evident that tomato seedlings are sensitive to metribuzin injury and at a rate of 0.56 kg/ha 75% of the plants can be killed. Stand losses in 1973 were also noted with metribuzin at rates of 0.28 and 0.14 kg/ha (reported elsewhere in these proceedings). Reduced phytotoxicity through effective adsorption of metribuzin in the seed row through the use of activated carbon has been demonstrated.

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Table 1. Influence of activated carbon treatments on tomato seedling survival in soil treated with metribuzin in 3 greenhouse experiments.

	Metribuzin		Number of tomato seedlings/35 cm row (mean of 4 replicates)				
	Treatment	Rate kg/ha ai	No carbon	Activated carbon + vermiculite	Activated carbon with seed	Vermiculite	A. carbon as surface spray
Experiment I (56 kg/ha A.C.)	Control	0	30.7[ab][a]	18.8[c]	37.5[a]	34.2[ab]	-
	Preplant	0.56	0 [e]	6.5[d]	2.6[de]	0 [e]	-
	Preemergence	0.56	0.25[e]	16.0[c]	4.9[d]	0.75[e]	-
Experiment II (56 kg/ha A.C.)	Control	0	44.4[a]	47.9[a]	46.2[a]	-	46.1[a]
	Preemergence	0.56	6.5[c]	46.3[a]	38.8[a]	-	46.2[a]
	Preemergence	1.12	1.1[d]	46.1[a]	26.0[b]	-	47.2[a]
Experiment III (5.6 kg/ha A.C.)	Control	0	45.2[a]	45.0[a]	41.3[ab]	-	42.6[ab]
	Preemergence	0.56	0 [d]	40.0[ab]	7.7[c]	-	38.1[b]

[a] Means within each experiment followed by a common letter are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 2. Influence of activated carbon treatments on tomato seedling fresh weight in soil treated with metribuzin in 3 greenhouse experiments.

	Metribuzin		Mean fresh weight - grams/plant				
	Treatment	Rate kg/ha ai	No carbon	Activated carbon + vermiculite	Activated carbon with seed	Vermiculite	A. carbon as surface spray
Experiment I (56 kg/ha A.C.)	Control	0	0.11^{abc} [a]	0.13^{ab}	0.13^{ab}	0.10^{bc}	-
	Preplant	0.56	0.0^{e}	0.09^{bc}	0.04^{d}	0.0^{e}	-
	Preemergence	0.56	0.02^{e}	0.14^{a}	0.08^{c}	0.01^{de}	-
Experiment II (56 kg/ha A.C.)	Control	0	0.58^{c}	0.95^{a}	0.83^{ab}	-	0.59^{c}
	Preemergence	0.56	0.19^{d}	0.88^{ab}	0.59^{c}	-	0.53^{c}
	Preemergence	1.12	0.05^{e}	0.71^{bc}	0.55^{c}	-	0.50^{c}
Experiment III (5.6 kg/ha A.C.)	Control	0	0.33^{abc}	0.27^{c}	0.39^{a}	-	0.37^{ab}
	Preemergence	0.56	0.0^{d}	0.30^{bc}	0.31^{abc}	-	0.32^{abc}

[a] Means within each experiment followed by a common letter are not significantly different at the 5% level (Duncan's Multiple Range Test).

Table 3. Tomato seedling survival and yield of ripe fruit as influenced by metribuzin and activated carbon treatments.

Treatment		Activated carbon kg/ha		No. tomato seedlings per 30.5 cm of row			Crop Phytotoxicity Rating 1-5[b]	Yield metric T/ha	Fruit size
Herbicide	Rate kg/ha ai	with vermiculite	as a surface spray	5/21	5/29	6/6	8/6	9/13	(grams)
Control (weeded)	0	-	-	5.0	6.5	6.3[a]	4.6[a]	28.2[ab]	95.8[de]
Control (unweeded)	0	-	-	6.2	6.5	6.9[a]	4.2[a]	10.7[d]	91.3[de]
Control (weeded)	0	2.8 - 5.6	-	5.9	6.6	6.5[a]	4.9[a]	28.7[ab]	95.8[de]
Control (weeded)	0	-	2.8 - 5.6	6.1	7.3	6.7[a]	4.7[a]	30.9[a]	100.4[cde]
Metribuzin	0.56	-	-	3.1	1.6	1.6[cd]	3.24[bc]	22.4[abc]	127.8[ab]
Metribuzin	0.56	2.8	-	4.9	4.0	4.2[b]	4.5[a]	30.7[a]	123.2[abc]
Metribuzin	0.56	5.6	-	5.7	5.1	5.1[ab]	4.7[a]	27.8[ab]	114.1[bcd]
Metribuzin	0.56	-	2.8	5.2	5.0	5.2[ab]	4.9[a]	31.6[a]	104.9[cde]
Metribuzin	0.56	-	5.6	5.8	6.2	6.1[a]	4.8[a]	28.7[ab]	86.7[e]
Metribuzin	1.12	-	-	2.9	0.6	0.48[d]	1.31[d]	10.5[d]	136.9[ab]
Metribuzin	1.12	2.8	-	3.5	0.9	0.8[cd]	2.5[c]	13.9[cd]	141.4[a]
Metribuzin	1.12	5.6	-	3.6	1.4	1.2[cd]	2.9[c]	19.7[bcd]	114.1[bcd]
Metribuzin	1.12	-	2.8	3.3	1.0	0.9[cd]	3.4[bc]	21.9[abc]	132.3[ab]
Metribuzin	1.12	-	5.6	4.3	3.1	2.8[c]	4.3[a]	28.9[ab]	132.3[ab]

[a] Means in columns followed by a common letter are not significantly different at 5% level (Duncan's Multiple Range Test).

[b] Phytotoxicity rating: 5 = no visible injury; 1 = complete kill.

VARIETAL SUSCEPTIBILITY OF TRANSPLANTED TOMATOES TO METRIBUZIN

Richard A. Ashley[1/]

Abstract

Eleven tomato varieties were evaluated to determine their response to metribuzin. Significant foliage injury was observed on Rex Chico, Springset and Super Beefsteak varieties of tomato following application of metribuzin at 1 lb ai/A. This early foliage injury was accompanied by reduced number and weight of fruit in early yield with Rex Chico and Springset. No significant reduction in number or weight of total yield was observed with any of the 11 varieties tested.

Introduction

An experiment was conducted in 1973 at the University of Connecticut Agronomy Research Farm in Storrs, Connecticut to determine the response of 11 tomato varieties to metribuzin (4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4H)one).

Materials and Methods

Eleven varieties of tomatoes (*Lycopersicon esculentum* Mill.) were seeded in the greenhouse April 17, transplanted in peat-vermiculite mix in 2¼-inch peat pots April 27, and field set June 7, 1973. Each variety was planted in two-row plots with rows 4 feet apart and 10 feet long. Varieties were arranged in a randomized block design and were replicated three times. Soil type was a Woodbridge fine sandy loam with a pH of 6.2 and an organic matter content of 3%.

After transplanting, one row in each plot was treated with metribuzin at 1 lb ai/A on June 22, 1973. The other row, intended as the control, was treated with diphenamid (N,N-dimethyl-2,2-diphenylacetamide) at 4 lb ai/A on the same date. Both herbicides were applied preemergence to weeds. Plots were hand weeded as necessary to reduce the effect of weed competition on yields. Last rainfall before herbicide application occurred on June 21, 1973 when 0.02 inches fell. After herbicide application, 0.37 inches of rain was recorded on June 23, 1973.

Crop injury ratings were taken June 29, 1973 using a 0 to 10 scale with 0 representing no effect and 10 representing complete kill.

Yield data were taken August 7, 14 and 23 and September 5 and 25, 1973. Both number and weight of fruit were recorded. The August 7 and 14 harvests are reported as early yield while all five harvests are reported in total yields.

1/ University of Connecticut, Storrs, Connecticut

Results and Discussion

Significant foliage injury was recorded in the June 29, 1973 rating on three varieties--Rex Chico, Springset and Super Beefsteak (Table 1). Injury ratings of 3 were obtained for Rex Chico and Super Beefsteak and a rating of 4 for Springset when these varieties were treated with metribuzin at 1 lb ai/A. No injury was obtained when these varieties were treated with diphenamid at 4 lb ai/A. No significant injury was recorded on the other varieties tested with either herbicide treatment.

Table 1. Effect of metribuzin on crop injury to eleven tomato varieties.

Herbicide	Variety										
	Campbell 28	Heinz 1350	Monte Carlo	Patio	Rex Chico	Roma VP	Set More	Springset	Stakeless	Super Beefsteak	Supersonic B
Metribuzin 1 lb ai/A	1	2	0	1	3	2	1	4	1	3	2
Diphenamid 4 lb ai/A	0	0	0	0	0	0	0	0	0	0	0

LSD 5% = 2

Early foliage injury resulting from the use of metribuzin caused significant reductions in the number (Table 2) and weight (Table 3) of fruit obtained in early yields from Rex Chico and Springset varieties. No fruit was harvested during this period from the Super Beefsteak variety. None of the other eight varieties showed any change in early yield as a result of treatment with metribuzin or diphenamid.

Table 2. Effect of metribuzin on number of fruit obtained in early yields from eleven tomato varieties.

Herbicide	Variety										
	Campbell 28	Heinz 1350	Monte Carlo	Patio	Rex Chico	Roma VF	Set More	Springset	Stakeless	Super Beefsteak	Supersonic B
Metribuzin 1 lb ai/A	26	17	13	33	27	4	15	33	10	0	4
Diphenamid 4 lb ai/A	32	24	7	26	92	4	24	52	9	0	3

LSD 5% = 8

Table 3. Effect of metribuzin on weight in pounds of fruit obtained in early yields from eleven tomato varieties.

Herbicide	Variety										
	Campbell 28	Heinz 1350	Monte Carlo	Patio	Rex Chico	Roma VF	Set More	Springset	Stakeless	Super Beefsteak	Supersonic B
Metribuzin 1 lb ai/A	6.7	4.0	3.9	6.2	3.6	0.6	4.0	7.0	3.2	0	1.0
Diphenamid 4 lb ai/A	6.8	5.7	2.2	4.6	10.2	0.7	6.1	9.6	2.4	0	0.7

LSD 5% = 2.5

No significant change in total number (Table 4) or weight (Table 5) of fruit harvested was observed with any of the 11 tomato varieties treated with metribuzin at 1 lb ai/A as compared to diphenamid at 4 lb ai/A.

Table 4. Effect of metribuzin on number of fruit obtained in total yield from eleven tomato varieties.

Herbicide	Variety										
	Campbell 28	Heinz 1350	Monte Carlo	Patio	Rex Chico	Roma VF	Set More	Springset	Stakeless	Super Beefsteak	Supersonic B
Metribuzin 1 lb ai/A	195	231	140	127	371	395	173	262	85	66	149
Diphenamid 4 lb ai/A	210	238	144	153	376	439	199	307	88	73	157

LSD 5% = NS

Table 5. Effect of metribuzin on weight in pounds of fruit obtained in total yield from eleven tomato varieties.

Herbicide	Variety										
	Campbell 28	Heinz 1350	Monte Carlo	Patio	Rex Chico	Roma VF	Set More	Springset	Stakeless	Super Beefsteak	Supersonic B
Metribuzin 1 lb ai/A	52.0	59.7	49.2	22.9	41.8	46.4	44.9	59.8	27.9	50.1	58.2
Diphenamid 4 lb ai/A	51.6	56.5	54.1	24.1	34.5	54.0	50.2	64.5	28.7	56.9	60.4

LSD 5% = NS

TOLERANCE OF TOMATO PLANTS TO POSTPLANTING METRIBUZIN

R. C. Henne and R. T. Guest [1]

ABSTRACT

Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one) was applied to transplanted tomatoes (Lycopersicon esculentum) under greenhouse and field conditions. Under greenhouse conditions severe phytotoxicity was observed with 0.56 kg/ha until transplants developed buds for the first flower cluster. Once bud initials were visible tolerance to the 0.58 kg/ha rate was attained. Under field conditions and using commercially grown transplants metribuzin applied during a period of 12-35 days postplanting did not result in significant crop phytotoxicity.

INTRODUCTION

Tomato transplants have shown considerable tolerance to the (experimental) herbicide metribuzin. Selective weed control through postplanting treatment would be of considerable benefit to tomato growers by providing control of troublesome species such as ragweed (Ambrosia artemisiifolia), mustard (Brassica sp.), velvetleaf (Abutilon theophrasti), ladysthumb (Polygonum persicaria) and galinsoga (Galinsoga parviflora) which are not well controlled by trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) or pebulate (S-propyl butylethylthiocarbamate). However adverse plant reaction following metribuzin applied to transplanted tomatoes has been observed. The authors in 1971 noted severe phytotoxicity when metribuzin was applied at 0.84 kg/ha to tomato plants that had been set for 12 days. Other trials in Ohio in 1970, 1971 and 1972 and in Delaware in 1972 indicated the crop would tolerate 0.56 and 1.12 kg/ha. In each of these trials tomato plants had been transplanted 1 month or more prior to treatment. Squire (unpublished data) in Ontario also observed stunting and foliage burning when metribuzin at 0.28 and 0.56 kg/ha was applied 3 weeks after transplanting but observed no phytotoxic symptoms when applications were delayed for 6 weeks.

While climatic condition may influence crop injury, age of transplants may also be a vital factor in establishing crop tolerance to this herbicide. This paper reports tomato crop response to postplanting metribuzin treatments at various stages of crop development under greenhouse and field conditions.

MATERIALS AND METHODS

Greenhouse trials: Experiment 1. Campbell 28 tomato seedlings that had been seeded in greenhouse flats 10 weeks earlier were pulled January 22, 1973 and replanted 3 plants to a 15.2 cm plastic pot. Transplants were 10-12 cm tall and in the 4th-leaf stage of development. Three replications were provided with 1 pot per treatment. Applications of metribuzin at 0.56 kg/ha were made in a volume of 470 l/ha, using a deVilbus atomizer with 0.7 kg/cm^2 of CO_2 for the propellant. Treatments were applied at 7 day intervals for 4 weeks, the

[1] Research Associate and Research Scientist, respectively, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

original intent of this trial. In order to extend treatments past 4 weeks pots originally designated as controls were used for the 5th and 6th weeks. These latter 2 treatments were therefore not replicated.

Experiment 2. A second greenhouse experiment was initiated using seedlings that were 30 days old, i.e. 2-leaf stage, as transplants. The first application of metribuzin was delayed until 11 days after setting so that plants were in a similar stage of growth as at the start of Experiment 1 (see Table 1). The second application was made after 20 days, comparable to the 3rd or 21-day stage in the first test. Plants 28 days after transplanting had developed flower bud initials and were comparable to those 35 days after planting in Experiment 1. While plants in Experiment 2 were initially smaller than in Experiment 1, they grew faster with the aid of fertilizer and longer daylight hours.

Field Trial: Land was prepared for the field trial of May 5, 1973 by applying trifluralin preplant incorporated at 1.12 kg/ha to eliminate any grassy weeds which may have become a problem in the test area. Commercially grown C-28 transplants grown in Georgia were 15-20 cm tall, bare-rooted, many with flower buds already formed. Plants were set on May 17 using a 33.5 cm plant spacing with single rows 1.7 m apart and 6.1 m long in a 4-replicate randomized block trial. Frequent rains delayed the metribuzin treatment scheduled for 7 days postplanting until May 29 (12 days after planting). At this time most plants had new leaf growth, with older leaves dying off, and flower buds in the first cluster were visible on the majority of plants. Growth was rather slow and plants did not appear to be well established until June 4 (18 days after planting).

Metribuzin was applied at 0.28 and 0.56 kg/ha using a bicycle plot sprayer delivering 357 l/ha using compressed air at 2.1 kg/cm^2 as a propellant. Twenty-eight days after transplanting rates were increased to 0.56 and 1.12 kg/ha. Broadleaf weeds (mustard and ragweed) were allowed to grow until completion of all treatments and on July 2 all plots were cultivated and kept weeded (control plots) until harvest. Yields were taken at a single harvest August 27 when 60% of the fruit were ripe.

RESULTS

Greenhouse trials. Crop response to metribuzin treatments are summarized in Table 1. In both trials phytotoxicity was extremely severe until tomato plants had developed flower bud initials for the first flower cluster. Once these initials were visible phytotoxicity was reduced to insignificant spotting on older lower leaves. Just prior to the flower bud formation there was a definite delay in phytotoxic symptom expression, indicating gradual tolerance developing as the plants grew older. Once flower buds were formed or open, plants were capable of tolerating 0.56 kg/ha of metribuzin without affecting subsequent fruit set and development.

Field trial: The commercial transplants that were obtained were considered physically sturdier than those in greenhouse trials. They were also physiologically further developed in that the first cluster of flower buds were formed and some flowers were open. Because no visible phytotoxicity was detected from 0.28 or 0.56 kg/ha of metribuzin after the first 3 applications,

rates were doubled for the final two treatments. Even at 1.12 kg/ha no significant foliage injury was detected, flowering was not affected nor fruit set or development. Slight stunting of growth was detected associated with the 35-day interval, Table 2. The lowest yield was also obtained by the high rate at the last application date. This may reflect some delayed crop growth associated with this treatment which was made on a hot humid day (Temp. 40° C - R.H. 75%) while previous applications were made under cooler weather conditions. Another factor to be considered is that broadleaf weeds not controlled by trifluralin (i.e. ragweed, wild mustard) were competing with the crop until metribuzin was applied (or in the "control" until cultivation on July 2). Therefore the slight downward trend in yield evident from the 6/6 date and on probably reflects some of the early weed competition.

DISCUSSION

Our observations were limited to responses obtained with the Campbell 28 variety and to metribuzin applied at 0.56 kg/ha. On the one occasion in 1971 when we observed severe phytotoxicity from postplanting metribuzin the rate used was 0.84 kg/ha. Apparently recently set transplants will not tolerate a 0.84 kg/ha rate of metribuzin. At the Vegetable Research Farm, University of Maryland, Beste in 1973 observed severe phytotoxicity to transplanted C-28 tomatoes treated with 0.84 kg/ha of metribuzin 10 days after planting, but no significant injury occurred at 0.28 or 0.56 kg/ha. The 0.84 kg rate 4 weeks after transplanting was tolerated by the crop. This supports our experience that tomato plants increase their tolerance to metribuzin with increasing age.

In commercial practice land preparation prior to planting generally leaves the field free of weed growth. Newly germinated weeds which emerge after transplanting would require approximately 10-14 days to reach 2-5 cm in height. This would permit transplants time to become established and tolerate metribuzin at rates of 0.28-0.56 kg/ha which is adequate to control seedlings of many broadleaf weed species.

Table 1. Influence of stage of tomato plant development on tolerance to metribuzi foliar sprays (at 0.56 kg/ha) under greenhouse conditions.

Days after transplanting		Stage of crop growth	Phytotoxicity rating 1-5 (1 killed, 5 no injury)	
Exp. 1	Exp. 2		Exp. 1	Exp. 2
7	11	3-4 leaf stage. 10.2-12.7 cm tall.	1	1
14	-	15 cm tall. 5-6 leaf stage.	1	-
21	20	17.8 cm tall, 25.4-30.5 cm wide spread; new axillary leaf initials present.	1	2
28	-	20.3-22.9 cm tall, 7-8 leaf stage.	2	-
35	28	25.4-22.9 cm tall, 8 leaf stage; flower buds for first cluster visible.	4.5	4.5
42	35	flower buds open.	5	5

Table 2. Response of tomatoes to postplanting metribuzin treatments under field conditions.

Date	Days after transplanting	Metribuzin rate kg/ha ai	Crop phytotoxicity rating 1-5	Yield metric tons/ha: Means for individual treat.	Yield metric tons/ha: Means for dates
Control	0	0	4.9^{ab} [a]	19.7^{bc}	19.7^{bc}
5/29	12	0.28	5.0^{a}	25.3^{ab}	24.9^{ab}
		0.56	5.0^{a}	24.4^{ab}	
6/1	15	0.28	4.9^{ab}	28.7^{a}	26.4^{a}
		0.56	5.0^{a}	24.2^{ab}	
6/6	20	0.28	5.0^{a}	23.1^{ab}	21.3^{bc}
		0.56	4.9^{ab}	19.7^{bc}	
6/14	28	0.56	5.0^{a}	22.4^{ab}	20.4^{bc}
		1.12	4.9^{ab}	18.6^{bc}	
6/21	35	0.56	4.6^{ab}	19.7^{bc}	17.2^{c}
		1.12	4.1^{b}	15.0^{c}	

[a]Means followed by a common letter are not significantly different at the 5% level (DMR).

WEED CONTROL IN DIRECT-SEEDED AND TRANSPLANTED TOMATOES

R. C. Henne and R. T. Guest [1/]

ABSTRACT

Four experiments were conducted to determine efficacy and crop response of experimental herbicides and combinations with registered herbicides for use on direct-seeded or transplanted tomatoes (*Lycopersicon esculentum*). Metribuzin (4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazin-5(4H)one) and U-27,267 (3,4,5-tribromo-N,N,*a*-trimethylpyrazole-1-acetamide) were considered promising new compounds for both methods of crop culture. Napropamide (R 7465) (2-(*a*-naphthoxy)-*N*,*N*-diethylpropionamide) and S 6044 (chemistry not available) have potential for use on transplanted tomatoes.

INTRODUCTION

In 1973 the authors (2) reported that the experimental herbicides metribuzin, U-27,267 and napropamide appeared to be promising for use in direct-seeded and transplanted tomatoes. This paper presents additional data on experimental herbicidal compounds evaluated alone and in combination with proprietary herbicides for weed control in direct-seeded and transplanted tomatoes.

MATERIALS AND METHODS

The four experiments reported here are similar to those conducted in 1972 (2). Herbicides included in 1973 trials are listed in Table 1 together with chemical designations and formulations.

Direct-seeded Experiments: Preplant treatments were applied on April 30 and May 1, and incorporated immediately 9-10 cm deep with a rotary cultivator. Soil temperature was 15° C at a depth of 7 cm and moisture was abundant. Campbell 28 variety tomatoes were seeded May 1 with a Planet Jr. seeder and preemergence treatments applied May 4 to a damp soil surface. Precipitation totaled 1.52 cm during the next 4 days. Postemergence treatments were applied June 14 when tomato seedlings were 7-10 cm tall (4-leaf stage). All plots were cultivated once on July 2 and a single harvest was made on Sept. 12 for Experiment I (62% of fruit were ripe) and Sept. 17 for Experiment II (70% ripe fruit).

Transplanted Experiments: Preplant treatments were applied and immediately incorporated May 10. Soil temperature was 24° C at the 7 cm depth and soil moisture was good. Campbell 28 tomatoes were transplanted May 16. Post-transplanting treatments were applied June 14 when plants were well established. Tomatoes were cultivated and side-dressed once on July 2 and a single harvest was made to Experiment III and IV on August 21 with 61% ripe fruit.

1/ Research Associate and Research Scientist, respectively, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

All treatments were applied with a bicycle sprayer at 355 l/ha and 2.1 kg/cm^2 using compressed air as a propellent. Ragweed (Ambrosia artemisiifolia), lambsquarters (Chenopodium album), velvetleaf (Abutilon theophrasti), crabgrass (Digitaria sp.) and barnyard grass (Echinochloa crus-galli) were the major weed species represented. Grass and broadleaf weed control ratings were made on a 1-9 scale where 1 represented no control and 9 complete kill. Crop phytotoxicity was rated on a 1-5 scale where 5 represented no visible injury and 1 complete kill.

RESULTS

Direct-seeded Trials - Experiment I: Diphenamid applied preplanting provided satisfactory control of the broadleaf and grass weeds present in this trial and produced yields similar to the weeded control (Table 2). A-820, S 6044, MBR 8251, BAS 72461-H, and CGA 10832 were extremely phytotoxic to seeded tomatoes and of these only S 6044 and MBR 8251 provided satisfactory broad-spectrum weed control. Tomatoes demonstrated a tolerance to IMC 3950 while BAS 78897X and isopropalin were moderately phytotoxic. Of these, BAS 68897 gave poor weed control while the other two materials only controlled grasses. Isopropalin combined with metribuzin reduced stands by 50% but gave excellent weed control and produced a yield statistically comparable to the weeded control.

Experiment II: Preplanting diphenamid was somewhat less effective against broadleaf weeds in this experiment but control was considered satisfactory. The addition of trifluralin as a postemergence treatment did not enhance control obtained by diphenamid alone (Table 3).

Grass control was poor when metribuzin was applied alone but all combination treatments were very effective against grasses and broadleaf weeds. Phytotoxicity in terms of significant stand reductions occurred with all treatments or combinations involving metribuzin applied preplanting or preemergence. However, surviving plants continued to develop without a reduction in growth rate or vigor and in all cases final tomato yields were comparable to the weeded control. Tomato seedlings in the 4-leaf stage of growth tolerated overall postemergence treatments of metribuzin without significant crop injury and control of broadleaf weeds was good.

U-27,267 alone or in combination with diphenamid, napropamide, or metribuzin gave very good weed control and produced tomato yields similar to the weeded control. Napropamide alone and in combination with pebulate or diphenamid did not provide adequate broadleaf weed control and resulting weed competition reduced yields significantly.

Transplanted Trials - Experiment III: Trifluralin at 1.12 or 1.68 kg/ha failed to provide satisfactory broadleaf weed control in transplanted tomatoes (Table 2). S 6044 and BAS 3921-H were effective in controlling both broadleaf and grass weeds, while other materials generally were poor against broadleaf weeds or delayed crop maturity.

Experiment IV: Trifluralin applied alone controlled grasses but not broadleaf weeds, while the addition of diphenamid improved weed control and yields (Table 4). Likewise, the addition of metribuzin or U-27,267 to

trifluralin was effective in providing broad-spectrum weed control. These two materials also were effective when used alone. Tomatoes tolerated metribuzin postemergence and weed control was satisfactory from this method of application. Better control of ragweed was obtained at the 0.56 kg/ha rates than at 0.28 kg/ha.

Napropamide used at 1.12 kg/ha provided fair weed control in this experiment. Pebulate combined with napropamide (at 1.12 kg/ha) also was effective but when combined with 0.56 kg/ha of napropamide control of broadleaf weeds declined by the end of July. Pebulate was ineffective alone.

DISCUSSION

Metribuzin applied preplanting or preemergence to seeded tomatoes provided satisfactory weed control but significant stand reductions suggest considerable risk associated with these methods of application. Postemergence treatments were tolerated by seedlings in the 4-leaf stage. Earlier studies by the authors (unpublished data) indicated complete kill may occur to tomato seedlings treated in the cotyledon to 2-leaf stage of growth. Cialone and Braden (1) and Wilson et al. (3) have reported that tomato seedlings tolerated postemergence treatments of metribuzin at rates from 0.14 to 0.84 kg/ha. Further evaluation of postemergence treatments may confirm this to be the safest method of application for direct-seeded tomatoes.

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Table 1. Chemical names and formulations of herbicides included in Experiments I-IV.

Common name or designation	Chemical name	Formulation
A 820	N-secondary-4-tertiary-butyl-2,6-dinitroaniline	4 ec
BAS 3921-H	N-propyl-N-(2-chloroethyl)-2,6-dinitro-4-trifluromethylaniline	3 ec
BAS 68897X	--not available--	4 ec
BAS 72461-H	--not available	4 ec
CGA 10832	N-n-propyl-N-cyclopropylmethyl-4-trifluromethyl-2,6-dinitroanaline	4 ec
Diphenamid	N,N-dimethyl-2,2-diphenylacetamide	50 wp
IMC 3950	S-(4-chlorobenzyl-N,N-diethylthiol carbamate	8 ec
Isopropalin	2,6-dinitro-N,N-dipropylcumidine	6 ec
MBR 8251	4-phenylsulfonyltrifluoromethanesulfono-o-toluidide	50 wp
Metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one	50 wp
Napropamide (R 7465)	2-(a-naphthoxy)-N,N-diethylpropionamide	50 wp
Pebulate	S-propyl butylethylthiocarbamate	6 ec
S 6044	--not available--	3 ec
Trifluralin	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine	4 ec
U-27,267	3,4,5-tribromo-N,N,a-trimethylpyrazole-1-acetamide	75 wp

Table 2. Performance of several experimental herbicides in direct-seeded and transplanted tomatoes, Experiments I and III, 1973.

Herbicide	Rate kg/ha ai preplant	Weed control rating 1-9 Broadleaf 6/11	Broadleaf 7/27	Grass 6/11	Grass 7/27	Crop response Phyto. rating 1-5	Yield metric ton/ha 9/12
Experiment I							
Weeded control		9.0	9.0	9.0	9.0	5.0	25.5[ab] [a]
Unweeded control		1.0	1.0	1.0	1.0	5.0	2.2[fgh]
Diphenamid	6.72	8.5	8.3	8.7	9.0	4.9	28.9[a]
A 820	1.68	2.0	2.5	9.0	8.8	3.9	2.9[fgh]
A 820	3.36	2.7	3.0	9.0	9.0	1.4	1.8[gh]
S 6044	3.36	9.0	8.4	9.0	8.5	1.4	5.6[efg]
S 6044	4.48	9.0	8.8	8.5	8.0	1.2	8.1[def]
MBR 8251	1.68	7.5	7.3	8.5	8.0	1.7	2.5[gh]
MBR 8251	3.36	8.2	8.5	9.0	9.0	1.0	0.0[h]
IMC 3950	2.24	2.0	2.5	9.0	8.8	5.0	7.6[efg]
IMC 3950	4.48	5.5	4.8	9.0	8.3	4.7	9.4[de]
BAS 68897X	3.36	5.5	3.8	5.0	4.8	3.6	8.5[de]
BAS 68897X	4.48	7.5	5.6	8.2	4.8	4.7	13.2[cd]
BAS 72461-H	3.36	7.2	4.0	8.0	6.3	1.4	0.0[h]
BAS 72461-H	4.48	8.5	6.9	9.0	8.4	1.0	0.0[h]
CGA 10832	1.12	3.2	2.3	8.5	8.8	2.7	4.9[efg]
Isopropalin	2.24	4.0	3.4	8.5	9.0	3.5	4.7[efg]
Isopropalin + metribuzin	2.24 + 0.28	9.0	8.3	8.7	8.8	2.4	20.2[bc]
	LSD 5%	2.3	2.5	1.7	2.5	0.7	
	1%	3.0	3.4	2.2	3.4	0.9	
Experiment III		6/20	8/1	6/20	8/1	6/20	8/21
Weeded control		9.0	8.9	7	9	5	23.5[a]
Unweeded control		1.0	1.0	1	1	5	15.0[bc]
Trifluralin	1.12	4.1	5.3	9	9	5	15.2[bc]
Trifluralin	1.68	7.0	5.6	9	9	5	21.3[ab]
A-820	1.68	5.3	4.3	9	9	5	16.4[ab]
A-820	3.36	6.0	3.3	9	9	5	14.8[bc]
S 6044	3.36	7.6	5.0	9	9	5	16.8[ab]
S 6044	4.48	8.6	7.6	9	9	5	17.2[ab]
MBR 8251	1.68	7.8	7.0	9	9	5 (late)	10.1[cd]
MBR 8251	3.36	7.8	6.5	9	8	5 (late)	2.9[d]
IMC 3950	2.24	5.8	4.6	7	8	5	19.3[ab]
IMC 3950	4.48	3.8	5.6	9	5	5	17.2[ab]
BAS 3921-H	1.68	6.9	6.0	9	9	5	18.4[ab]
BAS 3921-H	3.36	7.6	6.6	9	9	5	15.9[ab]
	LSD 5%	2.1	3.1	0.6	2.6	NSD	
	1%	2.7	4.4	0.8	3.6		

[a] Means followed by a common letter are not significantly different at 5% level (D. M. R.)

Table 3. Performance of several herbicides alone and in combination in direct-seeded tomatoes, Exp. II, 1973

Treatment			Weed control rating 1-9				Crop response		
			Broadleaf		Grass			Phyto.	Yield
Herbicide	Rate kg/ha ai	Application method	6/8	7/23	6/8	7/23	Stand No./30.5 cm	rating 1-5 6/8	metric ton/ha 9/17
Weeded control			9.0	8.4	9.0	7.3	6.3	5.0	33.8[ab a]
Unweeded control			1.0	1.0	1.0	1.0	4.1	5.0	1.6[f]
Diphenamid	6.72	preplant	7.0	7.5	9.0	9.0	5.2	4.5	28.0[bcd]
Metribuzin	0.28	preemergence	8.0	7.5	8.0	2.8	3.4	4.0	25.9[bcd]
Napropamide	0.84	preplant	5.2	5.5	9.0	9.0	4.3	4.7	18.6[de]
U-27,267	1.68	preplant	8.0	7.6	9.0	8.5	5.4	4.6	35.4[ab]
Pebulate	3.36	preplant	1.7	1.0	1.0	3.0	4.2	4.9	2.5[f]
Diphenamid + metribuzin	4.48 + 0.14	preplant	8.1	8.0	9.0	8.8	3.5	4.5	30.2[abc]
Diphenamid + metribuzin	4.48 + 0.28	preplant	8.7	8.5	9.0	9.0	1.8	2.6	34.0[ab]
Diphenamid + metribuzin	4.48 + 0.28	preemergence	9.0	8.8	9.0	9.0	3.0	3.6	37.2[ab]
Diphenamid + napropamide	4.48 + 0.84	preplant	6.0	6.1	9.0	8.8	5.1	5.0	19.5[de]
Diphenamid + U-27,267	4.48 + 1.68	preplant	8.1	8.4	9.0	9.0	6.2	4.5	35.2[ab]
Napropamide + pebulate	0.84 + 3.36	preplant	6.5	6.3	9.0	8.8	6.3	4.6	19.5[cde]
Napropamide + pebulate	1.12 + 3.36	preplant	6.7	6.1	8.7	9.0	5.9	4.8	14.8[e]
Napropamide + metribuzin	0.84 + 0.28	preplant	8.6	7.8	9.0	7.5	2.4	3.0	31.8[ab]
Napropamide + U-27,267	0.84 + 1.68	preplant	7.5	8.0	9.0	8.5	7.9	4.7	30.2[abc]
Metribuzin + U-27,267	0.28 + 1.68	preplant	9.0	8.4	9.0	9.0	2.6	3.1	39.9[a]
Diphenamid + trifluralin	4.48 + 1.12	preplant postemergenge	6.2	7.8	9.0	9.0	5.7	4.8	35.2[ab]
Diphenamid + metribuzin	4.48 + 0.14	preplant postemergence	6.5	8.1	9.0	9.0	4.8	5.0	29.1[a-d]
Diphenamid + metribuzin	4.48 + 0.28	preplant postemergence	6.7	8.4	9.0	9.0	4.3	4.7	31.8[ab]
		LSD 5%	1.4	0.8	0.5	1.8	2.1	0.7	
		1%	1.8	1.1	0.6	2.5	2.8	0.9	

Means followed by a common letter are not significantly [illegible]

Table 4. Performance of several herbicides alone and in combination in transplanted tomatoes, Experiment IV, 1973

Treatment			Weed control rating 1-9				Yield
	Rate	Application	Broadleaf		Grass		metric ton/ha
Herbicide	kg/ha ai	method	6/20	7/23	6/20	7/23	8/21
Weeded control			9.0	7.1	9.0	4.5	25.3
Unweeded control			1.0	1.0	1.0	1.0	17.2
Trifluralin	0.84	preplant	3.5	4.0	9.0	9.0	19.0
Trifluralin	1.12	preplant	4.3	2.5	9.0	9.0	20.4
Metribuzin	0.58	preplant	8.8	8.6	8.8	8.1	23.3
Metribuzin	1.12	preplant	9.0	9.0	9.0	8.8	22.2
Metribuzin	0.58	postplanting	8.4	9.0	7.0	8.4	21.7
Napropamide	1.12	preplant	7.8	7.6	8.9	9.0	20.8
U-27,267	1.68	preplant	8.8	8.8	9.0	9.0	23.5
Pebulate	6.72	preplant	6.5	5.0	8.0	6.5	18.4
Trifluralin + diphenamid	0.84 + 4.48	preplant	8.0	7.5	9.0	9.0	24.6
Trifluralin + metribuzin	0.84 + 0.58	preplant	9.0	8.9	8.8	8.8	22.4
Trifluralin + napropamide	0.84 + 0.84	preplant	6.5	4.8	9.0	8.8	18.1
Trifluralin + U-27,267	0.84 + 1.68	preplant	8.6	9.0	9.0	9.0	21.5
Diphenamid + metribuzin	4.48 + 0.58	preplant	9.0	8.8	9.0	8.8	25.3
Diphenamid + napropamide	4.48 + 0.84	preplant	8.5	8.8	9.0	9.0	26.4
Napropamide + metribuzin	0.84 + 0.58	preplant	9.0	8.5	9.0	9.0	24.6
Napropamide + pebulate	0.58 + 3.36	preplant	6.7	5.5	9.0	8.9	27.8
Napropamide + pebulate	1.12 + 3.36	preplant	8.0	8.0	9.0	9.0	27.8
Trifluralin + metribuzin	0.84 + 0.28	preplant postemergence	7.9	7.6	9.0	9.0	19.7
LSD		5%	1.4	1.6	0.5	1.6	NSD
		1%	1.8	2.2	0.6	2.1	

EVALUATION OF SOME PREPLANT INCORPORATED HERBICIDE TREATMENTS IN TRANSPLANTED TOMATOES

D. J. Herman, Wm. J. McAvoy and R. D. Ilnicki 1/

Abstract

Efficacy of five aniline and toluidine derivative herbicides were evaluated alone and in some combinations with metribuzin (4-amino-6-tert-butyl-3-(methylthio)-s-triazin-5(4H) one) on transplanted tomatoes (Lycopersicon esculentum L.), variety Campbell 28. Major weed species present were lambsquarters (Chenopodium album L.), pigweed (Amaranthus retroflexus L.), wild radish (Raphanus raphanistrum L.), fall panicum (Panicum dichotomiflorum Michx.) and crabgrass (Digitaria ischaemum (Schreb.) Muhl.). All treatments were applied preplant incorporated unless otherwise specified. Nine harvests were made throughout the growing season as required. Treatment means were statistically compared with the cultivated check. The outstanding treatments taking into account both weed control and yield were: trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) + metribuzin at ½ + ¼ lb/A, trifluralin ½ lb/A followed by metribuzin applied post incorporated at ¼ lb/A 10 days later and subsequent applications of metribuzin at ¼ lb/A applied at 10-day intervals for three additional applications, and metribuzin ¼ lb/A followed by the same herbicide post incorporated at ¼ lb/A at 10-day intervals for five additional applications. These treatments all yielded significantly greater than the cultivated check. Total yields from the highest treatment was approximately 200 cwt/A.

1/ Research Intern, Ph. D. recipient and Research Professor of Weed Science, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey 08903.

WEED CONTROL IN TRANSPLANTED TOMATOES[1/]

C. E. Beste[2/]

Abstract. Transplanted tomatoes (Lycopersicum esculentum Mill., var. Campbell 28) showed slightly less early vigor reduction with isopropalin (2,6-dinitro-N,N-dipropylcumidine) than trifluralin (α, α, α,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), however, the control of common lambsquarters (Chenopodium album L.), large crabgrass (Digitaria sanguinalis (L.) Scop.), goosegrass (Eleusine indica (L.) Gaertn.), and stinkgrass (Eragrostis cilianensis (All.) Lutati) with trifluralin was better than isopropalin. Significant vigor and yield reduction occurred when metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H) one) at 0.75 lb/A was applied ten days after transplanting, however, an application twenty nine days after transplanting did not injure the tomatoes. Metribuzin at 0.25 and 0.5 lb/A applied postemergence ten or twenty nine days after transplanting did not reduce yields. Common lambsquarters control with trifluralin (0.5 lb/A) preplant incorporated (PPI) was 56 percent, and a combination of PPI trifluralin followed by metribuzin (0.25 lb/A) postemergence provided 100 percent control of lambsquarters. The application of three repeated postemergence metribuzin (0.25 lb/A) treatments did not reduce yields. Pebulate (S-propyl butylethylthiocarbamate) did not control common lambsquarters, however, a PPI combination of pebulate and napropamide (2-(α-naphthoxy-N,N-diethylpropionamide) at 3.0 and 0.75 lb/A, respectively, provided better weed control than either herbicide alone. S-6044 (undisclosed chemistry) at 1.0, 2.0, and 3.0 lb/A applied post-transplant provided excellent weed control without tomato injury.

