Field Evaluation of Two Wettable Powder Formulations of Linuron[1]

J. V. Parochetti[2]

ABSTRACT

A field study was conducted in 1971, 1972 and 1973 comparing preemergence applications of two different wettable powder formulations of linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea) at 1, 2 and 4 lb/A. Linuron injury at 4 lb/A to soybeans (Glycine max L.) was less for the coarse grind than the commercially available formulation one year out of the three years. For both formulations, the 2 lb/A rate caused between 0 to 21.3% soybean stand reduction. Weed control was similar between the two formulations.

INTRODUCTION

Linuron is used as a preemergence herbicide for the control of many annual weeds in soybeans. More than 50% of Maryland farmers using herbicides in soybean production use linuron either alone or in combination with another herbicide (1). Occasionally, linuron will cause soybean injury. Soybean injury is most common on the lighter textured soils with less than 1% organic matter. Injury is also associated with heavy rainfall shortly after linuron application and is assumed to be caused by the leaching of linuron onto the germinating seed.

Various techniques are employed to reduce linuron injury. Different application rates are recommended based on the texture of the soil and the amount of organic matter as noted on the product label. Soybean planting depth can be increased to 1 to 1½ inches in order to increase soybean protection.

In 1971, E. I. DuPont de Nemours and Company developed a coarse grind experimental 50% wettable powder formulation which was hoped would be less phytotoxic than the 50% wettable powder formulation. The objective of this study was to compare these two formulations under field conditions in soybean culture.

MATERIALS AND METHODS

Similar field studies were conducted in 1971, 1972 and 1973 at the Poplar Hill Research Farm, Salisbury, Maryland. Two 50% wettable powder formulations of linuron were compared as preemergence treatments at 1, 2 and 4 lb/A. Both formulations were provided by E. I. DuPont de Nemours and Company, Wilmington, Delaware. One formulation, referred to as regular grind,

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

was marketed prior to 1972 by DuPont as Lorox 50W; the other formulation, referred to as coarse grind, was an experimental formulation. Approximately 80% of the average particle size for the regular grind and the coarse grind was 4 to 10 u and 40 to 100 u, respectively.

Experimental procedure similar for all years. Plots were in the same general area each year; the soil was an Evesboro loamy sand. Linuron was applied with an experimental bicycle sprayer in 30 gpa water. The experimental design was a randomized complete block with 4 replications. Plot size was 10 by 20 feet with 4 rows per plot spaced at 30 inches. Visual percentage ratings on soybean injury were made 25 to 35 days after herbicide treatment. Weed control ratings were made only in 1971 because a sufficient number of weeds were not present in 1972 and 1973. The European rating system was used for weed control ratings (Table 2 lists rating system and corresponding % control). Soybean yields were taken from the center two rows after reducing the length to 16 feet; yields are expressed in Bu/A at 13% moisture. Rainfall within two weeks after herbicide application is listed in Table 1.

Table 1. Rainfall occurring within two weeks after herbicide application

1971		1972		1973	
Date	Rainfall (inches)	Date	Rainfall (inches)	Date	Rainfall (inches)
June 10	(treatment)	May 25	(treatment)	May 30	(treatment)
June 12	0.5	May 31	1.33	June 3	Trace
June 13	0.09	June 3	0.01	June 6	Trace
June 15	0.02	June 5	0.02	June 13	0.98
June 16	0.21				

In 1971 'York' soybeans were planted June 9 and herbicides were applied June 10. In 1972 "Kent" soybeans were planted May 24 and herbicides were applied May 25. In 1973 'Williams' soybeans were planted May 30 and herbicides were applied on May 30.

RESULTS AND DISCUSSION

Weed control resulting from the two different formulations of linuron at similar rates was similar for all weed species present except at the 1 lb/A for large crabgrass (*Digitaria sanguinalis* (L.) Scop.)(Table 2). Linuron controlled more than 96% giant green foxtail (*Setaria viridis* var. *major* (Gaud.) Posp.) and controlled more than 95% carpetweed (*Mollugo verticillata* L.); control of morningglory (*Ipomea* spp.) varied from 80 to 90%.

The coarse grind formulation caused less injury to soybeans one year out of three years. When comparing similar linuron rates, soybean injury was similar for all years except in 1971. In 1971 linuron at 4 lb/A as the regular grind caused a 50% soybean stand reduction which was significantly higher than linuron at 4 lb/A as the coarse grind (Table 3). Soybean yields were reduced in proportion to soybean stand reduction. Greatest stand reduction occurred in 1972 when 1.33 inches of rainfall occurred one day after preemergence treatment. Although the rainfall patterns for 1971 and 1973 were similar,

in 1973 both formulations of linuron at 4 lb/A caused similar soybean stand reductions of (38 to 45%); in contrast in 1971 the coarse grind at 4 lb/A caused significantly less soybean stand reduction than 4 lb/A of the regular grind. For both formulations, the 2 lb/A rate, which was three to four times the recommended rate for this soil type, caused between 0 to 21.3% stand reduction (Table 3).

ACKNOWLEDGEMENTS

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

LITERATURE CITED

1. Bookhout, B. R., L. A. Gambrell, and J. V. Parochetti. 1970. Chemical control of weeds in corn and soybeans on Maryland farms 1969. Md. Crop Reporting Service. Publication No. 44

Table 2. Weed control following preemergence treatments of two 50% wettable powder formulations of linuron in 1971.

Treatment	Rate lb/A	June 29, 1971						July 15, 1971	
		Giant green Foxtail		Carpetweed		Morningglory		Large Crabgrass	
		Rating[a]	(%)[b]	Rating[a]	(%)[b]	Rating[a]	(%)[b]	Rating[a]	(%)[b]
Control		8.25	(24)	8.75	(10)	8.0	(33)	8.75	(10)
Control Cultivated		9.0	(00)	9.00	(0)	9.0	(0)	4.25	(88)
Linuron regular grind	1.0	3.25	(96)	1.25	(99)	5.5	(80)	6.25	(73)
Linuron regular grind	2.0	1.50	(99)	1.0	(100)	4.0	(90)	3.25	(96)
Linuron regular grind	4.0	1.00	(100)	1.0	(100)	3.25	(96)	2.0	(97)
Linuron coarse grind	1.0	2.00	(97)	1.75	(98)	5.0	(85)	3.25	(96)
Linuron coarse grind	2.0	2.25	(97)	1.0	(100)	4.75	(86)	4.50	(87)
Linuron coarse grind	4.0	2.75	(96)	3.0	(95)	5.0	(85)	4.25	(88)
	LSD 0.05	2.49		2.26		3.6		2.63	

[a] The European rating system used. The rating and corresponding % control is as follows: 1 = 100%, 2 = 97.5%, 3 = 95%, 4 = 90%, 5 = 85%, 6 = 75%, 7 = 66%, 8 = 33%, 9 = 0%.

[b] The % is an approximation.

Table 3. Soybean stand and yield following preemergence treatments of two 50% wettable powder formulations of linuron in 1971, 1972, and 1973.

Treatment	Rate lb/A	1971		1972		1973	
		Soybean Stand Reduction (%)	Soybean Yield (Bu/A)	June 19 Soybean Stand Reduction (%)	Dec. 2 Soybean Yield (Bu/A)	June 26 Soybean Stand Reduction (%)	Oct. 9 Soybean Yield (Bu/A)
Control	-	0	19.6	1.3	28.9	1.3	30.1
Control Cultivated	-	0	30.1	0.0	35.5	0	42.4
Linuron regular grind	1.0	0	28.8	21.3	22.1	0	32.6
Linuron regular grind	2.0	6	28.5	80.0	6.0	0	43.1
Linuron regular grind	4.0	50	5.0	99.7	0	38	14.8
Linuron coarse grind	1.0	16	26.9	18.8	22.6	0	35.0
Linuron coarse grind	2.0	1	28.5	85.0	0	0	42.1
Linuron coarse grind	4.0	15	22.6	100.0	0	45	20.3
	LSD 0.05	26	8.6	14.7	9.1	19	10.8

WEED CONTROL IN SOYBEANS WITH RH-2512 AND RH-2915

John P. Hartnett[1]

Abstract

Preemergence herbicide tests with RH-2512 and RH-2915 were conducted on soybeans (Glycine max.) in 1974 at Newtown, Pa. Both herbicides were evaluated alone, as a tank mix combination with alachlor and as preemergence treatments following ppi applications of trifluralin. RH-2512 applied preemergence at 0.75 to 1.0 lb. ai/acre provided excellent control of large crabgrass (Digitaria sanguinalis), fall panicum (Panicum dichotomeflorum), common lambsquarter (Chenopodium album), redroot pigweed (Amaranthus retroflexus), and smallflower galinsoga (Galinsoga parviflora). RH-2915 applied at 0.25 lb. ai/acre preemergence provided weed control equivalent to RH-2512 at 1.0 lb. ai/acre. Combinations of RH-2915 at 0.125 to 0.25 lb. ai/acre or RH-2512 at 0.5 to 0.75 lb. ai/acre applied preemergence with alachlor or following trifluralin gave outstanding broad spectrum weed control.

Introduction

RH-2512 and RH-2915 are broad spectrum preemergence and postemergence herbicides. Two experiments conducted at the Rohm and Haas Research Farm in Newtown, Pa., during the summer of 1974 demonstrate their usefulness as preemergence soybean herbicides. Experiment number one evaluated the preemergence activity of RH-2512 and RH-2915 alone and in combination with alachlor. Experiment number two evaluated the preemergence effectiveness of both herbicides alone and as over-lay treatments following preplant incorporated trifluralin.

Methods and Materials

Experiments were conducted at the Rohm and Haas Research Farm in Newtown, Pa., on a Bucks silt loam soil containing 1.8 percent organic matter. The experimental test design was a randomized complete block with four replications. The treatments were applied to 5 ft. by 25 ft. plots containing two rows of soybeans. Experiment No. 1 was planted and treated on May 21, 1974, and Experiment No. 2 on May 22, 1974. In both tests, 45 lb/acre of Adelphia soybeans were planted in rows 36 inches apart. The chemicals were applied in 40 gallons of water per acre using a tractor equipped with a compressed air sprayer and three 8004 Spraying Systems nozzles. Experiment No. 1 was harvested October 28, 1974 and Experiment No. 2 on November 2, 1974 with a small plot combine.

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[1] Agricultural Field Testing Group, Rohm and Haas Company, Spring House, PA

The major weed species in both tests were common lambsquarter, smallflower galinsoga, common ragweed, large crabgrass and fall panicum. Redroot pigweed was evaluated only in Experiment No. 2 because the population in Experiment No. 1 was very light.

Results and Discussion

Yield, crop tolerance and weed control data for Experiment No. 1 and Experiment No. 2 are presented in Tables 1 and 2 respectively and discussed separately below.

Experiment No. 1 - RH-2512 was applied at 0.5, 1.0 and 1.5 lb. ai/acre. Eight weeks after application, overall weed control at 1.5 lb. ai/acre was excellent (Table 1). At 1.0 lb. ai/acre, RH-2512 exhibited good activity against lambsquarter, crabgrass and fall panicum and galinsoga. At 0.5 lb. ai/acre, control of galinsoga was poor, control of lambsquarter was acceptable and control of all other species was good to excellent. These results indicate that under the conditions of this test, the optimum use rate for RH-2512 is 1.0 lb. ai/acre.

The combination of RH-2512 at 0.5 lb. ai/acre plus alachlor at 1.5 lb. ai/acre resulted in excellent broad spectrum weed control. This combination was superior to either herbicide applied alone. RH-2512 provided improved control of lambsquarter and alachlor provided improved control of fall panicum.

RH-2915 was applied preemergence at 0.125, 0.25 and 0.5 lb. ai/acre. RH-2915 at a dosage as low as 0.125 lb. ai/acre provided excellent control of lambsquarter and fair to good control of the other weed species. The optimum use rate of RH-2915 for broad spectrum weed control was 0.25 lb. ai/acre. At this dosage, RH-2915 provided effective control of all weed species except a late season fall panicum population.

RH-2915 at 0.125 lb. ai/acre plus alachlor at 1.5 lb. ai/acre was an effective combination treatment which provided excellent full season weed control that was comparable to alachlor at 1.5 lb. ai/acre plus linuron at 0.5 lb. ai/acre. RH-2915 improved the broadleaf weed control spectrum of alachlor while alachlor provided improved control of crabgrass and fall panicum.

Yields for all herbicide treatments in Experiment No. 1 ranged from 28.6 to 38.8 bu/acre and all were significantly better than the untreated check. In spite of some early season injury, RH-2512 at 1.0 and 1.5 lb. ai/acre and alachlor plus linuron at 1.5 plus 0.5 lb. ai/acre produced the three highest yields in the test. Yields from combination treatments of RH-2512/Lasso at 0.5 plus 1.5 lb. ai/acre and RH-2915/Lasso at 0.125 plus 1.5 lb. ai/acre were equivalent to Lasso/Lorox at 1.5 plus 0.5 lb. ai/acre.

Experiment No. 2 - PPI applications of trifluralin followed by preemergence applications of either RH-2512 or RH-2915 gave excellent broad spectrum weed control. Trifluralin at 0.5 lb. ai/acre ppi gave excellent control of all grasses, lambsquarter and pigweed. Galinsoga, a major weed species in the test, was resistant to trifluralin. Preemergence applications

of RH-2915 at 0.25 lb. ai/acre and RH-2512 at 0.75 lb. ai/acre alone and following trifluralin ppi provided good to excellent galinsoga control. Control of this weed resulted in significantly higher yields for RH-2915 and RH-2512 alone and following trifluralin than for trifluralin alone. Under the conditions of this test early season injury with RH-2915 and RH-2512 had no affect on yield.

In summary, RH-2915 at 0.125 to 0.25 lb. ai/acre and RH-2512 at 0.5 to 1.5 lb. ai/acre preemergence are effective broad spectrum herbicides for use on soybeans. Low rates of RH-2915 and RH-2512 also give excellent control of alachlor and trifluralin resistant weeds and when used in combination increase soybean yield.

Table 1. Soybean Yield, Crop Tolerance and Weed Control Ratings for Preemergence Applications of RH-2512 and RH-2915 Alone and in Combination with alachlor.

Treatment	Rate Lb ai/A	Soybeans[1] Yield[2] bu/A.	Soybeans[1] Injury 6/12	Soybeans[1] Injury 7/17	Soybeans[1] Injury 9/17	Weed Control Ratings[1] Overall 7/17	Weed Control Ratings[1] Overall 9/17	Crab-grass 7/17	Fall panicum 9/17	Lambs-quarter 7/17	Galin-soga 7/17
1. RH-2915 2E	0.125	31.0 bc	18	5	0	74	70	84	43	89	68
2. RH-2915 2E	0.25	32.5 abc	25	10	0	87	79	98	69	99	84
3. RH-2915 2E	0.5	33.4 abc	35	38	3	96	84	96	65	100	99
4. RH-2512 2E	0.5	29.6 bc	10	6	0	60	71	99	84	92	59
5. RH-2512 2E	1.0	38.8 a	20	5	0	82	85	98	89	100	80
6. RH-2512 2E	1.5	38.8 a	30	11	0	93	91	99	91	100	93
7. Alachlor 4E	2.0	31.0 bc	6	0	0	83	79	100	93	78	100
8. Linuron 50W	1.5	35.4 abc	25	15	0	100	95	100	95	100	100
9. Metribuzin 50W	0.25	34.4 abc	5	3	0	74	66	84	28	96	23
10. Chloroamben 2AE	3.0	28.6 c	3	3	0	38	73	99	68	95	99
11. Alachlor + Linuron	1.5+0.5	38.8 a	35	13	0	100	96	100	98	100	100
12. Alachlor + RH-2915	1.5+0.125	36.3 ab	31	8	0	98	91	99	93	99	100
13. Alachlor + RH-2915	1.5+0.25	34.9 abc	35	19	0	99	94	100	94	100	100
14. Alachlor + RH-2512	1.5+0.5	36.8 ab	19	6	0	99	93	99	98	99	99
15. Control (Avg of 7)	-	15.5 d	5	0	9	0	0	0	0	0	0

[1] Rating Scale: 0 = no injury or control, 100 = complete kill or control

[2] The small letters indicate Duncan's multiple range groupings of treatments which do not differ significantly at the 5 percent level.

Table 2. Soybean Yield, Crop Tolerance and Weed Control Ratings for Preemergence Applications of RH-2915 and RH-2512 Alone and Following Trifluralin PPI.

Treatment	Rate Lb ai/A	Appln time	Soybeans[1] Yield[2] bu/A.	% Injury 6/12	% Injury 7/17	% Injury 9/19	Weed Control Ratings[1] Overall 7/17	Overall 9/19	Total grass 7/17	Fall panicum 9/19	Lambs-quarter 7/17	Galin-soga 7/17	Pig-weed 7/17
1. RH-2915 2E	0.25	pre	43.6 a	25	14	1	93	93	92	85	99	95	100
2. RH-2512 2E	0.75	pre	40.2 ab	14	8	1	87	78	87	89	99	86	100
3. Trifluralin 4E	0.5	ppi	28.1 c	10	5	14	33	51	93	100	97	10	97
4. Vernolate 6E	3.0	ppi	32.9 bc	45	18	1	78	52	88	64	90	70	100
5. Trifluralin + RH-2915	0.5 + 0.25	ppi + pre	43.6 a	25	19	0	96	98	99	99	100	94	100
6. Trifluralin + RH-2512	0.5 + 0.75	ppi + pre	43.6 a	19	16	1	91	98	99	100	99	90	99
7. Control	-	-	18.9 d	0	0	0	0	0	0	0	0	0	0

[1] Rating Scale: 0 = no injury or control, 100 = complete kill or control

[2] The small letters indicate Duncan's multiple range groupings of treatments which do not differ significantly at the 5 percent level.

YELLOW NUTSEDGE CONTROL WITH CGA-24705 IN CORN AND SOYBEANS

E. R. Higgins, M. G. Schnappinger and S. W. Pruss[1/]

ABSTRACT

Several corn (Zea mays L.) and soybean (Glycine max.) trials were conducted in New York and Maryland in 1973 and 1974 to determine crop selectivity and yellow nutsedge (Cyperus esculentus) response to CGA-24705 [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide] from PPI and preemergence application.

Corn and soybean tolerance to CGA-24705 was excellent in all cases at rates providing acceptable control of yellow nutsedge.

CGA-24705 was more active than alachlor [2-chloro-2',6' -diethyl'N' (methoxymethyl)acetanilide], butylate (S-ethyl diisobutylthiocarbamate) plus atrazine [2-chloro-4(ethylamino -6(isopropylamino)-S-triazine] or vernolate (S-propyl dipropyl-thiocarbamate), regardless of method of application.

Although more effective against yellow nutsedge when applied preplant incorporated, CGA-24705 gave acceptable control following preemergence treatments.

INTRODUCTION

Yellow nutsedge is rapidly becoming one of the most serious weed problems in corn and soybeans throughout the northeast. There are few herbicides now on the market which will consistently give satisfactory control of this perennial weed species. In addition, a serious drawback to many of these compounds is the requirement that they either be incorporated or applied as split treatments.

The objective of the studies reported here was to obtain information regarding crop tolerance and the activity of CGA-24705 against yellow nutsedge as a function of rate and method of application.

1/ Senior Research Representatives & Research Manager, Northeast Region, Agricultural Division, CIBA-GEIGY CORPORATION, Washington, Pennsylvania

MATERIALS AND METHODS

The corn and soybean field experiments were performed in 1973 and 1974 on silt loam soils in New York and Maryland. Soil test results for each test site are shown in Table 1.

Each location had a previous history of moderate to heavy yellow nutsedge infestation.

Application of all herbicides was done with a CO_2 powered plot sprayer. All plots were 3.7 meters in width and varied in length from 6.1 to 9.2 meters. The experimental design consisted of randomized complete blocks with each treatment replicated 3 or 4 times. Incorporation was performed using a tandem disc within 6 hours after spraying, with exception of the butylate treated plots which were incorporated immediately. No further plot maintenance was performed during the season.

Rainfall patterns were normal in 1973 with the exception of a three week dry period in August. In 1974, heavy rains of short duration were a frequent occurrence throughout the summer, especially in New York.

Visual ratings of crop response and yellow nutsedge control were made using a scale of 0 to 10; 0 = no effect on crop and/or weed; 7 = satisfactory or commercially acceptable weed control; 10 = complete kill to crop and/or weed. All untreated check plots were regarded as having no effect on crop or weed growth, and thus were not entered in the tables.

RESULTS AND DISCUSSION

Data pertaining to corn and soybean selectivity and yellow nutsedge response to CGA-24705 are shown in Tables 2 through 6.

Both crops were tolerant to CGA-24705 at rates providing commercially acceptable yellow nutsedge control.

Preplant incorporated applications of CGA-24705 were more active than equal rates applied preemergence (Tables 2, 3, 5, and 6). The only exception occurred in a soybean trial performed at Centreville, Maryland (Table 6), where preemergence treatments proved slightly more effective. CGA-24705 has displayed excellent activity against yellow nutsedge regardless of application method. This becomes especially apparent when considering the degree of control achieved with high rates of alachlor or standard nutsedge treatments of butylate + atrazine in corn and vernolate in soybeans.

In some trials, levels of nutsedge control achieved in 1974 vary from that obtained in 1973 at virtually the same location. For example, in corn tests performed near Auburn, New York, under conditions of extremely heavy nutsedge pressure, all treatments were markedly less effective in 1973 (Table 2) than they were in 1974 (Table 5). Differences in herbicidal activity associated with preplant incorporated vs. preemergence treatments at the same location were of lesser magnitude during 1974. This can be partially attributed to the greater amounts and intensity of rainfall this year.

Table 1

Soil Information Pertaining to Various Test Locations

Expt.	Test Year	Test Crop	Location	Soil Type	% OM	pH	CEC meq/100 g
1	1973	Corn	Auburn, New York	silt loam	4.6	6.8	15.7
2	1973	Corn	Centreville, Maryland	silt loam	2.6	5.6	7.6
3	1973	Corn	Barton, New York	silt loam	3.5	6.2	11.0
4	1974	Corn	Auburn, New York	silt loam	5.9	6.6	16.4
5	1973	Soy-beans	Romulus, New York	loam	5.2	6.9	15.4
6	1974	Soy-beans	Seneca Falls, New York	loam	4.6	6.8	17.3
7	1974	Soy-beans	Centreville, Maryland	silt loam	2.2	5.2	5.9

Table 2. Corn Tolerance and Yellow Nutsedge Response to Preplant Incorporated and Preemergence Treatments of CGA-24705 at Auburn, N. Y.1/

Herbicide	Rate kg ai/ha	Method	Field Corn Phyto Rating2/		Yellow Nutsedge Control Rating2/	
			7/6	8/10	7/6	8/10
CGA-24705 6E	2.24	Pre	0	0	3.8	3.2
CGA-24705 6E	2.24	PPI	0	0	7.3	5.8
CGA-24705 6E	4.48	Pre	0.5	0	5.0	5.0
CGA-24705 6E	4.48	PPI	0	0	8.1	7.0
Alachlor 4E	2.24	Pre	0	0	0.8	0.8
Alachlor 4E	2.24	PPI	0	0	5.5	2.5
Alachlor 4E	4.48	Pre	0	0	2.5	2.0
Alachlor 4E	4.48	PPI	0	0	6.3	3.5
Butylate 6E + Atrazine 4L	3.36 + 1.12	PPI	0	0	4.3	2.3

1/ PPI and Pre treatments applied 6/8/73.
2/ Each datum represents a mean of 4 replications.

Table 3. Corn Tolerance and Yellow Nutsedge Response to Preplant Incorporated and Preemergence Treatments of CGA-24705 at Centreville, Maryland[1/]

Herbicide	Rate kg ai/ha	Method	Field Corn Phyto Rating[2/] 6/20	Yellow Nutsedge Control Rating[2/] 6/20	8/6
CGA-24705 6E	1.68	Pre	0	7.7	9.3
CGA-24705 6E	1.68	PPI	0	8.5	9.3
CGA-24705 6E	2.24	Pre	0	9.0	9.3
CGA-24705 6E	2.24	PPI	0	9.3	9.0
CGA-24705 6E	3.36	Pre	0	9.7	10.0
CGA-24705 6E	3.36	PPI	0	9.7	10.0
Alachlor 4E	3.36	Pre	0	7.2	8.8
Alachlor 4E	3.36	PPI	0	8.0	8.0
Butylate 6E + Atrazine 4L	3.36 + 1.12	PPI	0	3.0	4.2

1/ PPI and pre treatments applied on 4/19/73 and 4/25/73, respectively.
2/ Each datum represents a mean of 3 replications.

Table 4. Corn Tolerance and Yellow Nutsedge Control Following Preemergence Treatments of CGA-24705 at Barton, New York[1/]

Herbicide	Rate kg ai/ha	Field Corn Phyto Rating[2/]		Yellow Nutsedge Control Rating[2/]	
		7/3	10/3	7/3	8/10
CGA-24705 6E	2.24	0	0	6.8	5.8
CGA-24705 6E	3.36	0.5	0	8.8	8.9
CGA-24705 6E	4.48	0.5	0	9.0	9.6
Alachlor 4E	2.24	0	0	4.8	5.0
Alachlor 4E	4.48	1.0	0	6.5	7.3
Atrazine 4L	2.24	0	0	1.3	2.8

1/ Treatments applied 5/28/73.
2/ Each datum represents a mean value for 4 replications.

Table 5. Corn Tolerance and Yellow Nutsedge Control Following PPI and Preemergence Treatments of CGA-24705 at Auburn, New York[1/]

Herbicide	Rate kg ai/ha	Method	Field Corn Phyto Ratings[2/] 8/1	Field Corn Phyto Ratings[2/] 9/24	Yellow Nutsedge Control Ratings[2/] 8/1	Yellow Nutsedge Control Ratings[2/] 9/24
CGA-24705 6E	1.68	Pre	0	0	7.7	5.3
CGA-24705 6E	1.68	PPI	0	0	8.3	7.3
CGA-24705 6E	2.24	Pre	0.7	0.7	8.3	6.7
CGA-24705 6E	2.24	PPI	0.7	0	9.0	8.3
CGA-24705 6E	2.80	Pre	0	0	8.0	6.7
CGA-24705 6E	2.80	PPI	0	0	9.0	8.5
CGA-24705 6E	3.36	Pre	0.7	0	9.0	8.5
CGA-24705 6E	3.36	PPI	0	0	9.1	9.5
Alachlor 4E	2.24	Pre	0.7	0	6.7	3.7
Alachlor 4E	2.24	PPI	0	0	7.3	4.3
Alachlor 4E	3.36	Pre	0	0	7.2	4.7
Alachlor 4E	3.36	PPI	0	0	8.2	5.0
Butylate 6E + Atrazine 4L	3.36 + 1.12	PPI	0	0	7.2	7.0

1/ PPI and pre treatments applied 6/28/74.
2/ Each datum represents a mean value of 3 replications.

Table 6. Soybean Tolerance and Yellow Nutsedge Response to PPI and Preemergence Treatments of CGA-24705

Herbicide	kg ai/ha	Method	Seneca Falls, N. Y.[1/] Soybean Phyto Rating[3/] 7/8	Seneca Falls, N. Y.[1/] Yellow Nutsedge Control Rating[3/] 7/8	Centreville, Md.[2/] Soybean Phyto Rating[4/] 7/1	Centreville, Md.[2/] Yellow Nutsedge Control Rating[4/] 7/1	Centreville, Md.[2/] Yellow Nutsedge Control Rating[4/] 8/6
CGA-24705 6E	2.24	Pre	0	6.8	0	8.3	9.3
CGA-24705 6E	2.24	PPI	0	8.9	0	8.3	8.5
CGA-24705 6E	3.36	Pre	0	7.0	0	9.3	10.0
CGA-24705 6E	3.36	PPI	1.5	9.6	0	8.0	9.7
CGA-24705 6E	4.48	Pre	1.0	8.0	0	10.0	10.0
CGA-24705 6E	4.48	PPI	1.0	9.6	0	8.3	9.2
Alachlor 4E	4.48	Pre	0.5	7.5	0.3	8.0	9.0
Alachlor 4E	4.48	PPI	1.3	9.0	0	8.3	8.7
Vernolate 6E	2.80	PPI	-	-	0	6.8	7.7
Vernolate 6E	3.36	PPI	2.3	7.9	-	-	-

1/ Treated PPI on 6/5/74 and pre on 6/10/74.
2/ Treated PPI on 5/22/74 and pre on 5/23/74.
3/ Each datum represents a mean of 4 replications.
4/ Each datum represents a mean of 3 replications.

THE RESPONSE OF SOYBEANS TO SOME DINITROANILINE HERBICIDES

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

Six dinitroaniline herbicides were evaluated for weed control and soybean (Glycine max (L.) var. Williams) response on a Freehold sandy loam soil at the Adelphia Research Station, New Jersey Agricultural Experiment Station, Adelphia, New Jersey. All herbicide treatments were applied one day prior to planting and incorporated into the soil immediately after application. The herbicides and application rates included the following: N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine (profluralin) at 1/2, 1, and 1 1/2 lb/A; N^4,N^4-diethyl-a,a,a-trifluoro-3,5-dinitrotoluene-2,4-diamine (dinitramine) at 1/3, 1/2, and 2/3 lb/A; a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl p-toluidine (trifluralin) at 1/2, 3/4, and 1 lb/A; 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline (nitralin) at 3/4, 1, and 1 1/2 lb/A; N-sec butyl-4-tert-butyl-2,6-dinitroaniline (butralin) at 1 1/2, 2, and 3 lb/A; and N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl) aniline (fluchloralin) at 3/4 and 1 lb/A.

Weeds in the experimental area included pigweed (Amaranthus retroflexus L.), carpetweed (Mollugo verticillata L.) corn chamomile (Anthemis arvensis L.), shepherdspurse (Capsella bursa-pastoris (L.) Medic) and fall panicum (Panicum dichotomiflorum Michx.).

No reductions in stand or vigor of soybeans resulted from any rates of profluralin, dinitramine and nitralin. Slight reductions in stand and vigor of soybeans resulted from trifluralin at the two higher rates, the highest rate of butralin, and the two rates of fluchloralin. Reductions in vigor from these treatments were short-lived and later outgrown. Reductions in stand were not serious enough to be reflected in yield.

All herbicides were effective on pigweed and there were no differences between herbicides. Carpetweed was effectively controlled by all herbicides but control from butralin was not as

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1/ Research Professor of Weed Science, former Graduate Intern and Weed Control Technician, respectively, Soils and Crops Department, Cook College, Rutgers University, New Brunswick, New Jersey.

complete as from the other herbicides. Corn chamomile was more difficult to control. Control ranged from 40 to 70% with no great differences between herbicides. Control of shepherdspurse was not adequate from any herbicide; however, dinitramine proved to be more effective than the others. Control of up to 80% resulted from the highest rate of dinitramine.

Differences between herbicides as measured by the control of fall panicum were evident. Generally, the highest rate of all herbicides effected some degree of control of this species. Averaging out the control produced by all rates of each herbicide, the best were fluchloralin and butralin, followed by trifluralin and dinitramine than by nitralin and profluralin.

Control of Jimsonweed and Three Broadleaved Weeds in Soybeans with Herbicides[1]

J. V. Parochetti[2]

ABSTRACT

Excellent control of early and late germinating jimsonweed (Datura stramonium L.) in soybeans (Glycine max L.) was achieved with properly timed postemergence applications of bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2,2-dioxide) and chloroxuron (3-(p-(p-chlorophenoxyl)phenyl)-1,1-dimethylurea) and with 'at-cracking' treatments (applied as soybeans were emerging) of a three way combination of naptalam (N-1-naphythylphthalamic acid) plus dinoseb (2-sec-butyl-4,6-dinitrophenol) plus alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetamide). Excellent control of early but not late germinating jimsonweed resulted from 'at-cracking' treatments but not preemergence treatments of fluorodifen (p-nitrophenyl α, α, α-trifluoro-2-nitro p-tolyl ether). The most effective preplant incorporated herbicides for early germinating jimsonweed control was vernolate (S-propyl dipropylthiocarbamate).

Postemergence treatments of bentazon and chloroxuron controlled redroot pigweed (Amaranthus retroflexus L.). Greater than 90% control of velvetleaf (Abutilon theophrasti Medic.) was affected by dinoseb combinations applied 'at-cracking' and bentazon applied early postemergence. Only chloroxuron applied as a postemergence treatment was effective in controlling 3-inch tall morningglory (Ipomea purpuree (L.) Roth and I. headeracea (L.) Jacq.). Yields were not statistically reduced for any herbicide treatment.

INTRODUCTION

Most preemergence herbicides used in soybeans do not control the large seeded broadleaved weeds such as jimsonweed and morningglory. Maryland farmers report that jimsonweed and morningglory are troublesome weeds (1). For a number of years, jimsonweed has been controlled with dinoseb used alone or in combination with other herbicides. Postemergence treatments of dinoseb (2) and 2,4-DB(4-(2,4-dichlorophenoxy)butyric acid) have been reported to control jimsonweed (3). Smith and Rahn (3) reported that an integrated program utilizing these chemicals in combination with a vigorous growing soybean cultivar and cultivation was effective in controlling jimsonweed.

Recently bentazon (4) and several other herbicides have been reported to control many species of broadleaved weeds. The purpose of this research was to test a number of these herbicides for the control of jimsonweed and other broadleaved weeds in soybeans.

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

MATERIALS AND METHODS

Five field studies were conducted at the Wye Institute from 1972 through 1974. All studies were located in similar areas; the soil was a Mattapex silt loam with 1.5% organic matter. Plots were 10 by 20 feet with 4 rows of soybeans 2.5 feet apart. There were four replications. The center two rows of soybeans were harvested after eliminating one-foot of row at each end. Herbicides were applied at 30 gpa using an experimental sprayer. The European rating system was used for crop injury and weed control rating: Table 1 lists the corresponding percentage with the European rating system.

In all three years postemergence treatments were made at the following three stages: Post I when soybeans had unifoliate leaves and jimsonweed was 2 to 3 inches in height having 2 leaves; Post II when soybeans had between two and three trifoliate leaves and jimsonweed was 5 to 6 inches in height having three to four leaves; Post III when soybeans had five to six leaves and jimsonweed was 11 to 13 inches in height having 8 leaves. Redroot pigweed (present in 1972), ivy leaf and tall morningglory (present) in 1974), and velvetleaf (present in 1974) were the following heights, respectively, when treated at: Post I, 1, 1, and 2 inches; Post II, 4, 3, and 8 inches; and Post III, 7, 6, and 10 inches.

In 1972 one study was conducted. 'Cutler' soybeans were planted May 28. Prior to planting, 0.75 lb/A, trifluralin (α, α, α- trifluoro-2,6,-N,N-dipropyl-p-toluidine) was incorporated on the entire site to eliminate grassy weeds. Bentazon and chloroxuron were applied as postemergence treatments at three different stages: Post I on June 13; Post II on June 26; and Post III on July 10.

In 1973 three studies were conducted. 'Wye' soybeans were planted on May 31. Preplant incorporated and preemergence treatments were applied on May 31 (Experiment A and B). 'At-cracking' treatments were applied on June 7 when soybeans cotyledons were fully expanded and the unifoliate leaves were in the bud (Experiment B). Postemergence treatments (Experiment C) were applied at the following three stages: Post I on June 11; Post II on June 21; and Post III on July 5. Trifluralin 0.75 lb/A was preplant incorporated on the entire site of Experiment C prior to planting soybeans to eliminate grassy weeds.

In 1974 one experiment was conducted. 'Essex' soybeans were planted June 13. 'At-cracking' treatments were applied on June 19 when soybean cotyledons were approximately 50% emerged. Postemergence treatments were applied at the following three stages: Post I on July 2; Post II on July 12; and Post III on July 25.

RESULTS AND DISCUSSION

Bentazon compared favorably with chloroxuron as a postemergence treatment for jimsonweed control when applied at Post II to soybeans having two trifoliate leaves (Table 2); late postemergence application of bentazon at 1.5 lb/A plus surfactant was as effective as applications made at an earlier stage of development, whereas late postemergence applications of chloroxuron

did not control jimsonweed. Best control of jimsonweed resulted when bentazon was applied at the second trifoliate of soybeans. Early applications (Post I) of chloroxuron and bentazon resulted in jimsonweed control that varied from 70 to 92%; this variable control is probably due to later germinating jimsonweed as is evidenced by the large number of late germinating compared to early germinating jimsonweed in the Post I treatments (Table 2).

Bentazon did not control ivy leaf and tall morninglory when observed in 1973 (Table 2). Only chloroxuron applied when soybeans were in the second trifoliate controlled morningglory and jimsonweed (Table 2). Postemergence treatments of bentazon and chloroxuron controlled redroot pigweed at Post II timing.

Only in one (1972) out of three years did bentazon cause soybean injury and then only when applied as a late postemergence treatment with a surfactant (Table 2 and 3); in contrast chloroxuron caused soybean injury at almost all stages. Soybean injury did not reduce yields (Table 2 and 3). Bentazon applied at Post I (0.75 and 1.5 lb/A) and Post II (1.5 lb/A, only), resulted in 95% or better control of jimsonweed (Table 3).

Fluorodifen and dinoseb applied 'at-cracking' when soybean cotyledons were exposed caused soybean injury of 3 to 22% (Tables 3 and 4). One of the best treatments for early jimsonweed control was a three way combination of alachlor plus dinoseb plus naptalam (Table 3 and 4). In both 1973 and 1974 jimsonweed germinated after several of the best treatment as evidenced by the counts of small jimsonweed (late germinating) taken in late July. Also effective as 'at-cracking' treatments were naptalam plus dinoseb, and fluorodifen (Tables 3 and 4). Preemergence treatments of fluorodifen and dinoseb did not reduce the jimsonweed population.

In 1973 trifluralin, vernolate and alachlor were applied alone and in combination with chlorpropham (isopropyl m-chlorocarbanilate) or chlorpropham plus PPG 124 (p-chlorophenyl N-methylcarbamate). Those treatments which affected best jimsonweed control usually caused the greatest soybean vigor reduction (Table 5). Vernolate alone caused 20% or greater soybean injury as well as a three way combination of chlorpropham (4 lb/A) plus PPG 124 and either trifluralin (0.75 lb/A) or vernolate (3 lb/A). Only two treatments which affected early control of jimsonweed persisted for control of later germinating jimsonweed.

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LITERATURE CITED

1. Bookhout, B. R., L. A. Gambrell, and J. V. Parochetti. 1970. Chemical control of weeds in corn and soybeans on Maryland farms 1969. Maryland Crop Reporting Service. Publication No. 44.

2. Parochetti, J. V. 1974. Postemergence and postdirected broadleaved weed

control for soybeans. Proc. Northeast. Weed Sci. Soc. 27:75-79.

3. Smith, T. S., and E. M. Rahn. 1972. Herbicide combinations for control of problem weeds in soybeans. Proc. Northeast. Weed Sci. Soc. 26:116-123.

4. Thompson, J. L., and J. W. Daniel. 1974. Effectiveness of Basagran with air and ground applicators. Proc. S. Weed Sci. Soc. 27:74-76.

Table 1. European system for evaluating weed and crop responses utilized in these investigations.

Rating Number	Effect on Crop	% Crop injury	% Weed Control	Remarks
1	No injury	0	100.0	Completely Destroyed
2	May be injured	2.5	97.5	Very good control
3	A little injured	5.0	95.0	Good control
4	Injured, but satisfactory	10.0	90.0	Satisfactory
5	Injured, barely satisfactory	15.0	85.0	Just satisfactory
6	Not satisfactory	25.0	75.0	Unsatisfactory
7	Bad injury	32.5	65.0	Poor
8	Very bad injury	65.0	32.5	Very poor
9	100% destroyed	100.0	0	As untreated

Table 2. The effect of postemergence applied bentazon and chloroxuron on broadleaved weeds and soybeans in 1972 and 1973 (Experiment C).

Treatment	Time Herbicide Applied	Rate lb/A	1972 July 21 Redroot Pigweed (Rating)[a](%)[b]	1972 July 21 Jimson-weed (Rating)[a](%)[b]	1972 July 21 Soybean Vigor Reduction (Rating)[a](%)[b]	1972 July 21 Soybean Necrosis (Rating)[a](%)[b]	Yield Soy-beans (Bu/A)	1973 (Experiment C) July 17 Soy-bean Height (in.)	1973 July 17 Morning Glory (No./50 sq ft)	1973 July 17 Jimsonweed Early Germ. (No./50 sq ft)	1973 July 17 Jimsonweed Late Germ. (No./50 sq ft)	1973 Nov. 21 Soybean Yields (Bu/A)
1. Control	-	-	5.8(78)	8.8(3)	1.0(0)	1.0(0)	22	23.5	22.5	20.3	12.8	46
2. Control Cult.	-	-	1.8(99)	4.3(88)	1.0(0)	1.0(0)	19	22.3	11.8	2.3	1.5	49
3. Bentazon	Post I[c]	0.75	3.5(92)	5.8(76)	1.0(0)	1.3(2)	18	22.0	31.3	7.8	12.8	48
4. Bentazon	Post I	1.5	4.3(88)	3.8(92)	2.3(3)	1.3(2)	22	21.0	33.0	6.0	13.0	44
5. Bentazon + 0.25% Citowett	Post I	0.75	4.5(87)	6.5(70)	1.5(2)	1.3(2)	18	22.3	38.5	21.5	34.5	47
6. Bentazon + 0.25% Citowett	Post I	1.5	6.0(75)	5.8(76)	2.0(3)	1.5(2)	24	21.3	25.8	9.8	9.8	44
7. Chloroxuron + 0.5% Adjuvan-T	Post I	1.5	2.5(96)	4.3(88)	3.3(6)	1.8(2)	16	19.3	22.0	4.8	26.0	48
8. Bentazon	Post II	0.75	2.0(98)	1.5(99)	2.3(3)	1.3(2)	20	22.8	28.8	1.3	6.0	49
9. Bentazon	Post II	1.5	1.3(99)	2.5(96)	2.3(3)	1.5(2)	24	22.0	28.3	0	1.0	49
10. Bentazon + 0.25% Citowett	Post II	0.75	1.8(99)	1.0(100)	3.3(6)	2.3(3)	25	22.0	41.8	0.5	2.8	50
11. Bentazon + 0.25% Citowett	Post II	1.5	1.5(99)	3.8(92)	2.3(3)	1.3(2)	20	21.5	12.8	0	1.8	50
12. Chloroxuron + 0.5% Adjuvan-T	Post II	1.5	2.0(98)	2.0(98)	4.8(12)	2.3(3)	16	20.5	2.3	1.8	2.0	47
13. Bentazon	Post III	0.75	2.8(97)	1.5(99)	2.8(4)	3.0(5)	20	20.8	33.8	8.5	5.8	46
14. Bentazon	Post III	1.5	3.5(92)	2.5(96)	1.5(2)	3.0(5)	21	24.0	25.0	7.8	1.3	42
15. Bentazon + .25% Citowett	Post III	0.75	2.0(98)	1.0(100)	2.0(3)	5.3(20)	17	23.3	36.5	22.3	10.0	46
16. Bentazon + .25% Citowett	Post III	1.5	1.8(99)	1.3(99)	3.0(5)	5.5(20)	17	23.0	30.8	6.5	0.3	48
17. Chloroxuron +0.5% Adiuvan-T	Post III	1.5	1.0(100)	4.5(87)	3.0(5)	6.8(31)	25	22.0	32.5	24.5	11.0	47
	Bayes lsd 0.05		2.4	3.2	1.7	1.3	N.S.	2.2	23.4	11.2	11.6	N.S.

[a] The European rating system

[b] The % is an approximation

[c] A description of the timing of these treatments is listed in the Materials and Method section.

Table 3. The effect of several herbicides and combinations applied at cracking and postemergence in 1974.

	Treatment	lb/A	Time Herbicide Applied	July 2 Soybean Injury (Rating)[a](%)[b]	July 19 Jimsonweed (Rating)[a](%)[b]	July 19 Velvetleaf (Rating)[a](%)[b]	July 19 Soybean Injury (Rating)[a](%)[b]	July 28 Jimsonweed Early Germ. (No./50 sq ft)	July 28 Jimsonweed Late Germ. (No./50 sq ft)
1.	Control	--	--	1.0(0)	9.0(0)	9.0(0)	1.0(0)	90	25.8
2.	Control Cult.	--	--	1.0(0)	3.0(95)	2.0(98)	1.3(2)	2.8	44.0
3.	Naptalam + dinoseb	3 1.5	At cracking	2.5(3)	3.3(93)	1.5(99)	2.8(4)	9.0	22.5
4.	Naptalam + dinoseb + alachlor	3 1.5 1.5	At cracking	4.7(11)	1.5(99)	2.0(98)	3.8(9)	2.5	43.0
5.	Alachlor	1.5	At cracking	3.5(8)	4.8(87)	5.5(83)	1.0(0)	37.3	24.3
6.	Fluorodifen	3.0	At cracking	5.5(20)	2.5(96)	5.5(83)	1.8(2)	18.3	6.8
7.	Fluorodifen	5.0	At cracking	5.8(22)	3.0(95)	4.0(90)	1.8(2)	19.0	5.8
8.	Bentazon[c]	0.75	Post I	5(2)	2.0(90)	2.0(98)	1.0(0)	5.8	33.0
9.	Bentazon[c]	1.5	Post I	1.0(0)	2.0(100)	1.5(99)	1.5(2)	6.5	27.5
10.	Bentazon[c]	0.75	Post II	1.0(0)	1.5(99)	6.0(25)	1.0(0)	4.2	7.0
11.	Bentazon[c]	1.5	Post II	1.0(0)	1.0(100)	3.0(95)	1.0(0)	0	26.8
12.	Bentazon[c]	1.5	Post III	1.0(0)	-	-	-	7.3	8.8
			Bayes LSD 0.05	0.6	1.6	1.9	0.5	15.9	24.1

[a]The European rating system.
[b]The % is an approximation.
[c]These treatments contained 0.25% of a surfactant.

Table 4. The effect of several herbicides and combinations on jimsonweed and soybeans in 1973 (Experiment B).

	Treatment	lb/A	June 11 Soybean Vigor Reduction (Rating)[a](%)[b]	June 11 Soybean Necrosis (Rating)[a](%)[b]	June 26 Soybean Vigor Reduction (Rating)[a](%)[b]	July 24 Jimsonweed Early Germ. (No./50 sq ft)	July 24 Jimsonweed Late Germ. (No./50 sq ft)	Soybean Yield (Bu/A)
1.	Control	-	1.0 (0)	1.0 (0)	1.0 (0)	12.0	26.0	22
2.	Control Cult.	-	1.0 (0)	1.0 (0)	1.3 (2)	1.0	9.0	29
3.	Fluorodifen[c]	3.0	1.0 (0)	1.0 (0)	1.0 (0)	8.7	18.0	30
4.	Fluorodifen[d]	3.0	4.0 (10)	4.0 (10)	2.7 (4)	1.0	11.7	24
5.	Dinoseb[c]	3.0	1.0 (0)	1.0 (0)	1.0 (0)	12.3	11.0	32
6.	Dinoseb[d]	3.0	4.3 (11)	4.0 (10)	2.3 (3)	10.3	9.0	29
7.	Alachlor[d] + Naptalam +Dinoseb	1.5 2.0 2.0	3.3 (6)	4.0 (10)	2.7 (4)	0	2.3	27
8.	Naptalam[d] +Dinoseb	2.0 2.0	2.3 (3)	2.3 (3)	1.0 (0)	6.7	17.0	35
9.	Alachlor[d]	1.5	1.7 (2)	1.3 (2)	1.3 (2)	2.3	10.3	28
	Bayes LSD 0.05=		5	4		6.7	N.S.	N.S.

[a]The European rating system.
[b]The % is an approximation.
[c]These treatments were applied as preemergence applications.
[d]These treatments were applied as soybeans were cracking through the ground (at cracking).

Table 5. The effect of preplant incorporated applications of chlorpropham and combinations of trifluralin, vernolate, and alachlor on jimsonweed and soybean in 1973 (Experiment A).

Treatment	lb/A	June 11	June 25	July 24	
		Soybean Vigor Reduction		Jimsonweed	
				Early Germinating	Late Germinating
		(Rating)[a] (%)[b]	(Rating)[a] (%)[b]	(No./50ft^2)	
1. Control	---	1.0(0)	1.0(0)	38	61
2. Control Cult.	---	1.0(0)	1.0(0)	4	2
3. Trifluralin	0.75	1.0(0)	1.0(0)	42	66
+ Chlorpropham	2.0				
4. Trifluralin	0.75	5.3(20)	4.0(10)	13	30
+ Chlorpropham	4.0				
5. Trifluralin	0.75	4.0(10)	4.3(11)	13	39
+ Chlorpropham + PPG124	2.0 + 0.5				
6. Trifluralin	0.75	6.0(25)	4.7(12)	9	27
+ Chlorpropham + PPG124	4.0 + 1.0				
7. Trifluralin	0.75	1.3(2)	1.0(0)	23	49
8. Chlorpropham	2.0	1.3(2)	1.0(0)	40	52
9. Chlorpropham	4.0	1.3(2)	1.0(0)	32	36
10. Chlorpropham + PPG124	2.0 + 0.5	1.0(0)	1.0(0)	26	42
11. Chlorpropham + PPG124	4.0 + 1.0	1.7(3)	1.0(0)	9	12
12. Vernolate	3.0	4.3(11)	3.0(5)	6	32
+ Chlorpropham + PPG124	2.0 + 0.5				
13. Vernolate	3.0	6.3(27)	6.0(25)	18	61
+ Chlorpropham + PPG124	4.0 + 1.0				
14. Vernolate	3.0	4.7(12)	3.0(5)	4	80
+ Chlorpropham	2.0				
15. Vernolate	3.0	4.7(12)	2.7(4)	8	48
+ Chlorpropham	4.0				
16. Vernolate	3.0	5.7(23)	5.0(15)	1	25
17. Alachlor	1.5	1.0(0)	1.0(0)	38	44
+ Chlorpropham	2.0				
18. Alachlor	1.5	1.6(2)	1.0(0)	13	34
+ Chlorpropham	4.0				
19. Alachlor	1.5	1.0(0)	1.0(0)	24	35
+ Chlorpropham + PPG124	2.0 + 0.5				
20. Alachlor	1.5	3.0(5)	1.0(0)	10	13
+ Chlorpropham + PPG124	4.0 + 1.0				
21. Alachlor	1.5	1.0(0)	1.0(0)	42	58
Bayes LSD 0.05		1.02	1.92	24	30

[a] The European rating system.
[b] The % is an approximation.

METRIBUZIN IN COMBINATION WITH ALACHLOR, ORYZALIN, FLUORODIFEN, TRIFLURALIN, AND NITRALIN FOR WEED CONTROL IN SOYBEANS

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

Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H) one) has proved to be an effective herbicide for weed control in soybeans; however, injury sometimes results, particularly at rates necessary for the control of difficult-to-control weeds such as fall panicum (Panicum dichotomiflorum Michx).

An experiment was established at the Adelphia Research Station, New Jersey Agricultural Experiment Station, Adelphia, New Jersey, on a Freehold sandy loam to determine what herbicides could be used in combination with metribuzin to effect broad spectrum weed control with little or no crop injury. Herbicides combined with metribuzin included the following: 2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide (alachlor); 3,5-dinitro-N^4,N^4-dipropylsulfanilamide (oryzalin); p-nitrophenyl-a,a,a-trifluro-2-nitro-p-tolyl ether (fluorodifen); a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin); and 4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline (nitralin).

All herbicides and herbicide combinations were applied preemergence, one day after planting. Single herbicide rates included metribuzin at 1/4, 3/8, 1/2 and 1 lb/A; alachlor at 1 1/2, 2 and 2 1/2 lb/A; oryzalin at 3/4, 1 and 1 1/2 lb/A; fluorodifen at 2, 2 1/2, and 3 lb/A; trifluralin at 3/4 and 1 lb/A; and nitralin at 3/4 and 1 1/2 lb/A. Generally, all rates of single herbicides were combined with all rates of metribuzin.

Metribuzin at 1 lb/A reduced stand of soybeans approximately 12% and reduced vigor also. All rates were ineffective on fall panicum. Alachlor did not injure soybeans and was ineffective on lambsquarters (Chenopodium album L.) and velvetleaf (Abutilon theophrasti Medic). Excellent combinations included metribuzin at 3/8 to 1/2 lb/A with alachlor at 2 to 2 1/2 lb/A.

Oryzalin was not effective on fall panicum or lambsquarters. Combinations with metribuzin improved control of the latter but

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1/Research Professor of Weed Science, former Graduate Intern and Weed Control Technician, respectively, Soils and Crops Department, Cook College, Rutgers University, New Brunswick, New Jersey

not the former. Combinations that were effective included 1/2 + 3/4 lb/A and 3/8 to 1/2 + 1 1/2 for metribuzin + oryzalin, respectively.

Fluorodifen was an effective herbicide but did not control velvetleaf. Combinations with metribuzin only slightly improved the control of this weed. Good combinations of metribuzin + fluorodifen were 1/2 + 2, 3/8 + 2 1/2 and 3/8 + 3 lb/A.

Trifluralin by itself did not control lambsquarters. Combinations with metribuzin improved control as well as on pigweed (*Amaranthus retroflexus* L.) and velvetleaf. Good combinations included 1/2 + 3/4, 3/8 + 1, and 1/2 + 1 for metribuzin + trifluralin, respectively.

Nitralin at the rates used did not control lambsquarters, velvetleaf, or fall panicum. Control of the two broadleaf weeds was greatly improved when combined with metribuzin. Control of fall panicum was improved by certain combinations. Rates of 3/8 to 1/2 lb/A of metribuzin in combination with 3/4 to 1 lb/A of nitralin proved effective for general weed control. The same rates of metribuzin but in combination with 1 to 1 1/2 lb/A of nitralin were necessary for adequate fall panicum control.

Weed Control in Soybeans with Metribuzin and Combinations with Other Herbicides[1]

J. V. Parochetti[2]

ABSTRACT

Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one) in combination with other herbicides generally caused soybean (Glycine max L.) injury. Stand reduction occurred with rates higher than 0.75 lb/A of metribuzin; however, yields were not reduced. In two out of three years, less than .5 lb/A of metribuzin was not effective in controlling giant green foxtail (Setaria viridis var. major (Gaud.) Posp.). Combinations of metribuzin with dinitroaniline or acetamide herbicides controlled giant green foxtail. Metribuzin was very effective in controlling common lambsquarters (Chenopodium album L.).

INTRODUCTION

The dinitroaniline herbicides such as trifluralin (α, α, α-trifluro-2,6-dinitro-N,N-dipropyl-p-toluidine), nitralin(4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline), and profluralin (N-(cyclopropylmethyl)-α, α, α-trifluro-2,6-dinitro-N-propyl-p-toludine) are not effective in controlling some broad-leaved weed species such as jimsonweed (Datura stramonium L.) and common cocklebur (Xanthium pensylvanicum Wallr.) (2). Metribuzin in combination with oryzalin (3,5-dinitro-N^4,N^4-dipropylsulfanilamide) and other dinitroanilines was more effective in controlling jimsonweed in soybeans than either herbicide alone (1,2,3).

Soybeans have been injured by metribuzin both alone and in combination with other herbicides (1,2,3). The percent emergence of soybeans and subsequent yield were not, however, reduced (1).

The objective of this study was to evaluate metribuzin at several rates both alone and in combination with several herbicides including many dinitroanilines at the recommended rates as well as at twice their recommended rates.

MATERIALS AND METHODS

Four field studies were conducted from 1972 through 1974 at the Wye Institute, Queenstown, Maryland. All studies were randomized complete block designs with 4 replications. Plot size was 10 by 20 feet with 4 rows spaced at 2.5 feet, the center two rows were harvested after removing a 1 foot border on each end. An experimental bicycle sprayer was used which delivered 30 gpa.

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

Soil incorporated herbicides were applied prior to planting and incorporated 2 to 3 inches deep using a tractor mounted rototiller. The soil was a Mattapex silt loam with 1.5% organic matter.

The European rating system was utilized in these studies; ratings and corresponding percentages are listed in Table 1.

Rainfall which occurring two weeks after treatment is listed in Table 2.

In 1972 one study was conducted. 'Cutler' soybeans were planted on May 24. Preplant incorporated herbicides were applied on May 19. Preemergence herbicides were applied on May 24. Treatments are listed in Table 3.

In 1973 one study was conducted. 'Wye' soybeans were planted May 19. Preplant incorporated herbicides and preemergence herbicides were applied on May 19 and May 21, respectively. Treatments are listed in Table 4.

In 1974 two studies, Experiment A and Experiment B, were conducted; treatments are listed in Tables 5 and 6, respectively. 'Williams' soybeans were planted May 23. Preplant incorporated and preemergence herbicides were applied on May 22 and May 23, respectively.

For Experiment B the 2X rate was twice the X rate. The X rate for metribuzin, alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetamide) and vernolate (S-propyl dipropylthiocarbamate) was 0.375, 1.5 and 2 lb/A, respectively. The means of which several similar treatments were combined; the dinitroanilines and the X rate studied were trifluralin (0.75 lb/A), profluralin (0.75 lb/A) nitralin (0.75 lb/A) butralin (4-(1,1-dimethylethyl-N-(1-methylpropyl-2,6-dinitrobenzenamine)(2 lb/A), AC92390 (N-sec-butyl-2,6-dinitro-3,4-xylidine) (0.75 lb/A), AC 92553(N-(1-ethylpropyl)-2,6-dintro-3,4-xylidine) (0.75 lb/A), fluchoralin (N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl)aniline) (1.0 lb/A) and dinitramine (N^4,N^4-diethyl-α, α, α-trifluoro-3-5-dinitrotoluene-2,4-diamine) (0.33 lb/A).

Table 2. Rainfall occurring two weeks after herbicide application.

1972		1973		1974	
Date	Inches	Date	Inches	Date	Inches
May 20	0.14	May 21	0.3	May 24	0.6
		May 24	0.2	May 28	0.2
		May 25	0.45	May 30	1.12
		May 26	0.03	May 31	0.1
		May 27	0.55	June 2	2.0
		May 30	0.02		
		June 4	0.6		

RESULTS

The effect on soybeans. In 1972 when metribuzin was applied at 1 lb/A there was a significant reduction (22%) of the soybeans population based on the

control (Table 3). In other years the highest rate used was 0.75 lb/A; in 1973 0.75 lb/A metribuzin caused a significant reduction (5%) of the soybean population, but there was no stand reduction from this rate in 1974 (Tables 5 and 6). The injury difference can not be explained based on rainfall patterns after herbicide applications (Table 2).

Metribuzin, at 0.4 lb/A or less, in combination with several herbicides in 1972 through 1974 did not significantly reduce the soybean stand (Table 3-6).

Almost all metribuzin treatments caused necrosis of the first two to three leaves as is evidenced by the necrosis ratings in 1973 (Table 4). In addition, soybean vigor reduction resulted from many treatment combinations of metribuzin (Table 3-5).

Several dinitroaniline herbicides, especially when applied at 2X rates, caused soybean vigor reduction and stand reduction; highest injury ratings resulted from dinitramine at 0.67 lb/A and trifluralin at 1.5 lb/A in 1973 (Table 4). As with metribuzin treatment, the early injury of soybeans did not reduce soybean yield.

The most comprehensive study was done in 1974 (Table 6). The soybean stand, based on a percent of control was not significantly reduced even when metribuzin was applied at 0.75 lb/A either as a preemergence or preplant incorporated combination with several dinitroaniline herbicides (Table 6). There was excessive soybean vigor reduction with vernolate plus metribuzin (data not reported); although no stand reduction resulted, this combination should be avoided.

Giant Green Foxtail Control. Giant green foxtail was present in each study. The dinitroaniline controlled more than 85% of giant green foxtail. Metribuzin, especially at 0.375 lb/A, was not consistant in controlling giant green foxtail (Tables 4-6). Greater than 98% giant green foxtail control resulted from alachlor (Table 4), H22234 (N-chloroacetyl-N-(2,6-diethyl)-glycine ethyl ester) (Table 5), CGA 24705 (Chemistry not released) (Table 5), and vernolate (Table 6).

Yellow Nutsedge (Cyperus escenltus L) Control. Best (96%) yellow nutsedge control resulted from alachlor (Table 4). In 1972 no treatment affected greater than 89% control, except metribuzin at 1 lb/A which resulted in 95% control (Table 3). In 1973, except for the alachlor, all treatment resulted in less than 91% control with many treatments less that 70% control (Table 4).

Common Lambsquarters and Redroot Pigweed (Amaranthus retroflexus L) Control. All herbicide treatments controlled 100% of redroot pigweed (Table 3). Most treatments controlled common lambsquarters except H 22234 (Table 5) and CGA 24705 at 1 lb/A (Table 5).

DISCUSSION

The margin of safety of soybean tolerance to metribuzin is, at best, twice the recommended rate. Soybean stand reduction did occur but only at

three times the recommended rate. Even when metribuzin was applied at the recommended rate for the soil type on which the studies were conducted, the first few leaves of soybean were injured exhibiting chlorosis followed by necrosis. Initial injury did not reduce soybean yields. Grower acceptance of this initial injury will have to be balanced against a much greater spectrum of weeds controlled than by other registered herbicides.

Metribuzin was quite effective on common lambsquarters but did not consistantly control giant green foxtail. A combination of alachlor (which did not control common lambsquarter but controlled giant green foxtail) plus metribuzin affected full spectrum weed control. Metribuzin, at 0.75 lb/A or less, did not adequately control morningglory or yellow nutsedge. Jimsonweed has been reported to be controlled with metribuzin and combinations (1,3).

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LITERATURE CITED

1. Addink, S., M. L. Jones, W. E. Rogers, G. J. Shoop, D. H. Lade, and C. D. Christensen. 1974. Broad spectrum weed control in soybeans with trifluralin + metribuzin. Proc. Northeast. Weed Sci. Soc. 281:69-74.

2. Le Baron, H. M., and W. G. Westmoreland. 1972. Evaluation of CGA 10832 and other herbicides for soybeans in the southern states. Proc. S. Weed Sci. Soc. 25:42-48.

3. Rogers, W. E., S. Addink, M. L. Jones, G. J. Shoop, D. H. Lade, and C. D. Christensen. 1974. Preemergence Weed control in soybeans with oryzalin. Proc. Northeast. Weed Sci. Soc. 28:62-68.

Table 1. European system for evaluating weed and crop responses utilized in these investigations.

Rating Number	Effect on Crop	% Crop injury	% Weed Control	Remarks
1	No injury	0	100.0	Completely Destroyed
2	May be injured	2.5	97.5	Very good control
3	A little injured	5.0	95.0	Good control
4	Injured, but satisfactory	10.0	90.0	Satisfactory
5	Injured, barely satisfactory	15.0	85.0	Just satisfactory
6	Not satisfactory	25.0	75.0	Unsatisfactory
7	Bad injury	32.5	65.0	Poor
8	Very bad injury	65.0	32.5	Very poor
9	100% destroyed	100.0	0	As untreated

Table 3. The effect of metribuzin alone and in combination with several herbicides on weeds and soybeans in 1972.

Treatment	Rate (lb/A)	Time of Application	July 7 Soybean Vigor (Rating)[a]	(%)[b]	Soybean Stand (Rating)[a]	(%)[b]	Giant Green Foxtail (Rating)[a]	(%)[b]	Yellow Nutsedge (Rating)[a]	(%)[b]	Redroot Pigweed (Rating)[a]	(%)[b]	Nov. 4 Soybean Yield (Bu/A)
1. Control			1.0	(0)	1.0	(0)	9.0	(0)	9.0	(0)	9.0	(0)	27.7
2. Control Cultivated			1.0	(0)	1.0	(0)	9.0	(0)	9.0	(0)	9.0	(0)	38.8
3. Oryzalin	1.5	pre	1.75	(2)	1.0	(0)	3.0	(95)	8.25	(25)	1.0	(100)	38.2
4. Oryzalin	3.0	pre	1.25	(1)	1.0	(0)	2.25	(97)	7.0	(65)	1.0	(100)	42.2
5. Oryzalin	1.5	pre	1.25	(1)	1.0	(0)	1.25	(99)	7.25	(57)	1.0	(100)	41.1
+ Metribuzin	0.3												
6. Oryzalin	1.5	pre	1.75	(2)	1.0	(0)	2.25	(99)	5.75	(77)	1.0	(100)	35.5
+ Metribuzin	0.4												
7. Metribuzin	0.3	pre	1.0	(0)	1.0	(0)	8.25	(25)	6.5	(70)	1.0	(100)	40.5
8. Metribuzin	0.4	pre	1.5	(1)	1.0	(0)	5.25	(82)	7.0	(65)	1.5	(99)	43.1
9. Metribuzin	0.5	pre	3.5	(7)	1.75	(2)	2.75	(96)	4.25	(89)	1.0	(100)	41.4
10. Metribuzin	1.0	pre	7.0	(35)	5.75	(22)	1.75	(98)	3.0	(95)	1.0	(100)	24.7
11. Butralin	1.5	ppi	2.25	(3)	1.0	(0)	2.5	(96)	6.75	(68)	1.0	(100)	38.8
12. Butralin	3.0	ppi	3.0	(5)	1.0	(0)	2.5	(96)	6.25	(73)	1.0	(100)	39.6
13. Chloramben[c]	1.5	pre	2.25	(3)	1.0	(0)	5.25	(82)	6.75	(68)	1.0	(100)	33.1
+ Metribuzin	0.3	pre											
14. Chloramben	1.5	pre	1.5	(1)	1.0	(0)	4.25	(89)	6.75	(68)	1.0	(100)	39.9
+ Metribuzin	0.4	pre											
15. Butralin	1.5	ppi	1.25	(1)	1.0	(0)	2.5	(96)	6.75	(68)	1.0	(100)	39.0
+ Metribuzin	0.3	pre											
16. Butralin	1.5	ppi	1.5	(1)	1.0	(0)	2.75	(96)	5.25	(82)	1.0	(100)	37.0
+ Metribuzin	0.4	pre											
17. Chloramben	1.5	pre	1.0	(0)	1.0	(0)	8.0	(33)	7.0	(65)	3.0	(95)	35.7
		lsd 0.05 =	1.36		.49		1.83		2.48		1.7		7.0

[a] The European rating system.
[b] The % is an approximation.
[c] Chemistry is 3-amino-2,5-dichlorobenzoic acid.

Table 4. The effect of metribuzin alone and in combination with several herbicides on weeds and soybeans in 1973.

Treatment	Rate (lb/A)	Time of Application	June 11						June 25						Nov. 4
			Soybean Necrosis (Rating)[a]	(%)[b]	Soybean Vigor (Rating)[a]	(%)[b]	Soybean Stand (Rating)[a]	(%)[b]	Soybean Vigor (Rating)[a]	(%)[b]	Giant Green Foxtail (Rating)[a]	(%)[b]	Yellow Nutsedge (Rating)[a]	(%)[b]	Soybean Yield (Bu/A)
1. Control	-	-	1.0	(0)	1.0	(0)	1.0	(0)	1.0	(0)	9.0	(0)	8.75	(8)	44
2. Control Cultivated	-	-	1.0	(0)	1.0	(0)	1.0	(0)	1.0	(0)	2.75	(96)	2.75	(96)	46
3. Trifluralin	.75	PPI	1.0	(0)	1.25	(0)	1.0	(0)	1.0	(0)	1.25	(99)	7.5	(50)	45
4. Trifluralin	1.5	PPI	2.25	(3)	6.0	(25)	3.25	(6)	3.25	(6)	1.25	(99)	4.25	(89)	46
5. Trifluralin	.75	PPI	2.5	(4)	1.5	(1)	1.0	(1)	1.25	(1)	3.5	(93)	4.25	(89)	44
+ Metribuzin	.38	PPI													
6. Trifluralin	1.5	PPI	2.75	(4)	3.0	(5)	2.5	(4)	4.25	(11)	1.25	(99)	3.5	(93)	53
+ Metribuzin	.75	PPI													
7. Trifluralin	.75	PPI	1.5	(1)	2.0	(3)	1.0	(0)	1.75	(2)	1.25	(99)	7.0	(65)	48
+ Metribuzin	.38	PRE													
8. Trifluralin	1.5	PPI	1.25		6.25	(28)	2.25	(3)	4.25	(11)	1.0	(100)	4.0	(90)	45
+ Metribuzin	.75	PRE													
9. Oryzalin	1.0	PRE	1.0	(0)	1.0	(0)	1.0	(0)	1.0	(0)	1.75	(98)	6.75	(68)	43
10. Oryzalin	1.25	PRE	1.0	(0)	1.0	(0)	1.0	(0)	1.0	(0)	1.75	(98)	6.75	(68)	47
11. Oryzalin	2.0	PRE	1.0	(0)	2.5	(4)	1.25	(1)	1.5	(1)	1.5	(99)	6.0	(75)	52
12. Oryzalin	1.0	PRE	1.0	(0)	1.75	(2)	1.0	(0)	1.0	(0)	1.25	(98)	5.5	(80)	56
13. Oryzalin	1.25	PRE	1.0	(0)	1.25	(1)	1.5	(1)	1.0	(0)	1.25	(99)	6.75	(68)	44
+ Metribuzin	.38	PRE													
14. Oryzalin	2.0	PRE	3.0	(5)	2.75	(4)	2.0	(3)	2.5	(4)	1.0	(100)	4.0	(90)	46
+ Metribuzin	.75	PRE													
15. Metribuzin	.38	PRE	1.5	(1)	1.0	(0)	1.0	(0)	1.0	(0)	2.5	(96)	6.25	(73)	50
16. Metribuzin	.75	PRE	6.25	(26)	2.25	(3)	1.25	(1)	1.5	(1)	1.25	(99)	4.5	(87)	56
17. Metribuzin	.625	PRE	3.5	(7)	1.75	(2)	1.0	(0)	1.0	(0)	1.25	(99)	6.75	(68)	59
18. Metribuzin	.38	PPI	4.25	(11)	2.25	(3)	1.25	(1)	1.0	(0)	7.25	(57)	6.0	(75)	46
19. Metribuzin	.75	PPI	7.25	(42)	6.25	(28)	3.0	(5)	5.75	(22)	5.0	(85)	3.75	(91)	47
20. Alachlor	1.5	PRE	1.5	(1)	3.75	(9)	1.25	(1)	1.0	(0)	1.75	(98)	2.25	(97)	51
21. Metribuzin	.38	PRE	1.0	(0)	3.5	(8)	1.0	(0)	1.0	(0)	1.0	(100)	2.75	(96)	50
+ Alachlor	1.5	PRE													
22. Butralin	1.5	PPI	1.25	(1)	1.25	(1)	1.0	(0)	1.0	(0)	2.0	(98)	5.75	(78)	50
+ Metribuzin	.38	PRE													
23. Butralin	1.5	PPI	1.75	(2)	2.25	(3)	1.0	(0)	1.75	(2)	2.0	(98)	4.5	(87)	49
+ Metribuzin	.625	PRE													
24. Butralin	1.5	PPI	4.5	(13)	1.75	(2)	1.25	(1)	1.5	(1)	3.5	(93)	4.0	(90)	49
+ Metribuzin	.38	PPI													
25. Butralin	1.5	PPI	6.25	(28)	2.25	(3)	1.25	(1)	4.25	(11)	2.75	(96)	5.75	(78)	46
+ Metribuzin	.625	PPI													
26. Butralin	1.5	PPI	1.25	(1)	1.75	(2)	1.5	(1)	1.25	(1)	3.25	(94)	6.5	(70)	50
27. Butralin	2.0	PPI	1.0	(0)	1.0	(0)	1.0	(0)	1.0	(0)	3.25	(94)	6.75	(68)	50
28. Dinitramine	.33	PPI	1.0	(0)	1.75	(2)	1.5	(1)	1.0	(0)	5.0	(85)	5.5	(80)	45
29. Dinitramine	.5	PPI	1.0	(0)	4.25	(11)	4.0	(10)	3.75	(9)	3.5	(93)	5.0	(85)	42
30. Dinitramine	.67	PPI	1.0	(0)	7.0	(35)	6.25	(28)	5.5	(20)	3.25	(94)	4.25	(88)	39
		Bayes LSD =	1.3		1.81		1.11		1.38		1.39		3.04		N.S.

[a] The European rating system.
[b] The % is an approximation.

Table 5. The effect of metribuzin alone and in combination with several herbicides applied preemergence on weeds and soybeans in 1974 (Experiment A).

Treatments	Rate (lb/A)	June 19 Soybean Stand (% of control)	June 19 Soybean Vigor (Rating)[a]	June 19 Soybean Vigor (%)[b]	July 3 Soybean Vigor (Rating)[a]	July 3 Soybean Vigor (%)[b]	July 3 Giant Green Foxtail (Rating)[a]	July 3 Giant Green Foxtail (%)[b]	July 3 Common Lambsquarter (Rating)[a]	July 3 Common Lambsquarter (%)[b]
1. Control	-	-	1.0	(0)	1.0	(0)	9.0	(0)	9.0	(0)
2. Control Cult.	-	-	1.0	(0)	1.0	(0)	3.25	(94)	1.5	(99)
3. Oryzalin	1.0	80.5	1.75	(2)	2.25	(3)	1.75	(98)	1.0	(100)
4. Oryzalin	2.0	84.5	2.5	(4)	2.5	(4)	2.0	(98)	1.0	(100)
5. Oryzalin	1.0	77.3	1.75	(2)	1.25	(1)	2.75	(96)	1.0	(100)
+ Metribuzin	0.375	77.3	1.75	(2)	1.25	(1)	2.75	(96)	1.0	(100)
6. Oryzalin	2.0	101.0	2.5	(4)	3.75	(9)	1.25	(99)	2.5	(96)
+ Metribuzin	0.75									
7. CGA 24705[c]	1.0	102.8	1.5	(1)	1.0	(0)	1.75	(98)	5.5	(80)
8. CGA 24705	2.0	85.5	2.25	(3)	1.25	(1)	1.75	(98)	2.5	(96)
9. CGA 24705	3.0	91.3	1.75	(2)	1.25	(1)	1.0	(100)	2.25	(97)
10. CGA 24705	1.0	87.0	2.0	(3)	1.0	(0)	2.0	(98)	1.0	(100)
+ Metribuzin	0.375									
11. CGA 24705	1.5	101.5	3.0	(5)	1.0	(0)	1.25	(99)	1.0	(100)
+ Metribuzin	0.375									
12. CGA 24705	3.0	82.8	2.0	(2)	1.0	(0)	1.75	(98)	3.0	(95)
+ Metribuzin	0.75									
13. H22234	1.0	95.5	1.25	(1)	1.0	(0)	1.75	(98)	7.5	(49)
14. H22234	1.5	94.5	1.5	(1)	1.25	(1)	3.0	(95)	5.0	(85)
15. H22234	3.0	84.0	1.5	(1)	1.75	(2)	2.0	(98)	3.25	(94)
16. H22234	1.0	98.0	3.0	(5)	1.0	(0)	1.75	(98)	1.0	(100)
+ Metribuzin	0.375									
17. H22234	2.0	98.3	3.0	(5)	1.0	(0)	1.5	(99)	1.0	(100)
+ Metribuzin	0.75									
18. Fluoridifen[d]	3.0	84.8	2.25	(3)	1.5	(1)	1.5	(99)	1.0	(100)
+ Metribuzin	0.375									
19. Fluoridifen	6.0	61.8	3.5	(8)	2.25	(3)	1.5	(99)	1.0	(100)
+ Metribuzin	0.75									
20. Fluoridifen	2.5	75.0	1.75	(2)	1.25	(1)	3.0	(95)	1.25	(99)
+ Metribuzin	.375									
21. Metribuzin	.375	60.5	2.5	(4)	1.75	(2)	4.5	(87)	1.0	(100)
22. Metribuzin	.75	91.5	2.75	(4)	1.25	(1)	1.75	(98)	1.0	(100)
Bayes LSD .05		N.S.	1.35		1.20		1.46		1.84	

[a]The European rating system.
[b]The % is an approximation.
[c]Chemistry not released.
[d]Chemistry is p-nitrophenyl α, α, α, -trifluro-2-nitro-p-tolyl ether.

Table 6. The effect of metribuzin alone and in combination with several herbicides in 1974 (Experiment B).

Herbricide	Time of Application	Rate	June 19 Soybean Stand (% of Control)	July 3 Giant Green Foxtail (Rating)[a]	(%)[b]	Common Lambsquarter (Rating)[a]	(%)[b]
1. Dinitroaniline	PPI	X	92a[c]	2.6	(96)c-e	2.0	(98)ab
2. Dinitroaniline	PPI	2X	103a-c	2.4	(97)b-e	1.5	(99)ab
3. Dinitroaniline	PPI	X	107a-c	3.1	(94)de	1.3	(99)ab
+ Metribuzin	PPI	X					
4. Dinitroaniline	PPI	2X	88a	2.0	(98)a-c	1.2	(99)ab
+ Metribuzin	PPI	2X					
5. Dinitroaniline	PPI	X	108a-c	1.6	(98)ab	1.1	(99)ab
+ Metribuzin	PRE	X					
6. Dinitroaniline	PPI	2X	94ab	1.1	(99)a	1.1	(99)ab
+ Metribuzin	PRE	2X					
7. Vernolate	PPI	X+2X	80a	2.0	(98)c-d	1.9	(98)ab
8. Vernolate	PPI	X	119a-c	2.5	(96)b-e	1.3	(99)ab
+ Metribuzin	PPI&PRE	X					
9. Vernolate	PPI	2X	119a-c	1.0	(100)a	1.0	(100)a
+ Metribuzin	PPI&PRE	2X					
10. Alachlor	PPI&PRE	X&2X	99ab	2.9	(96)c-e	3.8	(91)c
11. Alachlor	PPI&PRE	X	143bc	3.6	(92)de	1.9	(98)ab
+ Metribuzin	PPI&PRE	X					
12. Alachlor	PPI&PRE	2X	116a-c	2.1	(97)a-d	1.3	(99)ab
+ Metribuzin	PPI&PRE	2X					
13. Metribuzin	PPI	X					
14. Metribuzin	PPI	2X	124a-c	4.2	(89)e	1.3	(99)ab
15. Metribuzin	PRE	X	170c	3.7	(91)de	1.7	(98)ab
16. Metribuzin	PRE	2X	99a-c	2.2	(97)a-e	1.7	(98)ab

[a]The European rating system.
[b]The % is an approximation.
[c]Means within the same column followed by the same letter are not significantly different at the 5% level of probability according to Duncan's New Multiple Range Test.

PROGRESS REPORT ON N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine[1/] FOR WEED CONTROL IN SOYBEANS

Edward K. Bender[2/]

Abstract

Herbicide N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine has been extensively evaluated as preplant incorporated and preemergence applications in soybeans and as preemergence applications in field corn in field trials in the United States in 1972, 1973, and 1974. The herbicide provides excellent control of annual grasses, seedling johnsongrass (Sorghum halepense (L) Pers., and broadleaf weeds such as pigweeds (Amaranthus spp.), lambsquarters (Chenopodium album L.), carpetweed (Mollugo verticillata L.), and purslane (Portulaca oleracea L.) in soybeans. In soybeans grown in the southern and southeastern states, the herbicide is most effective when applied as a preplant incorporated treatment at rates of 0.5 to 1.5 lb. ai/A. In the eastern and northeastern states, the herbicide can be used as a preplant incorporated treatment at 0.75 to 1.5 lb. ai/A or as a preemergence treatment at rates of 0.75 to 1.25 lb. ai/A. Sequential or tank-mix combinations of the herbicide with broadleaf herbicides are needed for control of species such as morningglory (Ipomoea spp.), cocklebur (Xanthium pensylvanicum Wallr.), common ragweed (Ambrosia artemisiifolia L.), and prickly sida (Sida spinosa L.).

The herbicide provides excellent weed control in soybeans when incorporated with a wide variety of power-driven and ground-driven implements. Depths of incorporation of 1 to 3 inches in light soils and 1 to 2 inches in medium and heavy soils are suggested for maximum herbicidal effect.

1/ PROWL® Herbicide; PROWL® Registered Trademark of American Cyanamid Company.

2/ Agriculturist, American Cyanamid Company, P. O. Box 400, Princeton, N.J., 08540.

ANNUAL WEED CONTROL IN SILAGE CORN - 1974

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

Abstract

Herbicides were applied alone and in combinations for evaluating annual weed control in silage corn. Two separate experiments were conducted, one to evaluate preemergence treatments and the second to evaluate preplant incorporated treatments. The experiments were conducted at the Agronomy Research Farm at the University of Connecticut. The dominant weed species was large crabgrass (Digitaria sanguinalis (L) Scop.) with lesser amounts of broadleaf weeds.

All the preemergence herbicide treatments tested gave significantly better weed control than the untreated check. MC 5714 and bifenox gave significantly lower crabgrass ratings than most herbicide treatments. This resulted in significantly greater silage yields than the check for all treatments except MC 5714 and bifenox used alone.

Alachlor in combination with atrazine, simazine, bifenox, and metribuzin provided better crabgrass control than when these compounds were used alone.

Preplant incorporated treatments resulted in significantly better control of both crabgrass and broadleaf weeds than the untreated check for the ratings taken on July 2, 1974. The July 23 ratings showed that all herbicide treatments gave significantly better control of crabgrass than the untreated check. However, only half the herbicide treatments on this date provided significantly better broadleaf weed control than the untreated check.

At the July 23 rating, the majority of the herbicide treatments gave significantly better crabgrass control than butylate (4L) at 4 lb/A.

Butylate (4L), EPTC plus R-25788, ethiolate with cyprazine formulation at 3 lb/A, and MC 8475 resulted in fair to poor broadleaf weed control.

Experiment 1

Preemergence Treatments

Methods and Materials

The experiment was conducted at the Agronomy Research Farm of the Storrs Agricultural Experimental Station. The experimental design was

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

a randomized complete block with 3 replications. Plot size was 8.5 feet by 30 feet. Funk's G 4082 was seeded in 34 inch rows (3 rows per plot) on May 30, 1974.

The soil type is a Woodbridge fine sandy loam, moderately well drained. The field was fertilized at the rate of 1000 lb/A with a 15-15-15 fertilizer on May 9, 1974 and the fertilizer plowed into the soil.

Large crabgrass was the major weed species with small amounts of redroot pigweed (*Amaranthus retroflexus* L.), lambsquarters (*Chenopodium album* L.) and Pennsylvania smartweed (*Polygonum pennsylvanicum* L.)

Preemergence applications of the herbicides were applied on May 31, 1974. Two rain showers were recorded on June 1 and 2, 1974 measuring 0.34 inches and 0.07 inches respectively. The next rainfall was on June 17, 1974, when 1.31 inches was measured.

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

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

Samples for silage yield determination were harvested on September 17, 1974. 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

Weed Control

All preemergence herbicide treatments resulted in significantly better weed control than the untreated check at both dates ratings were taken (Table 1.)

Atrazine plus alachlor, a standard herbicide treatment, gave good broadspectrum weed control.

Dicamba plus alachlor, chloropropham plus alachlor, CGA-18762, CGA-24705, and AC 92553 all resulted in good to excellent crabgrass control. The addition of either atrazine or cyanazine to AC 92553 did not improve control.

Simazine ec at 3 lb/A or in combination with atrazine or alachlor did not provide the good crabgrass control experienced in the previous year (1). This may be related to the limited precipitation within the 16 days following application, or to problems associated with the ec formulation in obtaining complete suspension.

R-31401, bifenox, and MC 5714 resulted in significantly poorer crabgrass control than the standard atrazine plus alachlor treatment. The

addition of alachlor to bifenox gave significantly better crabgrass control than compared to bifenox used alone.

Metribuzin provided only fair control of crabgrass but addition of alachlor at 2 lb/A to metribuzin resulted in excellent control. Combining alachlor with any of the herbicides improved crabgrass control when compared with the herbicides used alone.

All herbicide treatments except MC 5714 afforded good control of broadleaf weeds. Although MC 5714 gave significantly better broadleaf weed control than the untreated check, control was marginal with this compound.

Silage Corn Yields

All herbicide treatments resulted in significantly better silage corn yields than the untreated check except MC 5714 or bifenox used alone. The weed competition due to poor crabgrass and broadleaf weed control with MC 5714 and poor crabgrass control with bifenox reduced yields.

Experiment 2

Preplant Incorporated Treatments

Methods and Materials

The methods and materials employed in this experiment were the same as used in experiment one with the following exceptions.

Plot size was 8.5 feet by 25 feet.

The chemical treatments were applied on May 28, 1974. All herbicide treatments were incorporated within minutes with a power driven rototiller.

Results and Discussion

All herbicide treatments as noted on July 2 indicated significantly better control of crabgrass and broadleaf weeds than the untreated check (Table 2).

Vernolate with R-25788 plus atrazine gave significantly better broadleaf weed control than a majority of the treatments. The addition of atrazine to butylate and EPTC plus R-25788 improved broadleaf weed control compared to either of the two compounds used alone. The 4 lb/A rate of ethiolate with cyprazine formulation resulted in better broadleaf weed control than the 3 lb/A rate. Butylate (4F), MC 8475 and ethiolate with cyanazine at 3 lb/A gave poor broadleaf weed control.

The July 23 ratings indicated all herbicides gave significantly better crabgrass control than the untreated check. Butylate (4F) resulted in significantly less crabgrass control than butylate (6E). EPTC plus R-25788 treatments were more effective than butylate treatments. Buty-

late (6E), butylate (6E) plus atrazine, EPTC plus R-25788 plus atrazine, ethiolate with cyanazine, and vernolate plus R-25788 plus atrazine achieved significantly better broadleaf weed control than the untreated check.

No corn injury resulted from any of the herbicide treatments.

All herbicide treatments resulted in yields greater than the check but there was a poor relationship between weed control ratings and corn yields.

Literature Cited

1. Dest, W.M., R.A. Peters and A.C. Triolo. 1974. Annual weed control in field corn — 1973. Proc. NEWSS 28:17-23.

Table 1: Evaluation of Herbicides for Crabgrass and Broadleaf Weed Control and Silage Yields.

Treatment		Crabgrass and Broadleaf Control Ratings[1]				
		July 2, 1974		July 23, 1974		
Herbicide	Lb ai or ae/A	Crabgrass	Broadleaf	Crabgrass	Broadleaf	Silage Yield T/A[2]
Untreated Check		0g[3]	0f	0h	0.5e	7.6h
Atrazine	2	6.7abcdef	9.2ab	6.2abcdef	9.3a	23.5a
Atrazine+alachlor	1+2	8.2abc	9.3a	7.8ab	9.3a	19.4abcd
Atrazine+simazine	1+2	7.0abcde	8.8ab	5.5abcdef	8.3abcd	20.3abcd
Simazine	3	7.0abcde	8.5ab	5.8abcdef	8.7abc	20.1abcd
Simazine+alachlor	2+2	7.8abcd	8.8ab	5.8abcdef	8.3abcd	19.2abcd
Cyanazine	1.6	6.7abcdef	7.5abcd	4.3abcdefg	6.2abcd	18.8abcde
Cyanazine	2.4	7.7abcd	7.0bcd	7.3abc	6.8abcd	16.4abcdefg
R-31401	1	5.0bcdef	9.0ab	3.8bcdefg	9.3a	15.3cdefg
R-31401	2	4.7cdef	9.0ab	2.0fg	9.3a	14.3defg
CGA-18762	2	6.7abcdef	7.8abc	6.2abcdef	7.0abcd	20.3abcd
CGA-18762	2.4	7.5abcd	7.8abc	6.7abcde	7.0abcd	16.6abcdefg
CGA-18762	3.2	6.7abcdef	8.2abc	5.0abcdef	8.5abc	16.6abcdefg
CGA-24705	1.5	8.5ab	7.5abcd	6.8abcd	6.3abcd	18.1abcdef
CGA-24705	2	7.2abcde	6.7bcd	6.0abcdef	6.2abcd	16.8abcdefg
CGA-24705	3	8.5ab	4.8de	7.3abc	4.0d	18.1abcdef
AC 92553	1½	8.2abc	9.0ab	7.2abcd	8.5abcd	19.2abcd
AC 92553	2	7.8abcd	7.7abc	7.8ab	6.3abcd	18.1abcdef
AC 92553+atrazine	1½+1	7.8abcd	9.2ab	7.2abcd	8.3abcd	21.4abc
AC 92553+cyanazine	1½+2	7.7abcd	8.3abc	6.7abcde	8.2abcd	22.2ab
Bifenox	1½	3.5ef	8.5ab	2.5efg	7.7abcd	11.9fgh
Bifenox+alachlor	1+2	7.7abcd	8.7ab	6.3abcdef	8.8ab	19.9abcd
Bifenox+alachlor	1½+2	8.5ab	9.5a	8.2a	9.0a	18.8abcde
Metribuzin 50w	½	8.2abc	8.5ab	7.8ab	6.8abcd	19.0abcd
Butylate+R-31401	3+1	5.7abcdef	9.3a	3.0defg	9.3a	15.8bcdefg
MC 5714	½	4.2def	3.5de	3.5cdefg	4.2cd	12.1efgh
MC 5714	1	3.8g	5.7cde	1.1gh	4.2bcd	10.8gh
Dicamba+alachlor	½+2	7.3abcde	8.5ab	7.0abcd	8.0abcd	18.6abcdef
Metribuzin 70w	¼	6.2abcdef	7.0bcd	4.2abcdefg	7.0abcd	19.9abcd
Metribuzin 70w	½	6.5abcdef	8.2abc	5.2abcdef	7.8abcd	18.6abcdef
Metribuzin 70w+alachlor	½+2	8.7a	8.5ab	8.0ab	7.7abcd	21.4abc
Metribuzin 70w+alachlor	½+2	8.8a	9.0ab	8.3a	9.0a	19.9abcd
Chloropropham+alachlor	2+2	8.2abc	7.7abc	7.7abc	7.2abcd	18.4abcdef

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.

Table 2. Evaluation of Preplant Incorporation of Herbicides for Crabgrass and Broadleaf Weed Control and Silage Yields.

Treatment		Crabgrass and Broadleaf Control Ratings[1]				
		July 2, 1974		July 23, 1974		
Herbicide	Lb ai or ae/A	Crabgrass	Broadleaf	Crabgrass	Broadleaf	Silage Yield T/A[2]
Untreated Check		0b[3]	0d	1.2d	1.5d	14.5c
Butylate (6E)	4	7.7a	6.7bc	6.5ab	5.5abc	17.7abc
Butylate (4F)	4	5.8a	4.3c	3.3c	4.2bcd	17.3abc
Butylate (6E) + atrazine	3 + 1	6.7a	8.2ab	4.5bc	7.5ab	18.1abc
EPTC + R-25788	4 + 1/3	8.2a	6.5bc	8.0a	4.3bcd	19.0ab
(EPTC + R-25788) + atrazine	3 + $\frac{1}{4}$ + 1	8.2a	8.2ab	7.8a	7.5ab	21.4ab
Ethiolate + cyprazine	$2\frac{1}{2}$ + $\frac{1}{2}$	8.0a	5.8bc	7.7a	4.2bcd	16.8bc
Ethiolate + cyprazine	3 1/3 + 2/3	8.2a	7.2abc	8.0a	5.2abc	21.0ab
MC 8475	3/4	6.5a	4.5c	5.5ab	3.3bcd	17.1abc
MC 8475	$1\frac{1}{2}$	7.3a	4.3c	6.3ab	2.8cd	20.5ab
(Vernolate + R-25788) + atrazine	(3 + $\frac{1}{4}$) + 1	8.2a	9.3a	7.8a	9.2a	21.6a

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
Alachlor	4 lb/gal EC	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
Atrazine	80% WP or 4 lb/gal EC	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
AC 92553	3 lb/gal EC	N-(1-Ethylpropyl)-2,6-dinitro-3,4-xylidine
Bifenox	2 lb/gal EC	methyl-5-(2,4-dichlorophenoxy)-2-nitrobenzoate
Butylate	6 lb/gal EC or 4 16/gal EC	S-ethyl diisobutylthiocarbamate
CGA-18762	80% WP	Unknown
CGA-24705	6 lb/gal EC	Unknown
Chloropropham	4 lb/gal EC	isopropyl-m-chlorocarbanilate
Cyanazine	4 lb/gal EC	2-[[4 chloro-6(ethylamino)-s-triazin-2-ul] amino]-2-methyl-propionitrile
Cyprazine	1 lb/gal EC	2-chloro-4-(cyclopropylamino)-6-(isopropylamino)-s-triazine
Dicamba	4 lb/gal EC	3,6-dichloro-o-anisic acid
EPTC	6 lb/gal EC	S-ethyl dipropylthiocarbamate
Ethiolate+Cyprazine	4 3/4 lb/gal EC	S-ethyl diethylthiocarbamate plus 2-chloro-4-(cyclopropylamino)-6-(isopropylamino)-s-triazine
MC 5714	80% WP	Unknown
MC 8475	2 lb/gal EC	Unknown
Metribuzin	70% WP 50% WP	4-amino-6-tert-butyl-3-(methylthio)-s-triazin-5-(4H)-one
Protectant (R-25788)	½ lb/gal EC	N,N-dially-2,2-dichloroacetamide
R-31401	2 lb/gal EC	Unknown
Simazine	4 lb/gal EC	2-chloro-4,6, bis (ethylamino)-s-triazine
Vernolate	6 lb/gal EC	S-propyl dipropylthiocarbamate

ANNUAL GRASS AND BROADLEAF CONTROL IN CORN AND SOYBEANS WITH CGA-24705

M. G. Schnappinger, E. R. Higgins
and S. W. Pruss[1/]

ABSTRACT

Research was conducted in 1973 and 1974 to determine the effectiveness of CGA-24705 [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide] alone and in combination with atrazine [2-chloro-4(ethylamino)-6-(isopropylamino)-s-triazine] or chlorbromuron [3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea] for the control of annual grasses and broadleaves in corn (*Zea mays* L.) and soybeans (*Glycine max*.). Crop selectivity to preemergence applications of CGA-24705 at the rates tested was excellent for both corn and soybeans. Annual grass control with CGA-24705 was excellent and either superior or equal to similar rates of alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide). The effectiveness of CGA-24705 applied alone on broadleaf weeds was not commercially acceptable in most cases, while the tank mixes with either atrazine on corn or chlorbromuron on soybeans increased the spectrum of weeds controlled.

INTRODUCTION

Control of annual grasses and broadleaves in corn and soybeans continues to be a problem for the grower. In a search for herbicides which would aid the grower in obtaining weed control, CGA-24705 was synthesized in the Basle Laboratories of CIBA-GEIGY Ltd. The research reported herein is the result of replicated studies conducted with CGA-24705 over a 2-year period at locations in Maryland, New York and Virginia.

MATERIALS AND METHODS

Research was conducted at various locations throughout New York, Maryland and Virginia. Plot sizes varied from 1.8 x 5.5 m. in 1973 to 3.6 x 9.1 m. in 1974. Treatments were replicated either 3 or 4 times. All Herbicides were applied preemergence using hand operated plot sprayers with carbon dioxide as the pressure source.

1/ Senior Research Representative & Research Manager, Northeast Region, Agricultural Division, CIBA-GEIGY Corporation, Washington, Pennsylvania.

Annual grass and broadleaf control was evaluated using the scale 0 to 10 where a 0 represents no control and 10 equals complete reduction in stand and vigor. Weeds for which evaluations were made are the following: fall panicum (Panicum dichotomiflorum Micx.), witchgrass (Panicum capillare L.), yellow foxtail (Setaria lutescens (Weigel) Hubb), giant foxtail (Setaria faberi Herrm.), smooth crabgrass (Digitaria ischaemum (Schreb.) Muhl.), common ragweed (Ambrosia artemisiifolia L.), common lambsquarters (Chenopodium album L.), ivyleaf morningglory (Ipomoea hederacea L. Jacq.), carpetweed (Mollugo verticillate L.), and Pennsylvania smartweed (Polygonum pennsylvanicum L.).

RESULTS AND DISCUSSION

Corn - The results of ten herbicide trials where CGA-24705 was applied preemergence to corn are shown in Tables 1 and 2. CGA-24705 possessed good crop selectivity at rates up to 4.48 kg/ha (Table 1). Control of Panicum species with CGA-24705 was excellent, while its effectiveness on Setaria species in corn was fair. Witchgrass was controlled well on both light and medium textured soils with very little difference between CGA-24705 and alachlor. Excellent fall panicum control was obtained at 1.12 kg/ha on sandy loam soils, while 2.24 kg/ha were required to achieve the same effectiveness on medium textured soils. CGA-24705 was more effective than alachlor on fall panicum, especially at the lower rates tested. The foxtails were somewhat more difficult to control, requiring applications up to 3.36 kg/ha of either CGA-24705 or alachlor to obtain acceptable ratings.

The rates required to obtain broadleaf control were higher than those needed for control of grasses such as fall panicum. CGA-24705 was not very effective on ragweed and smartweed, while there appeared to be some activity on lambsquarters and carpetweed. CGA-24705 was slightly weaker than alachlor for broadleaves except for lambsquarters and carpetweed. Inclusion of 1.12-1.68 kg atrazine/ha in a tank mix with either CGA-24705 or alachlor gave complete control of all broadleaf weeds mentioned above (data not shown).

Soybeans - Tables 3 and 4 are a summary of eight trials conducted on soybeans. Crop tolerance to preemergence applications of CGA-24705 up to 4.48 kg/ha was excellent (Table 3). Annual grass control was very good to excellent, especially for the *Setaria* species and crabgrass. Slightly higher rates of CGA-24705 were required to control fall panicum in soybeans than in corn. Comparisons of CGA-24705 to alachlor showed few differences in annual grass control.

CGA-24705 had poor activity on ragweed, morningglory, and lambsquarters. Smartweed control was slightly better but remained only marginally acceptable. Alachlor was slightly more effective than CGA-24705 on ragweed on medium textured soils, while CGA-24705 was slightly superior for smartweed control. In tests where tank mix combinations of either CGA-24705 or alachlor plus chlorbromuron were applied, good to excellent ragweed, smartweed and lambsquarters control was obtained, while morningglory control remained poor.

SUMMARY AND CONCLUSIONS

A total of eighteen replicated trials were conducted with CGA-24705 on corn and soybeans in 1973 and 1974. Preemergence applications of CGA-24705 at rates up to 4.48 kg/ha were not phytotoxic. Annual grass control in both corn and soybeans was generally good to excellent at rates of 1.68-2.24 kg CGA-24705/ha and was either equal or superior to equivalent rates of alachlor. Broadleaf weed control was unacceptable in most cases for both CGA-24705 and alachlor.

From the data presented, it is apparent that CGA-24705 is an excellent grass herbicide which also possesses very good crop selectivity for both corn and soybeans. While broadleaf weed control with CGA-24705 was less than acceptable, tank mixes with atrazine or chlorbromuron in corn and soybeans, respectively, can provide the grower with excellent broad spectrum weed control.

TABLE 1 - Weed control in corn with various rates of CGA-24705 and alachlor on sandy loam soils.

			WEED CONTROL									
	Rate		Witchgrass		Fall Panicum		Ragweed		Lambsquarters	
Chemical	kg/ha	Crop Response	E[a]	L	E	L	E	L	E	Carpetweed
CGA-24705	1.12	0.0(2)[b]			9.7(2)	8.6(2)	0.0(1)	0.0(1)	6.7(1)	2.5(1)
	1.68	0.0(1)	10.0(1)	9.8(1)			0.8(1)	0.8(1)		
	2.24	0.0(3)	9.8(1)	10.0(1)	10.0(2)	9.4(2)	2.9(2)	1.2(2)	10.0(1)	7.8(1)
	2.8	0.0(1)	10.0(1)	9.5(1)			3.5(1)	1.0(1)		
	4.48	0.0(2)			10.0(2)	9.8(2)	5.8(1)	0.8(1)	10.0(1)	10.0(1)
Alachlor	1.12	0.0(1)			8.0(1)	7.0(1)			5.0(1)	
	2.24	0.0(3)	10.0(1)	9.8(1)	9.7(2)	9.4(2)			6.7(1)	7.5(1)
	4.48	0.0(1)			9.3(1)	9.5(1)			7.3(1)	

TABLE 2 - Weed control in corn with various rates of CGA-24705 and alachlor applied to medium textured soils.

				WEED CONTROL									
	Rate	Fall Panicum		Witchgrass		Yellow Foxtail		Giant Foxtail	Ragweed		Lambs-quarters	Smartweed	
Chemical	kg/ha	E[a]	L	E	L	E	L	E	E	L	L	E	L
CGA-24705	1.12	9.7(1)[b]	7.5(1)							2.3(1)			
	1.68					5.6(2)	5.0(1)	6.3(1)	3.7(1)	3.2(2)	8.3(1)	6.7(1)	3.2(2)
	2.24	10.0(1)	8.8(1)	10.0(1)	10.0(1)	7.2(2)	5.0(1)	7.8(1)	5.7(1)	5.5(4)	10.0(1)	5.7(1)	4.5(2)
	3.36			10.0(1)	10.0(1)	8.6(2)	7.6(1)		4.7(1)	4.8(2)		6.7(1)	8.5(1)
	4.48	10.0(1)	10.0(1)							8.5(1)			6.0(1)
Alachlor	1.12	8.3(1)	6.8(1)							6.7(1)			
	1.68					6.5(1)	4.3(1)						
	2.24	8.3(1)	5.7(1)	10.0(1)	10.0(1)	7.2(2)	5.8(1)	7.3(1)		6.5(3)	8.8(1)		7.8(1)
	3.36			10.0(1)	10.0(1)	8.3(1)	7.0(1)		9.5(1)	8.8(3)	9.3(1)	9.0(1)	8.0(2)
	4.48	10.0(1)	7.3(1)						9.3(1)	8.4(2)		10.0(1)	7.7(1)

a/ Evaluations made approximately 30 days after application (E) and 60-80 days after application (L).

b/ Numbers in parentheses indicate number of tests from which averages were derived.

TABLE 3 - Weed control in soybeans with various rates of CGA-24705 and alachlor applied to sandy loam soils.

			WEED CONTROL					
	Rate		Smooth Crabgrass	Fall Panicum		Ragweed		Morningglory
Chemical	kg/ha	Crop Response	L[a]	E	L	E	L	E
CGA-24705	1.12	0.7(3)[b]	10.0(1)	6.3(1)	8.4(2)	4.0(1)	0.0(1)	0.7(1)
	2.24	0.8(3)	8.7(1)	7.3(1)	8.5(2)	4.0(2)	2.8(2)	0.0(1)
	4.48	0.9(3)	10.0(1)	9.5(1)	9.4(2)	5.3(1)	5.2(1)	0.0(1)
Alachlor	1.12	1.3(1)	9.3(1)		8.0(1)			0.0(1)
	2.24	1.6(2)	9.7(1)	8.5(1)	8.4(2)	4.3(1)	2.2(1)	0.0(1)
	4.48	1.7(1)	9.8(1)		9.8(1)			3.2(1)

TABLE 4 - Weed control in soybeans with various rates of CGA-24705 and alachlor applied to medium textured soils.

		WEED CONTROL											
	Rate	Yellow Foxtail		Giant Foxtail		Ragweed		Morningglory	Smartweed		Lambsquarters	
Chemical	kg/ha	E[a]	L	E	L	E	L	E	E	L	E	L
CGA-24705	1.12		8.3(1)	9.3(1)	9.2(1)	2.3(1)	1.2(2)	3.3(1)	7.6(1)	6.0(1)		
	2.24	9.8(1)[b]	9.1(2)	10.0(1)	10.0(1)	4.5(3)	1.8(5)	2.8(2)	7.3(1)	7.0(1)	4.0(1)	0.0(1)
	3.36	10.0(1)	10.0(1)			4.6(3)	4.0(3)	5.0(1)			3.0(1)	1.3(1)
	4.48			10.0(1)	10.0(1)	8.2(2)	2.1(2)	6.2(2)	6.3(1)	3.5(1)		
Alachlor	1.12		7.8(1)				2.0(1)	1.7(1)				
	2.24	9.3(1)	9.4(2)	9.3(1)	9.5(1)	5.8(2)	2.8(4)	0.0(1)			2.3(1)	0.7(1)
	3.36					9.3(1)	5.7(1)		4.0(1)	4.7(1)		
	4.48											

a/ Evaluations made approximately 30 days after application (E) and 60-80 days after application (L).

b/ Numbers in parentheses indicate number of tests from which averages were derived.

A Status Report of Thiocarbamate Injury To Corn on the Maryland Eastern Shore

J. J. Crook[1]

ABSTRACT

A survey of 36 commercial applications of approximately 6 lb/A of EPTC plus protectant (N,N-diallyl-2,2-dichloroacetamide) or 4 lb/A of butylate (S-ethyldiisobutylthiocarbamate) plus protectant showed that when corn injury occurred, EPTC caused the greatest injury. Of those acreage reporting greater than 10% corn injury, EPTC had 50.3% and butylate 11%. Certain corn varieties appeared more susceptible to thiocarbamate injury. More injured occurred in lighter textured soils. Corn planted in April was injured to a similar extent as later planted as corn in May.

INTRODUCTION

In 1969 the Maryland legislature enacted a Noxious Weed Law which was aimed at the control and eradication of johnsongrass. Since that time the State of Maryland has had an active program for the control of johnsongrass. The State has presently entered into an agreement with sixteen (16) of the twenty-one counties in Maryland having johnsongrass on a matching fund basis to initate control programs for johnsongrass.

Until 1974, it had been the practice of the Maryland Department of Agriculture not to recommend corn to be planted in a serious infestation of johnsongrass. For 1974 the Maryland Department of Agriculture and the University of Maryland recommended EPTC plus protectant or butylate plus protectant for seedling johnsongrass control in corn. In previous years, a protectant had been demonstrated to protect corn from injury caused from these thiocarbamate herbicide in experimental plots at many agricultural experiment stations.

Many growers used these thiocarbamates at higher than presently labeled rates, based on research results indicating rhizometous johnsongrass control. However, there were a number of reports of injury from these two thiocarbamates plus protectant at rates of approximately 4 and 6 lb/A.

The purpose of this report was to obtain as much information about the commercial application of these two thiocarbamates plus protectant in order to test several theories as to why corn injury has occurred with commercial application.

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[1] Supervisor, Weed Control, Maryland Dept. of Agriculture, Parole, Maryland.

MATERIALS AND METHODS

A questionnaire was developed by the authors and distributed to the county supervisors employed by the Maryland Department of Agriculture along with a letter detailing each question. The county supervisor knew many of the farmers who had used these products for johnsongrass control; additional users were obtained from pesticide dealers. The forms were compiled by the county supervisors and returned to the State Supervisor Weed Control; the Supervisor State Weed Control made personal contact with a number of those surveyed to determine the accuracy of the report and to further discuss details of the farmer's method of application. The questionaires were summarized by J. V. Parochetti Associate Professor, Department of Agronomy (Weed Science). The average maximum and minimum temperature for the last half of April and the first half of May are present in Table 1.

Table 1. Average air temperature for the Eastern Shore, Maryland, calculated from 16 weather data stations as reported in the April and May issues of Climatological Data Maryland and Delaware, Volume 78 numbers 4 and 5, 1974.

	April 15-30	May 1-15
Maximum	71.1	72.7
Minimum	46.6	49.2
	58.8	60.9

RESULTS AND DISCUSSION

Of the two herbicides surveyed, EPTC plus protectant caused much more corn injury than butylate plus protectant (Table 2 and 3). Of the 17 farmers surveyed using EPTC plus protectant on 891 acres, seven farmers reported inury ranging from 2 to 30% which was 61% of the treated acreage. Only three farmers reported injury of 10% or more on 448 acres, or 50.3% of the total acreage.

For butylate plus protectant, 29 farmers reported they treated 2,381 acres (Table 3). Corn injury varied from 1 to 15% on 843 acres which represents 35% of the total butylate plus protectant treated acreage. Only three farmers reported corn injury greater than 10% on 262 acres representing 11% of the total butylate plus protectant treated acreage.

The survey was designed to test several theories to predict thiocarbamate injury to corn. One theory was that early planted corn which was planted in cold soil was injured more than later planted corn, which would be planted in warmer soil. The reports do not support this theory, although some growers reported severe injury when planting in April, others reported injury when planting in May. Lack of support of this theory could be that the air temperature for the Eastern Shore for last half of April and the first half of May was similar (Table 1).

Another theory which could not be supported by the data on the reports was that poor incorporation was contributing to corn injury. Several reports indicated incompatibility of thiocarbamates when applied with liquid nitrogen or complete liquid fertilizers as the carrier. Poor incorporation, such as the

application on rough plowed land or only one incorporation, were also evident on many reports, and although there appears to be a correlation between lack of johnsongrass control and/or corn injury with poor incorporation, there were notable exceptions.

Soil type appeared to be an important factor contributing to injury. For EPTC plus protectant, the most severe injury occurred on sandy loam or loamy sand soils. Although some injury occurred on silt loam soils. This may be due to a deeper planting of corn and subsequently greater injury. G. W. Burt (unpublished data) has found that the deeper corn is planted the greater the thiocarbamate (plus protectant) injury; this presumably is because the seed takes longer to emerge and is exposed to thiocarbamate longer.

Certain varieties of corn were injured more frequently than others (Tables 4 and 5). Several DeKalb varieties seem to be more susceptible to thiocarbamate plus protectant injury. Susceptible varieties did not always result in corn injury, and varieties which appear to be tolerant occasionally resulted in injury. A number of farmers reporting corn injury had used a systemic insecticide with the thiocarbamates. There seemed to be more injury where a systemic insecticide had been used, especially when a susceptible variety was used.

Table 2. Results of farmers using EPTC plus protectant[a] at approximately 6 lb/A for johnsongrass seedling control in corn in five (5) counties in Maryland in 1974.

County	No. of Reports	Acres Treated	Satisfied with Results[b]	Will use Again[b]	No. of Reports with Injury	Acreage with Injury	Range of % of Injury	Acreage with Injury % More Than 10%	No. of Reports with Injury More Than 10%
Caroline	1	280	1	(-1)	1	280	20%	280	0
Dorchester	5	230	4(-1)	2(-3)	3	168	2-30%	143	2
Kent	6	189	5(-1)	5(-1)	2	75	7-10%	5	
Wicomico	1	20	(-1)	(-1)	1	20	20%	20	1
Worcester	4	172	4	4	0	0	0	0	0
Total	17	891			7	543		448	3

Eradicane % of all treated acreage reporting injury = 61%
Eradicane % of all treated acreage reporting more than 10% injury = 50.3%

[a] EPTC plus protectant is sold as Eradicane 6EC
[b] The negative numbers in ( ) indicate those farmers responded negatively.

Table 3. Results of farmers using butylate plus protectant[a] at approximately 4 lb/A for johnsongrass seedling control in corn in seven (7) counties in Maryland in 1974.

County	No. of Reports	Acres Treated	Satisfied with Results[b]	Will use Again[b]	No. of Reports with Injury	Acreage with Injury	Range of % of Injury	Acreage with Injury % More Than 10%	No. of Reports with Injury More Than 10%
Caroline	4	91	2(-1)	3	1	10	1%	0	0
Dorchester	1	100	1	1	0	0	0	0	0
Kent	11	807	10(-1)	11	2	24	4-7%	0	0
Somerset	4	422	4	4	0	0	0	0	0
Talbot	5	649	1(-2)	4(-1)	4	539	5-15%	140	2
Wicomico	2	42	(-1)	2	0	0	0	0	0
Worcester	2	270	0	2	2	270	5-10%	122	1
Total	29	2381			9	843		262	3

Suntan+ % of all treated acreage reporting injury = 35%

Suntan+ % of treated acreage reporting more than 10% injury = 11%

[a] Butylate plus protectant is sold as Sutan+ 6EC

[b] The negative numbers in ( ) indicate those farmers responding in the negative.

Table 4. Corn varieties and incidence of injury and no injury when planted in EPTC plus protectant[a] treated soil, applied by Maryland farmers at approximately 6 lb/A.

Exhibiting Injury			Not Exhibiting Injury		
Company	Variety	Incidence	Company	Variety	Incidence
DeKalb	XL43	5	Funk G	4646	2
	XL44	1			
	XL64	2	Pioneer	3334	1
	XL80	1	Pioneer	3369A	5
Funk G	4646	1			
Todd	740	1			
Pioneer	3334	1			

[a] EPTC plus protectant is sold as Eradicane 6EC

Table 5. Corn varieties and incidence of injury and no injury when planted in butylate plus protectant treated soil applied by Maryland farmers at approximately 4 lb/A.

Exhibiting Injury			Not Exhibitin Injury		
Company	Variety	Incidence	Company	Variety	Incidence
DeKalb	XL42	1	DeKalb	535	1
	XL43	3	DeKalb	XL43	2
	XL44	2	DeKalb	XL44	1
	XL46	2	DeKalb	XL64	2
			DeKalb	XL66	2
Pioneer	3369A	1	Pioneer	3334	1
	3518	1	Pioneer	3369A	12
			Pioneer	3580	1
Funk G	4550	1	Pioneer	3585	1
	4646	1	Pioneer	3368	1

[a] Butylate plus protectant is sold as Sutan+.

SELECTED SOYBEAN HERBICIDES - ATRAZINE RESIDUE INTERACTION EFFECT ON SEEDLING SOYBEANS

Julian F. Hunt, Peter K. Fay and William B. Duke[1/]

Abstract

The greenhouse studies reported herein were initiated as a result of increased interest in New York State in soybean (Glycine max) production and the presence of large acreages of land previously treated with atrazine being used for this production. Three experiments were run consequitively. In each, a greenhouse sandy loam soil mix was placed in 5 in. pots and atrazine at varying low rates was thoroughly incorporated throughout the soil profile. Commercial rates of trifluralin and vernolate were incorporated into the upper 2 in. of the pretreated soil. Preemergence treatments of metribuzin, chloramben, alachlor plus linuron and alachlor plus chlorobromuron were also applied. Merit soybeans were planted 0.5 in. deep. Data on number of plants emerged, and final fresh weight were taken after four weeks.

The initial experiments showed significant soybean yield loss from interactions of atrazine residue with either metribuzin or vernolate, and slightly less injury from alachlor plus chlorobromuron. Applications of trifluralin, chloramben and alachlor plus linuron to soil containing very low rates of atrazine did not result in increased soybean injury. In the second planting, it was verified that there is a definite significant interaction between metribuzin and vernolate with atrazine residue with respect to their effects on soybean growth. In the final experiment, the combination of metribuzin and atrazine residue was studied in more detail. Examination of various rates of metribuzin ranging from 1/8 to 1/2 lb/A revealed an increasing toxicity to soybeans as the rate of atrazine residue reached 1/8 pound per acre and metribuzin was applied at 1/4 pound or more per acre. It is felt that care must be taken when applying either metribuzin or vernolate to soybeans where atrazine residue may be present.

1/ Experimentalist, Research Assistant and Associate Professor, respectively, Department of Agronomy, Cornell University, Ithaca, NY 14853.

WEED CONTROL IN A NEW SEEDING OF ALFALFA - 1974

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

Abstract

Several new compounds look promising for weed control on a new spring seeding of alfalfa. The principal weed species was large crabgrass (*Digitaria sanguinalis* (L.) Scop.) with lesser amounts of several broadleaf weeds.

AC 92390 applied at 1 lb/A and 2 lb/A, profluralin at 1 lb/A, 1½ lb/A and 3 lb/A in combination with 2,4-DB at 1 lb/A, dibutalin applied preplant incorporated at 1½ lb/A and 3 lb/A and CGA 17020 at 1 lb/A and 2 lb/A gave good to excellent weed control with little or no injury to the alfalfa. EPTC in combination with 2,4-DB, a standard herbicide treatment in new seeded alfalfa, gave excellent weed control. Benefin plus 2,4-DB also resulted in excellent weed control.

Dibutalin applied at 1½ lb/A preemergence was weak on crabgrass and broadleaf weeds and at 3 lb/A was only marginal in controlling crabgrass. The 3 lb/A rate of dibutalin applied preemergence injured the alfalfa. Trifluralin at ½ lb/A and 3/4 lb/A was weak on crabgrass and also injured the alfalfa. The trifluralin at 3 lb/A significantly reduced alfalfa yields compared to most herbicide treatments. CGA 24705 at 2 lb/A and 4 lb/A was very weak in controlling broadleaf weeds and at 4 lb/A injured the alfalfa, resulting in a significant decrease in yield.

Methods and Materials

The experiment was conducted at the Agronomy Research Farm of the Storrs Agricultural Experimental Station. The experimental design was a randomized complete block with 3 replications. Plot size was 5 feet by 15 feet.

The soil type is a Woodbridge fine sandy loam, moderately well drained. The field was fertilized on May 9, 1974 at a rate of 500 lb/A of an 0-20-20 fertilizer. The fertilizer was incorporated with a disk harrow. Alfalfa (*Medicago sativa* L. var. Saranac) was seeded on May 15, 1974 at a rate of 12 lb/A.

The major weed species was large crabgrass with small amounts of lambsquarter (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.) and Pennsylvania smartweed (*Polygonum pennsylvanicum* L.)

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

Preplant incorporated and preemergence treatments were applied on May 15, 1974. The preplant treatments were incorporated immediately with a rototiller. The postemergence treatment was applied on June 11, 1974. All herbicides were applied in water at a rate of 40 gal/A with a self-propelled sprayer. Herbicide rates are given in pounds ai or ae per acre.

Weed control and alfalfa injury ratings were taken on June 19, and July 22, 1974. A rating scale of 0-10 was used, 0 indicating no weed control or alfalfa injury and 10 indicating complete kill.

Yield samples were taken on July 23, 1974 from a 3 feet by 10 feet area in each plot and the green weights recorded. The total yield per plot was fractionated into alfalfa, crabgrass, and broadleaf components by hand separation of subsamples. Yields of each component are reported as lb/A on a dry matter basis.

Results and Discussion

EPTC in combination with 2,4-DB, a standard herbicide treatment in new seeded alfalfa, was used as the reference herbicide treatment. This treatment resulted in excellent weed control (Table 1.) The initial injury to the alfalfa was due to the contact effect of the 2,4-DB and was only temporary.

Benefin plus 2,4-DB gave good weed control. However this combination gave somewhat weaker control of broadleaf weeds then EPTC plus 2,4-DB although the difference in broadleaf yield was non-significant.

Trifluralin at ½ lb/A resulted in poor crabgrass control. The control of crabgrass improved significantly when 3/4 lb/A was applied. However even at this rate control was marginal. Broadleaf weed control was excellent at both rates of trifluralin. Trifluralin injured the alfalfa by thinning out the stand. The 3/4 lb/A rate further produced stunting of the alfalfa. The reduced growth caused a significant decrease in alfalfa yield when compared with most of the herbicide treatments.

There was an improvement in crabgrass control with AC 92390 in 1974 when compared with the results obtained with this compound at the Storrs station in the previous year (1). AC 92390 gave marginal control of broadleaf weeds although the yield of broadleaves was not significantly different from the majority of the better treatments.

The combination of profluralin at all rates with 2,4-DB gave excellent over-all weed control. As the application rate of profluralin increased there was a corresponding decrease in crabgrass yields. The highest rate (3 lb /A) used resulted in slight but temporary injury to the alfalfa.

Dibutalin at 1½ and 3 lb/A gave good weed control when used as a preplant incorporated treatment. The addition of 2,4-DB did not enhance the control of broadleaf weeds. Dibutalin applied preemergence was less effective in controlling weeds, particularly crabgrass. The preemergence treatments injured the alfalfa, the higher rate being more phytotoxic. There

was a significant reduction in alfalfa yield caused by both preemergence rates when compared with similar rates applied preplant incorporated. The yield reduction in alfalfa resulted from some stand thinning but primarily from weed competition due to the poor weed control experienced, particularly with the 1½ lb/A treatment.

Good weed control was achieved with CGA 17020. Increasing the application rate from 1 to 2 lb/A resulted in better crabgrass control as reflected by the ratings of June 19 and July 22, 1974 and the yield of crabgrass at harvest although the difference in yield was not significant.

CGA 24705 gave good crabgrass control at 2 and 4 lb/A but was extremely weak in controlling broadleaf weeds. There was a significant increase in broadleaf yields when compared with the majority of treatments. Alfalfa was injured by both application rates, the 4 lb/A rate resulting in stand thinning. This combined with the added competition from poor broadleaf weed control significantly reduced alfalfa yields below most of the herbicide treatments.

All the herbicide treatments reduced crabgrass yields significantly compared to the untreated check.

All treatments except dibutalin applied preemergence, trifluralin and CGA 24705 at 4 lb/A resulted in significantly better alfalfa yields then the untreated check.

Dibutalin applied preemergence, trifluralin and CGA 24705 at 4 lb/A either resulted in poor weed control or alfalfa injury.

Literature Cited

1. Dest, W.M. , R.A. Peters, and A.C. Triolo. 1974. An evaluation of herbicides for crabgrass control in a new seeding of alfalfa. Proc. NEWSS 28:47-51.

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

Treatment			Crabgrass and Broadleaf Weed Control and Alfalfa Injury Ratings[1]						Yield-lb/A Dry Matter[2]		
			June 19,1974			July 22, 1974					
erbicide	Lbs. ai or ae/A	Type of Application	Crab-grass	Broad-leaf	Alfalfa	Crab-grass	Broad-leaf	Alfalfa	Alfalfa	Crab-grass	Broad-leaf
ntreated Check			0	2.5	0	0.2	3.8	0	1016gh	987a	213abc
PTC+2,4-DB	3+1	ppi+post	9.2	9.5	1.0	8.5	9.6	0	2033abcde	19d	10c
enefin+2,4-DB	1.12+1	ppi+post	8.8	8.7	0	7.8	6.0	0	1873abcde	29cd	120c
rifluralin	½	ppi	6.5	8.8	4.7	3.8	9.0	0	1481defg	479b	4c
rifluralin	3/4	ppi	8.0	9.2	7.3	6.0	8.2	3.3	857h	185cd	10c
rifluralin+2,4-DB	½+1	ppi+post	6.3	9.7	5.0	2.2	9.7	1.5	1133fgh	537b	4c
C 92390	1	ppi	7.3	8.8	1.2	5.8	6.5	1.0	1989abcde	105cd	102c
C 92390	2	ppi	9.2	7.7	0	6.7	4.5	0	1830abcde	68cd	189bc
C 92390+2,4-DB	2+1	ppi+post	9.2	9.3	0	8.5	9.5	0	2120ab	39cd	164c
rofluralin+2,4-DB	1+1	ppi+post	8.8	8.8	0	7.8	8.3	0	2452a	87cd	48c
rofluralin+2,4-DB	1½+1	ppi+post	9.0	9.7	0	7.8	9.0	0	1713bcde	62cd	29c
rofluralin+2,4-DB	3+1	ppi+post	9.0	9.3	1.8	8.8	7.7	0	1960abcde	19d	39c
ibutalin	1½	ppi	9.2	9.2	0	7.7	8.0	0	2047abcd	54cd	25c
ibutalin	3	ppi	9.2	9.7	0	8.3	9.3	0	2090ab	33cd	62c
ibutalin	1½+1	ppi+post	9.0	8.8	0	7.8	7.8	0	2076abc	83cd	58c
ibutalin	1½	pre	6.7	6.8	0.5	3.2	2.8	1.2	1452efg	465b	199abc
ibutalin	3	pre	8.2	8.8	4.7	7.7	5.3	0.8	1495cdefg	251bcd	55c
GA 17020	1	pre	7.8	8.0	0.3	6.3	5.8	0	1917abcde	305bc	22c
GA 17020	2	pre	9.5	8.8	0.8	7.6	7.8	1.0	2047abcd	77cd	48c
GA 24705	2	pre	8.8	5.2	3.5	6.8	3.3	0	1583bcdef	77cd	498ab
GA 24705	4	pre	9.2	4.3	7.5	9.5	2.5	0.8	843h	14d	570a

/ Rating 0=no effect 10=complete kill

/ 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
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
Trifluralin	4 lb/gal EC	a,a,a-trifluroro-2,6-dinitro-N,N-dipropyl-p-toluidine
AC 92390	3 lb/gal EC	N-sec-butyl-2,6-dinitro-3,4-xylidine
Profluralin	4 lb/gal EC	N-(cyclopropylmethyl)-a-a-a-trifluoro-2,6-dinitro-N-propyl-p-toluidine
Dibutalin	4 lb/gal EC	N-secondary-butyl-4-tert-butyl-2,6-dinitroaniline
CGA 17020	4 lb/gal EC	Unknown
CGA 24705	6 lb/gal EC	Unknown

Carbetamide on Common Chickweed in Semi-Dormant Alfalfa[1]

J. V. Parochetti and A. W. Bell[2]

ABSTRACT

In semi-dormant alfalfa (Medicago sativa L.), carbetamide (D-N-ethyllactamide carbanilate) at 8 lb/A and chlorpropham (isopropyl m-chlorocarbanilate), at 1 lb/A, affected 96 and 100%, respectively, control of chickweed (Stellaria media L. Cyrillo). Common dandelion (Taraxacum officinale Weber) was not controlled, and alfalfa was not injured. Although carbetamide at rates of 2 to 4 lb/A affected 40 to 83% common chickweed control, these common chickweed plants were stunted and deformed and not dead.

INTRODUCTION

This paper discusses the possible use of carbetamide for common chickweed control in alfalfa in comparison with the registered herbicide chlorpropham.

MATERIALS AND METHODS

An experiment was established at the Forage Research Farm, Clarksville, Maryland, in a heavy chickweed infestation. Established Williamsburg alfalfa (planted in June, 1971) was sprayed in the semi-dormant stage on March 15, 1973. An experimental bicycle sprayer delivering 30 gpa was used for all treatments.

Carbetamide was sprayed at 4 rates, 2, 3, 4, and 8 lb/A with one treatment of chlorpropham at 1.0 lb/A. A completely randomized block with three replications was used. Soil texture was silt loam with approximately 2% organic matter.

Weed control ratings were done on a percentage basis, recording the amount of control. One alfalfa cutting was made with yields expressed in tons/acre, based on oven dry weight.

RESULTS AND DISCUSSION

One early rating for weed control and alfalfa injury was made; only one alfalfa cutting was made because the fundamental concern was initial weed control and alfalfa injury. The dandelion infestation was not affected by any of the treatments. (Table 1.)

Chickweed control was found to be progressively better with each increase in rate of carbetamide. In spite of an acceptable 80% level of controlled chickweed at 3 lb/A, 8 lb/A were required to approximate the control obtained with chlorpropham. Chlorpropham at 1.0 lb/A affected 100% chickweed control.

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[1] Scientific Article No. A2054 and Contribution No. 5007 of the Maryland Agricultural Experiment Station, Department of Agronomy.

[2] Associate Professor and Agricultural Aid, respectively, Department of Agronomy, University of Maryland, College Park, Maryland 20742.

Carbetamide caused stunted and swollen leaves in the chickweed. Chickweed plants exhibited growth abnormalities at all rates of carbetamide. Affected plants died at higher rates, and surviving plants, although not dead at the first alfalfa harvest, were severely stunted and did not contribute fresh weight to the first harvest.

Because there were no differences between alfalfa yields, the data suggest that chickweed is not detrimental to alfalfa yields when hand-harvested.

ACKNOWLEDGEMENTS

The authors acknowledge and appreciate the computer time made available through the facilities of the Computer Science Center of the University of Maryland and to the Chipman Division Rhodia, Inc., Bound Brook, New Jersey for financial assistance.

Table 1. The effect of carbetamide and chlorpropham on winter weeds and semi-dormant alfalfa in 1973.

	May 4				June 1
Treatments	Rate (lb/A)	Control of Dandelion (%)	Control of Chickweed (%)	Alfalfa Stand Reduction (%)	Alfalfa Harvest (Tons/A)
1. Control	-	0	0	0	1.10
2. Carbetamide	2	0	40	0	1.22
3. Carbetamide	3	0	80	0	1.55
4. Carbetamide	4	0	83	0	1.33
5. Carbetamide	8	0	96	0	1.30
6. Chlorpropham	1.0	0	100	0	1.45
Bayes lsd	0.05	n.s.	11	n.s.	n.s.

PROCYAZINE FOR ANNUAL GRASS AND BROADLEAF CONTROL IN CORN

E. R. Higgins, M. G. Schnappinger and S. W. Pruss[1/]

ABSTRACT

Several corn (Zea mays L.) trials were conducted in Maryland and New York in 1973 and 1974 in order to obtain additional information on annual weed control with the new triazine herbicide, procyazine (2-[[4-chloro-6-(cyclopropylamino)-1,3,5-triazin-2-yl] amino]-2-methylpropanenitrile). Also evaluated in most of the tests were a 3:1 procyazine + atrazine, [2-chloro-4-(ethylamino) -6-(isopropylamino)-s-triazine] combination and a selected standard treatment of cyanazine, [2-chloro-4-(1-cyano-1-methylethylamino)-6-ethylamino-s-triazine].

Procyazine and cyanazine gave good control of most annual grass and broadleaf weeds; however, the 3:1 ratio of procyazine + atrazine increased the weed control spectrum over that obtained when procyazine was used alone.

Bioassay trials reveal that the biological activity of procyazine in soil is of short duration. As a result, fall and spring seeded rotational crops can be established in fields previously treated with this short residual triazine herbicide.

INTRODUCTION

There remains a continuous effort to develop a herbicide or combination of herbicides which will provide broad spectrum annual grass and broadleaf weed control with the added benefit of having minimal rotational restrictions.

The objectives of the tests represented herein were to (1) obtain additional information on the weed spectrum control by procyazine or procyazine + atrazine and (2) more clearly define whether or not certain rotational restrictions are necessary following use of procyazine in corn.

[1/] Senior Research Representatives & Research Manager, Northeast Region, Agricultural Division, CIBA-GEIGY CORPORATION, Washington, Pennsylvania

MATERIALS AND METHODS

The small plot corn tests discussed in this report were performed in 1973 and 1974 on medium textured soils in New York and Maryland. Predominant weed species at the test sites included: smooth crabgrass (Digitaria ischaemum), large crabgrass (Digitaria sanguinalis), fall panicum (Panicum dichotomiflorum), witchgrass (Panicum capillare), yellow foxtail (Setaria glauca), giant foxtail (Setaria faberii) common ragweed (Ambrosia artemisiifolia), lambsquarters (Chenopodium album), Pennsylvania smartweed (Polygonum pensylvanicum), prostrate pigweed (Amaranthus graecizans) and wild mustard (Brassica kaber).

Treatments were applied preemergence with a CO_2 powered small plot sprayer. Plots were 3.7M by 6.1 or 9.2M. The experimental design was a randomized complete block with 3 or 4 replications. After spraying, no further plot maintenance operations were performed.

Crops known to be sensitive to triazine herbicides were seeded over some tests in order to obtain additional information on soil persistence of procyazine. Visual ratings of crop response and weed control were made using a scale of 0 to 10: 0 = no effect on crop and/or weed; 7 = satisfactory or commercially acceptable weed control; 10 = complete kill or crop and/or weed. All untreated check plots were rated 0 and, thus, are not included in the data tables.

RESULTS AND DISCUSSIONS

Results of preemergence treatments of procyazine are shown in Tables 1 and 2. No corn tolerance data are tabulated since previous studies have revealed that corn is not injured by rates as high as 9 kg ai/ha of procyazine applied preemergence to medium textured soils.

It is apparent from Table 1 that procyazine has good preemergence activity against smooth crabgrass, large crabgrass, fall panicum and witchgrass. Control of these species was generally equal to that obtained with cyanazine or with a 3:1 ratio of procyazine + atrazine.

Both procyazine and cyanazine were weaker against yellow foxtail and giant foxtail than against the annual grasses cited previously. This response was especially evident with giant foxtail where even the highest rates of application failed to produce a commercially

acceptable level of control. Best control of yellow foxtail occurred on plots treated with the procyazine + atrazine combination. Reference data pertaining to use of this combination and for control of giant foxtail are not available.

Data presented in Table 2 suggest that all treatments were very effective against common ragweed, lambsquarters, Pennsylvania smartweed and wild mustard. Procyazine and cyanazine gave excellent prostrate pigweed control early in the season but both had weakened somewhat later when plot evaluations were made. The 3:1 procyazine + atrazine combination gave excellent season-long control of prostrate pigweed.

Bioassay tests performed in Maryland have shown that barley, wheat, oats, rye and alfalfa were not injured when planted only 60 days after spraying with up to 3.6 kg/ha procyazine. In addition, no procyazine injury to fall seeded winter wheat or spring seeded oats has been observed at 3 test locations in New York.

Table 2. Annual broadleaf weed control in corn following preemergence treatments with procyazine.

Treatments		Average Control Ratings 1/									
		Common Ragweed		Common Lambsquarter		Pennsylvania Smartweed		Prostrate Pigweed		Wild Mustard	
Materials(s)	Kg ai/ha	E 2/	L 2/	E	L	E	L	E	L	E	L
Procyazine	1.8	10	10	10	10	10	10	-	-	-	-
Procyazine	2.2	10	10	10	10	10	10	-	-	-	-
Procyazine	2.7	9.8(3)	10(3)	10	10	10	10	9.8	6.5	10	10
Procyazine	3.1	9.8(2)	10(2)	-	-	-	-	10	7.5	10	10
Procyazine	3.6	10(2)	10(2)	-	-	-	-	10	8.0	10	10
Cyanazine	1.8	-	-	-	-	-	-	-	-	-	-
Cyanazine	2.2	10	10	10	10	10	10	-	-	-	-
Cyanazine	2.7	9.5	9.7	-	-	-	-	10	6.0	10	10
Cyanazine	3.1	9.8(2)	9.9(2)	-	-	-	-	9.8	7.3	-	-
Cyanazine	3.6	10	10	-	-	-	-	10	8.5	-	-
Procyazine + Atrazine (3:1)	1.8	10	10	10	10	10	10	-	-	-	-
"	2.2	10	10	10	10	10	10	-	-	-	-
"	2.7	9.9(2)	10(2)	10	10	10	10	10	9.3	10	10
"	3.1	10	10	-	-	-	-	10	9.8	10	10
"	3.6	10	10	-	-	-	-	10	10	10	10

1/ Unless otherwise denoted in paranthesis, each datum represents a mean value calculated from one test.

2/ E = early rating; L = late rating.

Table 1. Annual grass control in corn following preemergence treatments with procyazine.

Treatments		Average Control Ratings 1/										
		Smooth Crabgrass		Large Crabgrass	Fall Panicum		Witchgrass		Yellow Foxtail		Giant Foxtail	
Material(s)	kg ai/ha	E 2/	L 2/	L	E	L	E	L	E	L	E	L
Procyazine	1.8	-	6.8	9.3	8.9	8.2(2)	-	-	-	-	-	-
Procyazine	2.2	-	-	9.8	-	9.3	-	-	-	-	-	-
Procyazine	2.7	10.0	7.7	9.3	9.4	8.8(2)	8.6(2)	7.9(2)	6.7(2)	6.3	5.3	2.3
Procyazine	3.1	10.0	8.0	-	-	-	9.4(2)	8.5(2)	7.9(2)	7.0	4.6	1.0
Procyazine	3.6	10.0	8.8(2)	-	9.8	9.3	9.9(2)	8.3(2)	7.3(2)	8.3	4.0	0.5
Cyanazine	1.8	-	7.9	-	9.3	8.3	-	-	-	-	-	-
Cyanazine	2.2	-	-	9.7	-	-	-	-	-	-	-	-
Cyanazine	2.7	10.0	8.0	-	9.4	8.4	9.0	9.0	-	-	-	-
Cyanazine	3.1	9.8	8.3	-	-	-	9.8(2)	7.9(2)	7.2(2)	7.0	5.0	3.0
Cyanazine	3.6	10.0	8.3(2)	-	9.7	9.1	10.0	7.8	-	-	-	-
Procyazine + Atrazine (3:1)	1.8	-	-	9.7	-	9.7	-	-	-	-	-	-
"	2.2	-	-	9.7	-	9.7	-	-	-	-	-	-
"	2.7	9.8	6.3	9.0	-	9.0	9.8	7.8	9.3	6.5	-	-
"	3.1	9.8	6.3	-	-	-	9.3	8.4	10.0	8.5	-	-
"	3.6	9.8	8.0	-	9.4	8.3	10.0	8.8	9.8	9.0	-	-

1/ Unless otherwise denoted in paranthesis, each datum represents a mean value calculated from one test.

2/ E = early rating, L = late rating.

ANNUAL WEED CONTROL IN FIELD CORN 1974[1]

Jonas Vengris[2]

Abstract

Excellent grassy annual weed control in field corn was obtained by (a) atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) + simazine (2-chloro-4,6-bis (ethylamino)-s-triazine), (b) cyanazine (2-(4-chloro-6-ethylamino-s-triazine-2-yl-amino)-2-methyl-propionitrile), (c) CGA24705[3], (d) procyazine (2-[(4-chloro-6-(cyclo-propylamino)-s-triazine-2-yl] amino]-2-methylpropionitrile), (e) eradicane (s-ethyl dipropylthiocarbamate + N. N-diallyl-2, 2-dichloroacetamide), (f) butylate (S-ethyl diisobutylthiocarbamate). These herbicides did significantly better weedy grass control than the standard atrazine and alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl) acet-anilide) treatment. Bifenox (methyl 5-(2',4'-dichlorophenoxy)-2-nitrobenzoate) controlled fall panicum better than crabgrass. Eradicane was significantly more effective in broad-leaved annual weed control than butylate. From all treatments metribuzin(4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-5(4H)-one) was most injurious to corn. Slight corn injury was observed by bifenox and postemergent cyanazine applications.

Introduction

The main objective of our 1974 trials was to determine the effectiveness and practicability of some of the new promising herbicides or herbicide combinations which would give better and practical annual weed control in field corn in Massachusetts.

Materials and Methods

The experiment was conducted at the South Deerfield experimental farm on a fine sandy loam with good drainage. A randomized block design with three replications was used. Each plot consisted of four rows 25 ft long. Fall panicum (Panicum dichotomiflorum Michx.) and crabgrass (Digitaria spp.) were dominant weeds and together represented 80-90 percent of the total weed population. The rest of the weed population consisted of yellow foxtail

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[1] Contribution of the Massachusetts Agricultural Experiment Station, College of Food and Natural Resources, University of Massachusetts, Amherst, Massachusetts.

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

[3] Ciba-Geigy Chemical Company.

(Setaria lutescens (Weigel) Hubb.), lambsquarters (Chenopodium spp.) and redroot pigweed (Amaranthus retroflexus L.). The experimental area was uniformly infested with all the above mentioned weed species.

The seedbed was prepared on May 20. The next day preplant treatments were applied and Agway 590 X field corn was planted. A list of treatments and their application dates are presented in Table1. Withthe exception of cyanazine 2 + 2 lb/A treatment, all combination treatments were applied as a tank mix. Rainy weather conditions immediately after the application of preemergent treatments created good conditions for herbicidal action. At postemergent treatment applications on June 7 (Table 1), weedy grass seedlings were in the 2 to 3 leaf stage of growth (± 2.5 cm tall).

Two weeks after corn emergence the experimental area was topdressed with ammonium nitrate at 75 lb/A nitrogen.

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

The effects of different treatments on weeds and corn were observed throughout the growing season. Weed stands in all plots were evaluated four times during the growing season and the average percentage weed control determined.

Results and Discussion

All herbicides or their combinations used in these trials significantly controlled both of the dominant weedy grasses, fall panicum and crabgrass. Practical grassy weed control was obtained (Table 1) with the following herbicides: (a) atrazine and simazine, 1 + 2 lb/A preemergent, (b) procyazine, 3.2 lb/A postemergent, (c) CGA 24705, 2.5 lb/A preplant, (d) CGA 24705 and procyazine preemergent, (e) cyanazine, 3 lb/A, (f) eradicane and (g) butylate, 4 lb/A preplant treatments. These treatments did significantly better weedy grass control than in accepted standard alachlor and atrazine treatments. Procyazine is a promising herbicide in fall panicum-crabgrass control. Postemergent applications were more effective than preplant or preemergent treatments. Also, combinations of CGA 24705 and procyazine are promising. Bifenox and atrazine were the worst treatments in grassy weed control. Close observations indicate that bifenox is rather good in fall panicum control and poor in crabgrass control.

Thinly scattered broadleaved weeds were satisfactorily controlled with all treatments except butylate and CGA 24705. It is interesting to note that eradicane as compared with butylate was more effective in broadleaved annual weed control.

Corn was somewhat stunted by cyanazine 2 + 2 lb/A, preemergent and postemergent treatment. At harvest time no injury effects were observed. After emergence, 5-6 weeks, the corn treated with bifenox had whitish lesions on its leaves. Later these injury marks disappeared completely. From all treatments metribuzin was most injurious to corn. This

Table 1. Effect of herbicidal treatments on annual weed control and yields of silage corn.

Treatments	Date of application	–% Control– GW	BW	Yields Check = 100
1. Check		0	0	100
2. Check, clean		100	100	166
3. Atrazine, 2 lb/A, Pre	5.22	41	100	151
4. Atrazine + Simazine, 1+2 lb/A, Pre	5.22	99	100	166
5. Procyazine, 2 lb/A, PPI	5.21	76	99	156
6. Procyazine, 3.2 lb/A, PPI	5.21	89	100	159
7. Procyazine, 2 lb/A, Pre	5.22	74	100	156
8. Procyazine, 3.2 lb/A, Pre	5.22	86	100	156
9. Procyazine, 2 lb/A, Post	6.7	84	100	154
10. Procyazine, 3.2 lb/A, Post	6.7	97	100	152
11. Procyazine + Atrazine, 2:1, 2 lb/A, Pre	5.22	70	100	161
12. Procyazine + Atrazine, 2:1, 3.2 lb/A, Pre	5.22	82	100	154
13. CGA-24705, 1.5 lb/A, PPI	5.21	82	19	160
14. CGA-24705, 2.5 lb/A, PPI	5.21	94	25	155
15. CGA-24705 + Atrazine, 1.5+1.0 lb/A, Pre	5.22	84	100	162
16. CGA-24705 + Procyazine, 1.5+1.5 lb/A, Pre	5.22	95	100	161
17. Alachlor + Atrazine, 2+1 lb/A, Pre	5.24	86	100	160
18. Cyanazine, 2 lb/A, Pre	5.24	88	99	164
19. Cyanazine, 3 lb/A, Pre	5.24	98	100	154
20. Cyanazine, 2+2 lb/A, Pre + Post	5.24+6.7	100	100	141
21. Eradicane, 4 lb/A, PPI	5.21	96	99	154
22. Butylate, 4 lb/A, PPI	5.21	100	27	159
23. Metribuzin, 0.4 lb/A, Pre	5.24	68	100	147
24. Metribuzin, 0.8 lb/A, Pre		80	100	91
25. Bifenox, 1.5 lb/A, Pre		37	100	151
LSD at 5%		9		17

injury affected corn yields significantly (Table 1). With the exception of 0.8 lb/A metribuzin rate, all treatments significantly increased corn yields as compared with weedy check.

PROGRESS REPORT ON THE USES OF CROP OIL CONCENTRATE ADJUVANT

FRANK S. BLACK[1]

In 1968 we introduced a new concept in adjuvants for herbicides. It was a non-phytotoxic oil-surfactant, 4 to 1 blend, with a research number of AL-411-A. The EPA exempt from tolerance list caused a minor change in the product with a new research number, AL-411-F. The common names given this type of adjuvant are "oil surfactant concentrate", or "crop oil concentrate". It is being marketed by thirteen different companies throughout the U.S. and Canada. In the Northeast it is being sold by Agway Inc. under the trade name of Booster Plus E.

This adjuvant was originally designed for use on corn post emergence with the herbicide atrazine which is still one of its major uses. Recently, it is being used in a combination spray of atrazine plus alachlor on corn. This use has been called a delayed pre emergence spray or early post spray and is applied up to the three-inch stage of corn growth. This use of AL-411-F has resulted in yield increases at two universities two years running.

AL-411-F use has been expanded to include the following herbicides on the crops indicated:

Herbicide	Crop	Level of AL-411-F*
Chloroxoron	soy beans	1 pint/25 gals.
Diuron	cotton	1 pint/25 gals.
Linuron	cotton	1 pint/25 gals.
Pyrazon	sugar beets	1 pint/25 gals.
Propanil	rice	1 pint/5 gals.
Dinoseb	soy beans	1 quart/25 gals.
2,4-Damine	turf	1 pint/25 gals.

*The level of the AL-411-F adjuvant is sometimes critical for crop safety and for best weed control.

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[1]AgChem Development Associate, ICI United States Inc., Wilmington, Delaware

Another large use for this adjuvant has been found with harvest aid chemicals. The general uses are listed below:

Harvest Aid	Crop	Level of AL-411-F
Endothall	potato top kill	2 quarts/acre
Dinoseb	potato top kill	2 quarts/acre
Tributyl phosphorothioate	cotton	1 quart/acre
Merphos	cotton	1 quart/acre
Sodium chlorate	cotton	1 quart/acre
Ametryne	dry beans	2 quarts/100 gals.

The following research studies are being recommended for future investigation of adjuvant effect and crop safety:

Timing	Herbicides	Crop	Level of AL-411-F
Post	Bentazan	soy beans	1 pint/25 gals.
Pre to cracking	Alachlor + Dinoseb	soy beans	1 quart/15 gals.
Pre	Alachlor + Linuron	soy beans	1 quart/15 gals.
Early post up to 3-leaf stage	Cyanazine	corn	1 pint/25 gals.
Pre 0-7 days after planting	Cyanazine + Alachlor	corn	1 quart/15 gals.
Early post	Atrazine + Dicamba	corn	1 quart/15 gals.

This adjuvant has also been found to definitely improve the activity of miticides, aphicides, fungicides, and growth regulators. Research with these pesticide chemicals is progressing and a few firm recommendations will be a commercial reality in 1975.

METHODS OF APPLYING ACTIVATED CHARCOAL

K. E. CLAPP[1]

Abstract

The effect of activated charcoal is often dependent on the method of application. A wide range of methods have been tested to produce the desired effect. Details of the proper techniques are presented with specific examples of the results.

The varied techniques discussed include dry application, broadcast or banded application of water slurries, root dipping, seed coatings, seed wafers and incorporation in potting soils. Special emphasis is given to the spray application of water slurries of activated charcoal. An expanded discussion is included on nozzles, mixing, agitation, pumps, tanks, etc. Specific recommendations are included on the choice of nozzles to produce a particular application rate of activated charcoal.

[1]Development Associate, Specialty Chemicals Division, ICI United States Inc.

EVALUATION OF HERBICIDES FOR USE ON NO-TILLAGE CORN IN A RYE COVER CROP

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

Abstract

Glyphosate at 1½ lb ai/A was slower than paraquat at ¼ lb ai/A to act, but completely killed rye (Secale cereale L.) in sufficient time to pose no problem in corn (Zea mays L.) development. Non-toxic weed oil combined with atrazine ec with or without 2,4-D or with simazine ec did not give the degree of rye kill obtained from glyphosate or paraquat. There was sufficient kill to give corn yields significantly greater than the control, however, yields were poor compared to the glyphosate and most paraquat treatments.

Herbicides effective in giving preemergence crabgrass control included simazine wp, alachlor, cyanazine, AC 92390, CGA-24705 and NIA 22486. Metribuzin was very active on crabgrass but depressed corn yields.

Treatments which failed to give early control of crabgrass depressed corn yields. Some materials failed to prevent crabgrass coming in late in the season. No correlation was found between late crabgrass and corn yields. In fact, there may be an advantage in no-tillage fields in having a soil cover of crabgrass which serves as a mulch during the non-cropping season.

Introduction

An adequate no-tillage herbicide treatment has both knock-down and residual activity. Paraquat has given generally excellent kill of existing vegetation, especially of small grain cover crops (1). Glyphosate has more recently been shown to be very active on grasses (2). A residual herbicide is needed, however, with either paraquat or glyphosate to control any weeds which may subsequently germinate. Paraquat has a high level of oral toxicity so it will very likely be placed on the EPA restricted herbicide list. Alternate chemical treatments for controlling existing vegetation which would fall in the general use category would serve a very useful function since growers would not need to be certified applicators to use them. The objective of the following experiment is to 1) compare some herbicide mixtures for knock-down of rye which contain no paraquat with mixtures containing paraquat, and 2) to evaluate various herbicides and mixtures of herbicides for crabgrass control.

Materials and Methods

Plots were located at the Agronomy Research Farm, University of Connecticut, Storrs on a Paxton fine sandy loam. Plots were fertilized with

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

1000 lb/A of 15-15-15. The experimental design was a randomized complete block design with four-row plots 12 by 25 feet replicated 3 times.

Agway 590X corn was planted on May 22, 1974 in 34 inch rows with a Bridger no-tillage planter. The rye at the time of corn planting was fully headed out. Herbicide treatments were applied on May 24 in 40 gal/A of water using a self-propelled small plot sprayer. The chemical identity of the herbicides used are given in the Appendix. All herbicide rates are in terms of active ingredient or acid equivalent per acre.

Rye and crabgrass control was evaluated by rating on a 0-10 scale. Silage corn yields were determined by taking samples on September 17, 1974 from the two center rows of each plot.

Results and Discussion

Rye control

Excellent rye control was obtained from the treatment containing glyphosate at 1½ lb/A and from all the treatments containing paraquat. Substitution of weed oil for paraquat or glyphosate resulted in slow and limited rye kill. Seven weeks after treatment (July 7) the weed oil + atrazine had resulted in 50% kill of the rye. Virtually no control was obtained from the oil + simazine combination. Four other treatments resulted in very poor rye control. These were cyanazine, cyanazine + alachlor, R-31401 and NIA 22486.

Crabgrass control

Crabgrass control from most of the residual herbicides was quite satisfactory. There were marked exceptions, however. As usual, crabgrass control was poor when only atrazine was used as a residual herbicide. The simazine wp formulation in contrast, gave excellent control. The simazine ec formulation gave very poor control but this can be traced to problems with the formulation used associated with incomplete suspension even after shaking the concentrate. This very likely resulted in an application rate less than the 2 lb ai/A specified.

Other treatments which failed to give satisfactory crabgrass control were R-31401, bifenox, dicamba + 2,4-D and atrazine + weed oil.

Despite excellent control as rated on July 7, the following residual materials did not prevent crabgrass growth late in the season: Cyanazine 1.6 lb, cyanazine plus alachlor 2.4 + 2 lb, NIA 22486, AC 92390 plus atrazine ec 1½ + 1 lb, and bifenox plus alachlor 1½ + 2. There was no effect, however, on corn yields from the ground cover of crabgrass which developed on these plots.

Silage corn yields

There was no significant difference between the glyphosate treatment with atrazine ec plus simazine ec and paraquat treatments with atrazine

plus alachlor, simazine plus alachlor, simazine wp or simazine ec plus atrazine ec. Yields were significantly lower, however, when atrazine wp or simazine ec was used with paraquat. This depression was associated with the poor control of crabgrass from these treatments.

Substitution of weed oil for paraquat or glyphosate resulted in corn yields significantly greater than the check but significantly less than the best three treatments. Part of the corn yield depression, however, could be assessed to the poor control of crabgrass from the atrazine. The four other treatments containing no paraquat also resulted in poor rye control and low corn yields.

AC 92390 with cyanazine or atrazine as residual herbicides with paraquat appears quite promising in terms of crabgrass control and corn yields.

Metribuzin alone or with alachlor gave excellent crabgrass control but corn injury was indicated from the depressed corn yields.

Literature Cited

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

2. Peters, R. A. Glyphosate for perennial sod kill in no-tillage corn. Proceedings NEWSS 27:1-6. 1973.

Appendix

Common Name	Chemical Name
AC 92390	N-sec-butyl-2,6-dinitro-3,4-xylidine
Alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide
Atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
Bifenox	methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate
CGA-24705	Unknown
Cyanazine	2-[[4-chloro-6-(ethylamino)-s-triazin-2-yl]amino]-2-methylpropionitrile
Dicamba	3,6-dichloro-o-anisic acid
Glyphosate	N-(phosphonomethyl)glycine
Metribuzin	4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one
NIA 22486	6-tert-butyl-3-isopropylisoxazolo-(3,4-d)pyrimidin-4(5H)-one
Paraquat	1,1-dimethyl-4,4',bipyridinium ion, dichloride salt
R-31401	Unknown
Simazine	2-chloro-4,6-bis(ethylamino)-s-triazine
Weed oil (Booster plus E)	Paraffin base oil (83%) + polyoxyethylene sorbitan fatty acid ester (16%)

Table 1. Evaluation of Herbicides for Rye and Crabgrass Control in No-Tillage Corn.

Chemical Treatment	Rate lb ai/A	Rye Control[1] 6/6	Rye Control[1] 7/7	Crabgrass Control[1] 7/7	Crabgrass Control[1] 9/16	Silage Yields T/A 30% DM
Glyphosate + atrazine ec + simazine ec	$1\frac{1}{2}$ + 1 + 2	7.0	10.0	10.0	7.0	20.1a[2]
Paraquat[3] + AC 92390 + cyanazine	$\frac{1}{4}$ + $1\frac{1}{2}$ + 2	8.7	10.0	10.0	9.7	18.8ab
Paraquat + simazine ec + alachlor	$\frac{1}{4}$ + 2 + 2	9.0	9.3	10.0	8.0	18.6ab
Paraquat + AC 92390 + atrazine ec	$\frac{1}{4}$ + $1\frac{1}{2}$ + 1	8.7	9.7	10.0	7.3	18.4abc
Paraquat + simazine wp	$\frac{1}{4}$ + 3	8.3	9.0	10.0	8.0	18.1abc
Paraquat + simazine ec + alachlor	$\frac{1}{4}$ + 1 + 2	8.7	10.0	10.0	7.3	17.9abc
Paraquat + simazine ec + CGA-24705	$\frac{1}{4}$ + 1.6 + 2	8.7	9.7	10.0	9.0	17.9abc
Paraquat + dicamba + atrazine ec	$\frac{1}{4}$ + $\frac{1}{2}$ + 2	8.7	10.0	9.7	9.0	17.5abc
Paraquat + simazine wp	$\frac{1}{4}$ + 2	7.7	9.3	9.3	6.7	17.1abc
Paraquat + atrazine ec + simazine ec	$\frac{1}{4}$ + 1 + 2	9.0	10.0	8.3	5.0	16.6abc
Paraquat + dicamba + 2,4-D	$\frac{1}{4}$ + 1/8 + $\frac{1}{4}$	8.7	9.7	5.0	5.0	16.6abc
Paraquat + atrazine ec	$\frac{1}{4}$ + 2	8.7	10.0	2.7	5.0	16.4abcd
Paraquat + cyanazine	$\frac{1}{4}$ + 1.6	8.7	9.7	8.7	5.7	16.4abcd
Paraquat + atrazine ec + alachlor	$\frac{1}{4}$ + 1 + 2	9.0	10.0	7.7	7.0	16.2abcd
Paraquat + atrazine ec + CGA-24705	$\frac{1}{4}$ + 1.6 + 2	9.0	10.0	10.0	8.7	15.6abcd
Paraquat + bifenox	$\frac{1}{4}$ + $1\frac{1}{2}$	8.3	9.7	2.7	5.0	15.6abcd
Paraquat + simazine ec	$\frac{1}{4}$ + 3	8.7	9.0	4.3	5.0	15.3abcde
Paraquat + metribuzin	$\frac{1}{4}$ + $\frac{1}{2}$	8.7	10.0	10.0	8.7	15.3abcde
Paraquat + bifenox + alachlor	$\frac{1}{4}$ + $1\frac{1}{2}$ + 2	9.0	9.7	9.0	5.7	14.9bcde
Paraquat + dicamba + 2,4-D	$\frac{1}{4}$ + $\frac{1}{4}$ + $\frac{1}{2}$	9.0	9.7	2.3	5.0	14.3bcde
Paraquat + atrazine wp	$\frac{1}{4}$ + 2	8.3	10.0	3.0	5.7	14.0bcde
Paraquat + simazine ec	$\frac{1}{4}$ + 2	9.0	9.0	4.7	5.3	13.6bcde
Cyanazine	2.4	2.7	5.3	10.0	7.7	13.6bcde
Simazine ec + weed oil + 2,4-D	2 + 1 qt + $\frac{1}{2}$	1.3	0.0	9.7	9.0	13.4bcde
Cyanazine + alachlor	2.4 + 2	1.0	1.0	9.7	6.0	12.7cde
Atrazine ec + weed oil	2 + 1 qt	3.0	5.0	3.0	5.0	12.5cde
Atrazine ec + weed oil + 2,4-D	2 + 1 qt + $\frac{1}{2}$	3.0	5.0	2.0	4.7	12.5cde
R-31401	2	2.3	2.0	4.3	5.0	12.5cde
Paraquat + metribuzin + alachlor	$\frac{1}{4}$ + $\frac{1}{2}$ + 2	9.0	10.0	10.0	9.0	10.8de
NIA 22486	1	1.3	0.7	10.0	6.3	10.2e
Control		0.0	0.0	2.2	0.9	3.1f

1/ Rating scale 0 - no effect; 10 - complete kill.

2/ Values followed by the same letter do not differ at the 5% level of significance according to the Duncan's Multiple Range Test.

3/ Paraquat Cl - $\frac{1}{4}$ lb ai/A plus X-77 at rate of 8 oz/100 gal carrier.

Field Evaluation of Surfactants with Paraquat[1]

J. V. Parochetti[2]

ABSTRACT

The effects of seven surfactants on paraquat (1,1'-dimethyl-4,4'-bipyritinium ion) toxicity when applied in a fertilizer solution on Kentucky bluegrass (Poa pratensis L.) and rye (Secale cereale L.) were evaluated. All surfactants significantly increased paraquat toxicity to Kentucky bluegreen and rye when compared to paraquat applied without a surfactant. Paraquat toxicity was reduced by the addition of atrazine. The addition of atrazine (2-Chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) was, however, necessary to prevent regrowth of bluegrass. At 16 oz/100 gal six different surfactants were equally effective in increasing paraquat toxicity with the exception of Miller's Aide which was initially less effective.

INTRODUCTION

The label directions for paraquat recommend the use of the non-ionic surfactant Ortho X-77 at the rate of 8 oz/100 gal of water. During the Spring of 1974 Ortho X-77 was in critically short supply. The purpose of the present study was to evaluate several non-ionic surfactants in combination with paraquat.

MATERIALS AND METHODS

Two field studies were conducted in 1973 and 1974. In both studies the liquid carrier was a 12-8-8 complete fertilizer solution made by reacting phosphoric acid and anhydrous ammonia and dissolving KCl into the resulting hot mixture. The fertilizer had no clay base.

An experimental bicycle sprayer was used to apply herbicides at 30 gpa. Both studies were randomized complete block designs with 4 replications. Plot size was 5 by 20 feet.

In 1973 bluegrass established for more than 2 years was treated on May 10. Rye was planted in the fall of 1973 and treated when 24 inches tall on April 24. Cover crop kill was visually estimated by estimating the percentage necrosis.

RESULTS AND DISCUSSION

Bluegrass Study. When observed 4 days after treatment, paraquat plus 8, 16, and 32 oz/100 gal solution caused greater bluegrass kill than paraquat

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[1] Scientific Article No. A 2053 and Contribution No. 5006 of the Maryland Agricultural Experiment Station, Department of Agronomy, College Park, Maryland.

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

without surfactant. When atrazine was added to paraquat plus Ortho X-77 and Miller's Aide surfactant, usually phytotoxicity was reduced when compared to paraquat plus surfactant alone. When comparing similar treatments of Miller's Aide and Ortho X-77 at 16 and 32 oz/100 gal solution there was less phytotoxicity with Miller's Aide (Table 1).

When observed at 18 days after treatment, paraquat plus any surfactant was not significantly different from paraquate alone. The addition of atrazine plus Ortho X-77 at 16 and 32 oz/100 gal solution significantly increased percentage kill compared to all treatments without atrazine.

When observed at 53 days after treatment, bluegrass in any treatment without atrazine was recovering as evidenced by the reduced phytotoxicity. Although paraquat caused initial rapid bluegrass kill, atrazine was needed to kill the regrowth of bluegrass.

Rye Study. Only 53% rye kill occurred when paraquat was applied in the liquid fertilizer carrier without a surfactant; this was significantly less than any of the treatments containing surfactants (Table 2). Of all the treatments with a surfactant only Miller's Aide at 16 oz/100 gal of solution resulted in significantly less rye kill, but at 8 oz/100 gal of solution Miller's Aide affected similar rye kill.

ACKNOWLEDGEMENTS

The author wishes to express appreciation to the Computer Science Center of the University of Maryland for the computer time made available and to Willard Chemical Company, Frederick, Maryland, for providing the fertilizer solution used in these studies.

Table 1. The kill of established bluegrass following treatment with paraquat at 0.5 lb/A in a 12-8-8 complete liquid fertilizer carrier with two surfactants at several concentrations alone and with atrazine in 1973.

Paraquat plus		Bluegrass Kill (%) Days after treatment			
Surfactant oz/100 gal	Atrazine	(4)	(18)	(45)	(53)
-	-	48.3	78.3	83.3	45.0
-	+	43.3	86.7	100.0	100.0
Ortho X-77 8	-	71.7	88.3	90.0	48.3
Ortho X-77 8	+	36.7	80.0	100.0	96.7
Ortho X-77 16	-	68.3	86.7	88.3	63.3
Ortho X-77 16	+	55.0	95.0	100.0	100.0
Ortho X-77 32	-	65.0	81.7	81.3	21.7
Ortho X-77 32	+	55.0	99.0	100.0	100.0
Miller's Aide 8	-	65.0	80.0	90.0	43.3
Miller's Aide 8	+	48.3	85.0	100.0	100.0
Miller's Aide 16	-	45.0	86.7	86.7	66.7
Miller's Aide 16	+	45.0	88.3	99.7	100.0
Miller's Aide 32	-	58.3	85.0	83.3	48.3
Miller's Aide 32	+	43.3	83.3	99.7	100.0
	Bayes LSD 0.05	8.3	9.7	8.4	24.2

[a]The + indicates 2.5 lb/A of atrazine as the 80% wettable powder formulation was used; the - indicates no atrazine used.

Table 2. Rye kill following treatment with 0.25 lb/A of paraquat applied in a 12-8-8 complete liquid fertilizer carrier with several surfactants at 8 and (6 oz) 100 gal of solution in 1974.

Surfactant[a]	Rye Kill (%) 4 Days after treatment	
None, only paraquat	53	
	(8 oz/100 gal)	(16 oz/100 gal)
Ortho X-77	75	80
WEX	73	78
Amway Spray Adjuvant	80	83
LOC, regular	80	78
Miller's Aide	73	65
Agway 144-2	73	83
LC	83	81
Bayes LSD 0.05	8	

[a]All treatments included paraquat.

POTENTIAL FOR NO-TILLAGE CORN IN CROWNVETCH SODS[1/]

D. L. Linscott and R. D. Hagin 2/

In 1974, a sod of crownvetch (Coronilla varia L.) located at Aurora, New York was sprayed with herbicides prior to seeding of corn (Zea mays L.) with a no-tillage planter. The objective was to control vegetation sufficiently to obtain a satisfactory corn yield while retaining sufficient crownvetch for ground cover in the

Herbicides were applied to crownvetch 25 cm tall on May 22. Corn, variety Cornell M-3, was seeded at 30,000 kernels/A on May 28. At planting, 260 lb/A of 10-20-20 (N-P_2O_5-K_2O) fertilizer and 1 lb/A of granular carbofuran were applied in bands. Yield and cover data were taken October 9.

Treatment	Rate	Grain corn yield	Crownvetch yield	Crownvetch cover
	lb/A	bu/A	lb/A	%
Control	1/2	32 g	2490 a	98 a
Paraquat	1/2	38 g	2080 a-e	90 ab
Glyphosate	1/2	54 f	2240 abc	91 ab
2,4-D	1/2	28 g	2350 ab	97 a
Atrazine	2	78 e	1870 b-e	90 ab
Simazine	2	67 ef	2150 a-d	89 b
Paraquat, Atrazine	1/2,2	97 bcd	1520 efg	57 cde
Glyphosate, Atrazine	1/2,2	92 d	1330 fgh	65 cd
Paraquat, Simazine	1/2,2	98 bcd	1690 c-f	68 c
Glyphosate, Simazine	1/2,2	93 cd	1680 def	70 c
Paraquat, Atrazine, 2,4-D	1/2,2,1/2	112 ab	1210 gh	40 fg
Glyphosate, Atrazine, 2,4-D	1/2,2,1/2	102 bcd	1600 d-g	63 cd
Paraquat, Simazine, 2,4-D	1/2,2,1/2	109 abc	1320 gh	39 fg
Glyphosate, Simazine, 2,4-D	1/2,2,1/2	114 ab	1050 gh	43 efg
Glyphosate, Atrazine	1/2,4	110 abc	1320 gh	50 def
Glyphosate, Atrazine, 2,4-D	1/2,4,1/2	123 a	800 h	33 g

Means (5 rep) followed by identical letters are not different (5% level).

At the experimental site, the long term average of corn yield is 110 bu/A with conventional tillage, weed control and fertilization practices. By comparison several of the herbicide combinations in this no-tillage study resulted in equal or better yields. The 4 lb/A rate of atrazine plus glyphosate and 2,4-D at 1/2 lb/A damaged crownvetch too severely for satisfactory fall ground cover. However, corn yielded most with this combination. The 1974 results confirm data of previous years and give further credence to the potential for no-tillage corn in sods of crownvetch.

1/ Cooperative investigations, Agricultural Research Service, U.S. Department of Agriculture and Cornell University, Ithaca, NY 14853.

2/ Research Agronomists, North Atlantic Area, Agricultural Research Service U.S. Department of Agriculture.

SUPPRESSION OF PERENNIAL LEGUME AND GRASS COVER CROPS FOR NO-TILLAGE CORN

N. L. Hartwig and L. D. Hoffman[1/]

Abstract

Maximum dry matter production of corn grain plus corn stover with cover crop regrowth was the objective. Over 12,000 lbs of DM yield per acre was obtained with atrazine-simazine-bentazon, atrazine-simazine-paraquat-bentazon, atrazine-cyanazine-bentazon, and cyanazine-paraquat-bentazon on birdsfoot trefoil (Lotus corniculatus) and atrazine-simazine-dalapon-bentazon on a birdsfoot trefoil-smoothbrome (Bromus inermis) mixed sod. Consistent treatments across all sods were those containing atrazine and simazine, atrazine and cyanazine, or cyanazine alone or in combination with dalapon or paraquat. Ease of suppressing the three sod species varied from the easiest, birdsfoot trefoil, crownvetch (Coronilla varia), to smoothbrome being the most difficult. Birdsfoot trefoil was suppressed so severely in some cases that there was very little regrowth, especially when it was growing in combination with smoothbrome. Smoothbrome in the sod mixture increased control of redroot pigweed (Amaranthus retroflexus) and yellow foxtail (Setaria lutescens) but it did not result in increased corn or total dry matter yields. Crownvetch was the easiest to manipulate without danger of losing it.

Introduction

The success of no-tillage corn depends upon the presence of a mulch to slow soil erosion and rain water runoff, increase infiltration and reduce surface soil evaporation losses. Where corn was to follow corn or small grains, it was necessary to establish a cover crop every fall to provide the mulch. A perennial cover crop that could be suppressed so as not to compete excessively with the corn but still recover in the fall of the year to provide winter cover and a living mulch for next years crop would be ideal. A legume cover crop has the added advantage of not competing for nitrogen and if managed correctly may actually contribute some nitrogen to the crop. Smoothbrome was included because work at West Virginia has shown that corn growth was stimulated when planted into suppressed smoothbrome. Sod species which have the ability to spread by underground rootstocks or rhizomes such as crownvetch or smoothbrome is a necessary asset for a good cover crop. The possible reestablishment by seed is a possible alternate method to maintain a cover crop for as long as desired without the necessity for reseeding every year.

[1/] Assistant Professor of Weed Science and Assistant Professor of Agronomy, Pennsylvania State University, University Park, Pa. 16802.

Methods and Materials

This trial was established at University Park, Pa. on a Murrill Silt Loam made up of 16% sand, 67% silt, 14% clay and 2.5% organic matter with a cation exchange capacity of 10.7. No lime was applied and the average soil pH was 6.5. Four different perennial sods were established on August 11, 1972. These sods and seeding rates were Viking birdsfoot trefoil at 8 lb/A and Penngift crownvetch at 6 lb/A alone and in combination with Lincoln smoothbrome at 6 lb/A. The new seedings were harvested once for hay in 1973. Eighteen different herbicide treatments were applied to each sod strip on April 30, 1974 with a small plot sprayer in 20 gallon per acre of water with an 80015 low pressure nozzle (15 psi). Smoothbrome spring growth was 8 to 10 inches and crownvetch and birdsfoot trefoil showed 4 to 6 inches of new growth at this time. Funks 4444 (120 day) corn hybrid was planted 8 days later on May 8, 1974 at a population of approximately 25,000 plants per acre in 38 inch rows with an Allis Chalmers no-tillage 4 row corn planter. Plots consisted of 4 rows of corn, 20 feet long. Rainfall and soil moisture was adequate but not excessive. A post treatment of 1 lb/A active bentazon and 1/2 pint/A of Citowett, was broadcast over all plots to control yellow nutsedge which was invading some plots. It was applied on June 17 when the corn was 12 inches and the yellow nutsedge 4 to 6 inches tall. The corn was fertilized according to soil test. All corn stand and yield data was taken from the center two corn rows. Corn stover silage yields were obtained after grain harvest. A small plot flail forage harvester was used to harvest a 3 foot strip over one of the two middle corn rows for the full length of the plot.

Results and Discussion

The first and perhaps obvious conclusion is that how well a particular herbicide or herbicide mixture works depends on the species composition of the sod being treated (Table 1). In general, the greater the sod suppression, the higher the corn yields with maximum yields obtained when the sods were almost wiped out. However, I am most interested in a treatment that will produce a reasonable corn grain yield but at the same time allow the cover crop to recover in the fall and total dry matter yield is probably a better measure of this goal. Those treatments that produced over 12,000 lbs of DM yield per acre were atrazine-simazine-bentazon, atrazine-simazine-paraquat-bentazon, atrazine-cyanazine-bentazon and cyanazine-paraquat-bentazon on birdsfoot trefoil and atrazine-simazine-dalapon-bentazon on a birdsfoot trefoil-smoothbrome mixed sod. Birdsfoot trefoil was more easily suppressed than crownvetch or smoothbrome. Bentazon contributed nothing to the sod control as shown by treatment 18 and would be needed only if yellow nutsedge were a problem.

The treatments that were most consistent on all sods were those containing atrazine and simazine (Treatments 5, 6, 7), atrazine and cyanazine (Treatments 8, 9, 10) or cyanazine (Treatments 14, 15, 16). Cyanazine and alachlor (Treatments 11, 12, 13) suppressed birdsfoot trefoil but was too weak to suppress crownvetch or smoothbrome at the rates used. The addition of

dalapon or paraquat to atrazine-simazine or cyanazine improved sod suppression which resulted in higher corn yields. Excessive control of birdsfoot trefoil may have been obtained when dalapon was included. The addition of dalapon or paraquat to atrazine-cyanazine or cyanazine-alachlor mixtures did not improve suppression of birdsfoot trefoil or crownvetch but it did help in suppressing smoothbrome.

The pronomide-metribuzin combination caused too much corn stand reduction when applied 8 days prior to planting but may have looked much better if applied a month or two ahead of planting.

Suppression of birdsfoot trefoil and crownvetch was much easier and sometimes excessive when they were grown in combination with smoothbrome due to reduced legume vigor caused by competition from the smoothbrome.

The control of redroot pigweed and yellow foxtail was generally improved when crownvetch or smoothbrome were present. Since birdsfoot trefoil was suppressed more than the other two species, redroot pigweed and yellow foxtail were more of a problem in these plots when not effectively controlled by the herbicide treatment.

Corn stands and yields were much better in the birdsfoot trefoil than any of the other cover crops as shown by the average over all 18 herbicide treatments.

In summary, I question the value of smoothbrome in the mixture. Corn stand and yields were the greatest on birdsfoot trefoil but excessive suppression in some cases may mean there won't be enough sod cover for future use. Crownvetch I feel is easier to manipulate without danger of losing it.

Table 1. Herbicide suppression of birdsfoot trefoil, crownvetch and smoothbrome and the resulting effect on redroot pigweed and yellow foxtail control plus the total effect on corn stand, corn grain yield, corn stover silage yield and total dry matter yield per acre.

Treatment					Species Ratings[b] 9-4-74					Corn Stand	Corn Yield	Silage DM Yield[c]	Total DM Yield
No.	Herbicide	Rate lb ai/A	Timing	Cover Crop[a]	CV	BFT	SB	Pig	YF	Plants/A	bu/A	bu/A	lb/A
1	pronamide +	1.0	PP	BFT + SB	--	90[d]	22	94	84	11,520	47.0	5,426	7,650
	metribuzin +	1.0	PP	BFT	--	52	--	60	57	17,195	97.2	5,868	10,468
	bentazon	1.0	Post	CV + SB	45	--	62	100	92	11,348	40.0	5,047	6,940
				CV	35	--	--	100	78	11,864	66.4	5,960	9,102
2	dalapon +	3.0	PP	BFT + SB	--	80	12	99	100	14,444	29.0	5,226	6,598
	bentazon	1.0	Post	BFT	--	0	--	92	96	12,036	37.2	4,463	6,223
				CV + SB	30	--	25	100	99	13,584	20.2	4,658	5,614
				CV	0	--	--	99	98	14,959	41.6	5,054	7,022
3	paraquat +	.25	PP	BFT + SB	--	98	0	100	98	15,131	21.2	5,729	6,732
	bentazon	1.0	Post	BFT	--	45	--	90	5	19,430	62.6	5,395	8,357
				CV + SB	70	--	10	100	98	13,928	18.4	5,952	6,823
				CV	25	--	--	97	50	17,367	16.8	5,176	5,971
4	glyphosate +	1.0	PP	BFT + SB	--	98	28	99	92	17,710	32.8	5,790	7,342
	bentazon	1.0	Post	BFT	--	99	--	42	0	21,837	81.4	6,562	10,414
				CV + SB	72	--	28	99	88	19,258	34.9	5,203	6,854
				CV	85	--	--	50	0	17,882	47.6	5,162	7,414
5	atrazine +	1.0	PP	BFT + SB	--	80	78	100	98	15,647	93.3	5,766	10,181
	simazine +	1.0	PP	BFT	--	52	--	90	90	20,634	106.8	7,612	12,666
	bentazon	1.0	Post	CV + SB	70	--	70	100	99	18,398	85.3	5,066	9,102
				CV	62	--	--	99	92	18,398	101.4	5,742	10,540

Table 1. cont.

Treatment					Species Ratings[b] 9-4-74					Corn Stand	Corn Yield	Silage DM Yield[c]	Total DM Yield
No.	Herbicide	Rate lb ai/A	Timing	Cover Crop[a]	CV	BFT	SB	Pig	YF	Plants/A	bu/A	lb/A	lb/A
6	atrazine +	1.0	PP	BFT + SB	--	85[d]	80	99	99	17,710	104.0	7,108	12,029
	simazine +	1.0	PP	BFT	--	95	--	100	100	22,353	121.0	5,034	10,760
	dalapon +	3.0	PP	CV + SB	80	--	90	100	98	18,570	99.8	5,497	10,220
	bentazon	1.0	Post	CV	80	--	--	99	92	18,398	101.4	5,742	10,540
7	atrazine +	1.0	PP	BFT + SB	--	96	85	90	98	17,710	103.6	5,875	10,777
	simazine +	1.0	PP	BFT	--	78	--	95	99	22,353	120.4	7,094	12,791
	paraquat +	.25	PP	CV + SB	65	--	85	100	99	18,914	101.4	6,507	11,305
	bentazon	1.0	Post	CV	88	--	--	97	97	17,023	84.5	4,958	8,956
8	atrazine +	1.0	PP	BFT + SB	--	96	48	100	54	15,475	87.2	5,202	9,328
	cyanazine +	2.0	PP	BFT	--	92	--	95	92	20,978	114.5	7,276	12,694
	bentazon	1.0	Post	CV + SB	60	--	90	100	99	19,086	90.4	4,864	9,142
				CV	75	--	--	90	72	18,393	91.0	6,151	10,457
9	atrazine +	1.0	PP	BFT + SB	--	89	82	100	95	17,882	95.4	6,625	11,140
	cyanazine +	2.0	PP	BFT	--	98	--	80	82	22,009	100.0	6,183	10,915
	dalapon +	3.0	PP	CV + SB	88	--	95	100	99	18,914	104.7	5,524	10,478
	bentazon	1.0	Post	CV	80	--	--	92	82	18,398	117.1	6,096	11,637
10	atrazine +	1.0	PP	BFT + SB	--	96	88	78	98	18,226	101.3	5,516	10,310
	cyanazine +	2.0	PP	BFT	--	79	--	88	92	21,150	104.4	5,859	10,800
	paraquat +	.25	PP	CV + SB	70	--	78	100	92	18,570	87.4	5,539	9,675
	bentazon	1.0	Post	CV	82	--	--	95	78	19,086	80.9	5,766	9,594
11	cyanazine +	2.0	PP	BFT + SB	--	99	32	98	90	13,756	43.4	5,598	7,652
	alachlor +	2.0	PP	BFT	--	89	--	58	38	20,978	115.8	5,715	11,195
	bentazon	1.0	Post	CV + SB	50	--	58	99	98	16,851	62.1	5,508	8,446
				CV	45	--	--	94	88	16,851	51.4	5,687	8,119

Table 1. cont.

Treatment					Species Ratings[b] 9-4-74					Corn Stand	Corn Yield	Silage DM Yield[c]	Total DM Yield
No.	Herbicide	Rate lb ai/A	Timing	Cover Crop[a]	CV	BFT	SB	Pig	YF	Plants/A	bu/A	lb/A	lb/A
12	cyanazine +	2.0	PP	BFT + SB	--	99[d]	60	85	85	18,742	58.1	5,416	8,165
	alachlor +	2.0	PP	BFT	--	69	--	85	58	22,181	109.6	6,674	11,860
	dalapon +	3.0	PP	CV + SB	55	--	50	100	95	17,367	46.6	5,526	7,731
	bentazon[e]	1.0	Post	CV	72	--	--	60	37	19,774	83.5	5,372	9,323
13	cyanazine +	2.0	PP	BFT + SB	--	90	52	94	90	17,539	66.7	6,420	9,576
	alachlor +	2.0	PP	BFT	--	52	--	62	45	20,806	84.8	6,734	10,747
	paraquat +	.25	PP	CV + SB	55	--	40	99	97	19,946	48.6	5,337	7,637
	bentazon	1.0	Post	CV	48	--	--	95	82	17,023	78.6	6,487	10,206
14	cyanazine +	3.0	PP	BFT + SB	--	98	68	94	98	17,882	104.2	6,588	11,519
	bentazon	1.0	Post	BFT	--	60	--	48	80	22,697	89.2	5,513	9,734
				CV + SB	45	--	65	98	98	17,882	72.9	6,186	9,636
				CV	50	--	--	65	62	16,507	71.6	5,925	9,313
15	cyanazine +	3.0	PP	BFT + SB	--	95	58	94	92	19,946	67.2	5,637	8,817
	dalapon +	3.0	PP	BFT	--	98	--	35	48	18,398	95.1	6,474	10,974
	bentazon	1.0	Post	CV + SB	60	--	68	94	98	18,226	87.4	6,113	10,249
				CV	75	--	--	60	40	17,539	99.5	7,048	11,756
16	cyanazine +	3.0	PP	BFT + SB	--	92	78	72	90	17,882	98.0	5,954	10,591
	paraquat +	.25	PP	BFT	--	90	--	30	78	19,946	98.8	7,566	12,241
	bentazon	1.0	Post	CV + SB	40	--	75	98	75	17,538	79.4	6,189	9,946
				CV	62	--	--	89	82	18,398	80.6	5,882	9,696
17	cyanazine +	1.0	PP	BFT + SB	--	98	58	100	98	17,023	73.7	5,803	9,290
	bentazon	1.0	Post	BFT	--	62	--	100	96	19,774	95.4	5,974	10,488
				CV + SB	60	--	68	100	100	18,226	68.5	5,383	8,624
				CV	55	--	--	100	90	18,914	100.6	5,970	10,730

Table 1. cont.

Treatment					Species Ratings[b] 9-4-74					Corn Stand	Corn Yield	Silage DM Yield[c]	Total DM Yield
No.	Herbicide	Rate lb ai/A	Timing	Cover Crop[a]	CV	BFT	SB	Pig	YF	Plants/A	bu/A	lb/A	lb/A
18	bentazon	1.0	Post	BFT + SB	--	99	0	100	100	0	0.0	5,341	5,341
				BFT	--	5	--	96	96	8,253	37.5	5,078	6,852
				CV + SB	55	--	0	100	100	0	0.0	5,236	5,236
				CV	0	--	--	98	100	5,674	7.5	4,615	4,970
	Average of all 18 herbicide treatments on each cover crop.			BFT + SB	--	93	52	94	92	15,790	68.1	5,834	9,056
				BFT	--	68	--	75	70	19,611	92.9	6,171	10,567
				CV + SB	59	--	59	99	96	16,478	63.8	5,518	8,537
				CV	57	--	--	88	73	16,745	73.8	5,717	9,209

a/ BFT = birdsfoot trefoil, CV = crownvetch, SB = smoothbrome.

b/ All ratings are percent control, CV = crownvetch, BFT = birdsfoot trefoil, SB = smoothbrome, pig = redroot pigweed, YF = yellow foxtail.

c/ Silage dry matter yields are yields of corn stover and regrowth of cover crop taken after the corn was harvested for grain.

d/ All values are an average of 2 replications.

e/ cyanazine, alachlor and dalapon do not mix.

Perennial Soil Conserving Cover Crops for No-Till Corn

L. D. Hoffman and N. L. Hartwig[1/]

ABSTRACT

Three research trials were conducted using various preplant herbicides for no-till corn planted into established sods of the following species; orchardgrass (Dactylis glomerata), smoothbrome (Bromus inermus), crownvetch (Coronilla varia), birdsfoot trefoil (Lotus corniculatus), plus combinations of smoothbrome and each of the above mentioned legumes. In each trial the objective was to suppress the sod, but allow some recovery by fall to continually have a soil conserving cover crop available over the winter months.

The soil conservation benefits of no-till corn is well documented. There are many areas, however, not suitable for row crop production prior to the no-till concept that are now being utilized for no-till corn production, where soil losses can and do occur.

This paper is presented to discuss; the amount of cover crop available by November 1st and its affect on the yield of corn, the amount of crop residue available for late fall or early spring grazing, and the nitrogen contribution by crownvetch to the corn crop.

Several of the short residue triazines look very promising when corn is planted into orchardgrass; ie, CGA-18762 + CGA-24705 + Paraquat (1,1-dimethyl 1-4, bipyridium dichloride) and cyanazine plus paraquat. While both of the above treatments and others showed a slight reduction in yield accompanied by more than 50% ground cover by November 1, a farmer may be forced to accept them as a management tool in view of pending clean streams legislation if he wishes to grow corn on certain acreage in the Northeast.

Further evaluation of short residual herbicides is needed to develop timing and rates which will give consistent early season control of existing soils with recovery of those sods late in the growing season.

[1/]Assistant Professor of Agronomy and Assistant Professor of Weed Science, respectively, The Pennsylvania State University, University Park, Pa. 16802.

FALL PANICUM CONTROL IN NO-TILLAGE CORN

N. L. Hartwig[1/]

Abstract

Increasing soil pH in the zone of major herbicide activity resulted in improved fall panicum (Panicum dichotomiflorum Michx.) control for all treatments except atrazine-cyanazine-paraquat, cyanazine and cyanazine-paraquat at the highest soil pH of 7.1. Long residual herbicides such as simazine may be applied up to one month in advance of planting without loss of fall panicum control. The addition of alachlor and paraquat to cyanazine did not improve fall panicum control as compared to cyanazine alone. Paraquat used in combination with atrazine and simazine, atrazine and cyanazine or cyanazine alone did not increase control of fall panicum in the 2 leaf stage or increase corn yields compared to the use of these herbicides without paraquat. AC 92553 gave good fall panicum control and it was improved when used in combination with atrazine.

Introduction

The control of fall panicum as well as crabgrass (Digitaria sanguinalis (L.) Scop.) and witchgrass (Panicum capillare L.) is not effectively controlled with alachlor in no-tillage corn. Simazine and cyanazine have been used for control of these annual grasses in no-tillage corn but soil pH is known to have an effect on the activity of these herbicides on soils with a cation exchange capacity of 5.0 to 10.0 or more. This trial was designed to determine which herbicides will control fall panicum in no-tillage corn and what effect soil pH has on their activity.

Materials and Methods

This trial was established at University Park, Pa. on a Hagerstown Silt Loam soil made up of 10% sand, 67% silt, 20% clay and 2.5% organic matter with a cation exchange capacity of 12.4. Strips were limed at 3 levels on March 29, 1973; 0#/A, 2000#/A and 4000#/A. Approximately one year later when the first herbicides were applied, the average pH of the surface inch of soil was 6.0 at 0#/A, 6.5 at 2000#/A and 7.1 at 4000#/A. Fourteen different herbicide treatments were applied to each limed strip at various intervals with a small

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[1/] Assistant Professor, Department of Agronomy, Pennsylvania State University, University Park, Pa. 16802.

plot sprayer in 20 gallon per acre of water with an 80015 low pressure nozzle (15 psi). Some treatments were applied on April 17, 1974, 29 days before planting and before there was any fall panicum germination. Most treatments were applied on May 8, 1974, 8 days before planting and just as the fall panicum was starting to germinate. One treatment was applied post-emergence on May 28, 12 days after planting when the corn and fall panicum were in the 2 leaf stage. Funks 4445 (120 day) corn hybrid was planted to a stand of approximately 25,000 plants per acre in 38 inch rows with an Allis Chalmers no-tillage 4-row corn planter on May 16, 1974. Plots consisted of 4 rows of corn, 20 feet long. Rainfall and soil moisture was adequate, but not excessive for all herbicide treatments and corn germination. The corn was fertilized according to soil test. All corn stand and yield data was taken from the center two corn rows. Fall panicum dry matter yields were determined from a .5 sq. meter quadrat, hand harvested on September 5, 1974.

Results and Discussion

Although soil conditions at time of planting were ideal, there was still a loss of 40 to 50% of the stand due to unknown reasons. There was a trend of decreased stands with an increase in the pH of the surface inch of soil as was indicated by the hoed check (Table 1). This may be the reason why corn yields for most treatments did not increase when the soil pH increased to 7.1.

Fall panicum control improved with an increase in soil pH for all treatments except atrazine-cyanazine-paraquat, cyanazine and cyanazine-paraquat at the 7.1 soil pH level. Corn stands decreased somewhat at this pH level which decreased the competition provided by the corn and due to the short residue of cyanazine, chemical control was not sufficient to hold the fall panicum in check.

The long residual herbicide, simazine, may be applied a month ahead of planting without losing fall panicum control as shown by a comparison of treatments 1 and 6. Increased soil pH also improved fall panicum control but due to a decrease in corn stand, there was a decrease in corn yield.

FMC 25213 caused too much corn injury which resulted in very low yields.

AC 92553 gave good control of fall panicum at both the 1.5 and 2.0 lb rates. Control improved somewhat as soil pH increased. Best control was obtained at pH levels above 6.5 when it was tank mixed with atrazine.

Alachlor and paraquat used in combination with cyanazine did not improve fall panicum control as compared to cyanazine alone. Paraquat used in combination with atrazine and simazine, atrazine and cyanazine or cyanazine alone did not improve fall panicum control or increase corn yields over the use of these herbicides without paraquat. The fall panicum was just beginning growth when these herbicides were applied and I'm sure the need for paraquat increases as the size of the fall panicum increases.

Table 1. Effect of soil pH on the activity of some herbicides for the control of fall panicum in no-tillage corn, University Park, Pa. - 1974.

Treatment			Days to Plant-ing[a]	Soil pH, Surface inch	Control Rating[b]		Fall Panicum DM Yields	Corn Stand	Corn Yield
No.	Herbicide	Rate lb ai/A			6-27	9-25	lb/A	Plants/A	bu/A
1	atrazine 80W +	1.0	-29	6.0	80[c]	85	1415	15,475	100.9
	simazine 80W	2.0	-29	6.5	87	93	1188	14,558	99.8
				7.1	92	97	489	12,266	82.6
2	FMC 25213	2.0	-29	6.0	88	83	1223	13,756	48.9
				6.5	97	72	2690	10,890	31.7
				7.1	95	90	803	15,017	42.3
3	AC 92553	1.5	- 8	6.0	75	87	1467	16,736	92.0
	(Prowl (3EC))			6.5	80	89	1397	14,787	88.4
				7.1	82	87	629	14,787	95.0
4	AC 92553	2.0	- 8	6.0	92	93	1781	10,546	73.9
	(Prowl (3EC))			6.5	83	91	1083	15,361	103.4
				7.1	90	95	1188	14,214	89.2
5	AC 92553	1.5	- 8	6.0	87	91	2515	14,444	79.5
	(Prowl (3EC))+			6.5	87	94	1293	11,807	79.3
	atrazine 4L	1.0	- 8	7.1	92	97	506	17,883	93.3
6	atrazine 4L +	1.0	- 8	6.0	72	53	2515	13,756	71.3
	simazine 4L	1.0	- 8	6.5	82	85	1991	17,424	115.7
				7.1	85	82	908	15,246	88.6
7	atrazine 4L +	1.0	- 8	6.0	73	68	2865	13,870	89.1
	simazine 4L +	1.0	- 8	6.5	78	80	1607	13,412	79.6
	paraquat	.25	- 8	7.1	82	85	1257	16,507	103.6
8	atrazine 4L +	1.0	- 8	6.0	75	77	2410	10,661	83.3
	cyanazine 80W	2.0	- 8	6.5	82	77	2201	14,100	90.8
				7.1	78	82	1852	16,163	86.6
9	atrazine 4L +	1.0	- 8	6.0	83	75	1991	12,839	78.1
	cyanazine 80W +	2.0	- 8	6.5	83	83	1397	15,246	89.2
	paraquat	.25	- 8	7.1	78	73	1677	14,558	94.3
10	cyanazine 80W	3.0	- 8	6.0	75	67	1712	14,329	83.4
				6.5	85	92	1153	15,819	100.2
				7.1	82	82	1293	13,068	93.8

Table 1. cont.