INTRODUCTION

The continued shift to mechanical harvesting of tomatoes has increased the need for full-season weed control through harvest. Trifluralin has been reported to inadequately control some broadleaf weeds (3, 4). Metribuzin has shown considerable promise as a postemergence treatment for tomatoes (2, 3, 5). Cialone and Braden (2) reported that metribuzin at 0.75 lb/A applied to 4 to 5 inch tall seeded tomatoes caused slight injury. Metribuzin applied forty five days after transplanting caused leaf tip burn, but tomato yields were not reduced (3). Agamalian (1) reported that metribuzin postemergence at 0.5 lb/A on tomatoes in the three to four leaf stage reduced yields, however, tomatoes 12 to 14 inches tall were unaffected by metribuzin.

The purpose of this study was to evaluate several experimental herbicides and determine the tolerance of tomato transplants to metribuzin.

1/ Scientific Article No. A1949, Contribution No. 4879, of the Maryland Agricultural Experiment Station, Department of Horticulture.
2/ Assistant Professor, University of Maryland.

MATERIALS AND METHODS

Single row herbicide plots of 64 inch width and 16 ft. row length were established in a Norfolk loamy sand (0.6% organic matter). Each herbicide treatment was replicated four times in a randomized complete block design. PPI herbicide treatments were applied May 14 prior to transplanting. Incorporation was 3 inches deep with a tractor-mounted rotatiller. Tomato seedlings (var. Campbell 28) from Georgia were transplanted on May 14 with an in-row spacing of 14 to 16 inches and a row spacing of 64 inches. Preemergence (Pre) herbicide treatments were applied after transplanting on May 15. Early postemergence (E. Post) treatments were applied on May 24 and late postemergence (L. Post) treatments and late postemergence directed (L. Post-D.) were applied on June 12. Postemergence incorporated (Post-Inc.) treatments were applied July 7 and incorporated 3 inches deep with a garden rotatiller. Lay-by postemergence (Lay-by Post) treatments were applied July 7. The sprays were applied over the tops of the tomato plants except for the Post-Inc. and L. Post-D. treatments which were directed sprays to the base of the plant. Spray volume was 34 gallons per acre. Stand and vigor ratings were made on June 16 and weed control evaluation of large crabgrass, goosegrass, stinkgrass, and common lambsquarters were made on June 16 and August 16. On August 16, the fruit was approximately 90% ripe, and a single harvest of ripes and pinks was made on a 10 ft length of row in each plot. The crop response and weed control data are an average of four replications.

RESULTS AND DISCUSSION

Trifluralin caused slightly more tomato stunting than isopropalin, and grass and common lambsquarters control was better with trifluralin (Table 1). Trifluralin (0.5 lb/A) was weak on common lambsquarters and a postemergence application of metribuzin (0.25 lb/A) following trifluralin provided 100 percent common lambsquarters control. Metribuzin at 0.5 lb/A was more phytotoxic when applied PPI than when applied Pre, and grass control was slightly better with the PPI application. Grass control with metribuzin alone was unacceptable. Significant vigor and yield reduction occurred when metribuzin at 0.75 lb/A was applied ten days after transplanting, however, an application twenty nine days after transplanting did not injure the tomatoes. Metribuzin at 0.25 and 0.5 lb/A postemergence ten or twenty nine days after transplanting did not reduce yields. Applications of two and three repeated postemergence metribuzin (0.25 lb/A) treatments did not reduce yields. The PPI combination of trifluralin and metribuzin (0.5 plus 0.5 lb/A) provided excellent weed control without crop injury. Pebulat did not control common lambsquarters and was weak on grass control, however, a PPI combination of napropamide and pebulate at 0.75 and 3.0 lb/A, respectively, provided better weed control than either alone. This confirms a similar observation by Wilson et al. (5). Yield reductions with pebulate were due to weed competition. S-6044 at 1.0, 2.0, and 3.0 lb/A applied Pre provided excellent weed control without tomato injury.

In summary, postemergence metribuzin applied in combination with an effectiv PPI or Pre grass herbicide appears to be a very promising weed control system for tomato growers.

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Table 1. An evaluation of several herbicides and herbicide combinations for weed control and crop response in transplanted tomatoes on a Norfolk loamy sand.

Treatment			Stand and Vigor[1/] % of Control		Percent Weed Control[2/] June 16		August 16		
Herbicide	lb. ai/A	Method	Vigor	Stand	Lambs-quarters	Grasses	Lambs-quarters	Grasses	Yield Ton/A
1. none	----	----	100	100	0	0	0	0	5.9
2. weeded control	----	----	100	100	100	100	100	100	24.0
3. trifluralin (4EC)	0.25	PPI	93	100	85	98	29	61	13.7
4. trifluralin	0.5	PPI	86	100	95	100	56	94	20.0
5. trifluralin	1.0	PPI	87	100	96	98	81	88	17.4
6. isopropalin (6EC)	1.0	PPI	91	100	90	94	44	69	14.2
7. isopropalin	2.0	PPI	94	100	98	100	86	84	21.5
8. metribuzin (50WP)	0.5	PPI	86	100	100	100	100	58	19.0
9. metribuzin	0.5	Pre	93	100	100	100	99	13	19.7
10. trifluralin + isopropalin	0.19+ 0.56	PPI	93	100	94	96	55	76	17.0
11. trifluralin + isopropalin	0.25+ 0.75	PPI	94	100	95	99	71	85	15.5
12. pebulate (6EC)	3.0	PPI	90	100	95	100	46	60	11.4
13. pebulate	4.0	PPI	91	100	95	100	58	69	14.4
14. napropamide (2EC)	0.5	PPI	98	100	95	95	66	76	18.6
15. napropamide	0.75	PPI	96	100	92	99	50	93	17.6
16. napropamide + pebulate	0.5+ 3.0	PPI	90	100	100	100	89	83	18.1
17. napropamide + pebulate	2.0+ 4.0	PPI	83	100	100	100	95	98	22.8
18. pebulate	4.0	Post-Inc.	100	100	0	0	76	81	15.3
19. trifluralin + metribuzin	0.5+ 0.5	PPI	85	100	100	100	100	94	21.4
20. S-6044 (3EC)	1.0	Pre	98	100	100	100	98	87	21.2
21. S-6044	2.0	Pre	94	100	100	100	100	93	21.8
22. S-6044	3.0	Pre	87	100	100	100	100	95	19.7
23. trifluralin + metribuzin	0.5 0.25	PPI+ E. Post	89	100	100	100	100	100	21.6
24. trifluralin + metribuzin	0.5+ 0.5	PPI+ E. Post	73	90	98	100	100	100	21.8

(Cont'd on

Table 1. Continued

Treatment			Stand and Vigor[1/] % of Control		Percent Weed Control[2/] June 16		Percent Weed Control[2/] August 16		
Herbicide	lb. ai/A	Method	Vigor	Stand	Lambs-quarters	Grasses	Lambs-quarters	Grasses	Yield Ton/A
25. trifluralin +	0.5+	PPI+							
metribuzin	0.75	E. Post	63	69	100	100	100	100	16.3
26. trifluralin +	0.5+	PPI+							
metribuzin	0.25	L. Post	94	100	93	99	100	100	22.2
27. trifluralin +	0.5+	PPI+							
metribuzin	0.5	L. Post	88	100	96	99	96	98	24.1
28. trifluralin +	0.5+	PPI+							
metribuzin	0.75	L. Post	84	100	98	100	100	100	21.0
29. trifluralin +	0.5	PPI+							
metribuzin	0.5	L. Post-D.	91	100	96	99	99	91	24.6
30. trifluralin +	0.5	PPI+							
metribuzin	1.0	L. Post-D.	85	100	98	100	98	99	21.2
31. trifluralin +	0.5+	PPI							
metribuzin +	0.25+	E. Post +							
metribuzin	0.25	L. Post	90	100	100	100	100	100	23.2
32. trifluralin +	0.5+	PPI+							
metribuzin +	0.25+	E. Post +							
metribuzin +	0.25+	L. Post +							
metribuzin	0.25	Lay-by Post	83	100	100	100	100	100	21.8
LSD .05									7.1
LSD .01									9.4

1/ Rated June 16, 1973.
2/ Weed Population: Lambsquarters - 60%, Grasses (Large Crabgrass, Goosegrass, and Stinkgrass) - 40%.
3/ PPI (preplant incorporated), Pre (preemergence to weeds and post-transplant to tomatoes), E. Post (early post), L. Post (late post), L. Post-D. (late postemergence-directed), Post-Inc. (postemergence incorporated), Lay-by Post (lay-by postemergence).

AN EVALUATION OF STORAGE-TIME EFFECT ON TOMATO TRANSPLANTS WITH NITRALIN AND TRIFLURALIN

L. B. Lynn, C. E. Beste, and F. C. Stark[1/]

Abstract. Prolonged storage of tomato (*Lycopersicum esculentum* Mill.) transplants has been implicated as a deleterious factor on yield of marketable fruit. This response may be modified by herbicide treatments. The purpose of this study was to determine the effect of herbicide treatments and tomato-transplant storage-time on yields, and to determine if an interaction occurred between these factors.

Trifluralin (α,α,α-trifluro-2,6-dinitro-*N*,*N*-dipropyl-*p*-toluidine) and nitralin (4-(methylsulfonyl)-2,6-dinitro-*N*,*N*-dipropylaniline) were incorporated 7.6 cm deep at 0.5X, 1X, and 3X the recommended rate (nitralin - X = 0.84 kg/ha and trifluralin - X = 0.56 kg/ha). Field grown Georgia tomato (var. Campbell 28) plants were delivered two days after pulling, and stored at 7C for one, eight, and eleven days prior to transplanting. Ripe fruit was harvested three times, and green-fruit yields were also determined in the third harvest. The experiment was conducted in 1973 on a Norfolk loamy sand at the University of Maryland Vegetable Research Farm at Salisbury.

Ripe-fruit yields from the first harvest were significantly reduced by the following factors with no interaction: (a) type of herbicide, (b) herbicide rate, and (c) storage time of transplants. None of these variables affected ripe-fruit yields in the second and third harvests. The first-harvest yield of plots treated with trifluralin was 36% greater than nitralin treated plots. The effect of these variables on the green-fruit yield substantiated the observations on ripe-fruit yields. The 3X nitralin rate increased green-fruit yield by 153% over control plots, which correlated with the observation that nitralin treatments produced less ripe fruit than the trifluralin treatments. The total yield of ripe and green fruit combined was not significantly affected by nitralin or trifluralin. Only the 3X rate of nitralin significantly reduced the total ripe-fruit yield and significantly increased the green-fruit yield. The first-harvest yields of plants stored eight and eleven days were significantly less than plants stored one day.

Several matters of practical application are to be noted: (a) for maximum early fruit, growers should not delay transplanting after plants are received (b) recommended rates of nitralin and trifluralin should not be exceeded for optimum early fruit yields, and (c) nitralin significantly delayed early fruit yields more than trifluralin although total yields were not significantly different.

1/ Faculty Research Assistant, Assistant Professor, and Chairman, Department of Horticulture, University of Maryland, College Park.

COMPETITIVE ABILITY OF POTATO CULTIVARS WITH MAJOR WEED SPECIES[1]

C. P. Yip, R. D. Sweet and J. B. Sieczka[2]

ABSTRACT

Field experiments were conducted to evaluate the competitive ability of potato (Solanum tuberosum L.) cultivars with redroot pigweed (Amaranthus retroflexus L.), lambsquarter (Chenopodium album L.) and yellow nutsedge (Cyperus esculentus L.); and to identify some of the aboveground growth characteristics that contribute to their competitiveness. Green Mountain and Norchip were competitive with broadleaved weeds and yellow nutsedge. In addition, Hudson competed very well with yellow nutsedge. Yields of Green Mountain and Norchip were not significantly reduced by redroot pigweed and lambsquarter. Sebago and Katahdin were least competitive, and yield reduction was significant. Yields in cultivated and non-cultivated plots were not significantly different. However, both were reduced as compared to weed-free herbicide plots. The competitive ability of Green Mountain, Norchip and Hudson was correlated with early emergence, rapid early growth and the ability to maintain a dense leaf canopy throughout the growing season.

INTRODUCTION

Weeds in potatoes (Solanum tuberosum L.) cause severe losses in terms of both yield and quality reduction (9,11). In addition, they interfere with mechanical harvesting (7). The Agricultural Research Survey (7) indicated a loss in efficiency of mechanical harvesting of up to 50% and as high as 20% of the tubers lost in masses of rootbound soil carried over the machine. Dallyn and Sweet (4) estimated a 4% loss in yield from weeds. Yellow nutsedge (Cyperus esculentus L.) and quackgrass [Agropyron repens (L.) Beav.] grow through potato tubers, rendering them unmarketable (4,11).

Potatoes are slow to emerge and offer little competition to weeds from the time of planting until the plants begin to fill the rows. Later in the growing season, the vines of some cultivars fall and open up, often allowing late germinating weeds especially grasses to grow vigorously until the crop is harvested (3,4). Cultivation and herbicides are normally used to control weeds during the first of these vulnerable periods, but there is little the grower can do during the second. One hundred percent of the potato acreage in New York and throughout the world receives some form of mechanical weed control. These include cultivation, drag-off and hilling (4).

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[1]Paper No. 661 of the Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

[2]Assistant, Professor and Extension Specialist, respectively. Department of Vegetable Crops, Cornell University, Ithaca, New York, 14850.

Potato growers have observed less weed prevalence in certain potato cultivars than in others (14). On Long Island, the problem of yellow nutsedge, barnyardgrass (Echinochloa crusgalli L.) and later germinating weeds has increased since the replacement of Green Mountain by Katahdin, which in recent years has been the leading commercial cultivar in the Northeast (10,14). A preliminary experiment by the authors with different potato cultivars indicated varietal differences in broadleaved weed suppression (14).

The objectives of this study were (a) to evaluate the competitive ability of major foliage types of potato cultivars with major weed species; (b) to identify those aboveground growth characteristics which determine the competitiveness of potato cultivars.

MATERIALS AND METHODS

Description of potato cultivars:

The aboveground characteristics of the four potato cultivars used in all four experiments are summarized in Table 1. They are generally accepted by potato specialists (1,2,6,8,13). Selection of cultivars were based on the different growth habits and maturity. In addition, Hudson, a new cultivar released in 1972 by New York State (8) was included in the yellow nutsedge competition study on Long Island.

Broadleaved weed competition:

The experiment was conducted on a Howard gravelly loam soil at Freeville, New York. The growing season is relatively short, about 150 days. Predominant weed species under study were redroot pigweed (Amaranthus retroflexus L.) and lambsquarter (Chenopodium album L.).

Four potato cultivars were planted in 4-row plots, 7.62 m long with a 2-row potato planter on May 28, 1973. Row width was 0.86 m and seed pieces were spaced 22.9 cm apart. Fertilizer was applied in bands at planting at a rate equivalent to 1680 kg/ha of 10-20-20. The experiment was designed as a split plot in a complete randomized block with four replications. Cultivars were subplots and weed control methods, that is, herbicide treatment, one and no cultivation, were main plots. Herbicide plots received a delayed preemergence application of 3-(3,4-dichlophenyl)-1-methoxy-1-methylurea (linuron) at 1.5 kg/ha on June 4th. Cultivation plots were cultivated on June 22nd when redroot pigweed and lambsquarter were 5-6 leaf stage, and the potato plants 6-15 cm tall. All plots were hilled a week later. A weekly insecticide and fungicide spray schedule was maintained as recommended (12). Growing season was normal, with plots irrigated when necessary.

Weed density was determined in cultivated and non-cultivated plots after hilling, and it varied from 10 to 15 per 0.5 m^2 for both species. However, lambsquarter population was extremely low (0-5/0.5 m^2) in two replications. Other weed species including ladysthumb (Polygonum persicaria L.), common purslane (Portulaca oleracea L.) and witchgrass (Panicum capillare) were prese

Table 1. Aboveground characteristics of five potato cultivars.

Cultivar	Maturity	Plant Size	Foliage Type	Other Growth Habits
Green Mountain	Very late	Very large and spreading.	Terminal and primary leaflets relatively small to medium in size. Secondary leaflets medium in number. Tertiary leaflets few. Heavy foliage.	Vigorous vines and considerably branched. Early emergence and rapid early growth. Tight and dense canopy throughout the growing season.
Hudson	Late	Very large and spreading.	Terminal and primary leaflets relatively large with few secondary and tertiary leaflets. Dense foliage.	Vigorous vines and considerably branched in July. Early emergence and rapid early growth. Maintains dense canopy until late August or early September.
Norchip	Early	Medium--large sized and upright.	Terminal and primary leaflets large. Leaves relatively close to each other. Few secondary leaflets and many tertiary leaflets. Dense foliage.	Not heavily branched. Early emergence with dense cover early in the season. Canopy opens up in mid-August.
Sebago	Very late	Large, erect to spreading.	Terminal and primary leaflets medium in size. Secondary leaflets medium to few. Tertiary leaflets few. Sparse foliage.	Branching medium. Slow early growth with open canopy early in the season, but dense canopy very late in the season.
Katahdin	Late	Medium to large and spreading.	Terminal and primary leaflets large. Many secondary and tertiary leaflets. Sparse foliage.	Branching medium. Slow early growth with open canopy and no dense cover.

but in low numbers. Two non-random 0.5 m^2 subsamples per plot were staked out on the basis of visual judgement of redroot pigweed and lambsquarter density. Both species were tagged and numbered in each subsample. Visual ratings of the severity of redroot pigweed and lambsquarter infestations were taken on August 20th and September 12th. In addition, weeds were harvested in mid-September and dry weights determined. Vigor of the weeds was recorded.

Aboveground growth characteristics were recorded in terms of dates of emergence, closing in and falling over of the vines, and their canopy types. By late September, the number of stems per seed piece and branches per stem were determined for two randomly selected plots in the herbicide plots.

Weeds in the cultivated and non-cultivated plots were mechanically mowed prior to the application of 2-sec-4,6-dinitrophenol (dinoseb) plus diesel fuel on September 17th at 2.1 kg/ha and 47 l/ha respectively as a vinekiller. Nine days later, the same materials were applied to the experimental area to kill the vines of Green Mountain and Sebago which were still green. Potatoes were harvested a week after the second application and total yields determined.

Other data obtained but which will not be presented in this paper included light measurements under the canopies of the potato cultivars, height and spread of the cultivars, and height and stem diameter of the weeds. Techniques described by Friend (5) and Wien (15) were used to estimate the amount of light intercepted by weed and potato canopies.

Yellow nutsedge competition:

These experiments were located in a commercial potato field having Sassafras sandy loam soil on Long Island and on the Agronomy Research Farm at Aurora. Both sites were heavily infested with yellow nutsedge. Long Island has a much longer growing season (about 215 days) than upstate New York.

Plots were four rows wide each 0.91 m apart, by 7.62 m long and randomized in a complete block design with five replications. Preplant operations were done by the grower, and included plowing and banding of an 8-16-8 fertilizer at 2912 kg/ha. Rows were left open by removing the covering discs of the planter in the process of banding the fertilizer. On April 19th seed pieces were planted by hand. The experimental area was dragged off twice prior to emergence of the potatoes to remove early germinating annual broadleaved weeds.

All plots were sprayed with linuron at 0.5 kg/ha on May 22nd to control broadleaved weeds. In three replications, α,α,α,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) was also applied at the same rate to control annual grasses. Potatoes were 1-5 cm tall and nutsedge 2-5 cm tall. Final cultivation was done in mid-June just before hilling. Insect and disease control measures plus irrigation were maintained by the farmer. The growing season was normal except that the problem of controlling Colorado potato beetles [*Leptinotarsa decemlineata* (Say)] was very severe.

Prior to hilling, the level of nutsedge infestation was estimated. Nutsedge population in two replications was minimal. Two 45 cm^2 subsamples were selected and staked out in each plot. Visual ratings of the growth and density of nutsedge were made on July 24th and August 13th. In addition, the two nutsedge subsamples were harvested and the number of shoots, weight and number of nutlets determined. Subsamples were dug with a fork 30 cm deep to obtain all the nutsedge tubers. Only newly formed tubers were counted.

Four randomly selected potato plants were tagged in mid-June, and stem and branch count made on August 12th. The growth characteristics of the potato cultivars were noted periodically. The experiment had to be terminated prematurely as a result of complete defoliation of the potatoes by Colorado potato beetles. Potatoes were harvested on August 27th and the extent of damage to the tubers by nutsedge shoots and rhizomes was determined by visual examination of every potato tuber for punctures.

The experiment at Aurora was later discontinued as a result of poorly drained soil and lack of irrigation equipment.

Quackgrass competition:

This experiment was located in a commercial potato field at Bath, New York where the growing season is relatively short (about 135 days) with cooler temperatures. Data collected but not presented here included height and spread measurements, dates of emergence, closing in and falling over of potato vines, and weed yields.

RESULTS AND DISCUSSION

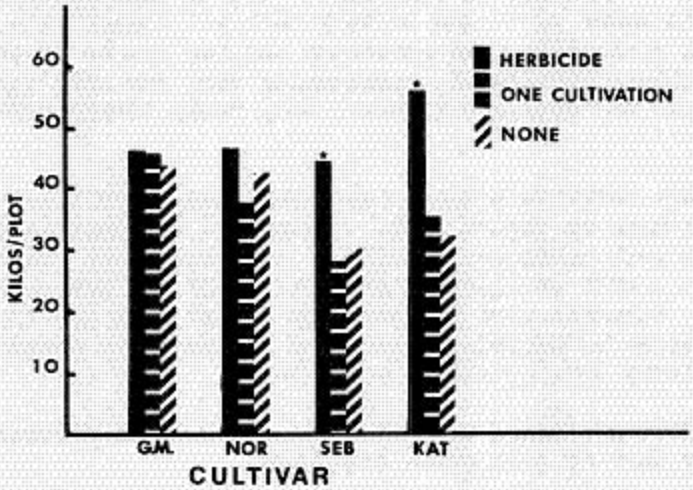
Broadleaved weed competition:

Redroot pigweed and lambsquarter reduced the yields of Katahdin and Sebago in both the cultivated and non-cultivated plots by 32 to 42% (Fig. 1). Yields of Green Mountain and Norchip were not reduced (Fig. 1).

Green Mountain and Norchip competed very well with redroot pigweed and lambsquarter, whereas Katahdin and Sebago were clearly unacceptable commercially in this characteristic (Table 2). Similarly, weed yields were lower in Green Mountain and Norchip than in Sebago and Katahdin (Tables 3 and 4). There was no significant difference between cultivated and non-cultivated plots (Table 3). Linuron at 1.5 kg/ha gave complete control of both weed species (Tables 3 and 4).

The competitive ability of Green Mountain and Norchip was correlated with early emergence and rapid early growth (Table 5). Though the vines of Green Mountain fell over the following day after closing in due to a storm, it still maintained a dense canopy. The dense canopy lasted until the vines were killed in mid-September. Although weeds emerged under the canopy, they were mostly single-stemmed, elongated and fragile. They fell over with the potato vines. Most of these canopy weeds were dead in mid-September.

Figure 1. Effects of redroot pigweed and lambsquarter on yields of potato cultivars.



*Significant at 5% level as determined by Duncan's Multiple Range Test.

Table 2. The effects of potato cultivars and control methods on growth of redroot pigweed and lambsquarter.[a]

Potato Cultivar	Weed Control Method	Redroot Pigweed 8/20	Redroot Pigweed 9/12	Lambsquarter 8/20	Lambsquarter 9/12
Green Mountain	Herbicide	9.0	9.0	9.0	9.0
	One cultivation	8.4	8.5	8.5	8.5
	None	8.1	8.4	8.0	8.0
Norchip	Herbicide	9.0	9.0	9.0	9.0
	One cultivation	6.4	5.8	7.6	7.6
	None	5.9	6.0	6.8	6.7
Sebago	Herbicide	9.0	9.0	9.0	9.0
	One cultivation	4.0	4.1	5.0	4.9
	None	5.2	5.1	5.7	5.7
Katahdin	Herbicide	9.0	9.0	9.0	9.0
	One cultivation	4.7	4.4	6.6	6.2
	None	4.2	3.5	5.7	5.7

[a]Means of 4 replications. 9=complete weed control; 7=commercially acceptable; 1=no weed control.

Table 3. The effects of potato cultivars and weed methods on dry weight of redroot pigweed.[1]

Potato Cultivar	Herbicide[2] Dry Weight	One[3] Cultivation Dry Weight	None[3] Dry Weight
	g	g	g
Green Mt.	No weeds	48.8 a	105.5 a
Norchip	No weeds	241.7 ab	256.0 ab
Sebago	No weeds	489.9 b	255.8 ab
Katahdin	No weeds	513.1 b	424.4 b
Weed Control Method		N.S. (5% level)	
Interaction		N.S. (5% level)	

[1] Means of four replications each subsampled twice on 0.5 m^2 area.
[2] Not included in analysis of variance.
[3] Means within vertical column followed by the same letter are not significantly different at 5% level as determined by Duncan's Multiple Range Test.

Table 4. The effects of potato cultivars and control methods on dry weight of lambsquarters.[1]

Potato Cultivar	Herbicide	One Cultivation Dry Weight	None Dry Weight
		g	g
Green Mt.	No weeds	14.7	22.0
Norchip	No weeds	354.4	209.1
Sebago	No weeds	153.7	297.9
Katahdin	No weeds	98.4	430.8

[1] Mean of two replications each subsampled twice on 0.5 m^2 area.

Table 5. Above ground growth characteristics of potato cultivars.

Cultivars	Date of Emergence	Date of Closing In	Date of Falling Over
Green Mt.	6/14	7/5	7/28
Norchip	6/15-6/16	7/7	7/28
Sebago	6/16-6/17	7/9	7/11
Katahdin	6/16-6/17	7/8	7/11

Emergence of Norchip was erratic, as the seed pieces were shrivelled when planted. However, the cultivar was able to provide a tight and dense canopy early in the season until late July when it fell over (Table 5). Weeds emerged above the canopy as a result of the slow initial growth, but were not competitive enough to reduce yield significantly (Fig. 1).

Sebago and Katahdin have similar growth characteristics in that they were slow in emergence and in early growth (Table 5). Even when they had closed in, the soil surface on the hill was exposed. The hills remained exposed throughout the growing season for Katahdin. However, Sebago was able to establish a dense canopy in late August and maintained it until the vines were killed.

Yellow nutsedge competition:

Slight tip and marginal burn in the potato foliage resulted from post-emergence application of linuron and trifluralin. However, the potato plants soon recovered.

All the weeds were in the row and on the side of the hill. Cultivation and hilling eliminated the weeds between the rows. Green Mountain and Hudson were almost weed free, (Table 6). Norchip was intermediate. Both Sebago and Katahdin were heavily infested with yellow nutsedge. In two replications where nutsedge population was minimal, late germinating annual grasses were observed on July 24. As a result of their open canopy, plots of Sebago and Katahdin were densely covered with annual grasses by August 13 (Table 6). Vines of Norchip had fallen over around mid-July and exposed the hill. This allowed the late germinating grasses to grow vigorously (Table 6). Green Mountain and Hudson were practically free of annual grasses (Table 6).

Green Mountain, Hudson and Norchip significantly reduced the number of nutsedge shoots and tubers as well as fresh and dry weights of the tops (Table 7). Nutsedge plants under the canopy of Green Mountain and Hudson were elongated and less vigorous than in the other three cultivars. In Norchip, nutsedge growth was intermediate. Some of the nutsedge shoots in Sebago and Katahdin were flowering. There was no significant difference in weed yields between Sebago and Katahdin.

Table 6. Visual ratings[1] of yellow nutsedge and late germinating annual grasses as influenced by potato cultivars.

Potato Cultivars	Yellow Nutsedge 7/24	Yellow Nutsedge 8/13	Annual Grasses[2] 7/24	Annual Grasses[2] 8/13
Green Mt.	8.4	8.3	8.8	8.8
Hudson	8.3	8.0	8.8	8.8
Norchip	8.1	7.0	8.4	6.8
Sebago	5.8	4.1	8.4	6.3
Katahdin	6.5	5.3	8.4	6.8

[1] Means of five replications. 9=complete weed control; 7=commercially acceptable; 1=no weed control.
[2] Primarily *Digitaria* species and *Echinochloa crusgalli* L.

Table 7. Influence of potato cultivars on growth and tuberization of yellow nutsedge.[1]

Potato Cultivars	Foliage[2] Shoots No.	Foliage[2] Fr. Wt. g	Foliage[2] Dry Wt. g	Tubers[2] No.	Potato Tuber Damage %
Green Mt.	21.0 a	3.4 a	9.8 a	13.9 a	0.8
Hudson	27.0 a	4.6 a	12.2 a	13.1 a	1.3
Norchip	44.7 a	8.5 a	17.4 a	25.8 a	12.7
Sebago	176.7 b	37.0 b	35.2 b	48.0 b	28.8
Katahdin	140.8 b	32.3 b	35.9 b	45.9 b	15.5

[1] Means of five replications each subsampled twice on 45 cm^2 area.
[2] Means within vertical columns having same letters are not significantly different at 5% level as determined by Duncan's Multiple Range Test.

There was practically no damage to Green Mountain and Hudson potato tubers by nutsedge, whereas substantial damage occurred with Sebago, Katahdin and Norchip (Table 7).

Results of stem and branch count in potato cultivars in both experiments are summarized in Table 8. Green Mountain and Hudson were heavily branched, and presumably contributed to the dense foliage and heavy ground cover throughout the growing season, whereas Norchip, Sebago and Katahdin were not.

Table 8. Number of stems and branches for potato cultivars at harvest.

Potato Cultivar	No. Stem/Seed Piece		No. Branches/Seed Piece	
	Long Island[1]	Freeville[2]	Long Island[1]	Freeville[2]
Green Mt.	2.0	2.0	12.1	15.2
Hudson	1.3	-	12.9	-
Norchip	1.7	1.9	4.8	4.7
Sebago	2.6	2.9	5.9	6.0
Katahdin	2.6	3.8	5.2	3.1

[1] Means of five replications, each consisting of 4 plants/plot.
[2] Means of four replications, each consisting of 2 plants/plot.

CONCLUSIONS

Green Mountain and Norchip competed very well with redroot pigweed and lambsquarters. Sebago and Katahdin were the least competitive.

In addition to Green Mountain and Norchip, Hudson was very competitive with yellow nutsedge. It probably would have been competitive with broadleaved weeds. Sebago and Katahdin were poor competitors.

The competitive ability of Green Mountain, Norchip and Hudson with broadleaved weeds and yellow nutsedge was correlated with early emergence, rapid early growth and the ability to maintain a dense leaf canopy throughout the growing season.

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EVALUATION OF HERBICIDES FOR CONTROL OF WEEDS IN LONG ISLAND POTATOES - 1973

William J. Sanok[1/]

Abstract

Eleven chemical herbicides were applied alone or in combination either as an incorporated treatment or pre-emergence treatment on Long Island potatoes. Treatments were evaluated for control of annual broad-leaved weeds, annual grasses and yellow nutsedge and for phytotoxic effects to the potato crop. The incorporated type treatments were effective in giving season-long annual grass control, but the pre-emergence treatments were not. EPTC was the only effective material on a heavy stand of nutsedge.

Procedure

Two experiments were conducted on a commercial farm which had a history of high populations of nutsedge (*Cyperus esculentus L.*). The other predominant weeds were lady's thumb (*Polygonum species*), ragweed (*Ambrosia artemisiifolia L.*), wild mustard (*Brassica rapa*), bindweed (*Convulvulus arvensis L.*), crabgrass (*Digitaria sanguinalis L.*), barnyard grass (*Echinochloa crusgalli (L.) Beau.*), fall panicum (*Panicum pichotomiflorum michx*). The Superior variety of potato (*Solanum tuberosum*) was planted in 34" rows on April 5th. Fertilization was at the rate of 2,250 lbs. of 8-16-8 per acre banded at planting. The potatoes were cultivated once and dragged off before application of herbicides.

Plot size in all the experiments was two rows wide by twenty-five feet long. The experimental design was a randomized complete block with four replications. All materials were applied as a spray with a tractor-mounted two-row boom sprayer using a pressure of 20 p.s.i. and a volume of 38 gallons of water per acre.

Materials listed in Table 1 were applied to the area known to have the greatest incidence of nutsedge and were all applied as pre-emergence incorporate treatments. Materials applied as indicated in Table 2 were pre-emergence to the potatoes and weeds and not incorporated.

Because of frequent spring showers, applications of both experiments were delayed for several days. The incorporated materials were applied May 17th but because of the delay, about 50 - 60% of the potatoes were at the ground crack stage. Prior to application of these materials, the plot was dragged off to hasten drying of the soil surface. These materials were then applied and immediately incorporated with a finger weeder.

For the pre-emergence herbicides the DPX 2645 and DPX 2851 were applied on May 11th and the other materials applied on May 12th. Prior to application of these materials, the entire field had been dragged off and because of delays due to showers, about 40% of the potatoes were at the ground crack

[1/]Cooperative Extension Agent, Suffolk County

stage. As indicated for Trifluralin in Table 1 and Metribuzin in Table 2, a total of three treatments were applied on May 22nd, when the potatoes were at the 4 to 6" stage.

The total area was cultivated and hilled the week of June 17th. Weed control ratings were made on June 13th and August 13th for annual broad-leaved weeds, annual grasses and nutsedge. The potatoes were harvested the last week in August and yield in pounds per plot was taken. In October, the field was observed for possible effects of chemical treatment on subsequent rye cover crop.

Weed control ratings and yield were analyzed for statistical significance using the Duncan's Multiple Range Test at the 1% level.

RESULTS

As indicated in Table 1 EPTC alone and in the combination with R7465 was very effective in the control of nutsedge. The other materials had little if any effect on the growth of this species. The materials were quite effective in control of annual grasses through August but because of the high population of nutsedge, we feel that the population of grasses was limited by this. For annual broad-leaved weeds these materials were effective on all mustard, ragweed, and lady's thumb, but not very effective against bindweed. Bindweed because of its growth habits was not in all plots and this resulted in ratings that varied from plot to plot. The delayed application of Trifluralin and EPTC treatments were less effective against broad-leaved weeds than other treatments but as the season progressed, these differences were not significant.

As indicated in the last column on Table 1 the total yield in pounds per plot was not significantly different when comparing the various treatments. At one point following application, it appeared that the Trifluralin treatment at the 4" stage did cause a little injury but this recovered and the yield was not significantly different. A high percentage of potatoes had damage due to the penetration of the nutsedge stolens in all treatments.

Results of the pre-emergence herbicide trial are listed in Table 2. All of these treatments significantly reduced the population of broad-leaved weeds throughout the season but the control of annual grasses was much less than adequate.

During 1973 throughout Long Island we had a great deal of pressure from the high populations of the Colorado Potato Beetle. This plus the fact that the variety Superior has a small vine with a limited amount of ground cover resulted in more grass in the plots. In addition, the extreme measures taken by the cultivation and hilling practice exposed a great deal of untreated soil from which weeds germinated.

Alachlor and DPX 2851 were somewhat effective in controlling nutsedge, but did not give good commercial control. In addition, the nutsedge was not consistent throughout the plot which made ratings and comparisons difficult.

Alachlor either alone or in combination with Linuron or Chlorbromuron, severely stunted the potatoes early during the season. The intention was to put these treatments out before the potatoes emerged but because of a number of rainfalls we were forced to delay application and some of the potatoes were emerging at the time of treatment. Treatments with Chlorbromuron also caused some leaf burning.

Metribuzin at 1.5 pounds aia and the split treatment of .75 pounds pre-emergence followed with the same amount at the 4" stage severely stunted the potatoes early.

Injury caused by applications of DPX 2645 at 2 pounds aia, DPX 2851 at 2 pounds aia and the split treatment of Metribuzin at .75 pounds aia pre-emergence and .75 pounds aia at the 4" stage significantly reduced the yield.

In observing the seeded rye cover crop on October 29th, the only treatments affecting the crop were DPX 2645 at 2 pounds aia and DPX 2851 at both 1 and 2 pounds aia.

Discussion & Conclusion

Because of the frequent rainfall in early May, most of the potatoes were starting to emerge before applications were made. This resulted in some injury due to applications of Alachlor, Chlorbromuron and Metribuzin. It appears that the variety Superior is very sensitive to certain chemical herbicides, particularly Alachlor when applied too near crop emergence.

Although most chemicals are fairly effective in early control of broad-leaved weeds, heavy cultivation and hilling results in the exposure of untreated soil and an abundance of annual grasses. This coupled with the low and poor ground cover affect of the variety Superior resulted in less than adequate commercial control of barnyard grass, crabgrass, and fall panicum. In the incorporated treatments the annual grass control was adequate, but some of this was due to the high population of nutsedge which acted as a good ground cover preventing germination.

Table 1. Effect of Incorporated Chemicals on Weed Control[1] and Yield of Potatoes

Chemical	Formulation	lbs AIA	Time Applied	Broad-leaved Weeds[2] 6/13	Broad-leaved Weeds[2] 8/13	Annual Grasses[3] 8/13	Nutsedge 6/13	Nutsedge 8/13	Yields lbs/plot
Trifluralin	4 EC	0.75	drag off	8.25ab	7.5 a	10.0a	1.0 c	1.0 b	64.0 a
Trifluralin	4 EC	1.0	drag off	7.5 ab	7.5 a	9.5a	2.5 b	1.0 b	55.5 a
Trifluralin	4 EC	1.0	4" stage	6.0 b	4.75a	8.0a	1.0 c	1.75 b	48.5 a
Trifluralin	4 EC	0.75	drag off	9.5 a	5.0 a	9.5a	1.0 c	2.5 b	62.5 a
+Metribuzin	50 WP	0.25	tank mix						
CGA 10832	4 EC	1.0	drag off	6.75ab	8.0 a	9.0a	1.0 c	1.0 b	62.0 a
CGA 10832	4 EC	1.0	drag off	8.75a	7.5 a	8.5a	1.0 c	1.0 b	59.0 a
+Chlorbromuron	50 WP	2.0	tank mix						
EL 119	75 WP	1.0	drag off	8.75a	8.0 a	9.5a	1.0 c	1.0 b	60.5 a
EL 119	75 WP	1.0	drag off	9.5 a	7.5 a	9.0a	1.0 c	1.0 b	63.0 a
+Metribuzin	50 WP	0.25	tank mix						
EPTC	6 EC	4.5	drag off	7.0 ab	7.5 a	8.5a	8.75a	3.0 b	68.5 a
EPTC	6 EC	6.0	drag off	6.0 b	6.5 a	8.0a	9.0 a	6.5 a	68.25a
R 7465	2 EC	0.75	drag off	9.25a	5.5 a	10.0a	1.75 c	1.0 b	57.0 a
R 7465	2 EC	0.75	drag off	9.25a	7.5 a	10.0a	8.5 a	6.5 a	62.25a
+EPTC	6 EC	4.5	tank mix						
Check				1.0 c	3.5 a	3.5 b	1.0 c	1.0 b	65.25a

[1] Ratings within each column followed by the same letter are not significantly different at the 1% level (Duncan's Multiple Range Test).

Rating Scale: 1 = no control 7 = commercial control 10 = complete control

[2] Weeds present: field bindweed, wild mustard, ragweed, nutsedge, [3] crabgrass, barnyard grass and fall panicum.

Table 2. Effect of Pre-emergence Herbicides on Weed Control[1] and Yield of Potatoes

Chemical	Formulation	lbs AIA	Time Applied	Broad-leaved Weeds[2] 6/13	Broad-leaved Weeds[2] 8/13	Annual Grasses[3] 8/13	Nutsedge 6/13	Yields lbs/plot
Alachlor	4 EC	2.0	pre	7.75a	5.0a	5.0 ab	5.5 ab	70.0 ab
Alachlor	4 EC	2.0	pre	9.5 a	5.0a	2.5 ab	7.5 a	62.5 ab
+Linuron	50 WP	0.75	tank mix					
Alachlor	4 EC	2.0	pre	10.0 a	5.5a	2.5 ab	7.25a	61.25ab
+Chlorbromuron	50 W	1.5	tank mix					
Chlorbromuron	50 W	2.0	pre	9.25a	7.0a	3.5 ab	1.75 b	70.25ab
Chlorbromuron	50 W	4.0	pre	9.0 a	7.0a	6.75a	1.0 b	58.0 b
Linuron	50 WP	1.0	pre	6.25a	6.5a	5.50ab	1.75 b	62.0 ab
Metribuzin	50 WP	1.5	pre	9.0 a	8.0a	5.0 ab	5.0 ab	66.5 ab
Metribuzin	50 WP	0.75	pre	9.75a	5.5a	2.5 ab	5.25ab	60.25ab
+Metribuzin	50 WP	0.75	4" stage					
Metribuzin	50 WP	1.0	pre	9.25a	7.0a	2.5 ab	6.0 ab	49.5 b
+Metribuzin	50 WP	1.0	4" stage					
Linuron	50 WP	2.0	pre	8.5 a	7.0a	6.5 a	1.75 b	68.0 ab
DPX 2645	50 WP	0.5	pre	9.5 a	7.0a	3.0 ab	1.75 b	78.75a
DPX 2645	50 WP	1.0	pre	9.0 a	7.5a	5.5 ab	2.5 ab	64.25ab
DPX 2645	50 WP	2.0	pre	10.0 a	8.0a	4.5 ab	4.0 ab	46.25 b
DPX 2851	50 WP	0.5	pre	6.75a	6.5a	4.5 ab	3.25ab	67.75ab
DPX 2851	50 WP	1.0	pre	9.75a	7.5a	3.5 ab	1.75 b	62.75ab
DPX 2851	50 WP	2.0	pre	9.5 a	7.5a	1.0 b	6.0 ab	12.25 c
Check				1.0 b	1.0 b	2.75ab	1.0 b	64.75ab

[1] Ratings within each column followed by the same letter are not significantly different at the 1% level (Duncan's Multiple Range Test).