Treatment No.	Herbicide	Rate lb ai/A	Days to Planting[a]	Soil pH, Surface inch	Control Rating[b] 6-27	Control Rating[b] 9-25	Fall Panicum DM Yields lb/A	Corn Stand Plants/A	Corn Yield bu/A
11	cyanazine 80W +	3.0	- 8	6.0	73[c]	53	3458	13,297	71.0
	paraquat	.25	- 8	6.5	83	88	1135	15,705	102.2
				7.1	85	85	1677	13,870	87.4
12	cyanazine 80W +	2.0	- 8	6.0	77	63	3493	13,870	86.0
	alachlor +	2.0	- 8	6.5	78	68	2445	14,214	84.5
	paraquat	.25	- 8	7.1	83	84	1397	14,558	71.7
13	atrazine 4L +	1.0	+12	6.0	87	83	3493	11,005	71.3
	cyanazine 80W	2.0	+12	6.5	93	96	1048	13,641	103.3
				7.1	85	99	550	14,673	96.5
14	Hoed check	--	--	6.0	68	100	0	18,800	101.0
				6.5	73	100	174	17,424	109.1
				7.1	77	100	52	14,444	98.3

[a] Fall panicum growth at - 29 days = None (April 17)
- 8 days = Some (May 8)
+ 12 days = 2 leaves (May 28)

[b] All ratings are percent control.

[c] All values are an average of 3 replications.

OBSERVATIONS OF WEED CONTROL IN MINIMUM TILLAGE CORN

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

ABSTRACT

No tillage systems for growing field corn are steadily gaining acceptance by farmers in the Northeast. Various modifications of this system include the use of a rye cover crop, no cover crop (corn after corn) and planting directly into a sod. Weed species occurring with no-tillage include those of conventional corn plus a number of perennial broadleaf weeds generally found in pasture fields.

In 1974 experiments were conducted in New York and New Jersey evaluating approximately thirty-five (35) herbicide combinations in several types of no-tillage situations.

The annual weeds included yellow foxtail (Setaria glauca (L.) Beauv.), fall panicum (Panicum dichotomiflorum Michx.), large crabgrass (Digitaria sanguinalis (L.) Scop.), redroot pigweed (Amaranthus retroflexus L.), common lambsquarters (Chenopodium album L.) and common ragweed (Ambrosia artemisiifolia L.). Perennial weeds included common dandelion (Taraxacum officinale Weber), common milkweed (Asclepias syriaca L.), gray goldenrod (Solidago nemoralis Ait.), curly dock (Rumex crispus L.), quackgrass (Agropyron repens (L.) Beauv.), and yellow nutsedge (Cyperus esculentus L.). Sod plantings included Kentucky bluegrass (Poa pratensis L.), alfalfa (Medicago sativa L.) and orchardgrass (Dactylis glomerata L.).

The majority of treatments were based on a combination of paraquat plus atrazine or glyphosate plus atrazine. Alachlor, simazine, bifenox, metribuzin, cyanazine, N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine, banvel and the triethanolamine salt of 2,4-D were added to the above combinations as tank mixes or as separate postemergence treatments.

A comparison of overall weed control in the three situations showed that the rye cover crop provided the best situation for good weed control. Excellent rye kill was obtained with all treatments in one to two weeks except in combinations which contained bifenox and metribuzin. Speed of kill was also somewhat faster with the paraquat combination in comparison with the glyphosate programs.

1/ Product Development Manager, Agway Inc., Syracuse, NY and Crop Specialist, Agway Inc., Yardville, NJ

Annual broadleaf weed control was generally excellent with all treatments.

Comparing the annual grasses, yellow foxtail was most easily controlled followed by fall panicum and large crabgrass.

Plantings into sod were made in several locations. Bluegrass and timothy (Phleum pratense L.) sods were successfully controlled and to a lesser extent orchardgrass. Quackgrass control was best early in the season with the glyphosate treatments but by harvest time the high triazine programs (atrazine plus simazine or atrazine plus cyanazine) gave the best quackgrass control.

Perennials such as gray goldenrod and curly dock were controlled by almost all treatments.

Horsenettle (Solanum carolinense L.) and common dandelion were the most difficult of the perennials to control. The best treatments for horsenettle control were postemergent applications of banvel or 2,4-D or atrazine plus oil adjuvant concentrate*.

Nutsedge control was rather irratic but preemergent treatments which contained alachlor suppressed it and postemergence treatments which contained atrazine gave partial burnback.

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* Booster Plus E

Control of Fall Panicum in Conventional and No-Tillage Corn with Two Triazines as Influenced by Nitrogen Fertilizer Sources

V. A. Bandel, A. W. Bell , and J. V. Parochetti[1]

ABSTRACT

In 1974 two field studies comparing no-tillage versus conventional tillage corn (Zea mays L.) were conducted at the Poplar Hill Research Farm in Salisbury. In both studies, 1.25 lb/A of both atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) and simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) were applied at corn planting time.

In one field study nitrogen, as ammonium sulfate, had been surface-applied at 0, 40, 80, 120 and 160 lb/A in April; fall panicum (Panicum dichtomiflorum Mich.) control was significantly poorer in the no-tillage treatment as compared to conventional tillage (approximately 90% compared to 70%). When measured in September, pH levels at the 1-inch and 5-inch depths were not significantly different. In another study, 120 lb/A of nitrogen was surface-applied in April as either ammonium nitrate, urea, or a 30% aqueous nitrogen solution. Fall panicum control was similar for both tillage methods for these nitrogen sources.

[1] Associate Professor, Agricultural Technician, and Associate Professor, respectively, Department of Agronomy, University of Maryland, College Park, Maryland.

PASTURE RENOVATION AND SOIL CONSERVATION

L. D. Hoffman and W. L. McClellan[1/]

Abstract

Two separate no-till pasture renovation trials were initiated in fall 1973 and spring 1974. In both experiments the basic object was to change a predominately all grass sward to a legume grass mixture using the no-tillage concept. The fall instituted trial was undertaken to determine the possible range of available planting dates, commencing in mid-August and continuing until late fall. The spring plantings were made to initiate long-term beef pasture trials utilizing combinations of birdsfoot trefoil (Lotus corniculatus) in combination with orchardgrass (Dactylis glomerata), smooth brome (Bromus inermis), and Kentucky tall fescue (Festuca arundinacea). Legume establishment was successful in the fall plantings through late September. Birdsfoot trefoil and the above described grass species were successfully established producing up to 112 cow days/A of pasturage in the seeding year.

Introduction

There are an estimated 2.3 million acres of pasture in Pennsylvania. Somewhat over .75 million of these acres are situated on steep land, much of it marginal in productivity. Demand for food today, to say nothing of future demand, dictates that productivity on this and all agricultural land must be increased. National demand for beef and the subtle swing to more grass-fed cattle will place the Northeast in a more favorable economic atmosphere when considering beef production as a farming alternative.

Hopefully this potential demand will not be met at the expense of our most basic natural resource -- our soil. It behooves us to refine a technique to renovate or rehabilitate the several million acres in the Northeast that should never feel the steel of conventional renovation techniques.

Materials and Methods

A trial was instituted to evaluate how late in the fall birdsfoot trefoil and crownvetch (Coronilla varia) could successfully be planted using no-till

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[1/] Assistant Professor of Agronomy and Professor of Agronomy Extension, The Pennsylvania State University, University Park, Pa. 16802.

on a plot area treated in April 1973 with .25 lb/A dicamba. Plots were sprayed with .25 lb/A of paraquat per acre and planted with a Midland Zip Seeder. The first planting was made August 13, 1973 with subsequent plantings made on an approximate two-week interval. The final planting was October 4.

Stand counts were taken on November 8 and spring grass suppression ratings were made on May 2, 1974.

A second trial was established in late spring 1974 on six (five and one half acre) pastures. Three grass species were planted -- each alone and in combination with birdsfoot trefoil. In all pastures good to excellent stands of the planted species or combination was obtained. These pastures will be utilized in 1975 and later to evaluate cow-days of pasture, rate of gain, stocking rate, distribution of production over the grazing season, and economics on a pound-of-beef gained basis.

Results and Discussion

Fall trial. Table 1 indicates a wide range of legume present at first harvest (June 27, 1974). This was due in most cases to the amount of grass recovery by fall and how much of the grass was completely killed.

Table 1. Plant composition and fall legume seedling counts of no-till legume date of seeding trial.

Plot		Planting	Spray	Harvest % Legume	November Legume Stand Count
					(Plants/sq.ft.)
1A	Crownvetch	8/13/73	8/9/73	60	10
1B	Trefoil			60	14
2A	Trefoil	8/25	8/20	40	8
2B	Crownvetch			40	12
3A	Trefoil	9/5	8/30	40	9
3B	Crownvetch			40	11
4A*	Trefoil	9/17	9/13	90	8
4B*	Crownvetch			90	5
5A	Crownvetch	9/26	9/21	30	
5B	Trefoil			30	1
6A	Crownvetch	10/4	10/2	0	
6B	Trefoil			0	
Check				0	

*The September 13 spray treatment completely killed the bluegrass and fescue. There was a slight recovery of timothy and slight encroachment of dandelion, oxalis and Canada thistle.

Fall 1973 was moderate with killing frosts occurring October 18 and 22. Winter was open and mild. Good moisture was obtained in September.

Spring Seeding Trial. Pastures were sprayed with two .25 lb/A applications of paraquat three weeks apart. Planting was done with a Midland Zip Seeder. The first application included .5 lb/A of 2,4-D (LV4). Burndown at planting time was satisfactory of the original species which included orchardgrass, fescue, timothy (Phleum pratense), and alfalfa (Medicago sativa). The poorest control occurred in the alfalfa with approximately 50% recovery. Pastures were planted May 6, 1974 and were grazed in rotation during July and early August. No yield samples were taken for the first grazing. Nitrogen was applied to the grass pastures at a rate of 50 pounds per acre August 8, 1974. Table 2 summarizes the findings to date in this trial.

Table 2. Production of the second grazing of spring seeded no-till pastures-Haller Farm.

Lot No.	Specie Makeup	D.M. Production	Estimated Cow Days/A
1A	Fescue 80%, 20% other	2416#	97
1B	Fescue 60%, 25% trefoil, 15% other	1080#	43
2A	Orchardgrass 90%, 10% other	2793#	112
2B	Orchardgrass 60%, 20% trefoil, 20% other	1103#	44
3A	Sm. Brome 70%, 15% red clover, 15% other	1545#	62
3B	Sm. Brome 60%, 20% trefoil, 20% other	1070#	43

One must remember that this is the seeding year and the data presented is preliminary. Certainly by next fall, data of wider use and more quantitative in nature will be available from which sound economic decisions can be drawn.

Summary

No-till forage seedings can be successful when broadleaved perennial weeds are controlled prior to seeding. Both grasses and legumes can be established using this technique. Further development of planting equipment or adaptation of existing equipment is badly needed. An effective herbicide must be incorporated into spring programs to control annual broadleaved weeds. A residual herbicide for longer grass suppression would be desirable.

We must increase productivity of our pastureland in the Northeast, utilizing a technique that will be acceptable to farmers, conserve our soils, and be economically feasible.

WEED CONTROL DURING PASTURE RENOVATION (ABSTRACT) 1/

D. L. Linscott and R. D. Hagin 2/

During the years 1972 through 1974 we conducted twenty eight separate experiments involving the control of weeds prior to planting legumes by no-tillage methods. The objective is to develop the technology for reseeding forages on hill land sods with a minimum of soil disturbance.

Control of the competing existing vegetation is vital during the establishment phase for acceptable probabilities of success. Weed control centered on the herbicide glyphosate, N-(phosphonomethyl) glycine, and the application to emerged vegetation prior to seeding. Rates, timing of application, comparative effects of paraquat, (1,1'-dimethyl-4,4'-bipyridinum ion), and supplemental phenoxy herbicide requirements were evaluated. Four different no-tillage drill planters were assessed.

We succeeded in establishing legumes in thirteen of the twenty eight experiments. In all cases weeds and other competing forages were controlled sufficiently to allow legumes to establish. Failures were attributed to unfavorable weather, insects, and unsatisfactory seed placement, with the latter being most important. The drills used planted seeds either too shallow or too deep for most satisfactory emergence and early growth. More research on sod-drilling equipment is necessary before the full potential for no-tillage seeding of legumes can be exploited.

Glyphosate at rates in excess of 1 kg/ha controlled most grass weeds sufficiently to allow legume establishment. The more difficult to control grasses such as quackgrass (*Agropyron repens* (L.) Beauv.) and orchard grass (*Dactylis glomerata* L.) and the emerged perennial broadleaf species, required 2 kg/ha of glyphosate. In several cases, broadleaf species were released by glyphosate treatment and supplemental treatment with 2,4-DB, [4-(2,4-dichlorophenoxy) butyric acid] at 1 to 2 kg/ha was required for control.

1/ Cooperative investigations, Agricultural Research Service, U.S. Department of Agriculture and Cornell University, Ithaca, NY 14853.
2/ Research Agronomists, North Atlantic Area, Agricultural Research Service U.S. Department of Agriculture.

Weed Control in Corn With N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitro-benzenamine[1/]

J. B. Dobson[2/]

ABSTRACT

American Cyanamid Company was granted an experimental permit by the EPA in 1974 for further evaluation of the use of [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitro-benzenamine] as a preemergence herbicide in field corn. This herbicide alone and in combinations with atrazine or cyanazine was evaluated for weed control, crop tolerance, and influence on yield at eight locations in New York State under grower conditions.

Predominant weed species encountered in the trials were fall panicum (Panicum dichotomiflorum), yellow foxtail (Setaria glauca), barnyardgrass (Echinochloa crus-galli), witchgrass (Panicum capillare), large crabgrass (Digitaria sanguinalis), lambsquarters (Chenopodium album), wild mustard (Brassica kaber), redroot pigweed (Amaranthus retroflexus), common ragweed (Ambrosia artemisiifolia) and smartweed (Polygonum pensylvanicum).

Organic matter content of soils exceeded 3% at all permit locations. Generally herbicides were applied in 10 to 20 gallons of water per acre. This herbicide applied alone at 1 1/2 to 2 lbs. active ingredient per acre provided good control of all annual grass and broadleaf weeds, except common ragweed and wild mustard. Treatments of AC 92,553 at 1 lb. or 1 1/2 lbs. active ingredient per acre plus atrazine or cyanazine at 1 to 1 1/2 and 1 1/2 to 2 lbs. active ingredient per acre, respectively, provided commercial control of all weed species. No crop injury was observed from any of these treatments. Corn yields obtained from these treatments were equivalent to or superior to those obtained with standard herbicide treatments.

1/ PROWL® Herbicide - Registered trademark of the American Cyanamid Company.
2/ Agriculturist, American Cyanamid Co., P.O. Box 400, Princeton, N.J.

GLYPHOSATE AS AN HERBICIDE FOR TWO SUBMERGED AQUATIC SPECIES

John H. Peverly and Thomas W. Crawford, Jr.[1/]

ABSTRACT

To test the ability of glyphosate [N - (phosphonomethyl)glycine] to kill vegetative structures (roots and buds) of water milfoil (Myriophyllum spicatum L.) and curlyleaf pondweed (Potamogeton crispus L.), glyphosate was applied in a jar experiment at concentrations of 0, 0.1, 10, and 5,000 ppm (w/w) for various periods of time, up to 10 hours. Glyphosate increased the phosphorus concentration of treated water and appears to stimulate stem elongation and dry weight gain of submerged aquatic macrophytes when it is present at low concentrations. Treatment for 5 hours at high concentrations of the herbicide on the order of 1,000 ppm are necessary for satisfactory control of milfoil and curlyleaf pondweed. Using treatments as high as 5,000 ppm in the water supporting the stems, glyphosate was found to be ineffective in preventing regrowth from roots, after 35 days in the glyphosate solution.

INTRODUCTION

In many parts of the northeastern United States, submerged aquatic plants such as water milfoil (Myriophyllum spicatum L.) and curlyleaf pondweed (Potamogeton crispus L.) are consistently troublesome weeds. A broad spectrum herbicide, glyphosate, has been shown effective in the control of terrestrial herbaceous species (Derting et al., 1) by destroying vegetative parts both above and below the soil surface. Because of its potential ability to kill vegetative matter above and beneath sediment surfaces, glyphosate was investigated for use as an aquatic herbicide to control milfoil and curlyleaf pondweed, species which depend on overwintering vegetative parts for annual regrowth.

METHODS AND MATERIALS

Since dilution due to currents and mixing may render aquatic herbicides less effective, the experimental design included four concentrations of the herbicide--0, 0.1, 10, and 5,000 ppm (ai, w/w). Check plants were used to determine plant growth with no exposure to the herbicide. Before the experiment both species were rooted and grown to a length of 30 to 40 cm in

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1/ Assistant Professor, Department of Agronomy, Cornell University, Ithaca, New York; and present address of Mr. Crawford is c/o Lamon, Wide Awake Ranch, Madera, California.

battery jars containing marsh sediment and 10 liters of water collected at the Cornell Pond Facility. Sixteen jars of each species were prepared with four jars for controls and four jars for each concentration of herbicide. At time zero, glyphosate [as the isopropylamine salt of N - (phosphonomethyl) glycine] was added to give the three concentrations with four jars per concentration.

At 0.5, 1, 5, and 10 hours, five 10 cm apical portions of stem were removed from a check jar and from one jar of each of the concentrations for both species. The stem sections were thoroughly rinsed and were cut to remove any lateral stems. Then, to determine regrowth of stems after exposure to glyphosate for different times, the five 10 cm sections from each jar were placed in corresponding jars containing only water and soil from the same source. After 35 days the transferred plants were removed, stem length taken, and dry weight determined for plants from each jar after drying at 80°C.

To observe regrowth of roots, the stems of both checks and treated plants in the battery jars were cut at the soil 35 days after the treatments; all treated water was removed and replaced with fresh water. The jars were then placed in the greenhouse to determine whether regrowth of stems from the roots would be prevented by any of the glyphosate treatments. Total soluble phosphorus from treated jars was determined three times during the experiment. The total soluble phosphorus from untreated jars was determined at the end of the experiment (Strickland and Parsons, 2).

RESULTS AND DISCUSSION

The glyphosate molecule has a gram molecular weight of 169.1 and contains one phosphorus atom. Using the ratio, at. wt. P/mol. wt. glyphosate, the concentrations of phosphorus proportional to the three treatment concentrations of glyphosate were calculated and added to the measured values of total soluble phosphorus from the check jars. These calculated, or hypothetical, concentrations of phosphorus for the treated jars represent the concentrations of phosphorus which would be present if none of the elements were removed from the solution. Linear regression equations were derived for the hypothetical P concentrations and for measured P concentrations in the treated jars (Figure 1).

For glyphosate concentrations from zero to 5,000 ppm, the hypothetical concentration of P ranged from 0.274 to 915 ppm, while measured concentrations of P ranged from 0.076 to 530 ppm. The herbicide enriched the water with phosphorus, but from six hours after addition, when the first water samples were taken, to the end of the experiment 35 days later slightly less than one third of the added phosphorus was present in soluble form. The glyphosate is, in a sense, acting as a phosphorus fertilizer. Such addition of a nutrient element must be nullified by the toxic properties of the herbicide if it is to be effective.

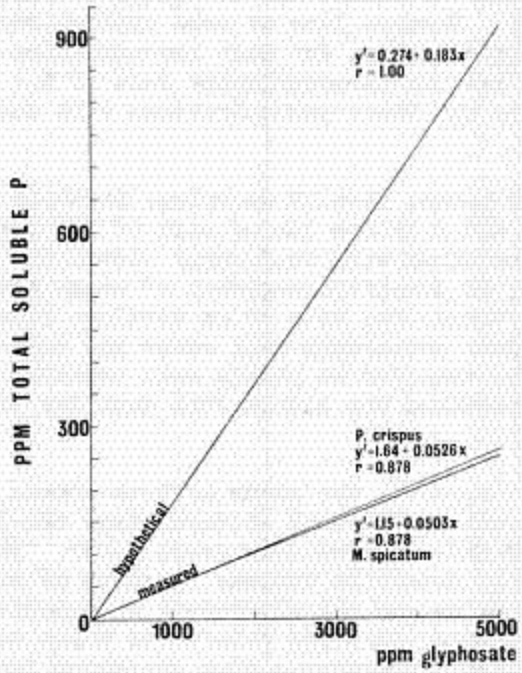


Figure 1. Theoretical and measured phosphate concentrations as a function of glyphosate treatment. Even though much of the phosphate added in glyphosate is rapidly adsorbed or precipitated, appreciable soluble phosphate remains after 35 days.

Milfoil

As indicated by stem length in Figure 2 and dry weight in Figure 3, satisfactory control was only achieved with 5,000 ppm glyphosate with exposure for at least five hours. The 5,000 ppm at one-half and one hour treatments produced a slight reduction in dry weight with respect to the untreated plants but no appreciable reduction in stem growth. The plants which were effectively controlled turned brown and were almost totally killed; on some of the stems the apical bud survived, but death of the stems was greater than 95 percent complete by visual estimates.

Treatment with 0.1 and 10 ppm glyphosate caused reduction in dry weight at all times of exposure except at one-half hour where the 0.1 ppm treatment plants showed the only growth above the mean growth of the untreated control plants. This increased growth may indicate a stimulatory effect of the phosphorus from the glyphosate which was not sufficiently counteracted by the toxic effect of the herbicide.

Stem elongation was not affected by these same treatments. Regrowth from the roots of all plants occurred, indicating that the milfoil roots were able to regenerate stems, regardless of glyphosate treatment.

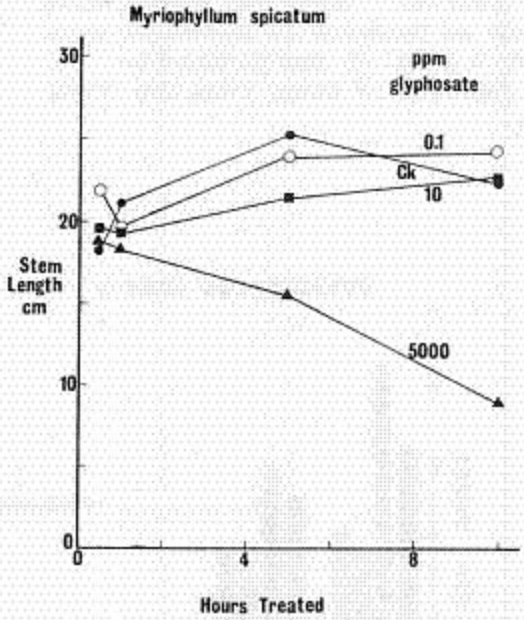


Figure 2. Stem length of water milfoil 35 days after treatment at indicated glyphosate concentrations and times. After treatment, five 10 cm lengths of stem from each treatment were transferred to glyphosate-free culture jars. Each point represents the average of five measurements.

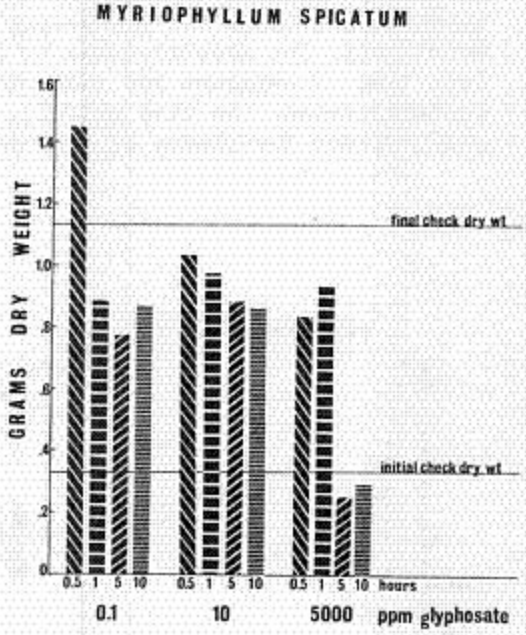


Figure 3. Dry weight of water milfoil stems 35 days after treatment at indicated times and glyphosate concentrations.

Curlyleaf Pondweed

Exposure of pondweed to 5,000 ppm of glyphosate for 0.5, 1, 5, and 10 hours brought complete control as indicated by stem length and dry weight measurements (Figure 4 and 5). Partial control at 0.1 and 10 ppm concentrations appears after 10 hours of treatment. The stems turned brown and no buds were found to have survived.

In Figure 5, decomposition of the stems treated with 5,000 ppm glyphosate is quite evident, since at the beginning of the experiment the mean dry weight of the 10 cm stem sections of pondweed was 0.14 g. As with

milfoil, curlyleaf pondweed shows possible stimulation of dry weight gains at lower concentrations with shorter times of exposure. The dry weight of pondweed exposed for one-half and one hour at 0.1 and 10 ppm glyphosate exceeds the dry weight of the controls. Under the experimental conditions, the effectiveness of glyphosate on pondweed is dependent upon both time of exposure and concentration at 0.1 and 10 ppm glyphosate concentrations. As with milfoil, normal regrowth of stems from the roots was observed for plants of all treatments.

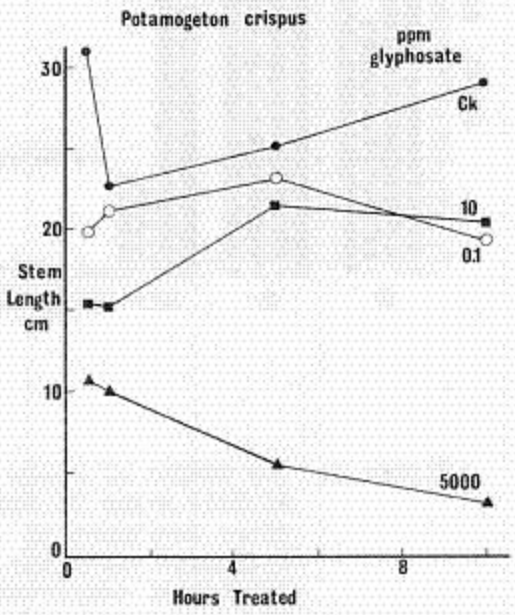


Figure 4. Stem length of curlyleaf pondweed 35 days after treatment at indicated glyphosate concentrations and times. After treatment, five 10 cm lengths of stem from each treatment were transferred to glyphosate-free culture jars. Each point represents the average of five measurements.

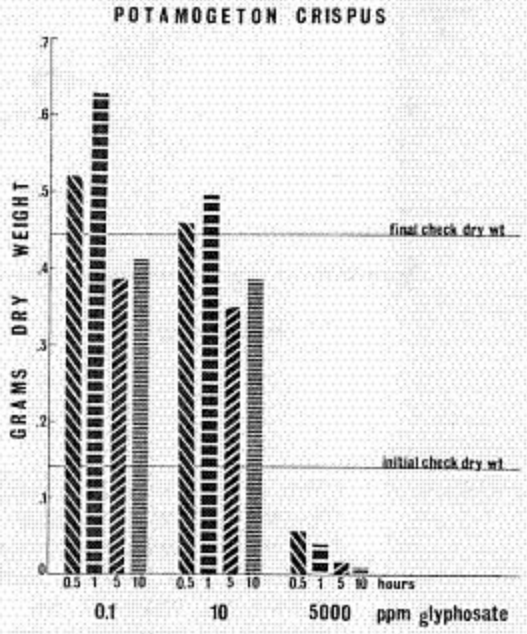


Figure 5. Dry weight of curlyleaf pondweed stems 35 days after treatment at indicated times and glyphosate concentrations.

Comparing the responses of milfoil and curlyleaf pondweed to treatment with glyphosate, milfoil is more tolerant of the herbicide, requiring relatively long exposure at extremely high concentrations for appreciable reduction in dry weight and stem elongation. The effectiveness of glyphosate in controlling curlyleaf pondweed at 5,000 ppm suggests that the herbicide may be effective at concentrations between 10 and 5,000 ppm with relatively short periods of exposure. The herbicide apparently stimulates submerged aquatic macrophyte growth, especially dry weight gains, at low concentrations and exposures of up to an hour. In addition, dry weights were more reduced than stem lengths at higher concentrations and exposure times.

LITERATURE CITED

1. C. W. Derting, O.N. Andrews, Jr., R.G. Duncan, and K.R. Frost, Jr. 1973 Proceedings of the 26th Annual Meeting of the Southern Weed Science Society, January 16, 17, and 18, 1973. New Orleans, Louisiana. Vol. 26.

2. J.D.H. Strickland, and T.R. Parsons. 1965. A manual of seawater analysis (with special reference to the more common micronutrients and to particular organic materials). Ottawa. Fisheries Research Board of Canada, Bulletin No. 125 (second edition, revised).

COPPER TOXICITY SYMPTOMS IN SAGO PONDWEED (*Potamogeton pectinatus* L.)

James B. Ryan and Donald N. Riemer[1/]

INTRODUCTION

Laboratory investigations using submerged aquatic plants present problems to the researcher not normally encountered in studies using terrestrial plants. Among these is the growth of algae in culture vessels. Besides competing with the test species for light and nutrients, algae alter test parameters being measured in the vessels and interfere with observations and interpretation of results.

The use of chemicals to eliminate or minimize problems associated with algae growth in experimental vessels is widespread. It must be recognized, however, that the use of an algaecide can present problems of its own unless it is highly selective. That is, it must be capable of controlling the algae without being detrimental to the test plant in any way. This study was designed to determine the toxicity symptoms of copper sulphate penthydrate, a commonly used algaecide, to sago pondweed.

LITERATURE REVIEW

Prior to the establishment of copper as an essential plant nutrient in 1931 by Sommer, the toxic properties of copper to plants were widely recognized and studied. According to Brenchley (1927), Otto discovered in 1893 that the roots of corn (*Zea mays* L.), wheat (*Triticum aestivum* L.), and pea (*Pisum sativum* L.), were stunted when grown in culture solutions made with ordinary distilled water. Root systems were not stunted when grown in nutrient solutions of the same composition made with water distilled in glass stills. Upon analysis, Otto attributed the root stunting to the presence of trace amounts of copper in the ordinary distilled water.

Barley (*Hordeum vulgare* L.) is particularly sensitive to trace amounts of copper. In 1910, Brenchley (1927) found that barley roots were stunted by the addition of 1.0 ppm of copper

[1/] Project Leader, Rohm and Haas Co., Spring House, Pa. and Assoc. Research Prof., Cook College, Rutgers Univ., New Brunswick, N. J. 08903.

sulfate (0.25 ppm Cu) to the nutrient solution. Top growth, however, was not stunted below a level of 4.0 ppm copper sulfate. Increased copper levels resulted in greater stunting of top growth until at 80 ppm growth ceased.

Another toxicity symptom which may develop is leaf chlorosis. According to Stiles (1958), Hewitt observed chlorosis in sugar beet (Beta vulgaris L.), and tomato (Lycopersicon esculentum Mill.) due to excessive amounts of copper in the soil. He noted that the chlorosis appeared very similar to that caused by iron deficiency.

Early recognition of the toxic properties of copper led to the use of copper compounds as fungicides, herbicides, and algaecides. Millardet discovered, in 1882, that a 1:1 mixture of lime and copper sulfate applied to plant leaves as a thin paste prevented the growth of downy mildew (Peronospora viticola). This fungicide is called Bordeaux Mixture and the active ingredient was found to be the copper ion (Frear, 1955).

Moore and Kellerman (1904) were the first to recommend the use of copper sulfate to kill algae and pathogenic bacteria in water. In one experiment they were able to control Spirogyra in water cress (Nasturtium officinale R. Br.) beds by the addition of 1 part $CuSO_4.5H_2O$ to 50,000,000 parts of water without harming the water cress.

The toxic properties of copper are still beneficially employed in the control of algae. Copper sulfate and copper-containing organic complexes are widely used in many types of waters, including potable water supplies, for the control of noxious algae blooms but toxicity symptoms exhibited by vascular aquatic plants have not been well described in the literature.

MATERIALS AND METHODS

A laboratory study was undertaken to study the copper toxicity symptoms of sago pondweed (Potamogeton pectinatus L.). The plants were grown from tubers selected for uniformity of size and weight. Five tubers were planted in each of 15 widemouth gallon jars containing 500 ml of washed beach sand and 3 l of a complete nutrient solution prepared with glass-distilled water. The tubers were placed just below the sand surface so that only the shoot buds were exposed. These shoots averaged 27 mm in length at the time of planting and consisted of a single node.

The nutrient solution was changed once a week by siphoning off the liquid to the sand surface and carefully refilling the jar to the proper level.

A completely randomized design was used with copper concentration in the nutrient solution being the only treatment variable. Five concentrations of copper (with 3 replications) were used as follows:

Treatment	Concentration $CuSO_4.5\ H_2O$	Concentration Cu
1	0.0 ppm	0.01 ppm[2/]
2	0.5 ppm	0.12 ppm
3	10.0 ppm	2.50 ppm
4	50.0 ppm	12.50 ppm
5	100.0 ppm	25.00 ppm

The plants were grown with continuous aeration, a light intensity of 400 foot candles at the water surface, and a photoperiod of 16 hours of light and 8 hours of darkness.

For the first 3 days, the plants were grown without copper sulfate to insure that they were all actively growing when the treatments were applied. At the end of this period, the 3 most uniform plants in each jar were selected and the other 2 were removed.

General observations and plant height measurements were recorded daily during the study. The experiment was terminated after 21 days at which time final observations were made. The plants were harvested,washed and oven dried at 100°F for dry-weight determination (excluding the tubers). The dried tissues were analyzed for P, K, Na, Ca, Mg, Fe, Mn, Cu, and Zn. P was determined colorimetrically by the reduced phosphomolybdate method. The other 8 elements were determined by atomic absorption spectrophotometry.

A representative sample of non-sprouted tubers was analyzed to determine the amount of copper initially present in them.

RESULTS AND DISCUSSION

Plant Height and General Appearance:

The average daily plant height measurements are presented in Table 1.

[2/]This Cu is from nutrient solution.

Table 1. Average increase in length (mm) of the above-sand portion of sago pondweed grown in 5 concentrations of copper sulfate penthydrate.

	$CuSO_4.5H_2O$ Treatments (ppm)				
Day	0.0	0.5	10.0	50.0	100.0
0	0	0	0	0	0
1	1	1	1	1	1
2	6	5	6	4	5
3	14	11	13	8	10
4	23	21	21	21	23
5	35	33	32	33	33
6	43	43	40	42	41
7	54	50	50	48	49
8	68	62	60	55	56
9	90	71	66	66	64
10	117	91	72	69	72
11	127	113	79	71	73
12	S	121	82	73	73
13	S	127	89	74	73
14	S	S	93	73	73
15	S	S	98	73	73
16	S	S	103	73	73
17	S	S	107	73	73
18	S	S	111	73	73
19	S	S	116	73	73
20	S	S	121	73	73
21	S	S	125	73	73
21*	453	320	173	127	129

------- represents treatment w/ $CuSO_4.5H_2O$

S = water surface (approx. 130 mm. above the initial shoot heights)

*Total length of plants stretched in a straight line after harvesting. All other values are increase in length above initial height at time of planting.

Twenty-four hours after planting the internodes of the shoot buds began to elongate and 72 hours after planting the first leaves had developed, and the plants had increased an average of 11 mm in height.

Three days after planting the copper sulfate penthydrate (CSP) treatments were applied. For the 4 days following, there was no significant difference in plant height among any of the treatments. Within 24 hours of treatment, however, the leaf tips turned brown on 10, 50, and 100 ppm plants. The browning became more severe and spread backward along the leaf blades at 2, 3, and 4 days. The leaf sheaths showed signs of burning and became a straw color.

The first statistically significant stunting occurred 5 days after treatment. At this time, plants grown in 50 and 100 ppm CSP averaged 55 and 56 mm in length respectively while the controls averaged 68 mm. Plants grown in these high CSP concentrations continued to increase in height slowly for 3 more days after which time (8 days after treatment), no further increase occurred. The browning of the entire plant surfaces continued and the internodes were very short, giving the plants a bushy, rosette-like appearance.

The plants grown in 0.5 and 10.0 ppm CSP were significantly shorter than the controls 6 days after the treatments were applied. The 0.5 ppm treatment resulted in a definite yellowing of the plants but no necrosis of the tissue occurred. They reached the water surface 10 days after the start of treatments, compared to 7 days for the controls.

The plants treated with 10.0 ppm CSP, on the other hand, exhibited the same symptoms of tissue burning as the 50 and 100 ppm plants, but to a less severe degree. Unlike the 50 and 100 ppm plants, however, they continued to increase slowly in height for the duration of the study and were nearing the water surface at the termination of the investigation, 18 days after treatment.

At the end of the experiment, the control plants were growing vigorously and had developed many lateral shoots and leaves. They also developed adventitious roots and stolons from the first and second nodes. New plants were already sprouting from the stolons.

The plants growing in 0.5 ppm CSP were shorter than the controls and did not have nearly as many side shoots or leaves. They did, however, develop adventitious roots and stolons similar to the controls.

The plants treated with 10 ppm CSP were severely stunted with short internodes but were still growing slowly at the end of the study. Most of the epidermal tissue was brown with only small patches of green remaining. These plants did not develop adventitious roots. They did develop stolons but no new plants arose from them.

The 50 and 100 ppm plants were similar to each other in all respects. They were severely stunted, dark brown in color, and had not developed adventitious roots or stolons. Although they had not increased in height after the first 8 days, they were not dead at the termination of the experiment.

Dry Weight Yield:

The dry weight yield of each treatment is presented in Table 2.

Table 2. Dry-weight yields (gm) of sago pondweed harvested 21 days after planting when grown in nutrient solutions containing 5 concentrations of $CuSO_4.5H_2O$.

ppm $CuSO_4.5H_2O$	Rep 1	Rep 2	Rep 3	Avg. of Reps
0.0	.58	.36	.47	.47
0.5	.32	.22	.24	.26
10.0	.20	.28	.25	.24
50.0	.15	.14	.12	.14
100.0	.13	.12	.12	.12

The average dry weight of the controls was significantly greater than the yield of any of the other 4 treatments. The 0.5 and 10.0 ppm treatments resulted in dry wt. yields of 0.26 and 0.24 gm which were not significantly different from each other despite the difference in plant heights. This was due to the fact that the 0.5 ppm plants were long and thin, while the 10 ppm plants were shorter but more bushy. Dry weight yields from both of these treatments were significantly greater than yields from the 50 and 100 ppm treatments which averaged 0.14 and 0.12 gm respectively.

Mineral Composition:

The average P, K, Na, Ca, Mg, Fe, Mn, Cu, and Zn content of the dried plant material from each of the 5 treatments is presented in Table 3 along with the composition of the original tubers before planting.

Table 3. Mineral composition of sago pondweed tubers before planting and the mineral content of sago pondweed tops at the end of the study.

		$CuSO_4.5H_2O$ Treatment (ppm)				
Element	Tuber	0.0	0.5	10.0	50.0	100.0
P %	0.50	1.50	1.27	0.88	0.68	0.65
K %	2.30	5.60	5.60	3.70	3.40	3.20
Na %	0.03	0.07	0.06	0.05	0.04	0.03
Ca %	0.04	1.00	1.00	0.85	0.70	0.70
Mg %	0.12	0.40	0.34	0.23	0.18	0.18
Fe ppm	50.0	620	500	380	320	200
Mn ppm	15.0	100	50	42	44	44
Cu ppm	12.5	275	875	5,500	15,000	39,000
Zn ppm	25.0	480	170	76	64	62

With the exception of Cu, all of the elements were highest in the control plants. Similarly, all of the elements except copper showed a continuing decreasing trend with increasing levels of CSP.

The Cu content of the control plants was 275 ppm while plants from the 0.5, 10, 50, and 100 ppm treatments averaged 875, 5,500, 15,000 and 39,000 ppm Cu respectively. The high Cu content of the CSP-treated plants indicates that much of it represents copper salt precipitates or copper-organic complexes on the plant surfaces and not solely absorbed copper. It is known that Cu will readily complex with organic matter and, therefore, it is probable that Cu formed complexes with dead cells and decaying organic material on the outer surfaces of the plants.

LITERATURE CITED

Brenchley, W. E. 1927. Inorganic Plant Poisons and Stimulants. second edition. University Press, Cambridge, England. 134 p.

Frear, D. E. H. 1955. Chemistry of the Pesticides. third edition. D. Van Nostrand Company, Inc., New York. 469 p.

Moore, G. T. and K. F. Kellerman. 1904. A method of destroying or preventing the growth of algae and certain pathogenic bacteria in water supplies. U.S.D.A. Bureau Plant Industries Bull. 64.

Sommer, A. L. 1931. Copper as an essential for plant growth. Plant Physiology. 6: 339-45.

Stiles, W. 1958. Essential micro (trace) elements. In Encycl. of Plant Physiology. IV: 571-73

SEED DORMANCY AND LONGEVITY IN *Potamogeton pulcher* Tuckerm.

Donald N. Riemer[1/]

Abstract. Seeds of *Potamogeton pulcher* Tuckerm. exhibited a natural dormancy and remained viable for 20 to 40 months when stored in water at 0-5°C.

INTRODUCTION

Aquatic weeds of the genus *Potamogeton* are troublesome over a large area of the United States and, indeed, the world. They occur in a wide variety of habitats and are economically detrimental in irrigation ditches, recreational ponds and lakes, and other bodies of water. A great deal of time, effort, and money has been expended in an effort to control them but relatively little attention has been paid to the role of seeds in disseminating the problem.

This experiment was conducted to study the longevity and dormancy of seeds of one species--*Potamogeton pulcher* Tuckerm.

REVIEW OF LITERATURE

A great deal of information has been published on seed longevity and seed dormancy but almost all of it pertains to terrestrial species. A few papers have appeared concerning germination in aquatic species.

Muenscher (1936) contested the view of Arber (1920) and others that seeds of aquatic plants, in general, require a long dormant period before germination and that drying favors germination. He found that drying kills the seed of many aquatic plants and induces prolonged dormancy in others. His extensive tests included five species of *Potamogeton*, all of which germinated best when stored in water at 1-3°C. Drying or storing at higher temperature drastically reduced germination and prevented it completely in all but a few cases.

[1/] Assoc. Res. Prof., Cook College, Rutgers--The State Univ. of N. J., New Brunswick, N. J. 08903

METHODS AND MATERIALS

Ripe seeds were collected at Adelphia, N. J. on 9 July 1970 and transported to the laboratory in plastic bags containing pond water. Germination was attempted on one group of seeds immediately and the remainder were stored in tap water in a refrigerator at 0-5 ^{o}C. Periodically over the next 46.5 months, groups of seeds was removed from storage and germination tests were run on them.

Tests were conducted in petri dishes with tap water, on a laboratory bench, at room temperature, under fluorescent lights, with a photoperiod of 16 hours of light and 8 hours of darkness.

Specific details of the individual tests are given below with the results for each group of seeds.

RESULTS

Because of the long time intervals involved, all time periods will be expressed to the nearest 0.5 months.

Group 1 - This group was not stored at all. Fifty seeds were placed in water in each of 3 petri dishes on the day they were collected. They were discarded after 3.5 months with no germination having occured.

Group 2 - This group was refrigerated for 0.5 months before being placed on the laboratory bench with 50 seeds in each of 3 petri dishes. They were discarded after 3 months with no germination having occured.

Group 3 - These seeds were removed from storage after 13.5 months and germination was attempted with 20 seeds in each of 5 dishes. Accumulative germination at various intervals is shown below:

months after removal from storage	months after collection	accumulative % germination
4	17.5	5%
8	21.5	6%
29	42.5	13%
30	43.5	15%
38	51.5	15%

Group 4 - These seeds were refrigerated for 20.5 months and germination was accomplished with 50 seeds in each of 5 dishes. Accumulative germination is presented below.

months after removal from storage	months after collection	accumulative % germination
1	21.5	2.4%
1.5	22	2.8%
4	24.5	3.6%
5	25.5	4.0%
11	31.5	4.4%
22	42.5	8.8%
23	43.5	9.6%
25	45.5	10.0%
28	48.5	10.4%
31	51.5	10.4%

Group 5 - This group was removed from storage after 42 months and trials were run with 50 seeds in each of 5 dishes. Results are shown below:

months after removal from storage	months after collection	accumulative % germination
1	43	0.8%
9.5	51.5	0.8%

Group 6 - Seeds in this group were treated differently from those in any of the preceding groups. They were removed from storage after 42 months and placed in germination trials. When no germination occurred after 4 months, the water was removed and the seeds were allowed to air-dry for 2 weeks after which the water was replaced. To date (4 months after replacing the water) no germination has taken place.

Group 7 - These seeds were stored for 46.5 months, after which germination trials were run with 50 seeds in each of 5 dishes.

months after removal from storage	months after collection	accumulative % germination
0.5	47	0.4%
5	51.5	0.4%

Group 8 - These seeds were removed from storage after 46.5 months also, but were placed dry in petri dishes and were left dry for 2 weeks, after which water was added. There were 35 seeds in each of 5 dishes. Results are presented below:

months after removal from storage	months after collection	months after H_2O was replaced	accumulative % germination
2	48.5	1.5	1.2%
5	51.5	4.5	1.2%

CONCLUSIONS

From the data presented above it can be concluded that seeds of *Potamogeton pulcher* will remain viable for somewhere between 20 and 40 months, after which the percentage of germination is reduced to almost nothing.

It can also be concluded from the germination data in Group 4 that the seeds have a natural dormancy which prevents them from all germinating at once. The seeds in Group 4 germinated slowly over a period of more than 2 years after they were removed from storage.

LITERATURE CITED

Arber, A. 1920. Water plants. Cambridge Univ. Press. London 436 pp.

Muenscher, W. C. 1936. Storage and germination of seeds of aquatic plants. Bull. 652. Cornell Univ. Agric. Expt. Sta., Ithaca, N. Y. 17 pp.

THE INFLUENCE OF NORFLURAZON ON CHLOROPHYLL CONTENT AND GROWTH OF *POTAMOGETON PECTINATUS*

by

Robert M. Devlin and Stanislaw J. Karczmarczyk[1/]

ABSTRACT

Chlorophyll content of sago pond plants grown under 1000 ft-c of light is significantly reduced by low concentrations of norflurazon. This influence of norflurazon is considerably reduced when the plants are exposed only to 10 ft-c of light. This and other studies suggest that norflurazon inhibits carotenoid synthesis leaving chlorophyll subject to photo-oxidation. Growth in length and fresh weight were not significantly affected by the norflurazon treatments. The data from this study suggests that cranberry growers can expect at least some herbicidal activity in bog ditches from small amounts of norflurazon present in water run-off after heavy rains or the removal of frost floods.

INTRODUCTION

It appears likely that 4-chloro-5-(methylamino)-2-(α,α,α-trifluoro-*m*-tolyl)-(2H)-pyridazinone (norflurazon) will be cleared for use by cranberry growers for the 1975 growing season. In the northeastern section of Massachusetts, which is the largest cranberry growing region in the world, this will mean that some very difficult weed problems will be solved. However, the use of norflurazon is not without some problems. For example, in some bogs where there are low areas that cause puddling, there sometimes accumulates amounts of norflurazon that can damage cranberry vines. This suggests that norflurazon, although practically insoluble in water, can be physically transported by streams of water leading to these low areas thus concentrating the herbicide. This phenomenon is most likely assisted by the fact that norflurazon is applied in a granular form to cranberry bogs.

1/ Professor and Research Associate, respectively, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts 02538

A cranberry bog is characteristically bordered by drainage ditches and may have one or more ditches dug across it dividing it into sections. These ditches become clogged by a variety of aquatic weed species, some of which belong to the genus Potamogeton. Run-off from the bog during heavy rains or as a result of frost flooding or sprinkling could carry norflurazon into the ditches. The data presented in this paper suggest that some herbicidal effect can be expected from this run-off.

MATERIALS AND METHODS

Before planting sago pond plant tubers were weighed, measured, washed in 0.1% mercuric chloride for 3 min and then rinsed several times with sterile distilled water. The tubers were first grown for 3 days in 4-liter battery jars containing 1 liter of sterile distilled water. After 3 days they were transferred to jars containing sterile complete inorganic media (Hoagland No. 1--half strength) and norflurazon at concentration of 0, 0.01, 0.1, 1, 10 and 100 ppm. All media were aerated 2 hr before the tubers were planted and for 2 hr every other day thereafter. Each jar contained 12 tubers to which metal washers were attached as weights. Temperature (25°C ± 1°C), light intensity (1000 ft-c and 10 ft-c) and light duration (continuous) were controlled by growing the plants in a growth chamber (Percival E-54U model). A constant pH of 5.0 ± 0.2 was maintained. Algal and fungal contamination were controlled through the use of sterile techniques and by transferring the plants to fresh sterile media 4 times during the growth period.

After a 17-day growth period the length, fresh weight, and dry weight of the plants were recorded. For chlorophyll extraction shoot tissue was collected, homogenized for 2 min in 80% acetone with a Virtis-45 homogenizer, and the homogenate allowed to stand in darkness for 20 hr at 4°C. The homogenate was then centrifuged at 32,700 g and 4°C for 10 min. The supernatant was decanted for chlorophyll determination. All pigment extraction procedures were performed under dim light conditions to minimize photodynamic destruction of chlorophyll. The optical density of the chlorophyll extract was read at 645 and 663 nm with a Perkin-Elmer double beam spectrophotometer. The amount of chlorophyll present in the extract, on the basis of mg of chlorophyll per g of shoot tissue extracted, was calculated according to the following equations

$$\text{mg chl a/g tissue} = \left[12.7(D_{663})-2.69(D_{645})\right] \times \frac{V}{1000 \times W}$$

$$\text{mg chl b/g tissue} = \left[22.9(D_{645})-4.68(D_{663})\right] \times \frac{V}{1000 \times W}$$

$$\text{mg total chl/g tissue} = \left[20.2(D_{645}) + 8.02(D_{663})\right] \times \frac{V}{1000 \times W}$$

In the above equations D represents the optical density reading of the chlorophyll extract at the specific indicated wavelength, V the final volume of the 80% acetone-chlorophyll extract, and W the fresh weight in g of the tissue extracted. Each experiment was replicated 4 times.

RESULTS

Low concentrations of norflurazon significantly reduce the chlorophyll content of sago plants grown under a light intensity of 1000 ft-c (Table 1). Total chlorophyll was down almost 8% at 0.01 ppm and almost 22% at 0.1 ppm norflurazon. However, a dramatic, and what has to be considered lethal, drop of 75% in total chlorophyll occurred when sago plants were treated with 1 ppm norflurazon. At 10 and 100 ppm the plants were practically bleached. The reduction of chlorophyll a and chlorophyll b due to norflurazon treatments paralelled that of total chlorophyll (Table 1).

Table 1. Effect of norflurazon on the growth and chlorophyll content of the sago pond plant. The plants were grown and treated under a light intensity of 1000 ft-c. The extracted chlorophyll is measured in ug/g fresh tissue.

Norflurazon	Chl a	Chl b	Total Chl	% Increase in length	% Increase in fresh weight
0.00 ppm	517	217	734	200	64
0.01 "	464	213	677	223	79
0.10 "	402	173	575	224	84
1.00 "	127	58	185	196	78
10.00 "	79	26	105	186	71
100.00 "	16	3	19	182	65
L.S.D. .05	70.2	143.9	111.8	-	-
.01	96.1	197.1	153.1	-	-

As might be expected, the chlorophyll content of untreated sago plants under a light intensity of 1000 ft-c was much higher than those grown under 10 ft-c of light (compare Tables 1 & 2). However, under low light intensity the effect of norflurazon on chlorophyll reduction was significantly reduced (Table 2). For example, total chlorophyll was reduced 37% in sago plants treated with 1 ppm norflurazon and grown under a low light intensity. Under high light intensity sago plants treated with 1 ppm norflurazon had a 75% reduction in chlorophyll content.

Table 2. Effect of norflurazon on the growth and chlorophyll content of the sago pond plant. The plants were grown and treated under a light intensity of 10 ft-c. The extracted chlorophyll is measured in ug/g fresh tissue.

Norflurazon	Chl a	Chl b	Total Chl	% Increase in length	% Increase in fresh weight
0.00 ppm	240	54	294	281	48
0.01 "	171	45	216	230	41
0.10 "	180	46	226	285	55
1.00 "	140	46	186	283	40
10.00 "	145	41	185	248	24
100.00 "	120	36	155	274	49
L.S.D. .05	31.5	24.9	48.3	-	-
.01	43.1	33.9	66.2	-	-

Aside from its effect on chlorophyll content, norflurazon appears to have had no influence on the growth of the sago plant (Tables 1 & 2). It is apparent that over the 17-day growth period sufficient carbohydrate and nitrogen were provided by the tubers to sustain the sago plants. However, in time this supply of nutrient would be exhausted and death would ensue.

DISCUSSION

The mode of action of norflurazon taken up by the sago plant can be ascertained by examining studies done on 4-chloro-5-(dimethylamino)-2-(α,α,α-trifluro-m-tolyl)-3(2H)-pyridazinone (SAN-6706), a close analogue of norflurazon. Hilton et al. (5) studied the effect of SAN-6706 on several different plant species

and found that it retarded chloroplast development. A study by Bartels and Hyde (2) strongly suggested that the inhibitory influence of SAN-6706 on chloroplast development was due to its inhibitory influence on carotenoid synthesis and accumulation. Carotenoids protect chlorophyll from photo-oxidation (1, 3, 6) and without chlorophyll normal chloroplast development is impossible (3). Finally, Yaklich et al. (4, 7, 8) have shown that norflurazon is the major metabolite found in cranberry vines that have taken up SAN-6706 and that this conversion of SAN-6706 to norflurazon is rapid. It seems likely that what was thought to be the mode of action of SAN-6706, was in reality that of norflurazon.

If we assume that norflurazon inhibits carotenoid synthesis, which in turn caused the photo-oxidation of chlorophyll, then we have an explanation for sago plants grown under a low light intensity being less sensitive to norflurazon. The simple conclusion is that with less light there is a reduction in chlorophyll destruction.

It is apparent also from this study that the growth of Potamogeton in bog ditches could be adversely affected by water run-off in which a small amount of norflurazon is present. Thus, when norflurazon is used on cranberry bogs to control grasses and sedges, at least partial control of some aquatic plants in bog ditches may also be possible. With this in mind, the testing of norflurazon directly as an aquatic weed herbicide seems warranted.

REFERENCES

1. I.C. Anderson, and D.S. Robertson. 1960. Role of carotenoids in protecting chlorophyll from photodestruction. Plant Physiol. 35:531-534.

2. P.G. Bartels and A. Hyde. 1970. Chloroplast development in 4-chloro-5-(dimethylamino)-2-(alpha, alpha, alpha-trifluoro-m-tolyl)-3(2H)-pyridazinone (Sandoz 6706)-treated wheat seedlings. Plant Physiol. 45:807-810.

3. R.M. Devlin and A.V. Barker. 1971. Photosynthesis. Van Nostrand Reinhold Co., New York.

4. R.M. Devlin and R.W. Yaklich. 1972. Translocation and metabolism of SAN-6706-C-14 in Vaccinium macrocarpon var. Early Black. Proc. Northeast. Weed Sci. Soc. 26:72-75.

5. J.L. Hilton, A.L. Scharen, J.B. St. John, D.E. Moreland, and K.H. Norris. 1969. Modes of action of pyridazinone herbicides. Weed Sci. 17:541-549.

6. N.I. Krinsky. 1968. The protective function of carotenoid pigments. In: Photophysiology (A.C. Giese, ed.), Vol. III, pp. 123-195. Academic Press, New York.

7. R.W. Yaklich, S.J. Karczmarczyk, and R.M. Devlin. 1974. Metabolism of ^{14}C-SAN-6706 and ^{14}C-norflurazon in cranberry plants. Weed Sci. (in press).

8. R.W. Yaklich, S.J. Karczmarczyk, and R.M. Devlin. 1974. The uptake and translocation of ^{14}C-SAN-6706 and ^{14}C-SAN-9789 in *Vaccinium macrocarpon* cv. Early Black. Weed Res. (in press).

EFFECTS OF LOW LEVELS OF SIMAZINE ON PLANKTON ALGAE IN A NON-STRATIFIED LAKE

S. W. Pruss and E. R. Higgins[1/]

ABSTRACT

Effects of repeated applications of simazine (2-chloro-4,6-bis[ethylamino]-s-triazine) on phytoplankton, zooplankton and dissolved oxygen were studied over a 3 year period in a 110 acre lake in western Connecticut.

Simazine applied at 0.3 ppm on August 10, 1972 provided excellent control of Anacystis cyanea and Coelosphaerium naegelianum, the colonial blue-green algae causing a problem in the lake. Twenty-one days after application, little algal growth was evident; however, there was a substantial increase in zooplankton. Secchi disk visibility increased from 2 1/2 feet pretreatment to 8 feet 21 days after treatment. Dissolved oxygen levels were essentially unaffected by the simazine treatment.

In 1973, 0.1 ppm of simazine provided satisfactory control of Anabaena limnetica and Staurastrum paradoxum for 4 weeks; however, 2 applications at that rate were necessary to control Anacystis cyanea. Most other green algae, dinoflagellates, diatoms, rotifers and crustaceans were not affected by the 2 applications at 0.1 ppm. Secchi disk visibility increased from 4 feet at pretreatment to 12 feet at 21 days after the second treatment, then decreased gradually to 8 feet by mid-October. Dissolved oxygen reached a low point, 4.1, at the 4 foot level on the same date.

Analyses of plankton samples taken July 26, 1974 show that 3 applications of simazine at a total rate of 0.5 ppm had little effect on plankton algae 1 year after the last application.

INTRODUCTION

The recreational and aesthetic value of many lakes in the Northeastern U.S. is seriously reduced by uncontrolled devel-

1/ Regional Manager & Senior Research Representative, Northeast Region, Agricultural Division, CIBA-GEIGY Corp., Washington, Pa.

opment of phytoplankton. The elimination of the probable cause, an excessive nutrient load, is a long term project; therefore, other methods of slowing the eutrophication processes are necessary. Simazine appears to be an excellent candidate for this use since it has a high degree of safety to fish (4, 5) and wildlife (1); relatively slow algaecidal activity (3), thereby reducing chances of serious dissolved oxygen depletion and a degree of selectivity for blue-green species over green species (3) and phytoplankton over zooplankton (2).

MATERIALS AND METHODS

In 1972, Lake Winnemaug, a 110 acre lake in western Connecticut, was treated with the 80W formulation of simazine at 0.3 ppm active triazine based on the total volume of the lake. The simazine was put into suspension in a 55 gallon drum and siphoned over the side of a 12 foot johnboat propelled at slow speed around the outer perimeters of the lake. Application was made to approximately 15% of the lake.

The following data and samples were taken at stations located in the north end and center of the lake.

Days After Treatment	DO/Temp.	Turbidity	Plankton Samples
0 (prior to Treatment)	X	X	X
3 days		X	
7 days		X	
14 days	X	X	X
21 days	X	X	X
28 days	X	X	X
79 days	X	X	X

Water samples were taken with a bilge pump and preserved in 10% formalin for future analysis. Dissolved oxygen and temperature profiles were obtained with a YSI-51A portable oxygen meter and turbidity evaluations with an 8 inch Secchi disk. Plankton samples were taken with a 180 mesh plankton net and preserved in 4 parts 70% isopropyl alcohol and 1 part formalin to 5 parts water. Organism identification and counts were made by Dr. Carole Lembi of Purdue University.

In 1973 the same lake was treated with 0.1 ppm Simazine on July 16 and August 13 by the method described above. Oxygen, temperature, pH and turbidity levels were recorded pretreatment and at 3, 7, 14, 21 and 28 days after the first application and again at 3, 7, 14, 21, 28 and 60 days after the

second application. Water samples were collected on the same dates to obtain qualitative as well as quantitative data on plankton. Collection and preservation of samples and methods used for obtaining turbidity, oxygen and temperature data were the same as used in 1972. The pH readings were taken with a Kruger and Eckel model 300 pH meter.

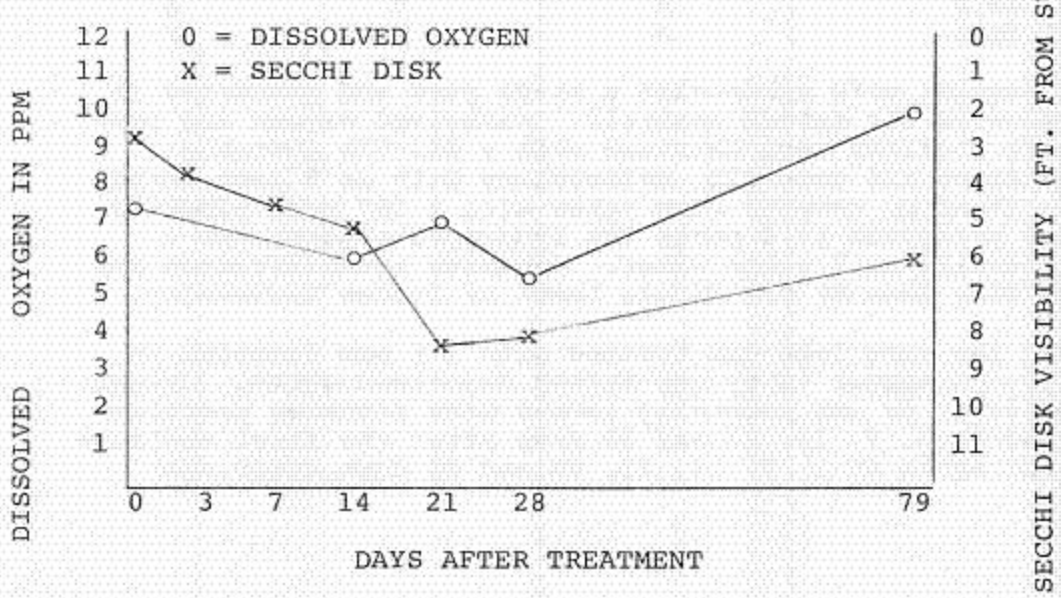
The lake was not treated in 1974, but plankton samples were collected for identification and counting, and Secchi disk readings were taken on July 26.

RESULTS AND DISCUSSION

I. RESPONSE TO 1972 APPLICATION

Water clarity at the central station increased from 2.5 to 5 feet between 0 to 14 days after treatment (Figure 1). The most improvement in visibility occurred between 14 and 21 days during which time Secchi disk visibility changed from 5 feet to 8 feet. At 28 days after treatment a decrease in visibility occurred. Based on dissolved oxygen and temperature data, it appears that an inversion occurred during this period. The increase in turbidity, therefore, was probably due to suspended detritus rather than from an increase in phytoplankton. The 79 day reading showed an increase in turbidity which correlates with an increase in the development of cool weather species of algae. Blue-green species did not reinfest the lake.

Figure (1). Dissolved oxygen at 4 ft. and Secchi disk readings at central station in Lake Winnemaug in 1972.



The decrease of turbidity at the north station was more rapid than at the central station with the major increase in visibility occurring between 7 and 14 days. This might be expected since this station was in the treated area.

Simazine application had little effect on dissolved oxygen since since the level stayed at or about the saturation point from the day of treatment until 21 days after treatment (table 1). Readings taken 28 days after application show a decrease in dissolved oxygen from the surface to a depth of 8 ft. with a corresponding increase from 10 feet to the bottom. This response indicates an inversion occurred between the 21st and 28th day.

Table 1. Dissolved oxygen profiles (ppm) of Lake Winnemaug taken near mid-day pretreatment to 79 days after treatment in 1972.

Ft. from Surface	Date of Observation (Days After Treatment)				
	8/10*	8/24	8/31	9/7	10/28
	(0)	(14)	(21)	(28)	(79)
2	7.5	7.6	7.4	6.2	10.0
4	7.5	7.6	7.3	5.5	9.6
6	7.5	7.3	7.3	5.2	9.6
8	7.5	6.0	7.2	4.8	9.7
10	5.1	0.8	0.2	4.6	9.5
12	0.2	0.0	0.0	4.3	9.3

*Simazine applied at 0.1 ppm on this date.

Plankton Analyses

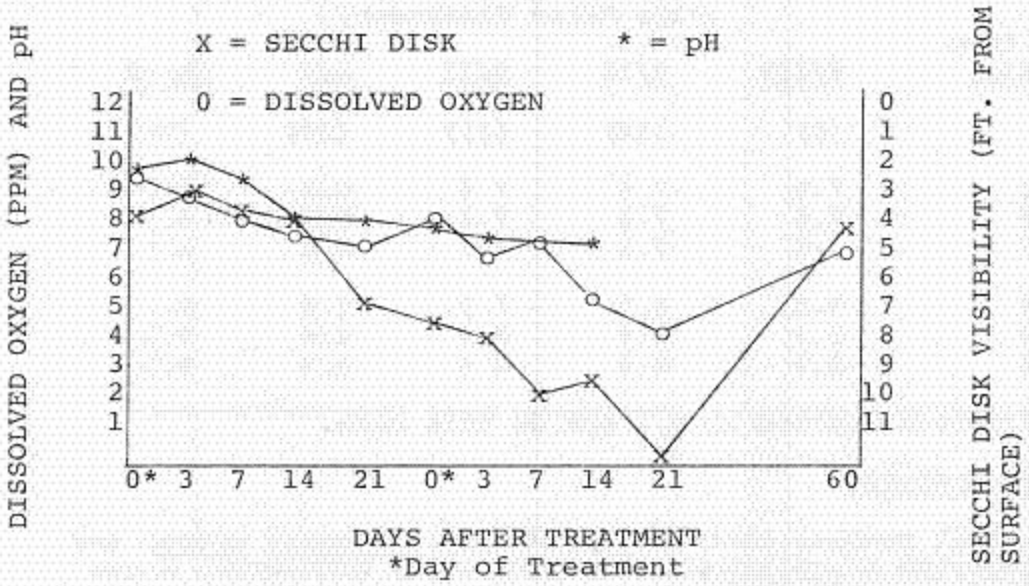
Pretreatment samples contained primarily *Anacystis cyanea* and *Coelosphaerium naegelianum*. These colonial blue-green algae were present in large numbers in colonies approximately 1 to 2 mm in diameter. Fourteen days after treatment, the percentage of the blue-green algae in the bio-mass was reduced. The remaining blue-green algae were present as healthy single cells, not as colonies, and were no longer floating on the water surface. Twenty-eight days after treatment, *Coelosphaerium* was still prevalent in the south end of the lake. However, there was a substantial increase in the number of *Asterionella* and *Melosira* spp. (diatoms). *Pediastrum* and *Staurastrum* (green algae species) were also present, but not in large numbers. The dominant invertebrate was a species of *Bosmina*; however, 4 species of rotifers

were also present. They were of the genera Polyartha, Keratella and 2 others which were unidentified. By October 28th, the golden brown alga Dinobryon spp., the diatom Melosira spp., the rotifer Keratella spp., and 1 unidentified rotifer were present at the central station. The colonial blue-green species, Coelosphaerium, was present only at the north station.

II. RESPONSE TO 1973 APPLICATION

Dissolved oxygen was the first parameter being monitored to show an indirect response to the application of simazine. Three days after application, the level of dissolved oxygen decreased from 9.4 to 9 ppm at the 4 foot depth, while visibility decreased from 4 feet pretreatment to 3 feet 3 days after treatment. The pH increased from 9.2 to 9.4 during the same period.

Figure 2. Dissolved oxygen and pH levels at 4 ft. and Secchi disk readings at central station in Lake Winnemaug in 1973.



Seven days after the first application, dissolved oxygen, pH and turbidity were declining. Between 7 and 21 days post-treatment, dissolved oxygen at the 4 foot level decreased from 7.8 to 7.2 ppm, and the turbidity decreased to an aesthetically acceptable level with a Secchi disk reading of 7 feet. Between 21 and 28 days, dissolved oxygen increased to 8 ppm, suggesting an increase in photosynthetic activity. The pH level decreased 0.37 of a pH unit during the same period. The second application had little effect on turbidity or pH by day 3; however,

dissolved oxygen decreased 7 ppm. On day 7, visibility increased to 10 feet, while the dissolved oxygen essentially remained at the same level. Visibility continued to increase, and reached 12 feet 21 days after the second application. Although dissolved oxygen was adequate to support fish life only to the 4 foot depth on this date (Table 2), there was no indication of oxygen stress. By October 15th, the dissolved oxygen level varied from 9.6 ppm at the surface to 3.0 ppm at the bottom.

Plankton Analyses

Major alga species present pretreatment were the green unicellular desmid, *Stauraustrum paradoxum* and the dinoflagelate, *Ceratium*. The blue-green algae, *Anacystis cyanes* and *Anabaena limnetica* were the next highest in number. Zooplankton consisted primarily of the copepods, *Diaptomis* and *Nauplius* species and the rotifers species, *Keratella* and *Brachionus*.

Anabaena limnetica and *Stauraustrum paradoxum* appeared to be most sensitive to the herbicide. *Anacystis cyanea*, on the other hand, showed some tolerance to the 0.1 ppm rate, but the population of this species was reduced drastically after the second application. The green species of algae, *Coelastrum* and *Pediastrum*, seemed quite tolerant, as did the filamentous diatom, *Melosira* spp. Although the populations of the flagellate, *Ceratium* fluctuated throughout the study, it did not appear to coincide with herbicide application.

Zooplankton were not affected by simazine.

III. OBSERVATIONS

Analyses of the 1974 samples show that simazine applications over a two year period did not cause an increase in simazine resistant species. In fact, the most sensitive species, *Anabaena limnetica* was the predominant species with a population density of 925,000 filaments per ml. *Coelosphaerium* and *Anacystis* species, the initial problem algae, were the next most numerous species with 150 colonies per ml. each.

Table 2. Dissolved oxygen profiles (ppm) of Lake Winnemaug taken near mid-day pretreatment to 90 days in 1973.

Ft. from surface	7/16*	7/19	7/23	7/30	8/6	8/13*	8/16	8/20	8/27	9/5	10/15
2	9.0	9.0	8.2	8.0	7.4	8.0	6.6	7.0	5.2	8.2	9.6
4	9.4	9.0	7.8	7.3	7.2	8.0	6.7	6.8	5.0	4.1	7.6
6	6.8	7.5	7.8	7.0	7.0	7.2	6.7	6.6	4.6	1.7	6.8
8	6.5	5.2	7.8	6.6	6.1	5.8	6.8	6.2	2.6	0.8	5.2
10	6.0	3.4	5.4	4.6	4.8	4.6	6.4	5.3	1.2	0.7	3.8
12	5.2	0.1	1.4	1.2	.8	2.0	6.0	3.1	0.4	0.6	3.0
14	0.3	0.1	.8	1.2	.4	0.6	0.1	0.3	0.2	0.7	3.0

*Simazine applied at 0.1 ppm on these dates.

CONCLUSIONS

1. Simazine at rates as low as 0.1 ppm provided control of some species of blue-green and green algae.

2. Dissolved oxygen was not seriously affected by the application of simazine at rates of up to 0.3 ppm.

3. Although dissolved oxygen was reduced slightly within 3 days after application, maximum effect of the treatment from the Secchi disk visibility standpoint was not evident until 14 to 21 days after application.

4. Qualitative data indicate an increase in desirable species of phytoplankton and zooplankton.

5. Based on data collected over a 3 year period, it appears that sensitivity to simazine is not a factor in the reinfestation of algal species.

LITERATURE CITED

1. Beliles, Robert P., et al, "Simazine Safety Evaluation on Fish and Wildlife", report to Geigy Agricultural Chemical, 1965.

2. Blinn, Dean, confidential report to CIBA-GEIGY Corp., 1974.

3. Evans, Jack, et al, "The Effects of Simazine and Terbutryn and Their Hydroxy Derivities on the Growth of Fresh Water Phytoplankton". Confidential report to CIBA-GEIGY Corporation.

4. Gilderhus, P. A., "Some Effects of Long-Term Exposure to Simazine on Goldfish, Bluegills and Aquatic Invertebrate", 1969 confidential report to CIBA-GEIGY Corporation.

5. Walker, Charles R., "Simazine and Other s-triazine Compounds as Aquatic Herbicides in Fish Habitats", Weeds, Vol. 12, April, 1964.

FACTORS INFLUENCING THE EFFECT OF GLYPHOSATE ON YELLOW NUTSEDGE (ABSTRACT) 1/

T. Tharawanich and D. L. Linscott 2/

Influence of 15°C, 25°C, and 35°C temperatures on the response of yellow nutsedge (Cyperus esculentus L.) to glyphosate (N-phosphonomethyl glycine) was studied in growth chambers set at 25 percent relative humidity (RH), 14 hour photoperiod and 1100 ft-candles light. The sequence of glyphosate activity on yellow nutsedge was: 15°C>25°C>35°C. At 25 percent RH, 25°C and 1100 ft-candles light, 14 and 16 hour photoperiods promoted vegetative growth while 10 and 12 hour photoperiods favored tuberization of yellow nutsedge. Most tuber production occurred at the 12 hour photoperiod. This finding verifies previous research. With the qualification that total light energy received by the plants differed, the sequence of glyphosate activity as affected by photoperiod was: 10 hrs>12 hrs>14 hrs>16 hrs.

Nitrogen-Phosphorous-Potassium (NPK) fertilizer (15-15-15) at 50, 100, 200, and 400 kg/ha in the greenhouse had no influence on the activity of glyphosate on nutsedge. However, tuber production increased markedly with increasing rates of fertilizer. Similarly, under field conditions glyphosate activity on nutsedge was not affected by application of N, P, K, NP, NK, PK, or NPK at 50 kg/ha to the soil growing media. Of all fertilizer treatments, P and K resulted in the highest tuber production.

Under both greenhouse and field conditions best control of nutsedge was from applications to plants 20-25 cm in height. The most satisfactory rates of glyphosate for the control of nutsedge was 2 kg/ha or higher. A rain free period of 8 to 24 hours following application of glyphosate to nutsedge is necessary for the most effect.

Glyphosate or paraquat at 2 kg/ha and higher prior to planting alfalfa gave satisfactory control of nutsedge during the establishment period. A combination of glyphosate and disking resulted in good weed control and subsequent establishment of alfalfa.

1/ Report from a Master of Science thesis, Cornell University, January 1975. Cooperative investigations of Cornell University and the Agricultural Research Service, U.S. Department of Agriculture, Ithaca, NY 14853.

2/ Graduate Assistant, Department of Agronomy, Cornell University and Research Agronomist, Agricultural Research Service, U.S. Department of Agriculture.

PRELIMINARY REPORT ON THE MECHANISM OF ACTION OF GLYPHOSATE (ABSTRACT)

B. J. Brecke and W. B. Duke 1/

Both whole plants and isolated intact cells were used to study the mechanism of action of N-(phosphonomethy)glycine (glyphosate). Corn (*Zea mays* L.) and bean (*Phaseolus vulgaris* L.) plants grown in solution culture were treated with glyphosate alone and in combination with phenyalanine to determine whether phenylalanine could, as in the case of *Lemna gibba* L. 2/, protect these plants from glyphosate injury. From the results obtained thus far phenylalanine appears to offer no such protection probably because sufficient amounts of the amino acid were not able to enter the plants.

Presently studies are being conducted using cells isolated from the primary leaves of 2 week old bean plants to determine the effect of glyphosate on several processes including photosynthesis, protein synthesis and nucleic acid synthesis.

1/ Graduate Assistant and Associate Professor, respectively. Department of Agronomy, Cornell University, Ithaca, NY 14853.

2/ Jaworski, E. G. 1972. The mode of action of N-(phosphonomethyl)Glycine: inhibition of aromatic amino acid synthesis. J. Agr. Food Chem. 20(6):1195.

SURFACTANT EFFECTS ON WETTING, PENETRATION AND MOVEMENT OF HERBICIDES IN PLANTS

Paul Lindner[1/]

ABSTRACT:

In applying herbicidal sprays to plant leaves the first step is to prevent bouncing and improve wetting. The kinetics of the wetting of a leaf surface can be estimated by using the Draves or modified Shapiro test. Biological activity is affected by the oil-water partition function expressed by Hansch equation. Surfactants will modify the equation and change the biological activity improving uptake of herbicides. Improved uptake is not parallel with the improvement in translocation or movement in the plant. It is often desirable that the surfactants are partitioned into the wax layer of the leaves. The physicochemistry of the surfactant is discussed to explain why excess surfactant may hamper penetration.

Impinging and wetting:

In applying foliar sprays the spray droplets must get on the leaves and stay there. The excess kinetic energy of the droplet has to be absorbed as compressive strain energy of the leaf or by increase in the total surface energy by breaking up of the droplet into smaller droplets and by wetting of the leaf surface. The droplets flatten on impact but will contract again elastically and will bounce off if during that time the decrease in free energy by sufficiently fast wetting of the leaf surface does not absorb the excess kinetic energy [36]. The kinetics of the wetting process or the wetting time will therefore be an important factor for keeping the spray on the leaf surface. The wetting of the leaf is a function of the wax coverage, the roughness of the surface, the waxy and hairlike outcrops [trichomes] and the contact angle with the applied water phase [22]. The area A covered by a droplet [20] is a function of its radius r and contact angle θ: $A=5.585r^2[2/3-\cos\theta+1/3\cos^3\theta]^{2/3}$. The contact angle will decrease and the covered area increase with better wetting. The applied herbicidal systems of solutions, emulsions, or suspensions in water contain surfactants which improve wettability which can easily be evaluated by a simple test, the Draves test [7], adapted by the American Association of Textile Chemists and Colorists [1]. The test measures the wetting time of a skein of unwashed cotton. Ashworth and Lloyd [2] recommended as more uniform the modified Shapiro test [33] of wetting a cotton tape of standard weave. The wetting time in such a wetting test can be experimentally correlated with the wetting of leaves covered with natural waxes. The shorter the wetting time the stronger the wetting agents, which may be required for a more waxy surface with a higher contact angle. The wetting time of 15 seconds in such a wetting test is sufficient for spray application on heavily wax covered cabbage leaves. In plain water such wetting time is reached with 0.02 to 0.08% of anionic surfactants or 0.035 to 0.5% of nonionic surfactants, the required concentration of the particular surfactants depending on their

1/ Witco Chemical Corporation, Chicago, Illinois

structure. If the test is applying to the wettability of apple leaves a wetting time of 40 seconds is sufficient, requiring a lower level of the concentration of surfactants. Testing of herbicide sprays in the field dilution concentration should be adapted in agricultural research, as the wetting of the leaves is a necessary prerequisite to the next step of allowing the herbicide to penetrate into the plant. In Table I are shown the wetting times of some nonionic surfactants at different concentrations. The Hydrophile-Lipophile Balance [HLB] has little bearing on wetting. Esters are inferior as wetters to ethers but show low phytotoxic effects which may be bound with lower penetration into the plants.

TABLE I

Draves Test Wetting time of some nonionic Surfactants in seconds

Surfactant	HLB	% Surfactant				
		0.1	.075	.050	.035	.025
C_{10}-C_{12} 7EO	12.8	9	11	36	-	-
C_{10}-C_{12} 5EO	11.2	5	-	15	36	86
C_{10}-C_{12} 10EO	14.4	10	-	40	-	
C_{11}-C_{15} 9EO	13.3	12	-	-	-	124
Nonyl Phenol 10EO	13.3	9	-	-	-	-
Oleic ester 9EO	10.8	250	-	-	-	-
Oleic ester 13EO	12.5	300	-	-	-	-
Oleic diester 9EO	8.6	850	-	-	-	-
Sorbitol 30EO Trioleate	13.3	600	-	-	-	-

Penetration:

After the surface is sufficiently wetted the herbicides have to be able to penetrate into the plant, move to the action site of the weed and destroy it selectively. On the way it has to pass the biolipid barrier of the leaf and eventually of the cells. The function of a toxicant is primarily dependent on its chemical structure which will interfere with a vital function. The biological activity of the homologs of a particular biocide will depend on the electronic characteristics of the substituents, or Hammett's $\rho\sigma$ function, the Taft steric factor E_s, and since it has to penetrate biolipid barriers and move in a water phase, it will depend on the partition function between oil phase and water phase. Hansch et al [16,17,18,19] worked out a system of partition of the biologically active materials between octyl alcohol and water. If the partition function $P=C_o/C_w$, where C_o is the concentration in the lipid phase and C_w in the water phase at equilibrium, using other oil phases the partition functions will have a simple relation: $\log P_1=a \log P+b$, where a and b are constants. A modification in structure will change the partition so if we put $\pi=\log P_x-\log P$, we should get for the homolog series:

$$\log 1/C = a\pi + b\pi^2 + c\sigma + dE_s + e$$

where C = concentration giving required activity, σ = Hammett's factor, E_s = Taft's steric factor, π = partition function, and a,b, c,d,e are numerical constants from regression analysis. Many systemic biocides [23] fit into such an equation for the homolog series. Hansch et al. [16] found the best set for phenoxy acetic

acids: $\log 1/C = 3.24\pi - 1.97\pi^2 + 1.86\sigma + 4.16$
Surfactants often affect the activity of herbicides [37] by modifying the Hammett factor σ and changing the oil/water partition P.

Surfactant phytotoxicity:

Surfactants added to sparsely water soluble herbicides increase considerably their water solubility [35] but when surfactants are used in larger concentration may show a phytotoxic effect depending on their structure, the particular plant, and their stage of growth. Plants at early stage are especially susceptible. Nonionic surfactants at a concentration of 0.25% may kill cucumbers at the 4 leaf stage while some ionic surfactants are tolerated up to 1% level [35]. Increased solubility of low phytotoxicity insecticide carbaryl will change it into a herbicide. Gast and Early [13] show that toxicity of emulsifiers and single surfactants on seedlings may be very low at 0.1% level concentration in water but often highly toxic at 1% level. In screening the data of Jansen's et al. [24] investigation of 63 surfactants it is apparent that esters or an ionic surfactants have lower phytotoxicity than the ether nonionic surfactants at higher concentrations. The surfactant phytotoxicity can be correlated with an increase in cell wall permeability which would suggest that surfactants may directly inter act with the membranes promoting uptake of herbicide so that small doses become very toxic[34].

To enhance wetting and cuticle penetration more polar herbicides require more polar surfactants [25,26,27] with the water solutions or emulsions penetrating through the ectodesmata [12]. In the literature you will find [3,6,9,21,29] that the reason for the surfactants enhancement of low soluble herbicides to be obscure, as there is no evidence that the surfactants facilitate translocation.

Water soluble herbicides:

Paraquat showed optimum enhancement of herbicidal activity with 0.06 to 1.12% of nonionic surfactant [9] and the enhancement decreased with excess surfactant. Optimum uptake was enhanced by a narrow range of ethylene oxide adducts depending on the lipophilicity of the hydrophobic part of the surfactant [5]. Increased amounts of surfactants improved uptake through the cuticle but diminished translocation into the plant. The surface penetration of Paraquat is a function of the partition of the surfactant between water and the leaf wax + lipid layer [4]. Any excess of surfactant over the amount necessary for wetting and penetration into the wax and lipid layer hampered translocation. This was established by extracting the wax and determination of the minute amounts of nonionic surfactants with cobaltocyanate reagent in an UV spectophotometer [15].

With di sodium methyl arsonate [DSMA] low level of surfactant 0.12% was most effective [30] and an increase in the level of surfactant gave only slight improvements.

With Dalapon [11,12,24,26,27,28,31] nonionic surfactants were observed to give enhancement at an optimum amount while excess surfactant over such an amount was hampering translocation. The more polar anionic surfactants gave better enhancement than nonionic.

Partition function of surfactants and translocation:

Surfactants are partitioned between the water phase of the spray and the leaf wax + the lipid layer in the cuticle. The desorption into the nutrient stream of the leaf's capillaries will depend on the surfactants partition function $P=C_o/C_w$, where C_o is the concentration in the lipids and C_w in water. The concentration of a surfactant in water in form of its monomer is limited by the critical micelle concentration [CMC]. If the amount desorbed is higher than CMC it will form micelles and more has to be desorbed until an equilibrium is reached when C_o=P[CMC]. Adapting the data from Greenwald et al. [14] and converting it into a graph of -log P=log C_w -log C_o vs. log C_w of a nonionic surfactant, octyl phenol 9.7 moles ethylene oxide adduct [OP9.7EO], we find log P constant until the CMC. Above this concentration C_o becomes a constant and log P becomes a function of log C_w, where C_w is the concentration in water of both monomer surfactant and in form of micelles, and is no more constant [Fig 1].

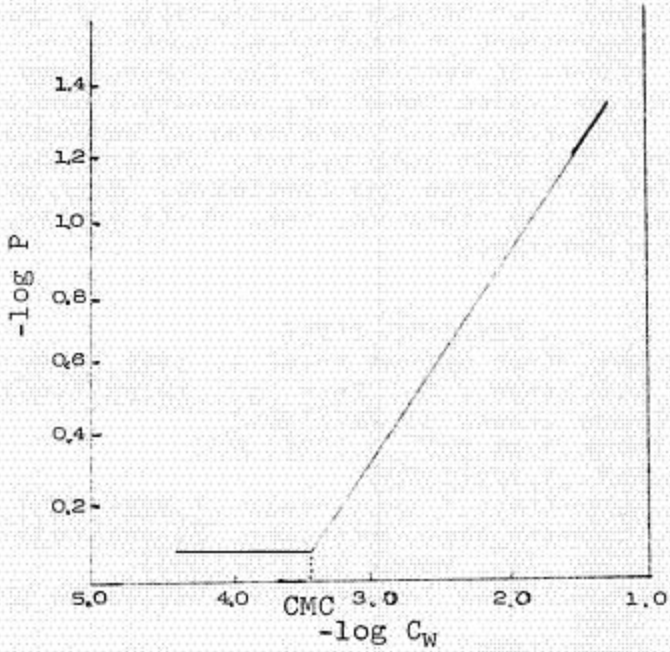


Fig. 1: Partition function log P vs. log concentration in water, log C_w, of a nonionic, octyl phenol 9.7 moles ethylene oxide adduct. Data adapted from Greenwald et al. [14]. log P is constant up to CMC.

Toxicants may form complexes with the surfactant which translocate more readily and this could improve the biological activity by giving faster a higher concentration at the site of action. Concentrations of surfactant above the CMC cannot increase activity as toxicants carried by the micelles can not be transported through biological membranes [32] and desorption from micelles to the membranes is very slow.

Surfactant behavior in capillaries and translocation:

According to a modified Laplace-Poisseuille-Washburn equation:

$$\frac{l^2}{t} = \frac{r}{k^2} \frac{\sigma \cos\theta}{2\eta},$$

where l is the distance a liquid of viscosity η is transported in time t through a capillary of diameter r with a tortureous factor k if the surface tension is σ and the contact angle θ. Addition of surfactant promotes movement through the capillaries as long as the lowering of the surface tension is more than compensated by an increase in cos θ. But in hydrophilic capillaries with a low contact angle addition of surfactant will only lower surface tension and hamper translocation.

CONCLUSION:

It may be desirable for better understanding of the effects of surfactants on enhancement of biological activity of herbicides to investigate the effect of wetting in the field-spray-concentration, changes in the partition function, measure translocation of surfactants in the system,look for complexes of surfactant monomers with herbicides, and take into account the critical micelle concentration of the surfactants and complexes. Such additional information may clarify the obscurity that still exists. As of now such data is not available.

LITERATURE CITED

1. AATCC Tech. Manual, Test Method AATCC 17-1952,44,B-168[1968]
2. R.DeB.Ashworth,G.A.Lloyd,J.Sci.Food Agr.,12,234[1961]
3. D.E.Bayer,H.R.Drever,Weeds 13,222[1965]
4. P.D.Bland,R.C.Brian,Pest.Sci.,3,133[1972]
5. R.C.Brian,Pest.Sci.,3,121[1972]
6. A.G.Dexter,O.C.Burnside,T.L.Lavy Weeds 14,222[1966]
7. C.Z.Draves,R.G.Clarkson,Amer.Dyest.Rep.,20,201[1931]
8. R.A.Evans,R.E.Eckert,Jr., Weeds 13,150[1956]
9. C.L.Foy,L.W.Smith,Advances in Chemistry Series 86 paper 6 ACS,Washington 1969
10. C.L.Foy, Weeds 10,97[1962]
11. C.L.Foy,L.W.Smith, Weeds 13,15[1965]
12. W.Franke,Pest.Sci.,1,164[1970]
13. R.T.Gast,J.E.Early,Ag.Chem., 11[14],42[1956]
14. H.L.Greenwald,E.B.Kice,M.Kenly,J.Kelly,Anal.Chem.33,465[1961]
15. R.A.Greff,E.A.Setzkorn,W.D.Leslie,J.Am.Oil Chem.Soc.,42,180[1965]
16. C.Hansch,R.M.Muir,T.Fujita,P.P.Maloney,F.Geiger,M.Streich, J.Am.Chem.Soc.,85,2817[1963]

17. C.Hansch,R.M.Muir,Annal.Rev.Plant Physiol.,6,157[1953]
18. C.Hansch,T.Fujita,J.Am.Chem.Soc.86,1616[1964]
19. C.Hansch,J.Chem.Ed.51,363[1974]
20. G.S.Hartley and R.T.Brunskill,"Surface Phenomena in Chemistry and Biology",p.214,Pergamon Press,N.Y.,1958
21. G.D.Hill,I.J.Belasco,H.L.Ploeg,Weeds 13,103[1965]
22. P.J.Holloway,Pest.Sci.1,156[1970]
23. M.Hussain,T.R.Fukuto,H.T.Reynolds,J.Agr.Food Chem.22,225[1974]
24. L.L.Jansen,W.A.Gentner,W.C.Shaw,Weeds 9,381[1961]
25. L.L.Jansen, Weeds 12,251[1964]
26. L.L.Jansen,J.Agr.Food Chem.12,223[1964]
27. L.L.Jansen,Weeds 13,117[1965]
28. L.S.Jordan,B.Day,R.Hendrixson, Weeds 11,198[1963]
29. C.G.McWhorter, Weeds 11,265[1963]
30. C.G.McWhorter, Weeds 14,191[1966]
31. C.G.McWhorter, Weeds 11,83[1963]
32. K.J.Mysels,Advances in Chemistry Series 86, paper 4, ACS, Washington,1969
33. L.Shapiro,Amer.Dyest.Rep. 39,38[1950]
34. J.B.St.John,P.G.Bartels,J.L.Hilton,Weed Sci.,22,233[1974]
35. R.E.Temple,H.W.Hilton, Weeds 11,297[1963]
36. J.W.van Valkenburg,Solvent Properties of Surfactant Solutions [K.Shinoda ed.]Chapter 6,M.Dekker, New York,1967
37. J.W.van Valkenburg and A.F.Yapel,Jr., Advances in Chemistry Series 114 paper 13, ACS, Washington,1973

Why Does EPTC Plus R-25788 Injure Corn?

Gordon W. Burt[1]

ABSTRACT

Corn injury caused by EPTC plus R-25788 has been occasionally observed in the field. This usually occurs at two distinct times: a) immediately after corn emergence or b) shortly before tasseling. Greenhouse and growth chamber studies were conducted to determine the factors affecting the severity of these injuries. The most important factor affecting corn seedling injury appeared to be the uniformity of soil incorporation of EPTC plus R-25788. Some seedlings were injured at a concentration as low as 14 ppm EPTC when the herbicide was poorly incorporated into the soil. In contrast, seedling injury was not observed under any condition at a concentration less than 50 ppm if the herbicide was thoroughly incorporated. At 62 and 112 ppm seedlings were injured more at 30 C than at 20 C. Soil moisture had little effect on injury caused by EPTC plus R-25788. Corn seedling injury with 112 ppm EPTC was greater when the corn seed was planted at a greater depth. More injury was also noted when the coleoptile was pointed upward compared to when it was pointed downward. Corn varieties were differentially susceptible to EPTC plus R-25788 at 99 ppm. Leaching and breakdown studies with corn seedlings indicated that R-25788 was not leached or brokendown faster in the soil than EPTC. Preliminary results indicate that the injury of EPTC plus R-25788 to corn plants after the seedling stage appears to be caused by an increased susceptibility of corn to EPTC plus R-25788 in the latter stages of growth.

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

WEEDY GRASS COMPETITION IN CORN[1]

Jonas Vengris[2]

Abstract

Two field experiments 1974 were conducted to study grassy annual weed competition in corn. In one experiment the field was heavily and uniformly infested with fall panicum (Panicum dichotomiflorum Michx.) and crabgrass (Digitaria sanguinalis (L.) Scop.). Here competition trials were conducted between these weedy grasses and field silage corn. In another experiment competitiveness of fall panicum with sweet corn (Zea mays L. var. Early Golden Giant) was investigated under various outdoor light intensities. In this experiment 18 fall panicum plants were established along each foot row of corn. Both experimental areas were liberally fertilized.

The yields of silage corn without weed competition were 30.6 kg/plot. When weeds competed for the whole season yields were 18.3 kg/plot. The longer weedy grasses were allowed to compete after corn emergence, the more corn yields were decreased. The period of weedy grass competition that field corn tolerated was approximately 3 weeks. Competition for moisture was probably a prime factor. In the experiment treatments were included in which weeds were controlled for different periods at the beginning of the season after corn emergence. Weedy grass control was most critical during the first two weeks after corn emergence. Grassy weed control for longer periods did not increase corn yields significantly. Field corn had a very significant competitive effect on weeds present. Competition for light and water was probably a major factor for weed suppression by corn.

Total sweet corn yields were decreased significantly by fall panicum emerging at the same time as corn. Fall panicum emerging 3 weeks later after corn emergence did not affect corn growth and yields in any way. Market sweet corn yields were less affected by fall panicum competition than stovers. Sweet corn and fall panicum responded similarly to various outdoor light intensities.

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[1]Contribution of the Massachusetts Agricultural Experiment Station, College of Food and Natural Resources, University of Massachusetts, Amherst, Massachusetts.

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

COMPETITION OF CORN AND NUTSEDGE IN ASSOCIATION

Brian J. Farwell and Larry R. Hawf[1/]

Abstract

Nearly pure populations of yellow nutsedge (Cyperus esculentus L.) were grown at three density levels in field corn (Zea mays L. cv. DeKalb X L64). Weed free corn, corn free nutsedge, and a natural mixed weed and corn population were grown for comparison purposes. Mineral composition of corn was determined when the corn was in the 5-6 leaf stage and at silking. Corn yields indicated a greater competitive influence of a mixed weed population than of the highest nutsedge density. Tissue mineral analysis revealed that low nutsedge populations did not significantly alter mineral accumulation. However, higher nutsedge populations and a mixed weed population resulted in a significantly lower accumulation of some nutrients.