Rating Scale: 1 = no control 7 = commercial control 10 = complete control

[2] Weeds present: field bindweed, wild mustard, ragweed, nutsedge, [3] crabgrass, barnyard grass and fall panicum.

WEED CONTROL IN WHITE POTATOES IN MAINE - 1973

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

Abstract

Potato weed control studies in Maine with combinations of 2,chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), with 4-amino-6-*tert*-butyl-3(methylthio)-*as*-triazin-5(4H)one, (metribuzin) 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione (methazole) and 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorbromuron) provided excellent broadleaved and perennial grass control, but most were somewhat ineffective for annual grass control. S-6044, M&B20035, and 2-*tert*-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-Δ^2-1,3,4-oxadiazolin) were all ineffective for control of annual grasses.

Combinations of 3,5-dinitro-N^4,N^4-dipropyl-sulfanilamide (oryzalin) with metribuzin, methazole, and linuron also provided good broadleaved weed and quackgrass control. Oryzalin alone was not effective for annual grass or quackgrass control.

The only chemical treatments that appeared to affect yielding ability of potatoes were 1.5 and 3.0 pounds of methazole applied when potatoes were 4-5% emerged.

Introduction

Several herbicides and combinations of herbicides were tested in Maine during 1973 for control of annual and perennial weeds growing in potatoes. In Maine, herbicides are required which have broad spectrum weed control, are flexible as to time and method of application, and are safe to use in respect to plant damage.

Rainfall during the 1973 growing season, as presented in Table 1, was above normal for May, below normal for June when most of the herbicides were applied, and with the exception of a 3.11 inch rainfall on July 4, July and August were also below normal for precipitation. Conditions for germination of annual broadleaved weeds and annual grasses were favorable in June and early July.

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[1]Associate Professor Agronomy and Crop Supervisor, Department of Plant and Soil Sciences, University of Maine; Orono, Maine 04473.

Materials and Methods

Katahdin potatoes, grown according to commercial production practices except weed control, were used for all test blocks reported. Soil type was a Caribou gravelly silt loam with an organic matter content of 4.52 percent. Plot areas had been fall plowed and the previous crop was spring oats without weed control.

Experimental plot designs were randomized complete blocks with six replicates. Individual plots consisted of 2 rows, 20 feet long, with single buffer rows between treatments.

Herbicides were applied with a compressed air sprayer calibrated to apply 80 gallons of mixture per acre at 40 pounds pressure. Herbicides were applied on the dates indicated on each table presented. Weed control ratings were also made at the two dates indicated in each table.

At harvest time, yield of tubers was obtained and 25 pound samples were saved from each plot for storage studies and as a supply of tissue for residue analyses.

Stored tuber samples were examined about 4 months after harvest for possible internal and external tuber discoloration. Replicates of treatments were composited after examination and stored at 38F. Tubers from selected treatments are to be planted the following year to determine if herbicides cause undesirable side-effects when treated tubers are used for seed.

Common names, trade names, and chemical names for herbicides tested are presented in Table 5.

Results and Discussion

Data presented in Table 2 indicate that all materials tested provided satisfactory control (>4.0) of the broadleaved weed species, such as: *Brassica campestris*, *Brassica napa*, *Chenopodium album*, and *Polygonum persicaria*. Quackgrass (*Agropyron repens*) was also controlled by all herbicides tested. Annual grass (*Echinochloa crusgalli*) was unusually poor.

Alachlor plus 1.0 pound of metribuzin and EPTC plus 3.0 pounds of methazole were the only two treatments that provided good control (3.5 to 3.9) of annual grass. Potato yield data, as presented in Table 2, do not indicate any great differences when comparisons are made with no treatment or with the standard treatment of DNBP plus dalapon.

Data presented in Table 3 present a comparison of time of application of methazole for weed control in potatoes using DNBP plus dalapon, linuron, and DNBP alone as standard treatments. All treatments provided satisfactory control of broadleaved weeds and quackgrass. All treatments

gave excellent early season annual grass control (5.0) but satisfactory (3.5 to 3.9) full season grass control, as shown in Table 3, was provided only by 3.0 pounds of methazole applied as a regular preemergence treatment and at first ground crack. Both rates of methazole applied when potato plants were 4-5% emerged gave satisfactory grass control but caused severe damage to potato plants resulting in decreased tuber yields.

Yield of potatoes, as presented in Table 3, was not affected by herbicide treatments except where methazole was applied at close proximity to time of emergence. This reaction by potatoes was not new since this has been previously reported from Maine and other potato growing areas.

Data presented in Table 4 indicate that all combinations of oryzalin with methazole, metribuzin, and linuron provided excellent control of broadleaved weeds and perennial quackgrass. Annual grass control was excellent early but decreased to satisfactory when only 1.0 and 1.5 pounds of oryzalin combined with linuron. Oryzalin applied alone did not control annual grass or perennial grass species in this test.

Yields of potatoes, as presented in Table 4, were not greatly affected by chemical weed control treatments when compared to the standard of DNBP plus dalapon.

Table 1. 1973 Rainfall - Presque Isle, Maine.

May	1	T
	2	T
	3	0.19
	4	0.07
	6	T
	10	0.06
	11	0.02
	12	0.12
	13	0.26
	16	0.52
	17	T
	19	0.40
	20	0.03
	21	0.87
	22	1.07
	23	0.05
	24	0.03
	25	T
	26	T
	27	T
	28	0.23
	29	1.14
	30	0.18
	31	0.31
		5.55
June	1	0.54
	2	0.40
	7	T
	8	T
	9	0.12
	10	0.02
	11	T
	12	0.32
	13	0.13
	15	0.51
	16	T
	25	0.40
	26	0.08
	28	0.26
	29	0.02
	30	T
		2.80
July	1	0.12
	4	3.11
	5	1.59
	6	0.69
	7	0.11
	8	0.98
	11	0.10
	16	0.05
	19	0.06
	21	0.02
	27	0.12
	28	0.02
	29	0.07
	30	T
	31	T
		7.04
August	1	T
	2	0.05
	3	0.27
	4	0.07
	5	0.50
	6	T
	7	0.12
	8	T
	9	T
	10	0.17
	11	0.26
	12	0.11
	13	0.22
	15	0.03
	17	T
	21	0.04
	22	T
	23	0.14
	24	0.17
	27	0.75
		3.10

Table 2. Effect of several herbicides on yield and weed control in white potatoes in Maine - 1973.

Treatments[1] Pounds of active material per acre	Yield Cwt./A.	Weed Control Ratings[2] Broadleaved 7-9	Broadleaved 8-29	Annual grass 7-9	Annual grass 8-29	Quackgrass 7-9	Quackgrass 8-29
Check - no treatment	114c	1.0	1.0	1.0	1.0	1.0	1.0
2.25 lbs. Alachlor plus 0.25 lbs. Metribuzin, P.E.	189ab	5.0	4.5	2.5	2.5	5.0	4.8
2.25 lbs. Alachlor plus 0.50 lbs. Metribuzin, P.E.	181ab	5.0	4.8	2.5	2.0	5.0	5.0
2.25 lbs. Alachlor plus 1.00 lb. Metribuzin, P.E.	211a	5.0	4.8	3.8	4.2	5.0	5.0
3.00 lbs. EPTC (Regular), P.P.I. plus 2.00 lbs. Chlorbromuron, P.E.	210a	5.0	4.8	2.3	2.7	5.0	5.0
3.00 lbs. EPTC (Flowable), P.P.I. plus 2.00 lbs. Chlorbromuron, P.E.	204a	4.8	4.7	2.7	2.8	5.0	5.0
2.25 lbs. Alachlor plus 3.00 lbs. Methazole, P.E.	162abc	5.0	4.8	2.2	1.8	5.0	5.0
3.00 lbs. EPTC, P.P.I. plus 3.00 lbs. Methazole, P.E.	190ab	5.0	4.8	3.8	3.8	5.0	4.7
1.50 lbs. Oryzalin plus 3.00 lbs. Methazole, P.E.	179abc	5.0	4.0	3.2	2.5	5.0	4.7
2.25 lbs. Alachlor plus 1.50 lbs. Methazole, P.E.	160abc	4.8	4.3	1.5	1.7	5.0	4.7
3.00 lbs. EPTC, P.P.I. plus 1.50 lbs. Methazole, P.E.	184ab	5.0	4.8	1.7	1.8	5.0	5.0
1.50 lbs. Oryzalin plus 1.50 lbs. Methazole, P.E.	170abc	5.0	4.5	2.8	2.2	5.0	4.8
3.00 lbs. S-6044, P.E.	183ab	5.0	4.8	2.0	2.3	5.0	5.0
6.00 lbs. S-6044, P.E.	179abc	4.8	4.5	2.5	2.8	5.0	4.7
1.50 lbs. S-6044, P.E.	173abc	5.0	4.5	2.5	2.3	5.0	5.0
1.00 lb. Oxadiazon, P.E.	157abc	4.8	4.7	1.3	2.3	5.0	4.8
1.50 lbs. Oxadiazon, P.E.	148abc	5.0	4.5	1.3	1.2	5.0	5.0
2.00 lbs. Oxadiazon, P.E.	126bc	5.0	4.7	2.5	2.3	5.0	5.0
0.75 lb. M&B20035, P.E.	150abc	5.0	4.3	2.0	1.7	5.0	4.5
1.50 lbs. M&B20035, P.E.	190ab	4.8	4.5	2.2	2.7	5.0	5.0
3.00 lbs. M&B20035, P.E.	136bc	5.0	4.5	3.7	2.8	5.0	4.7
4.50 lbs. DNBP plus 5.0 lbs. Dalapon, P.E.	188ab	5.0	4.7	2.5	2.5	5.0	4.8

[1]Preplant materials applied - May 28; preemergence materials applied - June 14, 1973. Weather - partly cloudy. Temperature - 72F.

[2]Rating code: 1 = no control; 5 = excellent control. Planted - May 28; harvested - September 12, 1973.

Table 3. Effect of rate and time of application of Methazole on yield and weed control in white potatoes in Maine - 1973.

Treatments[1] Pounds of active material per acre		Yield Cwt./A.	Weed Control Ratings[2] Broadleaved 7-9	Broadleaved 8-30	Annual grass 7-9	Annual grass 8-30	Quackgrass 7-9	Quackgrass 8-30
	Check - no treatment	174ab	1.0	1.0	1.0	1.0	1.0	1.0
4.5 lbs.	DNBP plus 5 lbs. Dalapon, P.E.	194a	5.0	4.7	5.0	3.0	3.2	4.7
1.0 lb.	Linuron, P.E.	200a	5.0	4.8	5.0	3.0	3.0	4.8
1.5 lbs.	Methazole, Early P.E.	173ab	4.8	4.7	5.0	3.3	3.7	4.7
3.0 lbs.	Methazole, Early P.E.	168ab	5.0	4.5	5.0	3.2	3.8	4.5
1.5 lbs.	Methazole, Regular P.E.	186ab	4.8	4.8	5.0	3.3	3.2	4.8
3.0 lbs.	Methazole, Regular P.E.	175ab	5.0	4.7	5.0	4.5	4.3	4.8
1.5 lbs.	Methazole, At first ground crack	182ab	5.0	4.5	5.0	3.2	3.3	4.7
3.0 lbs.	Methazole, At first ground crack	180ab	5.0	4.5	5.0	3.5	3.8	4.8
1.5 lbs.	Methazole, At 4-5% emergence of potatoes	158c	5.0	4.3	5.0	3.7	3.5	4.0
3.0 lbs.	Methazole, At 4-5% emergence of potatoes	161c	5.0	4.5	5.0	3.7	3.8	3.8
4.5 lbs.	DNBP, P.E.	186ab	5.0	4.8	5.0	3.2	2.2	4.8

[1]Early P.E. applied - June 19. Weather - sunny. Temperature - 72F.
Regular P.E. applied - June 22. Weather - cloudy and humid. Temperature - 80F.
At ground crack applied - June 25. Weather - partly cloudy. Temperature - 80F. Few plants emerged, slightly damaged at 3.0-lb. rate.
4-5% emergence materials applied - July 2. Weather - partly cloudy. Temperature - 80F. Severe damage to potato plants at both rates.

[2]Rating code: 1 = no control; 5 = excellent control.

Planted - June 6; harvested - September 13, 1973.

Table 4. Effect of Oryzalin in combination with Methazole, Metribuzin, and Linuron for pre-emergence weed control in white potatoes in Maine - 1973.

Treatments[1] Pounds of active material per acre		Yield Cwt./A.	Weed Control Ratings[2] Broadleaved 7-9	Broadleaved 8-29	Annual grass 7-9	Annual grass 8-29	Quackgrass 7-9	Quackgrass 8-29
	Check - no treatment	208c	1.0	1.0	1.0	1.0	1.0	1.0
4.5 lbs.	DNBP plus 5 lbs. Dalapon	248abc	5.0	5.0	5.0	4.0	3.7	5.0
1.0 lb.	Oryzalin plus 0.5 lb. Metribuzin	249abc	5.0	5.0	5.0	4.7	4.2	4.8
1.5 lbs.	Oryzalin plus 0.5 lb. Metribuzin	243abc	5.0	5.0	4.8	4.2	3.8	5.0
2.0 lbs.	Oryzalin plus 0.5 lb. Metribuzin	227abc	5.0	5.0	5.0	4.0	3.5	5.0
3.0 lbs.	Oryzalin plus 0.5 lb. Metribuzin	257ab	5.0	5.0	5.0	4.2	2.7	5.0
1.0 lb.	Oryzalin plus 1.0 lb. Metribuzin	231abc	5.0	5.0	5.0	4.0	4.0	4.8
1.5 lbs.	Oryzalin plus 1.0 lb. Metribuzin	225abc	5.0	5.0	4.8	4.0	3.2	5.0
2.0 lbs.	Oryzalin plus 1.0 lb. Metribuzin	236abc	5.0	5.0	5.0	4.5	4.0	5.0
3.0 lbs.	Oryzalin plus 1.0 lb. Metribuzin	237abc	5.0	5.0	5.0	4.7	3.3	5.0
1.0 lb.	Oryzalin plus 3.0 lbs. Methazole	240abc	5.0	5.0	5.0	4.8	4.2	5.0
1.5 lbs.	Oryzalin plus 3.0 lbs. Methazole	241abc	5.0	5.0	5.0	4.8	4.5	5.0
2.0 lbs.	Oryzalin plus 3.0 lbs. Methazole	258ab	5.0	5.0	5.0	5.0	4.2	5.0
3.0 lbs.	Oryzalin plus 3.0 lbs. Methazole	230abc	5.0	5.0	5.0	4.2	3.7	5.0
1.0 lb.	Oryzalin plus 1.0 lb. Linuron	243abc	5.0	5.0	5.0	3.7	2.8	5.0
1.5 lbs.	Oryzalin plus 1.0 lb. Linuron	244abc	5.0	5.0	5.0	3.3	2.5	5.0
2.0 lbs.	Oryzalin plus 1.0 lb. Linuron	237abc	5.0	5.0	5.0	4.5	3.3	5.0
3.0 lbs.	Oryzalin plus 1.0 lb. Linuron	214c	5.0	5.0	5.0	4.0	3.2	5.0
1.0 lb.	Linuron	262a	5.0	5.0	5.0	4.3	2.5	5.0
3.0 lbs.	Methazole	232abc	5.0	5.0	5.0	4.2	4.2	4.8
0.5 lb.	Metribuzin	248abc	5.0	5.0	4.7	4.5	3.2	5.0
1.0 lb.	Metribuzin	240abc	5.0	5.0	5.0	4.7	4.2	5.0
1.0 lb.	Oryzalin	216bc	5.0	5.0	2.2	2.2	1.3	3.2
1.5 lbs.	Oryzalin	245abc	5.0	5.0	3.2	3.2	2.2	3.2
2.0 lbs.	Oryzalin	246abc	5.0	5.0	2.0	2.7	1.7	2.8
3.0 lbs.	Oryzalin	249abc	5.0	5.0	3.3	3.0	1.8	4.2

Table 4 - continued.

[1]All materials applied - June 19. Weather - partly cloudy. Temperature 75F.

[2]Rating code: 1 = no control; 5 = excellent control.

Planted - June 8; harvested - September 13, 1973.

Table 5. Herbicides used in white potatoes in Maine - 1973.

Trade Name	Common Name	Chemical Name
Dowpon	Dalapon	2,2-dichloropropionic acid
Eptam	EPTC	*S*-ethyl dipropylthiocarbamate
Lasso	Alachlor	2-chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide
Lorox	Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
Maloran	Chlorbromuron	3-(4-bromo-3 chlorophenyl)-1-methoxy-1-methylurea
Premerge	DNBP	2-*sec*-butyl-4, 6-dinitrophenol
Probe	Methazole	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
Ronstar	Oxadiazon	2-*tert*-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-Δ^2-1,3,4-oxadiazolin-5-one
Sencor	Metribuzin	4-amino-6-*tert*-butyl-3(methylthio)-*as*-triazin-5(4H)one
Surflan	Oryzalin	3,5-dinitro-N^4,N^4-dipropylsulfanilamide
S-6044		
M&B20035		

ALACHLOR, CHLORBROMURON AND METRIBUZIN FOR WEED CONTROL IN POTATOES

R. C. Henne and R. T. Guest[1/]

ABSTRACT

Under conditions of light weed populations preemergence applications of chlorbromuron (3-(4-bromo-3-chlorphenyl)-1-methoxy-1-methylurea) and metribuzin (4-amino-6-tert-butyl-3-(methylthio-as-triazin-5(4H)one) were comparable to linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea), the standard treatment. Alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide) alone was not effective against broadleaf weeds but combinations with chlorbromuron, metribuzin or linuron were very effective. Metribuzin applied postemergence to the crop at the flower bud stage was very phytotoxic and while weed control was excellent total and marketable yields were suppressed.

INTRODUCTION

This experiment was undertaken to determine if new experimental herbicides were equal to or more effective than linuron which is labeled for preemergence weed control on potatoes. Linuron tends to lack effectiveness against some grass weed species and is moisture dependent for activation which can result in variable weed control in dry seasons. There is need for a selective postemergence herbicide and a material effective on grass weeds.

MATERIALS AND METHODS

This study was conducted at Clayton, Delaware on a Sassafras sandy loam soil with an organic matter content of 1%. White potatoes (*Solanum tuberosum* var. Superior) were planted on April 23 in plots, two rows 76.2 cm apart and 6.1 m long. Preemergence treatments were applied on April 30, to a randomized block design with four replicates. Applications were made with a bicycle sprayer using compressed air as a propellent and delivering 363 l/ha. Precipitation totaled 2.2 cm within 8 days of treatment. Postemergence treatments were applied June 6 when potato plants were 25 cm tall and flower buds had formed but were not open. Ragweed (*Ambrosia artemisiifolia*), the dominant broadleaf weed, was 7-8 cm tall at the time of postemergence treatment while velvetleaf (*Abutilon theophrasti*) was approximately 5 cm tall. The grass population was very light and consisted of foxtails (*Setaria* sp.).

Weed control ratings were made on a 1-9 scale where 1 represented no control and 9 complete weed kill. Broadleaf and grass species were rated separately. Ratings were made early in the season, June 1, and again prior to harvest, July 23. Potatoes were not cultivated and uncontrolled weeds were left to compete with the crop. "Weeded" controls were hand hoed three times during the season to prevent weed competition. Potatoes were harvested August 8 with tubers exceeding 5.1 cm in diameter graded marketable.

[1/] Research Associate and Research Scientist, respectively, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

RESULTS AND DISCUSSION

All preemergence treatments provided satisfactory control of the light grass infestation (Table 1). Initial broadleaf weed control was also satisfactory but alachlor alone was unable to contain ragweed and velvetleaf and resulting competition reduced total and marketable yields. Chlorbromuron and metribuzin were comparable in weed control and crop yield to linuron, the standard preemergence treatment. Unfortunately the natural weed population was not heavy enough to enable one to distinguish differences between these three materials. Preemergence combinations with alachlor also were very effective treatments and, while combinations were not necessary for adequate weed control in this study, it is probable that under heavy grass infestations they would be justified (5).

Postemergence applications with metribuzin resulted in moderate foliar burning of potatoes and while weed control was excellent the phytotoxicity observed was reflected in total and marketable yields similar to the unweeded control treatment. In 1972 Superior potatoes sustained temporary foliar injury from metribuzin applied at the same rate and at 2X this rate when the crop was 7 cm tall, but yields were not affected (3). Weather conditions at the time of postemergence treatment were similar in both years, i.e., sunny, calm, high temperatures 29-32° C and fairly high relative humidity. Apparently the phytotoxicity sustained in 1973 was at a more critical stage of crop growth and the physiological shock was reflected in poor tuber production. Fricke (1) in 1972 observed tip necrosis from metribuzin at 1.12 kg/ha applied to Superior potatoes at 10.2 cm and 20.4 cm height. Injury was not visible 10-14 days later but no yield data were reported. Lay et al. (4) reported marginal leaf burn and stunting of Superior potatoes from postemergence metribuzin at up to 2.24 kg/ha. Stage of crop was not reported but yields, while down, were not significantly different. Hawkins (2) made late season postemergence applications to Katahdin potatoes on August 11 and 19, 1972 and noted no injury. Stage of crop growth was not reported nor were yields.

Postemergence metribuzin application may be less injurious if applied to potatoes when plants are young and actively growing than if delayed until flower buds are forming. The response observed in this trial needs verification and differences in varietal response to postemergence metribuzin need study.

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Table 1. Weed control rating and potato response [illegible] veral herbicide treatments at Clayton, Delaware in 1973.

Treatment		Weed control rating 1-9				Yield metric ton/ha	
	Rate kg/ha ai	Broadleaf		Grasses			
Herbicide	(preemergence)	6/1	7/23	6/1	7/23	Total	Marketable
Weeded control		9^{a}	7^{a}	9^{a}	6^{a}	15.1^{abc}	7.9^{abc}
Unweeded control		2^{b}	1^{c}	3^{b}	3^{b}	12.8^{c}	5.1^{bc}
Linuron	1.12	9^{a}	9^{a}	9^{a}	8^{a}	16.1^{abc}	8.3^{abc}
Chlorbromuron	1.12	9^{a}	8^{a}	9^{a}	8^{a}	15.9^{abc}	7.8^{abc}
Chlorbromuron	2.24	9^{a}	9^{a}	9^{a}	9^{a}	18.7^{ab}	10.3^{a}
Metribuzin	0.56	9^{a}	9^{a}	9^{a}	8^{a}	19.3^{a}	10.1^{a}
Metribuzin	1.12	9^{a}	9^{a}	9^{a}	9^{a}	14.6^{bc}	7.4^{abc}
Alachlor	2.24	7^{a}	4^{b}	9^{a}	7^{a}	12.5^{c}	5.0^{c}
Alachlor + linuron	2.24 + 1.12	9^{a}	9^{a}	9^{a}	9^{a}	17.8^{ab}	8.6^{ab}
Alachlor + chlorbromuron	2.24 + 1.12	9^{a}	9^{a}	9^{a}	9^{a}	14.8^{bc}	6.7^{bc}
Alachlor + metribuzin	2.24 + 0.56	9^{a}	9^{a}	9^{a}	9^{a}	14.6^{bc}	6.9^{abc}
Metribuzin	0.84 (postemergence)	1^{b}	9^{a}	2^{b}	8^{a}	12.6^{c}	5.8^{bc}

[a] Means in columns followed by a common letter are not significantly different at the 5% level (Duncan's Multiple Range Test).

EFFECT OF COMBINATIONS OF CHLORBROMURON AND LINURON WITH ALACHLOR ON YIELD AND WEED CONTROL IN WHITE POTATOES IN MAINE - 1973

Hugh J. Murphy[1]

Abstract

Tests in Maine using 3-(4-bromo-3 chlorphenyl)-1-methoxy-1-methylurea (chlorbromuron) and 3-(3,4 dichlorophenyl)-1-methoxy-1-methylurea (linuron) indicated that both herbicides gave effective control of broadleaved and perennial weed species growing in white potatoes. Late season annual grass control, however, was attained only by combining 2-chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide (alachlor) with chlorbromuron and linuron.

Introduction

The use of chlorbromuron and linuron for weed control in white potatoes is not new since both herbicides are labeled for preemergence application. Frequently, however, Maine potato growers have reported foliage damage in fields where these herbicides had been used. Phytotoxicity symptoms could have been caused by application of either compound too close to time of potato plant emergence, using rates higher than recommendation, or application when soil conditions were too dry. In addition, control of annual grass (*Echinochloa crusgalli*) has been erratic in most years which probably indicates that the addition of a grass herbicide, such as 2-chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), might provide extended control of annual grasses where these herbicides are used. This short paper reports the results of a test conducted in Maine during 1973 to gain further knowledge on the effects of chlorbromuron, linuron, and alachlor on weed control and crop damage to potatoes.

Materials and Methods

A field of Katahdin potatoes planted on June 8, 1973, was used for application of the treatments listed in Table 1 on June 20, 1973, which was about two days before emergence of potato plants. Soil was moist but not wet, and in very good physical condition. Single row plots, 20 feet long, arranged in a randomized complete block design and with buffer rows between treatments were used. Combinations of each rate of herbicide tested were paired with the herbicide alone and all treatments were replicated five times. All materials or treatments were applied preemergence to potatoes in 80 gallons of water using 40 pounds pressure. Weed control rating and crop damage codes are presented at the bottom of Table 1. Phytotoxicity

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[1]Associate Professor of Agronomy, Department of Plant and Soil Sciences, University of Maine; Orono, Maine 04473.

ratings were made one week after plants emerged and continued at weekly intervals until symptoms disappeared.

Results and Discussion

Data presented in Table 1 indicate that all rates of chlorbromuron and linuron gave excellent full season broadleaved weed control for the species present, such as *Chenopodium album*, *Polygonum persicaria*, *Brassica napa*, and *Brassica campestris*. Quackgrass (*Agropyron repens*) was also completely controlled by the time the last readings were made on August 30. Control of annual grass (*Echinochloa crusgalli*) early in the season was also excellent, but readings taken on August 30 indicate that grass control had declined somewhat. It should be noted, however, that where alachlor was combined with either chlorbromuron or linuron, annual grass control late in the season was improved over either herbicide used alone. From the data presented in Table 1, one could conclude that a rate of 1.25 pounds A.I. of chlorbromuron was needed, if used alone, to control annual grass satisfactorily (3.5 to 3.9). Linuron, in this study, was more effective in controlling annual grass at the lower rates used than chlorbromuron.

Yield differences, as presented in Table 1, do not appear to be closely related to herbicide treatments or foliage damage as shown by phytotoxicity ratings. A probably explanation for these erratic yield differences might be soil moisture variation between replicates.

Foliar damage ratings, as presented in Table 1, indicate some injury occurred at the higher rates of both chlorbromuron and linuron used. These phytotoxicity ratings were not as high as expected, since the herbicides were applied before any potato plants emerged. Soil conditions were not dry, and a one week period after plant emergence was allowed for mild symptoms to disappear.

Table 1. Effect of rate of chlorbromuron and linuron in combination with alachlor on yield and weed control in white potatoes. Maine - 1973.

Preemergence Treatments[1] Pounds of active material per acre		Weed Control Ratings[2] Broadleaved 7-9	Broadleaved 8-30	Annual grass 7-9	Annual grass 8-30	Quackgrass 7-9	Quackgrass 8-30	Phyto-toxicity ratings[3]
Check - no treatment	238b-e	1.0	1.0	1.0	1.0	1.0	1.0	0
4.50 lbs. DNBP plus 5.0 lbs. Dalapon	240a-e	5.0	5.0	5.0	3.6	2.8	5.0	0
4.50 lbs. DNBP	244a-e	5.0	5.0	5.0	3.8	3.0	5.0	0
0.75 lbs. Chlorbromuron	249a-e	5.0	5.0	5.0	2.8	1.6	5.0	0
0.75 lbs. Chlorbromuron plus 2.25 lbs. Alachlor	237cde	5.0	5.0	5.0	4.2	2.6	5.0	0
1.00 lb. Chlorbromuron	263a-e	5.0	5.0	5.0	2.8	2.6	4.8	0
1.00 lb. Chlorbromuron plus 2.25 lbs. Alachlor	230e	5.0	5.0	5.0	3.2	2.6	5.0	0
1.25 lbs. Chlorbromuron	277ab	5.0	5.0	5.0	4.0	2.8	5.0	0
1.25 lbs. Chlorbromuron plus 2.25 lbs. Alachlor	256a-e	5.0	5.0	5.0	4.4	2.6	5.0	0
1.50 lbs. Chlorbromuron	257a-e	5.0	5.0	5.0	3.2	2.0	5.0	0
1.50 lbs. Chlorbromuron plus 2.25 lbs. Alachlor	264a-d	5.0	5.0	5.0	4.4	2.4	4.8	0
1.75 lbs. Chlorbromuron	259a-e	5.0	5.0	5.0	4.4	2.8	5.0	1
1.75 lbs. Chlorbromuron plus 2.25 lbs. Alachlor	261a-e	5.0	5.0	5.0	4.6	3.2	5.0	1
2.00 lbs. Chlorbromuron	245a-e	5.0	5.0	5.0	3.6	3.4	5.0	3
2.00 lbs. Chlorbromuron plus 2.25 lbs. Alachlor	267abc	5.0	5.0	5.0	3.8	2.0	5.0	3
0.75 lbs. Linuron	242a-e	5.0	5.0	5.0	3.6	2.4	5.0	0
0.75 lbs. Linuron plus 2.25 lbs. Alachlor	249a-e	5.0	5.0	5.0	3.8	2.8	5.0	0
1.00 lb. Linuron	238b-e	5.0	5.0	5.0	3.8	3.4	5.0	0
1.00 lb. Linuron plus 2.25 lbs. Alachlor	227e	5.0	5.0	5.0	4.0	3.2	5.0	0
1.25 lbs. Linuron	232e	5.0	5.0	5.0	2.6	1.2	5.0	0
1.25 lbs. Linuron plus 2.25 lbs. Alachlor	248a-e	5.0	5.0	5.0	4.0	3.0	4.5	0
1.50 lbs. Linuron	252a-e	5.0	5.0	5.0	3.4	2.4	5.0	1
1.50 lbs. Linuron plus 2.25 lbs. Alachlor	279a	5.0	5.0	5.0	3.8	2.6	5.0	1
1.75 lbs. Linuron	263a-d	5.0	5.0	5.0	3.6	2.7	5.0	3
1.75 lbs. Linuron plus 2.25 lbs. Alachlor	265a-d	5.0	5.0	5.0	4.0	2.7	5.0	3
2.00 lbs. Linuron	267abc	5.0	5.0	5.0	3.4	3.6	5.0	4
2.00 lbs. Linuron plus 2.25 lbs. Alachlor	222e	5.0	5.0	5.0	3.6	3.4	5.0	4

Table 1 - continued.

[1]All treatments applied preemergence - June 20, 1973. Weather - sunny. Temperature 80F. Broadleaved weeds - not heavy; annual grass - very good growth; quackgrass - lightly scattered but uniform.

[2]Rating code: 1 = no control; 5 = excellent control. Planted - June 8; harvested - September 13, 1973.

[3]Crop phytotoxicity ratings: 0 = none; 5 = medium, lasting at least 7 days; 10 = severe, lasting at least 21 days.

RATE AND TIME OF METRIBUZIN APPLICATION FOR WEED CONTROL IN WHITE POTATOES IN MAINE - 1973

Hugh J. Murphy[1]

Abstract

A study conducted in Maine during 1973 indicated that satisfactory weed control in potatoes could be obtained with 4-amino-6-*tert*-butyl-3-(methylthio)-*S*-triazin-5(4H)one (metribuzin) at rates of 16 ounces or less per acre. Minimal damage to potato plants and no yield reductions occurred when metribuzin was applied prior to emergence to potato plants.

Introduction

Frequent reports of damage to potato plants from trial use of metribuzin as an herbicide in 1972 stimulated an in-depth study to more closely define rates and time of metribuzin application for white potatoes in 1973. Since many of the potatoes grown in Maine are entered for seed certification, any damage to foliage that would mask or prevent disease detection cannot be tolerated. In addition, because of the limited length of growing season, plant damage that would delay either vine growth or maturity of tubers could be detrimental to potato yields and quality.

Materials and Methods

In an attempt to determine rates of metribuzin that potatoes could tolerate at various times of application, metribuzin was applied at five rates and six timing intervals to a field planted to Katahdin potatoes. Two-row plots, 20 feet long with single buffer rows between treatments were used and arranged in a randomized complete plot design. All treatments were replicated six times. Materials were applied in 80 gallons of water at 40 pounds pressure using a 4-nozzle, two-row brush type boom. Dates of application by stage of growth are presented in Table 1. Weed rating code used, weed species present, and crop phytotoxicity ratings used are also presented at the bottom of Table 1. Damage to plants, as indicated by phytotoxicity ratings, were made one week after plants emerged for preemergence treatments and at approximately weekly intervals until phytotoxicity symptoms disappeared.

Results and Discussion

Data presented in Table 1 indicate that rates of metribuzin applied

[1]Associate Professor of Agronomy, Department of Plant and Soil Sciences, University of Maine; Orono, Maine 04473.

at all stages of plant growth except at "layby" gave excellent full season control (4.0 or higher) of broadleaved weeds such as *Brassica campestris*, *Brassica napa*, *Chenopodium album*, and *Polygonum persicaria*. Control of annual barnyard grass (*Echinochloa crusgalli*) was less than full season when only 4 ounces of metribuzin was applied at early preemergence and regular preemergence. All rates of metribuzin applied at all stages of plant growth except "layby" gave excellent quackgrass(*Agropyron repens*) control which appeared to improve as the season progressed.

Yield of tubers from metribuzin treated plots, as shown in Table 1, was not affected by rate of application except when potato plants were emerged or when applied at layby. Significant yield reductions occurred where 24 ounces of metribuzin was applied to plants 3-4 inches high and at all rates applied at layby. Yield reductions during these later stages of plant growth are probably related to the high intensity of plant damage and length of recovery period from damage.

Damage to potato plants, as indicated by the relative phytotoxicity ratings presented in Table 1, probably represent how much a plant can be damaged and recover in time to prevent yield reductions. As an estimate, relative ratings of more than two would not be acceptable for potatoes grown for seed purposes since disappearance of the phytotoxic symptoms would not be soon enough. This suggests that when metribuzin is used on seed potatoes, rates should not exceed 16 ounces if applied as a regular preemergence treatment or never later than first sign of ground crack. For potatoes grown for processing and fresh market, rates of up to 20 ounces might be applied as late as first sign of ground crack and 16 ounces might be used when potatoes are 4-5 percent emerged.

Table 1. Yield and weed control ratings for white potatoes following application of 5 rates of Metribuzin at 6 stages of plant growth. Maine - 1973.

Treatments[1] Pounds of active material per acre	Yield Cwt./A.	Weed Control Ratings[2] Broadleaved 6-10	Broadleaved 8-30	Annual grass 6-10	Annual grass 8-30	Quackgrass 6-10	Quackgrass 8-30	Phyto-toxicity rating[3]
Check - no treatment	190c	1.0	1.0	1.0	1.0	1.0	1.0	0
4.5 lbs. DNBP plus 5 lbs. Dalapon, P.E.	228a	5.0	3.8	5.0	4.0	4.2	4.3	0
1.0 lb. Linuron, P.E.	214ab	5.0	4.0	5.0	3.7	3.3	4.3	0
4 oz. Metribuzin, Early P.E.	212bc	4.8	4.5	5.0	2.2	2.3	4.2	0
8 oz. Metribuzin, "	216ab	4.8	4.8	4.5	4.0	3.5	5.0	0
16 oz. Metribuzin, "	220ab	5.0	5.0	5.0	4.0	4.5	5.0	0
20 oz. Metribuzin, "	210bc	5.0	4.3	5.0	3.8	3.3	5.0	0
24 oz. Metribuzin, "	205bc	4.8	4.5	5.0	5.0	4.0	5.0	2
4 oz. Metribuzin, Regular P.E.	212bc	5.0	4.3	5.0	3.5	2.7	5.0	0
8 oz. Metribuzin, "	216ab	5.0	4.0	5.0	4.5	3.7	5.0	0
16 oz. Metribuzin, "	216ab	5.0	4.5	5.0	4.2	3.5	4.8	0
20 oz. Metribuzin, "	212bc	5.0	4.3	5.0	5.0	4.5	5.0	2
24 oz. Metribuzin, "	200c	5.0	4.2	5.0	5.0	4.0	5.0	3
4 oz. Metribuzin, First sign of ground crack	205bc	5.0	4.5	5.0	4.0	3.8	4.8	0
8 oz. Metribuzin, " " " "	202c	5.0	4.5	5.0	4.2	3.7	4.7	0
16 oz. Metribuzin, " " " "	204bc	4.8	4.7	4.8	5.0	4.2	5.0	2
20 oz. Metribuzin, " " " "	189c	5.0	4.0	5.0	5.0	4.2	5.0	4
24 oz. Metribuzin, " " " "	190c	4.8	4.8	5.0	5.0	4.7	5.0	5
4 oz. Metribuzin, Potatoes 4-5% emerged	190c	5.0	4.3	5.0	4.7	4.0	5.0	0
8 oz. Metribuzin, " " "	186d	5.0	4.3	5.0	4.5	3.8	5.0	2
16 oz. Metribuzin, " " "	186d	5.0	4.0	5.0	5.0	3.8	5.0	3
20 oz. Metribuzin, " " "	180de	5.0	4.3	5.0	5.0	3.2	4.8	5
24 oz. Metribuzin, " " "	175c	4.8	4.8	5.0	5.0	3.7	4.8	7
4 oz. Metribuzin, Potatoes 3-4 inches	180de	4.8	5.0	4.8	4.5	3.0	4.7	5
8 oz. Metribuzin, " " "	180de	4.8	4.7	4.8	5.0	3.7	4.7	6
16 oz. Metribuzin, " " "	175e	4.8	4.7	4.8	4.8	3.3	4.8	7
20 oz. Metribuzin, " " "	172ef	5.0	5.0	5.0	4.7	3.7	4.8	8
24 oz. Metribuzin, " " "	160g	5.0	3.8	5.0	5.0	4.0	5.0	10

Table 1 - continued.

Treatments[1] Pounds of active material per acre	Yield Cwt./A.	Weed Control Ratings[2] Broadleaved 6-10	Broadleaved 8-30	Annual grass 6-10	Annual grass 8-30	Quackgrass 6-10	Quackgrass 8-30	Phyto-toxicity rating[3]
4 oz. Metribuzin, Layby[4]	154g		1.2		1.2		1.2	10
8 oz. Metribuzin, "	154g		1.5		1.3		1.7	10
16 oz. Metribuzin, "	150gh		1.5		1.7		1.7	10
20 oz. Metribuzin, "	138i		1.0		1.0		1.0	10
24 oz. Metribuzin, "	135i		1.0		1.0		1.0	10

[1]Early P.E. applied - June 11; Regular P.E. applied - June 18; At ground crack applied - June 12; 4-5% emergence applied - June 25; Potatoes 3-4 inches applied - June 27; Layby applied - July 6, 1973. Weather - partly cloudy. Temperatures: 6-11 = 70F.; 6-18 = 73F.; 7-4 = 78F.

[2]Rating code: 1 = no control; 5 = excellent control.

[3]Crop phytotoxicity rating: 0 = none; 5 = medium, lasting at least 7 days; 10 = severe, lasting for at least 21 days.

[4]Extreme phytotoxicity lasting for 28 days.

THE INTEGRATION OF SEVERAL CULTIVATION SCHEDULES WITH ALACHLOR COMBINATIONS IN WHITE POTATOES

D. J. Herman, M. R. Henninger and R. D. Ilnicki 1/

ABSTRACT

Ideally, crops treated with herbicides should not need cultivation as an adjunct; however, there are management practices in potatoes such as drag-off and hilling which, while not performed for weed control alone, do serve as cultivations. This experiment was designed to determine what, if any, interactions there are between herbicide treatments and (A) no cultivation, (B) drag-off + hilling, (C) one cultivation + hilling and (D) drag-off + one cultivation + hilling.

Major weed species present were lambsquarters (*Chenopodium album* L.), pigweed (*Amaranthus retroflexus* L.), fall panicum (*Panicum dichotomiflorum* Michx), crabgrass (*Digitaria ischaemum* (Schreb.) Muhl.) and barnyardgrass (*Echinochloa crusgalli* (L.) Beauv.).

Single herbicides evaluated alone were linuron 1 lb/A, methazole 2 lb/A, chlorbromuron 3 lb/A, metribuzin 1 lb/A, and alachlor 2 lb/A, and combinations of the above with alachlor at 3/4 + 1½, 1½ + 1½, 2 + 1½, and 3/4 + 1½ respectively.

In general, weed control and yield performance ranked highest to lowest for cultivation schedules (C), (D), (B), and (A). With schedules (D) and (B) exposure and germination of new weed seeds and dilution of the herbicide due to drag-off may have resulted. Statistically, schedule (C) was better than (B) and (A) while (D) was only better than (A). The best treatments for weed control and yield, which were similar in performance, were chlorbromuron, alachlor + chlorbromuron, metribuzin, and alachlor + metribuzin. However, the alachlor + metribuzin treatment was nominally the highest yielding treatment for schedules (C), (D), and (B) while not being significantly different from the other three treatments.

1/Research Intern, Assistant Professor of Horticulture and Research Professor of Weed Science, Soils and Crops Department, respectively, Rutgers University, New Brunswick, N. J. 08903.

Appendix

Material & Formulation	Chemical Name	Manufacturer
alachlor (4EC)	2-chloro-2', 6'-diethyl-N-(methoxy-methyl) acetanilide	Monsanto
chlorbromuron (50W)	3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methyurea	CIBA GEIGY
linuron (50W)	3-(3,4-dichlorophenyl)-1-methoxy-1-methyl urea	E.I. DuPont
methazole(75W)	2-(3,4-dichlorphenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione	Velsicol
metribuzin (50W)	4-amino-6-t-butyl-3-(methylthio)-as-triazin-5(4H)-one	Chemagro

POTATO VINE KILLING IN MAINE - 1972

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

Abstract

Several chemical desiccants and adjuvants to increase their efficacy were tested on Katahdin potatoes in Maine during 1972. The dinitro compounds and Des-I-Cate in combinations with #2 furnace oil, Booster E, and Booster Plus E, in general, provided good vine desiccation in 1972. Evik at 3.75 pounds per acre gave good vine desiccation but decreased emergence and yield of tubers the following year. CP41845 was judged satisfactory for vine killing and gave excellent sprout inhibition of harvested tubers.

Introduction

The following paper reports the results of potato vine killing studies conducted in Maine during the 1972 growing season. Evaluation of tubers harvested from treated plots was made during the 1972-73 storage season, and emergence tests were conducted during the 1973 growing season.

Materials and Methods

All desiccants and adjuvants, unless otherwise specified, were applied in 80 gallons of water per acre at 40 pounds pressure to actively growing Katahdin potato vines and on the dates indicated in each table of data presented. A compressed air sprayer with a two-nozzle brush type boom was used for foliar application of all mixtures. Plots used were single rows, 25 feet long, and with single buffer rows between treatments. Plots were arranged in randomized complete block design with each treatment replicated six times.

Using a five-step rating system as listed in Table 1, vine kill ratings were made at 7-day intervals following application of chemicals.

Table 1. Potato vine-kill rating code. Maine - 1972.

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

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[1]Associate Professor of Agronomy and Crop Supervisor, Department of Plant and Soil Sciences; University of Maine, Orono, Maine 04473.

At harvest time, approximately 15 pounds of tubers were collected from each plot and stored at 50F. for examination during the winter storage season. Storage studies included: examination of tubers for possible storage disorders, vascular discoloration, and skin blemishes which might be caused by use of chemical desiccants. From these storage samples tubers were supplied to cooperators for residue analyses and quality tests.

Tubers that were snipped for observing vascular discoloration in early January 1973, were composited by treatment and stored at 38F. In May 1973, tubers from selected treatments were planted in replicated emergence and yield trials. These plots were observed at several growth stages to detect any possible side effects which might be related to desiccation treatments in 1972.

Table 4 presents source, names, and active chemical compounds in desiccants used in the 1972 Maine potato vine killing trials.

Results and Discussion

Data presented in Table 2 indicate that the combinations of Evik plus Booster Plus E, Evik plus Tronic, Dow General plus #2 oil, and Dytop at a rate of 8 pints per acre provided for satisfactory (>4.0) potato vine desiccation. Other combinations, such as: Evik plus Charger E, Dytop plus Booster Plus E, CP41845 plus #2 oil, and Dytop at 6 pints per acre, gave only good (3.5 to 3.9) vine desiccation. In this study during 1972, Miller Aide, Agway S.S., and Surfactant GA-701 did not improve the efficacy of Evik, Dow General, or Dytop.

Vascular discoloration of tubers from treated plots, as shown in Table 2, appeared to be highest when #2 oil was used with Dow General, Charger E with Evik, and Booster Plus E with Dytop. No severe vascular discoloration of tubers was found in this test, indicating that soil moisture conditions were probably high enough to prevent plants from becoming moisture stressed.

The only vine desiccants, as shown in Table 2, that affected emergence of treated tubers harvested for seed in 1972 was CP41845. This compound, developed as a chemical ripener for sugarcane, appears to have possibilities for sprout inhibition of potato tubers in addition to desiccation of potato vines.

Yields of potatoes grown from treated seed are also presented in Table 2. Analysis of variance indicated no significant differences in yields except for CP41845 where no tubers harvested were of marketable size.

Data presented in Table 3 indicate that treatment of 3-3/4 pounds of Evik plus GA-701, Dow General, Premerge, 2 gallons of Des-I-Cate plus either #2 oil or X-77 spreader-sticker, and Paraquat provided satisfactory

(>4.0) vine kill. Several other treatments, such as: Roundup (glyphosate) at 2 and 2-2/3 quarts per acre, Evik at 2-1/2 and 3-3/4 pounds, and CP41845 gave good (3.5 to 3.9) vine kill under the temperature, soil moisture, and slightly matured vine conditions present when the treatments were applied.

All three DNBP compounds, namely Dow General, Premerge, and Dytop, and Paraquat at 10 pounds per acre caused some severe vascular discoloration of tubers which was undesirable. Roundup (glyphosate) caused all tubers to rot either in the field or in storage.

Evik at 3-3/4 pounds per acre, as shown in Table 3, did have an effect on emergence of plants from treated tubers used as seed. CP41845 applied for vine killing appeared to have done an almost perfect job of sprout inhibition. Yields of potatoes grown from treated seed harvested in 1972 were significantly reduced by the treatments of 3-3/4 pounds of Evik and CP41845.

Table 2. Effect of several chemicals and additives on potato vine desiccation, discoloration of tubers, emergence and yield from tubers used for seed. Katahdin variety. Maine - 1972.

Treatments[1]			Vine kill ratings[2]			Percent vascular discoloration[3]			% emergence	Yield Cwt./A.
Material	Rate/Acre	Additive	8-25	9-1	9-8	Slight	Medium	Severe	1973	1973
No treatment			1.0	1.0	1.0	0.7			100.0	284
Evik (80W)	2½ lbs.	4 oz. Miller Aide	2.1	1.9	2.8*	0.6	1.2		100.0	280
Evik	2½ lbs.	8 oz. Charger E	3.1	2.9	3.6	1.7	3.3		100.0	286
Evik	2½ lbs.	2 qts. Booster Plus E	3.5	3.5	4.7	2.4	0.3		100.0	284
Evik	2½ lbs.	8 oz. Agway S.S.	2.2	2.2	2.6*	1.5			100.0	282
Evik	2½ lbs.	4 oz. GA-701	2.4	2.2	2.8*	0.3	0.3		100.0	281
Evik	2½ lbs.	1 qt. Tronic	3.4	3.1	4.5	0.5	3.2		100.0	284
Dow General	2 qts.	1 pt. Miller Aide	2.2	2.1	2.3*	1.9			100.0	271
Dow General	2 qts.	2 qts. Tronic	2.8	2.6	2.9	2.0			100.0	281
Dow General	2 qts.	5 gals. #2 oil	3.7	3.7	4.5	8.8	0.6		100.0	288
Dow General	2 qts.	1 qt. Booster Plus E	3.0	2.8	3.4	0.7			100.0	283
Dow General	2 qts.	8 oz. Agway S.S.	2.7	2.5	2.8*	1.3			100.0	280
Dow General	2 qts.	1 qt. Charger E	3.1	2.8	3.9	2.0	0.3		100.0	282
Dytop	4 pts.		2.4	2.4	2.4*	1.2			100.0	280
Dytop	6 pts.		3.2	3.1	3.9	0.6			100.0	281
Dytop	8 pts.		3.4	3.2	4.4	1.7	0.6		100.0	284
Dytop	6 pts.	1 qt. Booster Plus E	3.3	3.2	3.9	5.1	0.4		100.0	282
Dytop	6 pts.	8 oz. Agway S.S.	3.0	2.8	3.4	1.5			100.0	280
Dytop	6 pts.	1 qt. Charger E	3.1	3.1	3.6	1.0			100.0	284
CP41845	10 lbs.	5 gals. #2 oil	2.6	2.7	3.8	0.3	1.0		4.2	---

[1]/Materials applied - August 17, 1972. Weather - clear. Temperature - 70F. Vine growth vigorous but not dense. Soil conditions moist but not wet. [2]/Kill rating code presented in Table 1.
[3]/Examinations made on 15-pound samples from each of six replicates on January 3, 1973.

* New terminal vine growth started to appear on September 5, 1973.

Table 3. Effect of several chemicals applied at differential rates on vine kill, tuber discoloration, emergence, and yield of tubers used for seed. Katahdin variety. Maine - 1972.

Treatments[1]			Vine kill ratings[2]			Percent vascular discoloration[3]			% emergence	Yield Cwt./A.
Material	Rate/Acre	Additive	8-21	8-28	9-7	Slight	Medium	Severe	1973	1973
No treatment			1.0	1.0	1.0	0.7			100.0	287
Roundup (3E)	1 qt.		1.0	1.8	2.1	All tubers rotted			---	---
Roundup	1-1/3 qts.		1.1	2.1	2.4	"			---	---
Roundup	2 qts.		1.2	3.0	3.6	"			---	---
Roundup	2-2/3 qts.		1.2	3.0	3.9	"			---	---
Evik (80W)	2-1/2 lbs.		1.1	2.4	3.5*	0.3			100.0	281
Evik	3-3/4 lbs.		1.1	2.5	3.7*				93.0	255
Evik	2-1/2 lbs.	8 oz. GA-701	1.1	2.7	3.3*	0.3			100.0	275
Evik	3-3/4 lbs.	8 oz. GA-701	1.1	2.9	4.2				93.2	240
Dow General	2 qts.	5 gals. #2 oil[4]	3.0	4.4	5.0	2.7	0.9	0.3	98.3	273
Premerge	3 qts.	5 gals. #2 oil plus 1 pt. X-100[4]	2.7	4.2	5.0	2.3	1.8	0.6	97.9	276
Des-I-Cate	2 gals.	5 gals. #2 oil	4.2	4.3	4.8	0.5	0.3		100.0	276
Des-I-Cate	2 gals.	8 oz. X-77	3.7	4.0	4.1	0.3			100.0	275
Dytop	6 pts.		2.2	2.8	3.2*	0.7			100.0	289
Dytop	7 pts.		2.7	3.0	3.3*	2.1	0.6	0.3	100.0	294
Paraquat	2 pts.	8 oz. X-77	3.8	4.3	5.0	3.6	0.3		100.0	286
Paraquat	10 pts.	8oox. X-77	4.8	4.9	5.0	21.8	9.1	4.5	100.0	282
CP41845	10 lbs.		2.0	3.5	3.5*	0.7			1.7	---

[1]/Materials applied - August 16, 1972. Weather - partly cloudy. Temperature - 74F. Vine growth started to mature. Soil conditions moist to dry. [2]/Kill rating code presented in Table 1.
[3]/Examinations made on 15-pound samples from each of six replicates on January 4 and 5, 1973.
[4]/Split applications applied 5 days apart.

* New growth started to appear on September 1, 1972.

Table 4. Chemical desiccants used for Maine potato vine killing studies - 1972.

Compound	Active Ingredient	Source
Evik (80W)	2-(ethylamino)-4-(isopropylamino)-6-methyl-*S*-triazine	CIBA-Geigy Corporation
Dow General	4,6-dinitro-O-sec-butylphenol	Dow Chemical Company
Dytop	4,6-dinitro-O-sec-butylphenol	Niagara Chemicals Ltd.
CP41845	N,N-Bis-(phosphomethyl) glycine	Monsanto Commercial Products Company
Roundup	N-Phosphonomethylglycine	Monsanto Commercial Products Company
Premerge	4,6-dinitro-O-sec-butylphenol	Dow Chemical Company
Des-I-Cate	Mono-(N-dimethylathylanion salt of endothal)	Pennwalt Corporation
Paraquat	1,1-dimethyl-4, 4-bipyridium dichloride	Chevron Chemical Ompany
Aide	Activator	Miller Chemicals
Charger E	Adjuvant and wetting agent	Agway Incorporated
Booster Plus E	Surfactant	Agway Incorporated
Agway S.S.	Surfactant	Agway Incorporated
GA-701	Surfactant	CIBA-Geigy Corporation
Tronic		Colloidal Products Corporation
X-100	Spreader-sticker	Rohm and Haas Corporation
X-77	Spreader-sticker	Chevron Chemical Company

1972 POTATO VINE KILLING RESULTS - UPSTATE NEW YORK[1/]

J. B. Sieczka[2/]

ABSTRACT

Eight vine killing treatments were applied to vines of two potato cultivars (Solanum tuberosum L. 'Kennebec' and 'Russet Rural'). Data were collected on rate of vine kill, specific gravity, vascular discoloration, chip color, and sprout growth. Materials differed in the rate of vine desiccation. Twenty-four days after application to vigorously growing vines the only materials which did not result in satisfactory vine kill were 4-dimethylamino-thiocyanobenzene (RP2929) and 2(ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine (ametryne). The 2-sec-butyl-4,6-dintrophenol (dinoseb) treatments tended to result in more vascular discoloration than the check but were not significantly different from most other vine killing treatments. Some tubers of the Russet Rural variety had a diffuse discoloration near the vascular ring which was not associated with vine killing treatment. This discolored zone turned dark brown upon frying. Specific gravity, chip color, and sprout growth were not affected by vine killing treatment.

INTRODUCTION

An internal discoloration in 'Russet Rural' tubers, which turned dark brown upon frying, caused rejection of a substantial amount of this variety for the potato chip market in 1971 and 1972. The occurence of this disorder took place after dinoseb replaced sodium arsenite as the standard potato vine killer. Some growers and industry representatives speculated that the use of dinoseb was the cause of the problem.

The following paper summarizes the results of experiments conducted to investigate the effect of 8 vine killing treatments on internal discoloration of potato tubers of two cultivars used in potato chip production. Rate of vine kill, specific gravity, chip color and sprout growth were other parameters used in evaluating vine killing treatments.

MATERIALS AND METHODS

Two experiments were established in upstate New York. One was located at the Cornell University Vegetable Crops Research Farm at Freeville, New York. The other was located in a grower's field in Wyoming County, New York. The cultivars 'Kennebec' and 'Russet Rural' were planted in adjacent rows on May 17, 1972 at the Freeville location. 'Russet Rural' was planted at

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1/ Paper No. 662 of the Department of Vegetable Crops, Cornell University, Ithaca, New York 14850.

2/ Extension Specialist, Department of Vegetable Crops, Cornell University, Ithaca, New York 14850.

the Wyoming County site on June 2, 1972. Other than the difference in cultivars the experiments were conducted in a like manner. Plot size was 1.8 x 7.6 m. The experimental design was a randomized complete block with four replications. The spray material was applied with a hand carried, CO_2 pressurized sprayer which delivered approximately 340 l/ha. at 2.46 kg/cm^2. All chemical rates listed in the tables are active ingredient.

Visual ratings of vine kill were based on a scale of one to nine; one being equal to no effect on leaves and stems and nine equivalent to complete kill. Potatoes were harvested on September 20, 1972 at Freeville and October 5, 1972 at Wyoming County. Fifty tubers from each treatment in each replication were evaluated for stem end discoloration at time of harvest. These data were collected by trimming the stem end and enumerating the number of tubers with vascular discoloration approximately 0.6 cm. from the stem end. Since this method of collecting data did not distinguish between different types of discoloration, subsequent readings were taken in the following manner. After storage at 10°C fifteen tubers of each treatment in each replication were cut in half longitudinally (from apical to stem end) and internal discoloration was rated for type, intensity and depth. Two types of discoloration were scored and referred to as vascular and diffuse. A pencil line discoloration limited to the vascular ring is defined as the vascular type. The diffuse type is described as a diffuse discoloration extending from and including the vascular ring. The intensity rating was based on a scale of one to three (1 = no discoloration, 2 = slight, 3 = severe). Depth was scored on a scale of 1 to 5 (1 = no discoloration, 2 = discoloration extends up to $\frac{1}{4}$ of tuber length from the stem end, 3 = up to $\frac{1}{2}$, 4 = up to 3/4, 5 = greater than 3/4).

Chip color was determined by frying one slice of each of the tubers cut in the previously described evaluation. Chips with dark zones were enumerated and then were crushed to obtain Agtron reflectence meter readings.

Sprout weight produced on tubers from the Freeville experiment was obtained on March 20, 1973 after storage at 10°C.

RESULTS AND DISCUSSION

The results of the Freeville experiment listed in Table 1 show that materials differed in their initial rate of vine kill. Fifteen days after application all the materials except RP2929 resulted in reasonably good vine kill. The vines in this experiment were beginning to senesce at time of application. At the initiation of the Wyoming County experiment the vines were vigorously growing and proved to be more difficult to kill. However, only RP2929 and ametryne had ratings below eight 24 days after application. (See Table 2.) The dinoseb treatment with diesel fuel resulted in a faster rate of desiccation than did dinoseb with Booster Plus E in both experiments. However, the final ratings for both dinoseb treatments were similar. The unfortunate over-spraying of the Wyoming County experiment with dinoseb at 2.1 kg/ha two days before the last observation tended to increase the ratings of the marginal treatments. However, the relative position of the treatments still appears to be valid.

Table 1. 1972 Freeville vine killing experiment, vine kill ratings.

Treatment Chemical & Rate (kg/ha)	Vine Kill Rating[1] 'Kennebec' Days After Application 3	10	15	'Russet Rural' Days After Application 3	10	15
check	2.5	4.8	7.3	2.5	4.8	7.3
dinoseb, 2.1, and diesel fuel (46.8 l)	6.7	8.5	8.8	6.7	8.5	8.5
dinoseb, 2.1 and Booster Plus E (4.7 l)	4.7	7.0	8.3	4.7	7.0	8.3
ametryne, 2.8	2.7	7.5	8.8	2.7	7.5	8.5
RP2929, 3.4	2.7	5.8	8.0	2.7	5.8	7.3
endothall, 1.2	3.7	7.5	8.8	3.7	7.5	8.8
Terr-O-Pik 514, 2.2	6.2	8.5	9.0	6.2	8.5	8.8
sodium arsenite, 9.0	5.5	8.8	9.0	5.5	8.8	9.0
$D_{(.05)}$ Tukey	2.5	2.3	1.5	2.5	2.3	1.6

[1] Based on a rating scale of 1 to 9, 1 = green leaves and stems, 9 = complete kill.

Table 2. 1972 Wyoming County vine killing experiment, vine kill ratings.

Treatment Chemical & Rate (kg/ha)	Vine Kill Rating[1] Days After Application 5	17	24[2]	Specific Gravity
check	1.0	1.5	4.0	1.079
dinoseb, 2.1, and diesel fuel (46.8 l)	3.3	7.8	8.5	1.074
dinoseb, 2.1 and Booster Plus E (4.7 l)	3.0	7.8	8.3	1.076
ametryne, 2.8	1.3	5.0	7.5	1.076
RP2929, 3.4	4.0	4.0	6.8	1.076
endothall, 1.2	5.3	8.3	9.0	1.079
Terr-O-Pik 514, 2.2	3.3	9.0	9.0	1.077
sodium arsenite, 9.0	4.5	8.5	9.0	1.078
$D_{(.05)}$ Tukey	1.6	2.0	1.5	ns

[1] See footnote 1, Table 1.

[2] Experiment sprayed with dinoseb 22 days after experimental application were made.

The specific gravity was not affected by vine killing treatment in either of the experiments.

The intensity of internal discoloration did not appear to be affected by vine killing treatment (see Tables 3, 4, and 5). However, the dinoseb treatments tended to increase the extent of the discoloration in tubers from the Freeville site. The number of tubers having a "pencil line" discoloration limited to the vascular ring was greatest in the dinoseb treatments. The Terr-O-Pik treatment also resulted in more tubers with this type of discoloration in the Freeville experiment. The distribution of tubers with the diffuse type of discoloration appeared to be random and restricted to 'Russet Rural'. Dark areas in potato chips made from 'Russet Rural' tubers were closely associated with zones of diffuse discoloration in the raw tissue.

Agtron meter readings of crushed chips indicated that chip color of both varieties was not affected by the vine killing treatments. Likewise sprout weight was not influenced by the treatments used (see Table 6).

CONCLUSIONS

RP2929 was not effective in killing potato vines while ametryne only performed well on senescing vines. The dinoseb treatments resulted in more tubers having a "pencil line" discoloration limited to the vascular ring. A diffuse discoloration located near the vascular ring occurred in 'Russet Rural' tubers. This diffuse discoloration was distributed randomly and not associated with vine killing treatment. The virtual lack of this type of discoloration in 'Kennebec' tubers indicates the disorder is probably due to the susceptibility of the 'Russet Rural' cultivar to diseases such as *Fusarium eumartii* or leaf roll which can cause this type of discoloration.

Specific gravity, sprout growth and chip color were not influenced by the vine killing treatments used.

Table 3. 1972 Freeville vine killing experiment, Kennebec storage results.

Treatment Chemical & Rate (kg/ha)	Internal Discoloration in Tubers: Avg. Rating		Avg. No. of Tubers		Avg. No. of Chips with Dark Areas[1]
	Intensity[2]	Depth[3]	Vasc.[4]	Diff.[5]	
check	1.2	1.2	2.3	0.8	1.5
dinoseb, 2.1 and diesel fuel (46.8 l)	1.6	1.8	7.5	0	0.5
dinoseb, 2.1 and Booster Plus E (4.7 l)	1.6	2.0	9.0	0	0.5
ametryne, 2.8	1.3	1.3	4.3	0	1.0
RP2929, 3.4	1.2	1.2	3.0	0.3	0.5
endothall, 1.2	1.3	1.4	4.5	0	0.5
Terr-O-Pik 514, 2.2	1.6	1.6	7.3	0.3	1.0
sodium arsenite, 9.0	1.3	1.3	4.0	0	0.8
$D_{(.05)}$ Tukey	ns	0.7	5.5	-	-

1/ Fifteen tubers of each treatment were cut longitudinally in half from each of 4 replications. Samples were stored at 16°C until 1/3/73, the date of observation.

2/ Intensity Scale: 1 = no discoloration, 2 = slight, 3 = severe.

3/ Depth Scale: 1 = no discoloration, 2 = discoloration extends up to 1/4 of the tuber length (from stem end), 3 = up to 1/2, 4 = up to 3/4, 5 = greater than 3/4.

4/ Discoloration limited to the vascular ring.

5/ Diffuse discoloration usually extending from and including the vascular ring.

Table 4. 1972 Freeville vine desiccation experiment, 'Russet Rural' storage results.

Treatment Chemical & Rate (kg/ha)	Internal Discoloration in Tubers[1] Avg. Rating		Avg. No. of Tubers		Avg. No. of Chips with Dark Areas[1]
	Intensity[2]	Depth[3]	Vasc.[4]	Diff.[5]	
check	1.4	1.4	3.8	(2.3)	(2.0)
dinoseb, 2.1 and diesel fuel (46.8 l)	1.8	2.5	9.8	(1.7)	(2.0)
dinoseb, 2.1 and Booster Plus E (4.7 l)	1.8	2.2	6.0	(2.7)	(2.0)
ametryne, 2.8	1.4	1.4	3.3	(1.3)	(2.0)
RP2929, 3.4	1.6	1.6	4.3	(2.7)	(2.3)
endothall, 1.2	1.3	1.3	3.8	(0)	(0)
Terr-O-Pik 514, 2.2	1.7	1.9	7.3	(2.3)	(1.7)
sodium arsenite, 9.0	1.6	1.7	6.5	(1.7)	(1.7)
$D_{(.05)}$ Tukey	ns	0.8	5.2	(ns)	(ns)

1/ See footnote 1, Table 3, figures in parentheses are averages of 3 replications.

2/ See footnote 2, Table 3.

3/ See footnote 3, Table 3.

4/ See footnote 4, Table 3.

5/ See footnote 5, Table 3, figures in parentheses are averages of 3 replications.

Table 5. 1972 Wyoming County vine desiccation experiment, 'Russet Rural' storage results.

Treatment Chemical & Rate (kg/ha)	Internal Discoloration in Tubers[1] Avg. Rating		Avg. No. of Tubers		Avg. No. of Chips with Dark Areas[1]
	Intensity[2]	Depth[3]	Vasc.[4]	Diff.[5]	
check	1.8	2.1	3.5	6.5	6.3
dinoseb, 2.1 and diesel fuel (46.8 l)	1.9	2.2	9.0	2.0	2.5
dinoseb, 2.1 and Booster Plus E (4.7 l)	1.7	2.3	8.0	1.3	1.8
ametryne, 2.8	1.5	1.6	3.5	2.5	2.0
RP2929, 3.4	1.6	1.9	3.0	5.0	4.5
endothall, 1.2	1.6	1.8	4.3	4.0	3.3
Terr-O-Pik 514, 2.2	1.6	1.8	4.0	4.3	3.5
sodium arsenite, 9.0	1.6	1.9	6.0	2.3	2.3
$D_{(.05)}$ Tukey	ns	ns	4.5	ns	ns

1/ See footnote 1, Table 3.

2/ See footnote 2, Table 3.

3/ See footnote 3, Table 3.

4/ See footnote 4, Table 3.

5/ See footnote 5, Table 3.

Table 6. 1972 vine killing experiments, chip color[1/] and sprout weight[2/].

Treatment Chemical & Rate (kg/ha)	Freeville 'Kennebec' Chip Color	Freeville 'Kennebec' Sprout Weight	Freeville 'Russet Rural' Chip Color	Freeville 'Russet Rural' Sprout Weight	Wyoming County 'Russet Rural' Chip Color
check	63	5.1	68	4.3	51
dinoseb, 2.1 and diesel fuel (46.8 l)	65	4.7	69	3.5	53
dinoseb, 2.1 and Booster Plus E (4.7 l)	68	4.5	64	4.0	54
ametryne, 2.8	69	5.8	68	4.3	57
RP2929, 3.4	66	5.5	68	4.5	50
endothall, 2.1	65	4.3	69	3.9	53
Terr-O-Pik 514, 2.2	66	5.0	68	4.4	53
sodium arsenite, 9.0	68	4.5	68	3.6	53
$D_{(.05)}$ Tukey	ns	ns	ns	ns	ns

1/ Samples were stored at 16°C until frying on 1/3/73. Color of crushed chips on Agtron F reflectance colorimeter set so that discs 5005 and 5052.2 gave readings of 0 and 100, respectively. Higher values indicate lighter chip color. Minimum values for "generally acceptable color" would probably range from 55 to 65.

2/ Stored at 10°C from 9/20/72 until 3/20/73. Expressed as % of total weight.

EFFECT OF VINE KILLERS ON TOP-KILL AND INTERNAL TUBER QUALITY OF POTATOES

Joseph D. Harrington[1/]

Abstract

Seven chemical vine killers were foliar applied at one rate to evaluate the rate of vegetative top-kill and their effect on internal quality of Kennebec and R. Rural potato varieties at harvest and after storage at controlled temperatures. Rapidity of vegetative top-kill varied for variety and chemical vine killer. Faster top-kill was observed for Kennebec (less top growth) than Russet Rural. However, several chemicals killed more slowly than others. Chemical vine killers applied to both varieties did not affect internal tuber quality either after harvest or after storage, and in most cases, the differences among vine killers and the check (no treatment) were not significant.

Introduction

Extensive use of chemical vine killers on potatoes (Solanum tuberosum L.) as a management practice by commercial potato growers has been employed for many years. Successful fall crop harvest in the Northeast has depended, at least in part, on the grower's ability to harvest large acreages of a high internal quality raw product before the onset of inclement weather and unfavorable soil conditions. Extended delays could jeopardize the producer's crop.

Today, with the cancellation of sodium arsenite as a potato vine killer, and the possibility that too rapid a top-kill, e.g., mechanical beaters and chemical vine killers, result in lower tuber specific gravity and tuber discoloration (1, 2, 3), more recently developed vine killers warrant evaluation as alternatives for use on potatoes.

Materials and Methods

Experiments were conducted at the Agronomy Research Farm near Rock Springs, Pa. (central) in 1972. Soils at the experimental sites were deep, heavy, well drained, and slightly acidic. Seed pieces (4-cut) of Kennebec and Russet Rural were machine-planted 9 inches apart within 25-foot single row plots, with a 3-foot break between plots. Rows were 3 feet apart. At planting, a systemic insecticide and commercial fertilizer was banded to the side of the seed pieces. Fertilization at planting was 210-140-140 pounds of N-P_2O_5-K_2O per acre, respectively. Recommended cultural practices were maintained throughout the growing season. A completely randomized block design with three replications for each variety was employed.

[1/] Professor of Agronomy, Department of Agronomy, The Pennsylvania State University, University Park, Pa.

Chemical vine killers and rates per acre (treatments) were as follows:

1. Check (no treatment)
2. Dow General, 3 pt. + No. 2 Fuel Oil, 5 gal.
3. Dow General, 3 pt. + Booster Plus E, 2 qt.
4. Evik, 2.5 lb. a.i.
5. RP2929, 3.0 lb. a.i.
6. Des-I-Cate, 1.14 lb. a.i. (2 gal.)
7. Terr-O-Pik, 2.0 lb. a.i.
8. Sodium Arsenite, 8.0 lb. a.i. (2 gal.)

Dates on which various field and laboratory procedures were completed follow:

	Kennebec	Russet Rural
Planting	May 19	May 19
Vine Killer (V.K.) Applied	Sept. 8 (133 days after pltg.)	Sept. 15 (140 days after pltg.)
Harvest	Sept. 22 (14 days after V.K.)	Oct. 2 (17 days after V.K.)
Specific Gravity & 1st Chipping	Sept. 25 (3 days after harv.)	Oct. 3 (1 day after harv.)
2nd Chipping, after Storage (90 days at 52° F and 30 days at 70° F)	Feb. 7	Feb. 14

The data collected in these experiments were recorded as follows:

Tops Dead: 1, 3, 5, 7, 10, & 14 days after V.K. application; 1.0 = least, 9.0 = most

Vascular Discoloration after Harvest: 25 tubers chosen at random; Kenn. - 14 days after V.K. appli.; R.R. - 17 days after V.K. appli.; 1.0 = none, 2.0 = slight, 3.0 = moderate, 4.0 = severe

Specific Gravity after Harvest: determined on approx. 10-pound samples by the air-and water-method; Kenn. - 17 days after V.K. appli. and 3 days after harvest; R.R. - 18 days after V.K. appli. and 1 day after harvest

Chip Color, Rd, after Harvest: determined on 8-ounce samples of peeled, 1/16" sliced, and rinsed raw and fried potatoes (stem end); employed Gardner Color Difference Meter; Rd (reflectance) values 20.0 and above may be considered commercially acceptable, e.g., 20.0 = light, 30.0 = very light; varietal chip color evaluated same date as specific gravity

Sprout wt., g, after Storage: 18 to 26 tubers for all reps and treatments (24 samples/variety) were desprouted and average fresh sprout weight per tuber, in grams, was determined

Vascular Discoloration and Chip Color, Rd, after Storage: 12 tubers chosen at random; determined for each variety and treatment after controlled storage at 52° F for 3 months and reconditioning at 70° F for 1 month

Rainfall and air temperatures before and after vine killer application are summarized as follows:

	Rainfall, Total Inches	$\bar{X}$ °F, Max.	Min.
Week before V.K. Appli., Kenn.	0.10	77	51
Week before V.K. Appli., R.R.	1.29	73	53
1st Week after V.K. Appli., Kenn.	1.29	73	53
1st Week after V.K. Appli., R.R.	0.25	74	56
2nd Week after V.K. Appli., Kenn.	0.25	74	56
2nd Week after V.K. Appli., R.R.	0.85	56	44

Results

The data obtained from these experiments are presented in Table 1. Graphic illustrations showing the rate of top-kill 3-, 7- and 10-days after vine killer application are shown in Figure 1. Results may be summarized as follows:

Rapidity of vegetative top-kill varied for variety and chemical vine killer. Faster top-kill was observed for Kennebec (less top growth) than Russet Rural. However, regardless of variety, several vine killers at the indicated rates killed more slowly than others.

Slowest vine kill for Kennebec and Russet Rural (tops dead rating 3-, 5-, and 7-days after appli.) --Evik, RP2929

Fastest vine kill for Kennebec (least to most rapid tops dead rating 3 days after appli.) --Terr-O-Pik; Des-I-Cate; Dow Gen. + F. O.; Dow Gen. + Booster; Sod. Arsenite

Fastest vine kill for Russet Rural (least to most rapid tops dead rating 3 days after appli.) --Dow Gen. + F.O.; Terr-O-Pik; Dow Gen. + Booster; Sod. Arsenite; Des-I-Cate

With few exceptions, e.g., Evik and RP2929, 100 percent of Kennebec and Russet Rural vines were completely dead 7 days after vine killer application.

Chemical vine killers applied to both varieties did not affect internal tuber quality either after harvest or after storage. In most cases, differences among vine killers and the check (no treatment) were inconsequential. However, differences between varieties for several quality indices were observed.

> Tubers of Russet Rural compared with Kennebec showed slightly more vascular discoloration after harvest and storage. Regardless of treatment, stem end rot was observed in some tubers of Russet Rural, whereas the same disorder was not found among Kennebec tubers.
>
> Range in tuber specific gravity for varieties and treatments was from 1.089 to 1.092. For the check treatment, specific gravity for Kennebec tubers was 1.090, whereas tuber specific gravity for Russet Rural was 1.091.

Differences in chip color after harvest and storage among the eight treatments for each variety were not significant.

> Although chip color after harvest was acceptable regardless of variety or treatment, chips lighter in color were obtained for Russet Rural. Average Rd value for Russet Rural and Kennebec was 27.6 and 24.2, respectively.
>
> Chip color after storage for Kennebec (22.9 Rd), also, was acceptable; whereas, chips unacceptable in color were obtained for Russet Rural (13.9 Rd).

Chemical vine killers neither stimulated nor suppressed the amount of sprout growth, based upon sprout weight in grams, after controlled storage conditions.

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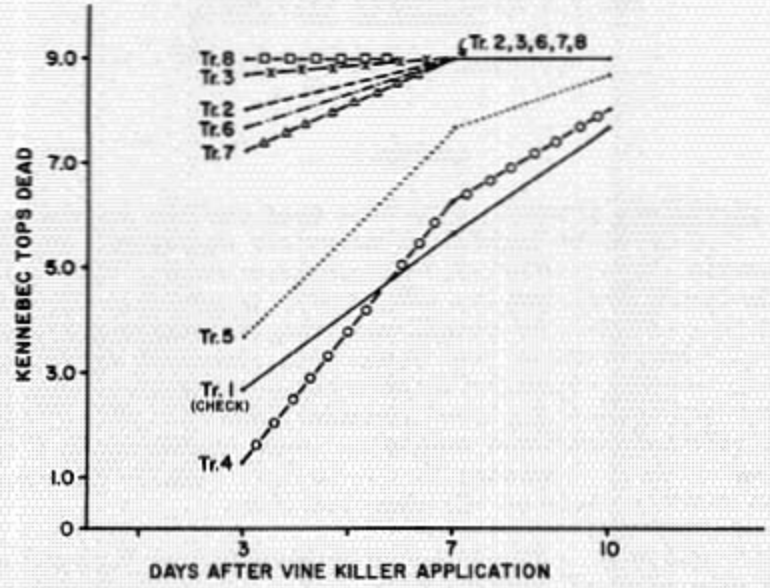
Table 1. Effect of vine killers on potatoes produced in central Pennsylvania, 1972.

VINE KILLERS & RATES/A (treatments)	TOPS DEAD, days after vine killer application 1	3	5	7	10	14
	- - - - - - - - - KENNEBEC - - - - - - - -					
1. Check (no treatment)	2.0	2.7	4.3	5.7	7.7	8.7
2. Dow General, 3 pt. + No. 2 Fuel Oil, 5 gal.	7.7	8.0	9.0	9.0	9.0	9.0
3. Dow General, 3 pt. + Booster Plus E, 2 qt.	7.7	8.7	9.0	9.0	9.0	9.0
4. Evik, 2.5 lb. a.i.	1.0	1.3	3.0	6.3	8.0	9.0
5. RP2929, 3.0 lb. a.i.	2.0	3.7	6.0	7.7	8.7	9.0
6. Des-I-Cate, 1.14 lb. a.i. (2 gal.)	4.7	7.7	8.7	9.0	9.0	9.0
7. Terr-O-Pik, 2.0 lb. a.i.	3.7	7.3	8.7	9.0	9.0	9.0
8. Sodium Arsenite, 8.0 lb. a.i. (2gal.)	3.9	9.0	9.0	9.0	9.0	9.0
L.S.D. (.05)	1.9	1.4	1.8	1.6	1.0	NS
	- - - - - - - - - RUSSET RURAL - - - - - -					
1. Check (no treatment)	2.0	3.0	4.7	6.3	7.7	9.0
2. Dow General, 3 pt. + No. 2 Fuel Oil, 5 gal.	4.3	5.7	7.7	8.3	9.0	9.0
3. Dow General, 3 pt. + Booster Plus E, 2 qt.	4.0	7.0	8.3	9.0	9.0	9.0
4. Evik, 2.5 lb. a.i.	3.3	4.3	6.7	7.7	8.7	9.0
5. RP2929, 3.0 lb. a.i.	2.0	2.7	5.7	7.0	8.0	9.0
6. Des-I-Cate, 1.14 lb. a.i. (2 gal.)	3.7	8.0	8.7	9.0	9.0	9.0
7. Terr-O-Pik, 2.0 lb. a.i.	3.7	6.0	8.7	9.0	9.0	9.0
8. Sodium Arsenite, 8.0 lb. a.i. (2 gal.)	2.7	7.7	9.0	9.0	9.0	9.0
L.S.D. (.05)	NS	2.3	1.9	1.3	0.7	NS

Table 1. (Cont'd.)