Introduction

The objective of this study was to determine the competitive effect of yellow nutsedge as a weed grown with corn, its influence on mineral composition and yield. Competition and other complex interactions between crop and weed have been demonstrated (5, 6, 7). Weeds remove and make unavailable large amounts of minerals, and under certain circumstances, these may be of critical importance. This study was designed to determine the effectiveness of nutsedge as a competitor for any macro- or micro-element. In selecting the sampling techniques, an attempt was made to accurately reflect and standardize the mineral balance in corn and relate this to nutsedge competition (3, 4, 8).

Materials and Methods

Corn was planted on an Evesboro loamy sand heavily infested with nutsedge on May 16, 1974. The experimental design was a randomized block with five replications. Each plot consisted of three 30-foot rows spaced 30 inches apart and separated by an untreated row. The corn was planted at 12-inch intervals within the row.

Nearly pure nutsedge infestations were obtained by applying a preemergence application of atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-S-triazine] + simazine [2-chloro-4,6-bis-ethylamino)-S-triazine] at a rate of 1.0 + 1.0 lb. a.i./A. The population density of nutsedge was established and maintained by

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

physically removing excess plants. One square foot samples repeated three times per plot categorized the densities as: low, 43.8 grams fresh weight; medium, 86.2 grams fresh weight; and high, 178.6 grams fresh weight.

A total of eight treatments was maintained: (1) corn treated with atrazine + simazine and kept weed free; (2) corn, weed free; (3) corn with a low density of nutsedge; (4) corn with medium density of nutsedge; (5) corn with a high nutsedge density; (6) corn with nutsedge plus a natural mixed weed population consisting, on a percent fresh weight basis, of 26% common ragweed (Ambrosia artemisiifolia L.), 15% large crabgrass (Digitaria sanguinalis (L.) Scop.) and giant foxtail (Setaria faberii Herm.) and 59% yellow nutsedge; (7) nutsedge only; and (8) nutsedge minus corn but with a mixed weed population as in 6 above.

Tissue samples were taken of corn and nutsedge at the 5 to 6 leaf and silking stages of corn. The upper three leaves of the whorl were removed from 5 plants per plot for analysis at the 5 to 6 leaf stage. At silking, the blade of the ear leaf was removed from 5 plants per plot for analysis. Nutsedge was sampled by cutting plants randomly throughout the plot.

Samples were frozen, washed, dried and ground in a Wiley Mill equipped with a 40-mesh screen. The samples were then thoroughly mixed and sub-samples taken for analysis. Each sample was analyzed for total nitrogen content by using the Neslers test (1) and for other minerals by spark emission spectroscopy (2).

Results and Discussion

Low nutsedge densities had no influence on the yield of corn (Table 1). However, medium and high densities of nutsedge significantly decreased yields but not to the extent of a mixed weed population containing 41% weeds other than yellow nutsedge. The plots containing a mixed weed population did have a greater total production of weeds on a fresh weight basis. The weed weights of the mixed weed population was about 1.5 times that of the high nutsedge density but the yield was nearly 5 times less in the mixed weed population. This may indicate that nutsedge is not as great a competitor to corn as are other weed species.

The first sampling date for tissue analysis of minerals revealed few significant differences among treatments, of individual element accumulation in corn (Table 2). None of the macroelements were significantly different. Manganese, boron and zinc content of corn increased with increasing nutsedge population. Complex mineral interactions or growth dilution effects may be influential in the reversal of an expected decrease in mineral accumulation with an increased level of nutsedge infestation. Corn grown in natural mixed infestations of this field generally had as great or greater individual element accumulation than any other treatment. Nutsedge was found to accumulate 1.5 to 2 times more calcium, magnesium and zinc than corn. Competition in soils low in elements such as these could be detrimental to corn growth.

Mineral analysis at the time of silking showed that the mixed weed population had the greatest influence on element accumulation in corn (Table 3). This was consistent with the greatest yield reduction in corn. Nitrogen, phosphorus, potassium, iron, boron, copper, and zinc were all significantly reduced in mixed weed plots when compared to weed-free plots. Increasing populations of nutsedge indicated a trend of decreased nitrogen, phosphorus, potassium, and zinc in corn. Several elements; manganese, iron and boron showed greater levels at the high density of nutsedge than at the medium or low densities. This phenomenon is probably due to complex mineral interactions in the plant. Accumulation of nitrogen, potassium, calcium, magnesium, manganese and zinc in yellow nutsedge would indicate a possibility for severe competitive effects to corn.

Literature Cited

1. Hawk, Philip et. al. Practical Physiological Chemistry (12th ed.) McGraw Hill. New York. 1951. 818
2. Jones, J. Benton, Jr., and Myron H. Warner. 1969. Analysis of plant-ash solutions by spark-emission spectroscopy. Developing Applied Spectroscopy. 7(A):152-160
3. Jones, J. Benton, Jr., Steyn, W. J. A. 1973. Sampling, handling and analyzing plant tissue samples. Pages 249-270 in Soil Testing and Plant Analysis. Soil Science Society of America, Inc., Madison, Wisconsin.
4. Melsted, S. W., H. L. Motto and T. R. Peck. 1969. Critical Plant Nutrient Composition Values Useful in Interpreting Plant Analysis Data. Agron. Jour. 61:17-20.
5. Vengris, J., Weeds, Robbers of our Farms. Better Crops, 1956, 40, (1):9
6. Vengris, J., M. Drake, W. G. Colby and J. Bart. 1953. Chemical Composition of Weeds and Accompanying Crop Plants. Agron. Jour. 45:213-218.
7. Vengris, J., Colby and M. Drake. 1955. Plant nutrient competition between weeds and corn. Agron. Jour. 47:213-216.
8. Walker, W. M. and T. R. Peck. 1972. A comparison of the relationship between corn yield and nutrient concentration in whole plants and different plant parts at early tassel at two locations. Comm. in Soil Science and Plant Analysis, 3(6), 513-523.

Table 1. Effect of Weed Density on Corn Yield

Treatment	Weed Weights[1/] Gm. F.W./Sq.Ft.	Bu/Acre
1. Corn Weed Free atrazine + simazine	———	89.3
2. Corn Weed Free	———	88.2
3. Corn Low Density Nutsedge atrazine + simazine	43.8	95.0
4. Corn Medium Density atrazine + simazine	86.2	73.1
5. Corn High Density atrazine + simazine	178.6	54.6
6. Corn Mixed Weed Population[2/]	263.4	10.8
7. Nutsedge atrazine + simazine	165.4	——
8. Nutsedge Mixed Weed Population	266.4	——
L.S.D. .05		12.6

1/ Fresh Weights taken on July 1

2/ Including on a fresh weight basis: 26% common ragweed, 15% large crabgrass and giant foxtail and 59% yellow nutsedge.

Table 2. Mineral Composition of Corn and Nutsedge Harvested at the 5-6 Leaf Stage of Corn (June 10)

Treatment	Composition of Corn[1/] Macroelements (%)					Microelements (ppm)					
	N	P	K	Ca	Mg	Mn	Fe	B	Cu	Zn	Mo
Weed Free atrazine + simazine	3.88	0.36	7.11	0.20	0.17	19	83	4	8	32	1.0
Weed Free	3.79	0.39	7.67	0.28	0.21	23	95	6	12	40	1.5
Low Density Nutsedge	4.14	0.36	6.56	0.28	0.20	20	102	3	7	24	0.9
Medium Density Nutsedge	3.73	0.36	7.73	0.26	0.21	23	91	5	11	31	2.0
High Density Nutsedge	3.62	0.44	8.49	0.25	0.23	29	90	5	12	44	1.7
Mixed Weed Population	3.33	0.42	7.58	0.31	0.25	29	102	6	13	40	2.0
L.S.D. .05	N.S.	N.S.	N.S.	N.S.	N.S.	7	N.S.	1	N.S.	10	0.8
	Composition of Nutsedge[1/]										
No Corn atrazine + simazine	3.73	0.51	7.69	0.48	0.34	35	126	5	17	71	2.3
Standard Deviation	0.63	0.03	0.91	0.02	0.01	7	4	2	5	16	1.0

1/ Percent and ppm expressed on a dry weight basis

Table 3. Mineral Composition of Corn and Nutsedge Harvested at the Silking Stage of Corn (July 22).

Treatment	Composition of Corn[1/] Macroelements (%)					Microelements (ppm)					
	N	P	K	Ca	Mg	Mn	Fe	B	Cu	Zn	Mo
Weed Free atrazine + simazine	2.01	0.30	3.26	0.31	0.21	30	93	16	9	26	1.3
Weed Free	1.88	0.30	3.30	0.31	0.21	33	96	14	10	24	1.3
Low Density Nutsedge	1.85	0.28	3.11	0.29	0.18	24	86	12	6	22	0.9
Medium Density Nutsedge	1.90	0.27	3.35	0.27	0.20	33	79	11	9	21	1.9
High Density Nutsedge	1.78	0.27	2.77	0.26	0.18	39	87	14	9	21	1.7
Mixed Weed Population	1.47	0.25	2.19	0.30	0.23	37	80	10	7	16	1.7
L.S.D. $_{.05}$	0.20	0.04	0.51	N.S.	N.S.	8	8	3	2	3	N.S.
	Composition of Nutsedge[1/]										
No Corn atrazine + simazine	2.21	0.22	4.68	0.59	0.30	79	82	19	7	50	1.3
Standard Deviation	0.71	0.02	0.73	0.08	0.09	19	9	3	2	19	0.8

1/ Percent and ppm expressed on a dry weight basis

GERMINATION, GROWTH AND FLOWERING OF SHEPHERDSPURSE ECOTYPES[1]

E. K. Stilwell and R. D. Sweet[2]

Abstract

Germination and flowering of shepherdspurse (Capsella bursa-pastoris L. Medic.) plants grown from seeds collected from seven different locations in the United States was investigated. Storing seeds at alternating temperatures of 21°C and 50°C for 12 hours each for 7 days increased germination of one ecotype by 100%, but did not affect germination of the other ecotypes. Germination of all ecotypes was reduced as osmotic pressures were increased from 0 to 15 atmospheres. No germination occurred at 15 atmospheres; however, 3 out of 8 ecotypes had 13-19% germination in 10 atmospheres. The number of days to flowering varied among ecotypes and was reduced by temperatures of 10°C to 15°C when compared with temperatures of 21°C to 30°C. A spring ecotype flowered 20 days earlier than a fall ecotype from the same location. Flowering of one ecotype was not influenced by the above two temperatures but subsequently was hastened by a constant temperature of 10°C for 2 weeks.

Introduction

Shepherdspurse is a winter annual belonging to the cruciferae family and is distributed throughout most of the temperate regions of the world. It is commonly found along roadsides, field edges and in vegetable crops. In the northeast as well as other vegetable growing areas of the United States it is recognized as a serious weed in cabbage, broccoli, lettuce, onions and spinach. Roberts and Stokes (9) speculated that it has increased as a pest problem because it is tolerant of certain selective herbicides and has a high reproductive potential if left unchecked.

Field observations indicate that overwintering plants from fall germinating seeds remain in the vegetative stage as a rosette for many months before flowering in the spring. Plants from spring germinating seeds grow vegetatively for only a few weeks before flowering.

Germination of shepherdspurse is an irregular process (1, 6, 8, 10). An important contributing factor may be seed dormancy which can be interrupted by rupturing the seed coat (2), treating with gibberellic acid (7) or potassium nitrate as shown by Green et al. (4). Germination in the field occurs in early spring and often continues through late fall depending upon the geographical location and the site within a location.

A broad range of temperature and photoperiod influence flowering of shepherdspurse. However, Green (4) reported that optimum flowering was induced by alternating temperatures of 7°C to 13°C and subsequent growth in 16 hour daylength and temperature of 21°C to 27°C.

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[1] Paper No. 684, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

[2] Graduate Assistant and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

Such variation in germination and flowering habits suggest the possible existence of sub-populations within the specie, which are defined as ecotypes according to Daubenmire (3).

The importance of studying how environmental factors affect germination, growth and flowering of shepherdspurse is ultimately to find a vulnerable point in its life cycle that will aid in its control. Such information might also explain why this weed is a problem in certain situations but not in others.

The purpose of these studies was to distinguish ecotypes of shepherdspurse on the basis of their differential response to temperature; and osmotic pressure on germination; and temperature and daylength on growth and flowering.

Experimental

General Materials and Methods

Experiments were conducted in both greenhouse and growth chambers.

Seeds of shepherdspurse were collected from seven different geographical locations and two different sites within the United States as described in Table 1. Seed was stored at 21° ± 2°C in the dark.

Table 1. The location, season and soil type from which seeds of eight shepherdspurse ecotypes were collected.

Location	Season	Soil Type
1. Canistota, N.Y.	Fall (F)	Muck
2. Freeville, N.Y.	Spring (S)	Mineral
3. Oswego, N.Y.	Fall	Muck
4. Weslaco, Texas	Spring	Mineral
5. Lake Ridge, N.Y.	Spring	Mineral
6. Freeville, N.Y.	Fall	Mineral
7. Courtland, Cal.	Fall	Mineral
8. Salisbury, Mary.	Fall	Mineral

Germination studies were always conducted with 9 cm plastic petri dishes, with 1 sheet of Whatman No. 42 filter paper in the bottom. Prior to placing 25 seeds in each dish, 2.5 ml of solution was added. Petri dishes were placed in plastic bags and sealed to prevent moisture losses, then placed in brown paper bags to exclude light during germination. Treatments were placed in a growth chamber and replicated four times in a completely randomized block design. Seeds were germinated at 20° to 30° ± 2°C in the dark. After 7 days the petri dishes were removed and germination counts were made. Seeds were considered germinated when the length of the radicle was equal to or longer than the length of the seed.

Germination

Experiment 1: The objective of this experiment was to determine the effects of various storage temperatures on germination of several shepherdspurse ecotypes.

Seeds of each ecotype were placed in a 8x14 cm manila envelop and stored in constant temperatures of 1° ± 1°C, 22° ± 2°C, and alternating temperatures of 22° to 38° ± 2°C and 22° to 50° ± 2°C for 12 hours each for periods of 1, 2 and 4 weeks. Seeds were removed at the end of their respective storage time and germinated as previously described.

As shown in Table 2, germination of the Canistota ecotype was increased 100% by storage temperatures of 22° to 50°C. This ecotype comes from a muck soil, and in late summer soil temperatures often reach 50°C which may interrupt seed dormancy, thus preparing seeds for germination when late summer rainfall begins. Length of the storage period at 22° to 50°C did not influence germination of the Canistota ecotype. The other three ecotypes were not affected by any of the storage temperatures.

Table 2. The effect of four storage temperatures and three storage periods on percent germination of shepherdspurse ecotypes.

	Storage Temperatures (°C)											
	1°			22°			22-38°			22-50°		
	Weeks			Weeks			Weeks			Weeks		
Ecotypes	1	2	4	1	2	4	1	2	4	1	2	4
1. Canistota, N.Y.	30	45	40	41	46	60	59	76	73	85	86	86
2. Freeville, N.Y. (S)	100	100	100	100	100	100	100	100	100	100	100	100
3. Oswego, N.Y.	92	99	98	91	98	100	100	100	100	99	99	100
4. Weslaco, Texas	39	36	33	41	43	42	33	53	33	47	47	43

Experiment 2: The purpose of this experiment was to determine the effects of simulated drought conditions on germination of shepherdspurse ecotypes.

Using the method described by Parmar and Moore (5), osmotic pressures of 0, 3, 5, 6, 8, 10 and 15 atmospheres were obtained by dissolving 0, 172, 210, 230, 261, 294 and 360 gm of Carbowax (polyethylene glycol 6000) in 1 liter of distilled water, respectively. Each treatment received 2.5 ml of the solution. Germination procedures are the same as previously described.

The results in Table 3 indicate that the effects of osmotic pressure on germination vary considerably among ecotypes. Germination of all ecotypes was reduced by increased osmotic pressure. However, ecotypes from Freeville, Oswego, Lake Ridge, N.Y. and Courtland, Cal. were more tolerant of higher osmotic pressures than those from Canistota, N.Y., Weslaco, Texas, and Salisbury, Mary. None of the ecotypes germinated in 15 atmospheres.

Table 3. The effects of osmotic pressure on percent germination of shepherds-purse ecotypes.

Ecotypes	Pressure[1] (in atmospheres)						
	0	3	5	6	8	10	15
1. Canistota, N.Y.	48	7	4	3	2	0	0
2. Freeville, N.Y. (S)	100	94	69	45	40	4	0
3. Oswego, N.Y.	100	76	75	20	24	19	0
4. Weslaco, Texas	14	5	5	1	0	0	0
5. Lake Ridge, N.Y.	100	89	76	26	29	14	0
6. Freeville, N.Y. (F)	76	69	7	11	2	0	0
7. Courtland, Cal.	68	68	40	36	30	13	0
8. Salisbury, Mary.	58	4	1	0	0	0	0

[1] Obtained by dissolving varying amounts of polyethylene glycol 6000 in distilled water.

Flowering

In the field flowering has been observed in early spring and late fall in California, Texas and Maryland. In contrast, flowering in New York occurs in late spring and early fall. This suggests that the time from emergence to flowering may differ among ecotypes depending on the temperature and photoperiod at which they are growing. With this background information an experiment was conducted.

Experiment 3: The purpose of this experiment was to determine the effect of temperature and photoperiod on the rate of flowering of shepherdspurse ecotypes.

A few seeds of a given ecotype were planted in 4 inch diameter styrofoam cups filled with Cornell Mix A which is composed of 50% vermiculite, 50% peat moss with 1.5 lbs. of $CaNO_3$, 2.0 lbs. of $CaHPO_4$ and 5 lbs. of $CaCO_3$ added per cubic yard of mix. After emergence the plants were thinned to one plant per pot. Plants were grown in 10, 12 and 16 hour photoperiods in a 10° to 15°C greenhouse and repeated in a 21° to 30°C greenhouse. High temperatures varied as much as 10°C in each greenhouse; however, low temperatures remained relatively constant. In both temperature regimes, long days were provided by supplementary lights from four 8-foot, 215 watt, VHO, cool, white fluorescent tubes. Short days were accomplished by covering the benches with black shade cloth. A completely randomized split-split plot design with four replications was used. The plants were fertilized weekly with 20-20-20, N-P_2O_5-K_2O Peter's solution. Dates of emergence and flowering were recorded every other day for 78 days after emergence. The criterion for flowering was the first appearance of white petals.

Optimum flowering conditions for 7 out of 8 ecotypes were temperatures of 10° to 15°C and a 12 hour daylength as shown in Table 4. Under these conditions the number of days to flower varied from 22 to 43 among ecotypes. Treatments had little or no effect on flowering of the Lake Ridge ecotype. High temperatures severely reduced the number of flowering plants of the Texas ecotype. Flowering of the spring ecotype from Freeville, N.Y. was 20 days earlier than that of the fall ecotype.

Table 4. The effects of temperature and daylength on days required for flowering of shepherdspurse ecotypes.

	Days to Flower[1]					
Daylength (hrs.):	10		12		16	
Temperature (°C):	10-15	21-30	10-15	21-30	10-15	21-30
Ecotypes	days	days	days	days	days	days
1. Canistota, N.Y.	70	51	33	46	42	35
2. Freeville, N.Y. (S)	59[2]	42	22	39	37	30
3. Oswego, N.Y.	73	48	32	44	44	33
4. Weslaco, Texas	76	54	43	0	44	45[2]
5. Lake Ridge, N.Y.	78[2]	0	0	0	0	0
6. Freeville, N.Y. (F)	73	48	42	53	53	40
7. Courtland, Cal.	51[2]	40	28	33	33	29
8. Salisbury, Mary.	71	49	32	47	42	36

[1] Days to first white petal emergence.
[2] Represents only one plant, other three did not flower; remaining data is from four plants.

Experiment 4: In the previous experiment only one out of 24 plants of the Lake Ridge, N.Y. ecotype flowered. It responded to temperatures of 10° to 15°C and 10 hour daylength. The other 7 ecotypes flowered best at the same temperature and 12 hour daylength. These two observations and the work of Green (4) suggests that vernalization may be the key to flowering of the Lake Ridge, N.Y. ecotype.

Two plants of the Lake Ridge, N.Y. ecotype from each of the 6 treatments in experiment 3 were grown at a constant temperature of 10°C with 12 hours of light in a growth chamber for 2 weeks. The remaining plants were grown in their respective temperatures with a 12 hour daylength. At this time the plants were approximately 80 days old and in the 12-16 leaf stage. After the cold treatment, the plants were returned to their respective temperatures. They were examined for bud and flower development 10 days later. The results are presented in Table 5.

Table 5. The effect of vernalization on floral development of the Lake Ridge shepherdspurse ecotype grown at two different temperatures.

	Greenhouse Temperatures			
	10-15°C		21-30°C	
	Cold Treatments		Cold Treatments	
	10°C	None	10°C	None
Growth Stage	No. Plants	No. Plants	No. Plants	No. Plants
Vegetative	0	0	0	3
Bud	2	5	6	3
Flower	4	1	0	0

Vernalization of the Lake Ridge, N.Y. ecotype at 10°C for 2 weeks hastened flower development. Maturation was more advanced in those plants grown at 10-15°C than at 21-30°C

Summary

Shepherdspurse ecotypes vary in their response to environmental factors. Seed dormancy of the Canistota, N.Y. ecotype was interrupted by high temperature storage while others were unaffected. Germination of all ecotypes decreased with increasing osmotic pressures. However, 3 out of 8 ecotypes had 13-19% germination in 10 atmospheres. The number of days to flower varied among ecotypes. High temperatures severely reduced the number of flowering plants of the Texas ecotype. Flowering of the spring ecotype from Freeville, N.Y. was 20 days earlier than that of the fall ecotype. Vernalization hastened flower development of the Lake Ridge, N.Y. ecotype. These preliminary studies indicate that different ecotypes are adapted to different environmental conditions.

Studies on the effects of pH on germination, effects of juvenility and vernalization on flowering of shepherdspurse ecotypes, are in progress.

Literature Cited

1. Chancellor, R. J. 1965. Emergence of weed seedlings in the field and the effect of different frequencies of cultivation. Proc. 17th Br. Weed Contr. Conf. pp. 599-606.
2. Crocker, Wm. 1906. Role of seed coats in delayed germination. Bot. Gaz. 42: 265-291.
3. Daubenmire, R. F. 1947. Plants and Environment. p. 1-424. John Wiley and Sons, Inc., New York.
4. Green, C. A. Jr. 1973. Studies on shepherdspurse [Capsella-bursa pastoris (L.) Medic.]. M.S. Thesis, Cornell Univ., Ithaca, N.Y.
5. Parmar, M. T. and R. P. Moore. 1966. Effects of simulated drought by polyethylene glycol solutions on corn (Zea mays L.) germination and seedling development. Agron. J. 58: 391-392.
6. Popay, A. I. and E. H. Roberts. 1970a. Factors involved in the dormancy and germination of Capsella-bursa pastoris (L.) Medic. and Senecio vulgaris L. J. Ecology 58: 103-122.
7. Popay, A. I. and E. H. Roberts. 1970b. Ecology of Capsella-bursa pastoris (L.) Medic. and Senecio vulgaris L. in relation to germination behavior. J. Ecology 58: 123-140.
8. Roberts, H. A. 1964. Emergence and longevity in cultivated soil of seeds of some annual weeds. Weed Res. 4: 296-307.
9. Roberts, H. A. and F. G. Stokes. 1966. Studies on the weeds of vegetable crops. Seed populations of soil under commercial cropping. J. Appl. Ecol. 3: 181-190.
10. Salisbury, E. J. 1964. Intermittent germination in Capsella. Nature, London. 199: 1303-1304.

WEEDS OF THE WORLD. IIa., THE WEEDS OF EUROPE

Lawrence J. King[1/]

ABSTRACT

This is a summary of a long-term project on a European weed survey - an alphabetical checklist providing the technical name, common and family name, life span and other biological data. Crop associations, distribution for certain countries, and bibliographies are also included. The large number of American weed introductions from Europe are noted - data indicate a value approximating fifty per cent for the troublesome weeds of the northeastern United States.

INTRODUCTION

An enumeration of the principal vascular weeds of Europe (exclusive of the European USSR) has been prepared (23). This survey is based upon a number of standard works on weeds for a number of the principal countries. The works utilized are provided in the work just cited. An inspection of this list reveals a large number of species that are considered weeds in certain portions of the United States. Thus some clues relating to the possible origins of many important American weeds may be found. Caution is needed here, however, for authorities differ on whether certain species are native or introduced. The problem of ecotypes or biotypes may further complicate the picture.

AMERICAN WEED INTRODUCTIONS

A number of writers on American weeds have provided data on the percentage of weeds that are introduced. Muenscher (28) examined the source of 500 weeds of the Northern United States. He states that 39.2 per cent (196 species) are native to North America; while 35.4 (177 species) are of European origin, and 13.2 per cent (66 species) are from Eurasia. Pammel and King (30) in their review of weed migration note L. H. Dewey's 1895 study of 200 weeds of the United States where 92 were native and 108 species were foreign (64 from Europe and 30 from the Old World). An 1892 list of Michigan plants contained 1,746 species of which 142 were introduced from Europe, and 57 of these were troublesome weeds. A Kansas weed list of 209 species included 42 introduced from Europe, and 38 from other sources. Of 110 troublesome California weeds 53 were native, 43 were from Europe and 5 from the eastern United States. Fogg (2) observed that of the 242 lawn and garden weeds 128 species (53 per cent) were European or Eurasian in origin, and 78 species (32.5 per cent) were native to

1/ Department of Biology, State University College of Arts and Science, Geneseo, N.Y.

North America.

Perhaps the earliest commentator on American weeds was John Josselyn in 1672 (7). He stated that several species of European weeds had "sprung up since the English planted and kept cattle in New England," thus implying they were introduced. He recorded no less than 40 European weeds introduced in this manner.

This author in a review published in 1956 (11) referred to the statement of the distinguished Norwegian weed biologist, Emil Korsmo, that in the northern temperate zone the weed flora may constitute 8 to 10 per cent of the entire vegetation. When based on species number the 571 species listed in W. C. Muenscher's Weeds (1955 edition) for the northeastern United States constituted slightly more than 10 per cent of the 5,523 species covered in the area of Gray's Manual (8th edition, 1950) range. Another example cited was the 413 weeds listed for New York State which comprised 14 per cent of the 2,876 species included in the State flora.

EUROPEAN WEEDS

The present survey of European weeds lists 575 species. Only an estimate can be made for the European vascular flora, perhaps 15,000 species and subspecies. The noxious flora percentage based on this estimate is then about 3.1. However, the Flora range covers large areas in sub-arctic, alpine and mountainous regions, out-lying islands, etc. - all generally unsuitable for intensified agriculture. Thus the Balkan areas noted below may be more representative due to a very long agricultural history. Professor T. G. Tutin estimates that the noxious element of the British Flora is about 4.5 per cent. Comments on the origin of some European weeds were included in Weeds of the World I. Reference was made to Turrill's 1929 study of the flora of the Balkan Peninsula (34) where 6,530 species of flowering plants were included, and 567 species were considered weeds (8.7 per cent of the total flora). The four families most plentifully represented were: Compositae (100 spp.), Gramineae (99), Umbelliferae (82), and Cruciferae (65).

This Balkan weed flora comprised 407 annuals, 39 biennials, and 121 perennials; while the ruderal flora consisted of 172 annuals, 39 biennials, and 77 perennials. The 61 species of the 17 genera of the Chenopodiaceae were particularly noted. Turrill noted that the main halophytic invasion had been one of Central Asian species via South Russia into the Dobruja. A number of genera contained sizable species numbers: Plantago (26 spp.), Galium (70 spp.), and the largest genus, Centaurea (171 spp.) - possibly indicating the center of origin of these genera.

Turrill also observed that the common chicory, Cichorium intybus var. glabratum, found in the British Isles is the same

variety that is common in the Balkans. Furthermore, the vast majority of the arable-land weeds found in the British flora were also found as weeds in the Balkans. He also noted that the Mediterranean is given as the most important single geographical source of the weed-aliens of Montpellier in France (Thellung, 1912, see, 18) and Tweedside in England (Hayward & Druce, 1919, see, 18), 416 species in the former and 113 in the latter having this origin.

The survey comprises an alphabetical checklist with the technical name, common and family name, life span and other biological data. Crop associations, distribution for certain countries, and bibliographies are also included. Illustrations and maps are utilized.

The present survey also includes extensive bibliographies - particularly of manuals for the weeds of the various European countries. The first volume in this series (18) also included references to such manuals, and in addition much attention was given to European studies of weed biology. Included were such topics as (new references are here added): allelopathy, pp. 248-254, (31); parasitic weeds, pp. 49-78, (26); weed phytosociological studies, pp. 260-283, (3, 36); ecotypes, pp. 233-234, (19); satellite weeds of crops, pp. 116-119; aquatic weeds, pp. 38-39, (33); phenology, pp. 208-219, (27); and seed biology, Chs. VI, VIII, (5, 6, 32).

Some earlier studies of this author have considered topics related to European weeds: propagation methods of Elodea (8), the early work of Osvald in Sweden on allelopathy (9), the crabgrasses (12, 24), von Hofsten's study of Taraxacum apomicts (14), possible origin of "weed" from "woad", Isatis tinctoria L. (13, 15, 20), ethnobotany of squills and other plants (17, 22), and studies on Setaria and Genista (10, 21).

DISCUSSION AND SUMMARY

Much of modern weed science has roots in research areas pioneered by European investigators. An enumeration of some of the older treatises on weeds is provided, and special note was made of the monographs published in the series, Arbeiten der Deutschen Landwirtschafts-Gesellschaft (1903-1917): on Equisetum, Agropyron, Veronica, Galinsoga, Sinapis, and the now classical work on Avena fatua and hybrids. Otto Wehsarg, and Bernhard Rademacher (1901-1973) (25) were illustrious contributors to weed biology. In England W. E. Brenchley, H. C. Long, E. J. Salisbury, R. L. Harper and many others are notable investigators. The series, Biological Flora of the British Isles, published as supplements to the Journal of Ecology, includes valuable data on many weeds. The Agricultural Weed Research Council publishes Weed Abstracts (1950 to date). Weed Research (1961 to date) is the official journal of the European Weed Research Council, and

notes and full reports of weed and pest conferences are regularly published.

As discussed in Vol. I the anthropic factors in relation to the origin and evolution of weeds and weed associations are highly significant. A. Thellung (1881-1928) (1) has written extensively in this area. The study of H. Hjelmqvist (1950) on flax weeds (see, 18, p. 57) further explores this subject and reviews some of the Russian contributions. The studies of Tüxen (36) and Frenkel (3) provide additional information; see also Muzik (29). Harlan and de Wet (4) noted that both domesticated plants and weeds are adapted to the same habitat and thus practices that tend to favor domesticates also tend to favor weeds.

More detailed information for the species listed in the checklist may be found in the volumes of the Flora Europaea (35). Information has not been directly obtained from this Flora although as noted below Professor Tutin has reviewed this weed checklist. Other useful floras are: Illustrierte Flora von MittelEuropa (G. Hegi, 1906-1931; Ed. 2, 1936, etc.), and Flora URSS (V. Komarov et al., 1934-1964). A list of basic and standard floras for most of the countries and regions covered by Flora Europea may be found in the introductory pages of each volume of that work. In addition, all monographs and other taxonomic literature cited are listed at the end of each volume.

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LITERATURE CITED

1. Anon. (1928). Albert Thellung (1881-1928). Physis 9:475-591.
2. Fogg, J. M., Jr. (1956). Weeds of Lawn and Garden. Univ. Penn. Press, Philadelphia. 215 pp. (Geographic origins, pp. 10-16).
3. Frenkel, R. E. (1970). Ruderal vegetation along some California roadsides. Univ. Calif. Public. Geography, 20:1-163. (Ch. II, Nature of disturbed habitats; treading [cattle and human trampling], "Trittpflanzen", pp. 16-18.)
4. Harlan, J. R. and J. M. J. de Wet (1965). Some thoughts about weeds. Econ. Bot. 19:16-24.
5. Hawkes, J. G. (ed.) (1966). Reproductive Biology and Taxonomy of Vascular Plants. Conference, Bot. Soc. Brit. Isles, Birmingham Univ., 1965. Pergamon Press, Oxford. 183 pp.
6. Heydecker, W. (ed.). (1973). Seed Ecology. Easter School in Agricultural Science, 19th. University of Nottingham, 1972. Butterworths, London; Penn. State Univ. Press. 578 pp.
7. Josselyn, J. (1672). New Englands Rarities. London, 114 pp. (Facsimile-edn.; by W. Junk, No. 25, 1926).
8. King, L. J. (1943). Responses of Elodea densa to growth-promoting substances. Botan. Gaz. 105:127-151.
9. King, J. J. (1948). Book Review of, "Weed Control Experiments," Edited by Hugo Osvald, Public. Inst. Plant Husbandry, Roy. Agic. Coll. Sweden, No. 2, Uppsala, 1947. 318 pp. In, Science 107:524-525.
10. King, L. J. (1952). Germination and chemical control of the giant foxtail grass (Setaria faberii). Contrib. Boyce Thompson Inst. 16:469-487.
11. King, L. J. (1956). Book Review of "Weeds" by W. C. Muenscher, MacMillan, N.Y. ed. 2. 560 pp. In, Science 123:334.
12. King, L. J. (1957). When does crabgrass germinate? Westchester County Farm and Home News (N.Y.), May.
13. King, L. J. (1957). Some early forms of the weed concept. Nature (London) 179:1366.
14. King, L. J. (1957). Book Review of "Studies on the genus Taraxacum Wigg. with special reference to the group Vulgaria DT in Scandinavia," C. G. von Hofsten, Stockholm, 1954. 432 pp. In, Economic Bot. 11:377-378.
15. King, L. J. (1958). On the origin of the term "weed." Proceed. Indiana Acad. Sci. 67:287-289.
16. King, L. J. (1959). Some world aspects of the biology and control of weeds. 6 pp. Paper read at I.B.C. - Abstract, Proc. Ninth Internat. Bot. Congr., Montreal, 1959, p. 193.
17. King, L. J. (1964). The ethnobotany of the squills (Urginea, Liliaceae) in Africa, Europe and Asia. (Abstract). Proceed. Tenth Inter. Bot. Congr. Edinburgh, 1964:400-401.
18. King, L. J. (1966). Weeds of the World - Biology and Control. Leonard Hill, London; Interscience, New York. 526 pp.
19. King, L. J. (1966). Weed Ecotypes - A Review. Proc. N.E. Weed Cont. Conf. (New York City) 20:604-611.

20. King, L. J. (1967). The Distribution of Woad (Isatis tinctoria L., Cruciferae) in North America. Proc. N.E. Weed Cont. Conf. (New York City) 21:589-593.
21. King, L. J. (1968). Notes on dyer's greenweed (Genista tinctoria L., Leguminosae). Proc. N.E. Weed Cont. Conf. (New York City) 22:501-503.
22. King, L. J. (1971). The Folklore and Symbolism of Plants - A World Synopsis and Information Guide. Geneseo, N.Y. 220 pp. Xerographic reproduction of typescript. Copies, Milne Library, SUC, Geneseo, N.Y.
23. King, L. J. (1974). Weeds of the World - IIa. A Checklist of The Weeds of Europe. Geneseo, N.Y. 187 pp. Xerographic reproduction of typescript. Copies: Milne Library, SUC, Geneseo, N.Y.; Mann Library, Cornell University, Ithaca, N.Y.; Boyce Thompson Institute Library, Yonkers, N.Y.; National Agricultural Library, Beltsville, Maryland.
24. King, L. J. and J. A. Kramer (1955). A review of the crabgrasses (Digitaria ischaemum and D. sanguinalis) with notes on their pre-emergence control in turf. Proc. N.E. Weed Conf. (New York City) 9:359-363.
25. Koch, W. (1974). Bernhard Rademacher (1901-1973), Obituary with portrait. Weed Res. 14:271-272.
26. Kuijt, J. (1969). The Biology of Parasitic Flowering Plants. Univ. Calif. Press, Berkeley. 246 pp.
27. Leith, H. (ed.) (1974). Phenology and Seasonality Modeling. Springer, N.Y. 444 pp.
28. Muenscher, W. C. (1955). Weeds, Second Edition. MacMillan, N.Y. 560 pp. (Sources of weeds, pp. 21-23).
29. Muzik, T. J. (1970). Weed Biology and Control. McGraw-Hill, N.Y. 273 pp. (Ch. 1, Weeds in Relation to Man, pp. 1-15).
30. Pammel, L. H. and Charlotte M. King (1926). The Weed Flora of Iowa. Geological Survey, Bull. No. 4, 715 pp.
31. Rice, E. L. (1974). Allelopathy. Academic Press, N.Y.
32. Roberts, E. D. (ed.) (1972). Viability of Seeds. Syracuse Univ. Press. 478 pp.
33. Sculthorpe, C. D. (1967). The Biology of Aquatic Vascular Plants. St. Martin's Press, N.Y. 610 pp.
34. Turrill, W. B. (1929). The Plant-Life of the Balkan Peninsula. A Phytogeographical Study. Clarendon Press, Oxford, 490 pp.
35. Tutin, T. G., Heywood, V. H., Burgess, N.A., Valentine, D. H., Walters, S. M., and Webb, D. A. (Eds.) (1964, etc.). Flora Europaea. Cambridge University Press, Cambridge. To be completed in four volumes. Vol. I, 1964; Vol. II, 1968; Vol. III, 1972.
36. Tüxen, R. (ed.) (1966). Anthropegene Vegetation. Internationale Symposium in Stolzenau/Weser, 1961. W. Junk, Den Haag. 398 pp.

THE PREPARATION OF ENVIRONMENTAL IMPACT STATEMENTS

Richard Stalter[1/]

ABSTRACT

Prior to the preparation of an environmental impact statement, each investigator, who should be an expert in his field, needs to be familiar with the project he is to evaluate and with the guidelines of the Environmental Policy Act. Sampling techniques should enable the investigator to rapidly and accurately measure the various parameters that influence life in the study area. Preferably the methods chosen should have been used by several scientists, each a scientist in a particular area.

After each study has been completed, the agency or individual acting as coordinator of the project can prepare the environmental impact statement.

1/ Environmental Studies Program, St. John's University, Jamaica, N.Y.

INFLUENCE OF NORFLURAZON ON CHLOROPHYLL PRODUCTION

By

Robert M. Devlin and

Stanislaw J. Karczmarczyk[1/]

ABSTRACT

The influence of 4-chloro-5-(methylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (norflurazon) on chlorophyll development in wheat, corn, and alfalfa under high and low light intensities was studied. Under high light intensity (1000 ft-c) chlorophyll production was markedly reduced, 1 ppm norflurazon almost completely bleaching both corn and wheat seedlings. Alfalfa proved to be more sensitive to norflurazon, 0.1 ppm causing almost complete chlorosis. Under low light intensity (1 ft-c) the influence of norflurazon on chlorophyll production was greatly reduced. From our data and from pertinent data in the literature it is thought that norflurazon inhibits carotenoid synthesis, leaving the plant's chlorophyll unprotected and subject to photodynamic destruction.

INTRODUCTION

On cranberry bogs norflurazon has proven to be an effective preemergence herbicide for the control of a number of troublesome weeds, particularly nutsedge (*Cyperus dentatus* Tort.) and cutgrass (*Leersia oryzoides* L. Sw.) (4,5). The control of these weeds is accomplished by retarding photosynthesis through the destruction of chlorophyll. The first visible symptom of the herbicide's activity is chlorosis along the veins of the leaf. In time, the entire chlorophyll-containing area of the plant is bleached and death soon follows. The pattern of chlorotic development suggests that it parallels translocation of the herbicide, the tips of the shoot and margin of the leaf being the last to bleach.

1/ Professor and Research Associate, respectively, Laboratory of Experimental Biology, Cranberry Experiment Station, University of Massachusetts, East Wareham, Massachusetts 02538.

In this study we observed the destruction of chlorophyll by norflurazon in alfalfa (Medicago sativa L. var. Saranac), corn (Zea mays var. Everta), and wheat (Triticum vulgare L. var. Mericopa) under high and low light intensities. It is apparent from our work and the work of others (1,2,8,15) that the mode of action of norflurazon is linked to its influence on carotenoid synthesis which, in turn, is associated with the protection of chlorophyll from photodynamic destruction (3,7,9,13).

MATERIALS AND METHODS

Imbibed alfalfa, wheat, and corn seeds were germinated and the seedlings grown in Petri dishes containing 50 ml of agar. Before being sown alfalfa seeds were soaked for 22 min in concentrated H_2SO_4 to facilitate germination. Norflurazon, when used, was dissolved in the agar. Corn and wheat seeds were covered with about 3 mm of washed sand while alfalfa seeds were left uncovered. All of the seedlings were grown in a Percival growth chamber (Model E-540) under various light intensities (0, 1, and 1000 ft-C) and a constant temperature of 25°C.

For pigment extraction shoot tissue was collected, homogenized for 2 min in 80% acetone with a Virtis-45 homogenizer, and the homogenate allowed to stand in darkness for 20 hr at 4°C. The homogenate was then centrifuged at 32,700 g and 4°C for 10 min. The supernatant was decanted for pigment determination. All pigment extraction procedures were performed under dim light conditions to minimize photodynamic destruction of chlorophyll. The optical density of the chlorophyll extract was read at 645 and 663 nm with a Perkin-Elmer double beam spectrophotometer. The amount of chlorophyll present in the extract, on the basis of mg of chlorophyll per g of shoot tissue extracted, was calculated according to the following equations.

$$\text{mg chl a/g tissue} = \left[12.7(D_{663})-2.69(D_{645})\right] \times \frac{V}{1000 \times W}$$

$$\text{mg chl b/g tissue} = \left[22.9(D_{645})-4.68(D_{663})\right] \times \frac{V}{1000 \times W}$$

$$\text{mg total chl/g tissue} = \left[20.2(D_{645}) + 8.02(D_{663})\right] \times \frac{V}{1000 \times W}$$

In the above equations D represents the optical density reading of the chlorophyll extract at the specific indicated wavelength, V the final volume of the 80% of acetone-chlorophyll extract, and W the fresh weight in g of the tissue extracted. Each experiment was replicated twice.

RESULTS

Chlorotic development was observed almost immediately upon emergence of the shoot of germinating corn and wheat seeds that had been treated with norflurazon. Corn seedlings treated with 0.1 ppm norflurazon and analyzed for chlorophyll 7 days after germination show a 40% drop in total chlorophyll content (Table 1). Chlorophyll content continued to drop sharply as the concentration of norflurazon was increased over a range from 0.1 ppm to 10 ppm (Table 1). In fact, at 5 ppm the shoot tissue was almost completely bleached. When analyzed for separately it was found that both chlorophyll a and chlorophyll b content dropped proportionately with the total chlorophyll content (Table 1).

Table 1. Effect of norflurazon on the chlorophyll content of corn seedlings 7 days after germination. Chlorophyll content is measured in ug/g fresh tissue.

Norflurazon	Chl a	Chl b	Total Chl
0.0 ppm	1388	389	1776
0.1 "	828	213	1040
0.5 "	429	116	544
1.0 "	124	68	192
5.0 "	30	37	67
10.0 "	4	4	9

Table 2. Effect of norflurazon on the chlorophyll content of wheat seedlings 7 days after germination. Chlorophyll content is measured in ug/g of fresh tissue.

Norflurazon	Chl a	Chl b	Total Chl
0.0 ppm	1146	309	1454
0.1 "	750	258	1008
0.5 "	434	161	595
1.0 "	97	51	147
5.0 "	34	42	75
10.0 "	25	38	63

Wheat seedlings reacted in the same manner to norflurazon as did corn (Table 2). Over the same concentration range chlorophyll content dropped sharply, very little chlorophyll being observed in those plants treated with 5 ppm norflurazon.

Alfalfa, a dicotyledon, was much more sensitive to norflurazon than either corn or wheat. For example, a noticeable drop in chlorophyll content was observed 7 days after treatment with 0.01 ppm norflurazon (Table 3). Application of 0.1 ppm under the same circumstances caused almost total chlorosis of the alfalfa plants (Table 3).

Table 3. Effect of norflurazon on the chlorophyll content of alfalfa seedlings 7 days after germination. Chlorophyll content is measured in ug/g fresh tissue.

Norflurazon	Chl a	Chl b	Total Chl
0.000 ppm	1115	377	1493
0.010 "	1034	344	1377
0.025 "	784	252	1035
0.050 "	100	82	182
0.075 "	77	101	177
0.100 "	57	45	102
0.250 "	52	13	69

One way to determine if norflurazon-induced chlorosis results from photodynamic action is to decrease the light intensity to which the treated plants are exposed to. If photodynamic action is involved then a sharp decrease in light intensity should retard the herbicide-induced chlorosis. When the light intensity to which the norflurazon-treated corn, wheat, and alfalfa plants were exposed to was reduced from 1000 ft-c to 1 ft-c chlorosis was markedly retarded (Tables 4,5,6). Note in Table 6, for example that the chlorophyll content of alfalfa plants treated with 0.025 ppm norflurazon and exposed to 1000 ft-c of light dropped 77%. The chlorophyll content of those exposed to only 1 ft-c exhibited a drop of only 4%.

Table 4. Effect of light intensity on chlorosis caused by norflurazon treatment of corn. The chlorophyll extracted is in ug/g fresh tissue.

Light Treatment	Control	Norflurazon 1 ppm	5 ppm	10 ppm
7 Days at 1000 ft-c	1709 Chl	56 Chl	49 Chl	41 Chl
7 Days at 1 ft-c	556 "	432 "	321 "	245 "
7 Days no light	0 "	0 "	0 "	0 "

Table 5. Effect of light intensity on chlorosis caused by norflurazon treatment of wheat. The chlorophyll extracted is in ug/g fresh tissue.

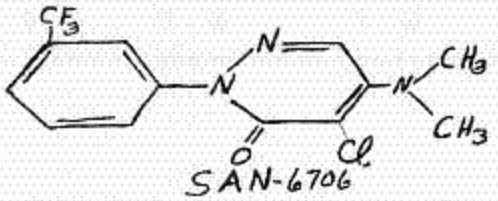
Light Treatment	Control	Norflurazon 0.5 ppm	1 ppm
7 Days at 1000 ft-c	1665 Chl	114 Chl	52 Chl
7 Days at 1 ft-c	658 "	472 "	343 "
7 Days no light	0 "	0 "	0 "

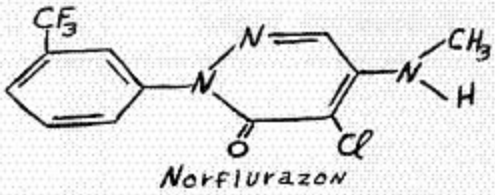
Table 6. Effect of light intensity on chlorosis caused by norflurazon treatment of alfalfa. The chlorophyll extracted is in ug/g fresh tissue.

Light Treatment	Control	Norflurazon 0.025 ppm	0.05 ppm	0.1 ppm
5 Days at 1000 ft-c	1606 Chl	382 Chl	231 Chl	150 Chl
5 Days at 1 ft-c	864 "	834 "	693 "	683 "
5 Days no light	0 "	0 "	0 "	0 "

DISCUSSION

Although very little work has been done on the mode of action of norflurazon some detailed studies have been made on its chemical analogue 4-chloro-5-(dimethylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (SAN-6706). Norflurazon has one less methyl group. Hilton et al. (8) working with a variety of plants found





that SAN-6706 inhibited the Hill reaction and CO_2 fixation in established green leaves and blocked chloroplast development in embryonic cells. They also established that SAN-6706 blocked carotenoid synthesis and caused a sharp drop in chlorophyll content. In a similar study Bartels and Hyde (1) demonstrated that SAN-6706 disrupted chloroplast development in wheat seedlings, blocked carotenoid synthesis, and caused a severe drop in chlorophyll content. It is interesting to note also that in the Bartels and Hyde study 70S ribosomes were almost completely eliminated in the SAN-6706-treated plants. This probably is one of the reasons chloroplast development is disrupted by this compound.

In both of the above studies the symptoms of SAN-6706 activity were observed in plants subjected to at least 1500 ft-c of light during photoperiods of from 12 to 16 hr. When light intensity was decreased to 1 ft-c with the plants being illuminated

continuously, the influence of SAN-6706 on chlorophyll content, carotenoid synthesis, and chloroplast development was severly curtailed (1). This observation, in addition to the fact that SAN-6706 blocks carotenoid synthesis, supports the concept that chlorophyll reduction in SAN-6706-treated plants is due to photodynamic action (1). It is well known that carotenoids protect chlorophyll from photodynamic destruction (3,9). However, at very low light intensities the possibility of the photodynamic destruction of chlorophyll occurring in the absence of carotenoids is considerably reduced.

In our laboratory and in studies at the Sandoz-Wander Laboratories[2/] it has been established that the first metabolic breakdown product of SAN-6706 in the plant is norflurazon and that this conversion occurs in a relatively rapid manner (6,10,11,14,16,17). Norflurazon is then reluctantly converted to its desmethyl derivative 4-chloro-5-amino-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (SAN-9774) (11,12,17). The rapid conversion of SAN-6706 to norflurazon coupled with the fact that norflurazon is relatively stable in the plant suggests that SAN-6706 per se has no herbicidal activity, that the activity observed in plants treated with SAN-6706 is that of norflurazon. This, in turn, suggests that the papers of Hilton et al. (8) and Bartels and Hyde (1) really describe studies of the activity of norflurazon not SAN-6706. Our data on norflurazon supports this assumption since it parallels that of Bartels and Hyde (1).

LITERATURE CITED

1. Bartels, P.G. and A. Hyde. 1970. Chloroplast development in 4-chloro-5-(dimethylamino)-2-(α,α,α-trifluoro-m-tolyl)-3(2H)-pyridazinone (Sandoz 6706)-treated wheat seedlings. Plant Physiol. 45:807-810.

2. Burns, E.R., M.C. Carter, and G.A. Buchanan. 1970. Carotenoid inhibition as a possible mechanism of action of pyriclor, dichlormate and amitrole. Weed Sci. Soc. Amer. Abstr. No. 23. Montreal, Canada.

3. Devlin, R.M. and A.V. Barker. 1971. Photosynthesis. Van Nostrand Reinhold Co., New York.

4. Devlin, R.M. and I.E. Demoranville. 1971. Tolerance of cranberry (Vaccinium macrocarpon Ait.) to alachlor and two fluorinated herbicides. Hort. Sci. 6:245.

2/ Personal communication.

5. Devlin, R.M. and K.H. Deubert. 1973. Tolerance of cranberry (Vaccinium macrocarpon Ait.) to SAN-9789: an experimental herbicide. Weed Res. 13:393-398.

6. Devlin, R.M. and R.W. Yaklich. 1972. Translocation and metabolism of SAN-6706-C^{14} in Vaccinium macrocarpon var. Early Black. Proc. Northeast. Weed. Contr. Conf. 26:72-75.

7. Griffiths, M., W.R. Sistrom, G. Cohen-Bazire, and R.Y. Stanier. 1955. Function of carotenoids in photosynthesis. Nature 176: 1211.

8. Hilton, J.L., A.L. Scharen, J.B. St. John, D.E. Moreland, and K.H. Norris. 1969. Modes of action of pyridazinone herbicides. Weed. Sci. 17:541-547.

9. Krinsky, N.I. 1966. The role of carotenoid pigments as protective agents against photosensitized oxidations in chloroplasts. In T.W. Goodwin (ed.), Biochemistry of chloroplasts. vol. 1. New York: Academic Press.

10. Motooka, P.S. 1972. Uptake, translocation and metabolism of Sandoz-6706 in soybean and sicklepod. Ph.D. Thesis, North Carolina State Univ., Raleigh, N.C. 87 pp.

11. Rahn, P.R. and R.L. Zimdahl. 1973. Soil degradation of two phenyl pyridazinone herbicides. Weed Sci. Soc. Amer. Abstr. 127.

12. Rogers, R.L. 1973. Behavior of H^3-SAN-9789 in soil and in cotton plants. Weed. Sci. Soc. Amer. Abstr. 129.

13. Stanier, R.Y. 1959. Formation and function of the photosynthetic pigment system in purple bacteria. In The photochemical apparatus--its structure and function. Brookhaven Symp. Biol. 11:43.

14. Strang, R.H. 1972. A study of the absorption, translocation and metabolism of two pyridazinone herbicides (SAN-6706, SAN-9789) by cotton, corn and soybean. PhD. Thesis, Louisiana State Univ., Baton Rouge, LA. 103 pp.

15. Vaisberg, A.J. and J.A. Schiff. 1974. Inhibition of carotenoid synthesis in Euglena gracilis var. bacillaris by SAN-9789 (4-chloro-5-(methylamino)-2-(alpha, alpha, alpha-trifluoro-m-tolyl)-(2H)-pyridazinone. Gen. Protozoo. Vol. 21 (No. 3), Abstr. F-122, p #447.

EFFECT OF 4-CHLORO- 5 - (DIMETHYLAMINO) -2- (ALPHA, ALPHA, ALPHA-M -THOLYL) - 3 (2H) - PYRIDAZINONE ON RESPIRATION AND GROWTH OF CHLORELLA PROTOTHECOIDES

Neil G. Grant [1]

Respiration of Chlorella protothecoides Kruger, Indiana Strain #25, is similar to that of some higher plants in having two mitochondrial oxidase systems; a cytochrome system inhibited by cyanide, carbon monoxide and antimycin and a so-called "alternate oxidase" system resistant to the above inhibitors but specifically inhibited by aromatic hydroxamic acids such as mCLAM [2] or SHAM. Only in the presence of both classes of inhibitors are oxygen uptake and growth greatly inhibited. Whole cell difference spectra show that the alternate oxidase branches from the cytochrome system before the cytochrome c region.

The herbicide Sandoz 6706 inhibits oxygen uptake of whole cells of C. protothecoides only in the presence of mCLAM or SHAM. It does not inhibit the cytochrome oxidase of this alga. Whole cell difference spectra indicate that Sandoz 6706 blocks mitochrondrial electron transport between the cytochrome b and c regions. Heterotrophic growth on glucose is about 70 to 80% of the control in the presence of either SHAM or Sandoz 6706 alone but is reduced to nil in the presence of both inhibitors together.

[1]Department of Biology, The City College of the City University of New York, New York N.Y. 10031.

[2] mCLAM: m-chlorobenzhydrox amic acid
SHAM: Salicyl hydroxamic acid
Sandoz 6706: 4-chloro- 5 - (dimethylamino) - 2 - (alpha, alpha, alpha-alpha- trifluoro -m - tolyl)-3(2H) - pyridazinone.

EFFECT OF IAA AND 2,4-D ON CELLULASE ENZYMES IN ABSCISSION ZONES OF *PHASEOLUS VULGARIS*

Philip D. Reid [1/]

Abstract

Application of high concentrations (500 ppm) of either IAA (indole-3-acetic acid) or 2,4-D (2,4-dichlorophenoxy acetic acid) to the distal abscission zones of debladed kidney bean explants resulted in inhibition of the abscission process, swelling of the pulvinus and enhanced cellulase activity. When cellulase which was extracted from treated abscission zones was subjected to isoelectric focusing, it was shown that the increase in activity was primarily restricted to an acidic form of the enzyme which is also present in untreated tissue. The major form of cellulase which has been previously extracted from abscising tissue was absent in the tissues treated with either IAA or 2,4-D.

Introduction

It has previously been shown that cellulase activity was increased in etiolated tissues which had been treated with IAA (4). It has also been reported that cellulase activity increased in *Phaseolus vulgaris* abscission zones as the process of abscission proceeded (1). The report of more than one molecular form of cellulase in this tissue (2) led to experiments which demonstrated changes in the isoelectric focusing patterns of cellulases extracted from freshly harvested abscission zones compared to similar patterns obtained from tissue which was treated with ethylene (5). Since the process of abscission can be inhibited by treatment with auxins, the present study compares the isoelectric focusing patterns of cellulase enzymes which have been extracted from abscission zones which were treated with either IAA or 2,4-D to those which have been previously published for untreated and ethylene treated abscission zones.

Materials and Methods

Phaseolus vulgaris L., cv Red Kidney seeds were planted in vermiculite and grown in a growth chamber at 25 C and 10 hr photoperiods for 12 days. Approximately 1000 fc of light was supplied by both incandescent and fluorescent bulbs. Explants were prepared by removing the primary leaf blades and the cotyledons, and the plant was cut off just above the soil leaving the main axis plus the petioles including the distal abscission zone of the primary leaves as a unit. IAA or 2,4-D were applied as 500 ppm lanolin pastes to the cut surface of the pulvinus. The explants were then allowed to sit in beakers of wa ter for 48 hr prior to enzyme extraction.

1/ Assistant Professor, Department of the Biological Sciences, Smith College, Northampton, Massachusetts 01060.

Cellulase was routinely extracted by grinding the tissue in 20 mM sodium phosphate buffer fortified with 1 M NaCl, pH 6.1 with a mortar and pestle. The extracts were then filtered through nylon cloth and centrifuged for 10 min at 10,000 g. Aliquots were removed for cellulase assays and the remainder prepared for isoelectric focusing. Cellulase activity was assayed by measuring the reduction in viscosity of a solution of carboxymethyl cellulose, type 7HF, (Hercules Powder Co., Wilmington, Del.). The assay mixture contained two parts of 1.2% (w/v) cellulose in 20 mM sodium phosphate buffer, pH 6.1, and one part of the enzyme solution. Drainage time through a calibrated portion of a 0.1 ml pipette was used as a measure of viscosity. Viscosity was usually measured after 1 hr reaction time at 30 C. Viscosity data were converted to relative units of activity as described by Lewis and Varner (1).

Isoelectric focusing was carried out using an LKB Model 1801 isoelectric focusing apparatus. The extracts were dialyzed overnight against two changes of 1% glycine prior to being combined with ampholine buffers (pH 3.0-10.0) at 300 v, and the column was fractionated into three ml aliquots. Each fraction was adjusted to pH 6.1 before being assayed.

Results

Treatment of dark grown bean epicotyls with IAA resulted in enhanced cellulase activity on both a units per segment and units per gram fresh weight basis (Table 1). These results are in agreement with those reported by MacLachlan et al. (4).

Table 1. Cellulase activity in 8 day old etiolated bean epicotyls.

Plants were grown for 8 days in the absence of light. The apical hook was removed and 10 mm segments were removed from 50 plants for zero time extraction of cellulase. IAA was applied as a 500 ppm lanolin paste to the cut end of remaining plants. Control plants were treated with lanolin without IAA. After 72 hrs, 50 IAA treated segments and 50 control segments were removed and assayed for cellulase.

Treatment	Units/segment	Units/gm FW
Zero time	2.0	29.2
+ IAA	8.3	56.5
- IAA	3.3	27.6

Treatment of abscission zones with either IAA or 2,4-D also resulted in enhanced cellulase activity (Table 2), even though the process of abscission was inhibited by these treatments. Both auxins resulted in swollen pulvinar tissue and consequently the increase in activity was more dramatic per abscission zone than per gram fresh weight.

Table 2. Cellulase activity in abscission zones.

Plants were grown for 12 days in a growth chamber and then debladed. Distal abscission zones were removed from primary leaf petioles and extracted immediately for zer time cellulase activity. IAA or 2,4-D treated explants were then allowed to incubate for 48 hrs before cellulase was extracted.

Treatment	Number of abscission zones	Units/zone	Units/gm FW
Zero time	200	1.1	48.9
+ IAA	200	4.9	146.0
+ 2,4-D	200	5.9	205.4
Lanolin	200	1.7	141.0
Untreated	1,634	2.1	101.3

Figure 1 shows that when cellulase activity from IAA treated abscission zones was fractionated by isoelectric focusing, the activity was primarily associated with a form of the enzyme which had an isoelectric point between pH 4.0 and 5.0. A much smaller amount of cellulase activity was also present which had an isoelectric point of approximately 8.0.

Figure 2 shows that when cellulase activity from 2,4-D treated abscission zones was fractionated by isoelectric focusing, the activity was also associated primarily with a form of the enzyme which had an acidic isoelectric point. Also present was a small amount of cellulase which focused at pH 8.0.

Discussion

Lewis and Varner (1) were able to show a correlation between enhanced cellulase activity and decreasing break strength in abscission zones of *Phaseolus vulgaris*. These results were confirmed by Reid et al. (5), and it was further shown that the enhanced cellulase activity in tissue which is abscising was primarily due to the appearance of a form of the enzyme which had an isoelectric point of pH 9.5. Since cellulase activity could

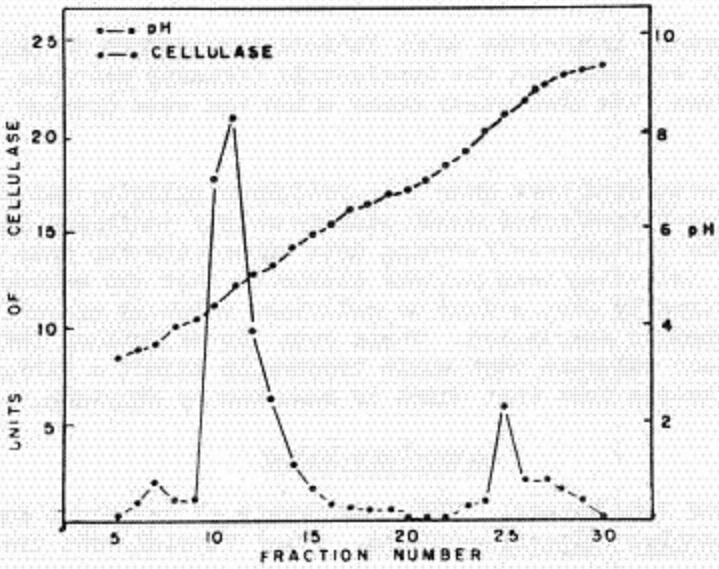


Figure 1

Isoelectric focusing pattern of cellulase enzymes extracted from abscission zones treated with 500 ppm IAA

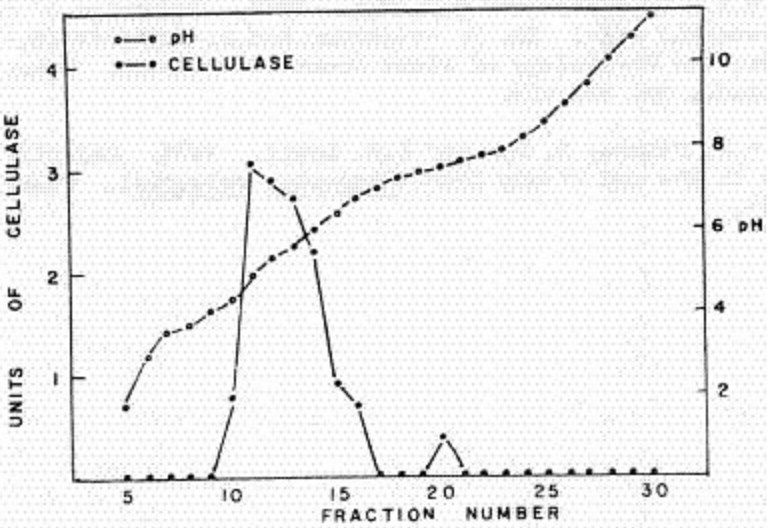


Figure 2

Isoelectric focusing pattern of cellulase enzymes extracted from abscission zones treated with 500 ppm of 2,4-D

be enhanced by hormone treatments which inhibit the process of abscission, it was of interest to determine the isoelectric focusing patterns of the cellulases extracted from abscission zones which had been treated with these hormones.

The results presented here show that cellulase activity was enhanced by both IAA and 2,4-D treatments which simultaneously inhibited the process of abscission. The isoelectric focusing data agree with the data presented by Linkins et al. (3) using bean petiole tissue in that the enhanced activity was associated primarily with a form of cellulase which is present in tissue which is not undergoing abscission. These data are of further interest since they represent evidence that auxin treatments effect a different molecular form of cellulase than that which is enhanced by ethylene.

Literature cited

1. Lewis, L.N. and J.E. Varner. 1970. Synthesis of cellulase during abscission of Phaseolus vulgaris explants. Plant Physiol. 46: 194-199.

2. Lewis, L.N., F.T. Lew, P.D. Reid and J.E. Barnes. 1972. Isozymes of cellulase in the abscission zone of Phaseolus vulgaris. In: D.J. Carr, ed., Plant Growth Substances 1970, Springer-Verlag, Berlin, pp. 234-239.

3. Linkins, A.E., L.N. Lewis and R.L. Palmer. 1973. Hormonally induced changes in the stem and petiole anatomy and cellulase enzyme patterns in Phaseolus vulgaris. Plant Physiol. 52: 554-560.

4. MacLachlan, G.A., E. Davies and D.F. Fan. 1968. Induction of cellulase by 3-indoleacetic acid. In: F. Wrightman and G. Setterfield, eds., Biochemistry and Physiology of Plant Growth Substances. Runge Press, Ottawa, Canada, pp. 443-453.

5. Reid, P.D., H.G. Strong, F. Lew and L.N. Lewis. 1974. Cellulase and abscission in the red kidney bean (Phaseolus vulgaris). Plant Physiol. 53: 732-737.

EFFECT OF ALACHLOR ON WATER UTILIZATION BY OAT (*AVENA SATIVA* L.) SEEDLINGS [1]

H. V. Marsh, Jr., K. Woodard and J. Bates[2]

(ABSTRACT)

During the course of our studies on the mode of action of alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide], it became apparent that sub-lethal concentrations of this herbicide reduced water utilization by oat seedlings. When seedlings growing in sand under controlled environmental conditions (12 hr light, 20°C; 12 hr dark, 18°C; 50 per cent relative humidity) were treated by sub-irrigation with alachlor (10^{-5}M to 10^{-8}M), it was found that water uptake was inhibited 80% by 10^{-5}M and 30% by 10^{-6}M alachlor, but unaffected by the more dilute concentrations. The time of onset of this inhibition corresponded approximately with the onset of shoot-growth inhibition.

In an effort to explain the reduced water utilization by alachlor-treated plants, the water deficits, transpiration rates and growth of the roots were examined. The water deficits of control plants and seedlings treated with 10^{-5}M and 10^{-6}M alachlor were all about 10%, whereas those plants treated with 10^{-7} and 10^{-8}M alachlor had water deficits of about 5%, significantly lower than the former.

Transpiration rates were estimated by following the decrease in weight of vials which contained 4 oat primary leaves pushed through holes in parafilm into alachlor solutions. The herbicidal treatments did not inhibit transpiration by these leaves. Instead, in fact, in some experiments there was an apparent slight stimulation of transpiration under these conditions.

Examination of the roots of control and alachlor-treated seedlings revealed that 10^{-5}M alachlor inhibited root growth several days before inhibition of shoot growth was apparent. The fresh and dry weights of the roots of seedlings treated with 10^{-5}M alachlor were reduced approximately 50% and 33%, respectively, 5 days after treatment, whereas the weights of the control and alachlor-treated shoots were the same.

Microscopic examination of the roots revealed in the alachlor-treated plants small areas of necrotic lesions, turning brown, in what appears to be the cell expansion area of root.

It thus appears probable that the reduced water utilization by alachlor-treated plants can be attributed to impaired root growth and water uptake.

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[1] Contribution from the Massachusetts Agricultural Experiment Station, Amherst.

[2] Associate Professor and graduate students, respectively, Plant and Soil Science Department.

HERBICIDES AS POTENTIAL TOBACCO SUCKER CONTROL AGENTS

G. L. Steffens [1/]

A number of herbicides have shown promise for inhibiting the growth of axillary buds (suckers) on tobacco (*Nicotiana tabacum* L.). Extensive field tests were conducted with chloropropham (isopropyl m-chlorocarbanilate) by the *ad hoc* Regional Tobacco Growth Regulator Committee in the early 1960's. This compound and several related carbamates were not consistently effective and usually caused some leaf distortion.

More recently, several dinitroanilines have been evaluated as potential tobacco sucker control agents. These include A-820 (*N*-*sec*-butyl-4-*tert*-butyl-2,6-dinitroaniline); AC 92553 [N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine]; and benefin (*N*-butyl-*N*-ethyl-α,α,α-trifluoro-2,6-dinitro-*p*-toluidine). Field trials at State Experiment Stations in the major tobacco producing areas have shown that these three chemicals can effectively control sucker growth on flue-cured, burley, fire-cured, cigar filler, and Maryland classes of tobacco. The dinitroanilines are not readily translocated, therefore they must come in direct contact with meristems. Thus, to be effective, spray solutions are applied to suckers in all leaf axils. Axillary bud growth is then inhibited with no evidence of bud kill. Relatively early applications of dinitroaniline sprays may result in restricted expansion of the upper immature leaves. Usually no leaf distortion is visible if the youngest leaves have nearly completed expansion at application.

1/ U.S. Department of Agriculture, Agricultural Research Service, Beltsville Agricultural Research Center, Beltsville, Maryland 20705.

ETHYLENE REGULATION OF ANTHOCYANIN BIOSYNTHESIS

L. E. Craker 1/

Ethylene can both promote and inhibit light-induced anthocyanin biosynthesis in plants. The use of metabolic inhibitors and specific enzyme analyses indicate that ethylene effects are changes in enzyme synthesis. The ethylene-induced promotion of anthocyanin biosynthesis continues for several days after removal of the ethylene stimulus, indicating changed metabolic patterns within the tissue. The final rate of anthocyanin biosynthesis in tissue appears to depend upon the time of ethylene treatment in relation to time of exposure of tissue to light. Tissue which is synthesizing anthocyanin produces more ethylene than non-anthocyanin-synthesizing tissue.

1/ Suburban Experiment Station, University of Massachusetts, Waltham, MA. 02154

ACTIVITY OF THE EXPERIMENTAL GROWTH REGULATOR AC-94,377 ON POTATOES[1]

H. P. Wilson, T. E. Hines and J. N. Belote III[2]
Virginia Truck and Ornamentals Research Station, Painter

Abstract. The experimental growth regulator AC-94,377[3] was evaluated as a seed piece dip and foliar application on potatoes (Solanum tuberosum L 'Pungo'). Seed piece dips reduced the number of plants per plot, total yield and yield of U. S. No. 1 tubers, increased the number of shoots per plant, earliness of blossoming, percent of malformed tubers and tubers sprouted at harvest. Time of foliar application influenced potato yield and percent of malformed tubers with potatoes receiving AC-94,377 early producing fewer U. S. No. 1 size tubers and more malformed tubers than those receiving the chemical 2 weeks later. Percent of potatoes sprouted at harvest was also increased by foliar applications of AC-94,377.

Introduction

Mature 'Pungo' potato tubers frequently sprout prior to harvest. Although much research has been conducted on the use of sprout inhibitors as they relate to sprouting of tubers in storage, little has been done on the use of inhibitors to control sprouting in the field prior to harvest. Limited research with foliar applications of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] indicated that field sprouting of some varieties could be reduced (3). Bishop (1) reported that foliarly applied MH (1,2-dihydro-3,6-pyridazinedione) retarded sprouting in prolonged field storage prior to harvesting and later in common storage. Dunton (2) found that during a 5-year study in Virginia, MH foliarly applied just after full bloom, reduced sprout formation in 'Pungo' potatoes when observed at harvest; however, the chemical caused significant yield reduction in one of the five years. In California the time of MH application influenced sprout inhibition of potatoes with foliar applications 3 weeks prior to harvest being more effective than those made 2 weeks before harvest (6). Rao and Wittwer (4) further reported that the effectiveness of foliar sprays of MH is dependent upon stage of plant development at the time of application and is also influenced by variety.

Treatment of seed potatoes prior to planting with gibberellic acid (GA) has decreased the time required for plant emergence and has influenced the uniformity of U. S. No. 1 tubers produced (7). Sprouting of newly dug potatoes immersed in solutions of GA was hastened 2 to 3 weeks (5).

The research reported in this paper was conducted to investigate the activity of the experimental growth regulator AC-94,377 as a seed piece dip and foliar application on potatoes.

1/ Contribution from the Plant Physiology Department, Virginia Truck and Ornamentals Research Station. Paper No. 162, Journal Series.

2/ Plant Physiologist and Agricultural Research Assistants, respectively.

3/ American Cyanamid Company, Princeton, N. J. 08540. Chemistry not disclosed.

Materials and Methods

Seed potatoes were hand-cut on March 21, 1973 into pieces averaging 40 g and stored at 10 to 15 C for 2 days. On March 23, pieces were dipped for 10 minutes in water dilutions of AC-94,377 at 0, 500, 1000 or 2000 ppmw, permitted to drain for 30 minutes and treated with mancozeb (zinc ion with manganese ethylenebisdithiocarbamate). Seed pieces were again stored at 10 to 15 C until March 26 when they were planted 0.3 m apart in 4-row plots which measured 3.6 m by 6.1 m, and treatments were replicated 4 times.

The soil was a Sassafras sandy loam with a pH of 5.6 and an organic matter content of 1.5%. Fertilizer was band-placed at the rates of 110, 50, and 93 kg/ha of N, P and K respectively. Prior to emergence, rows were dragged off with a spike-toothed harrow and the area between rows was cultivated. The entire experimental area was then treated with 0.8 kg/ha linuron (3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea), and cultivated twice during the season. Plant growth data collected included, 1) number of plants emerged, 2) percent plants blooming on May 22, and 3) total number of shoots per five randomly selected plants.

On May 24 plants in the two left rows of each plot received foliar applications of AC-94,377 at 0, 0.14, 0.28 and 0.56 kg/ha and plants in the two right rows were sprayed with similar rates on June 4. On July 16, plant height was measured. Potatoes were harvested on July 18 to permit determination of yields of U. S. No. 1 and U. S. No. 2 tubers, number of malformed tubers per 50 randomly selected tubers, and numbers of tubers with sprouts 0.6 cm or more in length per 50 randomly selected tubers. All data were analyzed statistically; data on malformed and sprouted tubers were converted to the transformed percent prior to analyses.

Results and Discussion

The effects of AC-94,377, as a seed piece dip on number of plants per plot, number of shoots per 5 randomly selected plants and percent plants in bloom on May 22 are presented in Table 1. The only concentration of AC-94,377 that did not reduce the number of plants per plot was 1000 ppmw. Dips of 1000 and 2000 ppmw increased both the number of shoots per 5 plants and the earliness of blossom formation as indicated by percent bloom.

Table 1. Effect of AC-94,377 as a potato seed piece dip on number of plants per plot, number of shoots per five randomly selected plants per plot and percent plants in bloom on May 22, 1973.[a]

Dip (ppmw)	Number plants per plot	Number shoots per 5 plants	Bloom (%)
0	73.3 a	15.9 a	4.2 a
500	60.6 b	17.4 ab	4.3 a
1000	73.6 a	19.6 bc	7.3 b
2000	69.1 b	21.1 c	7.9 b

a/ Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Notwithstanding that early observations showed that seed piece dips promoted rate of initial growth (7.6 to 10.2, 10.2 to 12.7, 15.2, and 15.2 to 23 cm in height on May 2 for potatoes receiving 0, 500, 1000, and 2000 ppmw AC-94,377 respectively), height of mature plants was not affected by seed piece dips. With the increased growth rate, there was an increase in stem brittleness to the extent that it appeared that high winds or mechanical contact could result in extensive stem breakage. Rate of foliar applications affected height of mature plants but time of foliar application had no effect; however, a significant interaction resulted between dip treatment and foliar rate (Table 2). Foliar applications had no effect on plant height in the absence of a seed piece dip but, although variable, generally tended to increase height in the presence of previously applied dips.

Table 2. Relationships between foliar application and seed piece dip of AC-94,377 on height of potato plants.[a,b]

Foliar Rate (kg/ha)	Potato height (cm) Seed piece dip (ppmw) 0	500	1000	2000
0	47.8 a	44.7 a	48.5 b	46.0 a
0.14	47.0 a	48.5 b	43.7 a	49.8 bc
0.28	46.0 a	49.3 b	46.7 ab	46.5 ab
0.56	48.5 a	48.5 b	48.8 b	52.1 c

a/ Data are averaged over both foliar application dates and 4 replications.

b/ Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

All concentrations of AC-94,377 applied as a seed piece dip reduced total yields and yields of U. S. No. 1 potatoes below those of potatoes receiving no chemical (Table 3). Averaged over all dip and foliar application rates, time of foliar application had no effect on total yields; however, plants treated on May 24 with foliar applications of AC-94,377 produced fewer U. S. No. 1 (18.9 q/ha) tubers than plants treated on June 4 (20.6 q/ha, significant at the 5% level). Neither time nor rate of foliar applications affected yields of U. S. No. 2 tubers but yields increased with concentrations of AC-94,377 up to 1000 ppmw applied as a seed piece dip. Furthermore, a significant interaction between date and rate of foliar applications showed that when applied on May 24, the high rate of AC-94,377 significantly increased production of U. S. No. 2 tubers (5.3, 5.6, 5.2 and 6.6 q/ha for 0, 0.14, 0.28 and 0.56 kg/ha AC-94,377 respectively).

Table 3. Effect of AC-94,377 applied as a seed piece dip on total yield, and yields of U. S. No. 1 and U. S. No. 2 potatoes.[a,b]

Dip (ppmw)	Potato yields (q/ha) Total	No. 1	No. 2
0	29.8 a	26.4 a	3.4 a
500	21.0 d	16.3 c	4.7 b
1000	26.4 b	19.5 b	6.9 c
2000	24.2 c	16.8 c	7.4 c

a/ Data are averaged over 2 times and 4 rates of foliar application and 4 replications.

b/ Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Effects of seed piece dip on percent of malformed U. S. No. 1 potatoes and percent of potatoes with sprouts 0.6 cm in length or longer are presented in Table 4. All concentrations of AC-94,377 significantly increased the percent of malformed tubers. The time of applying AC-94,377 to potato foliage also influenced potato shape with percent of malformed tubers being 62.6 for early applications and 54.5 for late applications (averaged over all seed piece dips, 4 foliar application rates, and 4 replications).

Table 4. Effect of AC-94,377 applied as a seed piece dip on percent of malformed tubers and tubers with sprouts at least 0.6 cm in length.[a,b]

Dip (ppmw)	Malformed tubers (%)	Tubers with sprouts at least 0.6 cm in length (%)
0	44.6 a	51.3 ab
500	58.7 b	52.9 b
1000	62.3 b	51.1 ab
2000	68.5 c	46.8 a

a/ Data are averaged over 2 times and 4 rates of foliar application and 4 replications.

b/ Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

The effect of rate of foliar applications on tuber shape is presented in Table 5. The high rate of AC-94,377 applied as a foliar treatment significantly increased the percent of malformed tubers.

Table 5. Effect of foliar applications of AC-94,377 on percent of malformed tubers and tubers with sprouts at least 0.6 cm in length.[a,b]

Foliar Rate (kg/ha)	Malformed tubers (%)	Tubers with sprouts at least 0.6 cm in length (%)
0	55.0 a	43.4 a
0.14	60.0 ab	49.1 b
0.28	57.2 ab	54.9 c
0.56	61.9 b	54.7 c

a/ Data are averaged over 4 seed piece dips, 2 times of foliar application and 4 replications.

b/ Means within columns followed by the same letter are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Notwithstanding that dips of AC-94,377 influenced the percent of potatoes with sprouts 0.6 cm or longer, no clear rate-response was observed (Table 4). However, foliar applications significantly increased the percent of potatoes with sprouts (Table 5); time of foliar application did not affect sprout formation.

In conclusion, 'Pungo' potatoes responded to both seed piece dips and foliar applications of AC-94,377, by exhibiting increased stem brittleness,

yield reduction, and increases in percent of malformed and sprouted tubers. These undesirable responses indicate that AC-94,377 will likely be of little value in commercial potato production.

Acknowledgments

The authors wish to express their sincere appreciation to Dr. Clyde Y. Kramer, Virginia Polytechnic Institute and State University, Blacksburg, for statistical analyses of the data.

Literature Cited

1. Bishop, J. C. and V. H. Schweers. 1961. Sprout inhibition of fall-grown potatoes by airplane applications of maleic hydrazide. Amer. Potato Jour. 38:377-381.

2. Dunton, E. M. Jr. 1964. A study of the influence of maleic hydrazide and irrigation on yields and sprouting of the 'Pungo' Irish potato. Pen. Hort. Soc. (Abstr.) p. 134-135.

3. Marshall, E. R., and O. Smith. 1950. Effect of field and storage applications of sprout inhibitors on potato tubers. Amer. Potato Jour. 27: 133-141.

4. Rao, S. N., and S. H. Wittwer. 1955. Further investigations on the use of maleic hydrazide as a sprout inhibitor for potatoes. Amer. Potato Jour. 32:51-59.

5. Rappaport, L., L. F. Lippert, and H. Timm. 1957. Sprouting, plant growth and tuber production as affected by chemical treatment of white potato seed pieces. I. Breaking the rest period with gibberellic acid. Amer. Potato Jour. 34:254-260.

6. Timm, H., J. C. Bishop, and B. J. Hoyle. 1959. Investigations with maleic hydrazide on potatoes. I. Effect of time of application and concentration upon potato performance. Amer. Potato Jour. 36:115-123.

7. Timm, H., L. Rappaport, J. C. Bishop, and B. J. Hoyle. 1962. Sprouting, plant growth, and tuber production as affected by chemical treatment of white potato seed pieces. IV. Responses of dormant and sprouted seed potatoes to gibberellic acid. Amer. Potato Jour. 39:107-115.

UNI-N252 - A NEW HARVEST AID CHEMICAL AND HERBICIDE

A.R. Bell[1/], R.B. Ames[1/], R.W. Neidermyer[1/] and A.D. Brewer[2/]

Abstract. UNI-N252 (2,3-dihydro-5,6-dimethyl-1,4-dithiin-1,1,4,4 tetroxide) has shown promising activity as a potato (*Solanum tuberosum* L.) vine desiccant, cotton (*Gossypium* sp.) defoliant and preemergence herbicide, selective in potatoes.

Mature potato vines were treated with UNI-N252 at 0.56, 1.12 and 2.24 kg a.i./ha at Bethany, Connecticut; Perham, Minnesota and Evesham, England. The chemical was applied by small plot sprayer in a dilute aqueous solution at 467.7 l/ha. An adjuvant such as Agral (90 alkyl phenyl ethylene condensate) was included at the rates of 0.7% and 1.0% of the final spray solution in England and U.S.A. respectively. Desiccation of potato vines was 100% after all rates of UNI-N252 application in Evesham and Bethany. Potato leaves and stems were 70% desiccated 15 days after application of 2.24 kg/ha UNI-N252 at Perham. However, dinoseb at 2.8 kg/ha desiccated potato leaves only 8% at Perham.

UNI-N252 was applied to mature cotton at the rates of 0.14, 0.28 and 0.56 kg a.i./ha at Senatobia, Mississippi and McAllen, Texas. The chemical was applied in 280.6 l/ha of water with a high clearance ground sprayer. At Benoit, Mississippi UNI-N252 was applied by air in 46.8 l water per hectare at rates of 0.25, 0.56 and 1.12 kg/ha. A special adjuvant, UNI-1126, was included at the rate of 1% of the final spray dilutions in all defoliation experiments. A commercial defoliant, S,S,S-tributylphosphorotrithioate, was included as a standard in each test at the rate of 1.26 kg/ha. UNI-N252 at the rate of 0.28 kg/ha defoliated cotton 79% and 87% at Senatobia and McAllen respectively. Aerial application of UNI-N252 at 1.12 kg/ha defoliated cotton 85% at Benoit. The commercial product at 1.26 kg/ha defoliated cotton 80% to 90% in all of the experiments.

UNI-N252, at 3.36 kg/ha, applied as a preemergence herbicide in 280.6 l water per hectare, controlled broadleaved weeds and grasses 87% in potatoes at Alma, Ontario. The species controlled included redroot pigweed (*Amaranthus retroflexus* L.), common lambsquarters (*Chenopodium album* L.), ladysthumb (*Polygonum persicaria* L.) and giant foxtail (*Setaria faberi* Herrm.).

[1/] Uniroyal Chemical, Agricultural Chemicals Research, Bethany, Connecticut.

[2/] Uniroyal Limited Research Laboratories, Guelph, Ontario.

THE EFFECT OF A NEW GROWTH REGULATING COMPOUND, N252 ON POTATO VINE DESICCATION IN MAINE

H. J. Murphy[1]

Abstract

During 1974 a new candidate chemical compound, UNI-N252 (2,3-Dihydro-5,6-dimethyl-1, 4-dithiin 1,1,4,4 tetroxide) was evaluated for potato vine desiccation in Maine. One year's results indicated this new growth regulant provided excellent vine desiccation as compared to standard recommended chemical treatments. Further testing to more closely define economic rates should be conducted in 1975.

Introduction

For the many reasons listed by Murphy (1) desiccation of potato vines prior to harvest is a necessary practice in Maine. Presently, very few chemicals are labeled for this purpose, none of which will provide complete vine desiccation in a limited period of time. In Maine, we continue to screen and evaluate new harvest aid products as they are developed.

In 1973, Uniroyal Chemical developed a new harvest aid product, UNI-N252. The previous speaker has presented the chemistry of this new compound which has defoliation, desiccant, and other plant growth regulant effects. Uniroyal offered the product to the University of Maine for evaluation as a potato vine desiccant in both 1973 and 1974. In 1973, the formulation was a 50% wettable powder and applied with a commercial adjuvant. Results obtained in Maine as reported by Murphy and Goven (2) indicated that N252 was worthy of further testing.

In 1974, a new liquid formulation of N252 containing 1.5 lbs. A.I. per gallon was applied with a special surfactant, UNI-1126, and evaluated in Maine for potato vine desiccation. The results of these tests are presented in this paper.

Materials and Methods

Compound UNI-N252 was applied to actively growing Katahdin potato vines on August 21, 1974, at Presque Isle, Maine, and at the rates indicated in Table 2. All rates of N252 were applied in 80 gallons of water at 40 P.S.I., using the UNI-1126 surfactant at a rate of 1% of the final spray dilution. A compressed air sprayer with a two-nozzle brush type boom was used. Nozzles used were Delavan Rain Drop type. Plots used were single

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[1]Associate Professor of Agronomy, Department of Plant and Soil Sciences, University of Maine, Orono, Maine 04473

rows 25 feet long, with single buffer rows between treatments. Plots were arranged in a randomized 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 treatment.

Table 1. Potato vine-kill rating code. Maine - 1974.

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

At harvest time, approximately 15-pound samples of tubers were collected from each plot and stored at 50F. for examination during the winter months to determine if the vine kill treatments caused any vascular discoloration, skin blemishes, or storage disorders. Results of these storage studies will be published next year in the Proceedings.

Results and Discussion

Vine kill ratings for N252 and standard desiccant treatments are presented in Table 2. N252 applied at rates of 1/3, 2/3, 1-1/3, and 2 gallons per acre and repeated 5 days after the initial treatment provided excellent (>4.0) vine desiccation. Single applications of N252 at all rates provided vine desiccation equal to recommended rates of Dow General, Des-I-Cate, and Evik. It would appear from the data presented in Table 2 for N252 that the speed and length of the killing period could be controlled by rate of material applied. Regrowth 21 days after the initial application was very heavy where standard treatments were used, medium where only single treatments of N252 were applied, and none where repeat treatments were made.

The results presented in Table 2 suggest that compound N252 performed well in 1974 as compared to standard recommended materials now being used. Upon the completion of storage studies to determine severity of vascular discoloration because of the rapid kill, perhaps further study of N252 for potato vine desiccation may be justified in 1975.

Literature Cited

1. Murphy, H. J. 1968. Potato vine killing. Amer. Pot. J. Vol. 45: 472-478.

2. Murphy, H. J. and M. J. Goven. 1975. Potato vine killing in Maine. Proceedings of N.E.W.S.S., Vol. 29.

Table 2. Effect of varying rates of compound UNI-N252 on vine desiccation of Katahdin potatoes in Maine - 1974.

Treatments[1]			Vine Kill Ratings[3]			Vine
Material	Product Rate/Acre	Additive	8-26	8-30	9-5	Regrowth[4]
No treatment			1.0	1.0	1.0	
N252	1/3 gal.	4/5 gals. UNI-1126	2.8	3.3	3.0	Heavy
N252	2/3 gals.	4/5 gals. UNI-1126	3.2	3.6	3.3	Medium
N252	1-1/3 gals.	4/5 gals. UNI-1126	3.2	3.7	3.4	Medium
N252	2 gals.	4/5 gals. UNI-1126	3.4	3.9	3.8	Medium
N252	1/3 gal.[2]	4/5 gals. UNI-1126[2]	2.8	4.0	4.4	Light
N252	2/3 gals.[2]	4/5 gals. UNI-1126[2]	3.2	4.5	4.8	None
N252	1-1/3 gals.[2]	4/5 gals. UNI-1126[2]	3.5	4.5	5.0	None
N252	2 gals.[2]	4/5 gals. UNI-1126[2]	3.8	4.5	5.0	None
Dow General	3 pts.	5 gals. #2 oil	2.9	3.3	3.0	Heavy
Des-I-Cate	2 gals.		2.7	3.0	2.8	Heavy
Evik	2 lbs.	8 oz. X-77	2.3	3.3	3.3	Heavy

[1]Materials applied - August 21, 1974. Weather - clear and sunny. Temperature - 82F. Soil conditions wet. Vine growth extremely vigorous.

[2]Treatments repeated on August 26, 1974.

[3]Kill rating code presented in Table 1.

[4]New terminal growth showing on September 12, 1974.

FMC 10637: TIME COURSE FOR GROWTH INHIBITION OF BEAN PLANTS

Woodland Hurtt[1/]

ABSTRACT

Previous dose-response studies suggested that bean plants treated with ethyl hydrogen 1-propylphosphonate (FMC 10637) exhibited a sharp decline in growth rate after a period of no apparent response. In order to confirm these earlier observations, bean (Phaseolus vulgaris L. cv. Black Valentine) plants were grown in a growth chamber from emergence until 10 days old at 25 ± 1 C, measured for initial height, and foliarly-treated with 0.3, 0.6, 0.9, or 1.2 kg/ha of technical grade retardant in 350 L/ha of water containing 0.2% Tween 20. After removal of a protective layer of vermiculite on the soil surface (to prevent soil contamination and root-uptake), the plants were placed in a greenhouse at 25 ± 5 C with supplemental fluorescent light. Growth values (increase in height from day of treatment) were obtained at 1, 2, 3, 4, 5, 7, 10 and 14 days.

Growth of the controls and all treatments was essentially identical for the first 3 days. The controls continued to grow in a linear manner for the entire 14 days (r = 0.992). At the fifth day some foliar damage was evident and all doses were significantly different from the controls except the 0.3-kg dose. When growth was plotted against dose, a straight-line relationship was observed in which each 0.3 kg increase in level of retardant caused a 5 to 7% increase in growth inhibition (r = 0.998). The fifth day was also the point at which the response curves for growth against time for all doses exhibited a sharp downturn and growth was no longer proportional to time. Maximum effectiveness of FMC 10637 was achieved between 5 and 7 days after treatment. Based on percent reduction in growth, however, effectiveness appeared to increase with time out to 14 days because of the continued growth of the control plants. The terminal buds of the plants in all treatment groups except 0.3 kg were dead at 10 days. By the fourteenth day most terminal buds were dead in the 0.3-kg group. One month after treatment the plants in this group exhibited a massive proliferation of axillary growth at the lower nodes with up to a dozen shoots attempting to grow from one node.

FMC 10637 has been characterized as a retardant that inhibits growth by killing the terminal buds. This does not appear to be its only mode of action since significant growth reductions of ca 15 to 30% were evident 5 days prior to terminal bud kill for the higher doses and 7 days prior to a 28% reduction in growth for the 0.3-kg dose. The five day delay prior to the onset of significantly reduced growth and the linear dose-response relationship that was exhibited only at the fifth day suggest that other mechanisms may also be involved in growth inhibition by FMC 10637.

[1/]Weed Physiology & Growth Regulator Research, ARS-USDA, P. O. Box 1209, Frederick, MD 21701. (Research conducted when employed by Dept. of Army, Vegetation Control Div., Fort Detrick, Frederick)

GROWTH AND YIELD RESPONSES OF SEVERAL SNAPBEAN VARIETIES TO TREATMENTS WITH SELECTED GROWTH REGULATORS

M. Abdel-Rahman[1/]

Abstract

Two field and one greenhouse experiments were conducted to evaluate the effects of treatments with four selected new growth regulators: 5-chloro, 2-thienyl, tri-n-butyl-phosphonium chloride (CHE 8728), Methyl 3,6-dichloro-0-anisate (Racusa), 3'-(Trifluoromethyl) phthalanilic acid (CGA 31273) and 1-[2-2,4-dichlorophenyl(-1,3-dioxolan-2-ylmethyl]imidazole (XE 326 S),[2/] on growth and yield of several snapbean varieties. Vegetative growth of treated plants was reduced by all treatments. Leaf mottling, marginal chlorosis and necrosis were observed on plants treated with higher rates of CHE 8728 and Racusa. Yield was increased by those treatments which slightly reduced vegetative growth, increased the number of pod set and/or increased the weight of pods harvested. In some cases yield increases were attributed to advancing the date of maturity.

Introduction

The use of growth regulators to increase yield in snapbean (Phaseolus vulgaris L.) was reported as early as 1946 using naphthenates. Other growth regulators were also tried with varying results (2,3,4 and 6). This study was conducted to evaluate the effects of some selected new chemicals on growth and yield of several snapbean varieties under New York State growing conditions.

Materials and Methods

Two field experiments were conducted at the Agway Product Development farm, LaFayette, New York during the summer of 1973 and 1974. The soil was a Chenango gravelly silt loam with a pH 6.5 - 6.9 The field was fertilized with about 300 lbs. of 15-8-12 before planting. In 1973 test, four Agway bean varieties; Contender, Green Garden, Sinclair Butterwax and Eastern Butterwax were planted on June 14, 1973 in rows spaced at 18" apart and about 6" between plants. Chemical treatments were applied as foliar sprays at early bloom (10%) on July 12, 1973. Treatments were replicated four times in a complete block randomized design. Each plot was 20 ft. long and contained 2 rows of each variety. In 1974 test, three Agway bean varieties were used; Long Tender Green, Provider and Red Kidney (dry bean).

1/ Plant Pathology and Physiology Development Manager, Fertilizer-Chemical Division, Agway Inc., Syracuse, N.Y. 13201.

2/ These four experimental compounds were obtained from Chemagro, Velsicol, CIBA-GEIG and Chevron chemical companies respectively.

Seeds were planted on May 28, 1974. Methods of planting, spacing chemical treatments and experimental design were similar to those of 1973. Treatments were applied on July 23, 1974 at the early bloom stage and/or on August 2, 1974 at the full bloom stage. Evaluations of plant growth and development were made periodically after treatments.

A greenhouse experiment started on September 20, 1974 at Ithaca, New York. Seed of the varieties Contender, Green Garden, Sinclair Butterwax and Eastern Butterwax were planted in 6" pots containing Cornell mix. Air temperature was maintained at 70/60°F. day/night temperature regime. Chemical treatments were applied as foliar sprays using aerosol hand sprayers. Five randomized pots of each variety were used as replicates for each individual treatment. Visual observations and measurements were made every week to evaluate the effect of treatments on plant growth and development, pod set, pod development, yield and phytotoxicity.