VINE KILLERS & RATES/A (treatments)	AFTER HARVEST VASC. DISCOLOR.	AFTER HARVEST SPEC. GRAV.	AFTER HARVEST CHIP COLOR, Rd	AFTER STORAGE SPROUT WEIGHT, g	AFTER STORAGE VASC. DISCOLOR.	AFTER STORAGE CHIP COLOR, Rd
KENNEBEC						
1. Check (no treatment)	1.3	1.090	25.0	2.4	1.0	23.6
2. Dow General, 3 pt. + No. 2 Fuel Oil, 5 gal.	1.3	1.091	23.1	2.0	2.0	24.2
3. Dow General, 3 pt. + Booster Plus E, 2 qt.	1.7	1.090	22.7	2.0	2.0	20.6
4. Evik, 2.5 lb. a.i.	1.0	1.089	24.7	2.1	2.0	22.2
5. RP2929, 3.0 lb. a.i.	1.3	1.091	23.8	1.8	1.0	23.9
6. Des-I-Cate, 1.14 lb. a.i. (2 gal.)	1.0	1.089	25.2	1.9	1.7	24.1
7. Terr-O-Pik, 2.0 lb. a.i.	1.3	1.090	23.5	1.9	1.7	23.4
8. Sodium Arsenite, 8.0 lb. a.i. (2 gal.)	1.3	1.089	25.2	2.0	1.7	21.3
L.S.D. (.05)	NS	NS	NS	NS	0.5	NS
RUSSET RURAL						
1. Check (no treatment)	2.0	1.091	26.0	1.9	2.0	12.7
2. Dow General, 3 pt. + No. 2 Fuel Oil, 5 gal.	2.0	1.091	26.9	2.1	2.0	15.4
3. Dow General, 3 pt. + Booster Plus E, 2 qt.	2.0	1.089	25.9	2.0	2.0	13.5
4. Evik, 2.5 lb. a.i.	2.0	1.089	28.3	2.1	2.0	13.0
5. RP2929, 3.0 lb. a.i.	2.0	1.090	30.5	2.2	2.0	13.8
6. Des-I-Cate, 1.14 lb. a.i. (2 gal.)	2.0	1.092	28.3	2.0	2.0	13.3
7. Terr-O-Pik, 2.0 lb. a.i.	2.0	1.090	27.7	2.0	2.0	15.0
8. Sodium Arsenite, 8.0 lb. a.i. (2 gal.)	2.0	1.089	27.2	2.1	2.0	14.6
L.S.D. (.05)	NS	NS	NS	NS	NS	NS



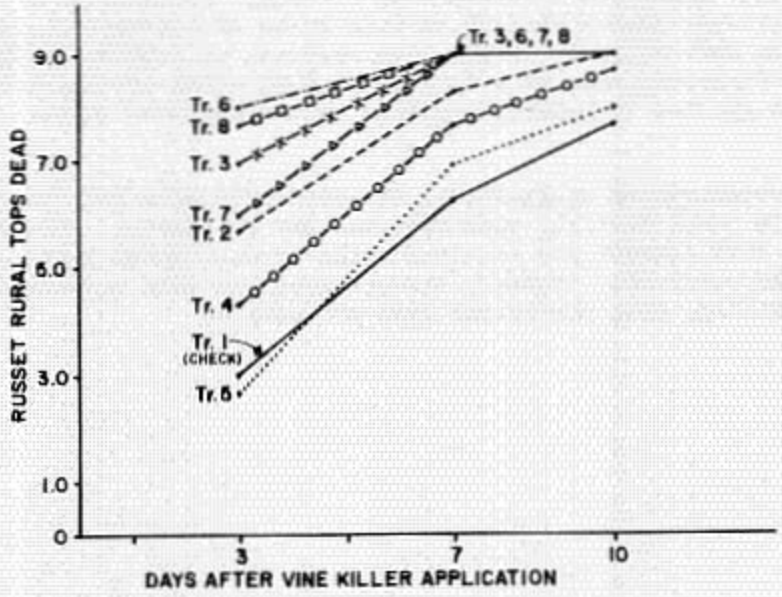


Figure 1. Rate of vegetative top-kill for Kennebec and Russet Rural potatoes 3-, 7- and 10-days after vine killer application.

CONTROL OF GALINSOGA PARVIFLORA

R. C. Henne and R. T. Guest [1/]

ABSTRACT

Galinsoga parviflora presents a serious weed problem to tomato growers in New Jersey. In 1972 eight herbicides materials registered for use in tomatoes; diphenamid (N,N-dimethyl-2,2-diphenylacetamide), trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), isopropalin (2,6-dinitro-N,N-dipropylcumidine), pebulate (S-propyl butylethylthiocarbamate), and paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) along with promising experimentals; metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one), napropamide (2-(a-naphthoxy)-N,N-diethylpropionamide), and U-27,267 (3,4,5-tribromo-N,N,a-trimethylpyrazole-1-acetamide) were evaluated in a heavily infested galinsoga plot at Rancocas, N. J. In 1973 results with metribuzin were verified in a small study at the same location.

In 1972 trifluralin at 1.12 kg/ha and isopropalin at 2.24 kg/ha rated poor, providing only a 15-20% reduction in galinsoga stand compared to the untreated control. Diphenamid at 6.7 kg/ha preemergence and pebulate, 6.72 kg/ha preplant incorporated (ppi), were rated slightly better with approximately a 60% reduction in galinsoga stand. Diphenamid at 6.72 kg/ha ppi and U-27,267 at 1.68 kg/ha ppi were considered fair with an 85% reduction in stand. Metribuzin at 0.28 kg/ha ppi provided 100% control. Postemergence applications to seedling galinsoga plants at 0.28 or 0.56 kg/ha of metribuzin also provided 100% control and were slightly better than paraquat at 0.56 kg/ha which gave 94% control. Metribuzin was 76% effective at 0.28 kg/ha and 98% effective at 0.56 kg/ha when applied to galinsoga plants that were 30-40 cm tall and in flower.

In 1973 postemergence applications of metribuzin were made to large galinsoga plants 40-45 cm tall, well branched and in flower. At 0.28, 0.56 and 1.12 kg/ha 100% control was attained while at 0.14 kg/ha leaves were burnt but plants survived. However, flowers appeared very sensitive to this rate and were killed, thus preventing seed production.

[1/] Research Associate and Research Scientist, respectively, Campbell Institute for Agricultural Research, Clayton, Delaware 19938.

SOIL-APPLIED HERBICIDES IN THE CONTROL OF[1/] NATIVE BROADLEAF WEEDS AND GRASSES

R. D. Shipman[2/]

Abstract. Soil-applied herbicides were studied for an eighteen month period, March 1969 - October 1970, for their effectiveness, rapidity of action, and duration of vegetation response in native stands of central Pennsylvania broadleaf weeds and grasses. Of 180 species taxonomically classified, three species were dominant: poverty grass (Danthonia spicata), Kentucky bluegrass (Poa pratensis), and timothy (Phleum pratense). Total vegetation control of all species increased directly with increased rate of herbicide. Most complete control occurred with bromacil (5-bromo-3-sec-butyl-6-methyluracil), karbutilate m (3,3-dimethylureido) phenyl-tert-butylcarbamate, and picloram (4-amino-3,5,6-trichloropicolinic acid) plus diuron 3- (3,4-dichlorophenyl)-1, 1-dimethylurea. Total vegetation control was more effective on clay-textured soils than on loamy sands or clay loam soils.

Materials and Methods

At each of four old-field test sites, 11 chemical treatments (single and combined herbicides), plus untreated and adjacent controls, were replicated three times on 200 square foot plots (10 x 20 feet). All chemicals and chemical combinations were first prepared in the laboratory according to rate and plot size accommodation and then spread by hand or sprayed (wettable powders) on the test plots during the period May 3-13, 1969. The following herbicides according to formulation and pounds per acre were applied:

	Herbicide	Formulation	Rates in lb/acre (a.i.)		
			Low	Medium	High
1.	bromacil[a]	85% granule	5	10	20
2.	bromacil	80% WP	5	10	20
3.	diuron[b]	8% granule	10	20	30
4.	karbutilate[c]	50% granule	5	10	20
5.	karbutilate	80% WP	5	10	20
6.	fenuron[d]	25% pellet	10	20	30
7.	picloram[e]	10% pellet	2	5	10

a Hyvar X; 5-bromo-3-sec-butyl-6-methyluracil.
b Karmex; 3-(3,4-dichlorophenyl)-1, 1-dimethylurea.
c Tandex; m(3,3-dimethylureido)phenyl-tert-butylcarbamate.
d Dybar; 3-phenyl-1, 1-dimethylurea.
e Tordon; 4-amino-3, 5, 6-trichloropicolinic acid

1/ Portions of a final report, The Pennsylvania State University, University Park, Pennsylvania. Contract No. DAAA13-69-C-0085 with Fort Detrick, Frederick, Maryland. May 1969 - August 1971.

2/ Associate Professor of Forest Ecology, School of Forest Resources, The Pennsylvania State University, University Park, Pennsylvania.

	Herbicide	Formulation	Rates in lb/acre (a.i.) Low	Medium	High
8.	picloram plus bromacil (1:4)	11.25% pellet plus 45% granule	6 1/4	12 1/2	25
9.	picloram plus karbutilate (1:4)	10% pellet plus 45% granule	6 1/4	12 1/2	25
10.	picloram plus diuron (1:8)	33.3% granule plus 8% granule	11 1/4	22 1/2	25
11.	diuron plus bromacil (1:1)	5% granule plus 4% granule	5 5/8	11 1/4	22 1/2

Results

The analysis of variance for the data presented in Table 1, obtained two years after the initial application, showed that all first order factors, i.e., site, herbicide and rate, were statistically significant at the 1% level of probability. By use of Duncan's Modified (Bayesian) Least Significant Difference Test, the following means were obtained. Means followed by the same letter are not significantly different from each other:

Site (soil)	Mean
Clay, lowland	4.9 A
Clay, upland	4.7 A
Loamy sand	4.4 B
Clay loam	4.1 B

Herbicide	Mean
bromacil (WP)	7.4
karbutilate (G)	6.5 A
karbutilate (WP)	6.2 A
picloram/diuron (G)	6.1 AB
bromacil (G)	5.6 B
diuron (G)	4.7
fenuron (P)	3.6 C
diuron/bromacil (G)	3.3 CD
picloram/bromacil (P,G)	2.9 D
picloram/karbutilate (P,G)	1.8 E
picloram (P)	1.5

Rate	Mean
3 (High)	6.1
2 (Medium)	4.5
1 (Low)	2.9

(WP) = Wettable powder
(G) = Granule
(P) = Pellet

Total vegetation control on both lowland and upland clay soils was significantly better than either loamy sand or clay loam sites, although the former were not significantly different from each other.

The bromacil wettable powder formulation gave the highest control of all herbicides tested for combined rates, site and time after application. The next three highest ranked herbicides for total vegetation control, not significantly different from each other were: granular karbutilate, wettable powder karbutilate, and granular picloram/diuron 1:8 mixture.

Control of vegetation increased with an increase in rate of herbicide applied for all sites and herbicides. The degree of control showed significant differences among the three application rates.

The four herbicides which produced the most complete control when the highest rate only is included in the significant difference test were: bromacil wettable powder, granular picloram/diuron, granular karbutilate and granular bromacil. None of these four were significantly different from each other, although given above in order of decreasing total kill of vegetation. The next two most effective herbicides, not significantly different from each other, were bromacil wettable powder at the medium rate of application and karbutilate wettable powder at the high rate. A numerical rating of area-wise vegetation control, two years after herbicide application is summarized in Table 1, according to site, rate and kind of herbicide applied.

Other Variables Influence Vegetation Control

The persistence of the soil-applied herbicide residues, their breakdown, and lateral movement was influenced by the amount of rainfall, rate of application, degree of slope, kind and extent of vegetation, and the herbicide's ease of dissolving in water.

Eighteen months after application, bromacil--the most effective controller of all vegetative weed killers tested--showed detectable parent residues at a depth of 12 inches on all four soil types. Concentrations generally decreased for all herbicides as time passed and differences in residue concentration were directly related to initial rates of application.

For bromacil, the rate of residue disappearance was significantly related to soil type. However, the amount of residues remaining in all four textural classes were minimal to a 12-inch depth. Ranking the soils in decreasing order of pounds per acre loss of bromacil, the loamy sands consistently showed highest residue concentrations of approximately 0.68 pounds per acre from an initial 15 pounds per acre application. The least residues were present on clay-textured soils, with 0.31 pounds per acre detected. From an environmental standpoint, bromacil residues remaining in any of the four soils tested would be considered insignificant, or negligible after 18 months. The remaining herbicides were not analyzed for residue disappearance.

Table 1. Numerical rating of area-wise vegetation control two years after herbicide application (June, 1971)

Herbicide	Rate:	Site: Clay (lowland) Low	Clay (lowland) High	Clay (upland) Low	Clay (upland) High	Loamy sand Low	Loamy sand High	Clay loam Low	Clay loam High	Mean Herbicide
1 bromacil (WP)		5.4[a]	8.2	5.7	8.1	8.0	8.8	5.9	8.8	7.4
2 karbutilate (G)		4.5	8.7	4.7	7.4	5.6	8.5	4.7	7.4	6.5
3 karbutilate (WP)		6.1	6.9	4.7	6.0	6.8	9.3	4.2	6.6	6.2
4 picloram/diuron (G)		5.9	9.0	5.5	9.1	1.6	6.0	2.4	8.1	6.1
5 bromacil (G)		2.1	7.5	5.0	7.8	2.7	7.8	3.3	8.1	5.6
6 diuron (G)		4.1	8.2	3.4	7.7	0.6	3.1	1.4	7.5	4.7
7 fenuron (P)		2.2	4.5	3.3	5.2	2.2	7.2	0.9	3.7	3.6
8 diuron/bromacil (G)		2.2	5.1	1.4	5.6	0.6	4.7	0.9	6.2	3.3
9 picloram/bromacil (P,G)		1.7	4.9	1.7	4.9	1.4	4.4	0.7	4.0	2.9
10 picloram/karbutilate (P,G)		1.1	5.4	0.5	4.1	0.8	2.8	0.0	2.5	1.8
11 picloram (P)		1.9	2.4	0.4	1.8	1.4	3.5	0.3	1.5	1.5
Mean - rate		3.4	6.5	3.3	6.2	2.9	6.0	2.2	5.8	
Mean - site		4.9		4.7		4.4		4.0		

a Mean values of three replications and six sampling dates per location.
Basis: 0-10, no effect to complete kill. WP = wettable powder, G = granule, P = pellet

PUCKERBRUSH FORESTRY

H. E. Young[1]

ABSTRACT

Biomass, nutrient and pulping studies at the University of Maine during the past fourteen years have led to intensive study of the puckerbrush species. These are the hardwood shrub and tree species that grow in dense stands and are seldom of any current commercial value. Exclusive of the leaves these stands produce about 1.2 dry tons per acre per year above ground. This material (the stems and branches-wood and bark) can be made into usable pulp of less yield but similar physical properties to commercial hardwood. With harvesting equipment designed for small material all of this material can be used instead of eliminated by burning or spraying.

INTRODUCTION

The dictionary and common usage agree that the definition of a weed is: a plant of no value and use. Puckerbrush, on the other hand, is a well known expression in Maine that characterizes dense young hardwood stands such as willow and alder, pin cherry, gray birch, red maple and aspen. These shrub and tree species are a few of the more than forty such species in Maine that are currently of little or no commercial use. I am making a major effort to have this term used all over the world to describe successional species. To most people "puckerbrush" is a strange word that seems to verge on an obscenity but by itself it does not mean a useless plant. This is very important to me. Puckerbrush can and should be used materially reducing weed plants to annuals and no doubt in time, imaginative investigators will discover interesting ways to use them.

COMPLETE TREE CONCEPT

Fourteen years ago biomass, nutrient and pulping studies were initiated at the University of Maine that led to the Complete Tree Concept (6). This term was borrowed from the title of Sir Issac Walton's book on fishing, The Complete Angler, to eliminate confusion with the terms: whole tree, total tree, full tree and tree length, all commonly used to refer to the bole above the stump. The Complete Tree Concept is defined as: biological and technological investigation of the entire tree from the root tips to the leaf hairs inclusive.

Following a pulping study of shrubs (4) this concept was extended into the Complete Forest Concept which is defined as: biological and technological investigation of all of the shrub and tree species with a view to intensive management of some areas with production techniques similar to agriculture and utilization akin to the cattle and hog industries. Research is conducted in the Life Sciences and Agriculture Experiment Station and the project title now is: Fiber Production and Utilization.

[1]Professor of Forest Resources, School of Forest Resources, University of Maine at Orono 04473.

There have been a number of papers and bulletins published at the University of Maine and only a few will be mentioned as I briefly summarize what has been learned at the University of Maine. This is now an area of considerable interest throughout the world as indicated in the magnificent literature review of Keays (5).

Young (7) has described a multi-stage destructive sampling procedure that has been used on fully stocked puckerbrush stands ranging from 10 to 45 feet in average height involving 17 species. The major results are as follows:

a. leaf mass averages 1.0 dry tons per acre with a maximum of 2.0 dry tons in several coppice stands.

b. dry matter above ground exclusive of the leaves accumulates at a rate of 1.2 tons per acre. This includes both wood and bark of the branches as well as the stem. A ton of dry matter is approximately equal to a cord of wood.

c. dry matter accumulates about 0.8 tons per linear vertical foot of height based on the average height of the stand.

PULPING STUDIES

All of the pulping studies have been done in collaboration with Professor Andrew Chase of the Chemical Engineering Department of the University. He is extremely competent in his field and I cannot imagine a better working arrangement with another scientist than I have experienced with him. We have jointly published several bulletins but he has never been given the credit that he properly deserves.

The standard practice in commercial pulping is to remove the bark. Inasmuch as we contemplated using the branches as well as the small boles of the puckerbrush species we deemed it impractical to remove the bark. Chase et al (3) established that the bark ranges from 10% on a weight basis of the bole to as high as 42% of the very tiny branches. Sampling studies indicated that bark constitutes approximately 18% of the above ground weight exclusive of the leaves with slight species variation.

Disk chippers with many knives are successfully used to reduce the solid bole to chips of the proper size for penetration of the liquors in the digestion process. We found that small branches and roots were often not cut to the desired length of one inch even when tied into bundles. The solution was the purchase of a drum type chipper from the Klockner Company in Germany. This machine has slow turning self-cleaning feed rolls with knives extending across the fast moving drum. This type of chipper does a very satisfactory job of chip preparation and tests showed that the distribution of chip sizes was similar to the conventional disk chipper.

Professor Chase "cooked" puckerbrush in several established methods (1,2) but concentrated on the Kraft process because it is so widely used. For laboratory pulping studies of the wood only of commercial species, it is customary to cook the material at temperature and pressure for two hours. Based on a series of cooks, it was determined that:

a. It is only necessary to cook puckerbrush for 30 minutes at temperature and pressure although a standard period of one hour was established to cover all situations.

b. The branches have a lower yield (about 37% in contrast to 45% for commercial wood) and poorer physical properties than pulp made from commercial wood.

c. Pulp made from composite samples of branches and stems proportional to the amount found in nature yield pulp of about 42% in the Kraft process with physical characteristics almost the same as commercial wood.

d. Depending on the species from 30 to 50% puckerbrush chips (wood and bark) can be mixed with regular commercial hardwood chips (wood only) and the resulting pulp is similar to that made from commercial hardwood alone.

In addition to the puckerbrush species, several cooks have been made from potato tops exclusive of the leaves. There are about 1.5 tons of potato tops per acre on 150,000 acres in Maine that are currently being burned or sprayed because of a virus. Our studies show about a 30% yield and fairly good physical properties. We have not mixed potato top chips with commercial hardwood chips in pulping studies as yet but it is entirely possible that 10 to 20% can be mixed without detracting from the final yield. The Northern Regional Research Laboratory of the Department of Agriculture in Peoria, Illinois has tested more than 387 annual plants with very few showing any potential for pulping and none producing the yield of potato tops.

AVAILABILITY OF PUCKERBRUSH

There are literally hundreds of shrub and tree species on this continent and countless more in the entire world literature of similar material. It has become quite evident that paper products can be made from any shrub or tree species. The questions is: How much is there and is it available for harvest?

There are no known inventories of such material. Young (8) has estimated that there are always several million acres in Maine alone as a result of the abandonment of farm land, forest fires and natural processes in some cutover acres. It therefore follows that there must be more than 25,000,000 acres of such land in the continental U.S.A. To this must be added the millions of acres on the rights-of-way on highway, railroad and transmission lines. Thus, there is a lot of puckerbrush and much of it is as accessible as most forest land, if not more so.

HARVESTING

Puckerbrush is smaller than commercial trees and cannot be harvested by existing forest harvesting equipment efficiently. The Klockner Company is currently making a prototype Puckerbrush Harvestor that will only require one operator, will be self-propelled, will harvest the tree or shrub, and place the above ground portion into a drum chipper which will be attached with a blower to a van. This machine will be designed for puckerbrush stands and for operational thinning of forest stands where the object is to permit the remaining stand to grow more rapidly to produce solid wood products.

Dr. Norman Smith of our Agricultural Engineering Department has designed a harvester that will cut and chip puckerbrush up to about one inch in diameter. As soon as funds are available, he intends to make a prototype. Once this concept is accepted and put into practice, other machines that are undoubtedly bet will be developed to harvest and transport puckerbrush.

OVER ALL OBJECTIVES

When Western Europeans came to the U.S.A. there were about 900 million acres of forests. That has been reduced in 350 years to about 400 million acres. In the long run, this will be reduced further as our already large population continues to increase. We need the forests for clean air, clean water, recreation and for the numerous forest products demanded by our affluent society. These demands have put tremendous pressure on our forests and this does not appear to be in the best interests of our nation over the long run.

Forest Management and Forest Industry has been based on the Merchantable Bole Concept which is: The usable portion of the tree bole of trees defined as being merchantable of species defined as merchantable and the forest stands defined as being merchantable. Our studies have demonstrated that the Merchantable Bole is only 65% of the total fiber of the tree so that if we used the logging residues we could increase the harvest per acre by 50%, at least. If we would use all tree and shrub species, we would make an additional vast reservior of fiber available.

At the present time, it is standard practice to cut and burn weed species or to spray weed species on rights-of-way. These are costly practices. Some counties and some states frown on brush burning and some are seriously questioning the use of chemical sprays. Should it become illegal to burn or spray, how can we dispose of this undesirable material? We should learn to think of these weed species as puckerbrush species and harvest them for useful purposes. In that proces we can change an enormous cost into a profit and simultaneously take some of the great pressure off of the high forest.

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RESIDUAL JOHNSONGRASS CONTROL WITH SOIL STERILANTS

I. M. Wedderspoon[1], G. W. Burt[2], and J. V. Parochetti[3]

ABSTRACT

In July 1972, four soil sterilants were compared as to their effectiveness in killing four foot high johnsongrass (Sorghum halepense (L.) Pers.). The sterilants were: bromacil at 64 kg/ha, karbutilate at 86 kg/ha, prometone at 272 kg/ha and two rates of sodium chlorate/sodium metaborate tetrahydrate; 1304 kg/ha chlorate with 2608 kg/ha borate and 1304 kg/ha chlorate with 652 kg/ha borate. In October 1973, visual ratings indicated that karbutilate had killed 90% of the rhizomes compared to prometone 70%, bromacil 62% and the two rates of chlorate/borate which both gave 51% johnsongrass rhizome control. Virtually no plant regrowth of any species occurred in the karbutilate plots. Common yellow woodsorrel, Oxalis stricta L. was the dominate plant species in the prometone treated plots. In all other treatments, a variety of grass and broadleaf plants were identified.

In July 1973, additional sterilant studies on johnsongrass control were begun with karbutilate at 44, 64, 86, and 126 kg/ha, bromacil at 64 and 86 kg/ha, asulam at 18 and 22 kg/ha and sodium chlorate/sodium metaborate tetrahydrate at 1304 kg/ha chlorate and 2608 kg/ha borate. At one location, the johnsongrass was approximately one foot high at the time of herbicide application. The plots were visually evaluated 3 months after treatment and no live rhizomes were found in the karbutilate, bromacil and chlorate/borate plots at the location where the johnsongrass was one foot high when the sterilants were applied. Rhizome control at the remaining two locations averaged 99% for the chlorate/borate treatments, 97 and 92% respectively for the 64 and 86 kg bromacil treatments, and 62, 87, 88, and 95% respectively for the 44, 64, 86, and 126 kg karbutilate treatments. Both asulam treatments resulted in less than 50% rhizome control at all locations.

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[1]Supervisor, Weed Control, Mary. nd Department of Agriculture, Parole Plaza Office Building, Annapolis, Maryland 21401

[2]Assistant Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742

[3]Associate Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742

TEBUTHIURON FOR TOTAL VEGETATION CONTROL ON RIGHTS-OF-WAY AND INDUSTRIAL SITES

C. D. Christensen, M. L. Jones and G. J. Shoop[1/]

ABSTRACT

Tebuthiuron, 1-(5-*tert*-butyl-1,3,4-thiadiazol-2-yl)-1,3-dimethylurea, was evaluated in the Northeastern United States for total vegetation control on railroad rights-of-way, along a highway guardrail and on industrial sites. Formulated as an 80 percent wettable powder, tebuthiuron provided effective control of annual broadleaf and grassy weeds at 2.5 to 5 pounds per acre, and acceptable control of most perennial weeds at 5 to 9 pounds per acre. Tebuthiuron has demonstrated several advantages in total vegetation control applications including long activity, low rate of leaching through soils, little lateral movement, and good stability on soil surfaces.

INTRODUCTION

Tebuthiuron, a new experimental herbicide for total vegetation control, is being developed by Elanco Products Company. Evaluation of tebuthiuron began in 1969 and registration has now been requested for use in total vegetation control.

Tebuthiuron is a thiadiazolylurea compound. Technical tebuthiuron is a white solid with a solubility in water of 2.5 mg/ml. It is light stable, noncorrosive, and nonflammable. It is a safe compound, with an oral acute LD_{50} of 500 mg/kg or higher in both test animals and fowl.

Tebuthiuron has foliar activity. However, it is primarily absorbed through the root system following movement into the soil by rain. It may be applied preemergence or postemergence to weeds and provides long lasting control of both herbaceous and woody plants. Tebuthiuron can be applied at any time of the year except to frozen soil or to areas with standing water. With one-half inch of rainfall, tebuthiuron moves into and becomes attached to soil particles. Once attached, vertical movement through leaching is very slow and lateral movement has been virtually nonexistent. Results are presented here from seven experiments which are typical of weed control obtained with tebuthiuron in the Northeastern United States. Four of the experiments were located on railroad rights-of-way, one along a highway guardrail and two on industrial sites.

1/ Eli Lilly and Company, Greenfield, Indiana.

MATERIALS AND METHODS

Commercial high rail sprayers were used to apply treatments on railroad right-of-way experiments. Applications were made in 50 to 70 gallons per acre volume in nonreplicated plots. Treatments were applied in a trial in Massachusetts in the spring of 1972 to plots 3 miles in length followed by one-half rates applied to one-half of each plot in the spring of 1973. Weed control evaluations were made 3, 12 and 16 months after single application treatments and 4 months after the retreatment--half rate applications. Railroad right-of-way treatments were applied in New York, Pennsylvania and Kentucky in the spring of 1973 to plots approximately 2.5 miles in length. Weed control evaluations were made 2 to 3 months later.

Treatments were applied along a highway guardrail in Indiana in the spring of 1972. Applications were made in 100 gal/A of water with a commercial sprayer equipped with a four-nozzle boom arranged to straddle the guardrail so that two nozzles were directed on each side of the guardrail. Plots were 200 x 3 feet in size and were not replicated. Control of the mixed fescue grass was evaluated 6, 12 and 16 months after application.

Single treatments at 9 lb/A of active compound were applied to an equipment storage area and an abandoned industrial site in Indiana in the spring and early summer of 1972. Application was made with a commercial, truck mounted sprayer using an orchard type handgun in 100 gallons of water per acre.

RESULTS AND DISCUSSION

I. Railroad and Highway Rights-of-Way: Tebuthiuron at rates of 4, 8 and 12 lb/A was applied to a railroad bed in Massachusetts which was not on a regular herbicide program and had not been treated in 1971. Treatments were applied in May 1972, with half rates of each treatment applied to one-half of each 3-mile plot in May 1973 (Table 1). When evaluated in September 1973 the 4 lb/A rate applied in 1972 plus 2 lb/A in 1973 resulted in 80 percent bare ground and 85+ percent control of smooth bromegrass (*Bromus inermis*), orchardgrass (*Dactylis glomerata*), red raspberry (*Rubus idaeus*), chicory (*Cichorium intybus*), annual fleabane (*Erigeron annuus*), and white sweet clover (*Melilotus alba*). Four pounds per acre in 1972 plus 2 lb/A in 1973 did not provide satisfactory control of Virginia creeper (*Parthenocissus quinquefolia*). Eight pounds per acre of tebuthiuron applied in 1972 without the 1973 treatment provided 90 percent bare ground and 85+ percent control of all weeds listed above except for some regrowth of smooth bromegrass the second year. The 4 lb/A rate applied only in 1972 failed to provide adequate weed control through the 1973 season largely because of reinvasion by shallow rooted annual grasses and because of Virginia creeper which was not controlled.

Table 1. Percent bare ground and weeds controlled on a railroad right-of-way in Massachusetts with initial applications followed by half-rate applications to one-half of each plot.

	Rate lb/A[a]		Percent Bare Ground		
Treatment	5/18/72	5/16/73	8/5/72	5/16/73	9/15/73
Tebuthiuron	4		75	80	30
	8		85	90	90
	12		95	95	95
Tebuthiuron	4	2			80
	8	4			95
	12	6			100
Control	0		0	0	0

Weeds controlled (85+ percent) with 4 lb/A in 1972+2 lb/A in 1973:

Smooth bromegrass	Chicory
Orchardgrass	Annual fleabane
Red raspberry	White sweet clover

Additional weeds controlled with 8 lb/A in 1972 only:

Virginia creeper

a/ Spray applications with a commercial high rail truck on trackage not treated with an herbicide in 1971.

Weed control obtained on railroad rights-of-way in three locations in 1973 is presented in Table 2. At the New York location where no herbicides had been applied for 2 years 4.8 lb/A of tebuthiuron was required to obtain 90 percent bare ground; whereas, 2.4 lb/A resulted in 93 and 95 percent bare ground in Kentucky and Pennsylvania where the railroads were treated the previous year. Tebuthiuron at 2.4 and 3.2 lb/A provided 90+ percent control of the following weeds at locations where they occurred: annual bluegrass (*Poa annua*), fescue (*Festuca* sp.), foxtail (*Setaria* sp.), plantain (*Plantago* sp.), rough pigweed (*Amaranthus retroflexus*), common ragweed (*Ambrosia artemisiifolia*), prickly sida (*Sida spinosa*), spurge (*Euphorbia maculata*), goldenrod (*Solidago canadensis*), common mullein (*Verbascum thapsus*), and bouncingbet (*Saponaria officinalis*). In at least one location shallow rooted or young

alfalfa (Medicago sativa), orchardgrass, and wild carrot (Daucus carota) were also controlled at these low rates, although 4.8 lb/A was required at another location where plants were older and deeper rooted. Additional weeds controlled at rates of 4.8 to 7.2 lb/A were milkweed (Asclepias syriaca), Virginia creeper and trumpetcreeper (Campsis radicans).

Table 2. Percent bare ground and weeds controlled on railroad rights-of-way following a single treatment application.

		Percent Bare Ground[b]		
Treatment	Rate lb/A[a]	New York 6/26/73	Penna. 7/25/73	Kentucky 8/30/73
Tebuthiuron	2.4	c/	95	93
	3.2	85		95
	4.8	90	98	98
	6.4	95		99
	7.2		99	
	9.6	95		
Control	0	0	55	40

Weeds controlled (90+ percent) at 2.4 and 3.2 lb/A rates:

Annual bluegrass	Prickly sida
Fescue	Spurge
Foxtail	Goldenrod
Plantain	Common mullein
Rough pigweed	Bouncingbet
Common ragweed	

Additional weeds controlled at 4.8 to 7.2 lb/A rates:

Alfalfa	Milkweed
Orchardgrass	Virginia creeper
Wild carrot	Trumpetcreeper

a/ Spray application with a commercial high rail truck in New York on 4/23/73, Pennsylvania on 5/7/73 and Kentucky on 6/1/73.

b/ The New York site had not been treated with an herbicide for two years. Pennsylvania and Kentucky sites were treated in 1972.

c/ Blank spaces indicate that the rate was not applied.

In May 1972, a highway guardrail trial was established on fescue sod in the Indianapolis area. One year after application 4 lb/A of tebuthiuron was providing complete control of fescue, however, by the end of the second summer after application giant foxtail (Setaria faberi) became established (Table 3). A second application of tebuthiuron at a low rate in 1973 would no doubt have given continued control. There was no lateral movement of the compound although treatments were applied on a 20 percent slope.

II. Industrial Sites: In late April 1972 tebuthiuron was applied as a spray treatment at the rate of 9 lb/A to weeds and brush growing in a construction company storage area in Indiana. Evaluation in October 1972 indicated near total vegetation control (98 percent). In September 1973 there was still 80 percent bare ground with 90+ percent control of bouncingbet, giant ragweed (Ambrosia trifida), common burdock (Arctium minus), shepherdspurse (Capsella bursa-pastoris), plantain, ground ivy (Glechoma hederacea), mulberry (Morus sp.), catalpa (Catalpa speciosa) and sumac (Rhus sp.). Common bluegrass (Poa pratensis), spurge, giant foxtail and crabgrass (Digitaria sp.) were becoming established at this time.

Table 3. Percent bare ground around a highway guardrail in Indiana.

Treatment	Rate lb/A[a/] 4/24/72	Percent Bare Ground 10/2/72	5/9/73	8/29/73
Tebuthiuron	4	99	100	65
	8	100	100	70
Control	0	0	0	0

a/ Spray applied with commercial equipment.

In June 1972 tebuthiuron was applied as a spray treatment to a dense growth of weeds and brush at an abandoned industrial site in Indianapolis. Evaluation in October 1972 indicated 95 percent vegetation control. In September 1973 there was still 85 percent bare ground with 85+ percent control of mulberry, tree of heaven (Ailanthus altissima), wild carrot, poison ivy (Rhus radicans) and bouncingbet. Climbing milkweed (Sarcostemma cyanchoides) and wild grape (Vitis sp.) were not completely killed, and by the fall of 1973 had begun to recover. Interestingly, field bindweed (Convolvulus arvensis) appeared to be only partially controlled in the fall of 1972 but by the fall of 1973 there was no field bindweed in the treated area.

In these trials tebuthiuron has shown long residual activity. It has provided excellent control of the more difficult to control weeds such as bouncingbet, Virginia creeper and common mullein. It has also demonstrated negligible lateral movement. In other trials in the United States not reported on in this paper, tebuthiuron has demonstrated versatility in timing of application and has been compatible with other commercially available herbicides.

A NEW BRUSH CONTROL AGENT

O. C. Zoebisch, T. T. Rushing, G. E. Barrier [1/]

The discovery of ammonium ethyl carbamoylphosphonate [2/] has introduced a new concept for the control of undesirable brush. Application of this growth regulator, after the main flush of annual growth has hardened, causes only a slight visible effect on the foliage. Normal seasonal leaf drop occurs during the fall, but leaf bud development the following spring is either severely limited or is prevented entirely. The stem and roots eventually die as little if any food or new tissue is produced. Undesirable brush can be controlled or eliminated efficiently by foliar sprays without unsightly discoloration or undue loss of leaves other than through the normal seasonal maturation process.

Ammonium ethyl carbamoylphosphonate has other attributes which minimize its impact upon the environment. Mammalian toxicity is extremely low with an LD_{50} of the four pound per gallon formulation of 24,400 mg/kg. Fish and other wildlife species are tolerant to the compound.

Ammonium ethyl carbamoylphosphonate, although extremely soluble in water, is readily adsorbed by the soil. It has a Freundlich K equilibrium constant on Keyport silt loam greater than 20, which indicates high adsorption on soil. It is also decomposed quickly by soil microorganisms. This material poses no problem of runoff into surface waters or leaching into subterranean aquafers.

Effective applications of ammonium ethyl carbamoylphosphonate can be made in the Northeastern Region during August, September and early October. Leaf necrosis may take place if treatment is applied at high temperatures. Generally, only the more susceptible species show this effect. The usual response, if any, is merely an earlier appearance of fall coloration of the foliage.

1/ Contribution of the Biochemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

2/ Ammonium ethyl carbamoylphosphonate is the active ingredient in "Krenite" Brush Control Agent (formerly designated DPX 1108). "Krenite" is a Du Pont trademark.

Effective rates for aerial applications range from 4 to 8 pounds active per acre depending on the species to be controlled. Ground applications in sufficient volume to give good coverage are effective at 2 to 6 pounds per 100 gallons. The addition of an effective wetting agent such as Du Pont Surfactant WK will enhance activity. The wetting agent will also increase the probability of leaf discoloration if, as previously stated, air temperatures are higher than normal.

Applications designed to get the spray into the canopy of the brush appear to be most effective. A typical hand gun application such as normally made with hormone type brush killers may not cover the leaves and branches in the top of the tree. Spray coverage of these upper limbs and subsequent inhibition of the buds is necessary for best results. Ground applications with as little as 25 gallons per acre which drop the spray into the leaf canopy have been effective.

Brush must be treated in the optimum period in order to get minimum foliar injury immediately after treatment and maximum bud inhibition the following spring. The response of woody plants to applications made before the optimum period varies considerably. Treatments made in the early spring when leaves are expanding usually injure the plant. Symptoms are leaf necrosis and chlorosis with some marginal puckering. The terminal branch and sometimes numerous laterals may defoliate often accompanied by tip dieback. Very little if any elongation takes place. The year following an early spring treatment many species will begin growth again so that the final result is just a retardation of the normal growth rate. At rates of 1 to 3 lbs./100 gallons a spring treatment will give growth retardation on some species such as the maples, ash and linden without serious injury symptoms. However, on mixed brush, significant retardation is seldom accomplished without excessive injury showing on some species.

Brush treated after the heavy flush of spring growth has been completed, but before the leaves and new stems have hardened, may not produce symptoms until the following spring. The response then is similar to the first year symptoms produced by early applications.

There is possibly a critical physiological or anatomical stage in the annual growth cycle of a deciduous tree relative to the effect of ammonium ethyl carbamoylphosphonate. All buds are suppressed if the chemical is applied after that stage is reached and the plant eventually dies. Earlier applications affect the leaves and suppress growth but the plant eventually recovers. If such a critical stage does exist it has not as yet been identified.

A number of problem trees on rights-of-way in the Northeast have been treated with ammonium ethyl carbamoyl-phosphonate. All of the oaks treated are sensitive. Sugar, red and silver maple respond readily. Black locust, red gum, hickory species, Crataegus and Malus species are susceptible.

The ash species tend to be variable but usually are controlled. Cherry, birch and poplar are similar but more variable than ash. Black willow is intermediate but the smaller, bunchy, glaucous types are quite sensitive. Sassafras and redbud are tolerant. The broadleaf evergreens, mountain laurel and rhododendron are also tolerant. Virginia and loblolly pine are susceptible.

Herbaceous plants do not respond significantly to ammonium ethyl carbamoylphosphonate. Perennials are sometimes repressed depending on the timing of the application. The undercover, including low shrubs protected by the canopy, takes over immediately so that there is no erosion problem. Broadleaf evergreens, if present, also continue unharmed.

The unique response of plants to this growth regulant makes possible the management of brush so that transmission and transportation arteries can be efficiently and aesthetically maintained with a minimum undesirable effect on the environment. Much remains to be learned in order to completely attain the potential of this brush management concept. Studies are required to determine the best time of treatment at different latitudes. Dormant applications have shown some promise but methods of application and methods to increase penetration need attention. Fall applications suppress root suckering suggesting the combination of chemical treatment followed by cutting the next year to lengthen the cutting cycle. The selective weeding of commercially important species is a possibility, but needs more researching.

PRE- AND POST-TRANSPLANT HERBICIDE APPLICATIONS IN JAPANESE HOLLY PLANTINGS

Chiko Haramaki[1]

Abstract

Pre-transplant application of nitralin and trifluralin and also post-transplant applications of alachlor and simazine and diphenamid combinations reduced weed growth. Chlorosis of the terminal leaves of the Japanese holly (Ilex crenata Thunb.) and Green Island holly (Ilex crenata 'Green Island') was present regardless of treatment. Low nitrogen levels in the soil is indicated as the probable cause.

Introduction

Effect weed control in newly planted nursery liners can be obtained if it is applied before or after transplanting prior to weed emergence. Varieties of Japanese holly (Ilex crenata) have been observed to be tolerant to a number of herbicides. Convexleaf holly (Ilex crenata convexa) has been observed to show no injury from alachlor, DCPA, diphenamid, EPTC, simazine and trifluralin (1,2,3). Heller Japanese holly (Ilex crenata helleri) exhibited no injury from alachlor, DCPA, diphenamid and simazine (4). Hetz Japanese holly (Ilex crenata hetzi) was tolerant to alachlor, diphenamid, EPTC, simazine and combinations (5).

The objective of this experiment was to obtain satisfactory weed control with little or no damage to newly planted Japanese holly liners.

Methods and Materials

The Hagerstown siltloam soil was plowed, disced and had two inches of sphagnum moss peat rototilled into it just prior to the experiment. The experiment was conducted at the Pennsylvania State University, Agricultural Research Farms at Rock Springs. On August 7, 1973 the pre-transplant herbicides were sprayed on extremely dry soil and rototilled in to a depth of approximately 2 inches. The air temperature was 88°F, soil surface temperature was 115°F, and 2 inches below the soil surface it was 96°F. The sky was clear and sunny with a wind of from 2-5 miles per hour.

The holly liners were transplanted from 4 inch pots on August 8th into a very dry soil. The weather was clear and sunny and the air temperature ranged from the high 80's to the low 90's during transplanting. Approximately ½ inch of water was sprinkler irrigated after planting.

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[1]Department of Horticulture, Pennsylvania State University, University Park, Penna.

The post-transplant herbicides were sprayed on August 12th. The weather was partly cloudy with a 5 mile per hour wind. The air temperature was 86°F and the soil surface temperature was 101°F. The soil was almost at field capacity.