Results and Discussion

Results of the 1973 field experiment (table 1) indicated that treatments with CHE 8728 at 0.5 oz. a.i./A or Racusa at 4 and 8 oz. a.i./A rates consistently increased yield of the early harvest by advancing the maturity. Differential varietal responses to treatments with the two growth regulators are evident. The green varieties Contender and Green Garden responded more favorably to Racusa than the other two Butterwax varieties; Sinclair and Eastern, which responded more favorably to CHE 8728. Phytotoxicity symptoms in the form of leaf mottling, marginal chlorosis and necrosis were observed on plants treated with CHE 8728 at 1 oz. a.i./A rate. All treatments reduced vegetative growth. Similar results were also obtained in the 1974 field experiment (table 2) and in the greenhouse experiment (table 3). In the greenhouse all chemical treatments decrease vegetative growth in proportion to their rate of application (table 3). However, significant yield increases resulted only from treatments with 0.5 oz./A of CHE 8728 and 2 and 4 oz./A of Racusa. Higher rates of these chemicals resulted in severe phytotoxicity. None of the 1973 field and greenhouse treatments resulted in any increase of the number of pod sets or harvested (tables 1 and 2), however, most of the chemical treatments increased the number of pod set, pod harvested or both (table 3). Although the treatments with CGA 31273 or XE 326 S resulted in significant increase in yield, the effective rates and yield responses varied with each bean variety.

The findings of this study are in accord with previous reports (1,2,3,5 and 6) and they indicate that treatments with growth regulators can increase yield and/or advance the maturity date of snapbean varieties. However, crop responses are greatly dependent on the bean variety, time and rate of application and environmental growing condition.

Table 1: Growth and yield responses of four snapbean varieties to treatments with different rates of growth regulators in 1973 season.

Variety: Treatments and rate(a. i. /A)	Vegetative Growth % of Control	Yield in lbs. /10 sq. ft. plots Once-Over Harvest Dates 7/30/73	8/3/73	8/7/73
Contender:				
CHE 8728, 0.25 oz.	94	2.0 a	2.4 b	2.5 b
CHE 8728, 0.50 oz.	87	2.0 a	2.7 a	2.8 a
CHE 8728, 1.00 oz.	73	1.5 c	1.8 c	2.3 b
Racusa, 8 oz.	85	1.8 b	2.6 a	2.8 a
Check	100	1.8 b	2.2 b	2.8 a
Green Garden:				
CHE 8728, 0.25 oz.	95	1.5 c	2.4 bc	2.9 bc
CHE 8728, 0.50 oz.	89	1.8 bc	2.5 bc	3.2 a
CHE 8728, 1.00 oz.	75	1.5 c	2.1 d	2.4 d
Racusa, 4 oz.	89	2.0 b	2.8 a	3.1 ab
Racusa, 8 oz.	82	2.5 a	2.6 ab	2.9 bc
Check	100	2.0 b	2.3 cd	2.8 c
Eastern Butterwax:				
CHE 8728, 0.25 oz.	92	1.4 b	1.9 c	2.4 b
CHE 8728, 0.50 oz.	86	1.8 a	2.3 ab	2.7 a
CHE 8728, 1.00 oz.	83	1.2 b	2.2 b	1.9 c
Racusa, 4 oz.	90	1.3 b	2.4 a	2.4 b
Racusa, 8 oz.	81	1.8 a	1.9 c	2.2 b
Check	100	1.7 a	2.2 b	1.8 c
Sinclair Butterwax:				
CHE 8728, 0.25 oz.	90	1.8 b	1.9 b	2.6 a
CHE 8728, 0.50 oz.	85	2.1 a	2.0 ab	2.5 a
CHE 8728, 1.00 oz.	81	0.8 c	2.1 a	2.2 b
Racusa, 4 oz.	88	1.5 b	2.1 a	2.4 ab
Racusa, 8 oz.	83	1.8 b	1.6 c	2.4 ab
Check	100	1.6 b	1.8 bc	2.2 b

Mean within each column for each variety followed by the same letter are not significantly different at the 5% level. (Duncan's Multiple Range Test)

Table 2: Effects of selected growth regulators on pod set and yield of three snap and dry bean varieties in 1974 season.

Variety: Treatments and rate (a. i. /A)	Average Number of Pod/Plants		Yield in lbs. /10 sq. ft. plots	
	Set	Harvested	8/20/74	8/27/74
Provider:				
CHE 8728, 0.5 oz.	8.3 c	7.5 b	1.95 cde	2.20 c
CHE 8728, 1.0 oz.	9.2 b	8.7 b	2.15 bc	2.25 c
Racusa, 4.0 oz.	9.4 b	9.0 b	2.30 b	2.60 b
CGA 31273, 1.5 oz.	9.3 b	8.6 b	2.25 b	2.40 bc
CGA 31273, 3.0 oz.	11.2 a	10.3 a	3.05 a	3.15 a
XE 326 S, 8.0 oz.	9.5 b	8.0 bc	2.00 cd	2.30 c
Check	8.0 c	7.6 c	1.75 e	1.95 d
Long Tender Green:				
CHE 8728, 0.5 oz.	12.4 a	11.0 a	2.90 a	3.20 a
CHE 8728, 1.0 oz.	10.9 bc	9.5 bc	2.40 b	2.75 c
Racusa, 4.0 oz.	8.7 d	8.0 d	1.70 c	2.20 d
CGA 31273, 1.5 oz.	11.7 ab	9.3 c	2.40 b	2.85 bc
CGA 31273, 3.0 oz.	10.5 c	8.5 d	2.00 c	2.30 d
XE 326 S, 8.0 oz.	11.3 b	10.0 b	2.65 b	3.00 ab
Check	10.7 c	8.4 d	1.90 c	2.45 d
Red Kidney:				
CHE 8728, 0.5 oz.	13.5 bc	10.8 cd		2.95 d
CHE 8728, 1.0 oz.	14.3 ab	11.2 bc		3.50 c
Racusa, 4.0 oz.	14.0 b	12.0 b		3.90 b
CGA 31273, 1.5 oz.	13.3 c	11.3 bc		3.40 c
CGA 31273, 3.0 oz.	13.5 bc	10.0 d		2.90 d
XE 326 S, 8.0 oz.	14.8 a	12.9 a		4.25 a
Check	13.1 c	11.1 c		3.30 c

Mean within each column followed by the same letter are not significantly different at the 5% level. (Duncan's Multiple Range Test)

Table 3: Vegetative Growth, Pod Set and Yield of Two Snapbean Varieties in Response to Treatment with Different Rates of Racusa and CHE 8728 in the Greenhouse, 1973.

Variety:	Vegetative Growth gm/plant	No. of pods/plant Set	No. of pods/plant Harvested	Wt. of pods gm/plant	Phytotoxicity rating*
Contender:					
CHE 8728, 0.25 oz.	121 c	11.8 b	8.7 b	63 b	0
CHE 8728, 0.50 oz.	98 d	12.4 ab	9.6 a	78 a	+
CHE 8728, 1.00 oz.	72 e	8.6 c	6.2 c	45 c	+++
Racusa, 2 oz.	134 b	13.1 a	9.8 a	75 a	0
Racusa, 4 oz.	126 c	13.5 a	9.5 a	79 a	0
Racusa, 8 oz.	95 d	12.0 b	8.7 b	59 b	+
Racusa, 16 oz.	64 e	9.3 c	6.0 c	34 d	+++
Check	148 a	13.4 a	9.4 a	68 b	0
Sinclair Butterwax:					
CHE 8728, 0.25 oz.	135 b	14.2 ab	9.2 b	82 c	0
CHE 8728, 0.50 oz.	116 c	14.6 ab	9.8 ab	86 bc	0
CHE 8728, 1.00 oz.	83 e	10.3 c	7.5 d	61 d	++
Racusa, 2 oz.	128 b	14.4 ab	10.4 a	98 a	0
Racusa, 4 oz.	120 c	14.7 ab	9.7 ab	93 ab	0
Racusa, 8 oz.	103 d	13.0 b	8.4 c	64 d	+
Racusa, 16 oz.	78 e	9.8 c	7.2 d	55 e	+++
Check	155 a	15.3 a	9.6 ab	79 c	0

Means within each column followed by the same letter are not significantly different at the 5% level. (Duncan's Multiple Range Test) *Ratings are: 0 = No; + = little; ++ = moderate; +++ = severe phytotoxic reaction.

Literature Cited

1. Fattah, Q.A. and D.J.Wort. 1970. Effect of light and temperature on stimulation of vegetative and reproductive growth of bean plants by naphthenates. Agron. J. 62:576-577.

2. Campbell, R.E. and J.K. Greig. 1973. Some effects of selected growth regulators on yield of snapbeans (Phaseolus vulgaris L.). Hort Science 8:281.

3. Tompkins, D.R., W.A. Sistrunk, and J.W. Fleming. 1971. Yield of snapbeans (Phaseolus vulgaris L.) as influenced by 5-chloro, 2-thienyl, tri-n-butyl-phosphoniumchloride. Hort Science 6: 393-394.

4. Weigle, J.L., M.L. Robbins, A.R. Beck and K.J. Batal. 1973. Influence of growth regulators on pod set and yield in snapbeans and related crops. Hort Science 8:35-36.

5. Wittwer, S.H. and A.E. Murneck. 1946. Further investigations on the value of 'hormone' sprays and dusts for green bush snapbeans. Proc. Amer. Soc. Hort Sci. 47:285-293.

6. Wort, D.J. 1969. Stimulation of vegetative and reproductive growth of bush bean plants by naphthenates. Can. J. Plant Sci. 49:791-796.

NEW HERBICIDES FOR LIMA BEANS

C. E. Beste

Abstract. Baby lima beans (Phaseolus lunatus var. Thaxter) tolerated bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one2,2-dioxide) applied postemergence at 1.5 and 3.0 lb/A with no yield reduction. Acceptable weed control and yields were obtained with trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) and profluralin (N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-N-propyl-p-toluidine) at 0.5 lb/A; however, dinitramine (N,N-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2,4-diamine) at 0.33 lb/A significantly reduced stand, vigor, and yields of baby lima beans. Alachlor (2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide) at 1.0 and 2.0 lb/A provided acceptable weed control without yield reduction; however, 4.0 lb/A rate reduced stands and yields.

INTRODUCTION

In the Delmarva area and Central Maryland, approximately 21,000 acres of lima beans are grown primarily as a fall crop for processing. Lima beans are planted during July when dry conditions prevail and most growers do not like to cultivate when the lima beans are under stress. These conditions may lead to weeds too large for good control by cultivation, and postemergence herbicides would be desirable. Lima bean yields may be increased 50% by planting narrow rows with 12 to 20 inch row spacing compared to conventional 36 inch row spacings, and the development of high-density mechanical pickers has provided an acceptable harvester for narrow rows. Effective cultivation of narrow rows will be more difficult, and this cultural system could benefit from postemergence herbicides which could substitute for cultivations.

The purpose of this experiment was to evaluate several new dinitroaniline herbicides, a new herbicide formulation, and a new postemergence herbicide for lima beans.

MATERIALS AND METHODS

The herbicide plots were 5 ft by 17 ft with 3 rows spaced 18 inches apart in each plot. All treatments were replicated three times in a randomized complete block design. The soil type was Norfolk loamy sand with 0.6% organic matter. Preplant incorporated herbicides were incorporated 3 inches deep with a power-driven rototiller on July 18, 1974. Thaxter variety lima beans were planted 1 1/2 inches deep on July 18 and preemergence treatments were applied in the evening at dusk. The postemergence treatments were applied on August 28 when the lima beans were in full bloom with 6 or 7 trifoliate leaves and the purslane was 1 to 4 inches tall with 2 to 4 true leaves. Early stand and vigor

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1/ Scientific Article No. A2050, Contribution No. 5003, of the Maryland Agricultural Experiment Station, Department of Horticulture.
2/ Assistant Professor, Department of Horticulture, University of Maryland.
3/ C. W. Reynolds. Department of Horticulture, University of Maryland. Personal Communication.

ratings were made on August 15 when the beans were in the three trifoliate leaf stage. Weed control ratings were obtained on 8-15-74 and 10-4-74 for the following weeds: large crabgrass (Digitaria sanguinalis (L.)Scop.), goosegrass (Eleusine indica (L.)Gaertm), and common purslane (Portulaca oleracea L.) The center row was harvested from each plot by cutting the stem at the ground level, and whole plant and shelled bean yields were obtained. A stationary viner was utilized to shell the beans. One-half inch of irrigation water was applied on July 19 and when required during the growing season.

RESULTS AND DISCUSSION

Bentazon applied postemergence at the time of full flowering on baby lima beans at 1.5, 2.0, and 3.0 lb/A was not phytotoxic. Acceptable weed control and yields were obtained with trifluralin and profluralin at 0.5 lb/A; however, dinitramine at 0.33 lb/A significantly reduced stand, vigor, and yields. Alachlor at 1.0 and 2.0 lb/A provided acceptable weed control without yield reduction although the 2.0 lb/A rate reduced slightly the early vigor rating. Alachlor at 4.0 lb/A significantly reduced shelled bean yields. Combinations of alachlor plus dinoseb (2-sec-butyl-4,6-dinitrophenol) improved purslane control compared to alachlor alone and a 2X safety factor was observed with the use rate of 1 lb/A alachlor plus 3.0 lb/A dinoseb. Dinoseb was tolerated by the baby lima beans at 6.0 lb/A, but grass control was unacceptable. The 6 lb/gal formulation of chloramben (3-amino-2,5-dichlorobenzoic acid) monomethylamine and ammonium salt mixture appeared to be slightly more phytotoxic than the 2 lb/gal ammonium salt formulation which has been observed previously (1). The 3.0 lb/A chloramben rate also appeared to reduce yields. Preemergence nitralin((4-methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline) provided acceptable weed control alone; however, dinoseb when combined with nitralin, caused a marked decrease in goosegrass control compared to nitralin alone.

LITERATURE CITED

1. Beste, C. E. 1972. 1972 Evaluation of Herbicides for Vegetable Crops. p.6-8. University of Maryland, Department of Horticulture Mimeo No. HR 38-72.

Table 1. The Evaluation of Several New Herbicides for Baby Lima Beans in a Norfolk Loamy Sand.

Treatment			Crop Response[b]			% Control[c]					Yield (Ton/A)[d]	
			8-15		10-3	8-15		10-3				
Herbicide	Lb/A	Method[a]	S	V	V	Grass	Purslane	Crabgrass	Goosegrass	Purslane	Whole Plant	Shelled Beans
1. Control-Weedy	---	----	100	100	60	0	0	0	0	0	---	---
2. Control-handweeded	---	----	100	100	100	100	100	100	100	100	5.2cd	1.14bcdef
3. trifluralin (4EC)	0.5	PPI	100	97	93	100	100	100	97	100	5.5cd	1.20bcdef
4. trifluralin	1.0	PPI	97	87	100	100	100	100	100	100	7.8abcd	1.37abc
5. profluralin (4EC)	0.5	PPI	100	90	90	100	100	100	93	100	6.9abcd	1.31abcd
6. profluralin	1.0	PPI	100	97	100	100	100	100	100	100	8.5abc	1.54ab
7. dinitramine (2EC)	0.33	PPI	73	70	100	100	100	100	100	93	5.4cd	0.88def
8. dinitramine	0.66	PPI	72	50	77	100	100	100	100	100	3.8d	0.43g
9. nitralin (4EC)	0.5	Pre	97	95	87	100	100	100	95	90	----	----
10. dinoseb (3EC)	3.0	Pre	97	97	80	23	100	0	0	97	----	----
11. dinoseb	6.0	Pre	100	97	92	73	100	47	20	67	----	----
12. nitralin + dinoseb	0.5 + 3.0	Pre	95	100	100	70	67	100	27	100	----	----
13. chloramben (2EC)	3.0	Pre	90	83	100	97	100	100	92	97	6.3bcd	0.85ef
14. chloramben (6EC)	3.0	Pre	97	75	100	100	100	100	90	97	6.1bcd	1.02cdef
15. alachlor (4EC)	1.0	Pre	97	97	90	100	100	100	96	80	6.5abcd	1.26bcde
16. alachlor	2.0	Pre	95	88	100	100	100	100	95	80	7.7abcd	1.37abc
17. alachlor	4.0	Pre	73	77	100	100	100	100	98	75	5.9bcd	0.77fg
18. alachlor + dinoseb	1.0 + 3.0	Pre	100	100	100	100	100	100	100	100	9.5ab	1.71a
19. alachlor + dinoseb	2.0 + 6.0	Pre	92	95	100	100	100	100	100	95	10.3a	1.45abc
20. trifluralin + bentazon (4EC)	0.5 + 1.5	PPI + Post	92	83	95	100	100	100	98	100	6.2bcd	1.28abcde
21. trifluralin + bentazon	0.5 + 2.0	PPI + Post	100	97	100	100	100	100	100	100	----	----
22. trifluralin + bentazon	0.5 + 3.0	PPI + Post	100	88	87	100	100	100	100	100	6.0bcd	1.22bcde

a/ Preemergence (Pre) and preplant incorporated (PPI)-July 18, 1974; Postemergence (Post)-August 28.
b/ % of control.
c/ Weed Population: 8-15, Large Crabgrass and Goosegrass (Grass)-50%, Purslane-50%: 10-3, Large Crabgrass-35%, Goosegrass-30%, Purslane-35%.
d/ Harvested October 4, 1974. Whole plant includes stem, leaves, pods, and seeds.
Means within columns followed by the same letter are not significantly different at the 5% level with Duncan's Multiple Range Test.

EFFECTS OF SOME PREPLANT INCORPORATED HERBICIDES ON WEED CONTROL IN SNAPBEANS AND LIMA BEANS

R. D. Ilnicki, D. J. Herman, and J. Somody 1/

A number of preplant incorporated herbicides were evaluated for weed control and crop tolerance in snapbeans and lima beans on a Sassafras loam soil at the Adelphia Research Station, Agricultural Experiment Station, Adelphia, New Jersey.

Included in the experiment were the following herbicides: N-sec butyl-4-tert butyl 2-6-dinitroaniline (butralin) at 1 1/2, 2, 2 1/2 and 3 lb/A; N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine (profluralin) at 1 and 1 1/2 lb/A; N^4,N^4-diethyl-a,a,a-trifluoro-3,5-dinitrotoluene-2,4-diamine (dinitramine) at 1/3, 1/2, and 2/3 lb/A; N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl) aniline (fluchloralin) at 3/4 and 1 lb/A; a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin); and S-ethyl dipropyl thiocarbamate (EPTC) at 3 lb/A. All herbicide treatments were applied prior to planting and incorporated. In addition to the above EPTC was applied at 3 lb/A, trifluralin at 1/2 lb/A, and profluralin at 1 1/2 lb/A preplant incorporated and all followed by p-nitrophenyl a,a,a-trifluoro-2-nitro-p-tolyl ether (fluorodifen) applied preemergence at 2 lb/A.

Of the dinitroaniline herbicides, the safest on snapbeans was profluralin followed by butralin, fluchloralin, trifluralin, and dinitramine. For lima beans, the safest herbicide was fluchloralin, followed by trifluralin, profluralin, butralin, and dinitramine. The difference in response of snapbeans and lima beans for the first four herbicides was not great and the differences may have been more apparent than read; however, dinitramine was definitely the most injurious of the group to both crops.

With respect to weed control, there were no great differences between the dinitroanilines; however, trifluralin was the least effective on shepherdspurse (*Capsella bursa-pastoris* (l) Medic)

1/ Research Professor of Weed Science, former Graduate Intern and Weed Control Technician, respectively, Soils and Crops Department, Cook College, Rutgers University, New Brunswick, New Jersey.

EPTC injured lima beans severely. No injury was observed on snapbeans.

Of the follow-up treatments, the safest was trifluralin followed by fluorodifen preemergence. Profluralin followed by fluorodifen preemergence produced slight injury to snapbeans and more severe injury to lima beans. EPTC followed by fluorodifen preemergence effected the same response to the crops as it did when it was applied alone prior to planting. With regard to weed control, there were no significant differences between the three follow-up treatments.

SNAP BEAN RESPONSE TO FLUORODIFEN[1]

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

Abstract

A study was conducted to determine the response of snap beans (Phaseolus vulgaris L. var. humilus cv. Spartan Arrow) to fluorodifen (2,4'-dinitro-4-trifluoromethyl-diphenylether dipropylaniline) applied at seeding and five days after seeding at 1, 1.5 and 2 lbs/A, alone and in combination with preplant incorporated treatments of EPTC (ethyl N,N-dipropyl thiocarbamate), trifluralin (a,a,a,trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), profluralin (N-n-propyl-N cyclopropylmethyl-4-trifluromethyl-2,6-dinitroaniline) and dinitramine (N3,N3-diethyl-2,4 dinitro-6-trifluoromethyl-m-phenylenediamine).

Rates and timings of fluorodifen did not affect plant stand. Fresh weight of plants and pods were influenced by rate and timing. Delayed preemergence applications were more toxic than preemergence and 2 lbs/A more injurious than either 1 or 1.5 lbs/A.

Significant reduction of stand and fresh weight was found with preplant incorporated treatments of dinitramine. Also a trend towards reduced pod yields was noted.

Introduction

In the Northeast, several experiments have been conducted examining fluorodifen as a selective herbicide for dry and snap beans (1, 2, 3, 4). In most instances the chemical has been used singly at rates of 2 to 4 lbs/A. At these rates adverse plant response has been noted, ranging from leaf symptoms (2) to stand reduction (4). The authors (2) observed that fluorodifen at 2 lbs/A in combination with currently recommended bean herbicides provided excellent control of many weed species including problem weeds such as galinsoga [Galinsoga ciliata (Raf.) Blake].

The purpose of this study was to determine the response of snap beans to low rates of fluorodifen applied preemergence or delayed preemergence, alone and in combination with preplant incorporated treatments of EPTC, trifluralin, profluralin and dinitramine.

Materials and Methods

Research was conducted in 1974 at Freeville, New York, on an Eel silt loam soil. Lime and fertilizer were broadcast over the experimental area, which was then plowed and disc harrowed. On June 14 the area was reworked with a spring tooth harrow, plots staked, and preplant incorporated treatments applied. Incorporation followed immediately, using a spring tooth harrow

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[1] Paper No. 681, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

[2] Graduate Assistant and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

pulled down and back over the experimental area at a depth of 2 to 3 inches. The plots were restaked, snap beans planted and preemergence treatments applied. June 19 the delayed preemergence treatments were applied and July 11 all plots received one cultivation.

All chemical applications were made with a hand held CO_2 powered small plot sprayer, calibrated to deliver 60 GPA at 35 PSI.

Plot size was 6 feet by 15 feet, with two rows of beans per plot. A split-plot design with three replications was utilized.

Rainfall was adequate for plant growth during the early growing season, however, was limited during the period of blossoming and fruit set. The preemergence treatments received 1 inch of rain over the three day period following treatments. The delayed preemergence received 0.3 inch following treatment. Temperatures were below average in the early season and near normal late in the season.

To compare yields between treatments in snap beans, the pods from each plot should be harvested when they are of a uniform maturity. However, some treatments may delay maturity but not affect yield. Observations of blossom and fruit set were made and it appeared that all treatments blossomed uniformly. Therefore, on August 7 when all plants had one pod with bean seeds formed, all pods with a diameter of 0.25 inch and above were harvested from 12 feet of row per plot. In addition, the number of plants per 12 feet and the total fresh weight was recorded. All data were statistically analyzed using "Least significant difference" (Lsd) and Tukey's "Honestly significantly difference" (Hsd).

Results and Discussion

Number of plants per treatment is recorded in Table 1. Of the five preplant incorporated treatments, only dinitramine significantly reduced plant numbers. The various rates and timings of fluorodifen did not affect the number of plants. The timing x rate interaction at 2 lbs/A delayed preemergence reduced plant stand.

Table 2 indicates the fresh weight (lbs.) of the snap bean plants in each treatment. Again dinitramine injury is reflected by the reduced plant weights. Timing of fluorodifen as well as rate affected fresh weights, with delayed preemergence treatments and 2 lbs/A being most toxic. The timing x rate interaction shows a trend towards reduced plant weights; however, it is not significant.

Fresh weight (lbs.) of pods are shown in Table 3. Yields were lower than normal due in part to the dry weather and should be looked at cautiously; however, trends are evident. Dinitramine appeared to slightly depress fruit yield, however, the reduction was not significant. Fluorodifen applied delayed preemergence at 2 lbs/A significantly reduced yield. The interaction of timing x rate was not significant.

Table 1. Number of snap bean plants from twelve feet of row.

PPI Treatment	Fluorodifen Rate (lbs/A)	Timing: Preemergence	Timing: Delayed Pre	PPI Treatment Mean
None	1.0	30.7	32.7	
	1.5	31.7	32.7	
	2.0	35.0	30.7	
				32.2
EPTC	1.0	34.0	31.7	
3 lbs/A	1.5	32.0	32.0	
	2.0	31.3	30.0	
				31.8
trifluralin	1.0	31.7	34.0	
0.75 lb/A	1.5	32.3	33.0	
	2.0	33.3	31.3	
				32.6
profluralin	1.0	33.0	32.3	
1 lb/A	1.5	31.3	32.7	
	2.0	33.0	28.0	
				31.7
dinitramine	1.0	30.7	25.7	
0.50 lb/A	1.5	27.7	29.7	
	2.0	30.0	28.3	
				28.7
				Hsd .05 = 2.06

Timing	
Pre	31.8
D.Pre	30.9
Lsd .05 = N.S.	

Fluorodifen Rate	
1.0	31.6
1.5	31.5
2.0	31.1
Lsd .05 = N.S.	

Timing x Rate	1.0	1.5	2.0
Pre	32.0	31.0	32.5
D.Pre	31.3	32.0	29.7
Hsd .05 = 2.81			

Table 2. Fresh weight (lbs.) of snap bean plants harvested from twelve feet of row.

PPI Treatment	Fluorodifen Rate (lbs/A)	Timing: Preemergence	Timing: Delayed Pre	PPI Treatment Mean
None	1.0	8.2	9.5	
	1.5	8.0	8.0	
	2.0	8.6	6.5	
				8.1
EPTC	1.0	8.3	9.3	
3 lbs/A	1.5	8.6	7.7	
	2.0	7.6	6.8	
				8.0
trifluralin	1.0	8.3	8.3	
0.75 lb/A	1.5	7.5	6.7	
	2.0	8.0	5.4	
				7.4
profluralin	1.0	8.9	7.6	
1 lb/A	1.5	7.4	7.3	
	2.0	7.6	6.2	
				7.5
dinitramine	1.0	6.6	4.6	
0.50 lb/A	1.5	5.6	7.3	
	2.0	4.6	4.5	
				5.5
				Hsd .05 = 1.99

Timing	
Pre	7.6
D.Pre	7.0
Lsd .05 = 0.6	

Fluorodifen Rate	
1.0	8.0
1.5	7.4
2.0	6.6
Lsd .05 = 0.75	

Timing x Rate	1.0	1.5	2.0
Pre	8.1	7.4	7.4
D.Pre	7.3	7.3	5.9
Hsd .05 = N.S.			

Table 3. Fresh weight (lbs.) of marketable snap bean pods harvested from twelve feet of row.

PPI Treatment	Fluorodifen Rate (lbs/A)	Timing: Preemergence	Timing: Delayed Pre	PPI Treatment Mean
None	1.0	1.2	1.4	
	1.5	1.4	1.2	
	2.0	1.5	0.9	
				1.3
EPTC 3 lbs/A	1.0	1.3	1.4	
	1.5	1.5	1.1	
	2.0	1.4	0.9	
				1.3
trifluralin 0.75 lb/A	1.0	1.3	1.8	
	1.5	1.7	1.2	
	2.0	1.6	1.0	
				1.4
profluralin 1 lb/A	1.0	1.8	1.3	
	1.5	1.3	1.4	
	2.0	1.5	0.9	
				1.4
dinitramine 0.50 lb/A	1.0	1.4	0.8	
	1.5	1.2	1.4	
	2.0	0.8	0.9	
				1.1
				Hsd .05 = N.S.

Timing	
Pre	1.4
D.Pre	1.2
Lsd .05 = 0.2	

Fluorodifen Rate	
1.0	1.4
1.5	1.3
2.0	1.1
Lsd .05 = 0.27	

Timing x Rate	1.0	1.5	2.0
Pre	1.4	1.4	1.4
D.Pre	1.3	1.3	0.9
Hsd .05 = N.S.			

Although this study was designed to look at crop response, weeds were not entirely eliminated from the experimental area. It was observed that at equal rates delayed preemergence treatments provided better weed control than preemergence treatments. This is implied in the data in Table 2 and 3 which generally indicates 1 lb/A preemergence had less plant and pod fresh weights than 1 lb/A delayed preemergence.

Dinitramine appeared to have a deleterious effect upon snap beans in all parameters measured. In 1973 the authors (2) did not observe this type of injury and it is not known why it occurred in 1974.

Acknowledgments

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Literature Cited

1. Ashley, R. A. 1973. Two-year study of weed control in snap beans. Proc. NEWSS 27: 178-183.
2. Boldt, P. F. and R. D. Sweet. 1974. Evaluation of herbicides on dry and snap beans. Proc. NEWSS 28: 155-160.
3. Lay, M. M., D. Herman and R. D. Ilnicki. 1973. Response of snap beans and lima beans to trifluralin, alone and in combination, with several herbicides. Proc. NEWSS 27: 184-191.
4. Wilson, H. P., J. N. Belote III and T. E. Hines. 1974. Activities of alachlor and fluorodifen in snap beans. Proc. NEWSS 28: 161-166.

WEED CONTROL IN DIRECT-SEEDED AND TRANSPLANTED TOMATOES

R. C. Henne [1/]

Abstract

Sixteen herbicides applied alone, in combination, or in sequence were evaluated for efficacy and crop response in four experiments involving both direct-seed and transplant tomato (Lycopersicon esculentum) culture. Metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one) applied preemergence was phytotoxic to seeded tomatoes reducing stands significantly. Activated carbon was effective in reducing metribuzin phytotoxicity. Tomato seedlings past the four-leaf stage of growth were tolerant of postemergence applications.

Metribuzin, napropamide (2-(a-naphthoxy)-N,N-diethylpropionamide), and U-27,267 (3,4,5-tribromo-N,N,a-trimethylpyrazole-1-acetamide) effectively controlled weeds in both tomato cultures while S-6044 (chemistry not released) was promising in the transplanted crop.

Introduction

The need for more effective herbicides for tomatoes necessitates continued evaluation of new experimental herbicides. Previous work by the author showed that metribuzin, napropamide, S-6044, and U-27,267 were materials with good potential for weed control in tomatoes (2, 3). Only napropamide has been registered for use on tomatoes and this use was restricted to California in 1974.

This paper presents additional data on the performance of these materials and others, either alone or 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 previously reported (2, 3). Herbicides included in 1974 trials are listed in Table 1, together with common names and/or chemical designations and formulations used.

Direct-Seeded Experiments: Preplant treatments (designated PPI in Tables) were made April 25 to 26 and incorporated 9 to 10 cm deep immediately after application with a rotary cultivator. Soil temperature was 19 C at a depth of 5 cm and moisture was in good supply. Campbell 28 variety tomatoes were seeded April 26 with a Planet Jr. seeder and preemergence treatments were applied April 30. Plots receiving activated carbon band treatments over the seed row were prepared the day prior to preemergence treatments. Precipitation on May 2 totaled 2.3 cm and provided ample moisture for seed emergence and

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

activation of herbicides. Postemergence treatments were made June 7 to tomato seedlings in the four-leaf stage of growth. Ragweed (Ambrosia artemisiifolia) seedlings (the dominant weed species) were 7.5 to 10 cm tall while crabgrass (Digitaria sp), barnyardgrass (Echinochloa crus-galli) and velvetleaf (Abutilon theophrasti) were 2.5 cm tall. Plots were not cultivated during the entire season and uncontrolled weeds were permitted to compete with the crop (with the exception of "hand-weeded controls"). Yield data were obtained on September 3 for Experiment I and on September 3 and 16 for Experiment II.

Transplanted Experiments: Preplanting treatments were applied and immediately incorporated on May 6. Preplant treatments not incorporated are designated by "pp" in Table 2. Transplants of Campbell 28 were set May 8. Precipitation on May 9 and 12 equalled 2.5 cm and assisted crop establishment and assured herbicidal activity. Postplanting treatments were applied May 28 when plants were well established and before weed seedlings exceeded 5 cm in height. Yield data were obtained from a single harvest with 80% ripe fruit on August 20 to 22.

All treatments were applied with a bicycle plot sprayer delivering 308 L/ha at 2.1 kg/cm^2 air pressure. Weed control was rated on a 1 to 9 scale where 1 represented no control and 9 represented complete kill. Crop phytotoxicity was rated on a 1 to 5 scale where 5 represented no visible crop injury and 1 represented complete kill.

Results

Direct-Seeded Trials - Experiment I: Diphenamid applied preplanting provided good early season control of broadleaf and grass weeds but by August control of broadleaf weeds, particularly ragweed and ivyleaf morningglory (Ipomoea hederacea), was unsatisfactory (Table 2). Diphenamid also suppressed tomato seedling development (as measured by phytotoxicity index of 4) and, combined with late season weed competition, resulted in significantly lower yields compared to the weeded control. Most new compounds included in this test controlled the grass weeds but failed to provide broadleaf weed control. FMC 25213 was phytotoxic but gave fair control at the 2.24 kg/ha rate. TH 30-843 showed no selectivity in seeded tomatoes. The best control was from a combination of diphenamid at 4.48 kg/ha followed by chloramben G at layby. There was no significant difference between chloramben formulations.

Direct-Seeded Trials - Experiment II: In the second direct-seeded experiment (Table 3) weed control with diphenamid was satisfactory throughout the season with only a few ragweed escapes. Significant phytotoxicity in terms of stunted seedling growth was evident with diphenamid but yields were not affected. U-27,267 provided good weed control early in the season but only the highest rate was effective by mid-season.

Napropamide alone at 0.84 kg/ha held grasses in check but broadleaf weeds escaped and the resulting weed competition reduced yields. When combined with metribuzin as a preplanting treatment, excellent weed control was obtained. There was some evidence of thinned stands from this combination which was attributed to metribuzin, but yields were not adversely affected.

Metribuzin applied alone as a preemergence treatment thinned stands at the 0.28 kg/ha rate and nearly eliminated the crop at 0.56 kg/ha. Early weed control was effective but by the end of July grass control was unsatisfactory at either rate. To reduce metribuzin phytotoxicity to tomato seedlings, activated carbon (A.C.) was applied in a 2.5 to 5 cm band over the seed rows prior to metribuzin application. Based on stand counts and phytotoxicity ratings, the activated carbon treatments were highly effective in reducing metribuzin injury and supports our earlier work (5).

Combination treatments of metribuzin at 0.28 kg/ha with diphenamid applied preemergence resulted in a greater level of phytotoxicity than was evident by either material used alone. This was measured in a greater stand reduction and also reflected in phytotoxicity ratings. Preemergence combination treatments provided somewhat better broadleaf weed control than obtained with diphenamid alone at 6.72 kg/ha preplanting, but grass control was slightly inferior. Combinations involving metribuzin as a postemergence spray (diphenamid used preplanting) resulted in minimal injury to the tomatoes. The only drawback with this treatment was that delaying application until the crop was at the four-leaf stage permitted ragweed (the dominant species) to reach a size (7.5 to 10 cm) where control was inadequate with 0.14 to 0.42 kg/ha of metribuzin. Other broadleaf weeds such as velvetleaf and smartweed (Polygonum persicaria) were small enough to be controlled by these rates.

Transplant Trial - Experiment III: Trifluralin failed to control broadleaf weeds - particularly ragweed and velvetleaf - but remaining weeds were not sufficient to competitively affect yields (Table 2). S-6044 provided better weed control than trifluralin. While not statistically significant, tomato yields were somewhat better where S-6044 was not incorporated than where treatments were incorporated. FMC 25213 provided good control but was phytotoxic with the high rate significantly reducing yields. Buban, butralin, fluchloralin, and dinitramine all failed to control broadleaf weeds and were therefore similar to trifluralin in activity. Phytotoxicity was evident with fluchloralin and dinitramine and yields were correspondingly reduced. Vel 5052 was applied postplanting and caused severe chlorosis and resulted in questionable weed control. Considering overall weed control and crop tolerance, S-6044 was the promising material in this experiment.

Transplant Trial - Experiment IV: Trifluralin alone failed to control broadleaf weeds and weed competition significantly reduced yields (Table 4). Metribuzin alone at 0.56 kg/ha provided excellent weed control in this experiment where populations of grasses were low. Yields were similar to the weeded control. The 1.12 kg/ha rate of metribuzin provided excellent weed control but some phytotoxicity was measured with 4 to 5% of the plants killed and others developing veinal chlorosis during early stages of growth. Combination treatments of trifluralin with metribuzin preplanting or metribuzin applied postplanting all provided excellent weed control even when trifluralin rates were lowered to 0.56 kg/ha. The postplanting metribuzin treatments resulted in considerable foliage burning at 0.28 and 0.56 kg/ha and a significant yield reduction occurred with the higher rate.

U-27,267 alone provided better weed control in this trial than in the seeded trial mentioned above. A significant synergistic reaction appeared to occur when metribuzin was applied postplanting to plots treated with U-27,267 preplanting. Twenty-five percent of the plants were killed and the survivors were severely stunted throughout the season and yields were reduced sharply. While postplanting metribuzin treatments on trifluralin plots also produced foliage burn, it was not nearly as severe as with the U-27,267 combination.

Napropamide alone was weak on broadleaf weeds and combinations with pebulate were no more effective. Napropamide combined with metribuzin was extremely effective on weeds and did not affect crop yields. Similarly, diphenamid alone was weak on broadleaf weeds but combined with metribuzin provided excellent broadspectrum weed control without crop injury.

Discussion

Metribuzin selectivity in direct-seeded tomatoes appears to be marginal at 0.28 kg/ha preemergence. To obtain consistent season-long weed control, it is felt higher rates - at least 0.56 kg/ha - are required. Use of activated carbon may be one technique that would provide the protection necessary for adequate crop tolerance. While crop tolerance was evident when postemergence treatments were delayed until seedlings were past the four-leaf stage, some weeds such as ragweed and morningglory also become well established and difficult to kill.

Metribuzin treatments applied 20 days after planting (Exp. IV) produced considerable phytotoxicity at rates of 0.28 and 0.56 kg/ha. According to Fortino and Splittstoesser (1) metribuzin produces the least amount of injury to tomatoes when applied under high light intensity. The postplanting treatments in this study were applied under a period of low light levels (cloudy prior to treatment) and other than the day of treatment, continued cloudy and rainy for 96 hr after treatment. These environmental conditions may have been responsible for greater than expected injury based on our previous work (3, 4).

Literature Cited

1. Fortino, J. Jr. and W. E. Splittstoesser. 1974. Response of Tomato to Metribuzin. Weed Sci. 22:460-463.

2. Henne, R. C. and R. T. Guest. 1973. Weed Control in Direct-Seeded and Transplanted Tomatoes. Proc. N.E. Weed Sci. Soc. 27:200-207.

3. Henne, R. C. and R. T. Guest. 1974. Weed Control in Direct-Seeded and Transplanted Tomatoes. Proc. N.E. Weed Sci. Soc. 28:257-263.

4. Henne, R. C. and R. T. Guest. 1974. Tolerance of Tomato Plants to Postplanting Metribuzin. Proc. N.E. Weed Sci. Soc. 28:253-256.

5. Henne, R. C. and R. T. Guest. 1974. Activated Carbon as a Method of Reducing Metribuzin Phytotoxicity to Seeded Tomatoes. Proc. N.E. Weed Sci. Soc. 28:242-248.

Table 1. Chemical names and formulations of herbicides included in Experiments I-IV.

Common name and/or designation		Chemical name	Formulation
-	Buban 37	3',5'-dinitro-4'(di-n-propylamino)acetophenone	2 ec
Butralin	A-820	4-(1,1-dimethylethyl-N-(1-methylpropyl)-2,6-dinitrobenzenamine	4 ec
Chloramben	Amiben G Super-6	3-amino-2,5-dichlorobenzoic acid	10 G
Chloramben	Amiben G Standard	3-amino-2,5-dichlorobenzoic acid	10 G
Cyperquat	S-21634	1-methyl-4-phenylpyridinium chloride	3 ec
Dinitramine	Cobex	N^4,N^4-diethyl-a,a,a-trifluoro-3,5-dinitrotoluene-2,4-diamine	2 ec
Diphenamid	-	N,N-dimethyl-2,2-diphenylacetamide	80 wp
Fluchloralin	Basalin	N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl) aniline	4 ec
-	FMC 25213	r-2-ethyl-5-methyl-c-5-(2-methylbenzyloxy)-1,3-dioxane	4 ec
Metribuzin	Sencor	4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one	50 wp
Napropamide	Devrinol	2-(a-naphthoxy)-N,N-diethylpropionamide	2 ec
Pebulate	-	S-propyl butylethylthiocarbamate	6 ec
-	S-6044	---chemistry not available---	3 ec
-	TH 30-843	---chemistry not available---	2 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
-	Vel-5052	---chemistry not available---	2 ec

Table 2. Performance of several experimental herbicides in direct-seeded and transplanted tomatoes, Experiments I and III, 1974.

Herbicide	Rate kg/ha preplant	Weed control rating 1-9				Crop response		
		Broadleaf		Grass		Stand No/30 cm	Phyto. rating 1-5	Yield metric ton/ha
Experiment I		6/11	8/8	6/11	8/8	5/30	6/11	9/4
Weeded control		9	8	9	9	4.8	5	19.0
Unweeded control		1	3	1	5	4.8	4	7.2
Diphenamid	6.72	8	6	9	9	5.1	4	13.9
Buban 37	2.24	3	3	9	7	5.2	4	10.0
Buban 37	4.48	5	2	9	7	4.0	2	11.6
FMC 25213	1.12	6	5	9	7	4.2	3	12.3
FMC 25213	2.24	7	7	9	9	3.8	2	14.8
TH 30-843	1.12	7	5	9	9	0.2	1	1.1
TH 30-843	2.24	7	3	9	9	0.1	1	0.7
Cyperquat	2.24 post	2	3	1	2	4.2	4	7.4
Cyperquat	4.48 post	1	2	1	3	4.2	4	6.3
Diphenamid + chloramben G Super 6	4.48 + 4.48	7	8	9	8	5.0	4	23.3
Diphenamid + chloramben G regular	4.48 + 4.48	7	7	9	8	4.9	4	24.4
	LSD 5%	1.9	2.3	1.0	3.1	0.5	0.8	2.7
	1%	2.3	3.0	1.3	4.1	0.7	1.1	3.6
Experiment III		6/11	7/31	6/11	7/31		6/11	8/20
Weeded control		9	9	9	9		5	50.8
Unweeded control		4	4	2	1		5	44.4
Trifluralin	1.12	8	5	9	9		5	49.7
S-6044	3.36	9	7	9	9		5	48.8
S-6044	4.48	9	8	9	9		5	43.5
S-6044	3.36 pp	9	7	9	9		5	51.7
S-6044	4.48 pp	9	8	9	9		5	51.1
FMC 25213	1.12	9	8	9	9		4	46.1
FMC 25213	2.24	9	9	9	9		4	31.6
Buban 37	4.48	8	5	9	9		5	42.3
Butralin	3.36	6	4	9	9		5	43.2
Butralin	3.36 pp	6	4	9	9		5	45.5
Fluchloralin	2.24	8	5	9	8		4	40.0
Fluchloralin	4.48	9	6	9	9		4	41.2
Dinitramine	0.28	7	5	9	6		5	46.1
Dinitramine	0.56	8	5	9	9		4	35.2
Vel-5052	0.56 post	-	3	-	5		5	45.9
Vel-5052	2.24 post	-	4	-	7		3	30.5
	LSD 5%	1.7	2.1	1.4	2.0		0.6	9.6
	1%	2.3	2.9	1.9	2.8		0.8	12.4

Table 3. Performance of several herbicides and combinations on weed control and crop tolerance in direct-seeded tomatoes, Exp. II, 1974

Treatment			Weed control rating 1-9				Crop response			
			Broadleaf		Grasses		Stand No/30 cm	Phyto. Rating 1-5		Yield metric ton/ha
Herbicide	Rate kg/ha	Application method	6/11	7/31	6/11	7/31	5/31	5/28	6/11	
Weeded control			9	9	9	9	4.4	5.0	5.0	42.3
Unweeded control			2	2	1	1	5.0	4.8	5.0	11.6
Diphenamid	6.72	PPI	9	7	9	9	5.0	3.1	3.8	47.9
U-27,267	0.56	PPI	8	6	8	6	5.0	4.6	4.8	27.3
U-27,267	0.84	PPI	8	6	8	6	4.6	4.5	4.9	34.0
U-27,267	1.68	PPI	8	7	9	8	4.2	4.0	4.4	37.7
Napropamide	0.84	PPI	6	5	7	8	4.9	5.0	5.0	21.9
Metribuzin	0.28	PE	9	8	8	4	3.0	2.9	3.4	45.9
Metribuzin	0.56	PE	9	8	9	6	0.4	1.2	1.2	33.6
Metribuzin	0.56	PE over AC 2.8 kg/ha	9	8	9	7	3.5	3.4	3.8	51.7
Metribuzin	0.56	PE over AC 5.6 kg/ha	9	8	9	7	3.8	4.6	4.0	43.7
Metribuzin	0.56	PE over AC 11.2 kg/ha	8	8	9	7	4.5	4.1	4.5	34.9
Metribuzin	1.12	PE over AC 22.4 kg/ha	9	9	9	8	3.4	3.1	3.1	47.7
Diphenamid + metribuzin	4.48 + 0.14	PE	7	7	9	9	4.4	3.5	3.5	37.2
Diphenamid + metribuzin	4.48 + 0.28	PE	8	8	9	7	2.3	2.0	2.0	43.4
Diphenamid + metribuzin	4.48 + 0.14	PE POST 4-leaf	8	7	8	9	3.0	2.8[a]	3.6	38.7
Diphenamid + metribuzin	4.48 + 0.28	PE POST 4-leaf	8	7	9	9	4.6	3.0[a]	3.5	41.4
Diphenamid + metribuzin	4.48 + 0.42	PE POST 4-leaf	8	7	9	9	4.7	3.9[a]	3.9	45.0
Napropamide + metribuzin	0.86 + 0.28	PPI	9	8	9	9	3.6	3.5	4.0	44.1
Napropamide + metribuzin	0.86 + 0.28	PPI POST 4-leaf	8	7	9	9	4.9	4.8	5.0	35.2
		LSD 5%	1.7	2.2	1.4	2.0	1.4	1.1	0.7	19.0
		1%	2.3	3.0	1.9	2.6	1.9	1.5	0.9	22.1

[a] Rated prior to post metribuzin application, therefore indicates only diphenamid phytotoxicity.

Table 4. Performance of several herbicides and combinations on weed control and crop tolerance in transplanted C-28 tomatoes, Exp. IV, 1974.

Treatment			Weed control rating 1-9				Crop response	
			Broadleaf		Grasses		Phyto. Rating 1-5	Yield
Herbicide	Rate kg/ha	Application method	6/11	7/31	6/11	7/31	6/11	metric ton/ha
Weeded control			9	9	9	9	5.0	57.3
Unweeded control			1	1	1	2	5.0	39.2
Trifluralin	0.56	PPI	2	1	9	9	5.0	34.7
Trifluralin	1.12	PPI	5	1	9	9	5.0	36.3
Metribuzin	0.56	PPI	9	9	9	9	5.0	55.8
Metribuzin	1.12	PPI	9	9	9	9	4.3	47.7
Trifluralin + metribuzin	0.56 + 0.28	PPI	9	8	9	9	5.0	53.3
Trifluralin + metribuzin	0.56 + 0.56	PPI	9	9	9	9	5.0	57.1
Trifluralin + metribuzin + metribuzin	0.56 + 0.28 + 0.28	PPI POST	9	9	9	9	4.3	45.7
Trifluralin + metribuzin	1.12 + 0.28	PPI	9	8	9	9	4.5	52.2
Trifluralin + metribuzin + metribuzin	1.12 + 0.28 + 0.28	PPI POST	9	9	9	9	4.0	44.6
Trifluralin + metribuzin	0.56 + 0.28	PPI POST	9	9	9	9	4.3	45.7
Trifluralin + metribuzin	0.56 + 0.56	PPI POST	9	9	9	9	3.4	36.5
U-27,267	0.84	PPI	9	8	9	8	5.0	51.9
U-27,267 + metribuzin	0.84 + 0.56	POST	9	9	9	9	2.3	23.7
Napropamide	0.84	PPI	8	6	9	9	5.0	45.2
Napropamide + pebulate	0.84 + 5.0	PPI	9	5	9	9	4.9	43.2
Napropamide + metribuzin	0.84 + 0.56	PPI	9	9	9	9	5.0	55.1
Diphenamid	3.36	PPI	8	5	9	8	5.0	45.2
Diphenamid + metribuzin	3.36 + 0.56	PPI	9	9	9	9	5.0	46.4
		LSD 5%	1.3	1.3	0.1	1.1	0.37	13.1
		1%	1.8	1.8	0.2	1.5	0.49	17.6

TIMING OF APPLICATIONS OF METRIBUZIN TO TRANSPLANTED TOMATOES

R. A. Ashley[1/]

Abstract

The effect of time of application of metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one) on crop injury and weed control in transplanted tomatoes (Lycopersicon esculentum Mill.) was studied during 1973 and 1974. No crop injury was observed where metribuzin was applied PPI during either year. Severe crop injury and stand reductions were recorded in 1973 where applications of metribuzin were made 7 days after transplanting and in 1974 where applications were made at transplanting. Foliage injury from metribuzin applications did not result in yield reductions. Yield reductions were observed only where stand reductions occurred.

Introduction

Experiments were conducted during 1973 and 1974 to determine the effect of time of application of metribuzin on injury to transplanted tomatoes.

Materials and Methods

Tomato plants cv. Heinz 1350 were field set June 8, 1973 on the University of Connecticut Agronomy Research Farm in Storrs, Connecticut. The soil type was a Woodbridge fine sandy loam with a pH of 6.4 and an organic matter content of 3½%. Treatments were arranged in a randomized complete block design with treated plots consisting of a single row 10 feet long. Rows were 4 feet apart.

Metribuzin was applied before planting on June 8, 1973 at a rate of 1 lb ai/A and incorporated into the soil to a depth of 2 to 3 inches using a garden tractor mounted rototiller. On the same date, a second application of metribuzin was made immediately following transplanting. Further applications of metribuzin at 1 lb ai/A were made on June 12, June 15 and June 22, 1974 - four, seven and 14 days after transplanting respectively. Measurable rainfall during the treatment period was 0.02 inches on June 6, 0.61 inches on June 14, 0.02 inches on June 17, 0.03 inches on June 19 and 0.37 inches on June 23.

Field experiments were repeated in 1974 with several changes reflecting the previous years experience. Tomato plants of the Roma VF variety were field set June 4, 1974. The variety Roma was used because work done in 1973 indicated Roma VF to be more sensitive to metribuzin than Heinz 1350. The test location, plot layout and soil conditions were the same as in 1973. Treated plots were 10 feet long with rows 5 feet apart.

1/ University of Connecticut, Storrs, Connecticut

Metribuzin was again applied preplant incorporated, at transplanting and 2, 7 and 14 days after transplanting. The rate was reduced to ½ lb ai/A as this was felt to be closer to the likely commerical useage rate. PPI applications were made June 3, 1974 and Post transplant applications were made on June 4, June 8, June 11 and June 18, 1974. Measurable rainfall during the treatment period was 0.34 inches on June 1, 0.07 inches on June 2, 1.31 inches on June 17 and 0.30 inches on June 22.

Predominant weed species present in the experimental area were: large crabgrass (Digitaria sanguinalis (L.) Scop.), lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), and Common Ragweed (Ambrosia artemisifolia L.)

Crop injury and weed control ratings were taken June 25, 1973 and June 10 and June 20, 1974 using a 0 to 10 scale with 0 representing no effect and 10 representing complete kill.

Yield data was taken August 21 and September 17, 1973 and September 5 and October 3, 1974.

Results and Discussion

In the 1973 experiment, significant crop injury occurred when metribuzin was applied at transplanting, 7 days after transplanting and 14 days after transplanting (Table 1). Crop injury ratings taken June 25, 1973 were 2, 1, 6 and 4 for plots treated with metribuzin at 1 lb ai/A at transplanting and 4, 7, and 14 days after transplanting respectively. Crop injury took the form of leaf necrosis and slight stunting. Where application was delayed for 7 days after transplanting stand reduction also occurred. Where metribuzin was applied PPI no crop injury was observed.

Table 1. Effect of time of application of metribuzin on crop injury and weed control in transplanted tomatoes - 1973 -

Herbicide	Rate Lb ai/A	Time of Application	Crop Injury[1]	Weed Control[1] CG[2]	PW[3]	RW[4]	LQ[5]	Yields Lb/Plot No.	Wgts.
Metribuzin	1	preplant incorporated	0	9	10	10	10	180	53.7
Metribuzin	1	at transplanting	2	10	10	10	9	172	54.4
Metribuzin	1	4 days Post transplant	1	9	10	10	10	182	59.9
Metribuzin	1	7 days Post transplant	6	10	10	10	10	85	27.6
Metribuzin	1	14 days Post transplant	4	10	10	10	10	147	56.6
Untreated	--		0	10	10	10	10	235	55.5
LSD 5%			2	NS	NS	NS	NS	59	16.3

1. Rated on 0 to 10 scale with 0 = no effect and 10 = complete kill.
2. CG = Large Crabgrass (Digitaria sanguinalis (L.) Scop.)
3. PW = Redroot Pigweed (Amaranthus retroflexus L.)
4. RW = Common Ragweed (Ambrosia artemisifolia L.)
5. LQ = Lambsquarters (Chenopodium album L.)

Significant reductions in weight of tomatoes harvested occurred only where stand reductions were observed. Plots treated with metribuzin at 1 lb ai/A applied 7 days after transplanting yielded 27.6 lb per plot as compared to 55.5 lb for the hoed control. Significant reduction in the number of fruit occurred with all metribuzin treatments as compared to untreated plots.

In 1974 significant crop injury occurred when metribuzin was applied at transplanting or 2 days after transplanting (Table 2). No crop injury was observed from metribuzin applied PPI or 7 or 14 days after transplanting. Crop injury ratings taken June 20, 1974 were 6 and 3 for plots treated with metribuzin at ½ lb ai/A at transplanting or 2 days after transplanting respectively. Again the crop injury took the form of leaf necrosis and slight stunting of the plant except with metribuzin applied at transplanting where stand reduction occurred.

Table 2. Effect of time of application of metribuzin on crop injury and weed control in transplanted tomatoes - 1974 -

Herbicide	Rate Lb ai/A	Time of Application	Crop Injury[1]	Weed Control[1] CG[2]	PW[3]	RW[4]	LQ[5]	Yields Lb./Plot
Metribuzin	½	PPI	0	9	10	10	9	83.2
Metribuzin	½	at transplanting	6	10	10	10	10	55.5
Metribuzin	½	2 days Post transplant	3	10	10	10	10	88.2
Metribuzin	½	7 days Post transplant	0	10	10	10	9	85.3
Metribuzin	½	14 days Post transplant	0	9	10	10	9	78.2
Untreated	--		0	10	10	10	10	85.6
LSD 5%			2	NS	NS	NS	NS	19.1

1. Rated on 0 to 10 scale with 0 = no effect and 10 = complete kill.
2. CG = Large Crabgrass (*Digitaria sanguinalis* (L.) Scop.)
3. PW = Redroot Pigweed (*Amaranthus retroflexus* L.)
4. RW = Common Ragweed (*Ambrosia artemisifolia* L.)
5. LQ = Lambsquarters (*Chenopodium album* L.)

Significant yield reduction occurred only where stand reduction was observed. Plots treated with metribuzin at ½ lb ai/A applied at transplanting yielded 55.5 lb per plot as compared to 85.6 lb for the hoed control.

There was no difference in weed control recorder in either experiment. Weed control was excellent overall and weed competition was not a problem in evaluating yields.

In conclusion, to obtain maximum crop tolerance of metribuzin on transplanted tomatoes applications should be made PPI or 14 or more days after transplanting.

TOLERANCE OF TOMATO PLANTS TO POSTPLANTING METRIBUZIN

R. C. Henne [1/]

Abstract

Tomatoes (Lycopersicon esculentum) were treated 3, 10, 20, and 30 days after transplanting with various rates of metribuzin (4-amino-6-tert-butyl-3-(methylthio-as-triazine-5(4H)one). The most severe phytotoxicity was observed from treatments applied 10 days after planting. With the exception of the initial treatment (three days after planting), tomato tolerance appeared to increase with increasing plant age and development. The influence of environmental conditions on plant response also is discussed.

Introduction

The author (3) in 1974 reported results from initial studies showing that tomato transplants tolerated postplanting applications of metribuzin and that tolerance appeared to increase with increasing plant development. Beste (1) reported significant crop injury from early applications (10 days after planting) of metribuzin at 0.56 and 0.84 kg/ha but later applications were tolerated by the crop.

This study was continued in 1974 to further define the rate of metribuzin/age of transplant relationship to ensure adequate crop tolerance to postplanting treatments.

Materials and Methods

Commercial 'C-28' transplants grown in Georgia were transplanted on May 14 in a randomized complete block with four replicates at Clayton, Delaware. Plots were 1.5 by 6.1 m in size with 18 plants per plot. Postplanting applications of metribuzin were made on 5/17, 5/24, 6/3, and 6/14. All applications were made with a bicycle plot sprayer delivering 308 L/ha at 2.11 kg/cm^2 air pressure. Rates of metribuzin were varied with application time interval and are shown in Table 1. Weather conditions prevailing at each treatment are shown in Table 2. All weeds were removed by hand to eliminate weed competition as a variable.

Plants were evaluated for phytotoxicity on a 1 to 5 rating system where 5 = no detectable injury and 1 = all plants killed. Yields were taken on August 27 and September 9.

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

Results and Discussion

Applications of metribuzin three days after planting at rates of 0.28 to 0.84 kg/ha resulted in a low level of injury with 1.5% of the plants killed at the 0.56 kg rate and 4.9% killed at the 0.84 kg rate (Table 1). Phytotoxicity symptoms were still detected on June 21 but were barely evident by July 9. The degree of phytotoxicity from this initial group of treatments may have been compromised by 0.89 cm of precipitation which was recorded within 24 hr of application. However, Fortino and Splittstoesser (2) reported that maximum C^{14} metribuzin uptake in tomatoes occurred within 1 hr of application and that longer exposures of 24 hr did not increase the amount of C^{14} metribuzin absorbed.

Applications made 10 days after transplanting were extremely toxic to tomato transplants with 30 to 56% of the plants completely killed and those surviving the higher two rates remaining chlorotic and stunted with depressed yields. While the 0.56 kg rate also was severely phytotoxic the surviving plants showed good recovery and while yields at the first picking were low, the second harvest brought the total yields equal to the control.

Applications 20 days after planting produced an initial leaf burn estimated at 20% of the leaf area with the 0.56 and 0.84 kg rates, and up to 50% at the 1.12 kg/ha rate. By June 21 (18 days after application) only plants receiving the 1.12 kg/ha treatment were exhibiting foliar symptoms. This high rate was the only one at this date to produce a low yield at the first picking and delay in fruit maturity was evident by a larger second harvest.

Applications 30 days after planting were even less phytotoxic than earlier treatments even though rates were increased. The maximum rate of 1.68 kg/ha resulted in 5 to 10% of the foliage developing a phytotoxic burn but the effects were only temporary and yields were not adversely affected.

Sequential applications of metribuzin at 3 and 10 days after planting with 0.14 and 0.28 kg/ha respectively were tolerated by the crop without significant plant response. However, the third application of 0.28 kg/ha, 20 days after planting, resulted in definite stunting of vine growth plus chlorosis and leaf tip burn. Because of the crop stunting, a fourth application scheduled at 30 days was not applied. The sequential treatments delayed fruit maturity as reflected by a relatively low first pick and a significantly higher second harvest. Total yield was not affected by this series of treatments.

Environmental conditions, particularly light intensities prior to and following treatment, were reported by Fortino and Splittstoesser to influence the degree of metribuzin injury in tomatoes (2). In particular, they indicated that low light incidence prior to treatment followed by a three-fold-higher light level resulted in the greatest phytotoxicity. Table 2 indicates weather conditions prior to, during, and following application of metribuzin and also shows a "predicted" phytotoxicity response based primarily on light conditions, and an "actual" response observed in this study. The results in this trial would tend to support the theory that cloudy weather (lower light levels) prior to treatment, followed by sunny conditions at or following

treatment tend to produce greater phytotoxicity (as observed at 10- and 20-day intervals) than obtained when conditions are reversed (3-day interval), or when sunny weather extends throughout the period (30-day interval). The confounding factor in this study was that plant development was not constant. The difference in phytotoxic response between the 10- and 20-day intervals, which were both predicted to be high, are thought to be influenced by transplant age and development with the older plants more able to sustain the injury than the younger ones.

Results of this study indicate that delaying metribuzin applications for at least three weeks after planting and not exceeding 0.56 kg/ha would ensure adequate crop safety, even under adverse climatic conditions. Delaying post-planting treatments for at least 24 hr after a cloudy period may also reduce the degree of crop phytotoxicity.

Literature Cited

1. Beste, C. E. 1974. Weed Control in Transplanted Tomatoes. Proc. N.E. Weed Sci. Soc. 28:265-267.

2. Fortino, J. Jr., and W. E. Splittstoesser. 1974. Response of Tomato to Metribuzin. Weed Sci. 22:460-463.

3. Henne, R. C. and R. T. Guest. 1974. Tolerance of Tomato Plants to Post-planting Metribuzin. Proc. N.E. Weed Sci. Soc. 28:253-256.

Table 1. Response of C-28 tomato transplants to metribuzin applied at four time intervals after planting at Clayton, Delaware, 1974.

Time Interval after Planting	Rate kg/ha	% Plant Kill	Phytotoxicity Rating 1-5 6/21	Phytotoxicity Rating 1-5 7/9	Yield Metric Ton/ha on 8/27	Yield Metric Ton/ha on 9/9	Yield Metric Ton/ha on Total
3 days	0.28	0.0	5.0	4.9	32.2[ab a]	9.8[bcd]	41.9[ab]
	0.56	1.5	4.5	4.9	28.9[b]	8.7[cd]	37.6[abc]
	0.84	4.9	4.0	4.8	25.1[b]	14.3[bc]	39.4[abc]
10 days	0.56	30.2	2.4	3.5	23.9[b]	16.1[abc]	40.1[ab]
	0.84	56.2	1.6	2.4	13.2[c]	16.8[ab]	30.0[bc]
	1.12	49.5	1.6	2.6	10.9[c]	15.4[abc]	26.4[c]
20 days	0.56	0.0	4.8	4.9	34.7[ab]	16.1[abc]	50.8[a]
	0.84	0.0	4.8	5.0	33.6[ab]	14.8[bc]	48.4[a]
	1.12	1.5	3.9	5.0	26.5[b]	21.9[a]	48.4[a]
30 days	0.56	0.0	5.0	5.0	40.5[a]	6.1[d]	46.6[a]
	1.12	0.0	5.0	4.8	33.8[ab]	6.3[d]	40.1[ab]
	1.68	0.0	4.1	4.9	32.7[ab]	9.2[cd]	41.9[ab]
3 + 10 + 20 days	0.14+0.28+0.28	1.5	4.25	5.0	27.6[b]	22.3[a]	49.9[a]
Untreated control	0	0.0	5.0	5.0	33.2[ab]	6.9[d]	40.1[ab]

[a] Means in columns followed by a common letter are not significantly different at 5% level according to Duncan's multiple range test.

Table 2. Weather conditions prior to, during, and following metribuzin treatment and a phytotoxicity level "prediction" and "actual" rating.

Treatment Time Interval	24 hr Before		Day of Treatment			24 hr After		Phytotoxicity Level [b]	
	Temp. Hi/Low	Sky Cover	Temp. Hi/Low	Sky Cover	% R.H. 10 AM/1 PM	Temp. Hi/Low	Sky Cover	"Predicted"	"Actual"
3 days	84/62	Sunny	88/66	Sunny	61/50	76/57	Cloudy + rain	Low	Low
10 days	72/63	Cloudy + rain	79/54	Sun with cloudy periods	59/59	70/52	Sunny	High	Very high
20 days	64/57	Cloudy [a] + rain	73/56	Sunny	66/57	78/51	Sunny	High	Moderate
30 days	75/51	Sunny	78/54	Sunny	64/42	77/57	Sunny	Low	Low

[a] Cloudy period extended 96 hr prior to treatment.

[b] Phytotoxicity level - "Predicted" based primarily on light conditions.
"Actual" based on response of plants to the 0.56 kg/ha rate of metribuzin.

WEED CONTROL IN TRANSPLANTED TOMATOES WITH METRIBUZIN IN COMBINATION WITH OTHER HERBICIDES

John A. Grande and T. Ombrello[1/]

Abstract. Transplanted tomatoes (*Lycopersicum esuclentum* Mill., cultivar Heinz 1350) were treated with four pre-plant herbicides; trifluralin (α,α,α, -trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), diphenamide (N,N-dimethyl-2,2-diphenylacetamide), U27,267 (3,4,5-tribromo-N,N,a-trimethylpyrazole-1-acetamide) and metribuzin (4-amino-6-tert-butyl-3--(methylthio)-as-triazin-5 (4H) one, along with overlay treatments of metribuzin post-plant at different rates and timings. Only U27,267 (1.5#/A) performed at an acceptable level of weed control when used alone. All pre-plant treatments followed by post-plant applications of metribuzin resulted in good weed control, one-half pound of metribuzin early post or late post being consistently the better treatment. None of the post-plant metribuzin treatments resulted in any significant injury to the tomatoes.

INTRODUCTION

Weed control programs in transplanted tomatoes are noted as having two general weaknesses. First, the presently registered herbicides are somewhat weak on certain broadleaf weeds, and second, full season weed control has been difficult to obtain.

There have been several reports on the activity of the herbicide metribuzin in transplanted tomatoes (1,2). Previous results indicate metribuzin provides effective control of many broadleaf weeds in tomato plantings for the entire season.

It has also been reported that phytoxicity may occur in tomatoes from post-emergence applications of metribuzin (1,3).

The purpose of this study was to evaluate weed control and crop response from post-emergence applications of metribuzin applied at different timings and rates in combination with other pre-plant herbicides.

METHODS AND MATERIALS

The experiment was established at the South Jersey Research Center in Centerton, New Jersey on Aura sandy loam soil (1.5% OM). Single row plots 5 ft. wide by 20 ft. long were layed out in a randomized complete block design. On June 3, 1974, ten-week-old greenhouse-grown tomato plants (cultivar Heinz 1350) were planted with an in-row spacing of

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[1/] Assistant Research Professor, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey and County Agricultural Agent, Cumberland County, New Jersey

2 ft., (which resulted in 10 plants per plot.) The pre-plant herbicide treatments were applied on June 3 prior to transplanting. Incorporated treatments were accomplished with an engine powered garden roto-tiller set to a depth of 3 inches. All pre-plant herbicide treatments were applied with a CO_2 powered back-pack sprayer set to deliver 27 GPA. The post-emergence treatments were applied with a tractor mounted sprayer set to deliver 40 GPA.

Tomato vigor and weed control ratings were recorded on July 1, and weed control ratings were again recorded on September 8. A complete single harvest of the entire plot was made on September 12. The weight of red and green fruit as well as total weight were recorded.

RESULTS AND DISCUSSION

Results of weed control ratings and yield (Tables 1, 2, 3) indicate that single pre-plant treatments of herbicides are not entirely satisfactory for full season weed control. Trifluralin applied at 0.5#/A resulted in poor weed control and low yield. Common ragweed and ivyleaf morningglory were not controlled and large crabgrass control was only marginal. U27,267 (1.5#/A) was the only pre-plant herbicide exhibiting adequate weed control for the entire growing season. The only observed weakness was on ivyleaf morningglory (*Ipomea hederacea* L.). Metribuzin applied pre-plant (0.25#/A) was weak on large crabgrass (*Digitaria sanquinalis* (L.) Scop.) and fall panicum (*Panicum dichotomiflorum* Michx.)as well as ivyleaf morningglory.

The post-treatments of metribuzin without a pre-plant herbicide resulted in good broad-leaf weed control. Common lambsquarter (*Chenopodium album* L.) and common ragweed (*Ambrosia artemisifolia* L.) were totally controlled by the post treatments (Tables 1 and 2). There was a difference in control of ivyleaf morningglory as related to the post-emergence applications of metribuzin. The 1/2#/A early post treatment of metribuzin was the most effective. This seemed due to the fact that the morningglory was just starting to initiate the first true leaves. The 1/4#/A did not burn the weed back as effectively as the one-half pound rate, and some plants survived. The multiple applications of metribuzin at 1/16#/A were not as effective on ivyleaf morningglory. Grass control from post metribuzin treatments ranged from poor to fair depending on the rate and timing. The 0.25#/A early post and the 1/16#/A multiple applications of metribuzin resulted in poor grass control. The best control of grasses from a single post applications of metribuzin was the 1/2# early post treatment. The 1/2# late post treatment did not control the grasses as well. The extra week delay in applications resulted in more seedling grasses emerging prior to treatment.

Combinations of metribuzin post-emergence with the pre-plant treatments generally resulted in greatly improved weed control. This was especially true if the pre-plant herbicides were effective on the grasses. The outstanding treatments at harvest time were post metribuzin combinations with either trifluralin or U27,267 pre-plant. The

timing of the post-treatments did not greatly influence weed control if the pre-plant treatment was effective. The treatments of metribuzin (0.25#/A pre-plant followed by metribuzin post resulted in good broadleaf and grass weed control. Diphenamide 4#/A, pre-plant with the various metribuzin post treatment was the weakest combination treatment.

Injury to the tomato plants from the post applications of metribuzin was very minimal regardless of the rate or timing. Slight necrosis on the margins of the younger leaves was evident with all post treatments. These symptoms were outgrown in a week to ten days.

SUMMARY

Full season broad spectrum weed control was obtained from combinations of metribuzin post-emergence with pre-plant herbicide treatments which were effective on large crabgrass and fall panicum. Minimal injury was observed with up to 1/2#/A of metribuzin, regardless of the timing. One ounce multiple applications of metribuzin did not provide any advantage over the higher rates applied as a single application.

LITERATURE CITED

1. Beste, C.E. 1974. Weed Control in transplanted tomatoes. Proc. Northeast Weed Sci. Soc. 28:265-267.

2. Henne, R.C. and R.T. Guest. 1973. Weed Control in direct-seed and transplanted tomatoes. Proc. Northeast Weed Sci. Soc. 27:200-207.

3. Henne, R.C. and R.T. Guest. 1974. Tolerance of tomato plants to postplanting metribuzin. Proc. Northeast Weed Sci. Soc. 28:253-256.

Table 1. Performance of Herbicides in Transplanted Tomatoes on July 1, 1974.

Treatment[a]	Rate (lb.ai/A)	Method of appl.[b]	Crop vigor	Weed Control[c] BL	Weed Control[c] GR	Predominant weeds[d]
Trifluralin	1/2	PPI	1.5	5.0	7.0	RW,MG,FP,CG
+Metribuzin	1/4	E.Post	0	10.0	10.0	-----
+Metribuzin	1/2	E.Post	1.0	10.0	10.0	-----
+Metribuzin	1/2	L.Post	1.0	9.5	10.0	MG,RW
+Metribuzin	1/16	(5x)Post	1.0	8.0	9.5	RW,MG,CG
Diphenamide	4.0	PRE	0	4.0	4.0	RW,MG,FP,CG
+Metribuzin	1/4	E.Post	0	10.0	10.0	-----
+Metribuzin	1/2	E.Post	1.0	10.0	10.0	-----
+Metribuzin	1/2	L.Post	1.0	10.0	8.0	CG,FP
+Metribuzin	1/16	(5x)Post	1.0	8.0	6.5	CG,FP,MG
U27,267	1 1/2	PRE	0	8.0	10.0	MG
+Metribuzin	1/4	E.Post	1.0	9.0	10.0	MG
+Metribuzin	1/2	E.Post	1.0	10.0	10.0	-----
+Metribuzin	1/2	L.Post	1.0	9.0	9.0	MG,CG
+Metribuzin	1/16	(5x)Post	2.0	9.5	9.0	MG,CG
Metribuzin	1/4	PRE	0	9.0	5.0	CG,MG
+Metribuzin	1/4	E.Post	2.5	9.0	9.0	CG,MG
+Metribuzin	1/2	E.Post	2.0	10.0	10.0	-----
+Metribuzin	1/2	L.Post	2.0	9.0	9.0	CG,MG
+Metribuzin	1/16	(5x)Post	1.0	9.0	9.0	MG,CG
Metribuzin	1/4	E.Post	0	9.0	4.0	CG,MG,FP
Metribuzin	1/2	E.Post	1.0	9.0	6.5	CG,MG,FP
Metribuzin	1/2	L.Post	2.0	8.0	4.0	CG,MG,FP
Metribuzin	1/16	(5x)Post	1.5	8.5	5.5	CG,MG,FP
Check						LQ,CG,FP,MG,RW

[a] Plus (+) indicates a combination treatment with the pre-plant treatment preceding

[b] E.Post--Early Post Timing 15 days after planting
L.Post--Late Post Timing 22 days after planting
(5x)Post--Five applications every two weeks starting at E.Post

[c] Weed control rating based on 0-10, 0=no crop injury or no weed control, 10=dead crop or perfect weed control.

[d] Predominant weeds:
MG - Ivyleaf morningglory (*Ipomea hederacea* L.)
LQ - Lambsquarter (*Chenopodium album* L.)
RW - Common Ragweed (*Ambrosia artemisifolia* L.)
CG - Large Crabgrass (*Digitaria sanquinalis* (L.) Scop.)
FP - Fall Panicum (*Panicum dichotomiflorum* Michx.)

Table 2. Performance of Herbicides in Transplanted Tomatoes on September 8, 1974.

Treatment[a]	Rate (lb.ai/A)	Method of Appl.[b]	Weed Control[c] BL	Weed Control[c] GR	Predominant weeds[d]
Trifluralin	1/2	PPI	4.0	6.0	RW,MG,CG
+Metribuzin	1/4	E.Post	10.0	8.0	CG,FP
+Metribuzin	1/2	E.Post	9.0	9.0	MG,CG
+Metribuzin	1/2	L.Post	9.0	8.5	MG,CG,FP
+Metribuzin	1/16	(5x)Post	8.5	5.0	MG,FP,CG
Diphenamide	4.0	PRE	4.0	5.0	MG,RW,LQ,FP,CG
+Metribuzin	1/4	E.Post	9.0	7.0	MG,FP,CG
+Metribuzin	1/2	E.Post	8.0	8.0	MG,CG
+Metribuzin	1/2	L.Post	9.0	7.0	MG,CG,FP
+Metribuzin	1/16	(5x)Post	8.5	6.0	MG,CG,FP
U27,267	1 1/2	PRE	8.5	8.5	MG,LQ,CG
+Metribuzin	1/4	E.Post	10.0	8.0	CG,MG
+Metribuzin	1/2	E.Post	9.5	10.0	MG
+Metribuzin	1/2	L.Post	8.0	8.0	MG,CG
+Metribuzin	1/16	(5x)Post	8.0	8.0	MG,CG
Metribuzin	1/4	PRE	8.0	2.0	CG,FP,MG
+Metribuzin	1/4	E.Post	9.5	8.5	CG,MG
+Metribuzin	1/2	E.Post	8.0	8.0	CG,MG
+Metribuzin	1/2	L.Post	10.0	8.0	CG
+Metribuzin	1/16	(5x)Post	9.0	8.0	MG,CG
Metribuzin	1/4	E.Post	8.0	5.0	MG,RW,FP,CG
Metribuzin	1/2	E.Post	8.0	7.0	CG,MG,FP
Metribuzin	1/2	L.Post	9.0	7.0	CG,FP,MG
Metribuzin	1/16	(5x)Post	7.5	2.0	CG,FP,MG,RW,LQ
Check					FP,MG,RW,LQ

[a] Plus (+) indicates a combination treatment with the pre-plant treatment preceding

[b] E.Post--Early Post Timing 15 days after planting
L.Post--Late Post Timing 22 days after planting
(5x)Post--Five applications every two weeks starting at E.Post

[c] Weed control rating based on 0-10, 0=no crop injury or no weed control, 10=dead crop or perfect weed control.

[d] Predominant weeds:
MG - Ivyleaf morningglory (*Ipomea hederacea* L.)
LQ - Lambsquarter (*Chenopodium album* L.)
RW - Common Ragweed (*Ambrosia artemisifolia* L.)
CG - Large Crabgrass (*Digitaria sanquinalis* (L.) Scop.)
FP - Fall Panicum (*Panicum dichotomiflorum* Michx.)

Table 3. A Comparison of the Yield from Various Metribuzin Combinations in Transplanted Tomatoes in New Jersey, 1974.

Treatment[a]	Rate (lb.ai/A)	Method of Appl. [b]	Yield lbs. fruit[c] Red wt.	Grn.wt	Total
Trifluralin	1/2	PPI	124.7	4.0	128.7
+Metribuzin	1/4	E.Post	216.8	6.2	223.0
+Metribuzin	1/2	E.Post	166.5	12.9	179.4
+Metribuzin	1/2	L.Post	221.2	21.8	243.0
+Metribuzin	1/16	(5x)Post	162.5	9.4	171.9
Diphenamide	4.0	PRE	121.3	3.4	124.7
+Metribuzin	1/4	E.Post	196.8	7.1	203.9
+Metribuzin	1/2	E.Post	168.3	12.1	180.4
+Metribuzin	1/2	L.Post	186.1	11.6	197.7
+Metribuzin	1/16	(5x)Post	127.5	7.8	135.3
U27,267	1 1/2	PRE	192.9	9.0	201.9
+Metribuzin	1/4	E.Post	204.8	14.0	218.8
+Metribuzin	1/2	E.Post	218.0	19.1	237.1
+Metribuzin	1/2	L.Post	189.2	14.1	203.3
+Metribuzin	1/16	(5x)Post	177.8	29.1	206.9
Metribuzin	1/4	PRE	113.0	1.0	114.0
+Metribuzin	1/4	E.Post	231.4	11.6	243.0
+Metribuzin	1/2	E.Post	195.8	16.5	212.3
+Metribuzin	1/2	L.Post	207.3	14.8	222.1
+Metribuzin	1/16	(5x)Post	187.5	13.3	200.8
Metribuzin	1/4	E.Post	147.2	4.5	151.7
Metribuzin	1/2	E.Post	154.8	10.2	165.0
Metribuzin	1/2	L.Post	171.6	7.1	178.7
Metribuzin	1/16	(5x)Post	130.8	3.0	133.8
Check			46.9	3.0	49.9

[a] Plus (+) indicates a combination treatment with the pre-plant treatment preceding

[b] E.Post--Early Post Timing 15 days after planting
L.Post--Late Post Timing 22 days after planting
(5x)Post--Five applications every two weeks starting at E. Post

[c] Single row - 5 x 20 ft. plot.

TOMATO VARIETY RESPONSE TO METRIBUZIN

R. C. Henne [1/]

Abstract

The growth and yield response of four Campbell tomato (*Lycopersicon esculentum*) varieties to metribuzin (4-amino-6-*tert*-butyl-3-(methylthio)-*as*-triazine-5(4*H*)one) applied preplanting or postplanting were determined. No differential varietal response was observed from metribuzin applied at 0.56 kg/ha, either preplanting or postplanting. At two or three times this rate, differences in varietal tolerance were detected in terms of transplant survival, degree of phytotoxicity, and yield at the second harvest.

Introduction

Metribuzin has been recognized as an effective herbicide with potential for use on tomatoes. Differences in varietal tolerance to metribuzin have been reported in potatoes (*Solanum tuberosum* L.) (3) and Ashley (1) found three tomato varieties of eleven studied to be sensitive to metribuzin injury. Fortino and Splittstoesser (2) have recently indicated 'C 1327' to be more susceptible to metribuzin injury than 'H 1429'. The purpose of this study was to investigate the varietal tolerance of four Campbell varieties to both preplanting and postplanting metribuzin applications.

Materials and Methods

Transplants of four Campbell varieties designated C-17, C-28, C-35, and C-37 were started in BR-8 blocks on March 26 in a greenhouse at Clayton, Delaware. Preplant treatments of metribuzin were made to a Sassafras sandy loam soil (1% organic matter) on May 6. Treatments were immediately incorporated with a power-driven rotary cultivator to a depth of 7.5 cm. Soil moisture was in good supply from 2.25 cm of rain recorded 96 hr earlier. Transplants were set (with the BR-8 fiber blocks attached) on May 15. Postplanting applications were made on June 5 (21 days after planting) to well-established transplants. All applications were made with a bicycle sprayer using compressed air as a propellant at 2.11 kg/cm^2 in a volume of 308 L/ha.

The experimental design was a four-replicate split plot with treatments as main plots and varieties as subplots. Subplots were 1.5 m by 6.1 m in size with 18 transplants per row. To eliminate weed competition as a variable, weeds were removed by hand in the untreated control plots as well as any escapes in the treated plots. Transplant survival was determined June 14 and on that date plots were evaluated for phytotoxicity on a 1 to 9 scale in which 9 = no visible injury and 1 = all plants killed. Fruit set was measured on

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

July 9 by averaging the counts from three consecutive plants per plot. Only fruit larger than 2.5 cm diameter were counted. Yields were taken on three harvest dates; August 6, August 21, and September 5.

Results and Discussion

Growth response measurements are summarized in Table 1. At 0.56 kg/ha no transplant fatalities were recorded but at 2x and 3x rates, some plants were killed. Variety C-17 sustained the greatest number of transplant fatalities to preplanting and postplanting treatments. Preplanting treatments as a whole resulted in more fatalities than the same rates applied postplanting. Phytotoxicity ratings taken on June 14 were at a time of maximum expression of foliage burning resulting from postplanting treatments and when veinal chlorosis and plant stunting were still very evident in preplanting treatments. Phytotoxicity was least severe with the C-35 variety, particularly with postplanting treatments, and greatest with the C-17 variety. Most of the phytotoxicity symptoms were not evident by July. Fruit set was delayed in all varieties by the 1.12 and 1.68 kg/ha rates. Varietal differences in fruit set reflect differences in maturity since C-28 and C-37 are earlier maturing than C-25, and C-17 is relatively late compared to the other three.

Yield responses to metribuzin treatments are summarized in Table 2. The 0.56 kg/ha rate did not significantly influence early or total yield of any variety. At higher rates yields were significantly reduced on the first and second picking.

On the second picking a highly significant (at 1% level) treatment by variety interaction was measured indicating a differential yield response occurred. Analysis of this interaction revealed that at the higher rates of application, either preplanting or postplanting, C-37 and C-35 yields were not decreased to the same degree as the other two varieties. For example, at 1.12 kg/ha preplanting, C-17 and C-28 yields were decreased 50% of their respective controls while C-35 and C-37 yielded 85 and 81% of their controls, respectively. At 1.68 kg/ha postplanting, C-17 and C-28 yielded 40 and 53% of their controls while C-35 and C-37 yielded 64 and 84% of their respective controls. Therefore at the second harvest there was a strong indication of differences in variety tolerance to metribuzin treatment as measured by yield of ripe fruit. At the third picking the greatest yields were obtained from those plots receiving the higher rates of metribuzin, which reflects a delay in fruit set and crop maturity. Considering total yield, only the 1.68 kg/ha rate applied preplanting significantly reduced yield compared to the controls, although a downward trend also was evident at this rate when applied postplanting.

While varietal differences in tolerance to metribuzin were not detected at a moderate rate of application, higher rates revealed a differential response. Considering the factors studied in this experiment, variety C-35 appeared most tolerant, C-37 = C-28 just slightly more sensitive than C-35, and C-17 decidedly susceptible. The response of C-17 may be due to one of its parents being C-1327 - a Campbell variety identified by Fortino and Splittstoesser (2) as being sensitive to metribuzin injury.

Literature Cited

1. Ashley, Richard A. 1974. Varietal susceptibility of transplanted tomatoes to metribuzin. Proc. N.E. Weed Sci. Soc. 28:249-252.

2. Fortino, J. Jr., and W. E. Splittstoesser. 1974. Response of tomato to metribuzin. Weed Science 22(5):460-463.

3. Vanden Born, W. H., Wm. T. Andrew, R. J. Schraa, and W. V. Beck. 1973. Tolerance of seven potato stocks to metribuzin. Canadian Horticulture Council 1973 Report. Abstract. p. 206.

Table 1. Growth response of four Campbell varieties to metribuzin applied preplanting and postplanting at Clayton, Delaware, 1974.

Treatment	Rate (kg/ha)	C-17	C-28	C-35	C-37	Treatment Mean
		% of Transplant Survival				
Preplanting	0.0	100	100	100	100	100[a]
	0.56	100	100	100	100	100[a]
	1.12	76	97	100	98	93[a]
	1.68	54	81	86	79	75[b]
Postplanting	0.56	100	100	100	100	100[a]
	1.12	100	100	100	100	100[a]
	1.68	82	100	100	89	93[a]
Variety means		87.5[b]	96.9[a]	98.0[a]	95.3[a]	
TxV interaction N.S.D. at 5% level.						
		Phytotoxicity Rating 1-9 6/14/74				
Preplanting	0.0	9.0	9.0	9.0	9.0	9.0[a]
	0.56	7.7	8.7	8.9	8.7	8.5[ab]
	1.12	4.5	5.5	6.7	6.0	5.7[d]
	1.68	3.4	4.1	5.0	4.1	4.2[e]
Postplanting	0.56	8.0	8.0	8.1	8.0	8.0[bc]
	1.12	7.2	7.0	7.7	7.0	7.3[c]
	1.68	4.5	6.0	7.0	5.5	5.8[d]
Variety means		6.3[c]	6.9[b]	7.5[a]	6.9[b]	
TxV interaction significant at 5% level.						
		No. Fruit Set/Plant 7/9/74				
Preplanting	0.0	6.6	18.8	10.0	15.5	12.7[a]
	0.56	4.5	14.7	10.8	16.1	11.5[ab]
	1.12	4.3	8.9	8.2	12.8	8.5[bc]
	1.68	1.6	6.0	4.6	7.7	4.9[d]
Postplanting	0.56	4.7	15.4	12.3	15.5	12.0[ab]
	1.12	5.3	13.1	8.4	9.4	9.1[abc]
	1.68	1.1	7.4	7.8	10.1	6.6[cd]
Variety means		4.0[c]	12.0[a]	8.9[b]	12.4[a]	
TxV interaction N.S.D. at 5% level.						

Table 2. Yield response of four Campbell tomato varieties to metribuzin applied preplanting and postplanting at Clayton, Delaware, 1974.

Yield Metric Tons/ha

Treatment	Rate (Kg/ha)	C-17	C-28	C-35	C-37	Treatment Mean
		1st Harvest 8/6				
Preplanting	0.0	6.3	9.6	13.0	14.1	10.7[a]
	0.56	6.3	10.3	13.0	15.5	11.3[a]
	1.12	4.0	7.2	8.7	9.6	7.4[c]
	1.68	1.6	3.8	4.7	4.7	3.7[d]
Postplanting	0.56	6.0	10.3	11.9	11.9	10.0[ab]
	1.12	5.4	8.3	11.9	7.6	8.3[bc]
	1.68	1.1	3.6	9.6	4.5	4.7[d]
Variety mean		(4.4[c])	(7.6[b])	(10.4[a])	(9.7[ab])	

Treatment x Variety interaction N.S.D. at 5% level.

		2nd Harvest 8/21 (non-cumulative)				
Preplanting	0.0	22.8	34.5	26.2	26.0	27.4[a]
	0.56	21.1	33.8	26.9	24.2	26.5[a]
	1.12	12.3	17.2	22.4	21.1	18.3[bc]
	1.68	4.9	8.7	10.3	14.6	9.6[d]
Postplanting	0.56	20.4	34.9	25.1	26.4	26.7[a]
	1.12	17.5	26.0	23.7	24.0	22.8[ab]
	1.68	9.2	18.4	16.8	21.7	16.5[c]
Variety mean		(15.5[c])	(24.8[a])	(21.6[b])	(22.6[ab])	

Treatment x Variety interaction is significant at the 1% level.

		Total Yield (at 9/5) (3rd harvest combined with 1 & 2)				
Preplanting	0.0	49.6	53.3	61.2	63.2	56.8[ab]
	0.56	47.3	57.1	61.6	65.2	57.8[a]
	1.12	38.8	49.3	62.5	61.2	52.9[ab]
	1.68	23.7	33.8	41.9	54.4	38.5[c]
Postplanting	0.56	46.6	55.6	57.6	61.8	55.4[ab]
	1.12	47.7	54.7	62.7	57.3	55.6[ab]
	1.68	34.5	43.7	58.5	54.7	47.9[b]
Variety mean		(41.2[c])	(49.6[b])	(58.0[a])	(59.7[a])	

Treatment x Variety interaction N.S.D. at 5% level.

AN EVALUATION OF METRIBUZIN FOR TRANSPLANTED TOMATOES[1/]

C. E. Beste[2/]

Abstract. Preplant incorporated (PPI) metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)one) was less phytotoxic than preemergence (i.e. post-transplant) treatments on transplanted tomatoes (Lycopersicum esculentum Mill., 'Heinz 1350'). 'Dorchester' tomatoes were more susceptible to metribuzin injury from PPI treatments than 'Heinz 1350' since 0.5 lb/A PPI metribuzin produced an 85 and 97% of control vigor rating with 'Dorchester' and 'Heinz 1350' tomatoes, respectively. PPI combinations of trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) at 0.33 or 0.50 lb/A with metribuzin at 0.25 or 0.50 lb/A were acceptable for these transplanted tomato varieties. Metribuzin at 0.25 lb/A applied 13 days after transplanting was acceptable for 'Heinz 1350' and 'Dorchester'; however, a 0.5 lb/A rate significantly reduced vigor and yields. Metribuzin at 0.25, 0.50, and 0.75 lb/A applied 29 days after transplanting did not cause injury. 'Dorchester' yields were significantly reduced by three multiple applications of metribuzin (0.25 lb/A) at 13, 29, and 56 days after transplanting; however, yields of 'Heinz 1350' were not significantly affected.

INTRODUCTION

The cost and lack of hand labor to hoe weeds in tomato fields, and the requirement of full season weed control for mechanical harvesters has made the grower more dependent on herbicides for weed control. Trifluralin and diphenamid (N,N-dimethyl-2,2-diphenylacetamide), which are recommended for transplanted tomatoes, do not control many problem broadleaved weeds (2,3,6,7) and metribuzin will control most of these problem weeds (3,6,7). The PPI combination of trifluralin (0.5 or 0.75 lb/A) plus metribuzin (0.5 lb/A) did not reduce yields of 'Campbell 28' transplant tomatoes (3,6,8). PPI metribuzin at 1.0 lb/A did not affect yields of 'Campbell 28' tomatoes when applied as a broadcast treatment at 10, 12, 28 or 29 days after transplanting (3,5); however, metribuzin at 0.75 lb/A caused significant injury and yield loss when applied 10 days after transplanting but this treatment was tolerated 29 days after transplanting (3). 'Campbell 28' tomatoes were not injured by a post-transplant treatment of 1.0 lb/A metribuzin 28 days after transplanting (5). Ashley (1) applied 1.0 lb/A metribuzin 15 days after transplanting on eleven varieties and observed significant injury on three varieties, reduced early yields on two varieties, but no significant effect on total yield.

The purpose of this study was to evaluate several different metribuzin treatments and combinations of metribuzin with other herbicides on two varieties of transplanted tomatoes.

1/ Scientific Article No.A 2049, Contribution No.5002, of the Maryland Agricultural Experiment Station, Department of Horticulture.
2/ Assistant Professor, Department of Horticulture, University of Maryland.

MATERIALS AND METHODS

Single row herbicide plots of 64 inch width and 16 ft length were established in a Norfolk loamy sand (0.6% organic matter) with two tomato varieties. The herbicide treatments with 'Heinz 1350' (early green-wrap, globe variety) were replicated three times and treatments with 'Dorchester' (pear-type, canning variety) were replicated four times. A randomized complete block design was utilized. PPI herbicides were incorporated 3 inches deep with a tractor-mounted rototiller on May 6, 1974. Southern-grown certified tomato plants were transplanted on May 7 with an in-row spacing of 14 to 16 inches and 64 inches between rows. Preemergence (Pre) (i.e. post-transplant) herbicide treatments were applied after transplanting on May 9. Broadcast post-transplant (Post) treatments were applied on May 20 (Post I), June 5 (Post II), and July 2 (Post III) over the tops of the tomatoes. A crop vigor rating was made on June 8 and a weed control rating on large crabgrass (Digitaria sanguinalis (L.) Scop.) and common lambsquarters (Chenopodium album L.) was made on August 1. A single harvest of 'Dorchester' tomatoes were made on July 30 and graded into ripe, green, and cull fruit. Four multiple harvests of ripe fruit of 'Heinz 1350' tomatoes were made on July 16, July 26, August 5, and August 15.

RESULTS AND DISCUSSION

Pre and PPI metribuzin at 0.5 lb/A was tolerated by 'Heinz 1350'; however, 1.0 lb/A Pre was more phytotoxic and significantly reduced early yields compared to the PPI treatment which caused some vigor reduction with no yield effect (Table 1). 'Dorchester' was more susceptible to metribuzin injury from PPI treatments than 'Heinz 1350' since 0.5 lb/A metribuzin PPI caused an 85 and 97% of control vigor rating with 'Dorchester' and 'Heinz 1350', respectively (Table 1 and 2). Yields of 'Dorchester' ripe fruit were not significantly affected by metribuzin 0.5 lb/A PPI, however, the trend was slightly downward. Metribuzin at 0.25 lb/A PPI did not affect vigor and yield of 'Dorchester'. Combinations of trifluralin at 0.33 or 0.50 lb/A with metribuzin at 0.25, 0.50, or 1.00 lb/A PPI did not cause vigor reduction greater than with either herbicide alone. This combination appears to be antagonistic with regard to tomato vigor of both 'Heinz 1350' and 'Dorchester'.

Combinations of metribuzin (0.5 lb/A) with nitralin (4-2(2-methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline), diphenamid, and napropamide (2-(-naphthoxy)-N,N-diethylpropionamide) provided better weed control than either herbicide alone. The preemergence combination treatments of metribuzin with nitralin or diphenamid would be useful for the application of herbicides at the same time as transplanting.

Metribuzin, as a Pre treatment followed by Post treatments, was weak on grasses, however, yields appeared normal with 'Heinz 1350'. Post-transplant treatments of metribuzin at 0.25 lb/A applied 13 days after transplanting did not injure or reduce yields of 'Heinz 1350', and this treatment did not injure or significantly affect ripe fruit yields of 'Dorchester'; however, ripe fruit yields appeared to be slightly reduced. Metribuzin (0.5 lb/A) applied 13 days after transplanting significantly reduced tomato vigor and early yields of 'Heinz 1350' and ripe fruit yields of 'Dorchester'. The vigor and yield of

'Heinz 1350' was also significantly reduced by metribuzin (0.75 lb/A) applied at 13 days after transplanting. Metribuzin at 0.25, 0.50, and 0.75 lb/A post-transplant at 29 days after transplanting was tolerated by 'Heinz 1350'. Multiple applications of metribuzin (0.25 lb/A) at 13, and 29, or 13, 29, and 56 days after transplanting did not injure 'Heinz 1350' and yields were not significantly reduced.

'Dorchester' yields were significantly reduced by three multiple applications of metribuzin (0.25 lb/A) at 13, 29, and 56 days after transplanting; however, two successive applications of metribuzin (0.25 lb/A) at 13 and 29 days after transplanting did not significantly reduce yields although the trend was lower. The 0.25 lb/A metribuzin rate applied 13 days post-transplanting appeared to be the maximum rate for the single treatment, and the multiple treatments seemed to prevent adequate recovery between treatments which reduced yields. The cull yields of 'Dorchester' were low and were not affected by any herbicide treatment.

Additional observations after treatments on June 5 did not indicate any phytotoxicity except with the second application of metribuzin at 0.5 lb/A on 'Dorchester' in treatment No. 11 (Table 2). Also no injury occurred from the July 2 Post III metribuzin treatments and these treatments did not cause blossom drop.

Relatively low solar radiation on the day preceding the post-transplant treatments on May 20 (Table 3) could be involved in the phytotoxicity of this metribuzin treatment. Fortino and Splittstoesser (4) have shown that low light before metribuzin treatments on tomatoes followed by high light levels was more injurious than continuous low light.

Although these studies in 1974 have shown slightly more phytotoxicity than in previous studies (3,5) only limited comparisons between studies can be made since 'Campbell 28' tomatoes were evaluated and a single harvest was made to determine total yields in previous studies (3,5); whereas, 'Dorchester' and 'Heinz 1350' tomatoes were utilized in this study and early harvest yields were determined in addition to total yields. The 'Dorchester' transplants were smaller than 'Heinz 1350' plants which may have enhanced metribuzin injury on 'Dorchester' in this study. Therefore, the apparent lower tolerance of 'Dorchester' to metribuzin, compared to 'Heinz 1350', may be due to plant size or varietal differences; and sufficient delay after transplanting before metribuzin post-transplant treatments should minimize the risk of injury due to these factors.

In summary, acceptable tolerance to metribuzin was observed for 'Dorchester' and 'Heinz 1350' transplanted tomatoes; however, several factors appear to be involved which could reduce the margin of safety.

LITERATURE CITED

1. Ashley, R. A. 1974. Varietal susceptibility of transplanted tomatoes to metribuzin. Proc. Northeast. Weed Sci. Soc. 28:249-252.
2. Beste, C. E. 1973. 1973 Evaluation of herbicides for vegetable crops. University of Maryland, Department of Horticulture Mimeo No. 38-73.
3. Beste, C. E. 1974. Weed control in transplanted tomatoes. Proc. Northeast. Weed Sci. Soc. 28:265-267.

Table 1. An Evaluation of Metribuzin with Several Herbicide Combinations for Transplanted Heinz 1350 Tomatoes in a Norfolk Loamy Sand.

Treatment			Crop Vigor[b]	% Control[c]		Yield (Ton/A)[d]	
Herbicide	LB/A	Method[a]	6-8-74	Crab-grass	Lambs-quarter	First Harvest	Total Harvest
1.none - weedy check		----	100	0	0	0.6abcd	1.7f
2.none - handweeded check		----	100	100	100	0.6abcd	7.8bcde
3.metribuzin (50WP)	0.5	Pre	95	52	100	0.7abcd	8.9abcde
4.metribuzin	1.00	Pre	63	58	100	0.2d	5.3e
5.metribuzin	1.50	Pre	57	73	100	0.2d	5.4de
6.metribuzin	0.25	PPI	97	50	96	0.5abcd	7.2bcde
7.metribuzin	0.50	PPI	97	50	98	0.5abcd	8.7abcde
8.metribuzin	1.00	PPI	83	70	100	0.6abcd	8.0abcde
9.trifluralin (4EC)	0.33	PPI	93	93	90	0.7abcd	8.5abcde
10.trifluralin	0.50	PPI	87	92	100	0.4bcd	9.4abcde
11.nitralin (75WP)	0.50	Pre	100	73	25	0.5abcd	5.1e
12.diphenamid (50WP)	3.00	PPI	98	67	35	0.7abcd	10.8ab
13.napropamide (2EC)	0.50	PPI	100	88	87	1.0ab	9.5abcd
14.trifluralin + metribuzin	0.33 + 0.25	PPI	88	82	97	0.7abcd	7.6bcde
15.trifluralin + metribuzin	0.33 + 0.50	PPI	88	93	99	0.8abcd	7.8bcde
16.trifluralin + metribuzin	0.50 + 0.25	PPI	98	92	100	0.7abcd	8.0abcde
17.trifluralin + metribuzin	0.50 + 0.50	PPI	97	100	100	0.8abcd	8.6abcde
18.trifluralin + metribuzin	0.50 + 1.00	PPI	88	95	98	0.5abcd	9.7abc
19.nitralin + metribuzin	0.50 + 0.50	Pre	100	85	90	0.7abcd	10.2abc
20.diphenamid + metribuzin	3.00 + 0.50	Pre	98	88	100	1.0ab	10.6ab
21.napropamide + metribuzin	0.50 + 0.50	PPI	97	95	100	0.9abcd	12.2a
22.metribuzin + metribuzin + metribuzin	0.50 + 0.25 + 0.25	Pre + Post I + Post III	93	73	100	0.6abcd	9.2abcde
23.trifluralin + metribuzin	0.50 + 0.25	PPI + Post I	87	87	100	0.6abcd	9.0abcde
24.trifluralin + metribuzin	0.50 + 0.25	PPI + Post II	100	97	100	0.7abcd	9.8abc
25.trifluralin + metribuzin	0.50 + 0.50	PPI + Post I	73	93	100	0.2d	7.3bcde
26.trifluralin + metribuzin	0.50 + 0.50	PPI + Post II	88	100	100	0.9abcd	8.9abcde
27.trifluralin + metribuzin	0.50 + 0.75	PPI + Post I	67	88	100	0.2d	6.2cde
28.trifluralin + metribuzin	0.50 + 0.75	PPI + Post II	93	100	100	1.2a	10.0abc
29.trifluralin + metribuzin + metribuzin	0.50 + 0.25 + 0.25	PPI + Post I + Post II	87	98	100	0.5abcd	7.6bcde

Continued

Table 1 Continued

Treatment			Crop Vigor[b/]	% Control[c/]		Yield (Ton/A)[d/]	
Herbicide	LB/A	Method[a/]	6-8-74	Crab-grass	Lambs-quarter	First Harvest	Total Harvest
30. trifluralin +	0.50	PPI					
metribuzin +	0.25 +	Post I +					
metribuzin +	0.25 +	Post II+					
metribuzin	0.25	Post III	88	100	100	0.4bcd	8.7abcde
31. trifluralin +	0.50 +	PPI +					
metribuzin	0.25	Post III	90	100	100	0.5abcd	9.3abcde
32. trifluralin +	0.50 +	PPI +					
metribuzin +	0.25 +	Post I +					
metribuzin	0.25	Post III	92	97	100	0.8abcd	8.4abcde
33. trifluralin +	0.50 +	PPI +					
metribuzin +	0.25 +	Post I+					
metribuzin	0.50	Post III	85	100	100	0.6abcd	6.9bcde
34. trifluralin +	0.5 +	PPI +					
metribuzin	0.5	Post III	82	97	100	0.7abcd	8.4abcde

a/ PPI - preplant incorporated (5-6-74), Pre - preemergence to weeds and post - transplant (5-9-74), Post I - 13 days after transplanting (5-20-74), Post II - 29 days after transplanting (6-5-74), Post III - 56 days after transplanting (7-2-74).

b/ % of Control.

c/ Rated 8-1-74. Weed population: large crabgrass-70%, common lambsquarters-30%.

d/ First harvest 7-16-74, Second harvest 7-26-74, Third harvest 8-5-74, Fourth and final harvest 8-15-74.

Means within columns followed by the same letter are not significantly different at the 5% level with Duncans Multiple Range Test.

Table 2. An Evaluation of Metribuzin in Combination with Trifluralin for Transplanted Dorchester Tomatoes in a Norfolk Loamy Sand.

Treatment			Crop Vigor[b] 6-8-74	% Control[c]		Yield(Ton/A)[d]		%
Herbicide	LB/A	Method[a]		Crab-grass	Lambs-quarter	Ripe Fruit	Green Fruit	Ripe Fruit
1.none-weedy check		----	100	0	0	1.2d	0.1c	81a
2.none-handweeded check		----	100	100	100	7.3a	4.0ab	64b
3.metribuzin	0.25	PPI	98	71	92	7.7a	3.9ab	65b
4.metribuzin	0.50	PPI	85	68	100	6.3ab	3.1b	65b
5.trifluralin	0.50	PPI	89	100	99	8.1a	4.4ab	64b
6.trifluralin + metribuzin	0.50 + 0.25	PPI	96	99	100	7.1ab	3.8ab	64b
7.trifluralin + metribuzin	0.50 + 0.50	PPI	86	100	100	6.9ab	3.1b	68ab
8.trifluralin + metribuzin	0.50 + 0.25	PPI + Post I	82	100	100	6.3ab	4.8ab	55b
9.trifluralin + metribuzin	0.50 + 0.50	PPI + Post I	70	100	100	3.1cd	4.9a	35c
10.trifluralin + metribuzin + metribuzin	0.50 + 0.25 + 0.25	PPI + Post I + Post II	82	100	100	6.3ab	4.5ab	59b
11.trifluralin + metribuzin + metribuzin	0.50 + 0.50 + 0.50	PPI + Post I + Post II	56	100	100	2.1d	3.8ab	34c
12.trifluralin + metribuzin + metribuzin	0.50 + 0.25 + 0.25	PPI + Post I + Post III	88	100	100	7.4a	3.9ab	66b
13.trifluralin + metribuzin + metribuzin + metribuzin	0.50 + 0.25 + 0.25 + 0.25	PPI + Post I + Post II + Post III	80	100	100	5.1bc	3.7ab	58b

a/ PPI - preplant incorporated (5-6-74), Pre - preemergence to weeds and post - transplant (5-9-74, Post I - 13 days after transplanting (5-20-74), Post II - 29 days after transplanting (6-5-74), Post III - 56 days after transplanting (7-2-74).

b/ % of control.

c/ Rated 8-1-74. Weed population: large crabgrass-50%, common lambsquarters-50%.

d/ Harvested 7-30-74.

Means within columns followed by the same letter are not significantly different at the 5% level with Duncans Multiple Range Test.

4. Fortino. J., Jr. and W. E. Splittstoesser. 1974. Response of tomato to metribuzin. Weed Sci. 22:460-463.
5. Henne, R. C. and R. T. Guest. 1974. Tolerance of tomato plants to post-planting metribuzin. Proc. Northeast. Weed Sci. Soc. 28:253-256.
6. Henne, R. C. and R. T. Guest. 1974. Weed control in direct-seeded and transplanted tomatoes. Proc. Northeast. Weed Sci. Soc. 28:257-263.
7. Henne, R. C. and R. T. Guest. 1974. Control of Galinsoga parviflora. Proc. Northeast. Weed Sci. Soc. 28:330.
8. Herman, D. J., Wm. J. McAvoy, and R. D. Ilnicki. 1974. Evaluation of some preplant incorporated herbicide treatments in transplanted tomatoes. Proc. Northeast. Weed Sci. Soc. 28:264.

Table 3. Climatological Conditions Five Days Before and After Post-transplant Metribuzin Treatments in 1974.

Dates	Temperature °F Max.	Temperature °F Min.	Daily Solar Radiation[a] Langleys	Rainfall Inches
5-15	79	49	626	----
5-16	86	49	483	----
5-17	87	50	590	----
5-18	88	64	431	----
5-19	72	58	225	----
5-20	74	49	655	----
5-21	75	49	626	----
5-22	82	46	589	----
5-23	82	46	188	0.27
5-24	80	60	400	----
5-25	81	60	482	----
5-31	73	55	283	----
6-1	82	67	359	0.01
6-2	78	62	79	1.43
6-3	67	57	485	----
6-4	77	48	575	----
6-5	77	48	629	----
6-6	78	48	654	----
6-7	76	50	126	0.05
6-8	76	50	260	0.07
6-9	82	64	523	----
6-10	90	62	624	----
6-27	80	58	215	----
6-28	66	60	118	----
6-29	84	60	466	0.35
6-30	86	62	610	----
7-1	84	56	395	0.05
7-2	90	61	612	----
7-3	90	71	592	----
7-4	91	71	604	----
7-5	91	73	484	----
7-6	84	72	279	0.12

a/ Hourly total for each day. Langley = gm-cal/cm^2/min.

GLYPHOSATE FOR WEED CONTROL IN VINEYARDS

G. W. Selleck, T. Zabadal and S. M. McCargo[1/]

Abstract

Postemergence-directed treatments were applied to field bindweed (Convolvulus arvensis), hedge bindweed (C. sepium), and other species in New York grapes at 22 locations during 1973 and 1974. The Concord variety of grapes was usually represented in the experiments, but varieties Aurora, Baco, Catawba, Delaware, Dutchess, Niagara and Seipel 5279 were also represented. Plot size was either 1 x 27 m or 2 x 27 m in vineyards which had been treated annually with diuron for several years. Efficacy comparisons were made at 2 months, 3 months and 15 months comparing early vs late treatments (May 15 vs June 15 in 1973; June 7 vs June 24 in 1974), dosage response, and repeated applications. Early treatments represented bindweed in development stages of 20 cm or less, late treatments 25 cm or more, usually with bindweeds in budding or flowering stages, and grapes in early-bloom. Rates of application ranged from 0.5 to 6 lb/A (0.57 to 6.8 kg/ha in 20 to 50 gal water/A.

Bindweeds

The later stage of treatment when the hedge bindweed was budding or flowering was considered more effective. At this stage of treatment, control was 50% or less with rates of 0.7 lb/A or less, 75% at 1 lb/A and 80% at 2 lb/A or more when evaluated two to three months after application. Field bindweed control was increased an average of ten percentage points at each rate. Complete control of either species was rarely achieved. Although rates of 3 and 4 lb/A usually improved control, economic control was 2 lb/A. The control ratings were reduced 10 to 15 percent by bindweed vegetative growth over the 12 months period after treatment. With 2 lb/A applied early to hedge bindweed 20 cm or less in size, prolific regrowth resulted in unacceptable control. Higher rates were not tested at the early treatment stage.

Repeated applications of glyphosate show promise for eradication of extablished bindweeds. Complete control was obtained Oct/74 from 2 lb/A applied in June of 1973 and 1974, but regrowth must be reassessed in 1975.

[1/] Respectfully, Market Development Dept. Monsanto Co., Cooperative Extension Specialist, Cornell University; and Crop Specialist, Agway, Inc.

Other Species

Weeds such as trumpet creeper (*Campsis Radicans*), milkweed (*Asclepias* spp.) and Jerusalem artichoke (*Helianthus tuberosus*) exhibit tolerance levels (to glyphosate) similar to the bindweeds. Brambles (*Rhus* spp.), dogbane hemp (*Apocynum cannabinum*), and Virginia creeper (*Parthenocissus guinguefolia*) appear to be somewhat more tolerant, and respond more favorably to increased rates of glyphosate, i.e. 3 to 4 lb/A. Certain species, notably brambles and dogbane hemp sometimes exhibit a delayed action to glyphosate with little effect visible three months after treatment. The following spring and summer, regrowth was often inhibited to 15% of the original stand.

Coltsfoot (*Tussilago farfara*) and waterhemlock (*Cicula maculata*) were controlled 95% or better at rates of 1 lb/A.

There was no evidence of drift injury on grapes. Suckers which were sprayed were usually defoliated within 2 weeks after treatment without evidence of leaf aberrations or abnormal vine growth.

GALINSOGA CONTROL IN CABBAGE AND BROCCOLI[1]

E. K. Stilwell and R. D. Sweet[2]

Abstract

Two field experiments were conducted to evaluate several herbicides singly and in combinations for control of hairy galinsoga [Galinsoga ciliata (Raf.) Blake] and smallflower galinsoga (Galinsoga parviflora Cav.) in cabbage (Brassica oleracea) cv. Danish Ballhead and broccoli (Brassica oleracea) cv. Waltham 29. Visual ratings on redroot pigweed (Amaranthus retroflexus L.) and Japanese millet [Echinochloa crusgalli var. frumentacea (Roxb)] infestations were also obtained. Preemergence applications of alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide] at 1 lb/A gave excellent control of Galinsoga spp., good control of redroot pigweed and Japanese millet with minimal crop injury. Postemergence treatments of nitrogen (NH_4NO_3) at 50 lbs/A gave good to excellent Galinsoga spp. control and negligible crop injury but poor control of redroot pigweed and Japanese millet. Other herbicides gave either poor weed control, crop injury or both.

Introduction

Two species of Galinsoga, hairy and smallflower, are both native to South America and are found in northeastern United States. During the last eight years in New York State they have become a serious weed problem in several vegetable crops including an estimated 18,000 acres of cabbage and broccoli.

Galinsoga spp. appears to be a problem in cole crops since the latter does not shade the ground between rows as the season progresses. In addition, these species according to Ivany (1) are tolerant to many of the herbicides used in these crops. Galinsoga spp. are excellent competitors and many suppress the growth of other weed species. Both species can become the prominent weeds in a particular field because of their ability to germinate continuously and to grow rapidly throughout the growing season. In addition, they produce abundant amounts of seeds with little dormancy.

The purpose of these studies was to evaluate the performance of several herbicides applied singly and in combination to various growth stages of Galinsoga spp., cabbage and broccoli in two different soil types.

Experimental

Materials and Methods

Two experiments were conducted in 1974. Experiment 1 was conducted in an Arkport fine sandy loam and experiment 2 in an Eel silt loam. The location, planting dates and timings of herbicide application are presented in Table 1.

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[1] Paper No. 683, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

[2] Graduate Assistant and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

Table 1. Location and dates of planting and herbicide applications.

Expt.	Location	Planted	Herbicide Applications				
			PPI	Pre	E.Post	Post	L.Post
1	East Ithaca, N.Y.	5/21	5/21	5/21	6/10	6/17	6/31
2	Freeville, N.Y.	7/2	6/25	7/2	--	7/21	8/5

Land preparation for both experiments consisted of plowing and disc harrowing in early May. Immediately prior to applying preplant incorporated treatments, the soil was reworked with a spring tooth harrow in experiment 1, and with a spring tooth harrow and meeker harrow in experiment 2. Herbicides were incorporated with the same equipment set to penetrate a depth of 2-3 inches. A CO_2 powered small plot sprayer which delivered 60 g.p.a. at 35 p.s.i. was utilized for all applications. The chemical names of the herbicides used in both experiments are given in Table 2. Rates of application in Table 4 and 5 are active ingredients. Cabbage, broccoli and Japanese millet were than direct seeded and preemergence herbicides applied. The stages of growth at which postemergence treatments were applied are described in Table 3.

Table 2. Chemical names of herbicides used in experiment 1 and 2.

Herbicide	Chemical Name
alachlor	[2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide]
butralin	4-(1,1-dimethylethyl)-N-(1-methylpropyl)-2,6-dinitrobenzenamine
DCPA	dimethyl 2,3,5,6-tetrachloroterephthalate
dinitramine	N^4,N^4-diethyl-a,a,a-trifluoro-3,5-dinitro toluene-2,4-diamine
nitraline	[4-2(2-methyl sulfonyl)-2,6 dinitro-N,N]
nitrofen	2,4 dichlorophenyl 4-nitrophenyl ether
nitrogen	ammonium nitrate
oil	a blend of 83% oil plus 17% surfactant
propachlor	2-chloro-N-isopropylacetanilide
profluralin	N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine
salt	sodium chloride
trifluralin	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine

The plot size was 90 ft^2 and a randomized complete block design with two replications was used in both experiments.

Rainfall was moderate throughout the early growing period for both experiments. Each experiment received 1.5 acre inches of water by overhead irrigation during the dry periods later in the growing season.

Table 3. The number of leaves observed at the time of postemergence treatments.

		Leaf Number				
Timing	Expt.	Broccoli	Cabbage	Galinsoga	Pigweed	Jap. Millet
Early post	1	2	2	2-4	4	3
	2	-	-	-	-	-
Post	1	3-4	3-4	9-10	5-8	4
	2	2	2	2-6	4-8	4
Late Post	1	8-12	8-10	9-16	6-12	5-10
	2	6-10	6-10	6-10	6-12	8-14

Visual ratings of experiment 1 were taken on July 3 when the crops were in the 8-10 leaf stage and Galinsoga spp. in the 10-16 leaf stage. In experiment 2, both the crops and Galinsoga spp. were in the 6-10 leaf stage when evaluated on August 2. A scale of 1 to 9 was used to rate the effects of herbicides on crops and weeds: 1=no effect on weeds or complete crop kill; 7=commercially acceptable weed control or minimal crop injury; 9=complete weed kill or no effect on crop.

Results and Discussion

Experiment 1: Alachlor at 1 lb/A preemergence gave excellent control of Galinsoga spp., redroot pigweed and Japanese millet and minimum crop injury (Table 4). Postemergence treatments of alachlor gave excellent control of Galinsoga spp. but poor control of redroot pigweed and Japanese millet. No advantage in weed control was provided by postemergence applications of alachlor following preemergence applications of the same herbicide. Pre or postemergence applications of propachlor (2-chloro-N-isopropylacetanilide) at 2 lbs/A also gave excellent weed control but the crops were severely stunted. However, Ivany and Sweet (3) reported that rates of 2 or 4 lbs/A of propachlor applied preemergence resulted in no cabbage injury. Postemergence treatments of nitrogen at 50 lbs/A gave excellent control of Galinsoga spp., poor control of redroot pigweed and Japanese millet, and negligible crop injury. Salt (NaCl) at 50 lbs/A applied postemergence gave acceptable control of Galinsoga spp. but poor control of redroot pigweed and Japanese millet with no crop injury. Trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) at 0.75 lb/A preplant incorporated in combination with postemergence treatments of either nitrogen at 50 lbs/A or alachlor at 1 lb/A gave excellent weed control and moderate crop injury. All other treatments gave poor control of Galinsoga spp.

Experiment 2: Alachlor applied preemergence at rates as low as 0.5 lb/A gave good control of Galinsoga spp. and no crop injury (Table 5). Excellent weed control and moderate crop injury was also obtained from 1.5 lbs/A of alachlor applied preemergence which agrees with the work of Ivany and Cutcliffe (2). Postemergence treatments of either alachlor at rates of 1.5 lbs/A or nitrogen or salt at 50 lbs/A resulted in good Galinsoga spp. control and moderate crop injury. Erradic control of Galinsoga spp. resulted from treatments of 0.5 or 1.0 lb/A of alachlor. Preplant incorporation of trifluralin at 0.75 lb/A followed by a postemergence treatment of alachlor at 1 lb/A plus Booster+E (a non-phytotoxic oil, see Table 2) at 1% per volume of water or

Table 4. Visual ratings of the effects of several herbicides applied singly and in combination on broccoli, cabbage, Galinsoga spp., redroot pigweed and Japanese millet grown in an Arkport fine sandy loam soil.

Herbicide	lbs/A (ai)	Timing	Crop Response[1]		Weed Control[1]		
			Broc.	Cab.	Gal.	Pig.	Jap.Mil.
alachlor	1.00	Pre	7.5	7.5	9.0	9.0	9.0
alachlor+alachlor	1.00+1.00	Pre+Post	7.0	8.0	9.0	9.0	9.0
alachlor+alachlor	1.00+1.00	E.Post+Post	8.5	8.5	9.0	4.0	2.0
propachlor	2.00	Pre	5.5	6.0	9.0	8.0	9.0
propachlor+propachlor	2.00+2.00	Pre+Post	6.0	8.0	9.0	7.5	9.0
propachlor+propachlor	2.00+2.00	E.Post+Post	7.5	6.5	9.0	6.0	6.0
nitrofen+nitrofen	4.00+2.00	Pre+Post	7.0	6.0	6.0	9.0	8.0
profluralin	1.00	PPI	5.5	5.0	7.5	4.0	9.0
dinitramine	0.50	PPI	6.0	6.0	6.5	8.5	8.5
trifluralin	0.75	PPI	6.5	6.5	3.5	9.0	9.0
butralin	1.00	PPI	8.0	7.5	4.5	7.0	8.0
nitralin	1.00	PPI	7.0	7.0	4.0	7.5	8.5
DCPA (WP)	7.50	PPI	8.5	6.5	4.0	8.0	9.0
DCPA (WP)	7.50	Pre	7.5	6.5	4.0	5.5	5.5
DCPA (EC)	7.50	PPI	7.5	5.5	5.5	4.5	9.0
DCPA (EC)	7.50	Pre	8.0	8.0	6.5	6.0	6.0
nitrogen	50.00	Post	8.0	8.0	9.0	4.5	1.0
salt	50.00	Post	8.0	8.0	7.5	1.0	1.0
trifluralin+nitrogen	0.75+50.00	PPI+Post	5.5	7.5	9.0	8.5	8.5
trifluralin+salt	0.75+50.00	PPI+Post	6.0	4.0	8.5	9.0	9.0
trifluralin+alachlor	0.75+1.00	PPI+Post	7.0	6.5	8.0	9.0	9.0
untreated check			8.5	8.0	4.0	2.3	1.3

[1] Visual ratings were based on a scale of 1 to 9: 1=no effect on weeds or crop completely killed; 7=commercially acceptable weed control or minimal crop injury; 9=complete weed kill or no effect on crop.

either salt or nitrogen at 50 lbs/A gave good control of all weeds and minimal to moderate crop injury. All other herbicides and combinations gave poor weed control, crop injury or both.

Results of both experiments indicate that cabbage is slightly more sensitive to alachlor, nitrogen or salt than broccoli which suggests that varieties may differ in their response to these herbicides. Consequently, further studies on the degree of tolerance of various members of the Cruciferae family to these herbicides will be investigated.

Literature Cited

1. Ivany, J. A. 1971. Galinsoga ciliata (Raf.) Blake and G. parviflora Cav.: Germination, Growth, Development and Control. Ph.D. Thesis, Cornell University, Ithaca, New York. 164 p.
2. Ivany, J. A. and J. A. Cutcliffe. 1973. Herbicides for cole crops in Eastern Canada. Proc. NEWSS 27: 194-198.
3. Ivany, J. A. and R. D. Sweet. 1969. Effect of herbicides on direct seeded crucifers. Proc. NEWCC 23: 44-49.

Table 5. Visual ratings of several herbicides and combinations on broccoli, cabbage, Galinsoga spp., redroot pigweed and Japanese millet in an Eel silt loam soil.

Herbicide	lbs/A (ai)	Timing	Crop Response[2]		Weed Control[2]		
			Broc.	Cab.	Gal.	Pig.	Jap.Mil.
alachlor	0.50	Pre	8.0	7.5	7.5	8.5	4.5
alachlor+oil[1]	0.50+1%	Pre+Pre	7.5	7.0	8.0	8.5	5.0
alachlor	1.00	Pre	7.5	7.0	8.5	8.0	7.0
alachlor+oil[1]	1.00+1%	Pre+Pre	8.5	8.0	8.5	8.5	7.0
alachlor	1.50	Pre	7.5	6.0	9.0	9.0	7.5
alachlor+oil[1]	1.50+1%	Pre+Pre	7.5	6.5	9.0	8.5	8.0
alachlor	0.50	Post	8.0	7.5	7.0	8.0	1.0
alachlor+oil[1]	0.50+1%	Post+Post	8.0	7.0	5.5	5.5	1.5
alachlor	1.00	Post	7.5	7.0	6.5	5.5	4.0
alachlor+oil[1]	1.00+1%	Post+Post	8.0	7.0	7.0	7.0	1.0
alachlor	1.50	Post	7.5	6.5	7.0	6.5	1.5
alachlor+oil[1]	1.50+1%	Post+Post	7.0	6.0	7.0	7.5	3.0
trifluralin	0.75	PPI	6.5	6.0	5.5	8.0	7.5
trifluralin+nitrofen	0.75+2.00	PPI+Post	6.5	5.5	8.5	8.5	7.0
trifluralin+salt	0.75+50.00	PPI+Post	7.0	7.0	7.0	7.0	7.0
trifluralin+nitrogen	0.75+50.00	PPI+Post	7.0	6.5	5.0	8.0	7.0
trifluralin+alachlor	0.75+0.50	PPI+Post	7.5	5.5	6.0	8.0	7.5
trifluralin+(alachlor+ oil[1])	0.75+0.50 +1%	PPI+Post	7.0	6.5	6.0	8.0	8.0
trifluralin+alachlor	0.75+1.00	PPI+Post	7.5	7.0	5.0	8.0	6.5
trifluralin+(alachlor+ oil[1])	0.75+1.00 +1%	PPI+Post	7.0	7.0	7.5	8.5	7.5
dinitramine	0.50	PPI	6.0	4.0	4.5	8.0	7.0
butralin	1.00	PPI	7.5	7.0	6.5	8.0	6.5
nitralin	1.00	PPI	7.5	7.0	6.0	8.5	5.0
DCPA (WP)	7.50	PPI	7.0	6.5	5.5	8.0	3.0
DCPA (EC)	7.50	PPI	7.5	6.0	7.5	7.5	4.0
DCPA (WP)	7.5	Pre	6.5	7.0	6.5	8.0	3.5
DCPA (EC)	7.5	Pre	5.0	6.0	6.0	7.0	5.0
nitrogen	50.00	Post	8.5	7.0	7.0	8.5	1.5
salt	50.00	Post	7.0	6.0	7.5	8.5	1.5
nitrofen	2.00	Post	6.0	7.0	7.0	8.5	3.5
nitrofen+nitrofen	2.00+2.00	Post+L.Post	6.5	6.0	7.5	7.5	3.0
nitrofen+alachlor	2.00+2.00	Post+Post	7.0	6.0	8.0	8.0	4.0
nitrofen+(alachlor+ oil[1])	2.00+1.00 +1%	Post+Post	5.0	4.5	9.0	9.0	5.0
oil	1%	Post	7.5	6.5	6.5	6.0	1.5
untreated checks			7.8	7.4	5.4	6.6	1.8

[1] Oil (Booster+E) used at the rate of 1% per volume of water.

[2] Visual ratings were based on a scale of 1 to 9: 1=no effect on weeds or crop completely killed; 7=commercially acceptable weed control or minimal crop injury; 9=complete weed kill or no effect on crop.

WEEDING OF CARROTS USING PREPLANT INCORPORATION HERBICIDES FOLLOWED BY PREEMERGENCE AND/OR POSTEMERGENCE HERBICIDES

Charles J. Noll[1/]

ABSTRACT

Five herbicides were used to weed carrots. Two, trifluralin and dibutalin were applied as preplant incorporation treatments. The other three, linuron, nitrofen and chloroxuron, followed the preplant treatments as either preemergence or postemergence treatments. In addition, the trifluralin preplant treatment was followed by linuron, nitrofen and chloroxuron applied as preemergence and postemergence treatments in all possible combinations.

In the preplant incorporation treatments, dibutalin at 2 lb (ai) per acre was significantly better than trifluralin at 1 lb (ai) per acre in weed control and yield. In general, linuron and chloroxuron were significantly better than applied as preemergence treatments. Nitrofen was best applied as a postemergence treatment. Many of the combinations of treatments kept the carrot rows free of weeds over the sixteen weeks growing season - in some cases yields were equal to the hand-weeded check.

INTRODUCTION

Carrots are difficult to weed with a single application of herbicide. They are slow to emerge, do not compete well with weeds and have a long growing season. The herbicides used in this trial are recommended herbicides or have been found to be of value in weeding of carrots. A preplant incorporation treatment followed by a preemergence or postemergence treatment or both was thought to be the most promising approach to this difficult weeding problem.

MATERIALS AND METHODS

The carrot weed control trials were conducted at the Rock Springs Farm, 10 miles west of University Park. The soil, a Hagerstown Silt Loam, was plowed in the fall of 1973 and the seedbed prepared April 22. All preplant incorporation treatments were applied and the carrots seeded that same day. The next day, April 23, the preemergence treatments were applied. The postemergence treatments were applied 59 days after the seeding of the carrots when the carrots were 3 to 4 inches in height.

Weeds present in order of importance were lambsquarters (*Chenopodium album* L.), yellow and giant foxtail (*Setaria lutescens* (Weigel) Hubb and *Setaria faberi* Herrom), ragweed (*Ambrosia artemisiifolia* L.), redroot pigweed (*Amaranthus retroflexus* L.), and a scattering of other weeds. Weeds between the rows were controlled by cultivation. The untreated check was hand weeded.

Single row plots were 27 feet long and 3 feet wide. Treatments covered the row for a width of 2 feet. Treatments were randomized in each of 8 blocks.

1/Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

Weed control and crop injury were rated on a 1 to 9 scale. One least desirable, no weed control and carrots dead; and 9 most desirable, no weeds present and no injury to the carrots.

A ten foot section of each plot was harvested August 12. Records were taken of the number of carrot plants and the weight of carrots.

RESULTS AND DISCUSSION

The results are presented in Table 1. In general, plots receiving three applications of herbicides, preplant incorporation, preemergence, and postemergence treatments, had the best weed control, the most carrot injury and a somewhat reduced yield. Looking at yield alone, the best plots were trifluralin preplant incorporation followed by chloroxuron applied one day after seeding and dibutalin preplant incorporation followed by linuron in a preemergence treatment. No herbicide or combination of herbicides significantly affected the stand of carrots.

The preplant incorporation treatments did not injure the carrots or reduce the stand of plants as compared to the handweeded check plot but weed control was poor and yields reduced. The best of the two was dibutalin applied at 2 lb (ai) per acre as compared to trifluralin at 1 lb (ai) per acre in regards to weed control and weight of carrots at time of harvest.

A comparison of preemergence and postemergence treatments results in the following conclusion. Yields were best when linuron and chloroxuron were applied as preemergence treatments and nitrofen as a postemergence treatment.

Table 1. Evaluation of five herbicides for weed control in carrots.

Herbicide	Lb. ai/A	Application Days from Planting	Average Per Plot: Weed[1] (1-9)	Injury[1] (1-9)	Harvest: No. Plants	Wt. Fruit (lbs)
1 Hand Weeded	---	---	9.0	8.8	439	33.4
2 Trifluralin	1	PPI-0	2.0	9.0	390	21.9
3 Dibutalin	2	PPI-0	4.8	8.9	369	26.4
4 Dibutalin	2	PRE+1	4.3	8.5	350	23.6
5 Trifluralin & Linuron	1&3/4	PPI-0&PRE+1	7.0	9.0	398	28.2
6 Trifluralin & Nitrofen	1&4	PPI-0&PRE+1	5.3	8.9	420	26.1
7 Trifluralin & Chloroxuron	1&4	PPI-0&PRE+1	6.5	8.9	394	33.1
8 Dibutalin & Linuron	2&3/4	PPI-0&PRE+1	8.1	9.0	382	32.1
9 Dibutalin & Nitrofen	2&4	PPI-0&PRE+1	4.4	8.9	331	28.1
10 Dibutalin & Chloroxuron	1&4	PPI-0&PRE+1	7.3	9.0	356	30.0
11 Trifluralin & Linuron	1&3/4	PPI-0&POST+59	8.6	8.4	415	25.9
12 Trifluralin & Nitrofen	1&4	PPI+1&POST+59	5.6	8.8	429	25.7
13 Trifluralin & Chloroxuron	1&4	PPI+0&POST+59	5.8	7.9	380	20.9
14 Dibutalin & Linuron	2&3/4	PPI-0&POST+59	8.9	8.5	426	29.9
15 Dibutalin & Nitrofen	2&4	PPI-0&POST+59	7.6	8.9	426	30.5
16 Dibutalin & Chloroxuron	2&4	PPI-0&POST+59	8.1	8.4	397	26.8
17 Trifluralin & Linuron & Linuron	1&3/4&3/4	PPI-0&PRE+1&POST+59	9.0	8.4	381	28.6
18 Trifl.& Linuron & Nitrofen	1&3/4&4	PPI-1&PRE+1&POST+59	8.9	8.5	366	28.9
19 Trifl.& Linuron & Chloroxuron	1&3/4&4	PPI-1&PRE+1&POST+59	8.6	8.3	365	25.8
20 Trifl.& Nitrofen & Linuron	1&4&3/4	PPI-0&PRE+1&POST+59	9.0	8.0	341	25.0
21 Trifl.& Nitrofen & Nitrofen	1&4&4	PPI-1&PRE+1&POST+59	7.6	8.4	368	28.0
22 Trifl.& Nitrofen & Chloroxuron	1&4&4	PPI-0&PRE+1&POST+59	8.4	8.3	373	25.5
23 Trifl.& Chloroxuron & Linuron	1&4&3/4	PPI-0&PRE+1&POST+59	8.8	8.5	371	25.6
24 Trifl.& Chloroxuron & Nitrofen	1&4&4	PPI-0&PRE+1&POST+59	7.6	8.5	352	29.8
25 Trifl.& Chloroxuron & Chloroxuron	1&4&4	PPI-0&PRE+1&POST+59	8.6	8.1	334	25.5
Least significant difference 5%			0.9	0.3	NSD	1.6
Least significant difference 1%			1.0	0.4	NSD	1.9

[1] Weed control and injury scale: (1-9) 1 least desirable; 9 most desirable.

EVALUATION OF OXADIAZON FOR ONION WEED CONTROL ON LONG ISLAND

William J. Sanok
Leon E. Weber[1]

Abstract

Oxadiazon (2-tert-butyl-4-(2,4 dichloro-5-isopropoxyphenyl)-Δ^2-1,3,4 oxadiazolin-5-one) at 3 rates and Chloroxuron (3-[-p-(p-chlorophenoxy) phenyl]-1,1-dimethylurea) at 2 rates were applied pre-emergence to weeds in transplanted onions. Excellent weed control was achieved from the use of both compounds with no significant effect on yield. The higher rates of both compounds has a longer effective control of the weeds present.

Procedure

This experiment was conducted on a sandy loam soil on eastern Long Island. Transplant onions (*Allium Cepa* L) (cv. Early Harvest) were planted approximately April 20th using southern grown transplants. These onions were planted three rows to a bed which is five feet wide. The soil was limed to a pH of 6.0.

Plot size in this experiment was three 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 hand-held two and one half gallon sprayer. The sprayer is equipped with two nozzles 18" apart and a pressure of twenty p.s.i. and volume of sixty gallons per acre. Application was made directly over the plants with no attempt made to avoid contact with the foliage.

The chemicals were applied May 14th when the onions were well established and only a few broad-leaved weeds had germinated. At the time of application the soil was moist, just thirty-six hours after a one inch rain.

This experimental site was selected because of the presence of smart weed (*Polygonum* spp.), barnyard grass (*Echinochloa crusgalli* (L.) *Beau*.), crabgrass (*Digitaria sanguinalis* L.), pineapple weed (*Matricaria matricariodes* L.), Galinsoga (*Galinsoga ciliata* (ROF) Blake). At the time of application some galinsoga had started to germinate.

The total area was not cultivated throughout the season. Weed control ratings were made on June 18th and July 1st. All treatments containing weeds were hand weeded on July 14th. The plot was harvested August 22nd and total weights of each treatment were recorded.

Weed control ratings and yield were analyzed for statistical significance using the Duncans Multiple Range Test.

[1]/Cooperative Extension Agents, Suffolk County, N.Y.

Results

As indicated in the table Oxadiazon at 1, 2 and 4 pounds aia gave excellent weed control of all weeds present. Plots treated with Chloroxuron at 2 and 4 pounds aia gave excellent control of all weeds except barnyard grass and crabgrass. By July 1st the lower rate of Oxadiazon had some grasses germinating. However, at the four pound rate the control remained excellent throughout the season.

No ratings for crop injury were made because there were no noticeable signs of phytotoxicity.

As mentioned in the procedure this plot was hand weeded in mid-July to cut down on the competition for the crop. At harvest on August 22nd the Oxadiazon at one-pound per acre had many weeds of all species present indicating that the material was no longer effective.

In the checks Galinsoga up to three feet high were present.

Chloroxuron at both the two and four-pound rate had some barnyard grass and galinsoga present.

The yield in pounds per plot are indicated in the table. There was no sufficient difference in the treatments indicating that little if any injury resulted from either of the materials used.

Discussion & Conclusion

In the past it has been reported that Oxadiazon has been considered phytotoxic to onions grown on muck soil. Based on this experiment on mineral soil, no effect of the chemical on the onions sprayed was noticed. From this experiment it appears that there is a great deal of potential for this material on transplanted onions on Long Island. Excellent season long weed control of the weed species present with no cultivation was experienced with the four-pound per acre rate.

Evaulation of weed control and yield of onions

Chemical	Formulation	Lbs.AIA	Weed Control Ratings 1/2/ 6/18	7/1	Yields Lbs/plot
Oxadiazon	2 EC	1	9.0 a	8.25 abc	97.0
Oxadiazon	2 EC	2	9.0 a	8.75 ab	94.5
Oxadiazon	2 EC	4	9.0 a	9.0 a	103.0
Chloroxuron	50 WP	2	7.25 b	7.25 c	89.5
Chloroxuron	50 WP	4	8.25ab	7.75 bc	92.2
Check			4.0 c	1.0 d	89.0

1/ Ratings within each column followed by the same letter are not significantly different at the 1% level (Duncans Multiple Range Test)

Ratings
1= no control
7= commercially acceptable control
9= complete weed control

2/ Weeds present: barnyard grass, crabgrass, pineapple weed, smart weed and galinsoga

THE EFFECT OF CHLOROXURON ON SEEDLING ONIONS[1]

H. H. Hatfield and R. D. Sweet[2]

Abstract

Chloroxuron [3-p-(p-chlorophenoxy) phenyl-1,1-dimethylurea] was applied at 1 and 3 lbs/A to seedling onions (Allium cepa L. cv. Elba Globe) at several stages of growth.

Onions at 2 leaf stage or older tolerated chloroxuron; younger plants were injured.

More injury resulted when chloroxuron was placed adjacent to the bases of the shoots of onion plants than from foliage application.

Germinating onion seeds were quite tolerant to chloroxuron layered in the bottom of growing containers but were injured severely when the chemical was mixed in the top layer, throughout or applied to the surface as a preemergence treatment.

Introduction

Postemergence applications of chloroxuron at 3 or 4 lbs/A provide good control of hairy galinsoga [Galinsoga ciliata (Raf.) Blake], shepherdspurse (Capsella bursa-pastoris L.), wormseed mustard (Erysimum cheiranthoides L.) and marsh cress [Roripa islandia (Oeder.) Borbas] which can be serious pests in onions. However, severe injury or complete kill of onions may result.

Preliminary investigations on Oswego muck soil by Cornell workers revealed that chloroxuron at rates which ranged from 0.5 to 4.0 lbs/A frequently injured small onions which had not yet developed 2 leaves. More recently, a program utilizing multiple low rate postemergence combinations of chloroxuron plus nitrofen (2,4-dichlorophenyl-p-nitrophenyl ether) following an initial application of chlorpropham (isopropyl m-chlorocarbanilate) plus CDAA (N,N-diallyl-2-chloroacetamide) were effective and safe.

Many factors such as stage of plant growth, light intensity and chemical interactions which can influence onion injury from chloroxuron have been studied (5). Investigations with other species have shown that their tolerance to chloroxuron is related to stage of growth (1, 2, 4, 6), site of uptake (6), moisture (3) and temperature (3). Application rate also influences toxicity.

Our purpose was to look closely at differences in tolerance levels between plants at several stages of growth and to observe how different sites of exposure affect the extent of injury from chloroxuron and to examine less intensively the effects of rate, water and temperature.

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[1]Paper No. 685, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

[2]Experimentalist and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

Materials and Methods

A 50% wettable powder formulation of chloroxuron was used and all rates are in active ingredient by weight. Elba Globe onions were grown in Oswego muck soil and used as transplants in the first two experiments. Cornell Peatlite Mix A was utilized in all the experimental treatments in fiber paks 2.75 inches deep. Applications were made with a belt sprayer equipped with a single 80015E nozzle and powered by compressed air at 20 p.s.i. Onions were grown in the greenhouse under 16 hours of 8,000 lumens supplemental light from a fluorescent source and fertilized weekly with a 20-20-20 nutrient solution. A 70(N)-80°F(D) regime was maintained in all experiments except for the low temperature condition in Experiment 3.

Four of six experiments conducted are reported. In the first experiment, onions were planted in muck soil weekly for 8 weeks and 10 days after the last planting, when the youngest seedlings were in early flag stage, onions from each planting were transplanted into peatlite mix, 6 plants per market pak according to 3 procedures as follows: In the first, paks were sprayed with 1 or 3 lbs/A of chloroxuron which was immediately incorporated and transplanting into the treated mix followed. Onion transplants were set into a second series of filled paks and sprayed with 1 or 3 lbs/A. In the third part, filled paks were sprayed with 1 or 3 lbs/A of herbicide and transplants were set into the paks, disturbing the surface treatment as little as possible.

Counts of injured and dead plants were taken regularly, 2, 3 and 4 weeks after treatment; plant heights and fresh top weights were measured 2 and 4-1/2 weeks, respectively, after spraying. Percent of injured and dead plants at 2 and 4 weeks and average fresh weights of tops harvested 4-1/2 weeks after treatment are given in Table 1.

In the second experiment, onion seedlings 3, 5, 7 and 9 weeks old were transplanted into paks of mix. Six days later the paks were treated with 1 or 3 lbs/A of chloroxuron followed by application of either 0.25 or 3.00 inches total water during the next 48 hours. The larger quantity of water was applied in 3 equal aliquots: The first immediately after spraying without washing onion foliage; the second 24 hours later; and the third 48 hours after chloroxuron application. As the paks dried routine watering was carried out. Paks which received 3 inches of water remained quite wet for a week or more. Fresh top weights recorded after 4 weeks are listed in Table 2.

In experiment 3, 2 rows of onion seeds were planted in paks and grown to loop stage at 70-80°F. On the sixth day after planting, the paks were divided into 2 lots and one lot was transferred to 60-70°F. Separate lots of onions were sprayed with 3 lbs/A of chloroxuron at loop stage and thereafter at weekly intervals through the 3 leaf stage at 7 weeks. Fresh weights of harvested plant tops are given in Table 3.

In the fourth experiment of this series, treatments were as follows: In the first three lots of paks, chloroxuron was sprayed onto mix and then incorporated into the top inch, the bottom inch, or throughout the entire flat, followed by seeding.

Table 1. Onion[1] responses to chloroxuron treatments[2]. (Experiment 1).

	Age of Plants (weeks) at Time of Application							
	1	2	3	4	5	6	7	8
A. % Injured or Dead -- 2 Weeks After Application								
Incorporation 1 lb/A	61	61	11	0	17	0	6	0
Postemergence 1 lb/A	44	33	17	0	0	6	0	11
Preemergence 1 lb/A	89	100	39	0	44	11	0	6
Incorporation 3 lbs/A	100	89	17	11	56	33	72	0
Postemergence 3 lbs/A	89	72	72	6	0	11	0	6
Preemergence 3 lbs/A	100	100	50	33	39	39	33	0
No herbicide	12	11	11	3	0	3	0	3
B. % Dead -- 4 Weeks After Application								
Incorporation 1 lb/A	50	33	33	0	0	0	0	0
Postemergence 1 lb/A	6	22	22	6	0	0	0	6
Preemergence 1 lb/A	50	100	28	33	33	17	6	6
Incorporation 3 lbs/A	100	100	89	89	44	39	0	0
Postemergence 3 lbs/A	33	56	78	17	6	0	0	6
Preemergence 3 lbs/A	100	100	100	94	83	61	67	6
No herbicide	0	14	14	3	0	3	0	3
C. Fresh Weight Per Plant (gm) 4-1/2 Weeks After Application								
Incorporation 1 lb/A	0.2	0.6	0.6	3.0	3.6	5.0	6.5	7.2
Postemergence 1 lb/A	0.7	1.4	2.5	3.2	6.2	5.5	7.9	7.4
Preemergence 1 lb/A	0.3	0.0	0.8	2.3	3.0	2.5	5.8	5.1
Incorporation 3 lbs/A	0.0	0.0	0.9	1.0	1.5	1.7	2.0	5.3
Postemergence 3 lbs/A	0.9	1.4	1.5	2.8	4.2	4.0	4.6	6.0
Preemergence 3 lbs/A	0.0	0.0	0.0	1.0	1.7	1.2	2.4	4.2
No herbicide	1.4	2.5	2.7	3.8	6.1	6.2	7.3	7.9

[1] Six plants per pak.
[2] All data average of three replications.

Table 2. Average fresh weight (gm) per plant[1] of onions four weeks after application of chloroxuron. (Experiment 2).

Herbicide Applied	Total Amount of Water (inch)	Age of Onion Plants (Weeks) at Time of Application			
		3	5	7	9
chloroxuron 1 lb/A	0.25	5.1	9.7	11.2	12.9
chloroxuron 1 lb/A	3.00	4.9	13.8	13.2	17.6
chloroxuron 3 lbs/A	0.25	4.1	10.3	10.4	14.2
chloroxuron 3 lbs/A	3.00	2.7	10.5	10.4	13.9
no herbicide	0.25	6.2	14.8	10.8	14.2
no herbicide	3.00	5.2	11.4	15.0	16.7

[1] Six plants per pak, three replicates.

Table 3. Average fresh weight (gm) per plant[1] of onions 7-1/2 weeks after planting. (Experiment 3).

Amount of Chloroxuron	Growth Stage at Treatment	Growing Temperature (F)	
		60-70°	70-80°
3 lbs/A	at loop	2.7	1.5
3 lbs/A	at flag	3.7	2.6
3 lbs/A	3 weeks	3.8	4.4
3 lbs/A	4 weeks	4.2	4.3
3 lbs/A	5 weeks	6.5	5.0
3 lbs/A	6 weeks	6.6	4.5
3 lbs/A	7 weeks	6.5	5.6
0	--	6.6	5.5

[1] Two rows of seedlings per pak, three replicates.

A fourth lot of paks was seeded and then surface sprayed and the final paks were seeded but not treated with chloroxuron. In all paks 2 rows of onions were planted 0.25 inch deep at the appropriate time with respect to application of the herbicide.

Results and Discussion

The data in Table 1 reveal that 3 lbs/A of chloroxuron was more toxic than 1 lb/A and that the older plants were more tolerant to both rates. Other workers found that soybeans [Glycine max (L.) Merr.] at the first trifoliate leaf stage and tall morning glory (Ipomea purpurea L. Roth) at 5 leaf stage were less tolerant to chloroxuron than younger or older plants (1, 6). In addition, the figures in Table 1 show that transplanted onions were more tolerant to postemergence chloroxuron sprays than to preplant incorporated or preemergence applications prior to setting the transplants. The data also show that onions at 1 leaf stage, around 4 weeks, and older onions, tolerated 1 lb/A of chloroxuron. On the other hand, 3 lbs/A injured all stages included; fresh weight of onions sprayed at 2 leaf stage (about 8 weeks) was reduced 25% compared to weight of untreated plants.

Three inches of water in combination with 3 lbs/A of chloroxuron caused a 50% weight reduction when applied to onions at 1 leaf stage (Table 2). Simulated rainfall after treatment with chloroxuron increased phytotoxicity to 6 species of plants (3). Onions which had developed beyond the 1 leaf stage appeared to tolerate an increased moisture level, though the fresh weights show some variation.

Elevated temperatures may augment chloroxuron injury especially to onions treated at loop and flag stage. A comparison of fresh weights (Table 3) shows that at 70-80°F, 3 lbs/A of chloroxuron caused weight reductions of 73 and 53% compared with untreated plants in contrast to 60 and 43% reductions, respectively, at 60-70°F. However, at 1 leaf stage or beyond, growth did not appear to be influenced by temperature. Increased phytotoxicity of chloroxuron to 6 species of plants was observed by other workers (3).

In the fourth experiment, onion growth from seeds was severely reduced by 3 lbs/A of chloroxuron in all placements evaluated, and by 1 lb/A in all but one treatment (Table 4). Incorporation of the lower rate into the bottom inch of the pak, where the chloroxuron was well below the germinating seed but distributed in the zone which roots rapidly grew into, caused some reduction in fresh weight of harvested onion tops, 10.2 grams compared to 12.2 grams of tissue from untreated paks; but it appeared that the differences here supported the findings with transplants in the first experiment. Root applications of chloroxuron were reported to cause more injury than foliar applications to soybeans and tall morning glory (4).

Seedling onions grow with a portion of their stem bases below the soil line along with the plate zone and roots. Placement of an herbicide in the upper inch of the growing medium, therefore, positions it adjacent to root and shoot tissue. Our results seem to point to the underground portion of the onion shoot and/or the plate zone as possible sites of uptake leading to injury by chloroxuron. Further studies with careful attention to more precise placement of chloroxuron might confirm this hypothesis.

Table 4. Average total fresh weight (gm) of onion plants[1] four weeks after planting and treatment. (Experiment 4).

Chloroxuron Placement	Rate in lbs/A 1	3
Incorporated in upper half	3.1	<0.1
Incorporated in lower half	10.5	3.3
Incorporated throughout	2.0	0.0
Preemergence (surface)	1.4	0.0
No herbicide	12.2	

[1] Two rows of seedlings per pak, three replicates.

Summary

Young onions were injured more severely by chloroxuron than older onions which had grown to the 2 leaf stage. Three pounds of chloroxuron was more toxic than 1 lb/A.

Surface or incorporated treatments of chloroxuron prior to transplanting caused more damage than postemergence applications.

Exposure of onion transplants or germinating onion seeds to chloroxuron placed where shoot bases or underground portions of developing stems are in direct contact with the herbicide in the growing medium causes more toxicity than foliar applications or chloroxuron placed only in the root growth zone. Evidence strongly indicates that more severe injury results from uptake of chloroxuron in the area of the plate or the underground portion of the onion shoot.

Onions at the 1 leaf stage were severely injured by 3 lbs/A of chloroxuron followed by 3 inches of water while plants with 2 leaves or older plants were not injured by water following application of the chloroxuron.

Onions grown at 70-80°F and sprayed with 3 lbs/A of chloroxuron at loop or flag stage were injured more than plants receiving the same treatment and grown at 60-70°F.

Acknowledgments

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Literature Cited

1. Anderson, R. N. 1968. Effects of postemergence chloroxuron treatments on weed free soybeans. Proc. Northcentral Weed Contr. Conf. 23: 27.
2. Anderson, R. N. 1971. Postemergence chloroxuron treatments on soybeans. Weed Sci. 10: 219-222.
3. Carlson, W. S. and L. M. Wax. 1970. Factors influencing the phytotoxicity of chloroxuron. Weed Sci. 18: 98-101.
4. Feeny, R. W., J. V. Parochetti and S. R. Colby. 1974. Selective action of chloroxuron on soybeans and tall morning glory. Weed Sci. 22: 143-150.
5. McReynolds, W. D. Jr. 1972. Alterations in chloroxuron selectivity induced by chemical and environmental factors. Ph.D. Thesis, Mich. St. Univ.
6. Parochetti, J. V., R. W. Feeny and S. R. Colby. 1972. Preemergence herbicides plus postemergence chloroxuron on soybeans. Weed Sci. 21: 548-553.

CHEMICAL WEEDING OF SEEDED ONIONS GROWN IN MINERAL SOILS

Charles J. Noll[1]

ABSTRACT

Seeded onions (Allium cepa) grown in mineral soils were successfully weeded with DCPA applied as a preemergence treatment and DCPA applied preemergence followed by methazole or chloroxuron 50 days after seeding. Another very successful herbicide used in the trial was propachlor. Propachlor in a preemergence treatment followed by methazole, chloroxuron, or nitrofen 50 days after seeding or propachlor followed by propachlor 30 or 30 and 60 days after seeding resulted in good weed control, little injury and good yield.

INTRODUCTION

The rising cost of sets and transplants make the growing of onions from seed of greater interest to our vegetable growers. The biggest problem in growing onions from seed is weed control. Hand weeding is expensive, the only practical solution to the weed problem is the use of herbicides.

MATERIALS AND METHODS

The weeding trials were conducted at the Rock Springs Farm located 10 miles west of University Park. The soil, a Hagerstown silt loam, was plowed in the fall of 1973 and the seedbed prepared April 17, 1974. The onions were seeded to the variety Downing Yellow Globe the same day and the preemergence treatments applied the next day, April 18. All postemergence treatments were preceeded by preemergence treatments. The postemergence treatments, propachlor and oxadiazon, were applied 30 days and 30 and 62 days after onion seeding. Methazole, nitrofen, chloroxuron and glyphosate were applied 50 days after onions were seeded.

Single row plots were 27 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. The untreated check row was hand weeded.

Weeds present in the greatest numbers were lambsquarters (chenopodium album L.), yellow, green and giant foxtail (Setaria spp.), ragweed (Ambrosia artemisiifolia L.), and redroot pigweed (Amaranthus retroflexus L.)

A rating scale of 1 to 9 was used to evaluate weeds and crop injury, 1 being least desirable, no weed control and onions dead, and 9 most desirable, perfect weed control and no injury to the onion.

All plots were harvested October 1, records were taken of number and weight of bulbs.

1/ Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

RESULTS AND DISCUSSION

The results are presented in Table 1. In all plots where chloropropham, oxadiazon or glyphosate were applied the onions were severely injured and the yield greatly reduced as compared to the better treatments. DCPA used as a preemergence treatment or as a preemergence treatment followed by propachlor, methazole or chloroxuron were good treatments. The addition of the post-emergence treatments in all three cases improved the weed control and increased the yield.

Propachlor was an excellent herbicide for the weeding of onions when applied as a preemergence herbicide. The weed kill was improved, without a yield reduction, by the addition of a postemergence application of propachlor, methazole, nitrofen or chloroxuron.

Table 1. The effect of herbicides on weed control and seeded onions grown in mineral soils.

Herbicide	Lb. ai/A	Application Days from Seeding	Average Per Plot: Weed[1] (1-9)	Injury[1] (1-9)	Harvest: No. Bulbs	Wt. Bulbs (lbs)
1 Hand Weeded	---	---	9.0	8.8	84.9	39.5
2 Chloropropham	6	PRE+1	6.9	4.4	18.5	10.6
3 DCPA	10	PRE+1	5.5	8.3	80.3	34.6
4 Propachlor	5	PRE+1	6.0	8.0	72.5	30.8
5 Chloropropham & Propachlor	6&5	PRE+1&POST+30	8.4	4.0	19.3	12.0
6 Chloropropham & Oxadiazon	6&1½	PRE+1&POST+30	9.0	2.1	3.0	1.7
7 Chloropropham & Methazole	6&2	PRE+1&POST+50	8.9	2.8	6.1	3.7
8 Chloropropham & Nitrofen	6&3	PRE+1&POST+50	8.1	4.4	18.0	11.3
9 Chloropropham & Chloroxuron	6&3	PRE+1&POST+50	8.8	3.5	12.3	8.6
10 Chloropropham & Glyphosate	6&1	PRE+1&POST+50	8.8	1.0	0.1	0.0
11 DCPA & Propachlor	10&5	PRE+1&POST+30	6.8	8.5	73.1	40.3
12 DCPA & Oxadiazon	10&1½	PRE+1&POST+30	8.8	4.0	15.9	11.3
13 DCPA & Methazole	10&2	PRE+1&POST+50	9.0	8.3	71.4	41.5
14 DCPA & Nitrofen	10&3	PRE+1&POST+50	5.9	8.0	71.8	33.9
15 DCPA & Chloroxuron	10&3	PRE+1&POSY+50	8.0	8.1	76.4	39.8
16 DCPA & Glyphosate	10&1	PRE+1&POST+50	9.0	1.0	2.3	0.6
17 Propachlor & Propachlor	5&5	PRE+1&POST+30	8.1	8.1	78.4	38.5
18 Propachlor & Propachlor & Propachlor	5&5&5	PRE+1&POST+30&62	8.3	7.6	79.6	35.9
19 Propachlor & Oxadiazon	5&1½	PRE+1&POST+30	9.0	2.4	4.6	3.3
20 Propachlor & Methazole	5&2	PRE+1&POST+50	8.0	8.0	71.8	35.3
21 Propachlor & Nitrofen	5&3	PRE+1&POST+50	7.5	8.4	79.0	41.2
22 Propachlor & Chloroxuron	5&3	PRE+1&POST+50	8.8	7.9	80.1	38.9
23 Propachlor & Glyphosate	5&1	PRE+1&POST+50	8.4	1.1	1.9	0.5
24 Oxadiazon & Oxadiazon	2&1½	PRE+1&POST+30	9.0	1.0	0.3	0.1
25 Oxadiazon & Oxadiazon & Oxadiazon	2&1½&1½	PRE+1&POST+30&62	9.0	1.0	0.0	0.0
Least Significant difference 5%			0.6	0.9	9.2	6.4
Least Significant difference 1%			0.7	1.1	11.0	7.7

1/Weed control and Injury rating scale: (1-9) 1 least desirable, 9 most desirable.

WEED CONTROL IN DIRECT-SEEDED CABBAGE

J. A. Grande [1/]

ABSTRACT

Six dinitroaniline herbicides were compared with regard to weed control and crop response in direct-seeded cabbage (Brassica oleracea (capita group) cv. Greenback). The most effective treatments in relation to crop safety and weed control were as follows: butalin (N-sec-butyl-4-tert-butyl-2,6-dinitroaniline) 2#a.i./A, trifluralin (α,α,α-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) 1/2#a.i./A, and CGA-10832 (N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-N-propyl-p-toluidine) 1 1/2#a.i./A. Dinitramine (N^4,N^4-diethyl-α,α,α-trifluoro-3,5-dinitrotoluene-2,4-diamine) 1/4#a.i./A, CGA-10832 2 1/2#a.i./A, and trifluralin 1#a.i./A resulted in measurable losses in crop stand and vigor. Fall panicum (Panicum dichotomiflorum Michx.), lovegrass (Eragrostis cilianesis (All.) Lutati), redroot pigweed (Amaranthus retroflexus L.), and common lambsquarter (Chenopodium album L.) were effectively controlled by all herbicides for 68 days with the following exceptions: Mobil 8475 (Chemistry undisclosed) and butalin 1#a.i./A. Late season broadleaf weed pressure depressed yields of cabbage with the lower rates of the herbicides studied.

INTRODUCTION

Cabbage production in New Jersey has traditionally been accomplished with transplants rather than direct-seeding in the field. However, recent increases in production costs, along with advances in field seeding technology and weed control, have created interest in production of direct-seeded cabbage.

This study was initiated to evaluate various herbicides, either presently registered, or promising candidates for weed control in direct-seeded cabbage.

MATERIALS AND METHODS

The study was initiated at the Adelphia Research Center, Adelphia, N.J., on a Freehold Sandy Loam (1.5% OM). Five ft. wide by 20 ft. long bedded plots were established in a randomized complete block design with three replications. Two rows spaced 18 inches apart were seeded at an average rate of 8 seeds per foot of row of cabbage.

The herbicide treatments were applied and incorporated on June 19, 1974. A CO_2 powered back-pack sprayer calibrated to 29 GPA was

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

utilized for all herbicide treatments. The herbicide incorporation was accomplished within one hour after spraying with a tractor-mounted roto-tiller and bed-shaper set to 3 inches. Dry soil conditions persisted until June 22.

Weed control and yield data were recorded during the course of the study.

RESULTS AND DISCUSSION

Six dinitroaniline herbicides were evaluated PPI on seeded cabbage. Visual ratings on crop stand and vigor are presented in Table 1. Dinitramine, CGA-10832 (above 1#a.i./A) and trifluralin (above 1/2#a.i./A). resulted in moderate to substantial losses in crop stand and vigor. Butalin and nitralin treatments did not exhibit any significant losses in crop stand and vigor.

Weed control ratings on July 25 (Table 1) indicated all PPI treatments, except Mobil 8475, resulted in excellent control of fall panicum and lovegrass. However, control of redroot pigweed and common lambsquarter was variable. Generally, Mobil 8475 was weak on both weeds, butalin was somewhat weak at 1#a.i./A but excellent at 2#a.i./A, CGA-10832 provided excellent control at all rates, control with trifluralin ranged from fair at 1/3#a.i./A to excellent at 1#a.i./A, and nitralin provided adequate control at 1/2 and 1#a.i./A.

Weed control was again visually rated on August 27, 68 days after seeding (Table 2). There was very little difference between treatments with regard to the control of fall panicum and lovegrass. Only butalin at 1#a.i./A and Mobil 8475 at 3/4 and 1 1/2#a.i./A resulted in "commercially" weak grass control. Good control of both pigweed and lambsquarter was obtained with all treatments with the following exceptions: Mobil 8475 (3/4 and 1 1/2#a.i./A), trifluralin (1/3#a.i./A) and butalin (1#a.i./A).

Comparison of yield data between the six herbicides (Table 2) generally reflects on the weed control and crop response ratings (Tables 1 and 2). The outstanding treatments among the PPI herbicides was butalin at 2#a.i./A.

Table 1. Comparison of weed control and crop response with several pre-plant incorporated herbicides on July 25, 1974 at Adelphia, N. J.

Herbicide (formulation)	Rate #a.i./A	Ratings[a] Crop[b] Std.	Vig.	Weeds[c] PW	LQ	FP	LG
Dinitramine (2E)	1/4	4.3	2.0	9.3	9.6	9.6	10.0
Dinitramine (2E)	1/3	5.0	2.6	8.0	8.0	10.0	9.3
Dinitramine (2E)	1/2	7.0	5.0	9.0	10.0	9.3	10.0
CGA-10832 (4E)	1	0	1.6	9.3	9.6	9.6	10.0
CGA-10832 (4E)	1 1/2	3.6	2.3	8.6	10.0	10.0	10.0
CGA-10832 (4E)	2 1/2	4.3	3.0	10.0	10.0	10.0	10.0
Mobil 8475 (2E)	3/4	0.66	0	3.0	3.0	6.6	6.6
Mobil 8475 (2E)	1 1/2	1.6	1.3	7.0	9.0	9.0	9.6
Trifluralin (4E)	1/3	0	0	8.0	9.0	9.3	10.0
Trifluralin (4E)	1/2	0	0	8.0	9.3	9.3	10.0
Trifluralin (4E)	1	2.3	2.0	9.6	10.0	10.0	10.0
Butalin (4E)	1	0.66	0.66	8.0	8.3	9.3	10.0
Butalin (4E)	2	1.3	1.3	10.0	10.0	10.0	10.0
Nitralin (4WD)	1/2	0	0	9.3	9.6	10.0	10.0
Check (weeded)		0	0	10.0	10.0	10.0	10.0
Check (unweeded)		0	7.0	0	0	0	0

[a]Visual ratings based on a scale of 0-10: 0=no effect on weed or crop; 10=perfect weed control or dead crop.

[b]Field-seeded cabbage (*Brassica oleracea* (capita group) cv. Greenback)

[c]PW=Redroot pigweed (*Amaranthus retroflexus* L.)
LQ=Common lambsquarter (*Chenopodium album* L.)
FP=Fall panicum (*Panicum dichotomiflorum* Michx.)
LG=Lovegrass (*Eragrostis cilianeses* (All.) Lutati)

Table 2. Comparison of weed control and yield in several pre-plant incorporated herbicides in direct-seeded cabbage experiment, Adelphia, N.J. 1974

Herbicide (formulation)	Rate #a.i./A	Weed Control[a] PW	LQ	FP	LG	Yield (lbs)[b]	Harv. rating[c]
Dinitramine (2E)	1/4	9.6	10.0	10.0	10.0	24.8	3.0
Dinitramine (2E)	1/3	9.6	9.6	9.6	9.0	5.3	3.3
Dinitramine (2E)	1/2	8.3	8.3	9.0	10.0	5.0	3.6
CGA-10832 (4E)	1	8.0	9.0	10.0	10.0	34.3	3.3
CGA-10832 (4E)	1 1/2	9.6	9.6	10.0	10.0	43.0	1.6
CGA-10832 (4E)	2 1/2	9.3	10.0	10.0	10.0	41.3	2.6
Mobil 8475 (2E)	3/4	2.0	2.0	5.3	7.0	2.8	4.6
Mobil 8475 (2E)	1 1/2	5.6	5.6	5.3	6.3	6.5	4.3
Trifluralin (4E)	1/3	7.3	7.6	10.0	7.0	54.1	3.6
Trifluralin (4E)	1/2	5.0	5.0	10.0	8.0	57.8	3.6
Trifluralin (4E)	1	9.3	9.6	9.6	9.0	50.8	2.3
Butalin (4E)	1	2.3	2.3	2.0	3.3	5.8	4.6
Butalin (4E)	2	9.3	9.3	9.0	9.0	60.1	1.3
Nitralin (4WD)	1/2	6.6	7.6	8.6	9.6	16.0	3.6
Nitralin (4WD)	1	8.3	9.3	10.0	9.0	34.6	2.6
Check (weeded)		10.0	10.0	9.6	9.0	58.3	1.0
Check (unweeded)		0.0	0.0	0.0	0.0	0.0	5.0

[a]Visual ratings based on a scale of 0-10; 0=no weed control, 10=perfect weed control.
PW=Redroot pigweed (*Amaranthus retroflexus* L.)
LQ=Common lambsquarter (*Chenopodium album* L.)
FP=Fall panicum (*Panicum dichotomiflorum* Michx.)
LG=Lovegrass (*Eragrostis cilianeses* (All.) Lutati)

[b]Yield of #1 (Marketable heads), complete harvest of two rows 18 in. apart, 5 ft by 20 ft plot.

[c]Hand harvest rating--1-5: 1=easy to harvest, no weeds; 5=very tall and heavy weed population.

HERBICIDE WEEDING OF CUCUMBER GROWN IN A STALE SEED BED

Charles J. Noll[1]

ABSTRACT

A field experiment was conducted to evaluate weed control and cucumber (Cucumis sativus) response in a stale seedbed with five herbicides. Twelve days after the seedbed was prepared the cucumbers were seeded and the herbicides applied. Taking into consideration weed control, cucumber injury, stand and yield from a single harvest the best treatments were glyphosate applied at 2 pounds (ai) per acre and paraquat applied at 2 pounds (ai) per acre.

INTRODUCTION

Conventionally seeded cucumber, no delay between land preparation and seeding, are difficult to weed with herbicides. Weather conditions determine in large part the effectiveness of the herbicide. Lack of rainfall may result in poor weed control, excessive rainfall may result in cucumber injury. Cool weather may delay weed seed germination and result in poor weed control.

By delaying the seeding of cucumber following land preparation the weeds emerge before the cucumbers emerge. The application of a contact herbicide following cucumber seeding should kill the seedling weeds and have less chance of injuring the cucumber.

MATERIALS AND METHODS

This study was conducted at the Rock Springs Farm located 10 miles west of University Park. The soil, a Murrill Loam, was plowed in the fall of 1973 and the seedbed prepared May 28, 1974. After a twelve-day delay, on June 10, the field was seeded to the cucumber variety Pioneer. At that time many weeds had emerged. All herbicides were applied June 11, the day following cucumber seeding. Weeds present in order of importance were: redroot pigweed (Amaranthus retroflexus L.), galinsoga (galinsoga parviflora Cav.), prostrate pigweed (Amaranthus blitoides S. Wats.), Pennsylvania smartweed (Polygonum pennsylvanicum L.), purslane (Portulaca oleracea L.), green and giant foxtail (Setaria viridis L. Beano and Setaria faberi Herrm.), and lambsquarters (Chenopodium album L.).

Single row plots were 36 feet long and 5 feet wide. Treatments covered the row for a width of 2 feet with cultivation controlling the weeds in the middles. Treatments were randomized in each of 6 blocks.

A rating scale of 1 to 9 was used to evaluate weed control and cucumber injury, 1 being least desirable - no weed control or all cucumbers dead; and 9 - perfect weed control and no injury to the cucumbers.

1/ Department of Horticulture, The Pennsylvania State University, University Park, PA 16802.

RESULTS AND DISCUSSION

The results are presented in Table 1. All herbicides significantly reduced the overall weed population. All herbicides except paraquat at the 2 pound rate injured the cucumbers, but only dinoseb at 3 pounds (ai) per acre, metribuzin at 1/2 pound (ai) per acre, and nitrofen at both rates 2 & 4 pound (ai) per acre significantly reduced the stand.

A single harvest was taken August 8 with the number and weight of fruit recorded. Glyphosate at 2 pounds (ai) per acre significantly increased the number of fruit as compared to the unweeded check. Dinoseb and metribuzin at 1/2 pound (ai) per acre and nitrofen at 4 pound (ai) per acre significantly reduced the number of fruit as compared to the check. Glyphosate at 2 pound (ai) per acre and paraquat at 2 pound (ai) per acre significantly increased the weight of fruit as compared to the untreated check.

Taking into consideration weed control, injury, stand of plants, and number and weight of fruit from a single harvest, the most promising herbicide treatments are glyphosate at 2 pounds (ai) per acre, paraquat at 2 pounds (ai) per acre, and possibly the combination of napthalam and glyphosate at 4 pounds (ai) plus 2 pounds (ai) per acre.

Table 1. The effect of herbicides alone and in combination on weeds and cucumbers grown in a stale seed bed.

Herbicide	Lbs. ai/A	Application days from seedbed Preparation	Average Per Plot: Weeds[1] (1-9)	Injury[1] (1-9)	Stand of Cucumber	Harvest: No. Fruit	Wt. Fruit
1 Nothing	---	---	1.3	9.0	72	100	38
2 Dinoseb	3	+12	8.0	2.1	11	15	5
3 Glyphosate	1	+12	6.8	7.3	62	114	50
4 Glyphosate	2	+12	7.3	7.7	69	161	65
5 Paraquat	1	+12	6.8	7.2	65	91	35
6 Paraquat	2	+12	7.8	8.2	77	133	59
7 Metribuzin	1/4	+12	3.8	4.0	57	58	20
8 Metribuzin	1/2	+12	4.5	2.2	32	14	3
9 Nitrofen	2	+12	7.5	4.2	27	80	29
10 Nitrofen	4	+12	8.0	2.5	22	19	6
11 Napthalam + Paraquat	4+2	+12	8.2	7.8	47	93	39
12 Napthalam + Glyphosate	4+2	+12	8.3	8.0	78	146	53
13 Chloramben + Paraquat	2+2	+12	8.8	4.3	27	54	23
14 Chloramben + Glyphosate	2+2	+12	8.8	5.8	35	74	33
Least significant difference 5%			1.0	1.0	30	57	20
Least significant difference 1%			1.3	1.4	40	75	26

1/ Weed control and injury rating scale: (1-9) 1 least desirable, 9 most desirable.

COMMENTS ON RATING SYSTEMS IN WEED SCIENCE[1]

R. D. Sweet[2]

Introduction

This presentation is an indirect result of the rather heated discussion of ratings at the Northeastern Weed Science Society business meeting last year in Philadelphia. A committee was appointed at that time to come in with a recommendation in 1975. Unfortunately, it did not function. Therefore, I took it on myself to put together some ideas on ratings. Just before the deadline for program details, Dick Ashley was asked if he also would present some ideas on ratings. Between the two of us we hope to stimulate your thinking. If this group can agree on something, perhaps a recommendation could be made to the officers and the members of NEWSS at this meeting or in an early mail ballot.

Discussions of ratings are not new for this group, for the other regional groups, or for the national. I have a rather voluminous folder of material generated as a result of these periodic discussions. Several years ago we in the Northeast discussed the European rating system. This system had two points in its favor: if we adopted it, our data would be readily understood internationally; and of equal importance, it had not become identified with any particular U.S. weed man so the personality problem of rating systems would be disposed of rather neatly. One of the most recent proposals was a recommendation from a committee of WSSA that all ratings must be on a 0-10 basis and must be directly convertible to percentages. Needless to say, I registered a rather strong objection to both aspects.

Use of Ratings

Historically weed scientists have always utilized ratings extensively in recording and reporting results of their experiments. There are many sound reasons for this practice. In the early days, the weed work was done by people who had many other responsibilities and money for supporting weed investigations was in very short supply. Thus, there were neither people nor money available for detailed objective measurements of results. Furthermore, economic pressures were great for having practical results available almost instantly. These pressures were present in both industry and in universities.

In present-day situations these pressures still exist to a certain extent and ratings still have good validity. They are relatively inexpensive to obtain; they are appropriate for preliminary tests; and for certain factors such as leaf distortion, color changes, etc. are more meaningful than alternative objective measurements. But what about considerations such as possible yield reductions? Labeling requirements, etc.? Are subjective ratings valid for these important decisions, or should we take the time and spend the money for objective, finite numbers such as stand counts, fresh and dry weights, etc.?

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[1] Paper No. 680, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853

[2] Professor, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853

In preparing for this presentation, I made a hasty search of the yearly proceedings of our Northeastern Weed Science Society. I was not surprised to find that almost every paper used at least some ratings as a means of explaining the results; and the great majority of authors used a 0-10 system. However, not all authors used that system the same way. For example, some rated weeds on the basis of control whereas others rated them on the basis of growth. Minority systems were 1 to 5, 1 to 9, and the European system. Almost universally only minimum information was given on interpretation of the ratings. For example, only a few indicated if his ratings on crops were correlated with yields. Furthermore, no one gave objective numbers on weed numbers or vigor in the checks. In most cases, there was no indication as to whether or not the ratings legitimately could be converted to percentages. From personal discussions, however, it became clear that authors intend that his ratings not be converted, others did not care and a few encouraged such conversions. In my opinion percentages often can be highly misleading and use of them should be with caution. Each author should state quite clearly just what he believes is appropriate for his ratings.

Some examples of types of problems encountered with ratings and percentages for both crops and weeds are given in Tables 1 and 2. If we use 150 bu. of corn and 400 bu. of potatoes as representative of good yields and then apply a rating system of 0-10 that has been converted to percentages we can see how absurb the numbers turn out. For example, acceptable crops are 105 and 280 bu. of corn and potatoes, respectively. We are saying it is acceptable for a grower to lose 45 bu. of corn or 120 bu. of potatoes. I am sure that there isn't a person in this room who would deliberately recommend a practice to a grower that caused him these losses. Unfortunately, however, the way weed scientists are reporting their data, coupled with the way it is being put into the computer and eventually retrieved for labeling and other uses, means we are actually generating data that is being grossly misinterpreted, but is treated as if it were accurate and factual.

Problems with weed data are just as critical. In Table 2, I have assumed that a heavy infestation of a particular weed could be 100 per square yard and a light infestation 10 per square yard. These numbers are not at all unusual. Many annual weeds will have initial populations of several seedlings per square inch. Grassy perennials such as quackgrass and nutsedge will have many shoots per square foot. Obviously, percentage control can be very misleading in a heavy versus a light infestation. Let us remember farmers are interested primarily in how many weeds remain in the field after treating. They really do not care how many weeds were killed. They want the number remaining to be small enough so that they do not reduce crop yield or quality or interfere with harvest.

Another problem with weed ratings is that too often we refer to the stand of a particular species as severe, light, or too few to rate. However, we rarely give a representative stand count for each category. Obviously investigators will vary in their interpretation. Perhaps a stand of 1 weed per square yard might be considered "light" by one author and "too few" to permit ratings by another author. However, not only are very light stands sometimes rated, but also they often are given a percentage control value and put into the computer, with no critical evaluation or weighing on the basis of whether the treatment killed 1000, 100, or 10 weeds per square yard.

Table 1. Crop growth.

	Rating	%	Yield* (bu/A) Corn	Potatoes
Perfect	10	100	150	400
	9	90	135	360
	8	80	120	320
Acceptable	7	70	105	280
	6	60	90	240
	5	50	75	200
	4	40	60	160
	3	30	45	120
	2	20	30	80
	1	10	15	40
Killed	0	0	0	0

* Theoretical estimate of a good crop.

Table 2. Weed control.

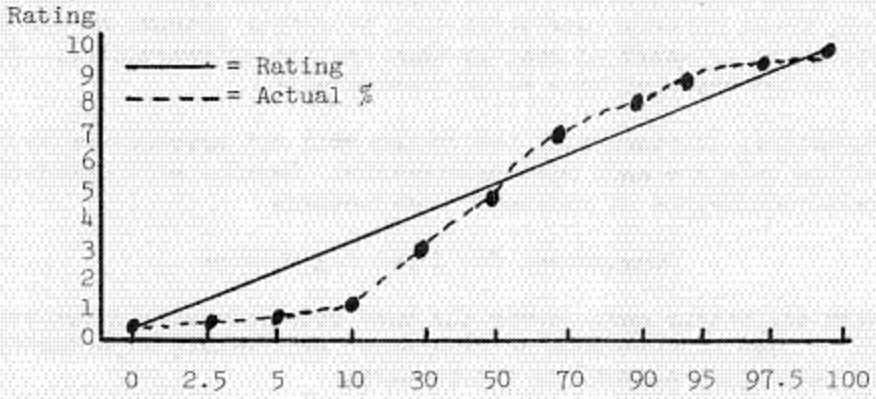
	Rating	%	Infestation Remaining* Severe	Light
Perfect	10	100	0	0
	9	90	10	1
	8	80	20	2
Acceptable	7	70	30	3
	6	60	40	4
	5	50	50	5
	4	40	60	6
	3	30	70	7
	2	20	80	8
	1	10	90	9
No Effect	0	0	100	10

* Assuming that 100 weeds and 10 weeds/sq. yd. would be a severe and light infestation, respectively.

Standardizing Rating Systems

Whenever the use of a standardized or uniform rating system is discussed, weed scientists generally begin to rise up in wrath. "Nobody is going to tell me how to run my research!" Another version is "Standardization is O.K. if my system is adopted as the standard." At least some of these objections would be overcome if the European rating system was adopted. A schematic comparison of percentages and ratings based on this system is presented in Table 3. Note that the European system accentuates the accuracy at each end of the scale and gives very little precision in the intermediate zone. I happen to like this type of emphasis and the system we use tries to accomplish the same end. Unfortunately, even though we state emphatically that our ratings are not percentages they are being treated as such by some data collectors. At

Table 3. European rating system (schematic).



least one author in 1974 NEWSS presented his data on the European system. He included both the ratings and the percentages. I suggest those interested look up his paper and see for yourselves what a difference it makes in the percentages that are reported. One last comment on this system -- many Europeans take their objective values first and then convert those numbers to percentages. This makes for excellent readily understood data but is an expensive procedure.

A comparison of rating systems with 11, 5 and 3 divisions is shown in Table 4. In my opinion a system with relatively few places or categories is sufficient. A fringe benefit of a rating system with few places is that it cannot be easily converted to percentages. Where precision and accuracy are needed, objective data are the preferred choice rather than a rating system with more divisions. Most of the literature shows that visual ratings

Table 4. Comparison of 11, 5 and 3 divisions.

10 Perfect		
9	5 Perfect	
8		3 Perfect to Good
7 Acceptable	4 Acceptable	
6		
5	3 Fair	2 Fair to Poor
4		
3	2 Poor	
2		
1	1 No Effect	1 Slight to No Effect
0 No Effect		

correlate well with relative ranking of treatments. Little work has been reported, however, to show how accurately weed and crop ratings can be substituted for actual objective data. Furthermore, how small can differences be and still be accurately measured by eye? This problem has not been resolved.

We are investigating this aspect of ratings and do not yet have a definite answer. It seems, however, that with some factors such as number and weight there may be less precision than with height. In all types of ratings we have studied, those observations which fall at either extreme of the scale are more likely to be noted accurately than are the intermediates. To date differences of 10% have not been rated consistently.

Unfortunately, standardizing the system will not prevent use of ratings where objective data are much more appropriate. Neither will standardization prevent unwise conversion of ratings to percentages.

Suggestions for Improving Ratings

1. Weed scientists must choose the most appropriate data for each experiment. I urge that ratings be limited to preliminary experiments where only fairly broad generalizations are required.

2. For tests that are designed to assist in getting label clearances or to develop precise recommendations for use, I urge that objective measurements rather than ratings be the major source of data.

3. Use percentages with great caution. Although they are convenient, they can be grossly misleading.

4. Do not convert data to percentages without approval or guidance from the researcher.

5. Consider using a rating system with only a few divisions. This eliminates the tendency to convert ratings to percentages. It also requires objective data if small differences are to be evaluated.

6. Consider a simplified standardized rating system to which researchers could convert their own ratings.

POTATO VINE KILLING IN MAINE - 1973

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

Abstract

Several desiccants and adjuvants were tested in 1973 for potato vine desiccation in Maine. None of the desiccants alone or with adjuvants gave exceptionally good vine kill. Evik plus Booster Plus E, Paraquat, Dow General plus Tronic, Dow General plus Staples oil mixtures, and Des-I-Cate at all rates provided satisfactory desiccation. Of the new materials, N252 looked promising at the highest rate used. Of all the adjuvants tested #2 oil gave the best results followed by Booster Plus E, Tronic, and Staples 1 and 5% oil mixtures. Considerable vascular discoloration was present in tubers from all treatments including 'no treatment'.

Introduction

The following paper reports the results of potato vine killing studies conducted in Maine during the 1973 growing season. Evaluation of tubers harvested from treated plots was made during the 1973-74 storage season, and emergence tests were conducted during the 1974 growing season.

Materials and Methods

All desiccants and adjuvants, unless otherwise specified, were applied in 80 gallons of water per acre at 40 P.S.I. 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 hand boom was used for foliar application of all mixtures. Nozzle type, T-jet #9006 tips was used. Plots were single rows, 25 feet long with single unsprayed buffer rows between treatments. Plots were arranged in randomized block designs and each treatment replicated six times.

Using a five-step rating system as presented in Table 1, vine kill ratings were made at 7 and 14 days following application of chemical desiccants.

Table 1. Potato vine kill rating code. Maine - 1973.

1 = Poor or no kill of leaves.
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.

[1]Associate Professor Agronomy and Crops Supervisor, Department of Plant and Soil Sciences; University of Maine, Orono, Maine 04473.

At harvest 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 analysis and quality tests.

Tubers that were snipped for observing vascular discoloration in late December were composited by treatment and stored at 38F. In May 1974, tubers from selected treatments were planted in replicated emergence and yield trials. These plots were observed during the growing season to detect any possible side-effects which might be related to desiccation treatments in 1973.

Table 4 presents source, names, and active ingredients in the desiccants used in the 1973 Maine potato vine killing trials.

Results and Discussion

Data presented in Table 2 indicate that none of the desiccants alone or in combination with adjuvants gave satisfactory (4.0+) potato vine desiccation in 1973. Evik plus Booster Plus E, Paraquat at the 2 pint rate, Dow General plus Tronic, and Dow General plus 5 gallons of #2 oil came close to a rating of 4.0, but vine regrowth was visible after 13 days, indicating their activity was completely over. Booster Plus E improved the activity of Evik and Tronic improved the activity of Dow General, although not quite as much as the old standard adjuvant of #2 oil. The inclusion of growth regulator, CP41845, increased the activity of Evik slightly but had very little desiccation activity when used alone.

Vascular discoloration of tubers from treated plots, as shown in Table 2, appeared to be highest when #2 oil was used with Dow General. Note also that vascular discoloration was present in the check or untreated plots indicating that plants were perhaps under some moisture stress at the time the desiccants were applied.

The only vine desiccants, as shown in Table 2, that affected emergence of treated tubers harvested for seed in 1973 were: Paraquat at the high rate, CP41845, and the split treatment of Bravo plus Dow General. In the case of Paraquat and Bravo plus Dow General, emergence was decreased slightly because of seedpiece decay, but CP41845 definitely inhibited sprouting of seedpieces.

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 of marketable size were harvested.

Data presented in Table 3 indicate that Dow General plus Staples 1% oil mixture, and Des-I-Cate at rates of 1.5 and 2.0 gallons per acre gave satisfactory (4.0+) vine desiccation. Other treatments that showed promising

activity were N252 at the 4-pound per acre rate, the high rate of Stam plus Sevin, Dow General plus Staples 5% oil mixture. Dow General plus #2 oil, and Des-I-Cate at the 1 gallon per acre rate. It is worthy of note that in this test the addition of #2 oil to Des-I-Cate did not increase the efficacy of Des-I-Cate at any rate of application. Note also that vine regrowth occurred only with Dow General treatments.

All treatments, as shown in Table 3, appeared to cause some vascular discoloration when compared to 'no treatment'. N252 at 4.0 pounds per acre, R24191 at 5.7 pounds per acre, and Premerge produced the highest percentage of tubers showing vascular discoloration.

Emergence of seed tubers from treated plots was not affected by any of the treatments listed in Table 3, nor was yielding ability of plants grown from these tubers affected.

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 - 1973.

Treatments[1]			Vine kill ratings[2]		Percent vascular discoloration[3]			% emergence	Yield Cwt./A.
Material	Product Rate/Acre	Additive	9-4	9-10	Slight	Medium	Severe	1974	1974
No treatment			1.0	1.0	7.3			100.0	327
Evik (80W)	2.5 lbs.		1.2	1.2	5.2	1.2		100.0	332
Evik	2.5 lbs.	2 qts. Booster Plus E	3.2	3.6*	5.6	0.5		100.0	335
Evik	2.5 lbs.	1 qt. Tronic	2.7	2.8	4.7			100.0	328
Paraquat	1.0 pts.	4 oz. X-77	2.7	2.8	4.1	0.3		100.0	318
Paraquat	2.0 pts.	4 oz. X-77	3.6	3.7*	3.8	0.6		90.0	307
CP41845	5.0 lbs.		1.3	1.9	1.8	0.3		0.8	18
CP41845	10.0 lbs.		1.2	1.3	9.8	0.6		0.0	8
Evik	2.5 lbs.	5 lbs. CP41845	2.4	2.3	4.8	0.3		1.7	26
Evik	2.0 qts.	10 lbs. CP41845	2.6	2.2	5.0	0.3	0.3	1.7	1
Dow General	2.0 qts.	1 pt. Miller Aide	1.6	1.2	7.1			100.0	334
Dow General	2.0 qts.	1 qt. Tronic	3.4	3.4*	3.7			100.0	330
Dow General	2.0 qts.	1 pt. Ivory detergent	1.8	1.7	6.8	0.3		100.0	336
Dow General	3.0 pts.	5 gals. #2 oil	3.8	3.9*	14.2	0.3		100.0	332
Premerge	5.0 pts.	5 gals. #2 oil plus 1 pt. X-100	2.3	2.2	8.8	0.6	0.3	100.0	338
Probe	4.0 lbs.		1.2	2.3	4.0			98.7	328
Probe	8.0 lbs.		1.4	2.2	5.3	0.5		95.8	330
Bravo[2]	1.0 pts.	1 qt. Niagara surfactant +							
Bravo[2]	1.0 pts.	1 qt. " " +							
		3 pts. Dow General	1.0	1.4	7.5			95.0	320

[1]Materials applied - August 27, 1973. Partly cloudy. 80F. Soil conditions dry but shower of 0.6 inches on night of August 27.
[2]First application of Bravo applied August 27 followed by second application on September 4.
[3]Kill rating code presented in Table 1.
[4]Examinations made on 15 pound samples from each of six replicates on December 26, 1973.
*New growth started to appear about September 10, 1974.

Table 3. Effect of several chemicals and additives on potato vine desiccation, discoloration of tubers, emergence, and yield from tubers used for seed. Katahdin variety. Maine - 1973.

Treatments[1]			Vine Kill ratings[2]		Percent vascular discoloration[3]			% emergence	Yield Cwt./A.
Material	Product Rate/Acre	Additive	9-4	9-10	Slight	Medium	Severe	1974	1974
No treatment			1.0	1.0	1.0	0.6		98.3	327
N252	0.5 lbs.	3.2 pts. Adjuvant T	1.6	1.3	4.5	2.3		100.0	340
N252	1.0 lbs.	3.2 pts. Adjuvant T	1.7	1.5	7.7	0.6	0.6	100.0	338
N252	2.0 lbs.	3.2 pts. Adjuvant T	2.2	2.0	8.4	2.0	0.2	100.0	329
N252	4.0 lbs.	3.2 pts. Adjuvant T	3.3	3.3	12.8	0.9	0.9	100.0	332
R24191	5.7 lbs.		1.1	1.3	9.3	0.3	0.6	100.0	325
R24191	8.6 lbs.		1.0	1.3	5.3	0.5	0.3	100.0	326
R24191	11.4 lbs.		1.1	1.4	5.3	1.2	0.3	99.2	332
Stam	11.4 lbs.	0.4 lbs. Sevin	1.7	2.5	3.8	0.6	0.3	100.0	316
Stam	17.1 lbs.	0.6 lbs. Sevin	2.4	3.4	7.9	0.7		100.0	318
Dow General	2.0 qts.	2.0 qts. Staples 1% oil mix	3.9	4.0*	3.6			100.0	334
Dow General	2.0 qts.	2.0 qts. Staples 5% oil mix	4.0	3.8*	4.8	0.3		100.0	336
Dow General	2.0 qts.	2.0 qts. Staples 10% oil mix	2.8	3.0	2.0			100.0	333
Dow General	3.0 pts.	5 gals. #2 oil	3.8	3.7*	7.4	1.9	0.3	100.0	338
Premerge	5.0 pts.	5 gals. #2 oil + 1 pt. X-100	2.2	2.1	9.1	1.2		100.0	338
Dow General	2.0 qts.	2.0 qts. Booster Plus E	3.2	3.1	8.4	0.9		100.0	332
Dow General	2.0 qts.	1.0 qt. Charger E	3.0	2.9*	5.5	0.3		100.0	336
Des-I-Cate	1.0 gal.		3.2	3.3	4.6	0.6		100.0	330
Des-I-Cate	1.0 gal.	5 gals. #2 oil	3.3	3.3	5.8	0.3		100.0	334
Des-I-Cate	1.5 gals.		3.8	4.0	1.4	1.3		100.0	332
Des-I-Cate	1.5 gals.	5 gals. #2 oil	4.2	4.3	1.5			100.0	332
Des-I-Cate	2.0 gals.		4.1	4.3	2.4	1.0		100.0	313
Des-I-Cate	2.0 gals.	5 gals. #2 oil	4.6	4.3	4.4	0.3		99.2	330

. . . . Continued

Table 3 (cont.)

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[1]Materials applied - August 28, 1973. Partly cloudy. 76F. Soil condiiton - field capacity.
[2]Kill rating code presented in Table 1.
[3]Examinations made on 15 pound samples from each of six replicates on December 28, 1973.
*New growth started to appear about September 10, 1974.