A split plot design with 3 replicates was used. Each plot was 3 feet by 5 feet and had 4 plants of each type of holly. The two types of hollies planted were Japanese holly (Ilex crenata Thunb.) and Green Island holly (Ilex crenata 'Green Island').

The predominant weeds present in order of frequency in the untreated plots were hairy chess (Bromus commutatus Schrad.), field pepperweed (Lepidium campestre R. Br.), dandelion (Taraxacum officinale Weber), common lambsquarter (Chenopodium album L.) mouseear chickweed (Cerastium vulgatum L.) wild carrot (Daucus carota L.) common purslane (Portulaca oleracea L.) and yellow woodsorrel (Oxalis stricta L.).

Results and Discussion

After 8 weeks the weed growth was observed to be less in all of the treated plots than the untreated ones but none were commercially acceptable. On October 4th, the plots treated with pre-transplant herbicides were observed (Table 1). Nitralin controlled hairy chess, common lambsquarter, wild carrot, common purslane, yellow woodsorrel and mouseear chickweed. The population of dandelion and field pepperweed seedlings were also reduced. Trifluralin controlled hairy chess, common lambsquarter, wild carrot, common purslane, yellow woodsorrel, and mouseear chickweed. The number of dandelion and field pepperweed was slightly reduced. All of the Japanese hollies whether in untreated or treated plots all exhibited slight chlorosis in the terminal and middle leaves. The terminal leaves of the Green Island hollies were chlorotic regardless whether they were in nitralin, trifluralin or untreated plots.

Table 1. Effect of pre-transplant applications of herbicides on weed prevalence and holly, 1973.

Treatment		Weed Prevalence*	Plant Injury** Green Island Holly	Plant Injury** Japanese Holly
Nitralin	0	7.3	2.0	2.0
	1#/A	5.3	1.9	2.0
	2#/A	4.7	1.9	2.1
	4#/A	3.7	2.1	2.4
Trifluralin	0	8.0	1.3	1.6
	1#/A	6.3	1.7	1.8
	2#/A	5.0	1.9	2.3
	4#/A	5.7	1.8	2.2

* - 0, No weeds; 10-100% weed coverage
** - 0, No injury; 5-dead.

Post-transplant applications reduce weed growth in all treatments, but none were commercially acceptable (Table 2). Alachlor controlled hairy chess, mouseear chickweed, common purslane, common lambsquarter, and yellow woodsorrel. The number of field pepperweed and dandelion seedlings was also reduced. Simazine and diphenamid combinations controlled field pepperweed, hairy chess, mouseear, chickweed, common purslane, common lambsquarter and yellow woodsorrel. The dandelion stand was partially reduced. All of the hollies showed some leaf chlorosis. In alachlor treated plots the Japanese hollies had light chlorosis in all leaves throughout the plant. The Green Island hollies had chlorotic leaves only in the terminal portions of the shoots. The Japanese hollies in the simazine and diphenamid treatments had marked chlorotic leaves throughout. The Green Island hollies showed very little chlorosis except for the new terminal leaves. Soil tests indicate that the chlorosis may be due to a low nitrogen level in the soil.

Table 2. Effect of post-transplant applications of herbicides on weed prevalence and holly, 1973.

Treatment		Weed Prevalence*	Plant Injury** Green Island Holly	Plant Injury** Japanese Holly
Alachlor	0	7.7	2.1	2.3
	1#/A	7.0	2.0	2.5
	2#/A	5.0	2.0	2.4
	4#/A	4.3	1.3	1.8
Simazine + diphenamid	0	8.0	2.1	2.3
	½ + 2#/A	4.7	1.9	1.8
	1 + 4#/A	4.0	1.7	2.3
	2 + 8#/A	4.0	1.3	2.6

* - 0, No weeds; 10-100% weed coverage
** - 0, No injury; 5-dead.

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CHEMICAL WEED CONTROL IN AZALEAS

Chiko Haramaki[1]

Abstract

Pretransplant applications of EPTC, nitralin and trifluralin, and posttransplant applications of alachlor, DCPA, diphenamid, and simazine reduced the weed population in beds of Korean azaleas (Rhododendron poukhanense Lev.). The weed control was commercially acceptable in the plots treated with simazine at 4 pounds per acre, but there was some leaf chlorosis and tip burn on the Korean azaleas. The other treatments produced little or no injury to the azaleas.

Introduction

Adequate weed control of both grasses and broadleaved weeds in beds of herbicide sensitive plants such as azaleas is difficult to achieve without causing injury to the crop plant. Broad spectrum herbicides such as simazine and herbicide combinations which include simazine can cause chlorosis along the leaf margin and throughout the entire leaf blade (2) and eventually death of the plant during the second growing season (3). EPTC can injure azaleas when used at 10-15 pounds per acre (4).

Little or no injury was reported if simazine was used alone at low rates (5) or in combinations with other herbicides at low rates (6). Azaleas grown in containers had little or no injury when treated with a granular form of diphenamid.

The objective of this experiment was to obtain adequate weed control with the uses of herbicides while causing little or no injury to azaleas.

Materials and Methods

The experiment was conducted on Hagerstown silt loam soil at the Pennsylvania State University Agricultural Research Farms at Rock Springs, Pennsylvania. Two inches of sphagnum moss peat was rototilled into the beds prior to treatment and transplanting. A split block design with 3 replicates was used. Each plot contained 9 square feet and 4 azalea plants. The Korean azalea (Rhododendron poukhanense Lev.) was the crop plant.

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[1] Department of Horticulture, Pennsylvania State University, University Park, Pennsylvania.

On August 7, 1973 the pretransplant herbicides were sprayed on and rototilled in immediately. The soil was very dry and there was a 2-5 miles per hour wind. The temperatures for the following were: air, 88°F; soil surface, 115°F; and soil 2 inches deep, 96°F. The azaleas were planted the next day on August 8 and irrigated with 1/2 inch of water. The post-transplant herbicides were sprayed on August 12. The soil was at almost field capacity and there was a 5 miles per hour wind. The sky was partly cloudy and the air temperature was 86°F and the soil surface temperature was 101°F.

The predominant weeds present in the control plots in decreasing order of frequency were hairy chess (Bromus commutatus Schrad.), dandelion (Taraxacum officinale Weber), field pepperweed (Lepidium campestre R. Br.), common lambsquarter (Chenopodium album L.), wild carrot (Daucus carota L.), common yarrow (Achillea millefolium L.), and yellow woodsorrel (Oxalis stricta L.).

Results and Discussion

Weed growth was checked on October 4, which was approximately 8 weeks after the herbicides had been applied. The weed population was reduced in all treated plots. Although the weed populations were reduced in the plots treated with pretransplant applications of herbicides (Table 1), the level of control was not commercially acceptable. EPTC controlled hairy chess, common lambsquarters, and wild carrot. It also reduced the population of dandelion, field pepperweed, and common yarrow. Nitralin controlled hairy chess and common lambsquarter and reduced the number of dandelion, field pepperweed, common yarrow and wild carrot. Trifluralin controlled common lambsquarter and reduced the stand of dandelion, field pepperweed, wild carrot and hairy chess. The azaleas exhibited very little or no injury during the growing season and had the normal fall coloration of orange-reddish purple leaves at the final examination on October 25.

Table 1. Effect of pretransplant applications of herbicides on weed prevalence and azalea, 1973.

Treatment		Weed Prevalence*	Plant Injury**
EPTC	0	8.3	0
	2#/A	5.3	0
	4#/A	5.0	0
	8#/A	3.7	0.2
Nitralin	0	8.0	0
	1#/A	7.0	0
	2#/A	7.3	0
	4#/A	4.3	0
Trifluralin	0	9.3	0
	1#/A	6.7	0
	2#/A	6.7	0
	4#/A	5.3	0.2

* - 0, no weeds; 10, 100% weed coverage
** - 0, no injury; 5, dead.

The plots which were treated with posttransplant applications of herbicides (Table 2), all had less weeds than the untreated plots but were commercially unacceptable except for the plots treated with simazine at 4 pounds per acre. Alachlor controlled hairy chess, common lambsquarter, wild carrot, common yarrow, and yellow woodsorrel. The population of dandelion, field pepperweed, and red sorrel was reduced. DCPA controlled common lambsquarter, wild carrot, and yellow woodsorrel. Hairy chess, dandelion, field pepperweed and common yarrow were not controlled. Diphenamid controlled hairy chess, common lambsquarter, wild carrot, common yarrow, and yellow woodsorrel. The dandelion and field pepperweed stands were reduced. Simazine controlled all of the weeds to a commercially acceptable level. Azaleas in plots treated with alachlor, DCPA, and diphenamid had little or no injury. Simazine at 4 pounds per acre caused some leaf chlorosis and tip burn, but at the lower rates it was negligible.

Table 2. Effect of posttransplant applications of herbicides on weed prevalence and azalea, 1973.

Treatment		Weed Prevalence*	Plant Injury**
Alachlor	0	7.7	0
	1#/A	5.7	0
	2#/A	5.7	0.1
	4#/A	5.7	0
DCPA	0	8.0	0.3
	4#/A	7.3	0
	8#/A	5.7	0
	16#/A	7.3	0.2
Diphenamid	0	8.0	0
	2#/A	5.3	0
	4#/A	5.3	0
	8#/A	5.3	0
Simazine	0	7.3	0
	1#/A	4.0	0.8
	2#/A	3.7	0.2
	4#/A	0.7	1.4

* - 0, no weeds; 10, 100% weed coverage.
** - 0, no injury; 5, dead

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WEED CONTROL ON ORNAMENTALS

A. Bing 1/

ABSTRACT

Combinations of each of the following chemicals with simazine gave good, safe preemergence control of annual weeds on the 14 cultivars of nursery stock treated: 2-(a-naphthoxy)-N,N-diethylopropionamide (napropamide), a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin), N-(cyclopropylmethyl)- -trifluoro-2,6-dinitro-N-propyl-p-toluidine (CGA 10832), N,N-dimethyl-2,2-diphenylacetamide (diphenamid), 2-chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide (alachlor), or 4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H) one (metribuzin). N-sec-butyl-4-tert-butyl-2,6-dinitroaniline (dibutalin) plus diphenamid was also very effective.

INTRODUCTION

The objective of the 1973 experiment was to compare the effectiveness of combination treatments for the control of annual grass and broadleaved weeds in newly planted nursery liners and relate the results with those of trials in previous years.

MATERIALS AND METHODS

Liners of 14 cultivars of the ornamental plants listed in Table 1 were set 2 ft apart in rows 3 ft apart, one 400 ft row for each cultivar, on May 9-11, 1973. The field was cultivated and hand weeded early in June and preemergence treatments applied in 8 ft bands across all the rows on June 14 and 15. Delayed postemergence treatments with glyphosate were applied to weeds 6-8 in high on July 24. Each treatment consisted of 2 replicates arranged by chance on the field. Chemicals are listed in Table 2.

Weed ratings were made on July 19, September 13, and October 15, using a system of 1 = no weeds to 10 = a plot full of weeds. The ratings of July 19 are presented in Table 3. The predominant weeds are individually rated. All plots were hand weeded and cultivated in late August. The individual plants were rated for vigor on October 15, using 1 = dead or missing to 10 = a vigorous plant. These data in Table 4 are averages of 2 replicates of 4 plants, except for trifluralin simazine and metribuzin simazine where an error in application made only 1 replicate usable.

A rating of 1-3 for weed growth shows good control: 4-6 is only fair control, and 7-10 is poor control. The napropamide alone gave fair control, (a rating of 3-4), but when combined with simazine, gave very good control of all annual weeds (a rating of 2). There was an interest in comparing CGA 10832 with trifluralin at equal rates. CGA 10832 and trifluralin were applied individually to plots at 2 lb/A but gave only fair weed control. The CGA 10832 was slightly less effective on non-grasses and broadleaved weeds. Alachlor simazine, metribuzin simazine, and dibutalin diphenamid gave very good control. The data in Table 3 shows that promamide at 1.5 lb/A was only fair. Glyphosate killed all weeds that were up at the time of treatment

1 Cornell Ornamentals Research Laboratory

except at the 1 lb rate large red root (Amaranthus retroflexus) plants were only injured and later made new growth.

The tolerance of the nursery plants to the herbicides is shown in Table 4. Values of 8-10 indicate vigorous growth, 1, no growth or a missing plant, 2-3 very poor plant, and 4-7 fair plants. Of interest, as indicated in the table, is that privet and forsythia were only damaged at the higher rates of glyphosate but these plants in time, recovered from the tip burn. Multiflora rose, crabapple, and probably Viburnum were also injured by all rates of glyphosate. The stand of Russian olive was too variable to draw conclusion, although where the stand was good, safety to the herbicide can be concluded.

DISCUSSION

With the exception of the postemergence application of glyphosate on several species, the herbicides gave safe preemergence weed control on the species tested. All the combinations gave safe effective weed control. The simazine alachlor and simazine diphenamid treatments were as effective as in previous years. The simazine plus metribuzin or napropamide also were very effective. Trifluralin and CGA 10832 performed better in 1973 than in 1972.

Table 1. Cultivars planted in the weed control test area.

Common name	Scientific name
White pine	Pinus strobus
Scots pine	Pinus sylvestris
White spruce	Picea glauca
Douglas fir	Pseudotsuga taxifolia
Andorra juniper	Juniperus horizontalis plumosa
Hicks yew	Taxus cuspidata hicksii
Russian olive	Eleagnus angustifolia
Toringo crabapple	Malus seiboldii
Multiflora rose	Rosa multiflora
Cranberry bush	Viburnum trilobum
Forsythia	Forsythia sp.
California privet	Ligustrum ovalifolium
Azalea	Rhododendron obtusum
Bronze winter creeper	Euonymus fortunei coloratus

Table 2. Herbicides used on the nursery plants in 1973.

Common name	Chemical name
Alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
CGA 10832	N-(cyclopropylmethyl)- -trifluoro-2,6-dinitro-N-propyl-p-toluidine
Diphenamid	N,N-dimethyl-2,2-diphenylacetamide
Dibutalin	N-sec-butyl-4-tert-butyl-2,6-dinitroaniline
Glyphosate	N-(phosphonomethyl) glycine
Metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H) one
Napropamide	2-(a-naphthoxy)-N,N-diethylopropionamide
Simazine	2-chloro-4,6-bis(ethylamino)-s-triazine
Trifluralin	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
Promamide	N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide

Table 3. Weed control ratings on a nursery planting - July 19, 1973

Treatment Herbicide	Rate	Weed Growth Index[a] General	Grass	Non-Grass	Predominant weed
Untreated		9	6	7	red root, carpetweed, crabgrass
Napropamide	4	4	3	4	red root
Napropamide	6	4	3	3	red root
Napropamide	8	3	2	3	none
Napropamide, simazine	4+1	2	1	2	none
Napropamide, simazine	8+2	2			none
Trifluralin	2	5	3	3	red root
Trifluralin, simazine[b]	1+1	3	2	2	red root
Trifluralin, simazine	2+1	3	2	2	none
Trifluralin, simazine	3+1	3	2	2	none
CGA 10832	2	6	4	5	red root, carpetweed, crabgrass
CGA 10832, simazine	1+1	4	3	3	red root
CGA 10832, simazine	2+1	3	2	2	none
CGA 10832, simazine	3+1	3	2	3	none
Diphenamid, simazine	4+1	3	3	2	none
Alachlor, simazine	3+.75	2			none
Alachlor, simazine	6+1.5	2	2		none
Metribuzin, simazine[b]	.5+1	1	1	1	none
Dibutalin, diphenamid	6	2	2	1	none

a Replicates of 2 plots
b only one replicate. 1 = no weeds, 10 = full of weeds

Table 4. The effect of herbicide treatments on the vigor of nursery liners[a]

Treatment															
Herbicide	Rate	White pine	Scots pine	White spruce	Douglas Fir	Andorra Juniper	Hicks yew	Russian olive	Toringo crabapple	Multiflora rose	Cranberry bush	Forsythia	California privet	Azalea	Bronze winter creeper
Untreated		7	6	9	8	10	10	3	7	6	4	9	8	9	9
Napropamide	4	7	4	9	8	9	10	4	8	9	8	10	10	10	9
Napropamide	6	7	4	7	7	9	10	6	9	6	5	10	10	10	7
Napropamide	8	7	5	9	8	10	10	5	4	7	4	10	10	10	8
Napropamide, simazine	4+1	6	4	6	6	10	10	5	8	9	4	10	9	9	8
Napropamide, simazine	8+2	8	4	8	8	9	10	8	7	6	7	10	9	10	8
Trifluralin	2	8	6	8	8	9	10	6	8	5	4	10	9	9	9
Trifluralin, simazine[b]	1+1	9	5	9	3	10	10	1	3	9	1	10	9	10	8
Trifluralin, simazine	2+1	8	3	7	6	10	10	7	8	4	5	10	9	10	8
Trifluralin, simazine	3+1	8	4	7	8	9	9	6	5	5	5	10	9	9	9
CGA 10832	2	9	5	9	8	9	10	4	6	7	6	10	9	9	9
CGA 10832, simazine	1+1	9	4	5	9	9	10	8	8	9	4	10	9	10	9
CGA 10832, simazine	2+1	8	5	5	7	10	10	8	9	9	6	10	9	9	8
CGA 10832, simazine	3+1	8	4	7	8	10	10	7	4	7	2	10	8	10	8
Diphenamid, simazine	4+1	7	5	9	7	9	9	5	7	8	5	10	10	10	9
Alachlor, simazine	3+.75	8	3	9	8	9	9	4	7	9	7	10	9	9	10
Alachlor, simazine	6+1.5	7	4	8	8	9	10	7	6	10	5	10	10	9	8
Metribuzin, simazine[b]	.5+1	7	5	8	7	10	10	3	6	6	6	10	8	8	3
Dibutalin, diphenamid	6	7	4	8	7	10	10	5	8	7	3	10	9	9	8
Glyphosate	1	6	5	8	7	9	10	4	4	3	3	9	7	9	8
Glyphosate	2	6	5	7	6	10	9	4	1	2	3	6	4	5	8
Glyphosate	3	4	4	7	6	8	10	2	1	2	2	5	3	7	8
Promamide	1.5	6	4	8	7	10	10	3	5	8	4	10	9	9	8

a 1=missing or dead, 10=excellent vigor
b only 1 replicate

SELECTIVITY OF GLYPHOSATE AND ASULAM IN ORNAMENTAL PLANTINGS AND CHRISTMAS TREES

John F. Ahrens[1]

INTRODUCTION

A number of herbicides are available for preemergence use in ornamental plantings, but few herbicides will selectively remove established weeds from established ornamentals. Directed sprays often are impractical because of the growth habit of the plants or they are time consuming and, therefore, expensive to use. Hand methods have been the only practical way to remove established growth from most ornamental plantings.

During 1972 we reported that glyphosate (N-phosphonomethyl) glycine) selectively removed weeds from plantings of white spruce (1), but severely injured white pine, Scotch pine and Douglas-fir. Burt, et al. (2) also reported that glyphosate was selective on certain ornamental plants. Other reports indicate that asulam (methyl sulfanilylcarbamate) may have potential uses for removing established weeds from woody plants (3). Dosage and time of application with respect to plant and weed growth seemed to be important factors in the selectivity of these herbicides. In the work reported here we investigated the effects of timing and dosage of glyphosate and asulam in several different woody plants.

METHODS AND RESULTS

Sprays of glyphosate[2] (N-phosphonomethyl) glycine, isopropyl amine salt) and asulam[3] (methyl sulfanilylcarbamate) were applied with a hand-held boom calibrated to deliver 50 gal solution/A. These sprays were applied over the tops of the weeds and ornamental plants. Details of each experiment are given below.

1. Glyphosate on dormant conifers and on sod - On Nov 7, 1972, glyphosate was applied at rates of 0.5, 1 and 2 lb/A over white spruce (*Picea glauca*), Scotch pine (*Pinus sylvestris*) and Douglas-fir (*Pseudotsuga menziesii*) growing in quackgrass (*Agropyron repens* (L.)Beauv.) sod. The trees had been planted in April 1972 and were completely dormant. The air temperature was 58° F at the time of treatment and rain fell 15 hours later. Two container-grown plants each of Colorado spruce (*Picea pungens*), *Taxus cuspidata* Greenwave and white pine (*Pinus strobus*) were set at the ends of each plot of the three replicates and were also sprayed with glyphosate. These containers remained in the field overnight and were then placed under a plastic storage facility. The container plants were brought into the greenhouse on Jan 24, 1973, and held at 65° F and on 16 hour days. In June they were transplanted into field plots for further observation.

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[1]The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor
[2]ROUNDUP by Monsanto
[3]ASULOX by Rhodia, Inc.

Quackgrass control in May was excellent at all rates, but in the fall control was fair (50-60%) at 0.5 lb/A and goo-to-excellent (85-90%) at 1 or 2 lb/A. Wild blackberry (Rubus spp.) that was in partial leaf at treatment was killed by dosages of 1 or 2 lb/A.

The Colorado spruce and white pine in the containers and the white spruce, Scotch pine and Douglas-fir in the field grew normally without injury from the glyphosate treatment. Taxus Greenwave showed growth suppression that increased with increasing dosage. At 0.5 lb/A growth was normal in most plants but a few buds on the tips of shoots were killed causing lateral branching. About half of the taxus receiving 1 lb/A showed mild-to-moderate growth suppression on some branches. At 2 lb/A, most plants showed suppression; affected branches had fewer and shorter needles, but needle color was normal.

Glyphosate also was applied at 0.5 and 1 lb/A on Nov 7, 1972 over seedlings of Taxus cuspidata capitata that were 2 to 3 in tall, infested with horseweed (Erigeron canadensis L.), mouseear chickweed (Cerastium vulgatum L.) and common speedwell (Veronica officinalis L.). The plants were covered with lath shade and cheesecloth the day after treatment and were uncovered in late March. When uncovered the weeds showed only mild chlorosis, but within three weeks, most of the weeds were dead. Control was over 90 percent with both dosages. Growth of the taxus seedlings was temporarily suppressed at 1 lb/A but not at 0.5 lb/A.

2. Actively-growing conifer seedlings - Applications were made over conifer seedlings at the State Forest Nursery at Voluntown, Connecticut, in June and July 1973. Glyphosate was applied on June 8 over seedlings of white pine, white spruce and Douglas-fir that were 1½ in tall approximately 1 month after germination. Few weeds were present in the plot area on June 8. Plots were 3 ft wide across 4 ft beds, and the treatments were replicated three times within each species. Irrigation water was applied three hours after treatment. Treatments on July 18 included glyphosate at 0.5 and 1 lb/A and asulam at 4 lb/A over the seedling conifers and established weeds. The injury evaluations in August are given in Table 1.

Table 1. Injury to conifer seedlings from glyphosate or asulam[1].

Herbicide	Rate a.i. lb/A	Date applied	Douglas-fir	White spruce	White pine
glyphosate	.4	June 8	3.0	0	0
	.8	June 8	7.7	1.7	0.3[2]
	.4	June 8	5.7	1.0	1.7
	.5	July 18			
	.8	June 8	8.3	2.7	3.3
	.5	July 18			
	.5	July 18	3.0	1.0	-
asulam	4.0	July 18	3.3	0	0

[1]0 = no injury, 10 = dead plants on August 23.
[2]White pine injury rating in July averaged 2.4, but the plants recovered by August.

Glyphosate at 0.5 lb/A in July killed mature crabgrass (Digitaria spp.) but asulam at 4 lb/A did not. Both glyphosate and asulam killed established oldfield toadflax (Linaria canadensis). Injury from glyphosate was least in white spruce, intermediate in white pine and greatest in Douglas-fir. Reapplying glyphosate in July increased the injury to the conifers. Asulam in July injured Douglas-fir but not white spruce or white pine.

3. Conifer transplant beds - Asulam at 3 lb/A and glyphosate at 0.5 lb/A were applied in August over conifers that had been transplanted in June 1973 at 4 x 4 in spacings. Plots were 3 ft wide across the 4 ft beds. The conifers included two-year-old seedlings of Douglas-fir and white spruce and rooted cuttings of Taxus cuspidata and Andorra juniper (Juniperus horizontalis plumosa). The white spruce and most of the Douglas-fir had ceased terminal growth, and the junipers and taxus were growing at the time of treatment. Mature plants of crabgrass, stinkgrass (Eragrostis cilianensis (All.) Lutati) and spotted spurge (Euphorbia maculata L.) were present at treatment and the temperature was 80° F. The plots were irrigated the following day and periodically thereafter.

Kill of these weeds required about 10 days with glyphosate and up to three weeks with asulam. Control ratings in early October averaged 98 percent with glyphosate and 85 percent with asulam. Asulam did not kill spotted spurge or the largest plants of crabgrass and stinkgrass. Neither herbicide caused any injury to the conifers in this test.

4. Newly-planted conifers in sod - Two-year-old seedlings of white pine, Douglas-fir and white spruce were planted on April 23, 1973 into a grass sod composed primarily of quackgrass and orchardgrass (Dactylis glomerata L.). Treatments were applied over six to eight plants of each species and replicated three times. The herbicides were applied on April 24, when the quackgrass was 4 to 6 in tall with 2 to 3 leaves. The orchardgrass was 8 to 12 in tall and the conifer buds were swollen and just breaking dormancy. The air temperature was 72° F and rain fell the following day. In one treatment, simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) was applied at 6 lb/A on April 24 and glyphosate was applied at 1 lb/A on Aug 9, when the conifer growth was hardening off. The air temperature was 85 to 90° F on Aug 9 and rain fell four days later.

The treatments and their effects on sod control and conifer injury and mortality are given in Table 2. A combination of glyphosate at 0.5 lb/A plus simazine at 4 lb/A controlled the sod as well as simazine at 6 lb/A. Glyphosate at 1 lb/A plus simazine at 4 lb/A gave season-long control of sod. However, glyphosate increased mortality in white pine at 0.5 lb/A in April and in Douglas-fir at 1 lb/A in April or August. White spruce was affected little by glyphosate, however.

Asulam suppressed the perennial grasses rather than killing them. In July, visual injury to the conifers from asulam was greatest in Douglas-fir intermediate in white spruce and least in white pine. In October, asulam at 3 or 6 lb/A slightly increased mortality in Douglas-fir and, at 6 lb/A, suppressed growth in white pine. Typical injury from asulam in Douglas-fir and white spruce was kill of certain lateral or terminal buds, with some needle loss.

Table 2. Sod control, visual injury[1] and mortality[2] of newly-planted conifers - 1973

Herbicide	Rate a.i. lb/A	Percentage sod control July 11	Percentage sod control Oct 1	White pine Injury	White pine Mort.	White spruce Injury	White spruce Mort.	Douglas-fir Injury	Douglas-fir Mort.
Untreated	-	0	0	0	9	0	8	0	7
simazine	6	78	53	0.7	7	1.0	17	1.0	0
simazine +	4+.5	80	58	2.7	30	0.7	22	0.7	6
glyphosate[3]	4+1	95	70	9.0	82	1.0	17	2.3	27
simazine + glyphosate[4]	6+1	88	96	0	38	0	6	0.7	38
asulam	3	30	7	0.3	13	1.0	0	2.0	12
	6	40	28	1.0	12	2.7	6	3.3	11

[1]Injury ratings in July - 0 - no injury, 10 - dead plants.
[2]Percentage mortality in October.
[3]Tank mix combination on April 24.
[4]Simazine applied on April 24 and glyphosate applied on August 9.

5. Timing studies with asulam and glyphosate over established nursery plants - Test A. Plants established in a sandy loam soil for three years were sprayed with asulam or glyphosate at three different times during the 1973 season. The plants in each plot of the three replicates included: 5 Andorra juniper, 3 spreading yews (*Taxus cuspidata*), and 5 white pines. 'Golden Charm' roses also were present in some of the plots. The herbicides were applied on April 19 when growth of the yews and junipers was just beginning and the pines had ½ to 1 in of new growth, on May 30 when all were actively growing, and on Aug 9 when the junipers and yews were still growing and the pines were setting new buds following a July shearing. The yews and junipers were sheared a few days before the April application. Since the pines were 2 to 3 ft tall the sprays of asulam at 3 and 6 lb/A and glyphosate at 0.5 and 1.5 lb/A were applied so that the lower three fourths of the pines were sprayed but the terminals were not. Rain fell on the evenings of April 19 and May 30 and two days following application on Aug 9. The air temperatures on the three dates were 75°, 80°, and 90° F, respectively.

Kill of established plants of crabgrass and horseweed was good with all rates of glyphosate and asulam. Mouseear chickweed and dandelion (*Taraxacum officinale* Weber) were not controlled by asulam at 3 lb/A but were partially controlled at 6 lb/A. Glyphosate at 0.5 lb/A controlled mouseear but only partially controlled dandelion, whereas, 1.5 lb/A controlled both species.

The summarized observations of the plant injury in Table 3 show that asulam caused no injury to the conifers but caused moderate-to-severe tip kill on the roses. Regrowth of the roses appeared normal except with asulam at 6 lb/A on Aug 9 which killed some of the plants.

Table 3. Condition[1] of asulam and glyphosate treated ornamental plants in July and October, 1973.

Herbicide	Rate a.i. lb/A	Time of application	Juniper	Taxus	Pine	Rose
glyphosate	.5	April 19	N	N	N	-
	1.5	April 19	P,SG	P,SG-July N-Oct	N	-
	.5	May 30	N	ST-July SG-Oct	SD-July N-Oct	MT,NR
	1.5	May 30	ST-July SG-Oct	MT-July MG-Oct	MT,MD-July O-Oct	ST,F
	.5	Aug 9	N	ST,N	N	MT,F
	1.5	Aug 9	ST,N	MT	P,A	Sev.T,F
asulam	3	April 19	N	N	N	-
	6	April 19	N	N	N	-
	3	May 30	N	N	N	MT,NR
	6	May 30	N	N	N	Sev.T,NR
	3	Aug 9	N	N	N	MT,NR
	6	Aug 9	N	N	N	Sev.T

[1]Injury code: P - needle or bud kill near pruned ends of branches; N - normal growth; G - growth suppression; S - slight; M - moderate; Sev. - severe; D - drooping of foliage; A - suppression of adventitious bud development following shearing; T - tip buds killed; F - regrowth fasciated; O - off color, but normal adventitious bud development; NR - normal regrowth.

Glyphosate killed the tips of rose shoots whenever they were sprayed, ad and the regrowth was stunted and fasciated. Glyphosate at 0.5 lb/A in April injured none of the conifers but in May it killed the tip buds of some shoots in taxus which slightly suppressed growth. It also caused the actively-growing shoots of white pine to droop slightly. In Aug, glyphosate at 0.5 lb/A had no effect on the junipers or recently-sheared pines, but it killed a few tip buds in taxus. Increasing the dosage of glyphosate to 1.5 lb/A in April killed needles and some buds near the sheared tips of taxus and juniper and suppressed growth in these plants without affecting their color. Tip injury and growth effects from glyphosate at 1.5 lb/A were most pronounced in taxus and white pine with the May application, but the August application caused needle browning near the sheared branch tips and suppressed formation of adventitious buds on the white pines.

Test B. Asulam was applied at 3 and 6 lb/A on May 27 and Aug 10 and glyphosate was applied at 0.5 and 1 lb/A on Aug 10 over established plants of white pine and privet (Ligustrum ovalifolium). Soil and weather conditions were similar to those in Test A. Asulam at 3 or 6 lb/A in May killed seedlings of crabgrass and horseweed and prevented regrowth of crabgrasses for 4 to 6 weeks. In contrast to Test A, asulam in May caused slight foliage discoloration on the white pines at 3 lb/A and moderate discoloration

at 6 lb/A. The plants recovered, however, and growth, color, and adventitious bud formation following shearing were normal in the fall. Glyphosate at 1 lb/A in August caused the same kind of injury and suppression of bud development on white pine as obtained in Test A. The lower dosages of both herbicides in August killed crabgrasses 2 to 4 in tall without injury to the pines. The privet was severely injured by both materials but regrowth appeared normal.

6. Container-grown plants - Three one-gallon containers of each of several nursery species were sprayed with glyphosate at 0.5 lb/A and asulam at 3 lb/A on June 28, 1973. The air temperature was 83° F and large crabgrass or horseweed was present in most of the containers at treatment. The treated plants were held under cover for 24 hours before exposure to rain or daily irrigation. Both herbicides killed the horseweed and glyphosate killed the crabgrass. Asulam browned and stunted but did not kill all of the larger plants of crabgrass.

The typical injury to the woody plants with both herbicides was kill of tip buds of actively-growing shoots. Glyphosate injured only a few tips on the junipers and none on the Mugho pines (Table 4). Plants of juniper, Euonymus 'Emerald Cushion' and Pieris that were injured by glyphosate in July appeared normal in September. Asulam caused less injury than glyphosate on most plants and many of the plants injured by asulam recovered fully. Their regrowth was normal and as good as comparable untreated plants in which weeds grew for a few weeks before removal. Forsythia did not recover from the asulam treatment, however.

Table 4. Injury to container-grown ornamental plants at two different times after treatment[1] - 1973.

	Glyphosate 0.5 lb/A		Asulam 3 lb/A	
Species	July 20	Sept 12	July 20	Sept 12
Forsythia intermedia	4	5	3	4
Cotoneaster horizontalis	4	4	2	0
Pieris japonica	3	1	3	1
Pieris floribunda	5	1	3	0
Juniperus horizontalis	1	0	0	0
Spirea nipponica	8	8	2	1
Euonymus fortunei 'Emerald Cushion'	3	0	1	0
Pinus mugo mughus	0	0	1	0
Leucothoe axillaris	3	3	5	0
Azalea hinodigiri	4	5	2	0
Mahonia aquifolia	3	7	3	0
Hypericum hidcote	5	7	3	0
Rosa alba	4	6	5	0

[1] 0 = no injury, good vigor; 10 = dead plants.

DISCUSSION AND SUMMARY

The results obtained in these experiments provide a framework for future studies with asulam and glyphosate in woody plants. Both herbicides killed established weeds with no injury or minor injury to several woody plants. Selective dosages center around asulam at 3 to 4 lb/A and glyphosate at 0.5 to 1 lb/A. At these dosages both controlled succulent annual weeds such as crabgrass and horseweed but glyphosate was more effective against perennial weeds such as mouseear chickweed, quackgrass and dandelion. Both herbicides killed weeds slowly, especially under cool temperatures. Whereas, glyphosate had no residual activity against germinating weeds, asulam controlled crabgrasses for 4 to 6 weeks.

Both herbicides affected the active growing points of weeds and of woody plants. Woody plants differ widely in their tolerance of these herbicides so cataloguing of their responses will be essential.

Conifers generally were more tolerant of asulam and glyphosate than deciduous plants. Conifers were more tolerant when dormant or fully mature than when growing rapidly. Asulam at 3 lb/A usually caused less injury to growing woody plants than glyphosate at 0.5 lb/A and deciduous plants usually recovered more rapidly from asulam treatments. However, fall applications of glyphosate at 0.5 or 1 lb/A on dormant conifers controlled perennial grasses and blackberry with only slight growth suppression in taxus and no injury to pines, spruces or Douglas-fir. Pruning before treatment was associated with injury from glyphosate at 1 or 1.5 lb/A in white pine, taxus and juniper. Pruning possibly allowed direct entry of glyphosate into the plant. This resulted in a slight growth suppression in taxus and juniper and suppression of the formation of adventitious buds that normally form following shearing in white pine.

The potential horticultural uses of these herbicides appear to be many. Fall applications of glyphosate on dormant conifers could be useful in the control of perennial grasses and blackberries in Christmas trees and annual and perennial weeds in nurseries. At a dosage of 0.5 lb/A, glyphosate can also selectively remove annual weeds from plantings of established conifers during the growing season. The safety of asulam on conifers and certain other ornamentals and its effectiveness against annual weeds also make it a potentially useful tool for postemergence weed control in nursery production during the growing season. The temporary growth suppression obtained in certain woody plants with these herbicides could make them especially useful in landscape plantings where maximal growth not only is unnecessary, but often is undesirable.

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GLYPHOSATE ON ORNAMENTALS

A. Bing 1/

ABSTRACT

Growth responses of several woody ornamentals to N-phosphoromethyl glycine (glyphosate) shows that Toringo crabapple (Malus sieboldii) and multiflora rose (Rosa multiflora) are very sensitive while Hicks yew (Taxus cuspidata hicksii) and Hetz juniper (Juniperus chinesis hetzi glauca) are quite tolerant even to sprays applied directly on the foliage. Other species included in these tests were intermediate in response. Glyphosate was very effective in controlling many perennial weeds including mugwort (Artemesia vulgaris), quackgrass (Agropyron repens), curly dock (Rumex crispus), and Canada thistle (Cirsium arvense).

INTRODUCTION

Control of nutsedge (Cyperus esculentus), mugwort, quack grass, Canada thistle, field bindweed (Convolvulus arvensis), hedge bindweed (Convolvulus sepium) and other perennial weeds has been a continuing unresolved problem in nursery and landscape plantings. These weeds have underground stolons or other plant parts that make them difficult to pull by hand. Cultivation, rather than being a control measure, contributes to the spread. The use of (2,4-dichlorophenoxy) acetic acid (2,4-D), (2,4,5-trichlorophenoxy) propionic acid (silvex), 3,6-dichloro-a-anisic acid (dicamba) or 3-amino-s-triazole (amitrole) to control these weeds is hazardous for most ornamentals in both nursery and landscape plantings because of spray drift or fumes. Residues in the soil of dicamba or 2-chloro-4-,6-bis (ethylamino)-s-triazine (simazine) can cause many problems to plants in the soil or to later plantings in the same soil. The development of a systemic non-soil residual herbicide for ornamental plantings is highly desirable. Glyphosate shows promise to fill this need.

METHODS AND RESULTS

Nursery planting. In this experiment, young nursery plants were lined out 2 ft apart in 400 ft rows spaced 3 ft apart. There were 14 cultivars each in 1 row. Table 1 lists the plants treated. Treatments were made in 8 ft bands across all rows with 4 plants of each cultivar in every replicate. The treatments were postplant delayed postemergence to weeds 6-8 in high. The glyphosate (Mon 2139 3 lb ai/gal) was sprayed with a hand pumped sprayer at 1,2 and 3 lb ai/A using a Spraying Systems 65002 nozzle, delivering 50 gal/A. The nursery plants were small liners planted May 9-11, and were well leafed out and growing when treated on July 24. In this experiment, the objective was crop tolerance. The weeds were mostly annuals. Observations on crop tolerance were made on October 10. The ratings were from 1 = a dead or missing plant to 10 = a vigorous plant. Table 1 shows the averages of 2 replicates of 4 plants per treatment.

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[1] Cornell Ornamentals Research Laboratory

There was considerable difference in the tolerance of the nursery plants to an overall spray of glyphosate: Andorra juniper, Hicks yew, and bronze winter creeper were not appreciably affected by the treatment as shown by the high index numbers at all rates used. White spruce, Douglas fir, forsythia and azalea were only slightly affected, while crabapple and rose were seriously injured. Later the treated roses developed dwarfed fasciated new growth. Forsythia and privet tips were burned by the treatment, but were making new growth at the time of rating.

Spot treatment. In an older nursery planting, some areas were badly infested with Canada thistle. These areas with 6 to 8 in high thistle were treated at rates of 1, 2 and 3 lb ai/A on July 12. Other areas with 16-20 in thistle were treated on August 8, at rates of 1, 1 1/2 and 2 lb ai/A. All treatments caused good top killand little regrowth occurred at even the lowest rate. Hemlock (*Tsuga canadensis*) foliage that was sprayed was severely burned, but the unsprayed parts of the plants grew normally. Yew and white pine were not noticeably injured.

Older plants. Three-4 ft *Rhododendron catawbiense*, andromeda (*Pieris japonica*), Exbury hybrid azaleas (*Rhododendron molle*), and several varieties of taxus (*Taxus cuspidata* and *Taxus baccata*) were infested with field bindweed and other weeds. The bindweed was growing over the plants. Replicated areas were treated by spray applications on July 12, and identical treatments applied to comparable replicated areas on August 8, with 1, 2 or 3 lb ai/A rates. In attempting to spray the foliage of the bindweed, some of the spray hit the tops of the plants. The weeds were well burned down by all the treatments but some bindweed grew back at the 1 or 2 lb ai/A treatments. Seedling weeds grew back in all areas soon after treatment. There was considerable tip burn on the andromeda, but only slight tip burn on some of the yew shoots. All plants grew back normally later in the season. Azaleas and rhododendrons were not appreciably affected.