Table 4. Chemical desiccants used for Maine potato vine killing studies - 1973.

Compound	Active Ingredient	Source
Evik (80W)	2-(ethylamino)-4-(isopropylamino)-6-methyl-*S*-triazine	Ciba-Geigy Corporation
Bravo	tetrachloroisophthalonitrile	Diamond Shamrock
CP41845	N, N-Bis-(phosphomethyl)glycine	Monsanto
Des-I-Cate	Mono-(N-dimethylathylanion salt of endothal)	Pennwalt
Dow General	4, 6-dinitro-O-sec-butylphenol	Dow Chemical Company
N252	2,3-Dihydro-5, 6-dimethyl-1, 4-dithiin 1,1,4, 4 tetroxide	Uniroyal
Paraquat	1,1-dimethyl-4, 4-bipyridium dichloride	Chevron
Premerge	4, 6-dinitro-O-sec-butylphenol	Dow Chemical Company
Probe	2-(3,4-dichloropheny1)-4-emthyl-1,2,4-oxadiazolidine-3,5-dione	Velsicol Chemical
R24191	1-(m-*t*-butylacetamidophenyl)-3-methyl-3-methoxy urea	Stauffer
Sevin	1-naphthyl methylcarbamate	Union Carbide
Stam	3', 4'-dichloropropionanilide	Rohm and Haas
Adjuvant T	Surfactant	Ciba-Geigy Corporation
Booster Plus E	Surfactant	Agway
Charger E	Adjuvant and wetting agent	Agway
Miller Aide	Activator	
Niagara Surfactant	Surfactant	Niagara
Staples Oil Mixture	Surfactant	C.W. Staples Company
Tronic	Spreader-Activator	Kalo Laboratories
X-77	Spreader-sticker	Chevron
X-100	Spreader-sticker-emulsifier	

VINE KILLERS ON KATAHDIN POTATOES IN CONNECTICUT

J. F. Ahrens[1/]

ABSTRACT

Chemical vine desiccants were tested on Katahdin potatoes (Solanum tuberosum L.) in September of 1973 and 1974. Rate of vine desiccation varied greatly with treatment and was more rapid in 1974 with higher temperatures following application than in 1973.

Propanil (3',4'-dichloropropionanilide) at 6 lb/A plus carbaryl (1-napthyl-N-methylcarbamate) at 2 lb/A gave unsatisfactory vine or weed kill within 19 days, and ametryn (2-ethylamino-4-(isopropylamino)-6-(methylthio)-s-triazine) gave satisfactory vine kill in 19 days at 2.4 lb/A, but not at 1.6 lb/A. Dinoseb (2-sec-butyl-4,6-dinitrophenol) at 2.5 lb/A plus 5 gal of diesel or fuel oil, dinoseb plus urea at 70 lb/A, and paraquat (1,1-dimethyl-4,4'-bipyridinium ion) at 0.25 or 0.5 lb/A all gave effective vine kill in 10 to 19 days. Diesel oil or paraquat at .125 lb/A improved vine and weed kill with endothall (7-oxabicyclo [2,2,1] heptane-2,3-dicarboxylic acid, mono (N,N-dimethyl alkamine)salt) or ametryn, and urea hastened vine kill with ametryn but not endothall. Tuber decay, net necrosis, vascular discoloration, and sprouting of stored tubers were not significantly affected by the 1973 treatments.

INTRODUCTION

Vines of Katahdin potatoes and weeds remaining at harvest must be thoroughly desiccated to minimize losses during mechanical harvest. Vine killing also is necessary to allow potato skins to toughen prior to harvest. In recent years dinoseb plus diesel or No. 2 fuel oil has replaced sodium arsenite as the standard vine killer in Connecticut, where Katahdin is the main variety grown for storage. With other vine desiccants now available it was the purpose of this work to determine under local conditions their effects on Katahdin vines, tubers, and associated weeds. Siezcka (1) and Murphy and Goven (2) reported that paraquat applied on vigorously growing vines or at high rates of application caused decay of tubers in storage. High rates of paraquat or ametryn also reduced sprouting of tubers the following spring (1, 2). Several reports have indicated the value of additives such as diesel or fuel oil, nitrogen, spray adjuvants or of combining different vine killers (2, 3, 4). Urea (46% N) has been applied with vine killers by some growers to supply nitrogen to the rye cover crop.

MATERIALS AND METHODS

Chemical desiccants were applied on September 7, 1973 and on September 6, 1974 in South Windsor, Connecticut. The chemicals used are given in Table 1. Plots were two rows 25 ft long separated by border rows and arranged in randomized complete blocks with four replicates. Sprays were applied at 60 psi using a handheld boom with four teejet 6506 nozzles, calibrated to deliver 70 gal/A. In both tests the vines were mature but green at treatment and the air temperature was 75°F. Rain started about 7 hrs after treatment in 1974. Temperatures and rainfall for periods after treatment are given in Table 2. A cover crop of rye was sown over the plot area on October 1, 1973.

1/ The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor.

TABLE 1. Chemicals used in vine killer tests.

Common name	Chemical name	Trade name and formulation	years applied
dinoseb	2-sec-butyl-4,6-dinitrophenol	Sinox General e.c. 5 lb/gal	1973
		Dow General e.c. 5 lb/gal	1974
ametryn	2-(ethylamino)-4-(isopropylamino)-6-(methylthio)-s-triazine	Evik 80 W	1973-74
		Evik e.c. 3 lb/gal	1973
paraquat	1,1'-dimethyl-4,4'-bipyridinium ion	Paraquat CL 2 lb/gal	1973-74
endothall	7-oxabicyclo/2,2,1/heptane-2,3-dicarboxylic acid, mono(N,N-dimethylalkamine)salt	Des-I-Cate .52 lb/gal	1973-74
carbaryl	1-napthyl-N-methylcarbamate	Sevin 50 W	1973
propanil	3',4'-dichloropropionanilide	Stam F-34 e.c. 3 lb/gal	1973

TABLE 2. Average daily temperatures and rainfall for periods following application of vine killers in 1973 and 1974.

	1973		1974	
Days after treatment	Temp °F	Rainfall in.	Temp °F	Rainfall in.
0-4	63	0	63	1.0
5-10	60	.95	68	.26
11-14	56	1.15	65	.14
15-19	58	.67	54	1.30
Avg	59		63	

Vine kill ratings were made at 4, 10, 14, and 19 days after treatment using a 1 to 9 system where 1 = no kill of leaves or stem, and 5 = 100 percent kill of leaves, 7 = 100 percent kill of leaves plus 50 percent kill of stems and 9 = 100 percent kill of leaves and stems. Kill of weeds was rated on a 0 to 10 scale at 10 or 14 days after treatment. The principal weeds present in both years were crabgrass (Digitaria sp.), barnyardgrass (Echinochloa cusgali) and common ragweed (Ambrosia artemisiifolia L.). At 19 days, approximately 16 pound samples of tubers were taken from each plot and placed in a storage held at approximately 60°F for the first month and gradually decreasing to 40°F thereafter.

The 1973 samples were evaluated in early February, 1974. Twenty-five tubers from each plot were cut lengthwise and net necrosis and the percentage vascular discoloration were estimated. Following these evaluations 25 tuber halves from each of three replicates were placed in flats, covered with unsterilized soil and held moist in a 65°F greenhouse according to the method of Sieczka (1). The number of decayed tuber halves and the number of sprouts over 1 inch in length were counted after 40 days.

RESULTS AND DISCUSSION

The 1973 results are given in Tables 3 and 4 and the 1974 results on vine and weed kill are given in Table 5. Vine kill ratings of 8.5 or better (100 %

kill of leaves plus 87% kill of stems) and weed kill ratings of at least 8.0 (80% kill) were considered desirable for mechanical harvest of Katahdin potatoes. The treatments differed markedly in their speed and effectiveness of vine and weed kill. Kill also was faster in 1974 than in 1973 for the contact killers dinoseb, paraquat, and endothall. Temperatures following treatment were somewhat higher in the 1974 test than in 1973 (Table 2) which may have increased the rate of vine desiccation.

Dinoseb is considered to be the current standard vine killer in Connecticut, to which all other materials might be compared. Dinoseb plus diesel oil required 19 days for satisfactory vine kill in 1973, and dinoseb plus No. 2 fuel oil satisfactorily killed the vines within 10 days in 1974. Replacing the diesel oil with urea at 70 lb/A in 1973 did not significantly affect vine kill but it reduced weed kill.

Propanil plus carbaryl, at the dosages applied in 1973 did not give satisfactory vine kill within 19 days.

TABLE 3. Average vine and weed kill ratings - 1973 trial.

Treatment	Rate, a.i. lb/A	Vine kill ratings 1/ 4 days	10 days	14 days	19 days	Weed kill 2/ 14 days
untreated		1	1	1	1	0
dinoseb+diesel oil	2.5+5 gal	5.8	7.1	7.9	8.5	9.3
dinoseb+urea	2.5+70	5.3	6.9	7.4	8.5	7.1
ametryn 80W	1.6	2.0	5.3	7.3	8.2	9.2
80W	2.4	2.0	5.8	7.3	8.4	9.6
e.c.	1.0	2.0	6.0	7.4	8.6	8.9
ametryn 80W+ diesel oil 3/	1.6+5 gal	3.0	6.3	7.5	8.6	9.9
ametryn 80W+urea	1.6+70	4.4	6.9	7.6	8.7	8.3
ametryn 80W+	1.6+.125	3.0	7.1	7.9	8.6	9.7
paraquat	1.6+.25	3.8	7.3	8.3	8.9	9.9
	1.2+.25	4.0	7.6	8.2	8.7	9.7
paraquat 3/	.25	3.9	6.1	7.8	8.5	9.8
3/	.5	6.8	8.5	8.8	8.9	9.8
endothall	.78	5.1	7.0	7.6	8.2	5.3
	1.04	6.1	7.5	7.9	8.6	8.1
endothall+diesel oil 3/	.78+5 gal	5.8	7.4	7.6	8.6	4.8
endothall+urea	.78+70	4.5	6.4	6.9	8.0	6.5
endothall+paraquat	.78+.125	5.3	7.4	7.9	8.5	8.8
propanil+carbaryl	3+.15	2.0	4.9	6.9	7.5	9.0
	6+.3	2.0	6.0	7.0	8.1	8.7
L.S.D. p = .05		-	0.7	0.6	0.5	-

1/ 1 = no kill, 3 = 50% leaf kill, 5 = 100% leaf kill, 7 = 100% leaf kill+50% stem kill, 9 = 100% leaf & stem kill.
2/ 0 = no control, 10 = dead weeds.
3/ X-77 wetting agent added at .06% v/v.

TABLE 4. Effects of 1973 vine killers on quality of whole tubers after storage and on sprouting of tuber halves in soil.

Treatment	Rate a.i., lb/A	No. of tubers with decay 1/	No. of tubers with net necrosis 1/	Vascular discoloration percent	Tuber halves: Number decayed	Tuber halves: No. of sprouts per tuber
untreated		2	3	1.1	0	2.8
dinoseb+diesel oil	2.5+5 gal	1	1	2.4	0	2.4
dinoseb+urea	2.5+70	0	2	1.6	0	1.9
ametryn 80W	1.6	2	1	1.5	0	2.4
80W	2.4	1	0	1.8	0	2.6
e.c.	1.6	0	2	2.1	0	2.6
ametryn 80W+diesel oil 3/	1.6+5 gal	0	4	1.8	0	2.2
ametryn 80W+urea	1.6+70	0	1	1.5	0	2.7
ametryn 80W+paraquat	1.6+.125	1	0	1.3	0	3.1
	1.6+.25	0	0	3.0	1	2.7
	1.2+.25	0	2	1.9	0	3.1
paraquat 3/	.25	3	2	1.8	1	2.7
3/	.5	2	2	1.9	0	1.9
endothall	.78	0	0	2.1	0	2.5
	1.04	1	4	1.4	0	2.5
endothall+diesel oil 3/	.78+5 gal	1	1	2.6	0	3.0
endothall+urea	.78+70	0	2	1.1	4	2.4
endothall+paraquat	.78+.125	0	2	1.7	0	2.2
propanil+carbaryl	3+.15	0	2	1.9	0	2.6
	6+.3	2	3	1.7	0	2.8
L.S.D. p = .05				N.S.		N.S.

1/ Number of tubers of 100 tuber samples with 15 percent or more decay.
2/ Number of tuber halves of 75 tuber halves with 90 percent or more decay.
3/ X-77 wetting agent added at .06% v/v.

Ametryn wettable powder alone at 2.4 lb/A required 19 days for satisfactory vine kill in both years. Ametryn alone at 1.6 lb/A was marginally effective at 19 days. Kill of mature barnyardgrass was unsatisfactory with ametryn alone at either dosage in 1974. Emulsifiable ametryn was slightly more effective on vines than the wettable powder form in 1973. Diesel oil, urea and paraquat all hastened vine kill with wettable ametryn. In the ametryn-paraquat combinations, dosage of paraquat determined the speed of vine kill.

Paraquat alone at .5 lb/A gave the most rapid vine kill in both years, requiring 10 days for acceptable results. Paraquat at .25 lb/A was about as effective as dinoseb plus oil in vine kill but was more effective than dinoseb in kill of grasses. Regrowth of occasional vines was obtained with paraquat at .25 lb/A, however. As little as .125 lb/A of paraquat with ametryn or endothall greatly improved weed kill over ametryn or endothall alone.

In 1973 endothall gave satisfactory vine kill in 19 days only at the higher dosage of 1.04 lb/A, but in 1974 .78 lb/A gave satisfactory vine kill in 14 days. In 1973 diesel oil or paraquat at .125 lb/A slightly improved vine kill with endothall at .78 lb/A, but urea did not. Kill of barnyardgrass and crabgrass was

TABLE 5. Average vine and weed kill ratings - 1974 trial.

Treatment 1/	Rate a.i., lb/A	Vine kill ratings 2/ 4 days	10 days	14 days	19 days	Weed kill ratings 3/ 10 days ragweed	grasses
untreated		1.0	2.0	2.3	5.0	0	0
dinoseb+fuel oil	2.5+5 gal	6.3	8.6	8.9	9.0	9.5	7.8
ametryn 80W	1.6	1.5	5.5	7.6	8.4	8.0	5.7
	2.4	1.8	6.4	7.9	8.6	7.0	5.3
paraquat	.25	4.0	8.4	8.9	9.0	10.0	9.3
	.5	6.0	8.8	9.0	9.0	10.0	9.7
ametryn+paraquat	1.6+.125	3.0	7.5	8.5	8.9	9.5	8.8
	1.2+.188	2.8	8.0	8.7	9.0	9.9	9.0
endothall	.78	5.3	7.7	8.8	9.0	5.5	1.3
	1.04	5.8	8.3	8.8	9.0	6.5	3.0
L.S.D. p = .05			1.2	0.4	0.3		

1/ All treatments included X-77 at .06% v/v.
2/ 1 = no kill, 3 = 50% leaf kill, 5 = 100% leaf kill, 7 = 100% leaf kill+50% stem kill, 9 = 100% kill of leaves and stems.
3/ 0 = no control, 10 = dead weeds. Grasses included crabgrasses and barnyardgrass.

poor with endothall except where paraquat was added.

As shown in Table 3, none of the vine killer treatments significantly affected decay, net necrosis or vascular discoloration in the samples of stored tubers. Similarly, decay and sprouting of the tuber halves in unsterilized soil were not affected by any treatment in 1973. None of the 1973 treatments significantly affected the stand of a rye cover crop sown after harvest.

CONCLUSIONS

Ametryn alone kills mature Katahdin vines and weeds slowly under cool September conditions in Connecticut. Diesel oil or low rates of paraquat may be needed to speed vine desiccation with ametryn. Paraquat and endothall compared favorably with dinoseb plus diesel or fuel oil in vine desiccation, but endothall alone may not be satisfactory in fields with heavy weed infestation. Paraquat gave the best control of weeds but at low rates applied alone allowed some potato vine regrowth. Further observations on tuber samples from the 1974 crop will be needed to assess better the vine killer effects on stored tubers.

LITERATURE CITED

1. Sieczka, J. B. 1972. The effect of potato vine killing with paraquat on storagability of potato tubers. Proc. Northeast. Weed Sci. Soc. 26:332-337.
2. Murphy, H. J. and M. J. Goven. 1973. Potato vine killing in Maine - 1971. Proc. Northeast. Weed Sci. Soc. 27:294-301.
3. Murphy, H. J. and M. J. Goven. 1974. Potato vine killing in Maine - 1972. Proc. Northeast. Weed Sci. Soc. 28:309-314.
4. Dallyn, S. and P. A. Schippers. 1971. Potato vine killing. Proc. Northeast. Weed Sci. Soc. 25:193-198.

EFFECT OF SEVERAL COMBINATIONS OF PREPLANT INCORPORATED AND PREEMERGENCE HERBICIDES ON WEED CONTROL IN POTATOES

H. J. Murphy[1]

Abstract

A comparison of *S*-ethyl dipropylthiocarbamate (EPTC) and N-(cyclopropylmethyl)-α,α,α-trifluro-2,6-dinitro-N-propyl-ρ toluidine (profluralin) applied preplant incorporated provided full season control of annual barnyard grass (*Echinochloa crusgalli*) in potatoes. Either compound when combined with preemergence herbicides 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron), 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorbromuron), or 2-sec-butyl-4, 6-ditrophenol (DNBP) provided full season control of *Brassica nigra, Brassica campestris, Polygonum persicaria, and Chenopodium album.*

Introduction

The use of preplant incorporated herbicides followed by preemergence herbicides for broadleaf weed control is a widely accepted practice in Maine. Until now *S*-ethyl dipropylthiocarbamate (EPTC) has been the only acceptable preplant herbicide for grass control but has the disadvantage of being volatile, requiring immediate soil incorporation. Reportedly, N-(cyclopropylmethyl)-α,α,α -trifluro-2,6-dinitro-N-propyl-ρ-toluidine (profluralin), a new preplant herbicide for grass control, was as effective as EPTC, but did not require immediate soil incorporation. The purpose of this study was to determine if EPTC and profluralin were competitive for grass control in potatoes and secondly, if broad spectrum weed control could be attained when combined with standard preemergence herbicides.

Materials and Methods

Preplant treatments of profluralin and EPTC as listed in Table 1 were applied and incorporated into a gravelly silt loam soil to a depth of 3 inches on June 6, 1974. Katahdin potatoes were planted on June 6 and preemergence herbicide treatments as listed in Table 1 were applied on June 12, 1974. Soil conditions were dry, air temperature 68F., and weather partly cloudy. All herbicides were applied in 80 gallons of water using 40 P.S.I. pressure. Plots were 2 rows (68 inches) wide and 20 feet long with single buffer rows and alleyways between treatments. Field plot design was a randomized block and all treatments were replicated six times. Weed control ratings were made on July 2, and again before harvest on September 28, 1974.

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[1]Associate Professor Agronomy, Department of Plant and Soil Sciences; University of Maine, Orono, Maine 04473.

Results and Discussion

Data presented in Table 1 indicate that all rates of profluralin gave satisfactory control (4.0+) of annual barnyard grass (*Echinochloa crusgalli*) as indicated by the 8-29 readings, but was slightly delayed in activity as indicated by the 7-2 ratings. Control of lambsquarters (*Chenopodium album*), black mustard (*Brassica nigra*), wild rutabaga (*Brassica campestris*), and lady's thumb (*Polygonum persicaria*) was not expected with profluralin, but ratings on both dates indicate fair (3.0+) broadleaf weed control. EPTC at the 3-pound per acre rate did not control annual grass or broadleaf weeds, but when combined with chlorbromuron, linuron, or DNBP provided excellent full season, broad spectrum weed control in this study. DNBP and linuron also provided satisfactory weed control but chlorbromuron at the 1.0-pound rate was not very effective for annual grass or broadleaf weed control.

It would appear from the data presented in Table 1 that combinations of profluralin with linuron or DNBP were as effective as combinations of EPTC and linuron and DNBP for full season control of annual grass and broadleaved weeds.

Table 1. Effect of profluralin and EPTC preplant incorporated and preemergence herbicides on weed control and yield of potatoes. Maine - 1974.

Treatments Pounds of Active Material per Acre	Yield Cwt./Acre	Weed Control Ratings[1] Broadleaved		Annual grass	
		7-2	8-29	7-2	8-29
No treatment	327	1.0	1.0	1.0	1.0
0.75 lbs. Profluralin (PPI)	342	3.4	3.0	3.0	4.2
1.0 lbs. Profluralin (PPI)	338	3.6	3.1	2.8	4.0
1.5 lbs. Profluralin (PPI)	334	3.4	3.2	3.2	4.5
2.0 lbs. Profluralin (PPI)	291	3.4	3.0	3.2	4.4
0.75 lbs. Profluralin (PPI) plus 1.0 lb. Chlorbromuron, P.E.	341	5.0	4.8	4.8	4.8
0.75 lbs. Profluralin (PPI) plus 4.5 lbs. DNBP, P.E.	349	5.0	4.5	4.4	4.6
3.0 lbs. EPTC (PPI)	310	2.4	2.0	2.0	3.6
6.0 lbs. EPTC (PPI)	348	5.0	2.5	4.8	4.8
3.0 lbs. EPTC (PPI) plus 1.0 lb. Chlorbromuron, P.E.	353	5.0	5.0	4.6	4.8
6.0 lbs. EPTC (PPI) plus 1.0 lb. Chlorbromuron, P.E.	346	5.0	5.0	4.6	5.0
3.0 lbs. EPTC (PPI) plus 1.0 lb. Chlorbromuron, P.E.	340	5.0	5.0	5.0	5.0
6.0 lbs. EPTC (PPI) plus 1.0 lb. Chlorbromuron, P.E.	340	5.0	5.0	5.0	5.0
3.0 lbs. EPTC (PPI) plus 4.5 lbs. DNBP, P.E.	362	5.0	4.5	4.6	5.0
6.0 lbs. EPTC (PPI) plus 4.5 lbs. DNBP, P.E.	361	5.0	4.8	5.0	4.8
4.5 lbs. DNBP, P.E.	346	5.0	4.0	4.4	3.8
1.0 lb. Linuron, P.E.	332	4.0	3.5	4.0	3.4
2.0 lbs. Linuron, P.E.	327	4.6	4.2	4.4	4.0
1.0 lb. Chlorbromuron, P.E.	333	1.8	2.0	1.8	2.0
2.0 lbs. Chlorbromuron, P.E.	349	3.2	3.6	3.0	1.8
Bayes L.S.D. (0.05)	42				

[1]Rating code: 1 = no control; 5 = excellent control.

THE EFFECT OF PRE-PLANT APPLICATIONS OF EPTC TO SOILS WITH AN ATRAZINE RESIDUE ON POTATOES [1/]

J. B. Sieczka, P. F. Boldt and R. D. Sweet[2/]

Abstract

EPTC (S-ethyl dipropylthiocarbamate) was applied as a pre-plant incorporated treatment to soils with a known atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] level. Symptoms of both herbicides were observed on two potato (Solanum tuberosum L.) clones ('Katahdin' and 'Superior'). Yield data indicate that residual atrazine can reduce yields but the data do not reveal any evidence of an interaction between atrazine and EPTC.

Introduction

The use of EPTC for the control of annual grasses and yellow nutsedge (Cyperus esculentus L.) in potatoes is widespread. The material may be applied pre-plant incorporated or after the potato plants have emerged. Numerous workers have reported on the efficacy of EPTC and most have not demonstrated adverse effects on crop yield (4, 7, 8). Often, the characteristic "fiddlehead fern" appearance is observed on emerging potato plants in fields treated with EPTC, especially as a pre-plant application. This symptom, however, is not necessarily associated with yield reductions even though occasional reductions have been reported. The two clones, 'Superior' and 'Pungo' have been identified as somewhat sensitive to pre-plant applications of the chemical (1, 2, 5). Cialone (2) reported that emergence of 'Pungo' plants was delayed and the vigor of plants was adversely affected by EPTC treatments. He also reported yields from EPTC plots were lower than the other herbicide treatments used, dinoseb (2-sec-butyl-4, 6-dinitrophenol) and linuron [3-(3, 4-dichlorophenyl)-1-methoxy-1-methylurea]. Using 'Katahdin' potatoes, Kuratle and Rahn (6) found that pre-plant applications of EPTC in Delaware caused stand, vigor and yield reductions when applied to early plantings while applications to late plantings resulted in no adverse effects. Fricke (4) and Murphy and Goven (8) in New York and Maine respectively have not observed the same degree of sensitivity in 'Katahdin'.

Stunted 'Superior' potato plants were observed in 1972 in upstate New York. The field on which they were growing received a pre-plant incorporated

[1/] Paper No. 686 of the Department of Vegetable Crops, Cornell University Ithaca, New York.

[2/] Extension specialist, Graduate Assistant, and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York.

application of granular EPTC. In 1971, atrazine had been applied to this field to control weeds in field corn (Zea mays L.). During the early part of the 1972 growing season, the field was wet due to the heavy rains of Hurricane Agnes. The wet conditions undoubtedly inhibited the metabolic breakdown of EPTC by the potato plants. The reported EPTC sensitivity of this clone may have also contributed to the poor growth. An interaction between EPTC and atrazine as reported by Duke, Rao and Hunt (3) in alfalfa might also be a factor. An investigation was initiated to determine if an interaction exists between EPTC and atrazine on two potato clones and to determine whether the two potato clones react differently to EPTC, atrazine and the combination. The effect of antidote R25788 was also observed.

Materials and Methods

The experiment was conducted on a Howard gravelly loam soil at Freeville, New York. The experimental design was a split-split plot with four replications. The main plots were atrazine treatments, the sub plots were EPTC treatments and the sub-sub plots were varieties. The main plots were 12 feet wide and 42 feet long. Atrazine was applied by a tractor-mounted boom sprayer at a rate equivalent to 1.4 lbs in 45 gallons of water per acre on October 27, 1972. Heavier than normal precipitation occurred after application but before March, 1973, when samples of the top six inches of soil were taken for atrazine bioassays. The bioassays with germinating seeds were negative for the presence of atrazine. A subsequent atrazine application was then made at a rate of 0.5 lbs/A in April. The land was plowed and disced prior to EPTC application on May 15, 1973. EPTC was applied at 6.0 lbs/A with a hand-held CO_2 pressurized sprayer applying 45 gal/A at 40 psi. Antidote R25788 was applied at 0.5 lbs/A to the entire experimental areas in two replications either in combination with EPTC or alone. Immediately after application, the total area was tilled twice with a spring tooth harrow. The varieties used in the final split of the split-split plot design were 'Katahdin' and 'Superior'. The potatoes were planted in 34 inch rows. The plot size for the variety treatments were 2 rows wide x 21 feet long. Yield data were collected on the center 18 feet of both rows of each variety. The potatoes were planted on May 15, 1973, vine killed September 7, and harvested September 17.

Results and Discussion

Plant and leaflet distortion (EPTC symptoms) were apparent on 'Superior' plants in the EPTC treated plots on June 12 (see Table 1). There were few emerged 'Katahdin' plants at this date, but those that were appeared normal. However, on June 22 the plant and leaf distortion was observed on the 'Katahdin' plants growing in EPTC treated soil. 'Superior' plants were beginning to grow out of the disorder on this date. Plant distortion was most pronounced in plots that received both EPTC and atrazine. By July 2, both varities were free of EPTC symptoms. Atrazine injury symptoms were greatest on June 22 for both varieties. 'Superior' plants were affected more by atrazine than were 'Katahdin' plants. EPTC did not increase the atrazine

Table 1. The effect of atrazine and EPTC on appearance of potato plants [1/]

Chemical and Rate (lb/A)		6/12 [2/]		6/22		7/2		8/22
		Leaflet		Leaflet		Leaflet		Vine
Atrazine	EPTC	Distortion	Color	Distortion	Color	Distortion	Color	Maturity
'Katahdin'								
0.5	6.0	1.0	1.0	3.5	1.5	1.0	1.0	1.4
0.5	0	1.0	1.0	1.5	1.7	1.0	1.0	1.2
0	6.0	1.0	1.0	2.2	1.0	1.0	1.0	1.5
0	0	1.0	1.0	1.0	1.0	1.0	1.0	2.2
'Superior'								
0.5	6.0	2.2	1.5	2.5	2.2	1.0	1.2	2.9
0.5	0	1.2	1.2	1.5	2.0	1.0	1.0	2.9
0	6.0	2.5	1.5	2.0	1.2	1.0	1.0	3.3
0	0	1.0	1.2	1.0	1.0	1.0	1.0	3.6

1/ Ratings based on a scale of 1-5. For leaflet distortion (EPTC symptoms), 1 = normal shape, 5 = severe crinkling; for color (atrazine symptoms), 1 = green, 5 = severe chlorosis; for vine maturity, 1 = vigorous growth, 5 = senescent vines.

injury in either clone. Symptoms of herbicide injury were not apparent on July 2. Vine maturity was noted on August 22. The vine growth of the clone 'Superior' was open and beginning to die down, whereas 'Katahdin' plants were relatively vigorous. In both clones, the control plots were more mature than those treated with EPTC, atrazine or the combination. This indicated that the herbicides retarded or delayed early growth. The inclusion of antidote R25788 did not reduce EPTC symptoms.

Data on yield, tuber size and specific quantity are presented in Table 2. Total yield and yield of 2-4" tubers was higher in the atrazine-free plots. EPTC applications did not affect crop yields. Mean tuber weight and specific gravity were not affected by chemical or varietal treatment. The difference in yield (total and 2-4") between clones was significant at the 1% level. The other main effects and interactions were not statistically significant.

Conclusions

EPTC symptoms on the foliage of 'Katahdin' and 'Superior' potatoes increased when atrazine was present in the soil. However, atrazine symptoms were not increased by the presence of EPTC. Yield reduction can be expected if there is a sufficient atrazine residue to cause foliage injury. At the present, there is no reason to assume that an interaction exists between EPTC and atrazine which will cause yield reduction in potatoes.

Literature Cited

1. Campbell, J. C. 1971. Personal communication.

2. Cialone, J. C. 1967. Weed control in Irish potatoes in eastern Virginia. NEWCC 21:137-144.

3. Duke, W. B., V. S. Rao and J. F. Hunt. 1972. EPTC-atrazine residue interaction effect on seedling alfalfa varieties. NEWSS 27:258-262.

4. Fricke, D. H. 1972. Evaluation of herbicides for annual weed control in white potatoes (1971). NEWSS 26:303-309.

5. Fricke, D. H. 1971. Personal communication.

6. Kuratle, H. and E. M. Rahn. 1968. Time of application of EPTC for nutgrass control in potatoes. NEWCC 22:424-428.

7. Lay, M. M., W. J. McAvoy, and R. D. Ilnicki. 1973. Some promising herbicides and herbicide combinations for weed control in white potatoes. NEWSS 27:266-273.

8. Murphy, H. J. and M. J. Goven. 1972. Weed control in white potatoes in Maine - 1971. NEWSS 26:316-323.

Table 2. The effect of atrazine and EPTC on yield, tuber size and specific gravity.

Chemical and Rate		Yield (cwt/A)		% of Total Yield			Mean Tuber Weight	Specific
Atrazine	EPTC	Total	2-4"	2-3 1/4	3 1/4-4	>4	(oz)	Gravity
'Katahdin'								
0.5	6.0	345	321	64	30	0.9	6.7	1.075
0.5	0	342	316	68	24	1.2	6.6	1.073
0	6.0	374	345	70	21	1.5	6.4	1.073
0	0	357	335	65	29	0.6	6.5	1.074
'Superior'								
0.5	6.0	383	359	75	21	0	6.5	1.075
0.5	0	351	329	75	19	0	6.1	1.073
0	6.0	397	378	78	17	0	6.5	1.074
0	0	413	396	74	28	0	6.5	1.073
Main effects:								
+ Atrazine		355	331				6.5	1.074
- Atrazine		385	363				6.5	1.073
+ EPTC		375	351				6.5	1.074
- EPTC		366	341				6.5	1.073
Katahdin		354	329				6.6	1.074
Superior		386	366				6.4	1.074

WEED CONTROL IN WHITE POTATOES IN MAINE - 1974

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

Abstract

Fourteen candidate preemergence herbicides were tested in three separate studies to determine their efficacy for control of lady's thumb (*Polygonum persicaria*), lambsquarters (*Chenopodium album*), mustard (*Brassica nigra*), and annual barnyard grass (*Echinochloa crusgalli*) in white potatoes in Maine.

Several of the compounds such as: r-2-Ethyl-5-methyl-c-5(2-methylbenzyloxy)-1,3-dioxane (NIA25213), 1-(3,4-Dichlorophenyl)-3-methyl-3-methyl-3-(1-formyloxy-2,2,2-trichloroethyl) Urea (Ortho 16793), N-methyl-N-cyclohexyldithio-N'-*o*-fluorophenyl Urea (Ortho 17111), Benzyl 3,5-dichlo-2-,6-difluoro-4-pyridyl ether (PP888), 2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione (Methazole), N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine (Prowl), and 4-Amino-6-*tert*-butyl-3(Methylthio)-*as*-triazine-5(4*H*)one (Metribuzin) all provided satisfactory weed control in potatoes without significant reduction in yield.

The remaining candidate compounds such as: CGA17020, CGA24705, TH30843, 3,4,5-Tribromo-N,N,α-trimethylpyrazole-1-acetamide (UC27,267), and N-sec-butyl-4-*tert*-butyl-2,6-dinitro aniline (Amex 820) all needed the support of standard herbicides such as chlorbromuron or linuron to provide satisfactory weed control in potatoes.

Introduction

Fourteen candidate herbicides were tested alone and in combination with standard herbicides for control of annual and perennial weeds growing in Maine potato fields during 1974. We were looking for herbicides which had broad spectrum weed control, non-phytotoxic to potatoes, and preferably herbicides that were flexible as to time and method of application.

Rainfall during the 1974 growing season was near normal for May, June, and August, and about one inch above normal for July. During the period of herbicide application (June 12, 13, and 14) only traces of rainfall occurred but for the week following, above normal rainfall was recorded. Conditions for germination of annual broadleaved weeds and annual grasses were very favorable.

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[1]Associate Professor of Agronomy and Crops Supervisor, Department of Plant and Soil Sciences, University of Maine; Orono, Maine 04473.

Materials and Methods

Katahdin potatoes planted on June 5 and 6 were used for all test blocks reported. Soil type was a Caribou gravelly silt loam with an organic matter content of 4.64%. Plot areas had been Fall plowed, harrowed twice prior to planting, and the previous crop was Spring oats without chemical weed control to permit growth of annual grass species.

Experimental plot designs were randomized complete blocks with six replicates of each treatment. Individual plots consisted of single row plots, 20 feet long with single untreated buffer rows between plots. Herbicides were applied with a compressed air sprayer calibrated to apply 80 gallons of mixture at 40 P.S.I. pressure. Herbicides were applied on June 12, 13, and 14 for the tests presented in Tables 1, 2, and 3, respectively. Weed control ratings were made on the dates indicated in each table.

At harvest time, on October 4 and 7, yield of tubers was obtained and 25-pound samples saved from each plot or treatment for storage studies and as a supply of tissue for residue analysis when requested.

Stored tuber samples will be examined about 4 months after harvest for possible internal and external discoloration. Replicates of each treatment will be composited and stored at 45F. and 90% R.H. Selected treatments from these stored samples will be planted in 1975 to determine if herbicidal treatments might cause undesirable side-effects when treated tubers are used for seed purposes.

Common names, trade names, and chemical names for herbicides tested in Maine during 1974 for weed control in potatoes are presented in Table 4.

Results and Discussion

Data presented in Table 1 indicate that all materials tested provided satisfactory control (4.0+) of lady's thumb (*Polygonum persicaria*), lambsquarters (*Chenopodium album*), mustard (*Brassica nigra*), barnyard grass (*Echinochloa crusgalli*), and some wild radish (*Raphanus raphamistrum*).

Metribuzin alone at the low rate of 0.25 pounds per acre provided nearly as good control of both broadleaved weeds and annual grass as the highest rate of 1.5 pounds per acre. When combined with Prowl, Metribuzin improved control of broadleaved weeds and grasses early and late in the season. NIA25213 and PP888 caused some chlorosis of terminal leaves when used at the higher rates. This chlorosis, although not serious, persisted all season and in the case of PP888 significantly reduced yield of tubers. Data in Table 1 also indicate that NIA25213 also reduced yields significantly as compared to 'no treatment'.

Data presented in Table 2 indicate that Amex 820, UC27,267, and

TH30,843 alone, did not control any broadleaf weeds, annual grass, or quackgrass (*Agropyron repens*). Amex 820 in combination with all rates of metribuzin provided excellent (4.0+) full season control of lady's thumb, lambsquarters, and black mustard (*Brassica nigra*) but only average control (2.5+) of annual barnyard grass and quackgrass. Amex 820 in combination with 1.0 or 1.5 pounds of metribuzin improved the efficacy of this combination on annual barnyard grass and quackgrass somewhat, but not enough for satisfactory control ratings. When DNBP was combined with UC27,267, satisfactory control of broadleaf weeds and barnyard grass was attained but unsatisfactory control of quackgrass. Linuron plus TH30843 gave satisfactory control of broadleaf weeds and annual grass but not quackgrass. Methazole and the butam-cyprazole mixture (S6044) were also unsatisfactory for control of quackgrass but satisfactory for all other weeds present.

Data presented in Table 3 indicate that both CGA17020 and CGA 24705 had to be combined with chlorbromuron to provide satisfactory control of broadleaf weeds and annual barnyard grass. Ortho 16793 and Ortho 17111 applied at all rates provided satisfactory control of broadleaf weeds and barnyard grass. None of the herbicides presented in Table 3 had any significant effect on yield of potato tubers.

Table 1. Effect of several preemergence herbicides on yield and weed control in white potatoes. Maine - 1974.

Treatments Pounds of A.I. per Acre	Yield Cwt./Acre	Weed control ratings[a]			
		Broadleaved		Annual grass	
		7-3	8-28	7-3	8-28
No treatment	389	1.0	1.0	1.0	1.0
0.25 lbs. Metribuzin	348	3.6	4.8	3.6	4.6
0.5 lbs. Metribuzin	369	4.0	4.4	3.6	5.0
1.0 lb. Metribuzin	357	5.0	4.8	5.0	5.0
1.5 lbs. Metribuzin	373	5.0	4.6	5.0	5.0
1.0 lb. NIA25213	377	3.7	4.6	2.8	4.8
2.0 lbs. NIA25213	327	4.4	4.6	4.0	4.4
2.5 lbs. NIA25213	323	4.2	4.8	4.0	4.6
3.0 lbs. NIA25213	355[b]	3.8	4.4	4.2	4.4
2.0 lbs. NIA25213 plus 0.5 lbs. Metribuzin	355	4.8	5.0	4.0	5.0
0.5 lbs. PP888	352	3.8	4.8	2.8	4.4
1.0 lb. PP888	358	5.0	4.8	4.2	5.0
2.0 lbs. PP888	302[b]	5.0	4.6	5.0	4.6
1.0 lb. Prowl	367	3.0	4.4	3.2	4.0
1.5 lbs. Prowl	376	3.2	4.6	2.6	4.2
2.0 lbs. Prowl	371	3.8	5.0	4.4	4.8
1.0 lb. Prowl plus 0.5 lbs. Metribuzin	368	4.6	4.4	3.8	4.8
1.5 lbs. Prowl plus 0.5 lbs. Metribuzin	377	5.0	4.4	4.6	5.0
2.0 lbs. Prowl plus 0.5 lbs. Metribuzin	363	4.6	4.8	4.4	4.6
4.5 lbs. DNBP plus 5.0 lbs. Dalapon	357	4.8	4.4	4.0	5.0
Bayes L.S.D. (0.05)	48				

[a] Rating code: 1 = no control; 5 = excellent control.

[b] Some chlorosis on terminal leaves of potato plants.

Table 2. Effect of several herbicides on yield and weed control in white potatoes. Maine - 1974.

Treatments Pounds of A.I. per Acre	Yield Cwt./Acre	Weed control ratings[a/]					
		Broadleaved		Annual grass		Quackgrass	
		6-27	8-29	6-27	8-29	6-27	8-29
No treatment	195	1.0	1.0	1.0	1.0	1.0	1.0
2.0 lbs. Amex 820	280	2.5	2.0	1.3	1.6	1.7	1.1
2.0 lbs. Amex 820 plus 0.5 lbs. Metribuzin	342	5.0	5.0	5.0	3.0	2.3	3.0
2.0 lbs. Amex 820 plus 0.75 lbs. Metribuzin	360	5.0	4.8	5.0	2.8	2.5	2.7
2.0 lbs. Amex 820 plus 1.0 lb. Metribuzin	338	5.0	5.0	5.0	3.2	3.0	3.4
2.0 lbs. Amex 820 plus 1.5 lbs. Metribuzin	338	5.0	4.8	5.0	3.2	3.0	3.8
2.0 lbs. Butam-Cyprazole mixture	349	4.7	4.0	4.8	4.0	1.5	2.2
3.0 lbs. Butam-Cyprazole mixture	320	4.8	4.3	5.0	4.5	1.5	3.0
4.0 lbs. Butam-Cyprazole mixture	348	4.8	5.0	4.7	4.0	2.2	3.7
2.25 lbs. UC27,267	244	1.1	1.0	1.0	1.0	1.0	1.0
3.0 lbs. UC27,267	220	1.1	1.0	1.0	1.0	1.0	1.0
2.25 lbs. UC27,267 plus 2.25 lbs. DNBP	309	5.0	4.2	5.0	4.0	1.0	1.8
3.0 lbs. UC27,267 plus 2.25 lbs. DNBP	318	5.0	4.7	5.0	4.0	1.0	2.0
0.75 lbs. TH30843	220	1.0	1.2	1.0	1.0	1.0	1.2
1.5 lbs. TH30843	266	1.0	1.2	1.0	1.0	1.0	1.0
0.75 lbs. TH30843 plus 1.0 lb. Linuron	336	4.7	4.5	5.0	4.5	1.5	1.3
1.5 lbs. TH30843 plus 1.0 lb. Linuron	320	5.0	4.3	5.0	4.5	1.7	2.0
1.5 lbs. Methazole	318	5.0	4.7	4.5	4.5	1.5	2.2
2.0 lbs. Methazole	323	5.0	4.8	5.0	4.8	1.7	2.2
2.5 lbs. Methazole	324	5.0	4.7	5.0	4.8	1.8	2.7
1.5 lbs. Methazole (first sign of ground crack)	311	5.0	4.8	5.0	4.8	1.8	3.0
4.5 lbs. DNBP plus 5.0 lbs. Dalapon	331	5.0	4.3	5.0	3.2	1.3	1.7
Bayes L.S.D. (0.05)	31						

[a]/Rating code: 1 = no control; 5 = excellent control.

Table 3. Effect of several new preemergence herbicides on yield and weed control in white potatoes. Maine - 1974.

Treatments Pounds of A.I. per Acre	Yield Cwt./Acre	Weed control ratings[a/] Broadleaved		Annual grass	
		7-2	8-28	7-2	8-28
No treatment	340	1.0	1.0	1.0	1.0
0.75 lbs. CGA17020	336	1.0	1.3	1.0	1.0
1.0 lb. CGA17020	371	1.5	2.2	2.0	2.2
1.5 lbs. CGA17020	388	2.0	3.2	3.3	3.6
0.5 lbs. CGA17020 plus 1.0 lb. Chlorbromuron	424	5.0	4.8	5.0	5.0
0.75 lbs. CGA17020 plus 1.0 lb. Chlorbromuron	389	5.0	4.8	5.0	5.0
1.0 lb. CGA17020 plus 1.0 lb. Chlorbromuron	337	5.0	5.0	5.0	5.0
1.5 lbs. CGA24705	342	1.7	2.5	1.0	1.2
3.0 lbs. CGA24705	380	1.8	3.3	1.0	1.6
1.0 lb. CGA24705 plus 1.0 lb. Chlorbromuron	415	4.8	4.8	5.0	5.0
1.5 lbs. CGA24705 plus 1.0 lb. Chlorbromuron	405	5.0	5.0	5.0	5.0
3.0 lbs. CGA24705 plus 1.0 lb. Chlorbromuron	372	5.0	5.0	5.0	5.0
1.0 lb. Chlorbromuron	378	3.0	4.7	1.8	2.9
2.0 lbs. Chlorbromuron	414	4.8	4.7	4.0	5.0
1.25 lbs. Chlorbromuron plus 2.25 Alachlor	407	4.3	5.0	5.0	5.0
1.0 lb. Linuron	411	4.3	4.7	5.0	4.6
1.0 lb. Metribuzin	410	5.0	5.0	5.0	5.0
2.0 lbs. Ortho 16793	387	4.8	4.8	5.0	5.0
4.0 lbs. Ortho 16793	384	5.0	5.0	5.0	5.0
1.0 lb. Ortho 17111	390	4.8	5.0	5.0	4.6
2.0 lbs. Ortho 17111	395	5.0	5.0	5.0	4.8
4.5 lbs. DNBP plus 5.0 lbs. Dalapon	406	5.0	5.0	5.0	4.5
Bayes L.S.D. (0.05)	81				

[a]/Rating code: 1 = no control; 5 = excellent control.

Table 4. Herbicides used in white potatoes in Maine - 1974.

Trade Name	Common Name	Chemical Name
Amex 820		N-sec-butyl-4-*tert*-butyl-2,6-dinitro aniline
CGA17020		
CGA24705		
Dowpon	Dalapon	2,2-dichloropropionic acid
Eptam	EPTC	*S*-ethyl dipropylthiocarbamate
Lexone	Metribuzin	4-amino-6-*tert*-butyl-3(methylthio)-*as*-triazin-5(4*H*)one
Lorox	Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
Maloran	Chlorbromuron	3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea
NIA25213		*r*-2-Ethyl-5 methyl-*c*-5-(2-methylbenzyloxy)-1,3-dioxane
Ortho 16793		1-(3,4-Dichlorophenyl)-3-methyl-3-(1-formyloxy-2,2,2-trichloroethyl)urea
Ortho 17111		N-methyl-N-cyclohexyldithio-N'-*O*-fluorophenyl urea
PP888		Benzyl 3,5-dichloro-2,6-difluoro-4-pyridyl ether
Premerge	DNBP	2-*sec*-butyl-4,6-dinitrophenol
Probe	Methazole	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiozolidine-3,5-dione
Prowl		N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine
Sencor	Metribuzin	4-Amino-6-*tert*-butyl-3(methylthio)-*as*-triazin-5(4*H*)one
Surflan	Oryzalin	3,5-dinitro-N^4,N^4-dipropylsulfanilamide
TH30843		
Tolban	Profluralin	N-(cyclopropylmethyl)-α,α,α-trifluoro-2,6-dinitro-N-propyl-ρ-toluidine
UC27,267		3,4,5-Tribromo-N,N,α-trimethylpyrazole-1-acetamide
Lasso	Alachlor	2-cloro-2',6'-diethyl-N-(methoxymethyl_acetanilide
S6044	Butam plus Cyprazole	2,2-dimethyl-N-(1-methylethyl)-N-(phenylmethyl)propanamide N-[-5-(2-chloro-1,1-dimethyethyl)-1,3,4-thiadiazol-2yl] cyclopropanecarboxamide

MULTIPLE POSTEMERGENCE APPLICATIONS OF LINURON AND METRIBUZIN TO POTATOES[1]

C. P. Yip, H. H. Hatfield, and R. D. Sweet[2]

Abstract

An experiment was conducted to determine the influence of multiple postemergence applications of linuron [3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea] and metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one] at low rates on potatoes (Solanum tuberosum L.). Single postemergence applications of either chemical caused slight to moderate chlorosis, but potato plants recovered, with no significant yield reductions. Multiple applications of metribuzin showed slight chlorosis and no yield reduction. However, multiple applications of linuron caused chlorosis, stunting, necrosis and reduced yield, even at 2 ounces/A. Higher rates resulted in even greater damage and yield reductions.

Introduction

Several herbicides such as linuron and dinoseb (2-sec-butyl-4,6-dinitrophenol) are commercially available to potato growers. However, these chemicals are labelled for preemergence or preplant applications, since they are not safe on potatoes, when applied postemergence. Application of linuron early postemergence or at lay-by at the rates of 2 and 4 lbs/A caused slight to severe chlorosis and significant yield reduction (1, 2). Preemergence application of the newer herbicide, metribuzin, had been shown to provide excellent broadleaved weed control with no injury to potatoes (4, 7, 8). However, postemergence application resulted in slight to severe chlorosis and decreased yields, depending on the rate of application and the stage of growth of the potatoes (3, 5, 6). In all cases, higher rates of 1/2 to 2 lbs/A were used in single application.

This experiment was conducted to determine the effects of multiple applications of linuron and metribuzin at low rates postemergence on potatoes.

Materials and Methods

The experiment was conducted on Howard gravelly loam soil at Freeville, New York. The experimental area was worked with a spring-toothed harrow on May 20 just prior to planting of Katahdin potatoes. Plots consisted of two 34-inch rows, 15 feet long. Seed pieces were spaced 9 inches apart. Treatments were replicated three times in a randomized complete block design. Ten days after planting, the area was reworked with a finger weeder.

Spray materials were applied with a hand-operated CO_2 pressurized sprayer delivering 60 gals/A at 35 lbs/in^2. Rates of application listed in

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[1] Paper No. 682, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

[2] Graduate Student, Experimentalist, and Professor, respectively, Department of Vegetable Crops, Cornell University, Ithaca, New York, 14853.

Table 1 are active ingredients. The entire experimental area received a delayed preemergence application of dinoseb at 2 lbs/A on June 3. The rates of metribuzin and linuron used are listed in Table 1. Single herbicide applications as well as the first of the multiple applications were made on June 13 when the potatoes were 1 to 2 inches tall; second applications were given on June 22 when the potatoes were 6 to 8 inches tall; and the third applications were made on July 2, a day after hilling and prior to closing in of the potatoes.

Foliage symptoms, where evident, were recorded after each chemical application. The final visual ratings of the foliage were taken on July 7. Potatoes were harvested on September 20, two weeks after the application of dinoseb at 2.5 lbs/A plus 5 gals/A diesel fuel as a vine killer. Total yield and the number of tubers were determined.

Results and Discussion

Dinoseb at 2 lbs/A gave excellent weed control. No weeds emerged after hilling in any of the treatments. Postemergence treatment with metribuzin resulted in slight to moderate chlorosis on the foliage, regardless of single or multiple applications. Chlorosis was evident within the first week after each application. However, potato plants soon recovered, with no significant reduction in the number or weight of tubers (Table 1 and 2). These results do not correspond to those reported by Murphy (6), who found significant yield reductions from single applications of metribuzin at 1/4 to 1/2 lb/A when plants were 3 to 4 inches tall and at lay-by. Severe yield reductions have been noted in other experiments when rates greater than 1/2 lb/A of metribuzin were applied postemergence (4, 6, 8).

In contrast to the results obtained with metribuzin and a single application of linuron, multiple applications of the latter chemical caused severe chlorosis and stunting, even at 2 ounces/A. Symptoms were evident within two weeks after each application. The severity of symptoms increased with higher rates (Table 1). Total yield and the number of tubers were significantly reduced when compared to that of the plots treated with metribuzin or dinoseb alone (Table 1 and 2). Moderate to severe chlorosis was noted in treatments with a single application of linuron, but the plants recovered, with no yield reduction. In this case, the plants had a longer period of recovery than those treated three times in a series. Weight per tuber was not different among any of the treatments receiving metribuzin, linuron or dinoseb.

Conclusions

Single and multiple applications of metribuzin at low rates resulted in slight to moderate chlorosis, with no yield reductions. In contrast, multiple applications of linuron caused severe stunting, necrosis and yield reduction, even at the rate of 2 ounces/A. No severe necrosis or yield reduction occurred with single postemergence applications of linuron. It appears that one of the applications in the multiple applications of linuron affected the potatoes at a critical stage. This deserves further investigation.

Table 1. Influence of single and multiple postemergence applications of metribuzin and linuron on visual ratings and total yield of Katahdin potatoes.

Chemical	Timing[1]	Rate ounce/A	Visual Rating[2]	Yield[3] lb/plot
metribuzin	Multiple P.E.	1+1+1	8.3	91.0 cd
metribuzin	Multiple P.E.	2+2+2	8.3	91.7 cd
metribuzin	Multiple P.E.	4+4+4	7.7	95.3 cd
metribuzin	Single P.E.	3	9.0	94.3 cd
metribuzin	Single P.E.	6	9.0	91.3 cd
metribuzin	Single P.E.	12	8.7	94.0 cd
linuron	Multiple P.E.	2+2+2	8.0	78.0 bc
linuron	Multiple P.E.	4+4+4	4.7	72.7 ab
linuron	Multiple P.E.	8+8+8	3.3	59.3 a
linuron	Single P.E.	6	9.0	93.7 cd
linuron	Single P.E.	12	8.3	98.7 d
linuron	Single P.E.	24	8.3	92.7 cd
dinoseb	Delayed Pre	32	9.0	94.0 cd
dinoseb	Delayed Pre	32	9.0	95.7 cd
		Coefficient of variation = 10.5%		

[1] Postemergence and first application in multiple postemergence was applied on June 13; second application on June 22; third application on July 2.
[2] 9=ideal crop; 7=commercially acceptable; 1=complete crop kill.
[3] Means of three replications. 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 2. Influence of single and multiple postemergence applications of metribuzin and linuron on number of tubers and weight per tuber.

Chemical	Timing[1]	Rate ounce/A	No. Tubers/Plot[2]	Wt./Tuber[3] lbs.
metribuzin	Multiple P.E.	1+1+1	247.0 a	0.37
metribuzin	Multiple P.E.	2+2+2	247.0 a	0.37
metribuzin	Multiple P.E.	4+4+4	268.7 a	0.36
metribuzin	Single P.E.	3	249.0 a	0.38
metribuzin	Single P.E.	6	235.0 a	0.39
metribuzin	Single P.E.	12	237.3 a	0.40
linuron	Multiple P.E.	2+2+2	180.3 b	0.43
linuron	Multiple P.E.	4+4+4	180.3 b	0.39
linuron	Multiple P.E.	8+8+8	135.0 b	0.45
linuron	Single P.E.	6	241.3 a	0.39
linuron	Single P.E.	12	251.0 a	0.39
linuron	Single P.E.	24	232.7 a	0.40
dinoseb	Delayed Pre	32	254.3 a	0.37
dinoseb	Delayed Pre	32	243.7 a	0.39
	Coefficient of variation =		12.6%	7.6%

[1] Postemergence and first application in multiple series was applied on June 13; second application on June 22; third application on July 2.
[2] Means of three replications. Means within vertical column followed by the same letter are not significantly different at 5% level as determined by Duncan's Multiple Range Test.
[3] Differences are non-significant.

Multiple applications of metribuzin warrant further studies, especially in terms of weed control and better timing of application, since there is a need for an herbicide that could be safe on potatoes when applied post-emergence.

Literature Cited

1. Bayer, G. H. and R. D. Sweet. 1963. Potato response to linuron and Hercules 7531 at four stages of growth on muck and mineral soils. Proc. NEWCC 17: 158-161.

2. Bayer, G. H. and R. D. Sweet. 1964. Potato herbicides: A summary of their performance under three years of field testing. Proc. NEWCC 18: 159-165.

3. Hawkins, A. 1973. Late applications of metribuzin on control of large established broadleaved weeds, crabgrass and nutsedge in Katahdin potatoes in Connecticut in 1972. Proc. NEWSS 27: 274-275.

4. Henne, R. C. and R. T. Guest. 1974. Alachlor, chlorbromuron and metribuzin for weed control in potatoes. Proc. NEWSS 28: 296-298.

5. Lay, M. M., W. J. McAvoy and R. D. Ilnicki. 1973. Some promising herbicides and herbicide combination for weed control in white potatoes. Proc. NEWSS 27: 266-273.

6. Murphy, H. J. 1974. Rate and time of metribuzin application for weed control in white potatoes in Maine--1973. Proc. NEWSS 28: 303-306.

7. Murphy, H. J. and M. J. Goven. 1974. Weed control in white potatoes in Maine--1973. Proc. NEWSS 28: 287-295.

8. Sanok, W. J. 1974. Evaluation of herbicides for control of weeds in Long Island potatoes--1973. Proc. NEWSS 28: 282-286.

POTATO VARIETY RESPONSE TO METRIBUZIN

R. C. Henne [1/]

Abstract

Two potato (Solanum tuberosum L.) cultivars were evaluated for their tolerance to metribuzin (4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one) at four stages of crop development and at two rates of application. Variety Katahdin tolerated both rates at all stages tested whereas Superior was found sensitive to metribuzin rates at various stages of crop growth.

Introduction

The Superior potato variety has been used by the author for the past two seasons and postemergence metribuzin treatments have resulted in significant foliar injury (2, 3). Hawkins (1) using Katahdin noted no injury from metribuzin applied postemergence but Murphy (4) reported significant yield reductions with Katahdin when metribuzin was applied at emergence to 7.5 to 10 cm tall (at 1.68 kg/ha) and at several rates when applied at layby. Vanden Born et al (5) has reported differences in varietal sensitivity to metribuzin with seven other varieties.

This study was undertaken to determine if stage of crop development was a factor influencing potato response to metribuzin and whether or not varieties Katahdin and Superior responded in the same manner to these treatments.

Materials and Methods

Potatoes were planted April 19 in a randomized complete block with four replications. Two-row plots (each variety spaced 75 cm apart) were 1.5 by 6.1 m in size. Preemergence treatments were applied April 29 and postemergence sprays were applied May 22 with the crop 7.5 to 15 cm tall; May 31 when vines were 25 to 32 cm tall and flower bud initials were visible; and on June 10 with Superior in full bloom and Katahdin at 50% bloom. All treatments were applied with a bicycle plot sprayer delivering 308 L/ha at 2.11 kg/cm^2 air pressure.

The weed population was very low and consisted of common ragweed (Ambrosia artemisiifolia) and crabgrass (Digitaria sp). Plots were evaluated for weed control using a 1 to 9 rating system where 9 = complete control and 1 = no control. Notes were taken on foliar phytotoxicity and vine maturity. Yields were determined on August 12 and 13, and marketable grade was obtained by weighing tubers over 5.1 cm diameter.

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

Results and Discussion

Weed control was complete from all treatments except the 0.84 kg/ha rate applied at flowering. Ragweed and crabgrass were evidently too large to kill with the rate.

Preemergence metribuzin treatment resulted in no visible growth response in either variety. Yields, both total and marketable, were not significantly affected (Table 1) by treatment.

Early postemergence applications to 7 to 15 cm tall plants with 0.84 kg/ha were tolerated by Katahdin but produced leaf burning on the Superior variety. The 1.68 kg/ha rate delayed vine maturity of both varieties (i.e., vines remained upright and foliage was green) for 10 to 14 days longer than in control plots. However, yields were not significantly depressed in either variety.

Application at the second postemergence stage produced 10 to 20% foliage burn to Superior plants at both rates while the higher rate only resulted in minor tip burn on foliage of Katahdin. The higher rate delayed vine maturity of both varieties but yields of Katahdin were unaffected by either rate. There was a trend to lower marketable and total yields in Superior plants receiving the 0.84 kg/ha rate and significant yield reductions were measured at the high rate.

Application at the flowering stage was tolerated by Katahdin with only minor leaf-tip burn at the higher rate but Superior plants sustained 10 to 20% foliage burn. Vine maturity of either variety did not appear to be affected by these treatments, nor were yields of the Katahdin tubers. There was a trend for lower yield of Superior from the 0.84 kg/ha rate, and significantly lower total and marketable yields with the higher rate.

A significant variety by rate by stage of application interaction was obtained with both total and marketable yield data. Analysis of this interaction indicates Katahdin yields were unaffected by either rates or stages of growth when applications were made. However, yields of the Superior variety were adversely affected by the higher rate and there was a downward yield trend from the 0.84 kg/ha rate when applied at the bud stage or at flowering. The high rate significantly reduced yields at these latter two stages of growth.

Based on results from the experiment it would appear that the Superior variety should be treated preemergence (at up to 1.12 kg/ha), or at early stages of crop development with rates of metribuzin at or below 0.84 kg/ha, if significant crop injury in terms of yield reductions are to be avoided.

While a differential variety response was measured in this study indicating Katahdin quite tolerant to metribuzin, we are unable to explain Murphy's (4) results which indicated Katahdin susceptible to injury from postemergence treatments. Maximum rates were identical in both experiments, however, we lack comparative information on environmental conditions which may significantly modify crop response.

Literature Cited

1. Hawkins, Arthur. 1973. Late application of metribuzin on control of large established broadleaf weeds, crabgrass, and nutsedge in Katahdin potatoes in Connecticut in 1972. Proc. N.E. Weed Sci. Soc. 27:274-275.

2. Henne, R. C. and R. T. Guest. 1973. Evaluation of five herbicides in white potatoes. Proc. N.E. Weed Sci. Soc. 27:263.

3. Henne, R. C. and R. T. Guest. 1974. Alachlor, chlorbromuron, and metribuzin for weed control in potatoes. Proc. N.E. Weed Sci. Soc. 28:296-298.

4. Murphy, Hugh J. 1974. Rate and time of metribuzin application for weed control in white potatoes in Maine - 1973. Proc. N.E. Weed Sci. Soc. 28: 303-306.

5. Vanden Born, W. H., Wm. T. Andrew, R. J. Schraa, and W. V. Beck. 1973. Tolerance of seven potato stocks to metribuzin. Canadian Horticulture Council Report. Abstract. p. 206.

Table 1. Yield response of two potato varieties to two rates of metribuzin at four stages of crop growth.

Treatment		Marketable Yield: metric ton/ha		Total Yield: metric ton/ha	
Stage	Rate kg/ha	Katahdin	Superior	Katahdin	Superior
Preemergence	0.0	35.5[a] [a]	32.2[ab]	42.6[a]	39.5[abc]
	1.0	31.8[abc]	32.7[ab]	38.9[abc]	39.5[abc]
7.5-15 cm tops	0.84	30.5[ab]	33.6[ab]	38.0[abcd]	41.6[ab]
	1.68	33.0[ab]	30.0[abc]	40.4[abc]	35.1[bcd]
25-32 cm tops (bud stage)	0.84	32.9[ab]	28.4[abc]	38.5[abc]	34.6[bcd]
	1.68	33.5[ab]	22.9[c]	38.0[abcd]	27.6[e]
Flowering	0.84	29.4[abc]	27.2[abc]	36.6[abcd]	33.8[cde]
	1.68	31.2[abc]	23.6[bc]	38.8[abc]	31.2[de]

[a] Means in columns, within each yield grade, followed by a common letter are not significantly different at the 5% level, DMR test.

EFFECT OF ORYZALIN IN COMBINATION WITH METRIBUZIN, LINURON, AND CHLORBROMURON ON YIELD AND WEED CONTROL IN WHITE POTATOES IN MAINE

Hugh J. Murphy[1]

Abstract

Tests in Maine on potatoes during 1974 using three rates of 3,5-dinitro-N^4,N^4-dipropylsulfanilamide (oryzalin) in combination with 3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea (linuron), 3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea (chlorbromuron) and 4-amino-6-*tert*-butyl-3 (methylthio)-*as*-triazin-5(4*H*)one (metribuzin) indicated all herbicides alone and in combination provided full season control of barnyard grass (*Echinochloa crusgalli*), lambsquarters (*Chenopodium album*) mustard (*Brassica nigra*), and lady's thumb (*Polygonum persicaria*). In this study oryzalin indicated unusual herbicidal activity on broadleaf weeds which has not been reported from Maine in previous tests (1,2,3).

Introduction

Previous studies in Maine (1,2,3) have indicated that oryzalin was most effective on annual barnyard grass (*Echinochloa crusgalli*), quackgrass (*Agropyron repens*), and least effective on broadleaved weeds such as mustard (*Brassica nigra*), lady's thumb (*Polygonum persicaria*), and lambsquarters (*Chenopodium album*). The purpose of this study was to determine if oryzalin in combination with linuron, chlorbromuron, or metribuzin would provide broad spectrum weed control in potatoes without affecting yields.

Materials and Methods

Preemergence treatments of three rates of oryzalin alone and in combination with metribuzin, linuron, and chlorbromuron were applied on June 19 to a field of Katahdin potatoes which had been planted on June 6, 1974. Weather was partly cloudy, soil conditions moist but not saturated, temperature 75F. On the evening of June 19, and the following day moisture accumulation was 0.68 inches. Soil texture was a gravelly silt loam. Plot size was single 20 foot rows arranged in a randomized block design with six replicates of each treatment. All materials were applied in 80 gallons of water using 40 P.S.I. pressure. Delavan Rain-drop type nozzles were used on a brush type boom. Weed control ratings were made on July 2 and on August 28, using a 1 to 5 rating code as indicated in Table 1.

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[1]Associate Professor of Agronomy, Department of Plant and Soil Sciences, University of Maine; Orono, Maine 04473.

Results and Discussion

Data presented in Table 1 indicate oryzalin, metribuzin, linuron, and chlorbromuron applied alone provided very satisfactory control (4.0+) of lady's thumb (*Polygonum persicaria*), lambsquarters (*Chenopodium album*), mustard (*Brassica nigra*), and annual barnyard grass (*Echinochloa crusgalli*). Oryzalin in combination with metribuzin, linuron, or chlorbromuron did not improve the efficacy of these herbicides when applied with 2.0 and 3.0 pounds of oryzalin. Neither did combining linuron, chlorbromuron, or metribuzin improve the efficacy of oryzalin. It would appear that under the conditions of this study the combinations were not needed to control the weed populations present. Yield of tubers was not significantly different between treatments. Oryzalin at the 3.0 pound rate did cause some visible stunting of the potato plants but was not reflected in significant yield reductions.

Results presented in this study of oryzalin combinations with linuron and metribuzin were not consistent with results obtained in Maine during 1972(2) and 1973(3). Previous results did not indicate that oryzalin had satisfactory herbicidal activity on broadleaf weeds as shown in this study.

Literature Cited

1. Murphy, H.J. and M.J. Goven. 1972. Weed control in white potatoes in Maine. Proc. of N.E.W.S.S. 26: 316-323.

2. Murphy, H.J. and M.J. Goven. 1973. Weed control in white potatoes in Maine. Proc. of N.E.W.S.S. 27: 284-293.

3. Murphy, H.J. and M.J. Goven. 1974. Weed control in white potatoes in Maine - 1973. Proc. of N.E.W.S.S. 28: 287-295.

Table 1. Effect of preemergence applications of oryzalin in combination with metribuzin and chlorbromuron on yield and weed control in potatoes. Maine - 1974.

Treatments Pounds of Active Material per Acre	Yield Cwt./Acre	Weed control ratings[a/] Broadleaved 7-2	 8-28	 Annual grass 7-2	 8-28
No treatment	374	1.0	1.0	1.0	1.0
1.0 lb. Oryzalin	420	1.2	4.2	1.0	4.2
1.5 lbs. Oryzalin	384	2.0	4.0	2.0	4.2
2.0 lbs. Oryzalin	404	2.2	4.7	2.5	4.8
3.0 lbs. Oryzalin	384*	2.3	4.7	2.3	4.2
1.0 lb. Metribuzin	419	5.0	5.0	5.0	4.2
2.0 lbs. Metribuzin	453	5.0	4.9	5.0	4.5
1.0 lb. Linuron	380	5.0	4.8	5.0	4.0
1.0 lb. Chlorbromuron	462	5.0	4.5	5.0	4.2
4.5 lbs. DNBP plus 5.0 lbs. Dalapon	423	5.0	5.0	5.0	4.0
1.0 lb. Oryzalin plus 1.0 lb. Metribuzin	414	2.0	4.8	2.0	4.0
2.0 lbs. Oryzalin plus 1.0 lb. Metribuzin	426	5.0	5.0	5.0	4.2
3.0 lbs. Oryzalin plus 1.0 lb. Metribuzin	398*	5.0	5.0	5.0	4.4
1.0 lb. Oryzalin plus 2.0 lbs. Metribuzin	406	5.0	5.0	5.0	5.0
2.0 lbs. Oryzalin plus 2.0 lbs. Metribuzin	393	5.0	5.0	5.0	5.0
3.0 lbs. Oryzalin plus 2.0 lbs. Metribuzin	390*	5.0	5.0	5.0	5.0
1.0 lb. Oryzalin plus 1.0 lb. Linuron	422	5.0	4.2	5.0	4.2
2.0 lbs. Oryzalin plus 1.0 lb. Linuron	409	5.0	5.0	5.0	4.2
3.0 lbs. Oryzalin plus 1.0 lb. Linuron	401*	5.0	5.0	5.0	4.4
1.0 lb. Oryzalin plus 1.0 lb. Chlorbromuron	427	5.0	4.7	5.0	4.2
2.0 lbs. Oryzalin plus 1.0 lb. Chlorbromuron	426	5.0	4.8	5.0	4.4
3.0 lbs. Oryzalin plus 1.0 lb. Chlorbromuron	395*	5.0	5.0	5.0	4.6
Bayes L.S.D. (0.05)	78				

a/Rating code: 1 = no control; 5 = excellent control.

*Some stunting of potato foliage.

CONTROL OF ANNUAL BROADLEAF WEEDS AND GRASSES IN POTATOES WITH METRIBUZIN COMBINATIONS.[1/]

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

ABSTRACT

Research was conducted for 2 years to evaluate combinations of metribuzin [4-amino-6-tert-butyl-3-(methylthio)-as-triazine-5(4H)one] with the following herbicides for weed control in potatoes (Solanum tuberosum L.): trifluralin (a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine), nitralin (4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline), profluralin [N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-p-toluidine], butralin [4-(1,1-dimethylethyl)-N-(1-methylpropyl)-2,6-dinitrobenzenamine], fluchloralin [N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl)aniline], and dinitramine (N^4,N^4-diethyl-a,a,a trifluoro-3,5-dinitrotoluene-2,4-diamine). Predominant weeds in the research areas differed with years but included lambsquarters (Chenopodium album L.), henbit (Lamium amplexicaule L.), pepperweed (Lepidium virginicum L.), large crabgrass (Digitaria sanguinalis (L.) Scop.) and fall panicum (Panicum dichotomiflorum Michx.). Herbicides were applied preemergence following drag-off and incorporated lightly with a finger weeder.

Several conclusions were drawn from the results. First, components of the herbicide combinations failed to provide broad-spectrum control alone. Metribuzin did not provide lasting control of annual grasses and all other herbicides lacked sufficient activity on broadleaf weeds. Second, to provide consistent season-long control, components of the combinations should be applied at the following rates on sandy loam soils: metribuzin - 1/2 lb/A, trifluralin, nitralin, profluralin and fluchloralin - 1 lb/A, butralin - 1 1/2 to 2 lb/A and dinitramine - 1/2 lb/A. Third, because of the generally shallow incorporation obtained with the finger weeder, the most appropriate combination of the foregoing herbicides might be metribuzin with dinitramine.

1/ Contribution from the Plant Physiology Department, Virginia Truck and Ornamentals Research Station.

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

THE EFFECT OF POSTEMERGENCE APPLICATIONS OF METRIBUZIN ON SIX POTATO CULTIVARS [1/]

J. B. Sieczka [2/]

Abstract

Postemergence applications of metribuzin (4 amino-6-t-butyl-3-(methylthio)-as-triazine-5-(4H)-one) caused foliar injury to six potato (Solanum tuberosum L.) clones. The clone, 'Green Mountain' appeared to be less susceptible to foliage injury and yield reduction than the other cultivars. Foliage symptoms were severe on 'Superior', 'Norchip', 'Katahdin' and 'Sebago'. Yield reductions due to postemergence applications of 1.0 lb ai/A varied from year to year.

Introduction

The use of metribuzin on an experimental basis as an herbicide for potatoes has demonstrated its effectiveness in the control of many annual and perennial weeds in potato fields. Most observers have noted good weed control and no adverse effects on yield when the material is applied preemergence to the crop (2, 3, 8, 9, 10, 11). However, postemergence treatments appear to be more effective in controlling quackgrass (Agropyron repens L.). Some workers have reported phytotoxic effects on foliage and yield reductions from postemergence applications of metribuzin (4, 6, 7, 11). Often the plants recovered with no reduction in yield (2, 5). Varietal differences to metribuzin applications were reported by Callihan (1). Studies were initiated in 1973 and 1974 to determine if clones commonly grown in New York State exhibit different tolerances to metribuzin.

Materials and Methods

The clones, 'Katahdin', 'Kennebec', 'Superior', 'Norchip', and 'Green Mountain' were planted in 1973 and 1974 in random arrangement in split plot design experiments. 'Sebago' seed was planted in the guard rows each year. The same metribuzin treatments were applied to the guard row as in the main experiment. Both years the crop was planted in 34-inch rows and fertilized with 1500 lbs of 10-20-20/A in bands at planting. The herbicide treatments were applied with a hand-held, CO_2 pressurized sprayer applying 45 gallons of spray/A at 40 psi. Chemical rates are given as ai/A throughout. There were

[1/] Paper No. 687 of the Department of Vegetable Crops, Cornell University, Ithaca, New York.

[2/] Extension Specialist, Department of Vegetable Crops, Cornell University Ithaca, New York.

four replications in each of the experiments.

In 1973, the main plots were metribuzin treatments and the sub plots were varieties. Treatments were arranged in a randomized complete block. Metribuzin treatments were: 1.0 lb preemergence, 0.5 lb and 1.0 lb postemergence. The preemergence treatments were made on June 1, the postemergence treatments on June 15. One complication arose from this arrangement and that was that postemergence treatments were applied to clones at different stages of growth due to differing emergence and growth rates. To illustrate this point, at the time of the postemergence application, 98% of the 'Superior' seed had emerged and was 7 inches tall. 'Green Mountain' 96% and 5", 'Kennebec' 90% and 5", 'Katahdin' 82% and 3 ", 'Norchip' 82% and 2" and 'Sebago' was at "ground crack".

The following year the split plot design was retained but the designation of main plots was reversed in an effort to place more power in the statistical analysis on the metribuzin treatments. The preemergence application of metribuzin was eliminated in 1974 and the entire plot area was sprayed with 1.5 lbs linuron (3-(3,4-dichloropheny1)-1-methoxy-1-methylurea) preemergence to provide uniform control of weeds. Postemergence applications of metribuzin were made when plots for a given clone had 90-100% stand and the plants were 4-5 inches tall. Postemergence treatments were applied on June 10, 1974 to all clones except 'Katahdin' and 'Sebago'. 'Katahdin' and 'Sebago' plots were sprayed on June 18.

Results and Discussion

Phytotoxicity ratings for both years are listed in Table 1. The results show that all the clones were affected by postemergence applications, especially the 1.0 lb rate. However, the degree of injury varied by variety. The marked difference in injury in 'Katahdin' and'Sebago' between 1973 and 1974 is probably related to the different stage of growth at time of application rather than a difference in weather conditions or some other factor.

Yield data for the 1973 experiments are listed in Tables 2 and 3. Varietal effects on total yield, 2-4" yield, mean tuber weight and specific gravity were significant at the 1% level in the main experiment. Metribuzin treatments resulted in statistically significant differences in total yield and mean tuber weight. The yield of 2-4" tubers closely paralleled total yield but the effect of metribuzin treatment was not significant at the 5% level. 'Superior', 'Kennebec' and 'Katahdin' had lower yields when 1.0 lb of metribuzin was applied postemergence. Differences due to metribuzin treatment were not observed in the 'Sebago' experiment.

In 1974, clonal differences were apparent in total yield, 2-4 inch yield, mean tuber weight and specific gravity (see Tables 4 and 5). Metribuzin treatments tended to lower yields of some cultivars but the differences were not statistically significant. 'Norchip', 'Katahdin' and 'Sebago' were most affected by postemergence applications of 1.0 lb/A of metribuzin.

Table 1. The effect of postemergence applications of metribuzin on foliage of six potato clones.

Variety and Metribuzin Rate [1/] (lbs ai/A)	Average Ratings [2/] 1973 6/21	1973 7/2	1974 6/13	1974 6/18	1974 6/20	1974 7/9
'Superior'						
0 or 1.0 Pre	1.0	1.0	1.0	1.0	1.0	1.0
0.5 Post	2.8	1.0	2.8	2.3	1.3	1.3
1.0 Post	3.0	1.3	2.3	3.3	2.8	2.0
'Norchip'						
0 or 1.0 Pre	1.0	1.0	1.5	1.0	1.3	1.0
0.5 Post	1.5	1.0	3.0	2.0	1.8	1.3
1.0 Post	2.0	1.0	2.5	2.5	3.5	2.0
'Green Mountain'						
0 or 1.0 Pre	1.0	1.0	1.3	1.0	1.0	1.0
0.5 Post	2.0	1.0	1.3	1.3	1.5	1.3
1.0 Post	2.7	1.0	1.5	1.8	1.8	1.3
'Kennebec'						
0 or 1.0 Pre	1.0	1.0	1.8	1.5	1.3	1.0
0.5 Post	1.8	1.0	1.5	1.3	1.8	1.3
1.0 Post	3.0	1.0	1.8	2.8	2.3	1.0
'Katahdin'						
0 or 1.0 Pre	1.0	1.0	---	---	1.3	1.0
0.5 Post	1.0	1.0	---	---	2.8	2.8
1.0 Post	1.3	1.0	---	---	2.8	2.5
'Sebago'						
0 or 1.0 Pre	1.0	1.0	---	---	1.0	1.0
0.5 Post	1.0	1.0	---	---	2.5	2.0
1.0 Post	1.3	1.0	---	---	2.8	2.3

[1/] Metribuzin was applied preemergence at 1.0 lb ai/A in 1973 and none was applied preemergence in 1974.

[2/] Rating system based on a scale of 1 to 5; 1 = no injury, 5 = severe injury.

Table 2. The effect of postemergence applications of metribuzin on 5 potato clones, 1973 1/

Planting Date:	5/15/73 and 5/23/73	Harvest Date:	10/1/73
Fertilization:	15 lbs of 10-20-20/A	Plot Size:	1 row x 20'
Spacing:	9 inches	Plot Design:	Split plot
Vines Killed:	9/7/73 and 9/12/73	Replications:	4

Variety and Metribuzin Treatment (ai/A)		Yield (cwt/A)		% of Total Yield		Mean Tuber Wt. (oz)	Specific Gravity
		Total	2-4"	2-3 1/4"	3 1/4-4"		
'Superior'	1.0 lb Pre	386	358	78	4	6.3	1.065
	0.5 lb Post	302	271	78	10	5.3	1.066
	1.0 lb Post	324	288	81	8	5.3	1.068
'Norchip'	1.0 lb Pre	350	294	71	13	5.0	1.075
	0.5 lb Post	371	311	70	14	4.9	1.074
	1.0 lb Post	351	289	69	13	5.0	1.073
'Green Mountain'	1.0 lb Pre	508	446	71	26	6.4	1.083
	0.5 lb Post	524	474	68	22	6.9	1.084
	1.0 lb Pre	496	452	66	25	6.8	1.084
'Kennebec'	1.0 lb Pre	569	521	65	26	7.6	1.074
	0.5 lb Post	529	493	70	23	7.8	1.076
	1.0 lb Post	489	442	69	21	7.1	1.074
'Katahdin'	1.0 lb Pre	371	334	66	24	5.8	1.064
	0.5 lb Post	389	349	68	21	5.6	1.065
	1.0 lb Post	338	314	78	15	5.4	1.062
Metribuzin		*	NS			*	NS
Clone		**	**			**	**
Metribuzin x clone		NS	NS			NS	NS

* Significant at the 5% level
** Significant at the 1% level
1/ Preemergence treatments were made June 1, 1973; postemergence treatments were applied June 15, 1973.

Table 3. The effect of postemergence applications of metribuzin on Sebago potatoes in 1973[1/]

Location:	Freeville, N.Y.	Harvest Date:	10/1/73
Planting Date:	5/15/73 and 5/23/73	Plot Size:	1 row x 20'
Fertilization:	1500 lbs of 10-20-20/A	Plot Design:	Randomized complete block
Spacing:	9 inches		
Vines Killed:	9/7/73 and 9/12/73	Replications:	4

Metribuzin Treatment (ai/A)	Yield (cwt/A)		% of Total Yield			Mean Tuber Weight (oz)	Specific Gravity
	Total	2-4"	2-3 1/4"	3 1/4-4"	4"		
1.0 lb preemergence	528	474	63	27	1	6.6	1.069
0.5 lb postemergence	506	456	65	26	1	6.6	1.068
1.0 lb postemergence	511	461	68	22	1	6.7	1.070
$D_{(.05)}$ Tukey	NS	NS				NS	NS

[1/] Preemergence treatments were made June 1, 1973; postemergence treatments were applied June 15, 1973.

Table 4. The effect of postemergence applications of metribuzin on 5 potato clones, 1974 1/

Location:	Freeville, New York	Harvest Date:	9/20/1974
Planting Date:	May 15, 1974	Plot Size:	1 row x 17'
Fertilization:	1500 lbs of 10-20-20/A	Experimental Design:	Split plot
Spacing:	9"	Replications:	4
Vine Killed:	September 9, 1974		

Variety and Metribuzin Treatment (ai/A)		Yield (cwt/A)		% of Total Yield		Mean Tuber Wt. (oz)	Specific Gravity
		Total	2-4"	2-3 1/4"	3 1/4-4"		
'Superior'	0.0	354	313	70	18	5.1	1.074
	0.5	348	310	71	18	4.8	1.078
	1.0	356	298	70	14	4.7	1.078
'Norchip'	0.0	390	327	71	13	4.9	1.076
	0.5	378	316	66	17	4.5	1.079
	1.0	356	294	71	12	4.8	1.078
'Green Mountain'	0.0	494	439	61	27	6.5	1.084
	0.5	468	420	65	24	6.3	1.084
	1.0	499	439	73	15	5.9	1.081
'Kennebec'	0.0	489	429	58	30	7.5	1.079
	0.5	518	474	52	40	7.3	1.077
	1.0	513	472	54	38	7.7	1.077
'Katahdin'	0.0	451	395	52	35	6.4	1.071
	0.5	430	376	55	32	6.1	1.072
	1.0	373	332	59	30	6.3	1.071
Clones	**	**				**	**
Metribuzin	NS	NS				NS	NS
Clones X Metribuzin	NS	NS				NS	NS

** Significant at the 1% level.

1/ Metribuzin applications were made when most of the plants of a given clone were 90-100% emerged and 4-5 inches tall.

Table 5. The effect of postemergence application of metribuzin on 'Sebago' potatoes, 1974 [1/]

Location:	Freeville, New York	Harvest Date:	9/20/1974
Planting Date:	May 15, 1974	Plot Size:	1 row x 17'
Fertilization:	1500 lbs of 10-20-20/A	Experimental Design:	Randomized complete block
Spacing:	9"	Replications:	4
Vine Killed:	September 9, 1974		

Variety and Metribuzin Treatment (ai/A)	Total	2-4"	2-3 1/4"	3 1/4-4"	> 4"	Mean Tuber Wt. (oz)	Specific Gravity
0	494	423	59	27	3	6.2	1.072
0.5	400	357	58	31	1	6.3	1.073
1.0	386	356	57	35	1	6.7	1.070
D (.05) Tukey	NS	NS					NS

[1/] See footnote 1, Table 4.

Conclusions

Postemergence applications of metribuzin resulted in foliar injury. Foliage symptoms tended to be severe on 'Superior', 'Norchip', 'Katahdin' and 'Sebago'. Affected plants usually grew out of the injury with the passage of time, however, yields were reduced on some clones. The susceptibility of clones to yield reduction by postemergence applications of metribuzin varied from year to year, probably due to weather conditions. Clonal "insensitivity" to postemergence application was demonstrated by 'Green Mountain'.

Literature Cited

1. Callihan, R. H. 1972. Crop and weed reaction to Sencor in potato culture. American Potato J. 49(9):357.

2. Fricke, D. H. 1972. Evaluation of herbicides for annual weed control in white potatoes (1971). NEWSS 26:303-309.

3. Hawkins, A. 1972. Chemical weed control in potatoes with Bay 94337 and trifluralin in Connecticut, 1971. NEWSS 26:329-331.

4. Henne, R. C. and R. T. Guest. 1974. Alachlor, chlorbromuron and metribuzin for weed control in potatoes. NEWSS 28:296-298.

5. _____ and _____. 1973. Evaluation of five herbicides in white potatoes. NEWSS 27:253-265.

6. Lay, M. M., M. J. McAvoy, and R. D. Ilnicki. 1973. Some promising herbicides and herbicide combinations for weed control in white potatoes. NEWSS 27:266-273.

7. Murphy, H. J. 1974. Rate and time of metribuzin application for weed control in white potatoes in Maine - 1973. NEWSS 28:303-306.

8. _____ and M. J. Goven. 1974. Weed control in white potatoes in Maine - 1973. NEWSS 28:287-295.

9. _____ and _____. 1973. Weed control in white potatoes in Maine - 1972. NEWSS 27:284-293.

10. _____ and _____. 1972. Weed control in white potatoes in Maine - 1971. NEWSS 26:316-323.

11. Sanok, W. J. 1974. Evaluation of herbicides for control of weeds in Long Island potatoes - 1973. NEWSS 28:282-286.

Evaluation of Potato Herbicides on Long Island 1974

W.J. Sanok and L.E. Weber [1]

Abstract

Seven chemical herbicides were applied alone or in combination either as an incorporated treatment, pre-emergence treatment, or post-emergence treatment on white potatoes. Treatments were evaluated for control of annual broadleaved weeds and annual grasses. Several of the materials were very effective in controlling grass and broadleaf weeds throughout the season.

Procedure

Several herbicides and combinations of herbicides were tested on a commercial Long Island farm for the effectiveness in controlling grass and broadleaved annuals in white potatoes. The Katahdin variety of potato *Solanum tuberosum* was planted in 34 inch rows on May 8, 1974. Fertilization was at the rate of 3,000 pounds of 8-16-8 per acre banded at planting. Thirty pounds of furadan 10G per acre was applied in the seed furrow at the time of planting.

The plot size of the experiment was 2 rows wide by thirty feet long. The experimental design was a randomized complete block with treatments replicated four times. All materials were applied as a spray with a tractor-mounted two row boom sprayer using a pressure of 20 psi and a volume of 38 gallons of water per acre. The materials, rates, and methods of application, which were used in this experiment are listed in Table 1.

The experimental plot was dragged off in the morning prior to applying the herbicide materials on May 17, 1974. The soil surface was dry but quite cloddy which was a result of plowing down a large cover crop of rye before planting. Incorporated materials were incorporated immediately after application with a finger weeder. An inch of rain fell immediately after all the herbicide materials were applied. Metribuzin at .75 pounds aia applied at the 4-inch stage was sprayed on June 14, 1974.

The total area did not receive any cultivation nor hilling during the season. Weed control ratings were made on June 19 and September 5th. Weed species present were lady's thumb (*Polygonum persicaria* L.) and barnyard grass (*Echinochloa crusgalli* (L.) *Beau*). The potatoes were harvested on October 9th and the yield in pounds per plot were recorded.

Weed control ratings and yields were analyzed for statistical significance using Duncan's Multiple Range Test at the one percent level.

[1] Cooperative Extension Agents, Suffolk County

Results

In spite of the heavy weed pressure as indicated by the check plots, three of the treatments maintained weed free plots throughout the season. The three treatments were: metribuzin at 1.5 pounds aia, a tank mix of metribuzin at .75 pounds aia plus Amex 820 at 1.5 pounds aia, and a tank mix of metribuzin at .75 pounds plus EPTC at 4 pounds aia.

Although not weed free, most of the materials maintained good weed control throughout the season. Amex 820 performed better at the 1.5 pounds aia rate then at the 2 pounds aia rate. The increased rate resulted in a decrease in both weed control and yield. The split application of metribuzin, .75 aia pre-emergence and .75 aia at the 4 inch stage, provided good weed control, but was not as effective as the 1.5 pounds aia rate of metribuzin applied pre-emergence. The split application of metribuzin resulted in a slight decrease in yield compared to the 1.5 pounds aia rate of metribuzin applied pre-emergence.

Three of the materials used in this experiment did not provide commercially acceptable weed control throughout the season. EPTC maintained good grass control but fell down on broadleaf control. CGA 10832 provided good grass control but broadleaf weed control was no better than the check plot. Dinoseb provided good broadleaf weed control but fell down on grass control.

The only treatment which produced a significant difference in yield at the 1% level was the check plot because of weed competition.

Discussions and Conclusions

Metribuzin, either alone or in combination with other materials, was very effective in controlling barnyard grass and lady's thumb. A number of other chemicals were also effective in maintaining commercially acceptable weed control throughout the season. The good weed control may have been a result of not disturbing the soil during the season and bringing weed seeds to the surface. EPTC and CGA 10832 did not provide commercially acceptable broadleaved weed control. Barnyard grass was not controlled by Dinoseb.

Table 1. Effect of Herbicides on Weed Control[1/] and Yield of Potatoes

Chemical	Formulation	lbs AIA	Application	Broad-leaved Weeds[2/] 6/10	Broad-leaved Weeds[2/] 9/5	Annual Grasses[3/] 6/19	Annual Grasses[3/] 9/5	Yields lbs/plot
Alachlor	4EC	2.0	pre	8.25 a	7.5 ab	9.0 a	9.0 a	108.0 a
Chlorbromuron	50WP	2.0	pre	8.5 a	8.75 a	8.5 a	8.25 a	114.6 a
EPTC	7EC	6.0	pre-inc	8.25 a	6.25 b	8.5 a	8.25 a	104.2 a
CGA 10832	4EC	1.0	pre-inc	4.25 b	1.0 c	8.75 a	8.0 a	96.8 a
Metribuzin	50WP	1.5	pre	9.0 a	9.0 a	9.0 a	9.0 a	119.4 a
Metribuzin +	50WP	0.75	pre	8.5 a	8.5 ab	8.5 a	8.5 a	99.9 a
Metribuzin	50WP	0.75	4" stage					
Metribuzin +	50WP	0.75	pre	9.0 a	9.0 a	9.0 a	9.0 a	124.2 a
Amex 820	4EC	1.5	tank mix					
EPTC	6EC	6.0	pre-inc	8.75 a	8.5 ab	9.0 a	8.25 ab	106.2 a
Amex 820	4EC	1.5	pre	8.0 a	8.0 a	8.75 a	8.75 a	115.6 a
Amex 820	4EC	2.0	pre	7.5 a	7.0 ab	8.0 ab	7.5 ab	100.8 a
Dinoseb	3EC	3.0	pre	8.25 a	7.75 ab	6.25 b	4.75 b	96.8 a
Metribuzin +	50WP	0.75	pre	9.0 a	9.0 a	9.0 a	9.0 a	112.0 a
EPTC	6EC	4.0	tank mix					
Alachlor +	4EC	2.0	pre	9.0 a	8.0 ab	9.0 a	8.25 a	108.8 a
Chlorbromuron	50WP	2.0	tank mix					
CGA 10832 +	4EC	1.0	pre-inc	8.0 a	7.75 ab	8.75 a	8.25 a	126.8 a
Chlorbromuron	50WP	2.0	pre					
Check				1.0 c	1.0 c	1.0 c	1.0 c	57.5 b

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 9 = complete control

2/Weeds present: lady's thumb 3/barnyard grass

GLYPHOSATE PHYTOTOXICITY TO CLONAL APPLE ROOTSTOCKS AND 'McINTOSH' APPLE TREES

W.J. Lord, M.L. Murphy, and D.W. Greene[1]

Abstract

Field studies were conducted in 1974, which showed that glyphosate [N-(phosphonomethyl) glycine] was phytotoxic to dormant and actively growing 1-year-old rooted layers of clonal apple rootstocks and to actively growing 'McIntosh' apple trees. Small amounts of glyphosate (.05 ml - 0.2 ml) at rates suggested for use in orchards, when applied to leaves or wood on actively-growing current season's terminal shoots, were phytotoxic to the growing point of these shoots. Glyphosate in larger amounts on 1-year-old wood or older appeared non-injurious except when applied to dormant MM. 111 rootstocks. Large amounts of glyphosate on dormant MM. 111 rootstocks caused severe growth suppression which resulted in death in some instances and sprays to actively growing shoots of MM. 106 rootstocks caused death of the sprayed tissue.

Introduction

Baird et al. (1) reported that glyphosate can be used safely in apple orchards for the control of herbaceous perennial and annual weeds. However, Curtis (2) showed that glyphosate when applied to apple buds, actively growing shoots or on shoots with fresh pruning wounds was phytotoxic. This is of concern because the probability of hitting foliage and wood of apple trees in nurseries and established plantings is great because of wind, uneven terrain, low limbs or carelessness. Therefore, it is important to determine the response of apple rootstocks and apple trees when a minimal portion of their surface is contaminated by glyphosate mixed to rates suggested for orchards. Preliminary findings from our studies with glyphosate at the Horticultural Research Center, Belchertown,Massachusetts in 1974 are reported herein.

Experiment I

Methods and Materials. A planting of 2-year-old 'McIntosh' apple trees on MM. 106 rootstocks was selected to receive local applications of glyphosate on June 11. Six single-tree replications of the following glyphosate treatments at 1.12 kg/ha with water[2] as a carrier at 281 L/ha

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[1]Department of Plant and Soil Sciences, University of Massachusetts, Amherst 01002

[2]Water used as carrier when preparing solutions in all experiments. The glyphosate formulation used was (MON 2139).

(1 lb/30 gpa) were established: (A) .05 ml of glyphosate soln on 1 mature leaf of a current season's terminal shoot; (B) .05 ml glyphosate soln on each of 3 mature leaves of a current season's terminal shoot; (C) .05 ml glyphosate soln on tree trunk (2-year-old wood); (D) .05 ml glyphosate soln on the central leader of tree (2-year-old wood); and (E) tree trunk sprayed with glyphosate soln. Visual observations for occurrence of phytotoxicity symptoms were made at periodic intervals following treatment.

Results. The treated leaves showed no visible evidence of injury but phytotoxicity occurred at the tip of the shoots on which the leaves were borne. The existing young leaves became chlorotic and new expanding leaves were chlorotic, attenuated and cupped. The 3-leaf treatment caused more phytotoxicity and persisted longer than the injury on the 1-leaf treatment. The leaves appeared normal on growth that occurred in late summer. No injury resulted from the treatments applied on 2-year-old wood (Treatments C,D and E).

Experiment II

Methods and Materials. A 4-year-old planting of 'McIntosh' trees on seedling roots was selected to receive known amounts of glyphosate on wood of current season's terminal shoots, 2-year-old wood and 4-year-old wood. Six single-tree replications of the following treatments were applied on June 11: (A) 0.2 ml of glyphosate soln at 1.12 kg in 281 L/ha (1 lb/30 gpa) on 4-year-old wood of trunk; (B) 0.2 ml of glyphosate soln at 1.12 kg in 935 L/ha (1 lb/100 gpa) on 4-year-old wood of trunk; (C) 0.1 ml of glyphosate soln at 1.12 kg in 281 L/ha on 2-year-old wood of scaffold branch; (D) 0.1 ml of glyphosate soln at 1.12 kg in 935 L/ha on 2-year-old wood of scaffold branch; (E) 0.1 ml of glyphosate soln at 1.12 kg in 281 L/ha on wood of a current season's terminal shoot; and (F) 0.1 ml of glyphosate at 1.12 kg in 935 L/ha on wood of a current season's terminal shoot.