In another area, Hicks yew and spruce were treated directionally at 2 and 3 lb ai/A twice during the growing season. There was good control of red sorrel (*Rumex acetosella*), curly dock (*Rumex crispus*), dandelion (*Taraxacum officinale*) and other perennial weeds. Nutsedge also showed top kill. The only damage to the nursery plants was a few burned side shoots. Where a heavy spray was intentionally applied over the top of yew and spruce, there was some burn of the taxus and the spruce were killed back considerably following a period of hot weather. Later in the season, regrowth started so no plants were considered killed.

Landscape plantings. The treatments on landscape plantings were for the control of mugwort, quack grass and field bindweed growing under and around large yew, rhododendron, azaleas, juniper, and leucothoe (*Leucothoe catesbaei*) and later for the control of hedge bindweed that grew over the tops of yew and Hetz juniper. Directional sprays of glyphosate under the large plants gave good, safe control of mugwort and quack grass at rates of 1 and 2 lb ai/A. The bindweed was burned down but there was some regrowth. Treatment over the top at 2 lb ai/A of hedge bindweed heavily covering large yews and junipers gave good top kill of the bindweed with only slight burn of some yew shoots and very little damage to the junipers.

SUMMARY

Glyphosate is very effective in controlling mugwort, quack grass, Canada thistle, species of Rumex and many other perennial weeds in landscape plantings. It is fairly safe under large plants. Some plants like yew and juniper are quite tolerant to over the top sprays while others including rose and crabapple are very sensitive. The best use probably would be in the treatment of areas with well developed, undisturbed perennial weeds before plowing and planting.

Table 1. The effect of spraying glyphosate on the vigor of growing nursery plants.

Plants treated	Vigor ratings[a]			
	Un-treated	Glyphosate lb ai/A 1	2	3
White pine (Pinus strobus)	7	6	6	4
Scots pine (Pinus sylvestris)	6	5	5	4
White spruce (Picea glauca)	9	8	7	7
Douglas fir (Pseudotsuga taxifolia)	8	7	6	6
Andorra juniper (Juniperus horizontalis plumosa)	10	9	10	8
Hicks yew (Taxus cuspidata)	10	10	9	10
Toringo crab (Malus sieboldii)	7	4	1	1
Multiflora rose (Rosa multiflora)	6	3	2	2
Cranberry bush (Viburnum trilobum)	4	3	3	2
Forsythia (Forsythia sp)	9	9	6	5
California privet (Ligustrum ovalifolium)	8	7	4	3
Azalea (Rhododendron obtusum)	9	9	5	7
Bronze winter creeper (Euonymus fortunei coloratus)	9	8	8	8

[a]Rating 1 dead or missing to 10 for a vigorous plant on October 10. Each figure the average of 2 replicates of 4 plants of each cultivar.

PREPLANT HERBICIDES FOR CONTROL OF QUACKGRASS IN ORNAMENTALS

John F. Ahrens[1]

ABSTRACT

At Windsor on a sandy loam soil preplant incorporated applications of pronamide in August gave quackgrass control that was comparable to surface applications. Control of quackgrass with pronamide at 2 lb/A was comparable to control with dichlobenil at 6 lb/A applied postplanting on the soil surface in December, and longer lasting than control with a preplant incorporated application of EPTC at 5 lb/A. Pronamide at 2 lb/A did not injure chrysanthemums, hydrangea, or euonymus but 4 lb/A reduced vigor of hydrangea.

At Bloomfield on a silt loam soil, pronamide, glyphosate, metribuzin and napropamide were applied to an established sod of quackgrass in November or in May before plots were planted with white pine, juniper, euonymus, and taxus. Metribuzin at 1.5 or 3 lb/A lightly incorporated before planting did not control quackgrass and severely injured the ornamental plants. Pronamide at 3 lb/A and napropamide at 8 lb/A did not injure the ornamentals and were more effective against quackgrass and annual weeds when incorporated before planting in May than when applied in November, but neither gave satisfactory control of quackgrass for the season. Glyphosate at 1.5 or 3 lb/A gave excellent control of quackgrass without injury to the ornamental plants when applied on quackgrass 6 to 10 in tall in May, eight days before plowing. Control of annual weeds was poor with glyphosate, short-lived with pronamide and long-lasting with a preplant incorporated application of napropamide at 8 lb/A.

INTRODUCTION

There are few chemical treatments that can be used to control quackgrass (Agropyron repens (L.)Beauv.) before planting ornamentals. Soil fumigants are very expensive and difficult to use and the herbicides that are very effective against quackgrass such as simazine, atrazine, or dichlobenil leave residues in the soil that will injure many ornamentals (1,2,3). EPTC suppresses quackgrass for only part of a growing season (1). The introduction of new herbicides that were reported to have activity against quackgrass (4,5,6,7) led us to determine their utility in plantings of ornamentals.

MATERIALS AND METHODS

Herbicides were applied on established stands of quackgrass at two locations. Sprays were applied with a knapsack sprayer with a hand-held boom calibrated to deliver 50 gal solution per acre. Granules were applied with an auger-feed applicator calibrated for each treatment. The following herbicides were tested: (a) EPTC [S-ethyl dipropylthiocarbamate], 6 lb/gal emulsifiable concentrate, (b) glyphosate [N-(phosphonomethyl) glycine, isopropylamine salt], 3 lb/gal liquid, (c) pronamide [N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide], 50% wettable powder, (d) napropamide [2-(α-naphthoxy)-N,N-diethyl propionamide], 50% wettable powder, (e) dichlobenil [2,6-dichlorobenzonitrile], 4% granules, (f) metribuzin [4-amino-6-tert-butyl-3-(methylthio)-s-triazin-5(4H)one], 50% wettable powder.

[1]The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor, Connecticut.

The first test was conducted on a sandy loam soil in Windsor, Connecticut, in 1971 and 1972. The plots were 6 x 10 ft, with three replicates in randomized complete blocks. The quackgrass sod was plowed, limed, and fertilized on August 25, 1971. The following day pronamide and EPTC were applied and rototilled 3 in into the soil within 15 min. At 1, 7 and 14 days after treatment, six Hydrangea 'Nikko Blue' and five Euonymus radicans 'Sarcoxie' were planted into each plot. These plants were cuttings rooted during the previous winter and grown in transplant beds for one season. Ten days after treatment 5 rooted cuttings of Chrysanthemum moriflorum 'Showtime' were also planted into the plots. Postplanting surface applications of pronamide and dichlobenil were made on December 13, 1971. Injury to the plants and control of quackgrass and other weeds were evaluated by visual ratings or by counts at varying intervals over the season following treatment. All weeds were removed from the plots following evaluation in May 1972.

Weeds that invaded the plot area in the fall of 1971 included large crabgrass (Digitaria sanguinalis (L.)Scop.), horseweed (Erigeron canadensis L.) and shepherdspurse(Capsella bursa-pastoris (L.)Medic). Weeds that invaded in the spring of 1972 included common ragweed (Ambrosia artemisiifolia L.), horseweed, common chickweed (Stellaria media (L.)Cyrillo), common dandelion (Taraxacum officinale Weber) and cinquefoils (Potentilla spp.).

A second test was conducted on a silt loam soil in Bloomfield, Conn. The herbicides were applied on 10 x 12 ft plots either on established sod in the fall or spring or after field preparation in the spring. The treatments were arranged in randomized complete blocks with three replications. The fall applications were applied on November 7, 1972, on quackgrass 6 to 12 in tall that had been mowed in August. The grass was mature and about 50 percent green. The air temperature on November 7 was 58°F and the soil temperature was 45°F at the 3 in depth. Heavy rains fell the following day. Applications of glyphosate on May 7, 1973 were made when the quackgrass was 6 to 10 in tall with 4 to 5 leaves. The air temperature was 63°F and the soil temperature at 3 in was 53°F. A light rain fell on May 8. The field was plowed and disked on May 15, 1973. Pronamide and napropamide were applied on May 17 and disked into the soil. Metribuzin was applied on May 21 and lightly incorporated with a rake. On May 24 and 25, the following ornamentals were transplanted into each plot: six two-year-old seedlings of white pine (Pinus strobus), six one-year-old plants (from cuttings) of Andorra juniper (Juniperus horizontalis plumosa compacta), six one-year-old plants (from cuttings) of spreading yew (Taxus cuspidata), and three two-year-old plants of Sarcoxie euonymus (Euonymus radicans).

Percentage weed control and plant injury were evaluated visually in July, August, and October, 1973. All weeds were pulled from the plots following the July evaluation. Counts of the number of quackgrass shoots and other weeds were made on August 25, 1973 on four one-sq ft sample areas within each plot.

Other weeds that invaded the experimental area included black nightshade (Solanum nigrum L.), common purslane (Portulaca oleracea L.), hairy galinsoga (Galinsoga ciliata (Raf.)Blake), stinging nettle (Urtica dioica L.), woodsorrel (Oxalis spp.), yellow rocket (Barbarea vulgaris R.Br.), and fall panicum (Panicum dichotomiflorum Michx).

RESULTS AND DISCUSSION

Windsor - A preplant incorporated application of EPTC at 5 lb/A gave complete control of large crabgrass in the fall, but only fair control of quackgrass (Table 1). By May, control of quackgrass was still fair but cinquefoils, horseweed, and common chickweed had invaded the EPTC plots. The short residual activity of EPTC limits its effectiveness as a preplanting treatment in ornamental plantings (2).

Pronamide at 2 or 4 lb/A either preplanting or on the soil surface in December gave good control of quackgrass, and poor control of cinquefoils, horseweed, dandelion, and common ragweed. The preplanting applications of pronamide controlled a fall invasion of shepherdspurse and markedly reduced stands of large crabgrass. Dichlobenil at 6 lb/A on the soil surface in December gave lasting control of quackgrass and the other weeds.

Time of planting following herbicide application had no effect on the hydrangea and euonymus transplants used in this test and, therefore, the data in Table 2 are averages for the 1, 7 and 14 day plantings. In most cases competition from the weeds caused more plant injury than the herbicide treatments. The preplant treatments of EPTC and pronamide at 1 or 2 lb/A were less injurious to euonymus, hydrangea and chrysanthemums than was the weed competition. Pronamide at 4 lb/A preplanting reduced vigor of the hydrangea but did not affect the other plants. As expected, dichlobenil applied in the late fall had little effect on the woody plants but it killed the chrysanthemums.

Bloomfield - Quackgrass stands were surprisingly light in this test (55% stand in control plots in July) even though a dense stand of quackgrass was plowed down. Competition from annual weeds was great, however, November applications of pronamide or napropamide on established sod followed by spring plowing did not satisfactorily control quackgrass or the other weeds (Table 3). The preplant incorporated applications of pronamide at 3 lb/A and napropamide at 8 lb/A gave only fair control of quackgrass but good control of annual weeds in July. Napropamide at 8 lb/A controlled the annual weeds all season. Metribuzin at 1.5 lb/A or 3 lb/A also controlled the annual weeds but did not control quackgrass.

Glyphosate was the most effective herbicide against quackgrass in this test. May applications of glyphosate on growing quackgrass sod were more effective in controlling quackgrass than November applications, but there was little difference between May applications at 1.5 or 3 lb/A. The dosage of 1.5 lb/A gave over 90 percent control of quackgrass for the season. Glyphosate did not control the annual weeds.

Injury and vigor of the ornamental plants in the treated plots was compared with that of plants in the hand-weeded control plots. Glyphosate, pronamide and napropamide had no significant effect on the white pines, junipers, yews or euonymus during the 1973 season. The plants grew well in all plots treated with these herbicides. Metribuzin caused moderate to severe injury on all species. On a scale of 0 = no injury to 10 = all plants dead, the following ratings were obtained in August:

	White pine	Taxus	Juniper	Euonymus
Metribuzin 1.5 lb/A	4	2	5.3	9.5
3 lb/A	6.6	5	6.0	9.5

The ornamental plants growing in the metribuzin-treated soil developed chlorotic and necrotic foliage and some eventually died.

The failure of pronamide in controlling quackgrass at the Bloomfield location is difficult to understand in view of the report by Viste (6), and our results at Windsor and at East Granby, Connecticut (8). One factor may be plowing and disking vs. rototilling the quackgrass sod. At Bloomfield we plowed the sod and the stony soil condition prevented the disk harrow from thoroughly breaking up the quackgrass rhizomes, whereas at Windsor rototilling thoroughly broke up the rhizomes. Further investigation of the preplant use of pronamide for control of quackgrass obviously is needed.

Napropamide should be tested further for preplanting use in ornamentals even though quackgrass was not satisfactorily controlled in this work. The long residual activity of enapropamide against annual weeds and yellow nutsedge (8) and its apparent safety in woody plants could make it a useful herbicide.

Of the herbicides tested in ornamental plants over the last decade, glyphosate seems to offer the most promise for controlling quackgrass before planting or as a directed spray in established stock (9). It is effective against quackgrass without leaving residues in the soil that affect plant growth. This lack of residual activity requires the use of other herbicides to control annual weeds after planting, but this is less difficult with current nursery herbicides.

Excellent control of quackgrass (90 percent or better) probably is more difficult to achieve in ornamental plants than in crops that compete with quackgrass. Most woody nornamentals grow slowly and provide little competition to herbaceous weeds for light, moisture and nutrients.

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Table 1. Control of quackgrass and other weeds with pre- and postplanting applications of herbicides at Windsor - 1971-72.

			Oct. 18, 1971 Percent control[2]		May 16, 1972			
					No.	Percent control[2]		
Herbicide	Rate a.i., lb/A	Timing[1]	Quack-grass	Large crab-grass	quackgrass shoots per sq ft[3]	Quack-grass	Other weeds	July 19 Quackgr contro
Untreated control			0	0	108	13	0	0
EPTC	5	pre-8/25	78	100	15	73	6	poor to fair
pronamide	1	pre-8/25	82	73	15	76	23	poor to fair
	2	pre-8/25	87	73	7	82	37	good
	4	pre-8/25	95	83	2	95	40	good to excelle
	1	post-12/13	-	-	9	70	30	poor to fair
	2	post-12/13	-	-	5	88	43	good
	4	post-12/13	-	-	5	92	37	good to excelle
dichlobenil	6	post-12/13	-	-	22	78	82	good

[1]Pre = preplant incorporated; post = postplanting, surface application.

[2]Visual ratings.

[3]Average of three square ft counts in each of three replicates.

Table 2. Effect of pre- and postplanting applications of herbicides on visual injury[1] to small ornamental plants one year after planting at Windsor.

Herbicide	Rate a.i., lb/A	Timing[2]	Hydrangea 'Nikko Blue'	Euonymus 'Sarcoxie'	Chrysanthemum 'Showtime'
Untreated			3.2	0.7	2.3
EPTC	5	pre-8/25	1.9	0	2.3
pronamide	1	pre-8/25	2.5	0	0
	2	pre-8/25	1.6	0	0
	4	pre-8/25	3.9	0	1.7
	1	post-12/13	0	0	1.0
	2	post-12/13	1.1	0	0
	4	post-12/13	1.3	0	0.7
dichlobenil	6	post-12/13	1.8	0.6	10 (dead)

[1]0 = no injury, healthy plants; 10 = dead plants.

[2]Pre = preplant incorporated; post = postplant surface application.

Table 3. Control of quackgrass and other weeds with preplanting applications of herbicides in Bloomfield - 1973.

			July 13		August 25			October 1	
			Percent control[1]		Quackgrass			Percent control[1]	
Herbicide	Rate a.i., lb/A	Timing	Quack-grass	Other weeds	No. shoots per sq ft	Percent control[2]	No. other weeds per sq ft	Quack-grass	Other weeds
weedy control			0	0	19.5	0	5.8	20	0
glyphosate	1.5	Nov 7	55	0	9.4	52	15.6	70	0
	3.0	Nov 7	75	0	4.8	76	11.5	70	0
	1.5	May 7	90	13	1.2	94	13.6	93	0
	3.0	May 7	87	26	3.2	84	15.2	92	0
pronamide	1.5	Nov 7	18	30	8.8	55	12.2	53	0
	3.0	Nov 7	55	0	13.8	29	10.0	43	0
	1.5	May 17	52	63	12.1	38	9.4	43	0
	3.0	May 17	76	88	10.3	47	5.2	65	47
napropamide	4	Nov 7	9	53	15.3	21	10.3	40	0
	8	Nov 7	33	63	17.0	13	8.8	40	17
	4	May 17	36	88	12.7	35	3.5	47	47
	8	May 17	64	99	9.1	53	1.2	70	92
metribuzin	1.5	May 21	21	98	13.0	33	1.2	43	77
	3.0	May 21	58	99	17.5	10	1.2	43	85

[1]Percent control based on visual ratings.

[2]Percent control based on counts of quackgrass shoots.

FALL APPLICATIONS OF HERBICIDES FOR CONTROL OF QUACKGRASS AND YELLOW NUTSEDGE IN *TAXUS CUSPIDATA CAPITATA*

John F. Ahrens[1/]

ABSTRACT

Herbicides were applied on the soil surface in December of two successive years in a new planting of *Taxus cuspidata capitata* on a silt loam soil infested with rhizomes of quackgrass (*Agropyron repens* (L.)Beauv.) and tubers of yellow nutsedge (*Cyperus esculentus* L.). Annual weeds and bird vetch (*Vicia cracca* L.) also invaded the site.

Granules and sprays of pronamide controlled quackgrass equally well. Control was more effective in May than later in the season. Season-long control of quackgrass was highly effective with pronamide at 4 lb/A during the second year. Pronamide did not control nutsedge, bird vetch, or most annual weeds.

Granules and sprays of simazine controlled quackgrass equally well but granular simazine at 3 lb/A gave better control of nutsedge and annual weeds than wettable simazine during the second year. Control of nutsedge with simazine was adequate only when a high rate of 6 lb/A was applied for two seasons. This dosage resulted in the best growth of Taxus among all treatments but would not be considered safe for many ornamental plants. Combinations of simazine at 3 lb/A with pronamide at 1 or 2 lb/A gave better control of quackgrass than simazine or pronamide alone during the first year, and better control of annual weeds than pronamide alone.

Dichlobenil at 6 lb/A effectively controlled quackgrass and nutsedge and greatly reduced stands of bird vetch but failed to control annual weeds during the exceptionally wet 1972 season. Napropamide at 6 lb/A gave excellent control of nutsedge and annual grasses and fair control of quackgrass and broadleafed weeds during the second season of its use. Control of annual weeds and bird vetch was good during the first season with napropamide at 3 or 6 lb/A. Diphenamid, nitralin, trifluralin, and methazole did not control quackgrass or nutsedge. Although most treatments produced plants of Taxus that were larger than control plants weeded periodically, pronamide at 4 lb/A caused foliage discoloration after two seasons.

INTRODUCTION

Pasture or hay land that is planted to ornamental nursery stock frequently is infested with quackgrass (*Agropyron repens* (L.)Beauv.) and yellow nutsedge (*Cyperus esculentus* L.). Although good management dictates that these weeds should be brought under control before the land is planted to nursery stock, pressures for land seldom allow this to be done. The result is vigorous weed competition from both quackgrass and nutsedge in the planted stock. Whereas control of either species in established nursery plantings is a challenge, the presence of both species compounds the problem, for any herbicide that controls one without affecting the other may do little to lessen the overall weed problem.

1/ The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor Connecticut.

Herbicides known to have activity against quackgrass or nutsedge in nursery plantings include simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) and dichlobenil (2,6-dichlorobenzonitrile) (1,2). Since many nursery plants do not tolerate these herbicides, it is desirable to search for other alternatives. Duke (3) reported activity of pronamide (N-(1,1-dimethyl propynyl)-3,5-dichlorobenazamide) in controlling quackgrass and Wilson (4) and Keeley, et al (5) reported activity of napropamide (2-(a-naphthoxy)-N,N-diethylpropionamide) against yellow nutsedge. In the work reported here we tested fall surface applications of these herbicides in a nursery planting in comparison with simazine and dichlobenil. We also tested the effects of other herbicides that have proven effective against annual weeds when applied in the fall (6).

MATERIALS AND METHODS

A commercial planting of Taxus cuspidata capitata (upright yews) in East Granby, Connecticut, on a silt loam soil infested with quackgrass plants and nutsedge tubers was used for this study. The yews were planted in September 1970 as 5 year-old transplants. The plants were spaced at 2 ft intervals in rows 3 ft apart. Herbicides were applied in two adjacent tests on this field, on December 1, 1970, and again on December 9, 1971. The following herbicides and formulations were included in these tests: (a) simazine (2-chloro-4,6-bis(ethylamino)-s-triazine), 80% wettable powder and 4% granules,(b) dichlobenil (2,6-dichlorobenzonitrile), 4% granules,(c) napropamide (2-(a-naphthoxy)-N,N-diethyl propionamide), 50% wettable powder,(d) pronamide (N-(1,1-dimethylpropynyl)-3,5-dichlorobenzamide), 50% wettable powder and granules,(e) trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), 4 lb/gal emulsifiable concentrate, (f) diphenamid (N,N-dimethyl-2,3-diphenylacetamide), 50% wettable powder, (g) nitralin (4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline), 75% wettable powder, (h) methazole (2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3-5-dione), 75% wettable powder. The plot size was 6 ft (2 rows) by 16 ft (8 plants) with untreated single rows of yews serving as borders between the plots. Granular herbicides were applied with a precision auger-feed machine calibrated for each treatment. Sprays were applied with a hand-held boom to deliver 50 gal/A over the tops of the yews.

At the time of treatment on December 1, 1970, the soil was moist and was 39°F at the 3 in depth. The air temperature was 45°F. In addition to quackgrass, other weeds in the plot area at treatment included seedlings of bird vetch (Vicia cracca L.), common chickweed (Stellaria media (L.)Cyrillo), and horseweed (Erigeron canadensis L.).

At the time of the second application on December 9, 1971 there was 1 to 3 in of soft snow on the ground and the air temperature was 39°F. This snow gradually melted over the next few days.

Stands of quackgrass, nutsedge and other weeds were evaluated by visual ratings periodically over the two year span of these tests. Following each evaluation the weeds were removed by pulling or hoeing and the field was cultivated Depending on the complexity of the weed population evaluations were made of percentage weed control as compared with the untreated plots or of the percentage stand of each weed. Data on percent stand then were converted to percent control. In September 1971 a count also was made of the percentage of yews infested with one or more plants of bird vetch.

The yews were observed periodically for injury and were sheared annually according to standard nursery practice. In the spring of 1973, the average height and width was measured on ten plants in each plot. Upright yews grow and are sheared in the form of an inverted cone. These measurements therefore were used to calculate the plant size by using the formula for the volume of a cone: $V = \frac{\pi r^2 h}{3}$.

The 1971 season in Connecticut had average rainfall, whereas the 1972 season had much greater than normal rainfall during the months of March, May and June.

The annual weeds invading the test area varied with the season and the year. In May of 1971, horseweed and common chickweed were predominant but in May of 1972 common ragweed (Ambrosia artemisiifolia L.) and lambsquarters (Chenopodium album L.) also were abundant. During the summer of both years the abundant broadleafed weeds included common ragweed, lambsquarters, carpetweed (Mollugo verticillata L.), redroot pigweed (Amaranthus retroflexus L.) and Pennsylvania smartweed (Polygonum pensylvanicum L.). The abundant annual grasses included large crabgrass (Digitaria sanguinalis (L.)Scop.), yellow foxtail (Setaria glauca (L.)Beauv.), and fall panicum (Panicum dichotomiflorum Michx).

RESULTS AND DISCUSSION

The effects of the herbicides on the weeds in the two experiments over the 2 year period are given in Tables 1, 2, 3, and 4.

Control of quackgrass - Control of quackgrass with pronamide at 1 or 2 lb/A was over 85 percent in May of both years but it diminished somewhat through the season (Tables 1 and 2). Reduced control with pronamide during the season also was observed by Duke (3). Two applications of pronamide at 4 lb/A gave almost complete control of quackgrass. Granular and wettable forms of pronamide controlled quackgrass about equally.

In contrast to pronamide, control of quackgrass with simazine improved during the season. Granular and wettable forms of simazine were about equal in controlling quackgrass. During the first year combinations of pronamide and simazine provided better control of quackgrass than simazine alone in May and better control than pronamide alone for the rest of the season. During the second season, simazine alone controlled quackgrass extremely well and the combinations were not more effective.

Napropamide at 6 lb/A controlled 85 percent of the quackgrass in May of the first season and 69 percent thereafter. During the second season control of quackgrass averaged 72 percent with napropamide at 6 lb/A but only 10 percent at 3 lb/A.

Dichlobenil at 6 lb/A in both tests controlled quackgrass to a high degree early in the season (88 and 94 percent) with control dropping off somewhat during the summer (82 and 78 percent) of the first season. Quackgrass control with dichlobenil was excellent during the second season, averaging 88 and 91 percent in the two tests.

Nitralin, trifluralin, diphenamid, and methazole did not control quackgrass in Test B (Table 3).

Table 1. Percentage weed control in 1971 following herbicide applications in December 1970 - Test A.

Herbicide	Rate, a.i., lb/A	May 1971 Quack-grass	May 1971 Broad-leafed weeds	July and September 1971 Quack[1] grass	July and September 1971 Nut[1] sedge	July and September 1971 Annual[2] broad-leaves	July and September 1971 Annual[1] grasses	July and September 1971 Vetch[3]
Untreated		0	0	0	0	0	0	0
pronamide, wp	1	86	56	57	0	4	24	0
	2	85	61	65	10	29	33	6
	4	90	78	81	0	41	47	0
pronamide,G	1	89	76	64	18	4	27	0
	2	86	73	49	0	21	14	0
	4	88	86	78	0	41	68	0
pronamide,wp+ simazine,wp	1+3	88	99	71	14	96	80	55
	2+3	98	99	80	0	100	75	60
	4+3	94	99	85	14	96	92	10
pronamide,G+ simazine,G	1+3	91	99	80	2	94	92	25
	2+3	88	98	69	38	96	84	45
	4+3	95	99	86	6	100	92	55
simazine,wp	3	63	96	84	14	100	83	60
	6	86	99	93	51	100	98	96
G	3	68	99	92	27	100	90	45
napropamide,wp	3	53	86	34	63	88	86	60
	6	85	85	69	72	90	100	81
dichlobenil,G	6	88	99	82	84	96	86	66

1/ Ratings of quackgrass, nutsedge and annual grasses were averaged for July and September 1971.
2/ Ratings of control of annual broadleafed weeds are for July, 1971 only.
3/ Ratings of control of vetch are based on counts of yews infested with vetch in September, 1971 only.

Control of nutsedge - Pronamide, methazole, nitralin, diphenamid and trifluralin had no measurable effects in controlling nutsedge. These results contrast with those of Keeley, et al (5) who reported good control of nutsedge with incorporated applications of methazole. Simazine at 6 lb/A suppressed nutsedge during the first season and provided good control (87%) during the second season. Granular simazine at 3 lb/A controlled nutsedge more effectively than wettable simazine during the second year, probably because of the greater persistence of granular simazine (3).

During the first season, dichlobenil gave the most effective control of nutsedge (82 percent) followed by napropamide which gave 72 percent control at 6 lb/A and 63 percent control at 3 lb/A. During the second season, control of nutsedge averaged 89 percent with dichlobenil at 6 lb/A, and 77 and 95 percent with napropamide at 3 and 6 lb/A, respectively.

Control of vetch - Bird vetch, emerging largely from seeds, invaded the plot area during the first season. This plant winds itself through ornamentals and creates a serious problem when abundant. Simazine at 6 lb/A provided the most effective control in these tests. However, dichlobenil, napropamide, and the combination of simazine plus diphenamid also greatly reduced the invasion of vetch. Dichlobenil was previously reported to be effective against established bird vetch (7).

Table 2. Percentage weed control in 1972 following a second annual herbicide application in December 1971 and plant sizes in the spring of 1973. Test A.

Herbicide	Rate, a.i., lb/A	Quack-grass[1]	Nut-sedge[2]	Broad-leafed weeds[3]	Annual grasses[4]	All weeds[5]	Plant size[6] percent of control
Untreated		0	0	0	0	0	100
pronamide,wp	1	77	0	20	29	10	109
	2	86	0	19	12	0	108
	4	95	0	41	44	0	109
pronamide,G	1	78	13	21	5	0	127
	2	81	0	43	34	10	95
	4	94	10	44	48	10	108
pronamide,wp+	1+3	90	49	55	54	40	162
simazine,wp	2+3	93	27	86	55	50	154
	4+3	91	10	63	65	27	120
pronamide,G+	1+3	92	75	93	93	87	135
simazine,G	2+3	90	70	95	90	70	153
	4+3	96	69	98	91	80	114
simazine,wp	3	90	5	77	72	37	148
	6	96	87	93	95	88	175
simazine,G	3	95	74	94	84	83	149
napropamide,wp	3	18	77	55	84	40	137
	6	72	95	61	96	72	157
dichlobenil,G	6	88	89	56	38	50	143
Least significant difference P = .05							37

1/ Quackgrass ratings averaged for May, July, and August 1972.
2/ Nutsedge ratings averaged for July and August 1972.
3/ Broadleafed weed ratings averaged for May and August 1972.
4/ Annual grass ratings averaged for July and August 1972.
5/ Overall rating of weed control for August 1972.
6/ Plant size, based on volume of plants determined by average height and width of ten yews in each plot and three replicates.

Control of annual and winter annual weeds - All of the herbicide treatments gave some control of annual weeds. Control typically diminished through the season, especially during the second year when excessive rainfall undoubtedly accelerated leaching of the herbicides. In normal practice, fall applications of herbicides would be supplemented in the late spring to maintain season-long control of annual weeds.

As in past studies granular simazine gave longer control of annual weeds than wettable simazine, and the addition of nitralin or trifluralin to wettable simazine gave longer control of annual grasses than wettable simazine alone (Table 4). Pronamide at 2 or 4 lb/A gave fair control of winter annual weeds such as horseweed and chickweed but did not control annual weeds satisfactorily in June or later. Control of annual weeds with methazole at 4 lb/A improved markedly during the second season. Napropamide gave excellent season-long control of annual grasses, but failed to control Pennsylvania smartweed during the second season.

Table 3. Percentage weed control in 1971 following herbicide applications in December 1970. Test B.

Herbicide	Rate, a.i., lb/A	May 18, 1971		July and September 1971				
		Quack-grass	Broad-leafed weeds	Quack-grass[1]	Nut-sedge[1]	Annual[2] broad-leaves	Annual[1] grasses	Vetch[3]
Untreated		0	0	0	0	0	0	0
simazine,wp	3	82	98	82	32	100	73	0
simazine,G	3	76	97	83	13	100	95	3
	6	85	99	95	65	100	100	100
nitralin,wp	2	13	20	0	16	65	79	0
simazine,wp+ nitralin,wp	3+2	75	99	64	0	100	73	3
simazine, wp+ diphenamid,wp	3+4	90	99	81	7	100	58	83
simazine,wp+ trifluralin,e.c.	3+2	88	99	87	0	100	92	20
dichlobenil,G	6	94	99	78	83	90	68	78
methazole,G	2	13	26	11	0	52	16	0
	4	13	80	9	0	57	42	0

1/ Ratings of quackgrass, nutsedge and annual grasses were averaged for July and September 1971.
2/ Ratings of control of broadleafed weeds are for July 1971, only.
3/ Ratings of control of vetch are based on counts of yews infested with vetch in September 1971, only.

Effect of the treatments on the yews - None of the herbicides caused any appreciable injury to the yews over the two year span. Slight discoloration of yew foliage was noted during the fall of the second year on plots treated with pronamide at 4 lb/A. Slight discoloration also was noted in some of the untreat plots, possibly a result of the severe weed competition. Competition from nut-sedge and annual weeds also was great in the plots treated only with pronamide. In general, the yews grew best on plots where the weeds were well controlled over the two year span. Simazine at 6 lb/A gave the best weed control and also produced the largest plants whereas the untreated plots that were hoed periodica as in normal practice produced plants that were the second smallest (Table 2).

Although we have observed in many experiments and in practice that *Taxus spp.* are particularly resistant to simazine and dichlobenil, many other ornament species would not tolerate the dosages of simazine or dichlobenil used in these tests. Pronamide and napropamide obviously do not control the spectrum of weeds of simazine and dichlobenil, but in related work we have learned that they are less injurious to ornamentals such as *Azalea* and *Euonymus* cultivars. A practica approach to the control of quackgrass or nutsedge in such sensitive species could be to combine low rates of simazine or possibly dichlobenil with pronamide or napropamide. Combinations or sequential applications of pronamide and napro-pamide also should be investigated for the control of quackgrass and nutsedge in nursery plantings.

Table 4. Percentage weed control in 1972 following a second herbicide application in December 1971. Test B.

Herbicide	Rate, a.i., lb/A	Quack-grass[1]	Nut-sedge[2]	Broad-leafed weeds[3]	Annual grasses[4]	All weeds[5]
Untreated		0	0	0	0	0
simazine,wp	3	93	30	66	45	33
simazine,G	3	90	59	91	81	70
	6	99	96	98	97	95
nitralin,wp	2	7	5	5	91	0
simazine,wp+ nitralin,wp	3+2	85	13	83	89	53
simazine,wp+ diphenamid,wp	3+4	91	34	64	55	43
simazine,wp+ trifluralin,e.c.	3+2	93	40	71	72	52
dichlobenil,G	6	91	89	44	26	55
methazole,G	2	23	0	46	35	10
	4	47	33	86	90	63

1/ Quackgrass ratings averaged for May, July, and August 1972.
2/ Nutsedge ratings averaged for July and August, 1972.
3/ Broadleafed weed ratings averaged for May and August 1972.
4/ Annual grass ratings averaged for July and August 1972.
5/ Overall rating of weed control for August 1972.

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WEED CONTROL IN FIELD-GROWN CHRYSANTHEMUMS

John F. Ahrens[1/]

ABSTRACT

Herbicide trials were conducted in newly planted rooted cuttings and established plants of Chrysanthemum moriflorum over two seasons. In the cuttings, the herbicides were applied before or after planting. No treatment controlled weeds all season without injury to the chrysanthemums, but several greatly reduced weed competition without severe injury. These included preplanting applications of trifluralin at 1.5 lb/A, nitralin at .75 or 1.5 lb/A, profluralin at 1.5 lb/A, oryzalin at .5, .75 or 1 lb/A and dibutalin at 3 lb/A, and postplanting applications of DCPA at 9 lb/A, granular oxadiazon at 1.5 lb/A, and oryzalin at 1 lb/A. Chloroxuron at 3 or 6 lb/A or 3 lb/A in combination with DCPA at 9 lb/A killed emerged seedlings of purslane with minor injury to chrysanthemum cuttings or to established plants. Chloramben ammonium salt at 4 lb/A and granular alachlor at 3 lb/A controlled purslane for one month, with only minor injury from alachlor and none from chloramben. Root dips of activated carbon reduced injury to chrysanthemums from herbicides applied before or after planting.

INTRODUCTION

A successful method of growing chrysanthemums (Chrysanthemum moriflorum) has been the planting of rooted cuttings into field rows in June and the digging of mature flowering plants for sale in September and October. Control of weeds is essential because chrysanthemums compete poorly with weeds and because weeds are unsightly in display areas. Records kept by a Connecticut grower during 1971 showed that the cost of weed control by cultivating and hoeing alone averaged $1000 per acre for six acres of chrysanthemums. Because of the diversity of the chrysanthemum crop any chemical method must be safe for use on many different varieties of chrysanthemums.

Chemical control of weeds in chrysanthemums has been investigated and several preemergence herbicides have proved safe and moderately effective in tests elsewhere (1, 2). It was the purpose of these studies to obtain further information on herbicides that might provide season long control of weeds in field-grown chrysanthemums under local soil and climatic conditions.

MATERIALS AND METHODS

Herbicides trials were conducted during the 1972 and 1973 season on fields of commercially grown chrysanthemums on a gravelly sandy loam in Bristol, Connecticut. The following herbicides and formulations were included in one or more of these tests:

a. trifluralin (a,a,a-trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine), 5% granules and 4 lb/gal emulsifiable concentrate.

1/ The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor

b. nitralin (4 (methyl sulfonyl)-2,6-dinitro-N,N-dipropylaniline), 75% wettable powder.

c. profluralin (N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine), 4 lb/gal emulsifiable concentrate.

d. oryzalin (3,5-dinitro-N,^{4}N^4-dipropylsulfanilamide), 75% wettable powder.

e. dibutalin (N-sec-butyl-4-tert-butyl-2,6-dinitroaniline), 4 lb/gal emulsifiable concentrate.

f. chloroxuron (3-(p-(p-chlorophenoxy) phenyl)-1,1-dimethylurea), 50% wettable powder.

g. DCPA (dimethyl tetrachloroterephthalate), 75% wettable powder and 5% granules.

h. alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide, 10% granules and 4 lb/gal emulsifiable concentrate.

i. oxadiazon (2-tert-butyl-4-(2,4-dichloro-5-isopropyloxyphenyl)-5-oxo-1,3,4-oxadiazoline), 75% wettable powder and 2% granules.

j. chloramben, ammonium salt (3-amino-2,5-dichlorobenzoic acid), 2 lb/gal liquid.

The herbicides were applied before or after planting rooted cuttings or over established plants that were spaced at 18 in intervals in rows 30 in apart. Sprays were applied in 50 gal solution per acre with a calibrated knapsack sprayer and granules were applied with an auger feed applicator calibrated for each treatment. The experimental areas were irrigated whenever rainfall was not adequate.

In 1972, the preplanting treatments were applied on June 28 and disked into the wet soil. The cuttings were planted by hand the same day and the postplanting treatments were applied on June 29. Four varieties of chrysanthemums were planted in single rows with 8 plants of each variety in each plot. The varieties were: 'Ruby Mound', 'Chapel Bells', 'Gay Sun', and 'Sandy Sue'. The treatments were applied on three replicates arranged in randomized complete blocks.

Visual ratings of weed control and plant injury were made on July 27, and September 11, 1972. All remaining weeds were removed from the plots after each rating and the field was cultivated on July 27. Chloramben at 4 lb/A was reapplied on August 1, after removing all weeds from the plots. In July the predominant weeds were common purslane (*Portulaca oleracea* L.) and large crabgrass (*Digitaria sanguinalis* (L.)Scop.) and in September common purslane was predominant.

Heavy rains (2.3 in) flooded the plot area two days after planting in

1972 and resulted in poor growth of chrysanthemums in parts of the experimental area. As a result, a second application of certain treatments was made on August 1, 1972 over newly planted rooted cuttings of 'Chapel Bells' and 'Ruby Mound' in similar plots replicated three times. Other applications were made in smaller supplementary trials at various dates during the 1972 season over newly planted cuttings or over established plants that were 3 to 4 in tall at treatment.

In 1973 the preplant treatments were applied on July 2 and disked into the moist soil within 1 hr of the first herbicide application. Cuttings of 'Chapel Bells' and 'Ruby Mound' were planted by machine on July 3rd. The roots of cuttings in alternate rows of each variety were dipped into a slurry containing 2 lb of activated carbon[1] per gal water before planting. Plots consisted of four rows, each containing eight plants, and the treatments were arranged in randomized complete blocks with three replicates. The postplant treatments were applied on July 6 and irrigation water was applied on July 7. An additional postplanting application of chloroxuron plus DCPA was made on July 24 when purslane plants were 2 to 6 in across and seedlings of lambsquarters (Chenopodium album L.) were 4 in tall.

The predominant weed during 1973 also was common purslane. Weed control and plant injury evaluations were made on August 3 and September. All weeds were removed from the plots following each rating and the soil was cultivated on August 3. To determine effects of the herbicides on earliness of flowering counts were made of the number of open flowers on September 27, early in the flowering period. A flower was considered open if it showed petal color all around the bud. Five plants were counted in each subplot of 'Chapel Bells' and three plants in each subplot of 'Ruby Mound'.

RESULTS AND DISCUSSION

Heavy rains in late June of 1972 made difficult the proper incorporation of the preplant herbicides with a disk harrow. The plot area also was flooded after the postplanting herbicides were applied. This flooding had a greater effect on growth of the chrysanthemums than any of the herbicide treatments and made difficult the evaluation of plant injury in the lowest spots. The wet soil conditions may also have contributed to the poor control of purslane in 1972 with many of the preplant treatments (Table 1).

In 1972 results are given in Tables 1 and 2 and the 1973 results are given in Tables 3 and 4.

Preplant treatments - Except for oryzalin, the higher rates of the herbicides applied before planting were required for satisfactory control of purslane. In 1973, little difference could be seen between trifluralin, nitralin, dibutalin, or profluralin in weed control. None of these caused noticeable injury to the chrysanthemums.

[1]Gro-Safe from Atlas Chemical Division of ICI America Inc.

Oryzalin at .75 lb/A in 1972 and .5 lb/A in 1973 provided satisfactory control of purslane for the season. At double these rates of oryzalin, weed control was outstanding but plant vigor was reduced on most varieties of chrysanthemums. In general, however, this injury was less than that caused by weed competition or by flooding.

Postplant treatments - Preemergence applications of chloroxuron at 6 lb/A provided good weed control for one month but little control thereafter (Tables 1 and 3). However, application of chloroxuron at 6 lb/A alone or 3 lb/A in combination with DCPA on emerged seedlings of purslane and lambsquarters, killed most of the weeds with only minor injury to newly planted chrysanthemum cuttings (Table 2). Minor chlorosis was sometimes observed but the plants soon recovered. Postemergence control with chloroxuron was most effective on seedlings of broadleafed weeds that were 1 to 2 in across and less effective on seedling grasses and larger seedlings of purslane.

Chloramben ammonium salt at 4 lb/A controlled weeds for one month in 1972, and a repeated application extended control for the rest of the season. Increasing the initial dosage to 8 lb/A did not extend weed control for the second month (Table 1).

Alachlor sprays at 2 lb/A also controlled weeds for one month without injury (Table 1) and granular applications at 4 lb/A caused no injury to established plants in 1972. However, sprays at 4 lb/A injured the chrysanthemums and we therefore applied only the granular form in 1973. Weeds were also controlled for one month with alachlor granules at 3 lb/A during 1973, but slight growth reduction and later flowering was obtained in 'Chapel Bells'.

Oxadiazon wettable powder at 1 lb/A controlled weeds for one month and gave partial control for 2 months during 1972 without injury to rooted cuttings (Table 1), but the same dosage on established plants caused moderate stunting (Table 2). Common chickweed (*Stellaria media* (L.)Cyrillo) invaded plots treated with oxadiazon. Changing to the granular formulation in 1973 we obtained good control of purslane and only minor early spotting of chrysanthemum leaves at 1.5 lb/A (Table 4). At 3 lb/A in 1973, however, granular oxadiazon reduced growth and delayed flowering of 'Chapel Bells'.

DCPA sprays at 9 or 18 lb/A controlled purslane for 2 months in 1972 but control for the second month in 1973 was satisfactory only at 18 lb/A. Slight vigor reduction was obtained at 18 lb/A on 'Chapel Bells' in 1973. Granular DCPA at 10 lb/A had no effect on established plants of several chrysanthemum varieties during 1972 (Table 2).

Weed control after two months with postplanting sprays of oryzalin and nitralin was not as effective as comparable dosages incorporated before planting. However, injury to the chrysanthemums with the postplanting applications was less with oryzalin and greater with nitralin than the preplanting applications (Table 4).

Root dips of activated carbon - Dipping of chrysanthemum cuttings into a slurry of activated carbon before machine transplanting was practicable and added little to the time required in planting. The carbon root-dip reduced the

injury caused by preplanting applications of oryzalin and by postplanting applications of chloroxuron, DCPA and granular alachlor at 3 lb/A (Table 4). However, the root-dip was less effective in protecting chrysanthemums from alachlor at 6 lb/A or from oxadiazon at 3 lb/A. Root-dips of activated carbon have been used in other transplanted crops to reduce herbicide injury (3).

Although treatments such as alachlor at 6 lb/A and oxadiazon at 3 lb/A reduced plant vigor and delayed flowering in 'Chapel Bells' during 1973, these treatments nevertheless produced a large proportion of saleable plants.

None of the herbicide treatments tested over the two year period controlled weeds safely in chrysanthemum cuttings for the entire season. Although we did not thoroughly investigate the use of multiple applications, these tests indicate several possibilities for the sequential use of herbicides to provide season-long control with minimal hand weeding. Preplanting applications of trifluralin, oryzalin, or dibutalin might be followed by postplanting applications of chloroxuron alone or in combination with DCPA on emerged seedlings of broadleafed weeds. Similarly, postplanting applications of DCPA, chloramben ammonium salt or low rates of granular alachlor might be reapplied four to five weeks after initial treatments. Such treatments could reduce hand weeding and cultivation requirements in chrysanthemums.

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Table 1. Weed control in chrysanthemums with herbicides applied before or after planting rooted cuttings in 1972.

Herbicide	Rate, a.i. lb/A	Weed control ratings 1/ July 27 Purslane	July 27 Grasses	Sept 11 Purslane
Untreated		1.3	2.2	0
Preplant Inc. Treatments				
profluralin e.c.	.75	3.3	8.0	3.3
	1.5	4.3	7.7	6.5
oryzalin, wp	.75	7.3	8.3	7.5
	1.5 2/	8.8	9.6	8.8
trifluralin, e.c.	.75	3.0	8.8	2.0
	1.5	4.3	8.8	7.0
dibutalin, e.c.	1.5	2.5	8.3	4.7
	3.0	7.7	9.0	6.8
Postplant Surface Treatments				
chloroxuron, wp	3	6.3	4.3	0
	6	8.5	8.8	2.3
alachlor, e.c.	2	9.2	9.9	1.3
	4 2/	9.8	9.9	0
chloramben, ammonium salt, liq.	4 + 4 3/	9.8	9.9	9.3
	8	9.8	9.9	2.0
DCPA, wp	9	9.1	9.6	7.3
	18	8.7	9.3	8.7
oxadiazon, wp	1	9.1	9.6	6.8
	2	9.5	8.7	8.5
DCPA + chloroxuron wp	3 + 9	8.7	9.0	7.5

1/ 0 = no control, 10 = 100% control of weeds.

2/ These treatments reduced the vigor of the chrysanthemums.

3/ Chloramben at 4 lb/A was reapplied on August 1.

Table 2. Injury observations in late September, 1972, of herbicides applied as supplementary treatments.

Herbicide	Rate, a.i. lb/A	Date applied	Chrysanthemum varieties treated	Injury observations
DCPA + chloroxuron, wp	9 + 3	July 15	'Spotless' cuttings planted July 14	Minor temporary yellowing of leave
		Aug 1	established plants of: 'Best Regards', 'Copy Cat','Pink Sentinel','Headliner', 'Martian', 'Sunny Glow', 'Shalimar'	No injury observed on any variety.
alachlor, e.c.	2	Aug 1	established plants of: 'Roselight', 'Wee Willie'	Curling of leaf tips.
G	4	Aug 23	well established plants of: 'Lamplighter', 'Volunteer', 'Welcome Sign', Gianna d' Angelo', 'Lemon Lace', 'Tangarine Spoon', 'Hansel'	No injury observed on any variety.
chloroxuron, wp	3	Aug 1	established plants of: 'Purple Waters', 'Desert Cactus','Gay Sun', 'Coppersmith', 'Lamplighter', 'Soldier Bold', 'Yellow Glow', 'Red Headliner', 'Good Humor', 'Valley Forge', 'Diva'	No injury observed on any variety.
oxadiazon, wp	1	Aug 1	established plants of: 'Folksinger','Drifted Snow'- 'Chapel Bells','Diva' -	Moderate stunting. No injury obser
	2	Aug 1	established plants of: 'Gay Petals','Yellow Starlet','Folksinger'	moderate to severe stunting
DCPA, G	10	Aug 23	established plants of: 'Shimmering Light', 'Orbit','Ivory Pinwheel', 'Pink Pagoda','Gay Petals', 'Best Man','Desert Cactus', 'Waltz Time'	no injury observ on any variety

Table 3. Control of common purslane with herbicides applied in 1973[1/].

Herbicide	Rate, a.i., lb/A	August 3	September 12
Untreated controls		1.0	0.8
Preplant incorporated treatments			
trifluralin, e.c.	.75	6.3	6.7
	1.5	8.7	7.0
nitralin, wp	.75	7.0	6.0
	1.5	7.7	7.0
profluralin e.c.	.75	6.2	5.3
	1.5	8.0	7.0
oryzalin, wp	.5	7.8	7.5
	1.0	9.3	8.7
dibutalin, e.c.	1.5	6.7	5.5
	3.0	8.2	7.5
Postplant surface treatments			
chloroxuron, wp	3	7.8	4.7
	6	8.8	5.3
DCPA, wp	9	8.8	5.7
	18	9.3	7.5
chloroxuron + DCPA	3 + 9	9.3	4.5
alachlor, G	3	9.5	3.7
	6	9.6	7.8
oxadiazon, G	1.5	9.2	6.8
	3	9.9	9.3
nitralin, wp	1.5	8.0	6.0
oryzalin, wp	1.0	9.3	7.3

1/ 0 = no control, 10 = 100% control of weeds.

Table 4. Injury and early flowering of chrysanthemums in 1973 as affected by herbicides and root dips of activated carbon.[1/]

Herbicide	Rate, a.i., lb/A	Injury[2/] Chapel Bells NoC	Chapel Bells +C	Ruby Mound NoC	Ruby Mound +C	Ave. number of open flowers per plant Chapel Bells NoC	Chapel Bells +C	Ruby Mound NoC	Ruby Mound +C
Untreated controls		0.5	0.5	0.2	0.2	2.7	1.9	9.1	12.7
Handweeded controls		0.7	0	0.3	0	2.1	4.9	11.7	19.3
Preplant incorporated treatments									
trifluralin, e.c.	.75	0	0	0	0	2.5	2.3	16.1	11.9
	1.5	0	0	0	0	1.3	3.1	9.4	8.3
nitralin, wp	.75	0	0	0	0	3.3	3.0	15.3	10.8
	1.5	0	0	0	0	3.2	2.9	17.0	13.7
profluralin e.c.	.75	0	0	0	0	1.5	2.3	21.7	18.8
	1.5	0	0	0	0	2.9	4.5	14.9	19.3
oryzalin, wp	.5	0	0	0	0	4.0	4.8	18.2	11.6
	1.0	1.0	0	0.7	0	3.4	3.7	4.9	9.2
dibutalin, e.c.	1.5	0	0	0	0	1.8	1.2	12.7	13.9
	3.0	0.3	0	0	0	3.4	2.5	13.8	16.9
Postplant surface treatments									
chloroxuron, wp	3	0	0	0	0	3.5	2.7	17.1	14.6
	6	0.7	0	1.0	0.3	2.4	4.7	16.1	19.2
DCPA, wp	9	0	0	0	0	2.7	3.7	12.9	12.0
	18	1.3	0	0	0	3.1	4.3	18.1	13.2
chloroxuron+DCPA, wp	3 + 9	0.4	0	0	0	2.3	4.3	13.1	10.9
alachlor, G	3	1.3	0	0.7	0	0.6	2.8	14.6	14.3
	6	2.3	1	1.3	0.3	0.5	0.5	8.2	17.6
oxadiazon, G	1.5	0.7	0.3	0	0	6.3	4.7	18.3	25.8
	3	2.4	1.3	1.2	0.4	0.5	1.2	12.0	13.1
nitralin, wp	1.5	1.0	0.7	0	0	2.5	3.3	19.6	12.6
oryzalin, wp	1.0	0	0	0	0	4.2	7.4	13.0	17.4
average						2.5	3.3	14.3	14.7
Least significant difference P = .05						2.8	3.0	11.6	10.4

1/ NoC = no carbon, +C = root dip of activated carbon.
2/ 0 = no injury, 10 = dead plants.

EVALUATION OF PREEMERGENCE HERBICIDES FOR CRABGRASS CONTROL IN 1973

T. L. Watschke, J. M. Duich, and D. V. Waddington[1]

ABSTRACT. Seven experimental and four commercial preemergence crabgrass herbicides were applied to Kentucky bluegrass and Creeping red fescue. Injury was more severe on creeping red fescue than Kentucky bluegrass except for EL-46531. Granular A-820 was the superior experimental chemical for both crabgrass control and tolerance, followed closely by the high rate of granular (vermiculite carrier) and flowable formulations of PPG-139. The high rate of the wettable powder and emulsified formulations of A-820 were comparable to the granular DCPA. El-46531 and G-10832 caused unacceptable injury at rates giving acceptable control. Although injury from both benefin materials was tolerable, control was not as good as from DCPA. The 3.6% formulation of bensulide was superior to the 7% formulation at both rates. PPG 124 provided short term control of crabgrass, but injury to both Kentucky bluegrass and creeping red fescue was severe.

INTRODUCTION

Each year experimental compounds are evaluated for preemergence crabgrass control against currently available standards. Safer chemicals are essential if they are to remain viable weed control tools. Closer scrutiny of new compounds by EPA has eliminated formulations with toxicities above prescribed limits. Alternatives to existing compounds should be as safe or safer, but their effectiveness must still be evaluated. The objective of this study was to evaluate crabgrass control and turfgrass phytotoxicity of seven experimental and four commercial chemicals on Kentucky bluegrass (*Poa pratensis* L.) and creeping red fescue (*Festuca rubra* L.).

MATERIALS AND METHODS

This research was conducted at the Joseph Valentine Turfgrass Research Center, The Pennsylvania State University. The soil was a Hagerstown silt loam and two adjacent 2-year old stands of Kentucky bluegrass and creeping red fescue were treated. Turf was maintained at a 1.25 in. height and received supplemental irrigation only during drougth stress. Smooth crabgrass (*Digitaria ischaemum*) predominated from natural reseeding and was plentiful enough to provide a 90 percent stand in untreated plots.

[1]Assistant Professor, Professor, and Associate Professor, respectively, Department of Agronomy, The Pennsylvania State University, University Park, Pa. 16802.

Sprayed plots (6 x 10 ft) and granular formulations (4 x 6 ft) were applied May 1, 1973. All PPG formulations were applied on May 17, 1973. Sprays were applied with a two-nozzle boom at approximately 40 psi and 40 gpa, and dry formulations with shaker bottles. Following application, approximately 1.5 inches of water were applied by traveling sprinklers.

The commercial chemicals were DCPA 5G and 75W, bensulide 7G, and benefin 2.5G and 25W. Experimentals were C-10832 (unrevealed); EL-46531 (unrevealed); PPG-139 (unrevealed); PPG-124 (unrevealed); bensulide 3.6G; N-secondary-butyl-2,6 dinitro-3,4-xylidine (AC-92390). Application rates are shown in Table 1.

Initial germination of crabgrass occurred on May 10, 1973, 10 days following application of all materials except PPG-139 and 124. Both of these materials were applied on May 17, 1973, and provided early postemergence control as well as preemergence control of later germinating crabgrass.

Additional emergence of crabgrass was noted June 5-10, and abundant germination was observed during the last week of June. Each treated plot was adjacent to a 2 ft check plot. Crabgrass control, turf discoloration and thinning were estimated by three individuals throughout the season.

RESULTS

Results of crabgrass control and turfgrass injury are shown in Table 1. Crabgrass control from DCPA 75W was superior to the granular formulation, however, injury to creeping red fescue was more severe.

The 3.6 percent formulation of bensulide was superior at both rates to the 7 percent formulation. The lower concentration probably resulted in improved distribution of active ingredient. Injury to both Kentucky bluegrass and creeping red fescue was less severe than for DCPA.

Commercial granular benefin was compared with the wettable powder formulation at 2 lb a.i./A. Both materials caused some injury to both turfgrasses while control of crabgrass was similar. Level of control did not equal that from DCPA or bensulide.

Crabgrass control was better on bluegrass than on red fescue for both rates of G-10832. However, acceptable control resulted only at the high rate. Phytotoxicity to creeping red fescue was unacceptable at the high rate which would limit the usefulness of this compound. Additional research on different bluegrass varieties would provide information on the spectrum of bluegrass tolerance.

EL-46531 provided excellent crabgrass control at the highest rate (4.5 lb a.i./A). However, at this rate phytotoxicity was unacceptably high, particularly on Kentucky bluegrass. Little permanant thinning occurred, but discoloration persisted for several weeks.

Control of crabgrass from AC-92390 at the high rate was comparable to that for granular DCPA. Slightly more injury occurred on bluegrass than red fescue. Injury to both was acceptable considering control. Further evaluation (at higher rates) with this compound should be conducted to determine if control can be improved to nearly 100 percent without appreciably increasing phytotoxicity.

PPG-124 provided very short term control and caused excessive injury to both bluegrass and red fescue. Crabgrass germination in late June virtually filled in the treated plots. Future use of this compound as a preemergence crabgrass herbicide on bluegrass and red fescue appears limited.

PPG-139 was applied using three formulations (granular, emulsified, and flowable) with two carriers for the granular (vermiculite and corn cob). The low rate was not sufficient to provide acceptable crabgrass control regardless of formulation. The high rate of all formulations gave good control with tolerable injury. The flowable and vermiculite granular gave control comparable to DCPA 75W and had less injury. The emusifiable formulation had 90 percent control, but little injury. Better control may be obtained at higher rates of the emulsifiable concentrate.

Three formulations (granular, wettable powder, and emulsifiable) of A-820 were tested. Only the granular gave results comparable to DCPA at both rates. The other two formulations gave excellent control at the high rate. Creeping red fescue was injured more by the wettable powder and emulsifiable than by the granular. This compound gave the most consistent control of crabgrass on both turfgrasses without unacceptable injury.

CONCLUSIONS

Better control, but more injury was observed for DCPA 75W compared to DCPA 5G. The 3.6 percent formulation of bensulide was superior to 7 percent and the granular DCPA. Both benefin formulations had less control than bensulide or DCPA.

A-820 and PPG-139 were the outstanding experimental compounds, particularly at the high rates. PPG-124 caused severe injury to both bluegrass and red fescue. AC-92390 gave good control, but should be tested at a higher rate since injury was not severe. Results from this test are encouraging in that there appeared to be some experimental compounds that gave control comparable to currently available materials without serious injury.

Table 1. Evaluation of commercial and experimental chemicals for preemergence crabgrass control and injury to Kentucky bluegrass and creeping red fescue. Applied May 1, except PPG materials which were applied May 17, 1973. University Park, Pa.

Treatment	Formulation	lb a.i./A	% Crabgrass control-August KBG	% Crabgrass control-August CRF	% Thinning KBG	% Thinning CRF
Bensulide	7 G	7.5	85	65	sl*	8
		10	90	75	sl	5
Bensulide	3.6 G	7.5	95	83	sl	sl
		10	97	93	sl	0
DCPA	5 G	10	93	90	8	15
DCPA	75 W	10	98	98	5	23
G-10832	2 G	1	85	70	sl	13
		2	95	80	10	25
PPG-139	1 EC	5	63	60	5	0
		10	90	90	sl	5
PPG-139	3 F	5	80	58	sl	0
		10	97	95	sl	8
PPG-139	5 G (cc)	5	85	65	5	sl
		10	90	83	sl	sl
PPG-139	5 G (v)	5	87	73	8	8
		10	97	93	5	10
PPG-124	2 G	4	25	10	80	90
AC-92390	2.5 G	2	90	80	5	5
		3	94	90	10	8
A-820	50 W	6	96	85	5	10
		8	97	90	5	15
A-820	4 EC	6	93	85	5	13
		8	97	93	5	10
A-820	2.3 G	6	94	95	5	5
		8	97	97	5	8
EL-46531	50 W	1.5	83	83	sl	8
		3	95	90	13	10
		4.5	98	97	28	10
Benefin	25 W	2	80	60	5	8
Benefin	2.5 G	2	83	70	5	5

*slight indicates less than 5 percent.

SEVEN YEARS OF SMOOTH CRABGRASS CONTROL IN TURFGRASS WITH REGISTERED AND EXPERIMENTAL HERBICIDES[1/]

John R. Hall, Elwyn E. Deal and Andrew J. Powell[2/]

ABSTRACT

Three experimental and six registered preemergence herbicides were evaluated in two studies to determine their effect on smooth crabgrass (Digitaria ischaemum (Schreb.) Muhl.) germination, turfgrass quality, root activity and germination of overseeded "Kenblue" Kentucky bluegrass (Poa pratensis L.). Materials were tested on Kentucky bluegrass-red fescue (Festuca rubra L.) turf. Granular formulations of A-820 (N-sec-butyl-4-Tertiary butyl 2,6-dinitro aniline), CGA 10832 (N-n-propyl-N-cyclopropylmethyl-4-trifluoromethyl-2,6-dinitro aniline) and AC 92390 (N-sec-butyl-2,6-dinitro-3,4-xylidine) at rates of 6, 2 and 3 lb (a.i./A.) respectively, provided satisfactory smooth crabgrass control. Root numbers were reduced at the 3" depth following 7 years of continuous bandane (polychlorodicyclopentadiene isomers) and tricalcium arsenate application. Bensulide (0,0-diisopropyl phosphoro dithioate S-ester with N-(2-mercaptoethyl) benzenesulfonamide)), (tricalcium arsenate) and A-820 (2.3G) provided the best combination of crabgrass control and turfgrass quality in the 1972 tests. Germination of overseeded Kentucky bluegrass was significantly reduced by continuous applications of bensulide and bandane.

INTRODUCTION

Continuous performance comparisons of registered and experimental turfgrass preemergence herbicides are an essential part of a turfgrass research program. These studies were undertaken to increase the body of knowledge which is accumulating from attempts to find more economical, efficient and safe methods of controlling annual grassy weeds in turfgrass. The objectives of these studies were: 1) compare smooth crabgrass control with liquid and granular formulations of registered and experimental preemergence herbicides; 2) determine satisfactory rates of herbicide application for maximum crabgrass control and minimum phytotoxicity. 3) evaluate the residual phytotoxic effect of spring applied experimental herbicides upon fall seeded Kentucky bluegrass; 4) determine the effect of preemergence herbicides upon root activity at the 3 and 6 inch depth.

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2/ Assistant Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742. Assistant Director, Cooperative Extension Service - University of Maryland, College Park, Maryland 20742 and Associate Professor, Department of Agronomy, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

MATERIALS AND METHODS

1972 Hopkins Farm Site

This experiment was conducted on a Kentucky bluegrass-creeping red fescue turf at the University of Maryland Plant Research Farm, Fairland, Maryland. The turf was maintained at 1 inch height of cut and the soil was a Chillum silt loam (45% sand, 36% silt and 19% clay). Soil pH was 6.0, phosphorus (P_2O_5) availability 201 lb/Acre, extractable potassium (K_2O) 135 lb/Acre and organic matter content 2.0%(1). Granular herbicide treatments were applied with a 3 ft drop type spreader. Liquid materials were applied in water from a back pack sprayer with a fan nozzle delivering 100 gallons per acre at a pressure of 25 pounds per square inch. The experimental design was a randomized complete block with 4 replications and individual plot size of 3 by 10 ft. Commercial materials have been applied annually from spring 1966 to spring 1972. Experimental materials were applied only in the spring of 1972 on plots containing greater than 50% crabgrass in the fall of 1971 and that had been devoid of chemical treatment for a minimum of 4 years. All plots were overseeded with crabgrass in the Fall of 1971.

Commercial materials evaluated were bandane, benefin (N-butyl-N-ethyl-, , - trifluoro-2,6-dinitro-p-toluidine), bensulide, DCPA (dimethyl tetrachloroterephthalate), tricalcium arsenate and siduron (1-(2-methylcyclohex 3-phenylurea). Experimental materials evaluated were A-820, CGA 10832 and GS 38946 (unrevealed). Formulations utilized have been noted in Tables 1 and 2. In 1972 all materials were applied on April 18 and were not irrigated. Initial germination of smooth crabgrass was observed May 11, 1972.

A soil core with a 4.25 inch diameter and a 5 inch depth was removed from selected plots on October 20, 1972 and transported to the greenhouse. Living turfgrass and dead thatch was removed from each core and 25 "Kenblue" Kentucky bluegrass seeds were planted on the soil surface. Cores were sub-surface irrigated and on December 14, 1972 the number of seedlings germinating and seedling vigor were noted. Shoot dry weights were determined from harvests taken December 14, 1972. On April 12, 1973 soil cores with a 0.75 inch diamete were taken to a 10 inch depth and living white roots visible at a 3 and 6 inch depth were counted.

1973 Norbeck Country Club Site

This experiment with granular experimental and registered herbicides was conducted on a sparse Kentucky bluegrass turf in the left rough of the 15th fairway at Norbeck Country Club, Rockville, Maryland. The area was maintained at a 1.25 inch cutting height and had been observed to contain a heavy populati of Smooth Crabgrass in the fall of 1972. The soil was a Chester silt loam (46% 38% silt and 16% clay) with a pH of 5.7, soil phosphorus (P_2O_5) available of 10 lb/Acre, exchangeable potassium (K_2O) of 78 lb/Acre and organic matter content of 3.9%. Herbicides were applied on April 18, 1973 and 14 lb/1000 sq f 12-4-8 (50% organic, 3.6% water insoluble) fertilizer was applied. Shade air temperature was 68 F. and soil temperature in the 0 - 2 inch depth was 57 F. on the day of herbicide application. All materials were applied with a 3 ft drop type spreader. The experimental design was a randomized complete block with 4 replications and individual plot size of 6 by 15 ft. Materials evaluated are listed in Table 2.

RESULTS AND DISCUSSION

Crabgrass Control and Turfgrass Quality

The best combination of crabgrass control and turfgrass quality was achieved with bensulide, tricalcium arsenate and A-820 2.3 G in the 1972 tests (Table 1). Turfgrass quality ratings were not made in the 1973 test because of the sparse turf, however, at the higher rates the experimentals all provided crabgrass control equivalent to bensulide (Table 2). Of particular notice in the 1972 test was the failure of the emulsifiable concentrate formulations of A-820, CGA 10832, and GS 38946 to provide good smooth crabgrass control (Table 1). Granular formulations of these materials considerably improved their effectiveness (Table 2). In both experiments the plots were not irrigated after application of the herbicides. This likely contributed to the loss of efficiency exhibited by the liquid formulations. Creeping red fescue was absent in the tricalcium arsenate and bandane plots and was noticeably decreased under the continuous application of DCPA. The 6 lb a.i./A. rate of A-820 visibly yellowed the creeping red fescue but did not visibly harm the Kentucky bluegrass in the stand. The continuous application of bandane to bluegrass-red fescue mixtures is deleterious to turf quality (Table 1).

Residual Effect on Germination

The continuous application of bandane, bensulide and tricalcium arsenate to turfgrass considerably reduces the probability of achieving success with bluegrass overseedings (Table 3). Seedling number and vigor is considerably diminished by the lengthy residual of these preemergence herbicides. A-820, benefin, DCPA, and siduron had little effect on fall germinating seedlings.

Herbicide effect on Root Number

Continuous application of only bandane and tricalcium arsenate significantly reduced root number at the 3 inch depth (Table 4). A-820, benefin, bensulide, DCPA and siduron had little effect on root count.

CONCLUSIONS

Granular formulations of A-820, CGA 10832 and AC 92390 at rates of 5, 3 and 2 lb (a.i./A.) respectively, have potential to provide satisfactory crabgrass control in Kentucky bluegrass turf. Emulsifiable concentrate formulations of all experimental materials performed unsatisfactorily under the conditions of this trial. Further studies are needed to definitely establish the rate at which acceptable crabgrass control and minimum phytotoxicity is achieved with these three experimental materials. Continuous applications of bandane and tricalcium arsenate significantly decrease root activity and germination potential in Kentucky bluegrass-red fescue turf.

LITERATURE CITED

1. Bandel, V. A., C. K. Stottlemeyer, and C. E. Rivard. 1969. Soil testing procedure, University of Maryland Soil Testing Laboratory, Agronomy Mimeo No. 37, University of Maryland, College Park, Maryland 20742

Table 1. Effect of chemicals on preemergence crabgrass control and turfgrass quality at the 1972 Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./a.)	Smooth Crabgrass in Plot 7/21/72 (%)	Smooth Crabgrass in Plot 9/8/72 (%)	Turfgrass Quality 7/21/72 (Rating)[x]	Turfgrass Quality 9/8/72 (Rating)
Bandane[y]	10 G[z]	35	0	0	3.2	2.5
Benefin	2.5 G	2	6	16	6.0	5.5
Ca_3AsO_4	48 G	187	0	0	7.2	5.0
Bensulide	12.5 G	12.5	0	0	6.0	6.5
A-820	4 EC	4	49	51	4.7	5.0
A-820	4 EC	5	62	64	4.2	5.0
A-820	4 EC	6	50	63	5.0	5.0
DCPA	75 WP	9	10	25	6.0	6.0
A-820	2.3 G	4	0	8	6.0	5.7
A-820	2.3 G	5	1	26	6.5	5.7
A-820	2.3 G	6	0	5	5.2	6.0
CGA 10832	3.5 EC	1	69	81	3.7	5.0
CGA 10832	3.5 EC	2	32	60	5.0	5.0
CGA 10832	3.5 EC	3	24	46	5.7	5.4
GS 38946	3.5 EC	1	81	85	4.0	5.0
GS 38946	3.5 EC	2	70	69	4.2	5.0
GS 38946	3.5 EC	3	70	72	4.2	5.0
Siduron	50 WP	12	28	57	5.0	5.0
Check		0	79	80	3.9	5.0
Bayes 5% LSD[w]			11	18	0.9	0.5

[w] Duncan, D. B. 1965. A Bayesian approach to multiple comparisons. Technometrics 7:171-222.

[x] Turfgrass quality ratings made on a 0 - 9 scale where 9 = maximum turfgrass quality, 6 = acceptable turfgrass quality and 0 = bare soil. Quality estimate includes uniformity, density, texture and smoothness.

[y] Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966 - 1972 and A-820, CGA 10832 and GS 38946 only in 1972.

[z] The abbreviations are G = granule, EC = emulsifiable concentrate and WP = wettable powder. The number in front of: G is % active ingredient, WP is % active ingredient and EC is lb a.i./gal.

Table 2. Effect of chemicals applied April 18, 1973 on preemergence crabgrass control at the 1973 Norbeck Country Club site, Rockville, Maryland.

Treatment	Formulation	Rate (lb a.i./A)	Smooth Crabgrass in Plot 7/17/73 (%)	Smooth Crabgrass in Plot 10/9/73 (%)
Bensulide	12.5 G[z]	12.5	0 a[x]	4 a
Benefin	2.5 G	2	17 b	42 d
A-820	2.3 G	4	2 a	24 bc
A-820	2.3 G	5	2 a	15 ab
CGA 10832	2 G	2	1 a	16 abc
CGA 10832	2 G	3	0 a	10 ab
AC 92390	2.5 G	2	1 a	32 cd
AC 92390	2.5 G	3	5 ab	19 abc
Check		0	57 c	70 e

[x] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z] The abbreviation is G = granule and number in front of G is the % active ingredient.

Table 3. Residual effect of preemergence crabgrass control chemicals applied on April 18, 1972, upon germination and shoot dry weight of Kentucky bluegrass seeded in the greenhouse on October 20, 1972[x].

Treatment	Formulation	Rate (lb. a.i./A.)	Seedlings Germinated 12/14/72 Per 25	Shoot Dry Weight Per Seedling 12/14/72 (g)
Bandane[x]	10 G[w]	35	7 ab[y]	.009 a
Benefin	2.5 G	2	12 cd	.037 b
Ca AsO_4	48 G	187	10 bc	.002 a
Bensulide	12.5 G	12.5	4 a	.003 a
DCPA	75 WP	9	14 cde	.022 ab
A-820	2.3 G	4	15 de	.021 ab
A-820	2.3 G	5	18 e	.024 ab
A-820	2.3 G	6	14 cde	.022 ab
Siduron	50 WP	12	16 de	.024 ab
Check		0	14 cde	.022 ab
Bayes 5% LSD[z]			4	.020

[w] The abbreviations are G = granule and WP = wettable powder. The number in front of G and WP is % active ingredient.

[x] Bandane, benefin, $CaAsO_4$, bensulide, DCPA and Siduron were applied annually from 1966 through 1972 and A-820 only in 1972.

[y] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z] Duncan, D. B. 1965. A Bayesian approach to multiple comparisons. Technometrics 7:171-222.

Table 4. Residual effect of preemergence crabgrass control chemicals applied on April 18, 1972 upon root counts taken at a 3 and 6 inch depth on April 12, 1973[x], Plant Research Farm, Fairland, Maryland.

Treatment	Formulation	Rate (lb a.i./A.)	Root Count/1.8 sq. inches 3 inch Depth (Number)	6 inch Depth (Number)
Bandane[x]	10 G[z]	35	5.5 a[y]	5.7 a
Benefin	2.5 G	2	22.0 bc	17.2 b
Ca_3AsO_4	48 G	187	15.0 ab	15.7 b
Bensulide	12.5 G	12.5	23.0 bc	14.2 ab
DCPA	75 WP	9	27.2 c	17.5 b
A-820	2.3 G	6	26.5 bc	17.0 b
Siduron	50 WP	12	32.7 c	21.0 b
Check		0	31.0 c	20.8 b

[x] Bandane, Benefin, Ca_3AsO_4, Bensulide, DCPA and Siduron were applied annually from 1966 through 1972 and A-820 only in 1972.

[y] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[z] The abbreviations are G = granule and WP = wettable powder. The number in front of G and WP is % active ingredient.

Computer time for this project was supported in full through the facilities of the Computer Science Center of the University of Maryland.

GERMINATION OF GRASS SEED PLACED ON SOIL BEFORE OR AFTER SPRAYING WITH GLYPHOSATE

Dayton L. Klingman[1/]

ABSTRACT

Glyphosate [N-(phosphonomethyl)glycine] kills established grass species in turf and pasture. The effect of treatment on subsequent grass seedings or on residual seed that may later volunteer is important. Seven treatments were applied to soil in pots in the greenhouse seeded with *Poa pratensis* L. (Merion), *Festuca rubra* L. (Pennlawn), and *F. arundinacea* (Ky. 31). Treatment sequences included: (a) grass seed placed on soil *before* spraying with herbicide; (b) seed on soil surface *no* herbicide; (c) seed placed on soil *after* herbicide; (d) herbicide on soil, cover with 1/4-inch soil, seed on surface; (e) seed placed on soil, cover with 1/4-inch soil *before* herbicide; (f) same as "e" but no herbicide; and (g) seed on soil, herbicide treatment before covering with 1/4-inch soil. Glyphosate was applied at rate of 4 lb/a. All pots were lightly covered with vermiculite after treatment and watered as needed. There were no significant differences in germination or rate of growth among treatments except for greatly reduced germinations in treatments "e" and "f". Similar results occurred in two separate experiments. I have no logical explanation for these differences. Treatments "e" to "g" are underway again plus some other variations that will be reported orally. These data indicate that renovation treatments with glyphosate will not reduce volunteer grass plants from residual seed on the treated site nor should there be any effect of glyphosate on the germination of seed sown in the area immediately after treatment.

1/ Turfgrass Laboratory, Plant Genetics and Germplasm Institute, Northeastern Region, Agricultural Research Service, U.S. Department of Agriculture, Beltsville Agricultural Research Center-West, Beltsville, Maryland 20705

QUACKGRASS CONTROL WITH GLYPHOSATE, PRONAMIDE AND DALAPON[1/]

John R. Hall and James V. Parochetti[2/]

ABSTRACT

Dalapon (2,2-dichloropropionic acid), Pronamide (N-1,1-dimethylpropynyl)-3,5-dichlorobenzamide) and glyphosate (N-phosphoromethyl)glycine) were tested for their ability to control quackgrass (Agropyrons repens (L.) Beauv.). Dalapon at 10 lb/A[3/] and glyphosate at 1.5 and 3 lb/A exhibited good initial knockdown of existing quackgrass. Rhizome kill was greatest with glyphosate at 3 lb/A. Data taken on quackgrass regrowth 10 months after initial herbicide application indicated glyphosate at 3 lb/A provided better quackgrass control than the 1.5 lb/A rate ($P < .10$). Quackgrass control with glyphosate at 1.5 and 3 lb/A was slightly better than with dalapon at 5 and 10 lb/A ($P < .25$). Pronamide at 1.5 and 3 lb/A provided inferior quackgrass control.

INTRODUCTION

Quackgrass is a serious threat to quality sod production in the State of Maryland. Herbicides currently available have not provided complete control of this noxious weed. This experiment was designed to compare quackgrass control achieved with dalapon, pronamide and glyphosate at various rates.

MATERIALS AND METHODS

The experiment was conducted on a quackgrass infested manor loam soil (42% sand, 37% silt and 20% clay) located on the Mayne Turf Farms, Montgomery County, Maryland. Soil pH was 5.7; available P_2O_5 302 lb/A and extractable K_2O 410 lb/A.[4/] All applications were applied in water at the rate of 30 gal/A with a CO_2 charged small plot sprayer delivering the material at 30 psi. The experimental design was a randomized complete block with 3 replications and plot size was 10 by 20 ft.

Treatments (Table 1) were applied on June 16, 1972. The quackgrass was approximately 3 inches high and the air temperature was 75 F. All plots were cultivated on July 12, 1972 with a rototiller to a depth of 6 inches. On August 10, 1972, 6 lb/1000 sq ft of 16-8-8 was applied and 1 lb/A of silvex (2-(2,4,5-trichloro-phenoxy) propionic acid) was applied for broadleaf weed control. On October 6, 1972, the plots were cultivated with a rototiller, fertilized with 2 lb N/1000sq ft from NH_4NO_3 and seeded to a blend of 25% 'Merion' Kentucky bluegrass and 50% 'Pennlawn' Creeping Red Fescue (Festuca rubra L.) at 2 lb/1000 sq ft.

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

3/ All rates are expressed as active ingredient.

4/ Bandel, V. A., C. K. Stottlemeyer and C. E. Rivard. 1969. Soil Testing Laboratory, Agronomy Mimeo No. 37, University of Maryland, College Park, Maryland 20742.

Data were taken on July 7, 1972, August 18, 1972 and April 19, 1973 to determine the effect of the applied herbicides on quackgrass control. Each observation was recorded as the average of two individual's ratings. Quackgrass tiller counts were made by randomly sampling 4 sq ft areas.

RESULTS AND DISCUSSION

The most rapid response to the applied herbicides was achieved with dalapon at 10 lb/A and glyphosate at 1.5 and 3 lb/A (Table 1). On August 18, 1972, approximately 8 weeks after herbicide application and 5 weeks after the first cultivation, there were significant patterns in quackgrass regrowth developing. The expected summer inactivity of pronamide was evident; glyphosate at 1.5 and 3 lb/A and dalapon at 10 lb/A continued to be most effective. During the first two months of the study glyphosate at 3 lb/A produced significantly better rhizome kill than the other materials. Visual observation of the rhizomes in the glyphosate plot revealed brown rhizomes with very dark-brown, localized, necrotic internodal regions.

Significant differences in the percent quackgrass control were obtained on April 19, 1973. Orthogonal single degree of freedom linear contrasts indicate that glyphosate at 3 lb/A provided better quackgrass control than glyphosate at 1.5 lb/A ($P < .10$) (Table 2 and 3). A non-orthogonal single degree of freedom linear contrast indicated that glyphosate at rates of 1.5 and 3 lb/A gave slightly better control of quackgrass than dalapon at 5 and 10 lb/A ($P < .25$). No reduction in germination occurred in any plot after the October 6, 1972 seeding with the Kentucky bluegrass blend.

It appears that single applications of these materials will not provide 100% control of quackgrass, even in conjunction with two cultivations. To establish quality turfgrass in an area infested with quackgrass, more than one application of these herbicides is necessary for quackgrass eradication.

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Table 1. Effect of glyphosate, pronamide and dalapon on quackgrass regrowth.

Treatment	Rate (lb/A.)	Area of plot in Living Grass[z] 7/7/72 (%)	Quackgrass Tillers per 4 sq ft 8/18/72 (number)	Rhizome Activity[y] 7/7/72 (rating)	Dead Rhizomes[y] 8/18/72 (%)
Dalapon	5	25 b[x]	17 ab	7.3 b	70 bc
	10	8 a	9 a	6.7 b	68 b
Pronamide	1.5	87 c	26 ab	8.0 bc	48 a
	3	83 c	20 ab	8.3 bc	62 b
Glyphosate	1.5	7 a	5 a	5.0 a	82 bc
	3	0 a	1 a	5.0 a	93 c
Check	0	95 c	39 b	9.0 c	35 c

[x] Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

[y] Rhizomes were randomly exhumed from each plot and visual estimates of either rhizome activity (0 to 9 scale where 9 = maximum rhizome activity and 0 = no rhizome activity) or the percent of rhizomes that were dead was recorded.

[z] Visual estimates of the percent of each plot covered by living grass.

Table 2. Analysis of variance table illustrating orthogonal single degree of freedom linear contrasts made on quackgrass counts taken April 19, 1973.

Source	degrees of freedom	Sum of Squares	Mean Square Error	F Value	P level
Replication	2	12427	6213	9.00	.01
Treatments	5	7790	1558	2.25	.25
Glyphosate vs. others	1	3820	3820	5.54	.05
Glyphosate (3 lb vs 1 lb)	1	2590	2590	3.74	.10
Remainder	3	1380	460	.66 n.s.	
Error	10	6917	692		

Table 3. Effect of applied herbicides upon quackgrass control.

Treatment	Rate (lb/A.)	Quackgrass Control[x] 4/19/73 (%)
Dalapon	5	31
	10	46
Pronamide	1.5	17
	3	27
Glyphosate	1.5	45
	3	82
Check		0

[x] Total number of quackgrass tillers in each plot was determined. Individual control values were calculated.