Results. Glyphosate at 1.12 kg in 281 L/ha on wood of a current season's terminal shoot (Treatment E) induced phytotoxicity symptoms as described in Experiment I and the injury persisted all summer whereas the same glyphosate rate in 935 L/ha caused no visible injury. None of the treatments involving 2 or 4-year-old wood caused visible injury.

Experiment III

Methods and Materials. The response of MM. 106 apple rootstocks, planted in April, to several concn of glyphosate was determined by establishing the following treatments on June 6: (A) .05 ml glyphosate soln applied on 1 mature leaf of a current season's shoot; (B) .05 ml of glyphosate soln applied on each of 3 mature leaves on a current season's shoot; (C) .05 ml glyphosate soln applied on wood of current season's shoot; (D) .05 ml glyphosate soln applied on base of rootstock (1-year-old wood); (E)terminal portion of rootstock consisting of current season's growth

and 1-year-old wood sprayed with glyphosate soln; and (F) base of rootstock sprayed. Each glyphosate treatment was applied at the following concn: 1.12 kg in 281 L/ha (1 lb/30 gpa); 1.12 kg in 935 L/ha (1 lb/100 gpa); 2.24 kg in 281 L/ha (2 lb/30 gpa); and 2.24 kg in 935 L/ha (2 lb/100 gpa). Eight replications of each concn were applied of each treatment. Glyphosate phytotoxicity was rated in mid-July and mid-August.

Results. Regardless of concn, glyphosphate (Treatments D and F) applied on the 1-year-old wood at the base of the rootstock caused no observable injury. To the contrary, all concn applied on the terminal portion of the rootstocks (Treatment E) caused death of the sprayed portion. Glyphosate soln applied on 1 leaf, 3 leaves, or on wood of current season's shoots caused phytotoxicity symptoms similar to those described in Experiment I. The leaves receiving the droplets of glyphosate soln showed no injury.

The effect of concn was clearly evident only in Treatment C in which 0.5 ml of glyphosate soln was applied on wood of current season's shoots. With this treatment, glyphosate at 1.12 kg in 281 L/ha killed the terminal growing point whereas the same rate in 935 L/ha generally caused only cupping and chlorosis of the young terminal leaves. As the season progressed, the injury caused by application of glyphosate on 1 or 3 leaves became less evident and new growth was normal.

Experiment IV

Methods and Materials. On April 16, glyphosate soln at 2.24 or 4.48 kg at 281 L/ha (2 or 4 lbs/30 gpa) was applied by brush on basal or terminal 6 cm-length portion of freshly dug dormant rooted layers of MM. 106 apple rootstocks to observe the effect of contamination on basal or terminal portions of these rootstocks. The rootstocks were placed horizontally during treatment to prevent contamination of greater than 6 cm length of wood. The rootstocks were then planted in a nursery and observations of phytotoxicity were made at periodic intervals. Ten replications of each treatment were established.

Results. Growth was less than satisfactory even on the controls. Regardless, the performance of glyphosate-treated rootstocks was significantly affected with injury varying from the presence of some small attenuated leaves to death of the rootstock (Table 1). Apparently, glyphosate was translocated both basipetally and acropetally since both basal and terminal treatments caused injury to developing leaves along the entire length of the rootstock. At the last observation in August, 17% of the glyphosate-treated rootstocks were dead, 27% had small attenuated leaves along the entire length of rootstock, 22% had tip die-back and small attenuated leaves on the basal portion of the rootstock, and 22% had many small attenuated leaves.

Because of variable rootstock performance within a treatment, the effect of rate or placement of glyphosate soln is not clear (Table 1).

Table 1. Phytotoxicity of glyphosate on MM. 111 clonal apple rootstocks, 1974.

Place of glyphosate[z] on stem of rootstock and rate	Performance rating (0-5)[y]		
	6/12	7/12	8/14
Control	0.3c[x]	0.1c	0.6c
On base, 2.24 kg/ha	1.7b	1.7b	1.7bc
On base, 4.48 kg/ha	3.1ab	2.6b	3.1a
On terminal, 2.24 kg/ha	2.7ab	2.6b	2.6ab
On terminal, 4.48 kg/ha	3.4a	3.8a	3.5ab

[z]With water as carrier at 281 L/ha (30 gpa)

[y]Performance rating: 0= normal foliage and growth; 5= rootstock died. Ten single-tree replications.

[x]Mean separation, within columns, by Duncan's multiple range test at the 5% level.

However, the 4.48 kg/ha rate applied on the terminal portion of the rootstock appeared more phytotoxic than other treatments. The "second-flush" of growth in late summer produced normal leaves on all living glyphosate-treated rootstocks.

Discussion and Conclusions

In these studies, we found that glyphosate, even in small amounts, was phytotoxic to clonal apple rootstocks and 'McIntosh' apple trees (Experiment I - II). The severity of phytotoxicity was related to age of the plant part treated, kg of glyphosate/ha or amount of water carrier/ha, and the amount of plant surface treated. Glyphosate caused phytotoxicity when applied to leaves and wood on current season's growth (Experiments I, II and III) but was non-toxic when applied on wood 1-year or older, (Experiments I, II and III) except when applied to dormant MM. 111 rootstocks. Why 2.24 kg of glyphosate on 1-year-old wood of actively growing MM. 106 rootstocks was non-toxic (Experiment III) but toxic on the same aged wood of dormant MM. 111 rootstocks (Experiment IV) is not known. However, these observations show that sufficient amounts of glyphosate can be absorbed through 1-year-old wood to be phytotoxic. In unpublished preliminary trials, we observed phytotoxicity on lower branches of 3-year-old 'McIntosh' trees in June, 1974, that had received 4.48 kg glyphosate in 281 L/ha on their trunks in mid-July, 1973. Furthermore, based on these unpublished observations and those of Curtis (2), it is possible that phytotoxicity symptoms may appear in 1975 on some glyphosate treatments applied in 1974. Use of water at 935 L/ha as compared to 281 L/ha may reduce phytotoxicity if only small amounts of glyphosate drift onto the tree (Experiments II and III) but not when the sprayed portion is thoroughly wetted (Experiment III).

In conclusion, glyphosate can be safely used for weed control in apple tree nurseries and orchards only if contamination can be avoided because unlike 1,1'-dimethyl-4,4'-bipyridinium ion (paraquat), which is in general use, it is translocated. Spray drift or direct application of glyphosate to apple foliage and wood, not only causes injury or death to contaminated shoots and adjacent non-treated shoots but may also appear the following year (2).

Literature Cited

1. Baird, D.D., N.J. Shaulis, and C.G. Waywell. 1974. Glyphosate for herbaceous perennial weed control in Northeastern apple orchards and vineyards. Proc. Northeastern Weed Sci. Soc. 28:205-212.

2. Curtis, O.F., Jr. 1974. Apple response to local application of glyphosate on foliage and pruning wounds. Abstract. Proc. Northeastern Weed Sci. Soc. 28:219.

SUCCESSION ON POWER LINE RIGHTS-OF-WAY

Richard Stalter[1/]

ABSTRACT

On power line rights-of-way, clearing techniques and various parameters affect rates of plant succession. Parameters that affect rates of succession are the type of community surrounding the right-of-way, soil conditions (including shallowness or coarse texture), texture, pH, organic content, water holding capacity, competition for soil moisture, shading, microclimate, topography, phytochemical considerations (allelopathy), faunal influence (activity of insects, and small and large mammals), the previous use of the land (including the type of crop grown on the land), and the type of management of the management of the right-of-way. Presently, there are several maintenance techniques employed by right-of-way managers, including selective cutting of tall undesirable shrubs and trees, bush-hogging, mowing, plowing, and the selective or indiscriminate use of herbicides, which will produce a special type of plant community.

Thus, the method of right-of-way management coupled with the aforementioned environmental factors greatly influences both the rate of succession and the ultimate stability of plant communities on power line rights-of-way.

1/ Environmental Studies Program, St. John's University, Jamaica, N.Y.

A PROGRESS REPORT ON DPX 1108 BRUSH CONTROL AGENT 1/

T. J. Hernandez, W. H. Hudson, and T. T. Rushing 2/

ABSTRACT

"Krenite" (DPX 1108) (ammonium ethyl carbamoylphosphonate) a plant growth regulant has been extensively tested by Du Pont Field Test Personnel in the northeastern United States during the last two years. It is promising for control of several brush species of economic importance on Rights-of-Ways on railroads, utilities, pipelines, drainage systems and roadsides. Rates of 6 to 10 pounds active/acre applied via standard application techniques, one to two months before leaf senescence (usually August or September) has been effective on such troublesome species as Pines (Pinus spp.), Oaks (Quercus spp.), Black Locust (Robina spp.), Hawthorn (Crataegus spp.), Sumac (Rhus spp.), Blackberry (Rubus) and Maple (Acer).

1/ "Krenite" is the registered trademark of E. I. du Pont de Nemours & Co., Inc. for DPX 1108.

2/ Biochemicals Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware 19898

PRELIMINARY RESULTS WITH GLYPHOSATE FOR CONTROL OF POLYGONUM CUSPIDATUM

J. F. Ahrens[1/]

SUMMARY

Polygonum cuspidatum Sieb & Zucc. commonly known as Japanese knotweed, is an escaped ornamental that has become a troublesome perennial weed along roadsides, utility and railroad rights of way, and around homes. It grows to 10 ft, crowds out all other vegetation, and creates a fire hazard in the dormant season. The only effective controls known (chlorinated benzoics and picloram) cannot safely be used in the root zones of trees and shrubs and they frequently leave soil residues that preclude early replanting to many crops.

The systemic nature and short residual life of glyphosate (N-phosphonomethyl) glycine) led us to test it for the control of P. cuspidatum.

Replicated field experiments were conducted during 1973 and 1974 in Windsor and Suffield, Connecticut. P. cuspidatum 6 to 8 ft tall was treated in June with glyphosate at 3, 6, and 9 lb/A, using a knapsack mistblower. Dicamba (3,6-dichloro o-anisic acid) was also included as a standard comparison at 1.5 and 3 lb/A in 1973 and at 2 lb/A in 1974.

At Windsor in 1973 dicamba caused some browning of leaves but glyphosate merely stopped growth of the plants. The stalks were cut down and removed 5 weeks after treatment and regrowth was evaluated. Regrowth was somewhat malformed and reduced, but control was not considered satisfactory with any treatment. The glyphosate treatments were reapplied on the regrowth September 1973 and growth was evaluated in June 1974. Control of regrowth was excellent in 1974 with the glyphosate applications in 1973, regardless of dosage (0 to 3 shoots per 20 sq ft compared with 9 to 29 for untreated controls). However, seedlings of P. cuspidatum were found germinating in glyphosate plots the second season. Control with one application of dicamba at 1.5 or 3 lb/A in 1973 was poor in 1974.

In the 1974 test at Suffield, the stalks were cut down either 10 or 30 days after treatment and regrowth was evaluated in August. In the control plots regrowt was unaffected by time of cutting, but with the herbicides regrowth was less in plots cut 30 days than it was in plots cut 10 days after treatment. As in 1973, regrowth from single applications of glyphosate or dicamba was much less than regrowth in control plots but was sufficient to cause extensive reinfestation without further treatment. Repeating the 1974 treatments on regrowth in August resulted in over 90 percent top kill of the weed in September with all treatments. Soil samples were taken from the plots in October and planted to beans or tomato transplants. None of the treatments affected growth of beans or tomatoes. Live roots of P. cuspidatum were found in all plots two months after the second application, but root sections from glyphosate treated plots produced fewer shoots in the greenhouse than roots from control plots.

Glyphosate is effective against P. cuspidatum, but two or more applications will be required to eradicate the pest on a given site and continued control of seedlings will be required to prevent reinfestation. With repeated applications, 3 lb/A appears as effective as 9 lb/A.

1/ The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor.

ANTAGONISTIC EFFECTS WITH GLYPHOSATE HERBICIDE[1/] PLUS RESIDUAL HERBICIDE COMBINATIONS

G. W. Selleck[2/]

Abstract

It was reported at this conference last year (Selleck & Baird unpubl.) that antagonism occurred between glyphosate and certain of the residual herbicides in tank-mixed combinations, as indicated by reduced weed control compared with glyphosate alone. When assessed 108 days after treatment, glyphosate at 2 lb/A completely controlled common milkweed (Asclepias syriaca) and was superior to glyphosate combinations with bromacil plus diuron, bromacil, atratol, and diuron. The same phenomenon occurred with bouncing bet (Saponaria officinalis). All of the above herbicides except atratol reduced the control of toadflax (Linaria vulgaris) when tank-mixed with glyphosate. Antagonism was not evident with any of the combinations for the control of bluegrass (Poa pratensis), goldenrod (Solidago spp.), or brambles (Rubus spp.).

In order to learn more about this apparent antagonism, glyphosate was applied at 2 lb/A alone, and tank-mixed with 6 lb/A each of diuron, terbacil, bromuron and simazine, and 4 lb/A of amitrol in triplicated, 2 x 6.7 m plots Aug. 6, 1974 at Ajax, Ontario. These residual herbicides were applied separately also on glyphosate-treated plots at intervals of 30 minutes, 3 days and 7 days following the glyphosate application.

Smooth bromegrass (Bromus inermis) was the only species that responded differently to the various treatments in the autumn of 1974. Glyphosate plus diuron (2 + 6 lb/A) was the only tank-mix combination that controlled bromegrass equivalent to glyphosate alone 31 days after treatment (DAT) and was more effective than glyphosate alone 78 DAT. The residual herbicides terbacil, simazine, bromacil and amitrol merely delayed manifestation of the glyphosate in the mix at 31 DAT, but no effect was observed 78 DAT. Amitrol and simazine tank-mixed with glyphosate reduced the effectiveness of glyphosate. This antagonism was avoided when applications were made separately the same day or with residual treatments delayed 3 or 7 days. Possible antagonistic effects will be assessed further on additional species in these plots during the spring of 1975.

1/ Roundup (R) Registered trademark of Monsanto Company.

2/ Monsanto Company, St. Louis, Missouri.

VEGETATION CONTROL WITH 3, 5, 6-TRICHLORO-2-PYRIDYLOXYACETIC ACID

B. C. Byrd, W. G. Wright, and L. E. Warren[1/]

ABSTRACT

3, 5, 6-trichloro-2-pyridyloxyacetic Acid, at rates from 0.5 to 9.0 lb. ae/a (0.56 to 10.1 kg/ha), has exhibited excellent herbicidal activity on a broad range of woody plants in performance trials on industrial sites in 15 states throughout the United States. These results suggest that this compound is more effective at lower rates than 2, 4, 5-T on a broader range of woody species. Established grasses were not permanently injured by the rates used in these tests.

Forestry and rangeland trials are underway in one or more of eight states and trials of various kinds have been established in other countries around the world. Grass residue and watershed runoff programs are at various stages prior to completion and preliminary estimates of impact on non-target organisms are underway.

Preliminary toxicological information indicates that the chemical has a moderate acute oral toxicity to mammals and should pose no problem from ingestion incidental to handling and spraying. The chemical also has a very low toxicity to fish and birds.

1/ Respectively, Herbicide R & D Specialist; Charlotte, N.C.; Midland, MI; Davis, CA; Dow Chemical Company.

DPX 3674, A NEW NON-SELECTIVE HERBICIDE FROM DU PONT [1]

T. J. Hernandez, W. H. Hudson, J. E. Prendergast [2]

ABSTRACT

Velpar® (DPX 3674) [3-cyclohexyl-6-(dimethylamino)-1-methyl-S-triazine-2, 4(1H,3H)-dione] is a new non-crop herbicide which is relatively non-selective. In trials it has shown a high degree of foliar and soil activity. It has shown activity over a wide range of annual, biennial and perennial broadleaved weeds and grasses, as well as many species of brush. Rates have ranged from 2 to 12 lbs. per acre depending on degree of control desired.

Trials have been conducted under many soil, climatic and species complex situations on various industrial weed control sites in the northeastern region of the United States.

1/ Velpar® is the registered trademark of E. I. du Pont de Nemours & Co., Inc., for DPX 3674

2/ Biochemicals Department, E. I. du Pont de Nemours & Co., Inc. Wilmington, Delaware 19898

CONTROLLING HARDWOOD SPROUTS WITH 2,4,5-T AND FENURON - A FIVE-YEAR SUMMARY

Robert D. Shipman[1/]

ABSTRACT

In March, 1965 a mixed upland oak-hickory stand of timber, 50 to 60 years of age, was completely clearcut on a 1.2 acre block in Huntingdon County, Pennsylvania. Following the cutting, 614 individual cut stumps of the original stand, two inches in diameter and larger, were measured according to species, stump diameter, height of stump, number of sprouts, and length of longest sprout. In June, 1965 stumps on five .1A blocks were treated with fenuron (3-phenyl-1, 1-dimethylurea) and five blocks with 2,4,5-T. Two .1A blocks were left untreated (controls). Factors analyzed were 12 treatments x 5 species x 4 periods. The major variables investigated for each treatment were (a) total sprouts per stump (b) average sprouts per stump (c) average height of longest sprout and (d) average diameter of longest sprout. Scarlet oak produced the largest sprouts and the greatest number of stumps with sprouts; however, white oak stumps produced the highest number of sprouts per acre.

Five years after treatment, the data indicated significant differences among and between species according to herbicide application. However, there were non-significant differences between fenuron and 2,4,5-T for individual species. Both herbicides were significantly better in reducing the number and size of stump sprouts than the untreated (control) blocks.

1/ Associate Professor of Forest Ecology, School of Forest Resources, The Pennsylvania State University, University Park, Pennsylvania.

AERIAL APPLICATION OF HERBICIDE PELLETS FOR BRUSH CONTROL ON POWER LINE RIGHTS-OF-WAY

E.J. Medicky[1]

Abstract. The on-target application of Tordon 10 K (4-amino-3,5,6-trichloropicolinic acid) pellets from aircraft poses increasing difficulties as flying height and speed increase. In 1973, Ontario Hydro evaluated three pellet dispersal systems in order to arrive at a system which could deliver 35 to 50 lbs product (3.5 to 5.0 lbs ai) on target from flying heights ranging from 100 to 300 feet. The Grumman Venturi and the Field Aviation Pellet Dispersal Systems indicated that good dispersal was provided with respect to swath width distribution, and delivery rate. Difficulties were encountered with respect to swath width and delivery rate in the Simplex Seeder System. Further development work of the three systems is planned in 1974.

Annually, Ontario Hydro treats approximately 40,000 acres of brush covered right-of-way with herbicides. The purpose of this endeavour is to provide the 7,000,000 inhabitants of the Province of Ontario with a safe, reliable and economical supply of energy. Of this total acreage 3,000 to 4,000 acres or 7.5% to 10% are treated from the air.

Aerial brush control operations are carried out in areas where:

1. access is limited because of a lack of roads,

2. topography is such that ground equipment would have great difficulty traversing it,

3. areas to be treated are so extensive that they could not be treated in a short period of time (one growing season).

Associated with these factors, of course, is the cost element. Costs per acre of aerial applications must fall within reasonable limits. Costs will not be discussed in this presentation.

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[1]Forester - Right-of-Way Management
Forestry Department, Ontario Hydro

Access, topography and the time element limit our operations to Northern Ontario. A further restriction here is that Tordon applications are not made in Southern Ontario where problems with crops could occur.

In 1969 trials were carried out with Tordon 10 K (4-amino-3,5,6-trichloropicolinic acid, 10% active ingredient) pellets. These trials indicated that Tordon pellets at a rate of 3.5 lbs ai (35 lbs product) per acre would provide adequate control of mixed, coniferous-deciduous brush on rights-of-way. The choice of pellet applications over liquid applications was dictated by the fact that on rights-of-way having towers of a height exceeding 90 feet drift problems could become serious if not insurmountable. It was felt that only pellets would be acceptable in these situations, and then only if an untreated buffer strip were left at each edge of the right-of-way. The buffer strip would vary from 10 feet to 15 feet depending on the actual width of the right-of-way. The problem, then, became one of devising suitable application equipment and techniques.

In 1971 the Dow Helicopter Slung Dry Application System, more commonly known as the Dow Bucket, was used to treat some 2,000 acres of brush. This system, incorporating the use of a rotating disk to spread the pellets, left something to be desired. Mechanical problems were numerous and calibration was difficult.

Also, because the bucket was suspended underneath the helicopter, some bucket sway was experienced. Although the job turned out to be quite acceptable we did not feel that we had enough control over the equipment to provide for the extremely accurate placement of the pellets which was necessary on a right-of-way situation.

In 1973, faced with a larger than usual brush control program we set out to find equipment which would provide the following pellet dispersal characteristics:

1. Application rate could be varied from 3.5 lbs ai to 5.0 lbs ai (35 lbs to 50 lbs product) per acre depending on brush conditions.

2. Uniform distribution of pellets on the right-of-way could be obtained.

3. Sharp cut-off of pellets at the edges of the swath would be possible.

4. Quick shut-off of the dispersal system would be available, while in flight, to avoid depositing pellets in water courses or on roads crossing the right of way.

5. Placement of pellets could be made with great accuracy from flying heights of 100 to 300 feet.

The equipment would have to suit every combination of accessibility, tower height, work load, topographic conditions, and species density and height.

Hence, three methods come under scrutiny:

1. Grumman Venturi

2. Simplex Seeder

3. Field Aviation Pellet Dispersal System.

1. Grumman Venturi:

The Grumman Venturi is mounted on a Grumman Ag-Cat. This aircraft is designed with short take-off and landing capabilities and can make use of make-shift airstrips such as fields and logging roads.

The dispersal system, mounted underneath the aircraft, employs venturi and airflow principles to deliver and spread pellets.

The fiberglass hopper, having a capacity of 2,000 lbs, is located between the engine and the cockpit. Pellets are metered into the spreader through a gate in the throat of the hopper. Through the action of gravity and air suction an appropriate amount of pellets drops into the venturi. Four airfoil shaped vanes and two centre plates provide for the distribution of the pellets. The air foil design of the vanes allows for a smooth flow of air at the venturi. This results in an extremely uniform distribution of pellets on the ground.

The ground speed of the aircraft during this operation was 90 mph. At a flying height of 100 feet a swath width of 90 feet was obtained. This was applied on a 120 foot right-of-way leaving a 15 foot wide buffer strip on each side. Rate per acre was 35 lbs product. This rate could easily be increased to over 100 lbs per acre if necessary.

2. Simplex Seeder:

The Simplex Seeder employs a blower principle to spread the pellets. It was mounted on a Bell G2 helicopter.

In this system, pellets are metered into an air stream from saddle tanks. A blower unit, driven by a hydraulic power take-off pump, produces a wind velocity of 140 mph in two tubes connected to the metering devices below the hoppers. The pellets

are then ejected through the delivery tubes. Delivery tubes can be mounted to either one side or both sides of the ship. In our case they were mounted to one side.

Our thinking here was that the helicopter could fly just over the tree tops on the edge of the right-of-way and blow the pellets to just beyond the centre line. With two passes, in opposite directions, the entire right-of-way could be treated. The advantage would be that damage to the right-of-way, because of drift or misapplication, could be minimized or eliminated.

The problem with this system was that the necessary dispersal tube wind velocity of 180 mph could not be attained. The result was a swath of just over 50 feet. This was less than the required width of 60 feet. The system was only marginally acceptable to our needs. More work is planned to try to perfect this system.

Design criteria for the Simplex System call for an aircraft airspeed of 40 mph while providing a 60-foot swath with an application rate of 35 to 50 lbs product per acre. Flying height would be 60 to 80 feet.

3. Field Aviation Pellet Dispersal System

The Field Aviation Dispersal System was designed and built by Field Aviation and is mounted on a Sikorski S-58T twin turbine helicopter.

The hopper is mounted inside the helicopter and is designed to carry 3,000 lbs of pellets. The pellets are metered into three tubes. They are allowed to fall in undisturbed air and attain a velocity of 125 mph before leaving the system.

The three tubes are suspended below the ship and their disposition determines, in part, the swath width. The other factor determining swath width is flying height.

The tubes are shaped like an air foil to provide smooth air flow around them. They are retracted when landing.

An air scoop is incorporated into the system. Through the forward motion of the aircraft, air is conducted through it to the dispersal tubes. This prevents back pressure from building up in the system.

Rate per acre is controlled by changing sprockets and the chain between the metering device and the drive mechanism controlling the scoops delivering pellets to the tubes.

Design criteria for this system call for an air speed of 60 knots while producing a swath width of 70 feet at an application rate of 35 to 50 lbs product per acre.

More work is planned to further develop this system.

These methods of applying herbicide pellets were investigated in response to the need for an efficient brush control program on power line right-of-way corridors. Over the last few years, because of rising costs and increased environmental concerns, this need has become rather acute. Through proper and accurate placement of herbicides, whether they are liquids or pellets, costs can be kept in line and damage to the sides of the right-of-way minimized.

It is hoped that the three pellet dispersal systems described will provide for the continuance of a safe, reliable and economical supply of energy to the customer while at the same time avoiding adverse criticism from public opinion groups.

FURTHER STUDIES ON THE USE OF GLYPHOSATE ON ORNAMENTALS

A. Bing 1/

ABSTRACT

Juniper, pine, spruce, holly and rhododendron are fairly tolerant while privet, forsythia, sweet gum, rose, maple and crabapple are susceptible to sprays of glyphosate (N-(phosphomethyl) glycine). Directed sprays of glyphosate are very effective in controlling perennial weeds in plantings of resistant nursery plants.

INTRODUCTION

Glyphosate is a very effective postemergence systemic herbicide that leaves no residue in the soil. It effectively controls mugwort (Artemesia vulgaris), Canada thistle (Cirsium arvense), quackgrass (Agropyron repens), curly dock (Rumex crispus) and field bindweed (Convolvulus arvensis) which are some of the most difficult to control perennial weeds in ornamental plantings (1) (2) (3). Glyphosate does not leave a residue in the soil thus allowing a crop to be planted shortly after treatment. The absence of a residue avoids the danger of leaching through the soil with absorption by the roots as is possible with more persistent herbicides such as amitrole (3-amino-S-triazole) and dicamba (3,6-dichloro-o-anisic acid).

These experiments are a continuation of last year's studies on 1. evaluation of tolerance of young nursery liners to effective rates of glyphosate and 2. elimination of perennial weeds in larger nursery plants with none or an acceptable level of injury to the plants.

MATERIALS AND METHODS

In the experiment with liners, young nursery plants were lined out April 17 to May 1 at a spacing of 2 ft in 400 ft rows spaced 3 ft apart. There were 14 cultivars each in 1 row. Table 1 lists the plants treated. Treatments with glyphosate were made in 8 ft wide bands across all rows with 4 plants of each cultivar in each replicate. The treatments were postplant delayed postemergence on July 1 when the weeds were 6-12 in high and the liners were well established. The glyphosate 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. Observations on weed growth were made August 1. The rating was from 1 = a dead or missing plant to 10 = a vigorous plant. Crop growth was evaluated on October 3 using the same measure of plant growth: 1 = a dead or missing plant to 10 = a vigorous plant.

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[1] Cornell Ornamentals Research Laboratory, Farmingdale, N.Y.

In another series of experiments older plants were treated in nursery rows with directed sprays of glyphosate to control mugwort, field bindweed, or Canada thistle. A planting of yews that were 12-16 in high was treated on April 25 with preemergence herbicides to control seedling weeds. Preemergence treatments were made April 25 on blocks consisting of four 184 ft rows of yews 2.5 ft apart. The following treatments were made: DCPA (dimethyl tetrachloroterephthalate) 75 WP and 6F at 14 lb ai/A, simazine (2-chloro-4,6-bis (ethylamino)-S-triazine 4G at 1 lb ai/A plus napropamide (2-Naphthoxy)-N, N-diethylpropionamide) 50WP at 4 lb ai/A, simazine 4G 1 lb ai/A plus alachlor (2-chloro-2,6-diethyl-N-(methoxy methyl) acetanilide) 8G at 4 lb ai/A and simazine 4G at 1 lb ai/A plus diphenamid (N,N-dimethyl -2, 2-diphenylacetamide) at 4 lb ai/A. Seedling weeds were controlled in all blocks but soon perennial weeds, especially mugwort, were growing vigorously. A directed spot spray of glyphosate at 1.5 lb ai/A was made on the weeds in May and repeated in June on those weeds missed in May or that were newly emerged.

In another area known to be infested with field bindweed a preemergence treatment with simazine 4G at 1 lb ai/A plus alachlor 4 lb ai/A was made earlier in the season. When the bindweed vines were about 12 to 18 in long, most of the vines were carefully pulled from the plants and placed in the open area between the rows of plants with the vines still attached to their roots. Glyphosate at 1½ lb ai/A was sprayed on the bindweed. A repeat treatment was made a month later to catch the few newly emerged.

RESULTS AND DISCUSSION

Liners. Except for the survival of a few large redroot pigweed (*Amaranthus retroflexus*) and *Galinsoga ciliata* which were not completely killed by the 1 lb ai/A rate the glyphosate sprays were very effective in killing existing weeds (Table 2). Within two weeks many seedlings were growing in all treated plots. As the time of spraying the weeds provide some protection to the shorter liners and this may partially explain the lack of effect of the glyphosate on the liners. As shown in Table 3, growth of Japanese holly, Japanese juniper, white pine and Norway spruce were not appreciably affected while California privet, sweet gum, Japanese maple, multiflora rose and Toringo crabapple were seriously affected. These results are similar to those reported last year (3). The untreated uncultivated plots showed a marked decrease in growth. Table 3 shows comparable 1973 results in parentheses. The results are very similar.

Established yews. There was no crop injury and weed control in all the blocks was very effective.

Miscellaneous established plants. Bindweed control was near perfect. There was no injury from the directed spray to the many kinds of nursery plants. An over all spray on bindweed left on yew and rhododendron plants caused negligible tip burn to yew and no injury to rhododendron.

Table 1. Nursery liners used in 1974 weed control experiments.

Common Name	Scientific Name	Date Planted
Bearberry cotoneaster	*Cotoneaster dammeri* "Skogholm"	4/19
California privet	*Ligustrum ovalifolium*	4/17
Goldenbells	*Forsythia sp.*	4/17
Hicks yew	*Taxus media hicksii*	4/17
Japanese black pine	*Pinus thunbergii*	5/1
Japanese garden juniper	*Juniperus chinensis procumbens*	4/19
Japanese holly	*Ilex crenata* "Green Gem"	4/17
Japanese maple	*Acer palmatum*	4/19
Kousa dogwood	*Cornus kousa*	4/19
Multiflora rose	*Rosa multiflora*	5/1
Norway spruce	*Picea abies*	5/1
Sweet gum	*Liquidambar styraciflua*	4/19
Toringo crabapple	*Malus sieboldii*	5/1
White pine	*Pinus strobus*	5/1

Table 2. Weed growth[a] in nursery liners treated with glyphosate. Treatment made July 1, observations made August 1, 1974.

Weed	Treatments: Glyphosate lb ai/A 1	2	3	Cultivated	None
General	3[b]	2	1	1	10
Canada thistle (*Cirsium arvense*)	1	1	1	1	c
Carpet weed (*Mollugo verticillata*)				1	4
Crabgrass (*Digitaria sp.*)				1	4
Foxtail grass (*Setaria glauca*)				1	3
Galinsoga (*Galinsoga ciliata*)	2			1	5
Groundsel (*Senecio vulgaris*)				1	4
Ragweed (*Ambrosia artemesifolia*)				1	2
Redroot (*Amaranthus retroflexus*)	2	2[d]		1	6

[a] 1 = dead or missing, 10 = excellent growth
[b] Average of 2 plots 42 x 8 ft
[c] Untreated plots were not heavily infested with Canada thistle
[d] Newly germinated plants

Results of 1973 (3) and 1974 treatments with glyphosate show great promise for its use as a directed spray to control perennial weeds in rows of nursery plants especially rhododendrons, coniferous evergreens, and trees. Mugwort and Canada thistle are very susceptable at all stages of growth.

LITERATURE CITED

1. Ahrens, J. F. 1974. Chemical control of quackgrass and nutgrass in nursery liners. Proc. NEWSS 28: 372-375.

2. Ahrens, J. F. 1974. Selectivity of glyphosate and asulam in ornamental plantings and Christmas trees. Proc. NEWSS 28: 361-368.

3. Bing, A. 1974. Glyphosate on ornamentals. Proc. NEWSS 28:369-371.

Table 3. Growth[a] of nursery liners treated with glyphosate. Treatments made July 1. Observations made October 1, 1974 compared to 1973 treatments [b].

Plants treated	Treatments: Glyphosate lb ai/A 1	2	3	Cultivated	None
California privet	4(7)	2(4)	3(3)	9(8)	8
Forsythia	5(9)	5(6)	5(5)	9(9)	6
Japanese holly	8	10	9	9	9
Hicks yew	8(10)	9(9)	6(10)	9(10)	8
Japanese garden juniper	7(10)	9(9)	9(8)	9(10)	7
Bearberry cotoneaster	9	4	4	8	5
Sweet gum	4	3	1	8	9
Kousa dogwood	1	1	2	2	2
Japanese maple	5	3	2	9	6
Multiflora rose	2(3)	2(2)	2(2)	9(6)	5
Toringo crabapple	5(4)	3(1)	2(1)	9(7)	5
White pine	8(6)	7(6)	9(4)	9(7)	7
Japanese black pine	7	5	5	7	3
Norway spruce	8(8)	8(7)	8(7)	8(9)	8

[a] Average of 2 replicates of 4 plants each rating 1 = dead or missing to 10 = excellent growth.

[b] 1973 ratings are shown in parentheses (7). Different cultivars of juniper and spruce were planted in 1973 and 1974.

NAPROPAMIDE FOR CONTROL OF WEEDS IN ORNAMENTALS AND COMMERCIAL NURSERIES

J. R. Barnes [1/]

ABSTRACT

2-(a-naphthoxy)-N,N-diethylpropionamide (napropamide) has been evaluated on numerous ornamental cultivars over the past 3-4 years. Data summarizing plant tolerance and weeds controlled for napropamide alone or in combination with 2-Chloro-4,6-bis (ethylamino)-s-triazine (simazine) are reviewed.

Flexible use patterns and various timings of application give effective seasonal weed control. Use rates for napropamide vary from 4-6 lb./A for fall applications to 3-6 lb./A for spring applications. Simazine at 3/4-1 lb./A is added to improve overall broadleaf weed control on triazine tolerant species.

1/ NE Field R&D Representative, Stauffer Chemical Company, Dayton, New Jersey 08810

OXADIAZON-WEED CONTROL IN ORNAMENTALS

James E. Merrick[1]

Abstract

A granular formulation of 2-Tert-butyl-4- (2,4-dicloro-5-isopropoxyphenyl) -4[2]- 1,3,4 - oxadiazon -5-one (oxadiazon resulted in excellent annual broadleaf and grass weed control when applied preemergence at 2.0 and 4.0 lb ai/A. No difference in weed control was noted with oxadiazon applications to either bare soil or mulched container plants.

Introduction

This research was conducted primarily to evaluate weed control activity and crop tolerance when applying oxadiazon at 2.0, 4.0, 6.0, and 8.0 lb ai/A. to various container ornamentals. The site of research was at wholesale Nurseries in Lake County, Ohio during the spring of 1974.

Methods and Materials

Oxadiazon (2G) was applied at the rates of 4.0 and 8.0 lb ai/A. and 2.0, 4.0, and 6.0 lb ai/A. for preemergence weed control in container ornamental plants consisting of bare soil and mulched plants respectively. The soil media was composed of a sand to peat (3:1) mixture and a bark mulch.

Application rates of 4.0 and 8.0 lb ai/A. to bare soil were made on May 14, 1974 to one year old plants consisting of 'Girard's Rainbow' Leucothoe fontanesiana, Rhododendron P.J.M. Hybrid, 'Royal Beauty' Cotoneaster dammeri, 'Green Lustre' Ilex convexa, Rhododendron Cunninghama, and 'Jade River' Juniper. The partially decomposed bark mulch was removed before herbicide application.

1/ Product Development Representative, Agricultural Div. of Rhodia, Inc., Somerset, N. J. 08873

Application rates of 2.0, 4.0, and 6.0 lb ai/A. were applied immediately after potting and application of shredded bark mulch on May 23, 1974. The varieties employed were Euonymus f.r. Sarcoxie 'Green Lane', Magnolia Dr. Merrilli, 'Wiltoni' Juniperus horizontalis, and 'Royal Beauty' Cotoneaster dammeri.

Weed Species found within the soil media at most Nurseries were extremely variable. The weeds most commonly found in the untreated check plots were hairy crabgrass (Digitaria sanguinalis), barnyardgrass (Echinochloa crusgalli), green foxtail (Setaria viridis) Fall Panicum (Panicum dichotomiflorum), carpetweed (Mollugo verticillata), Common chickweed (Stellaria media), yellow wood sorrel (Oxalis stricta), and purselane (Portulaca oleracea). Some less prominent weed species were Pennsylvania Smartweed (Polugonum pennsylvanicum), Lambsquarters (Chenopodium album), sheep sorrel (Rumex acetosella), Knotweed (Polygonum aviculare), dandelion (Taraxacum officinale), and Annual bluegrass (Poa annua).

Results and Discussion

Weed control results in respect to visual ratings and weed counts of the untreated check were made on July 2 and August 15, 1974. However, only the results of the latter date are presented in Tables I and II. The visual ratings were based on a scale of 0 to 10, where 0 = no control and 10 = complete control. Prior to July 2, 1974, periodic observations were made in regards to crop injury.

Weed Control was excellent with oxadiazon as a preemergence application on both bare soil (Table I) and mulched container plants (Table II), when evaluated three months after application. The minimal rate of 4.0 lb ai/A. to bare soil and 2.0 lb ai/A. to mulched varieties proved excellent in both tests for the control of annual broadleaves and grasses. However, the annual common chickweed (Stellaria media) exhibited a moderate tolerance in comparison to the other commonly found annuals. There was no phytotoxicity to any of the ornamentals employed.

This performance data alone warrants further investigation for the use of oxadiazon in container Nursery stock.

TABLE I EVALUATION of OXADIAZON for WEED Control in One Year Container Plants.[1/]

TREATMENTS	RATE (lb ai/A)	WEED CONTROL[2/] LEUCOTHOE[3/]	AZALEA	COTONEASTER	ILEX	RHODODENDRON	JUNIPER
Oxadiazon	4.0	9.8	9.1	10	9.8	7.5	9.1
Oxadiazon	8.0	9.8	7.5	10	9.3	9.1	9.6
Check	0.0	0	0	0	0	0	0
		(4)[4/]	(34)	(1)	(12)	(16)	(9)

1/ Application date (5/14/74); Plot Size (98.7 ft.^{2}). Trace of Rainfall within 12 hours after application.

2/ Weed Control evaluation (8/15/74); 0 = no control, 7 = acceptable control, 10 = complete control.

3/ Average weed rating of 3 replications.

4/ Weed species count of both Broadleaves and grasses within check.

TABLE II EVALUATION of OXADIAZON for WEED CONTROL in NEWLY POTTED CONTAINER PLANTS.1/

WEED CONTROL2/

TREATMENT	RATE (lb ai/A)	JUNIPER BLV4/	JUNIPER GR	MAGNOLIA BLV	MAGNOLIA GR	EUONYMUS BLV	EUONYMUS GR	COTONEASTER BLV	COTONEASTER GR
Oxadiazon	2.0	9.1	9.1	9.4	9.0	9.5	8.3	9.9	8.1
Oxadiazon	4.0	9.6	9.4	9.6	8.9	9.7	8.8	9.9	8.7
Oxadiazon	6.0	9.5	9.6	9.6	9.8	9.7	9.3	9.6	9.1
Check	0.0	0	0	0	0	0	0	0	0
		(27)5/		(22)		(8)		(1)	

1/ Potted (May); Application date (5/23/74); Plot Size (21 ft.^{2}). Trace of Rainfall within 12 hours after application.
2/ Weed Control Evaluation (8/15/74); 0 = no control, 7 = acceptable control, 10 = complete control.
3/ Average weed rating of 4 replications
4/ Blv = Broadleaves; GR = Grasses
5/ Weed species count of both broadleaves and grasses within check.

NURSERY WEED CONTROL EXPERIMENTS

A. Bing 1/

ABSTRACT

Combinations of 1 lb ai/A simazine (2-chloro-4,6-bis (ethylamino)-S-triazine) with 4 lb ai/A alachlor (2-chloro-2' 6'-diethyl-N-(methoxy methyl) acetanilide), or 0.5 lb ai/A metribuzin (4-amino-6-tert-butyl-3-methylthio) -as-triazin-5 (4H) one) or 4 lb ai/A napropamide (2-(q-naphthoxy)-N,N-diethyl-propionamide) are effective preemergence herbicides and safe on a variety of cultivars of nursery stock.

INTRODUCTION

Preemergence weed control is very important in the growing of plants in a nursery. The 1974 experiment is a continuation of the study of the effect of preemergence herbicides on growth of weed seedlings and nursery liners (1). This year's experiment is a repeat of some of the herbicide treatments of last year plus some additional ones. Some of the cultivars of nursery stock are the same as last year, others are different because of the availability of plants. This makes possible a partial comparison of this year's with last year's results.

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 April 17 to May 1. The field was irrigated after planting and then cultivated several days later. Noticable weeds were removed by hand before treatments were applied. Most preemergence herbicides (Table 2) were applied to 2 replicates of each treatment on May 15. Norflurazon and dibutalin plus diphenamid were applied about 1 month later after again removing weeds. The granular applications were made with hand shakers, the sprays with a handpumped sprayer using a Spraying System 80003 T Jet nozzle delivering 100 gal/A. Each treatment was in an 8 ft wide band across all rows with 4 plants of each cultivar in each replicate.

Observations on weed control were made August 1. The ratings were made on general weed control and for specific weeds that were a problem in the area. The ratings shown in Table 2 were from 1 = no weeds to 10 = many vigorous weeds. A rating of 2 or 3 indicates very few weeds, 4 or 5 reasonably good control while a general rating of 9 or 10 indicates complete ground coverage by weeds. After further observations in early September all plots were cultivated several times and hand weeded. Velvet leaf (*Abutilon theophrasti*) and Canada thistle (*Cirsium arvense*) plants were hand pulled from the plots several times and not considered in the ratings.

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[1] Cornell Ornamentals Research Laboratory, Farmingdale, N.Y.

On October 1 each individual liner was rated for vigor with a rating of 1 = a dead or missing plant to 10 = a vigorous plant. The averages of the 2 replicates are in Table 3.

The ratings of weed and crop growth for 1973 are shown in parentheses in Table 2 and 3 where there were comparable treatments and crops.

RESULTS AND DISCUSSION

All treatments are expressed in lb ai/A. The 1973 figures (1) are shown in parentheses. The stand of Kousa dogwood was too poor to be included in Table 3 for interpretation of crop tolerance. Simazine 1 plus alachlor 4 and simazine 1 plus metribuzin 0.5 were very effective in 1973 and 1974 as shown by the low indices of weed growth in Table 2. Metribuzin 0.5 plus napropamide 4 or diphenamid 4 had ratings of 3 in 1974 showing good weed control. The resistent weed in the metribuzin plots was redroot pigweed.

The simazine plus napropamide applications in 1974 were not as effective as in 1973. Napropamide alone was only fairly effective as was dibutalin plus diphenamid. DCPA and norflurazon were not very effective against redroot pigweed and galinsoga.

Crop tolerance is summarized in Table 3 with a comparison of 1974 with 1973 results. As shown by the high index numbers most cultivars were tolerant to all the treatments. Where observations were too erratic to interpret, no figure is given. Japanese maple is apparently injured by metribuzin as all replicates show a low index number of 3.

LITERATURE CITED

1. Bing, A. 1974. Weed control on ornamentals. Proc. NEWSS 28:357-360.

Table 1. Preemergence herbicide used on nursery liners in 1974.

Common name	Chemical name
alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
DCPA	dimethyl tetrachloroterephthalate
dibutalin	N-secondary-butyl-4-tertiary-butyl-2,6-dinitroaniline
diphenamid	N,N-dimethyl-2,2-diphenylacetamide
metribuzin	4-amino-6-tert-butyl-3-(methylthio)as-triazine-5(4H) one
napropamide	2-(a-naphthoxy)-N,N-diethylpropionamide
norflurazon	3-(hexahydro-4,7-methanoindan-5-yl)-1,1-dimethylurea
simazine	2-chloro-4,6-bis(ethylamino)-s-triazine

Table 2. Weed growth[a] in nursery plots treated with preemergence herbicides in 1974 and 1973[b]. Treated May 15, rated August 1, 1974.

Treatment		Weeds									
Material	Rate	General	Purslane	Groundsel	Crabgrass	redroot pigweed	foxtail grass	lambs quarters	carpetweed	galinsoga
Cultivated		1								
Untreated		9(9)		4	4[c]	6[c]	3	5	4[c]	5
norflurazon 5G[d]	8	6	2	2	2	5		3	2	2
metribuzin 50WP napropamide 50WP	0.5 4	3				3				
metribuzin 50WP diphenamid 80WP	0.5 4	3				3				
simazine 80WP napropamide 50WP	1 4	3(2)				3				
simazine 4G napropamide 10G	1 4	5(2)	3		2	4	2			
simazine 4G napropamide 10G	1.5 6	4	2		2	4	2			
simazine 10WP napropamide 40WP	1 4	3(2)				3				
simazine 2G alachlor 8G	0.75 3	2(2)		2	2					
simazine 2G alachlor 8G	1.5 6	2(2)			2					
napropamide 50WP	4	6(4)		2		4[c]			2	2
metribuzin 50WP simazine 80WP	0.5 1	2(1)				2				
DCPA 75WP	16	6		2		4		2		3
dibulalin 2.3G[d] diphenamid 5G	4 6	5		4	2	2				2

a A rating of 1 = no live weeds to 10 = full of vigorous weeds
b Comparable 1973 ratings are in parentheses (9)
c Also problem weeds in 1973
d Treated June 22

Table 3. Tolerance[a] of nursery liners to preemergence herbicides in 1974 and 1973[b] Plant growth observed October 1, 1974 October 15, 1973.

Treatment		Plants treated												
Material	Rate lb ai/A	Privet	Forsythia	Holly	Yew	Juniper	Cotoneaster	Sweet gum	Maple	Rose	Crabapple	White pine	Black pine	Norway spruce
Cultivated		9(8)	9(9)	9	8(10)	9(10)	8	8	9	9(6)	9(7)	9	7	8
Untreated		6	5	9	5	7	-	7	6	5	5	7(7)	3	7(9)
norflurazon 5G	8	10	10	9	8	9	4	7	6	6	6	7	5	4
metribuzin 50WP + napropamide 50WP	0.5 4	7	9	9	9	7	9	7	3	7	8	7	5	8
metribuzin 50WP + diphenamid 80WP	0.5 4	8(9)	10(10)	9	10(10)	9(10)	6	5	3	8(9)	6(8)	7(6)	4	9(6)
simazine 80WP + napropamide 50WP	1 4	8	10	9	9	7	7	8	5	7	6	7	4	9
simazine 4G + napropamide 10G	1 4	9	10	9	8	9	9	6	7	7	8	7	6	7
simazine 4G + napropamide 10G	1.5 6	10	10	9	8	9	-	8	-	10	6	6	5	6
simazine 10WP + napropamide 40WP	1 4	9	10	9	8	7	9	8	5	5	9	9	7	7
simazine 2G + alachlor 8G	0.75 3	9(9)	9(10)	10	9(9)	8(9)	8	8	9	9(9)	6(7)	5(8)	4	8(9)
simazine 2G + alachlor 8G	1.50 6	9(10)	10(10)	7	7(10)	8(9)	9	8	6	6(10)	7(6)	8(7)	-	8(8)
napropamide 50WP + metribuzin 50WP	4 0.5	9(10)	9(10)	9	9(10)	9(9)	9	8	8	7(9)	7(8)	7(7)	5	8(9)
simazine 80WP	1	8(8)	10(10)	8	9(10)	9(10)	7	9	3	5(6)	6(8)	8(7)	3	7(8)
DCPA 75WP	16	8	7	8	8	-	-	-	6	7	7	6	7	7
dibulalin 2.3G + diphenamid 5G	4 6	10(9)	10(10)	9	9(10)	9(10)	6	7	7	3(7)	5(8)	7(7)	2	8(8)

(a) Average of 2 replicates of 4 plants each rating 1 = dead or missing to 10 = excellent growth.
(b) 1973 ratings are shown in parentheses (7).

FURTHER EXPERIMENTS ON THE CONTROL OF QUACKGRASS IN ORNAMENTALS

J. F. Ahrens[1/]

SUMMARY

The 1974 results of three field experiments in which herbicides were applied to control quackgrass (Agropyron repens (L.)Beauv.) before or after planting ornamentals are summarized here.

At Bloomfield, treatments were made in the fall of 1972, or before planting ornamentals in the spring of 1973. The details of this experiment and the 1973 results were reported earlier (1). The same herbicides were reapplied a second time either on November 5, 1973 or on April 25, 1974, over the established ornamentals which included Taxus cuspidata, Juniperus horizontalis plumosa compacta, Pinus strobus, and Euonymus radicans 'Sarcoxie'. The herbicides included napropamide (2-(α-naphthoxy)-N,N-diethylpropionamide) at 4 and 8 lb/A, pronamide (3,5-dichloro-N-(1,1-dimethyl-2-propynyl)benzamide) at 1.5 and 3 lb/A, and glyphosate (N-(phosphonomethyl)glycine). Glyphosate had been applied at 1.5 and 3 lb/A before planting but these rates were reduced to .75 and 1.5 lb/A the second year. All were applied as sprays over the ornamentals the second year, except that the pines in glyphosate plots were covered with plastic bags during the April 1974 spraying to avoid expected injury (2).

During 1974, napropamide caused no injury to the ornamentals but gave only fair control of quackgrass. Similar results were obtained with pronamide applied in April. However, pronamide in November at 3.0 lb/A gave over 90 percent control of quackgrass without injury to the ornamentals. Glyphosate at .75 or 1.5 lb/A either in the fall or spring practically eliminated quackgrass, but the April application reduced the vigor and early growth of Taxus and Euonymus, particularly at 1.5 lb/A. The November application of glyphosate had no significant effect on growth of the ornamentals.

In the second trial at Windsor, glyphosate and asulam (methylsulfanilylcarbamate) were applied alone or in combination with simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) in August 1973 and again in June 1974 over established Euonymus radicans 'Sarcoxie' and Hydrangea 'Nikko Blue' infested with quackgrass. Quackgrass control and plant injury were evaluated in August 1974. Glyphosate at .5 lb/A in August followed by .75 lb/A in June alone or with simazine at 1 or 2 lb/A gave excellent control of quackgrass (97 percent) with very slight injury to Euonymus and moderate injury to Hydrangea. At 1 lb/A followed by 1.5 lb/A of glyphosate, injury to Euonymus was still slight but injury to Hydrangea was excessive. Two applications of asulam at 8 lb/A alone or with simazine at 1 or 2 lb/A gave only 60 percent control of quackgrass with slight injury to Euonymus and moderate injury to Hydrangea.

The third experiment compared preplanting applications of glyphosate, pronamide, napropamide, and EPTC (S-ethyl dipropylthiocarbamate) on a sandy loam soil at Windsor. Glyphosate was applied on May 16 on quackgrass 6 to 12 in tall with 4 to 5 leaves and the others were incorporated with a tiller on May 31. On June 7 we planted 2 year old transplants of Juniperus horizontalis plumosa compacta and Taxus cuspidata and gladiolus corms of 'White Friendship' and 'Pink Romance'.

1/ The Connecticut Agricultural Experiment Station, Hallen Laboratory, Windsor

Glyphosate gave over 90 percent control of quackgrass at 2, 4, or 8 lb/A. Glyphosate did not adversely affect growth of the woody plants, but at 8 lb/A it reduced corm yields of gladiolus. Pronamide gave about 80 percent control of quackgrass at 4 lb/A and poor control for the season at 2 lb/A, without injury to the ornamentals. Napropamide gave only about 60 percent control of quackgrass at 8 lb/A and less at 4 lb/A without injury to the ornamentals. EPTC at 6 lb/A controlled quackgrass for about one month and it reduced the growth of the junipers and corm yields of gladiolus. The treatments in this test will be repeated in the fall of 1974 for a second year of evaluation.

The results of these and other experiments to date indicate that high levels of quackgrass control can be obtained in ornamentals with glyphosate. Preplanting applications at 1.5 to 4 lb/A on growing quackgrass in the spring appear safe for several herbaceous and woody ornamental plants. When preplanting applications of glyphosate have been followed by fall applications at lower dosages quackgrass has been reduced to levels approaching eradication. Overhead sprays of glyphosate at rates of .75 to 1 lb/A appear safe on several evergreen ornamentals, particularly when applied in the fall. Preplanting or fall surface applications of pronamide also have been moderately effective against quackgrass and safe on a number of ornamentals (1,3).

LITERATURE CITED

1. Ahrens, J. F. 1974. Preplant herbicides for control of quackgrass in ornamentals. Proc. Northeast. Weed Sci. Soc. 28:372-378.

2. Ahrens, J. F. 1974. Selectivity of glyphosate and asulam in ornamental plantings and Christmas trees. Proc. Northeast. Weed Sci. Soc. 28:361-368.

3. Ahrens, J. F. 1974. Fall applications of herbicides for control of quackgrass and yellow nutsedge in Taxus cuspidata capitata. Proc. Northeast. Weed Sci. Soc. 28:379-385.

CHEMICAL CONTROL OF NUTSEDGE IN GLADIOLUS CORMELS

J. F. Ahrens[1/]

ABSTRACT

Herbicides were applied before or after planting gladiolus cormels in soil infested with yellow nutsedge (Cyperus esculentus L.). Alachlor (2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide) at 4 lb/A preemergence controlled nutsedge for 2 months with minimal injury to the gladiolus. Preplant incorporated applications of alachlor severely injured gladiolus cormels. Napropamide (2-(α-naphthoxy)-N,N-diethylpropionamide) at 3 lb/A preplant incorporated and glyphosate (N-phosphonomethyl)glycine) at 1 lb/A on growing nutsedge preemergence to gladiolus gave short term control of nutsedge with no injury to the gladiolus. Perfluidone (1,1,1-trifluoro-N-[2-methyl-4-(phenylsulfonyl)phenyl]methane sulfonamide) and higher rates of napropamide or alachlor injured the gladiolus, and diuron (3-(3,4-dichlorophenyl)-1,1-dimethylurea) followed by 2,4-D ((2,4-dichlorophenoxy) acetic acid) did not control nutsedge.

INTRODUCTION

Yellow nutsedge is a serious weed pest in gladiolus plantings. It is difficult to control because gladiolus cormels are especially sensitive to herbicides (1). This report describes a preliminary study in which several herbicides reported to be effective against nutsedge were tested for use in gladiolus cormels.

MATERIALS AND METHODS

A field was chosen in Enfield, Connecticut that had a solid stand of yellow nutsedge in May of 1974. The soil was a Ninegret very fine, sandy loam. The nutsedge was plowed down in early June and the land was fitted and fertilized. Several treatments were applied before planting on June 20, and incorporated with a tiller running approximately 2 in deep. Two hundred and fifty cormels of White Friendship and Pink Romance then were planted in each plot and covered 1-2 in deep. Plot sizes were 6 ft x 12 ft, separated by 4 ft borders. The treatments were arranged in randomized complete blocks with three replicates.

The herbicides and time of application are given in Table 1. The herbicides were applied as sprays in 50 gal of solution per acre or with an auger feed granular applicator. Glyphosate and 2,4-D were applied on July 7 before emergence of the cormels when the nutsedge was 3-5 in tall with 4 to 6 leaves. The 2,4-D was reapplied on July 29 when the cormels were 3 to 4 in tall. Plots other than those receiving 2,4-D were weeded in an 8 in band over the cormels on July 29 to allow the cormels to survive. The 2,4-D plots were weeded over the row and weeds between the rows were mowed with a sickle bar mower on August 17. The corms were harvested on October 4. Rainfall was adequate for good plant growth and no irrigation was supplied.

RESULTS AND DISCUSSION

Ratings of the control of yellow nutsedge, common ragweed (Ambrosia artemisiifolia L.), and numbers of corms produced are given in Table 2. Only corms (bulbs)

1/ The Connecticut Agricultural Experiment Station, Valley Laboratory, Windsor.

Table 1. Herbicides used in nutsedge trial in gladiolus cormels.

Common name	Chemical name	Trade name and formulation	Time of application
glyphosate	N-(phosphonomethyl)glycine	Roundup 3 lb/gal,a.e.	on emerged nutsedge, preemergence to gladiolus
alachlor	2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide	Lasso 4 lb/gal, e.c.	preplant incorporated, preemergence
diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	Karmex 80 W	preemergence
napropamide	2-(α-naphthoxy)-N,N-diethylpropionamide	Devrinol 50 W	preplant incorporated
2,4-D	(2,4-dichlorophenoxy)acetic acid	Weedone LV-4	twice on emerged nutsedge
perfluidone	1,1,1-trifluoro-N-[2-methyl-4-(phenylsulfonyl)phenyl]methanesulfonamide	Destun 5 G	preemergence

larger than 3/8 in were counted. Germination of White Friendship was erratic. Because of late planting and a heavy nutsedge population, yields of corms were low in this test, but they do indicate which treatments were injurious.

Glyphosate slowly killed or stunted most of the nutsedge present at treatment, but did not control nutsedge tubers germinating later. However, the glyphosate spray caused no injury to the cormels which had not emerged at treatment. All of the herbicides controlled ragweed.

Preplant incorporated applications of alachlor caused more injury to the cormels and did not control nutsedge longer than preemergence applications. Alachlor applied preemergence at 4 lb/A caused little injury to the cormels and controlled nutsedge for 2 months. Adding diuron to alachlor increased injury to cormels without improving control of nutsedge. In tests by Wilson, et al, alachlor clearly was more effective against nutsedge when incorporated than when surface applied (2). Earlier work showed that preemergence applications of alachlor were injurious to cormels, but not corms on a sandy soil (3).

Napropamide at 3 lb/A did not injure the cormels but controlled nutsedge satisfactorily for only about a month. At 6 lb/A napropamide controlled nutsedge for over two months but was injurious to the cormels. In another experiment in gladiolus corms during 1974, however, napropamide at 8 lb/A caused no injury (4).

Granular perfluidone controlled nutsedge for over two months at 4 lb/A but

injured cormels at 2 lb/A. Preemergence applications of diuron had no effect on nutsedge and two applications of 2,4-D on growing nutsedge merely stunted it. Because the 2,4-D plots were not weeded in the row as soon as the others, competition from nutsedge crowded out the cormels.

LITERATURE CITED

1. Ahrens, J. F. 1972. Herbicide combinations for gladiolus cormels. Bull. North Amer. Glad. Council 110:64-68.

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

3. Bing, A. 1973. Weed control in 1972. Bull. North Amer. Glad. Council 113:67-68.

4. Ahrens, J. F. 1975. Further experiments on the control of quackgrass in ornamentals. Proc. Northeast. Weed Sci. Soc. Vol. 29.

Table 2. Effects of herbicides on nutsedge, ragweed, and gladiolus cormels.

Herbicide	Rate a.i., lb/A	Timing[1/]	Weed control[2/] Nutsedge 7/16	Nutsedge 7/29	Nutsedge 8/17	Nutsedge 9/10	Ragweed 7/16	Gladiolus Stand[3/] White Friendship	Stand Pink Romance	No. corms per plot White Friendship	No. corms per plot Pink Romance
weedy check			0	0	0	2	0	5.0	8.3	6.7	16.3
glyphosate	1	Post	6.0	7.3	1.7	0	10	6.3	9.7	18.7	57.7
alachlor	4	PPI	9.6	8.6	6.5	3.0	9.2	3.7	4.7	2.3	1.3
	8	PPI	9.9	9.8	9.7	6.8	9.6	0	0	0	0
	4	Pre	9.5	9.2	9.2	2.3	9.6	6.0	7.7	20.3	24.3
	8	Pre	9.8	9.3	9.6	7.3	9.9	4.3	7.3	12.0	18.3
alachlor+diuron	4+.5	Pre	9.5	9.0	8.2	0	9.9	6.0	8.3	15.3	13.3
napropamide	3	PPI	8.3	7.0	2.7	0	8.6	7.0	8.7	27.0	37.3
	6	PPI	9.0	8.5	8.3	6.3	9.0	4.3	7.3	9.0	6.0
perfluidone	2	Pre	8.0	6.8	6.2	3.0	9.2	3.3	4.3	3.0	4.0
	4	Pre	8.8	8.3	8.8	6.0	10.0	3.7	3.3	1.7	2.0
perfluidone+ diuron	2+.5	Pre	7.8	7.3	6.0	2.0	9.6	4.5	4.0	3.7	0.7
diuron+2,4-D	.5+1	Pre+Post	3.7	2.3	1.7	0	9.7	-	-	0.7	0.7
	.5+2	Pre+Post	4.3	3.3	4.0	0	10.0	-	-	0.7	2.3
L.S.D. p = .05										11.1	19.8

1/ PPI = preplant incorporated, Pre = preemergence, Post = postplanting, on emerged nutsedge.
2/ 0 = no control, 10 = 100% control.
3/ 0 = no stand, 10 = 100% stand of cormels.

CHEMICAL WEED CONTROL IN SELECTED GROUND COVERS

Chiko Haramaki[1/]

ABSTRACT

A common problem faced by landscape contractors is the rampant weed growth in newly planted ground cover beds, which soon overgrow the ground cover plants. The weed growth is not only unsightly but retards or kills the ground cover plants if not periodically weeded. The main objective was to find herbicides which would control the weed growth if applied before or after transplanting but not affect the growth of the ground covers adversely. Baltic ivy (Hedra helix 'Baltic') Japanese pachysandra (Pachysandra terminalis), and Purpleleaf wintercreeper (Euonymus fortunei 'Purpleleaf') liners were transplanting. EPTC, nitralin, metribuzin, and trifluralin were incorporated into the soil at several rates seven days before transplanting. Alachlor, diuron, sencor, and a simazine plus diphenamid mixture were sprayed on five days after transplanting on other plots.

The predominant weed species were yellow foxtail (Setaria glauca), downy brome (Bromus tectorum), redroot pigweed (Amaranthus retroflexus), common purslane (Portulaca oleraceae), field pepperweed (Lepidium campestre), dandelion (Taraxacum officinale), and common lambsquarter (Chenopodium album).

Pretransplant applications of EPTC at 2, 4 and 8 pounds per acre, and nitralin at 1, 2, and 4 pounds per acre gave excellent weed control. Trifluralin at 1, 2, and 4 pounds per acre gave good weed control. The ground cover plants showed little or no injury in the EPTC, nitralin and trifluralin treated plots. Metribuzin at 1, 2, and 4 pounds per acre gave excellent weed control but severely injured the ground covers. In the posttransplant applications diuron and sencor at 1, 2, and 4 pounds per acre did an excellent job of weed control but severely damaged the ground covers. All rates of diuron did not adversely affect the growth of purpleleaf wintercreeper. Alachlor at 1, 2, and 4 pounds per acre and the simazine plus diphenamid mixture at 1/2 + 2, 1 + 4, 2 + 4 pounds per acre gave good weed control with little or no damage to the ground cover plants.

1/ Associate Professor, Department of Horticulture, Pennsylvania State University, University Park, Pennsylvania 16802.

SURVEY OF ACTIVATED CHARCOAL RESEARCH WITH ORNAMENTALS

K. E. CLAPP[1]

Abstract

Activated charcoal is useful in agriculture because of the ability to adsorb a wide range of organic pesticides and toxins. The degree of adsorption varies with many factors, but generally increases with decreasing water solubility. Most researchers used activated charcoal as a part of a weed control program to protect the desirable plant from herbicide caused stunting or mortality. Typical data is presented from published and unpublished research.

Researchers testing with woody plants include J. Ahrens, University of Connecticut; P. Carpenter, Purdue University; T. MacCubbin, University of Maryland; A. Bing, Cornell Univ.; C. Elmore, University of California; H. Holt, University of Arkansas; H. Burnett, Florida Department of Agriculture. Plant species tested include: Cotoneaster, Euonymus, Forsythia, Red Maple, Privet, Pyracantha, Weigla, Azalea, Holly, Juniper, White Spruce and Loblolly Pine. Herbicides include: Atrazine, simazine, dichlorbenil, trifluralin, EPTC, bromacil, alachlor and diuron.

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[1]Development Associate, Specialty Chemicals Division, ICI United States Inc.

GRANULAR HERBICIDE COMBINATIONS IN NURSERY BEDS

William J. Bennett 1/

Abstract

Combinations of granular herbicides were mixed prior to application to nursery beds in two Massachusetts nurseries. Simazine 4G at 1 lb. ai/A. was combined with several herbicides and applied on duplicated plots in June 1974. Herbicides mixed with simazine included profluralin 2G at 2 lbs. and 3 lbs. ai/A; trifluralin 5G at 2 lbs. ai/A; napropamide 10G at 4 lbs. ai/A; Diphenamid 5G at 4 lbs. ai/A.

All combinations resulted in satisfactory weed control through August 1974. No injury was noted in any of the plant species treated.

Introduction

Granular herbicides have been found to be extremely practical for application to nursery crops (2). Combinations of simazine with one of several herbicides recognized effective in controlling annual grasses have been shown to be effective in season long control of common nursery weeds (1). The use of such combinations on immature species in nursery beds needs to be investigated.

Methods & Materials

Field trials were conducted in two Massachusetts nurseries in 1974. Rooted cuttings of several nursery species were planted in nursery beds and granular herbicide combinations were applied within two days. Plant species included Emerald Gaiety Euonymus (Euonymus Fortunei 'Emerald Gaiety'), Mugho pine (Pinus Mugho), Andorra juniper (Juniperus horizontalis plumosa), American arborvitae (Thuja occidentalis), Japanese holly (Ilex crenata convexa), and Sawara cypress (Retinispora plumosa).

Simazine 4G at 1 lb. ai/A. was combined with several herbicides and hand applied to duplicated plots on May 30 and June 18, 1974. Plots were 32 sq. ft. in one location and 75 sq. ft. in the other. Soil type was a fine sandy loam in both places. Herbicides combined with simazine and rates were: profluralin 2G at 2 lbs. ai/A.; profluralin 2G at 3 lbs. ai/A.; trifluralin 5G at 2 lbs. ai/A.; napropamide 10G at 4 lbs. ai/A.; and diphenamid 5G at 4 lbs. ai/A.

Predominant weed species were large crabgrass (Digitaria sanguinalis (L.) Scop.), green foxtail (Setaria viridis (L.) Beauv.), pigweed (Amaranthus retroflexus L.), lambsquarters (Chenopodium album L.), purslane (Portulaca oleracea L.), fall panicum (Panicum dichotomiflorum Michx), carpetweed (Mollugo verticillata L.), and Pennsylvania smartweed (Polygonum pennsylvanicum L.).

1/ Regional Floricultural & Nursery Specialist, Massachusetts Extension Service, West Springfield

Weed control evaluations were made on July 3, 1974, July 31, 1974 and August 28, 1974. The rating system was based on a scale of 1.0 - 9.0 with 1.0 = no control and 9.0 = complete control, with 7.0 = acceptable commercial control. These data are shown in Table 1.

Table 1. Evaluation of granular herbicide combinations in nursery beds, 1974.

Herbicide Treatments	Rate (ai/A)	Average Weed Control Ratings 1/			
		Hadley		Westfield	
		Broadleaf	Grass	Broadleaf	Grass
1 simazine 4G + profluralin 2G	1 lb. 2 lbs.	9.0	8.7	7.7	8.2
2 simazine 4G + profluralin 2G	1 lb. 3 lbs.	9.0	8.3	7.7	8.1
3 simazine 4G + trifluralin 5G	1 lb. 2 lbs.	9.0	8.1	8.7	8.0
4 simazine 4G + napropamide 10G	1 lb. 4 lbs.	9.0	9.0	7.0	8.6
5 simazine 4G + diphenamid 5G	1 lb. 4 lbs.	9.0	8.3	7.5	8.7
6 check		4.5	3.0	2.0	3.0

1/ Weed control rating on a scale of 1.0 - 9.0; 1.0 = no control, 9.0 = complete control and 7.0 = acceptable commercial control.

Results and Discussion

All combinations of granular herbicides provided at least acceptable commercial weed control under the conditions of these trials. The Hadley nursery had a lower weed population in general than the Westfield location, but annual grasses were more prevalent than broadleaf weeds. Simazine + trifluralin resulted in the highest weed control ratings, but were not appreciably superior to simazine + napropamide which rated lowest in these trials.

No plant injury was noted in these trials even though two species included are generally considered to be relatively sensitive to simazine, especially on newly planted immature plants.

Literature Cited

1. Bennett, W. J. 1973 Field mixing of granular herbicides for nursery weed control. Proc. NEWSS 27:308

2. Havis, J. R., W. J. Bennett and R. D. Fitzgerald, 1965. Herbicide combinations for summer weeds in nursery crops. Proc. NEWCC 19:155-159

CONTROL OF CRABGRASS AND GOOSEGRASS WITH PREEMERGENCE CHEMICALS IN TURFGRASS [1]

L. H. Barrett and J. A. Jagschitz [2]

Abstract. Experiments were conducted to evaluate herbicides for preemergent control of crabgrass and goosegrass and to determine if split applications would improve their control. Effective crabgrass control was achieved by bandane, benefin, DCPA, terbutol, tricalcium arsenate and from six newer materials - Buban 37, CGA-10832, El-131, napropamide, oxadiazon, and PPG-139 Results with H-22234, HOE-22870, HOE-23408, MBR-8251, proxazolon, R-24191, RO-7-6145 were poor while alachlor, CGA-17020, and H-25893 deserve further study. Of the eleven herbicides tested on goosegrass, good to excellent control was provided by bandane, DCPA, El-131, nitralin, and oxadiazon. Split applications did not improve control.

Introduction

Crabgrass (*Digitaria ischaemum* (Schreb.) Muhl.) is selectively controlled in turfgrass areas by preemergent herbicides (2,4,5). One of the two studies reported in this paper evaluated some newer materials as well as the standard ones in an attempt to find herbicides that are more effective and less phytotoxic. The second study evaluated several herbicides for preemergent control of goosegrass (*Eleusine indica* (L.) Gaertn.) in turfgrass. In recent years, this weed has become more prevalent and difficult to control and results with standard herbicides have been disappointing (1,3,4). In both studies, split applications were evaluated to determine if residual control could be improved.

Materials and Methods

The crabgrass studies were initiated at the R.I. Agricultural Experiment Station in 1973 and 1974. The turf established in the fall of 1966 contained predominately red fescue (*Festuca rubra* L.) with some Kentucky bluegrass (*Poa pratensis* L.) and colonial bentgrass (*Agrostis tenuis* Sibth.). It was maintained at one-inch height with weekly mowing. The area contained crabgrass seed from natural stands and broadcast seeding. Water was applied during the test to enhance germination of crabgrass seed and to avert drought.

Granular herbicides were applied by hand, and sprays were applied at 272 gpa and 30 psi. These were applied to plots measuring 4 x 5 ft in three randomized complete blocks in each of the two tests. The herbicides, forumulations and rates used are shown in Table 1. The treatments were

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[1] Contribution No. 1572, Agricultural Experiment Station, Kingston, R.I.

[2] Graduate Assistant and Assistant Professor, respectively, Plant and Soil Science Department

applied between April 30 and May 1 in the 1973 test and between April 24 and May 3 in the 1974 test with split applications (second treatment) on June 6. Visual estimates of turfgrass injury were made monthly through September. The scale used was 0-10, with 0 indicating no injury and 10 brown or dead turf. Estimates of crabgrass cover in each plot were made in early September. Percent control was determined by comparing treated to untreated plots.

The preemergence goosegrass study was initiated at the Potowomut Country Club in Warwick, R.I. in the spring of 1974 on a predominately annual bluegrass (Poa annua L.) turf. Herbicides were applied as previously described. The rates, formulations and dates of application of the chemicals are shown in Table 2. Percent goosegrass control was calculated by comparing treated to untreated plots in early September.

Results and Discussion

Crabgrass control

The effects of herbicides for preemergent control of crabgrass are shown in Table 1. At certain rates and formulations the standard materials bandane, benefin, DCPA, terbutol, and tricalcium arsenate produced excellent control (90-100%) with only slight injury to turfgrass (less than 2.0). Benefin in a granular formulation gave better control than the wettable powder The granular formulation of DCPA produced less turf injury than the spray. The granular formulation of siduron, which provided good results in the past, provided poor results in these tests. The wettable powder formulation provided excellent results.

Some of the newer materials tested provided excellent control with slight turf injury at certain rates and formulations. These were: Buban 37, CGA-10832, E1-131, napropamide, oxadiazon, and PPG-139. Although CGA-10832 provided excellent control, it appears that the susceptibility of turfgrass to injury may limit its use. The spray formulations of oxadiazon produced more turf injury than the granular forms. The vermiculite formulation of PPG-139 provided better control than either the spray or cob formulations.

Good (80-90%) to excellent control at certain rates and formulations with only slight turf injury was exhibited by butralin, AC-92390, BAS-3921. Butralin in a vermiculite formulation yielded better results than the spray and cob formulations. Poor results were provided by alachlor, CGA-17020, H-22234, H-25893, HOE-22870, HOE-23408, MBR-8251, proxazolon, R-24191, RO-7-6145. Since turf injury was slight with alachlor, CGA-17020 and H-25893, they could be investigated at higher rates.

Crabgrass control was not improved by the use of split applications. Evaluation of split applications was not conclusive because there was limited late germination to properly evaluate residual effects.

Table 1. Crabgrass control and turfgrass injury from preemergent herbicide treatments applied to separate tests the spring of 1973 and 1974.

Herbicide	Granular or spray	Rate lb ai/A	Percent crabgrass control 1973	Percent crabgrass control 1974	Maximum turfgrass injury [a] 1973	Maximum turfgrass injury [a] 1974
alachlor	S	3	-	52	-	.9
"	"	6	-	60	-	1.2
bandane	G	35	92	94	.9	.9
benefin	G	1.5 - 1.5 [b]	-	94	-	1.9
"	"	2	86	66	1.7	1.5
"	"	3	98	93	1.8	1.7
benefin	S	2	49	42	.6	.4
"	"	3	55	43	1.0	2.0
bensulide	G	5 - 5	-	71	-	.3
"	"	10	83	94	.4	.9
butralin	G (cob)	4	79	-	.4	-
"	" "	6	93	-	1.3	-
butralin	G (verm)	2 - 2	-	86	-	1.0
"	" "	4	95	83	.7	.6
"	" "	8	-	89	-	1.7
butralin	G (weed)	4	95	-	1.5	-
butralin	S (wp)	4	79	68	1.2	.3
"	" "	8	-	82	-	1.8
butralin	S (liq)	4	77	-	1.2	-
DCPA	G	5	75	-	.7	-
"	"	5 - 5	-	99	-	1.8
"	"	7.5	90	-	1.4	-
"	"	10	95	89	1.7	2.0
DCPA	S (wp)	10	98	99	2.2 [c]	2.6 [c]
DCPA	S (flow)	10	-	99	-	3.2 [c]
napropamide	S	2	-	58	-	.4
"	"	4	-	91	-	.8
oxadiazon	G	1.5	79	-	.6	-
"	"	1.5 - 1.5	-	87	-	2.3
"	"	3	90	95	1.5	1.3
"	"	4	94	-	2.4	-
"	"	6	-	99	-	3.7 [c]
oxadiazon	S (ec)	3	97	-	5.0	-
"	" "	4	99	-	4.3 [c]	-
oxadiazon	S (flow)	3	-	99	-	5.7 [c]
oxadiazon	S (wp)	3	-	98	-	4.8 [c]
proxazolon	G	2	95	-	4.7 [c]	-
siduron	G	6 - 6	-	40	-	.6
"	"	12	57	27	1.0	.4
"	"	15	60	-	.0	-
siduron	S	6 - 6	-	98	-	.7
terbutol	G	10	86	-	.0	-
terbutol	S	10	-	90	-	.7
tri-Ca-arsenate	G	105	91	-	1.4	-
"	"	209	99	92	2.1	1.2

Table 1. (Continued)

Herbicide	spray	rate	control		injury	
AC-92390	G	1	67	-	.9	-
"	"	1.5	79	-	.4	-
"	"	2	88	74	1.7	.6
"	"	3	92	87	1.5	.9
BAS-3921	S	.5	65	-	.7	-
"	"	1	80	79	.8	1.0
"	"	2	97	89	1.8	.9
Buban 37	S	2	32	-	.5	-
"	"	4	37	52	.3	.8
"	"	8	-	91	-	.4
CGA-10832	G (cob)	1	-	69	-	.5
"	" "	2	-	84	-	1.2
"	" "	4	-	97	-	2.7
CGA-10832	G (sand)	1.5	94	-	3.3	-
"	" "	2	-	86	-	2.1
"	" "	3	99	-	2.9 [c]	-
CGA-17020	G	2	-	0	-	.8
CGA-17020	S	1	-	15	-	.5
"	"	2	-	21	-	.5
E1-131	S	1.5	88	-	.8	-
"	"	1.5 - 1.5	-	94	-	.9
"	"	2	93	73	.6	.2
"	"	3	96	95	1.0	1.3
"	"	4	97	70	1.8	1.5
H-22234	S	2	-	20	-	.7
"	"	4	-	28	-	.6
"	"	8	-	62	-	3.7
H-25893	S	4	-	30	-	1.0
HOE-22870	S	1	-	40	-	.6
"	"	2	-	25	-	.3
"	"	4	-	8	-	.2
HOE-23408	S	2	-	51	-	2.1
MBR-8251	S	6	42	-	2.5	-
"	"	12	30	-	4.5	-
PPG-139	G (cob)	5	-	48	-	.7
"	" "	10	-	74	-	.4
PPG-139	G (verm)	5	-	85	-	.2
"	" "	10	97	87	.2	.7
"	" "	15	-	98	-	.7
"	" "	30	-	99	-	.5
PPG-139	S	5	-	56	-	.8
"	"	5 - 5	-	71	-	.0
"	"	10	-	61	-	.5
R-24191	S	.5	0	-	1.3	-
"	"	1	0	-	3.1	-
"	"	2	0	-	5.6	-
RO-7-6145	S	8	-	2	-	.3

Crabgrass cover in untreated plots = 71% in 1973 and 58% in 1974

[a] Turfgrass injury scale 0-10 (0 = none, 10 = complete brown or kill) from May through September. Untreated plots did not exceed .3

[b] Application on April and June

[c] Reduction in fescue

Goosegrass control

The data in Table 2 show that six of the eleven herbicides tested provided less than 80% control. These materials were: benefin, bensulide, butralin, siduron, HOE-22870, and PPG-139. Excellent control was provided by oxadiazon and good control by bandane, DCPA, El-131, and nitralin. The split applications showed no improvement over the single application rate. Based on previous tests (3,4) and the data from this test the chemicals ranked in order of effectiveness are: tricalcium arsenate, oxadiazon, nitralin, bandane, and DCPA.

Table 2. Percent goosegrass control in September from preemergent herbicide treatments applied in spring 1974 at Potowomut Country Club

Herbicide	Granular or spray	Rate lb ai/A	Percent goosegrass control: Full rate	Percent goosegrass control: Split rate [a]
bandane	G	45	80	--
benefin	G	3	48	67
bensulide	S	12	53	25
butralin	S	4	58	0
DCPA	S	17	80	48
nitralin	G	2.5	88	--
oxadiazon	G	3	95	99
siduron	S	12	32	33
El-131	S	2.5	89	--
HOE-22870	S	4.3	23	--
PPG-139	S	10	3	25

Goosegrass cover in check plots = 38%

[a] Split rate = 1/2 applied on April 30 and 1/2 on June 3

Literature Cited

1. Engel, R. E. and K. J. McVeigh. 1971. Crabgrass and goosegrass control with several preemergence herbicides. Proc. Northeast Weed Sci. Soc. 25: 103-108.

2. Hall, J. R. and E. E. Deal and A. J. Powell. 1974. Seven years of smooth crabgrass control in turfgrass with registered and experimental herbicides. Proc. Northeast Weed Sci. Soc. 28: 389-405.

3. Jagschitz, J. A. 1972. Preemergence crabgrass and goosegrass control in turfgrass with herbicides. Proc. Northeast Weed Sci. Soc. 26: 205-210

4. Jagschitz, J. A. 1973. Control of crabgrass and goosegrass in turfgrass with herbicides. Proc. Northeast Weed Sci. Soc. 27: 320-323

5. Watschke, T. L. and J. M. Duichm and D. V. Waddington. 1974. Evaluation of preemergence herbicides for crabgrass control in 1973. Proc. Northeast Weed Sci. Soc. 28: 395-398

Appendix

A list of the chemicals used and the company supplying them.

Herbicide	Company	Herbicide	Company
alachlor	Mallinckrodt	BAS-3921	BASF Wyandotte
bandane	Velsicol	Burban 37	Buckman
benefin	Eli Lilly	CGA-10832	CIBA Geigy
bensulide	Stauffer	CGA-17020	CIBA Geigy
butralin	Amchem	El-131	Eli Lilly
DCPA	Diamond Shamrock	H-22234	Hercules
napropamide	Stauffer	H-25893	Hercules
nitralin	Shell	HOE-22870	American Hoechst
oxadiazon	Rhodia	HOE-23408	American Hoechst
proxazolon	Sankyo	MBR-8251	3M Company
siduron	DuPont	PPG-139	PPG Industries
terbutol	Hercules	R-24191	Stauffer
Tricalcium arsenate	Rhodia	RO-7-6145	HLR Sciences
AC-92390	American Cyanamid		

CRABGRASS CONTROL IN 1974 USING PREEMERGENCE HERBICIDES

T. L. Watschke, J. M. Duich, and D. J. Wehner[1/]

ABSTRACT. Five experimental preemergence herbicides and DCPA were applied to Kentucky bluegrass and creeping red fescue. All chemicals injured red fescue more than bluegrass except EL-131. Granular A-820 controlled crabgrass better on both bluegrass and red fescue than the other chemicals at the highest rate applied, however three of the experimentals (PPG-139 5G, EL-131, and AC-92390) were comparable to DCPA. CGA-10832 gave good control, but caused unacceptable thinning of bluegrass and red fescue at the high rate. An experimental formulation (6F) of DCPA was also tested and controlled crabgrass comparable to the granular and wettable powder formulations with slightly less injury to red fescue. CGA-17020 and the flowable formulation of PPG-139 did not sufficiently control crabgrass. The wettable powder formulation of A-820 was comparable to DCPA, but required slightly higher rates than the granular and caused slightly more injury to red fescue.

INTRODUCTION

Preemergence control of crabgrass in turfgrass has been a reality for more than twenty years, but testing of new materials has continued on an annual basis. Alternatives to existing materials are necessary to insure flexibility in the total herbicide program of any turfgrass facility. Little or no phytotoxicity and control equivalent to available materials is the overall goal. Safer materials are needed for application on red fescue. The economic advantage of having an increased selection of materials is obvious. The objective of this study was to evaluate crabgrass control and turfgrass phytotoxicity of five experimental preemergence compounds and DCPA 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 8-year old stands of Kentucky bluegrass and red fescue were treated. Turf was maintained at 1.25 inch height and received supplemental irrigation only during drought stress. Smooth crabgrass (*Digitaria ischaemum*) was plentiful from natural reseeding and provided 85 percent turf cover in untreated plots.

[1/] Assistant Professor, Professor, and Graduate Assistant respectively, Department of Agronomy, The Pennsylvania State University, University Park, Pa. 16802.

Treatments were applied to two replications of each grass on April 29, 1974. Sprays were applied to 6- by 10-ft plots using a hand-held two-nozzle boom at approximately 40 psi and 50 gpa. Granular formulations were applied to 4- by 6-ft plots with shaker bottles. After application approximately one inch of water was applied by traveling sprinklers.

The commercial materials used were DCPA (dimethyl ester of tetrachloroterephthalic acid) 5G, 75W and 6F (experimental formulation). Experimental chemicals were CGA-17020 (unrevealed); EL-131 (unrevealed); PPG-139 (unrevealed); CGA-10832 (N-n-propyl-N-cyclo-propylmethyl-4-trifluoromethyl-2,6-dinitroaniline); AC-92390 (N-sec-butyl-2,6-dinitro-3,4-xylidine), and A-820 (N-sec-butyl-4-tertiary-butyl-2,6-dinitroaniline). Application rates are shown in Table 1.

Crabgrass germination was considerably later than usual, primarily because of below normal rainfall during May. First germination was observed on May 28, but the majority of germination occurred during the second week of June. The experiment was designed to include a two-foot check adjacent to each treated plot. Turf injury and crabgrass control were rated by three individuals beginning late in July.

RESULTS

Crabgrass control and turfgrass phytotoxicity ratings are shown in Table 1. PPG-139 granular formulations were superior to the flowable formulation at both rates. When PPG-139 was formulated on corn cob, control at 5 lb ai/A was better than the vermiculite formulation at that rate. At the 10 lb ai/A rate, both granular formulations were comparable to DCPA without serious phytotoxicity. An intermediate rate (possibly 7.5 lb ai/A) should be tested for the granular corn cob formulation because of bluegrass injury (10%) at 10 lb ai/A and relatively good control at 5 lb ai/A. Red fescue had excellent tolerance to this formulation at the high rate.

EL-131 gave good control at all rates tested. Injury on bluegrass exceeded that on red fescue regardless of rate, with 4 lb ai/A causing unacceptable injury to bluegrass. Control at 2.5 lb ai/A, however, was excellent and injury was considerably reduced. Red fescue injury was acceptable at all rates of EL-131.

Crabgrass control from both formulations of A-820 was excellent. The granular formulation was slightly more active at lower rates than the wettable powder (5 lb ai/A for the granular was similar to 8 lb ai/A for the powder). Injury to both turfgrass species was tolerable at the rates required for good crabgrass control. There was a tendency for slightly more injury for the wettable powder on red fescue.

AC-92390 at the high rate had crabgrass control similar to DCPA without injury to either turfgrass. The lower rates had good control, but 4 lb ai/A appears necessary for this material to be competitive with DCPA. Even at the high rate, there was no injury to red fescue.

Neither formulation of CGA-17020 caused injury to bluegrass or red fescue, but crabgrass control was poor indicating that higher rates should be tested. CGA-10832 had excellent control of crabgrass at the high rate, but injury was unacceptable on both turfgrasses. Injury to red fescue was similar to that from DCPA, however, injury to bluegrass was greater than that observed for DCPA. Phytotoxicity problems limit the usefulness of this compound for turf.

Injury and crabgrass control from DCPA was similar for all formulations. Some reduction of injury to red fescue was observed when a flowable formulation was used rather than a wettable powder.

CONCLUSIONS

Several experimental compounds (PPG-139, EL-131, A-820, and 92390) controlled crabgrass similar to DCPA. More importantly, these compounds have low phytotoxicity on red fescue. Results from this test are promising because alternatives to presently available materials appear imminent. The flowable formulation of DCPA appears to be a partial solution to the injury to red fescue.

Table 1. Evaluation of commercial and experimental chemicals for pre-emergence crabgrass control and injury to Kentucky bluegrass and creeping red fescue, applied April 29, 1974. University Park, Pa.

Treatment	Formulation	lb a.i./A	% Crabgrass control-August KBG	% Crabgrass control-August CRF	% Injury* KBG	% Injury* CRF
PPG-139	3 F	5	40	45	0	0
PPG-139	3 F	10	68	78	sl†	sl
PPG-139	5 G (v)	5	78	78	sl	8
PPG-139	5 G (v)	10	97	97	sl	sl
PPG-139	5 G (cc)	5	93	97	0	0
PPG-139	5 G (cc)	10	99	95	10	sl
EL-131	50 W	2	94	97	5	sl
EL-131	50 W	2.5	97	98	10	5
EL-131	50 W	3	99	98	10	sl
EL-131	50 W	4	99	99	20	10
A-820	50 W	4	93	99	5	5
A-820	50 W	5	83	98	sl	5
A-820	50 W	6	90	99	0	sl
A-820	50 W	8	98	99	10	8
A-820	2.3 G	4	97	99	0	sl
A-820	2.3 G	5	99	99	5	sl
A-820	2.3 G	6	99	99	sl	sl
A-820	2.3 G	8	99	99	5	5
AC-92390	2.5 G	2.5	88	94	sl	sl
AC-92390	2.5 G	3	95	94	sl	sl
AC-92390	2.5 G	4	97	99	sl	0
CGA-17020	4 EC	1	20	23	0	0
CGA-17020	4 EC	2	18	25	0	0
CGA-17020	5 G	1	20	18	0	0
CGA-17020	5 G	1.5	18	10	0	0
CGA-17020	5 G	2	18	20	0	0
C-10832	2 G	1.5	94	98	5	10
C-10832	2 G	2	97	99	15	20
DCPA	75 W	10	99	99	sl	25
DCPA	6 F	10	99	99	sl	15
DCPA	5 G	10	99	98	sl	10

*Injury refers to discoloration and/or thinning.

†Slight indicates less than 5 percent.

CRABGRASS AND GOOSEGRASS CONTROL IN TURFGRASS WITH SEVERAL PREEMERGE HERBICIDES

R. E. Engel, C. W. Bussey, Philip Catron [1/]

Abstract. Several experimental preemergence herbicides were applied for crabgrass and goosegrass control in cool-season turfgrasses during the mid-to-late spring season. A820, CG10832, PPG139 and RP17623 gave good crabgrass control. April versus May application of several of preemergence types show that more specific guidelines are needed to obtain most efficient crabgrass control. The loss in performance of several chemicals when applied with water as a carrier versus a dry carrier shows that dry application should be used until the performance of spray applications is proven.

Goosegrass (*Eleusine indica*) control was fair to good for several chemicals, but on the basis of consistency of control and the amount of turf injury, all materials can be considered poor to unsatisfactory. Far better preemergence herbicides should be sought for goosegrass control.

INTRODUCTION

Crabgrass (*Digitaria ischaemum* and *D. sangumalis*) and goosegrass (*Eleusine indica*) are the two most troublesome summer weeds in cool-season turf. The latter occurs most often in northeastern United States where bentgrass-annual bluegrass turf is under heavy traffic. Crabgrass is found commonly in both lawn and fine turf. The use of preemergence herbicides gives similar results for both of these grassy weeds. Usually, they are more effective on crabgrass. Better control of these weeds and greater safety to the turfgrasses are still important needs (2). Also, it is possible that some improvement in performance of the currently used preemergence herbicides can be obtained by their application at more precise periods of the growing season and by choice of the carrier (1).

The purpose of this study is to determine (1) the potential of several experimental chemicals for preemergence control of crab-

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1/ Research Professor, Head Soils and Plants Technician, and Research Intern, respectively, Department of Soils and Crops, Cook College, Rutgers University, New Brunswick, N. J. 08903.

grass and goosegrass (2) to measure effects of season of application and the influence of carriers on several standard experimental preemergence herbicides for the same weeds.

MATERIALS AND METHODS

The Chemicals Used - Among the experimental herbicides used were: A820 (N-sec-butyl-4-*tert*-butyl-2,6-dinitroaniline)-AMEX 820, CGA10832 (N-(cyclopropylmethyl)-a,a,a-trifluoro-2,6-dinitro-N-propyl-*p*-toluidine)-profluralin (WSSA), RP17623 (2-*tert*-butyl-4-(2,4-dichloro-5-isopropyloxyphenyl-5-oxo-1,3,4-oxadiazoline)-oxadiazon, PP139 (unrevealed), E1131 (unrevealed), FMC25213 (unrevealed), HOE22870 (unrevealed), HOE23408 (unrevealed) and VEL4207, a dicamba derivative).

The following chemicals were used as standards: benefin (N-butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-*p*-toluidine), bensulide (O,O-diisopropyl phosphorodithioate *S*-ester with N-(2-mercaptoethyl) benzenesulfonamide), DCPA (dimethyl tetrachloroterephthalate), and siduron (1-(2-methylcyclohexyl)-3-phenylurea).

Methods of Herbicide Application - Herbicides on a dry carrier were applied with a 3-foot drop spreader. Those applied in a water dilution were sprayed on the turf with a CO_2 knapsack sprayer at a rate of 40 gallons of solution per acre. All tests were watered in following application.

Experimental Design and Evaluation - All chemical treatments were replicated three times in a randomized block design. Control and injury ratings were obtained by estimates as field results dictated.

The Test Sites and Growing Conditions - The crabgrass test was on a mature lawn turf of Kentucky bluegrasses. The site was overseeded with a mixture of *D. ischaemum* and *D. sanguinalis* in March of 1974. An application of 40 lbs nitrogen (activated sewage sludge) per acre was used to disperse and apply the crabgrass seed. The Kentucky bluegrass of the site was cut in the range of 1 to 1½ inches to encourage the crabgrass. Clippings were removed.

The goosegrass test sites at Buena, New Jersey, and Cream Ridge, New Jersey, were on sandy and loam soils, respectively. Both sites had a close-cut mixed turf of bentgrass, annual bluegrass and Kentucky bluegrass. The respective sites were a walk-off area in front of a tee and a practice fairway turf with low fertility maintenance. Soil moisture was on the low side for both sites during the test period.

DISCUSSION OF RESULTS

Crabgrass Control Test - A good stand of crabgrass was obtained. Water was applied on June 12 and July 19 to aid development of the crabgrass. Control of crabgrass for benefin, bensulide, DCPA and siduron as standard treatments, were 68, 87, 83 and 38, respectively (Table 1). The better performances of the experimental types were: RP17623 - 93%, PPG139 - 85%, A820 - 100%, and CG10832 - 98%. EL139 gave 65% crabgrass control at 3 lbs/acre. FMC25213, HOE22870 and HOE23408 at 3 lb rates did not give significant preemergence crabgrass control.

With regard to dates of application (Table 2), April was better than May for DCPA application, while May application of benefin was better than April application. With CG10832, crabgrass control was not influenced by the date of application. These results support earlier work that chemicals vary in optimum application date. May application has appeared late for DCPA on previous occasions, while benefin has appeared less subject to changes in application date (1).

Dry applications of DCPA, PPG139, benefin and CG10832, indicate better crabgrass control than with spray application equivalents with water as a carrier. This result is similar to those of previous studies (1). While not all chemicals have responded this way, it can be expected that most chemicals are more efficient when applied on a dry carrier.

Goosegrass Control Test - A820, bensulide and RP17623 gave fair-to-good goosegrass control in both tests (Table 4). All three gave serious turfgrass injury. DCPA and CG10832 gave fair-to-poor control in the two tests. In one test, a repeat treatment of DCPA gave good control. Benefin, one of the standards which is sold for goosegrass control, failed to give worthwhile goosegrass control in either test. As used, the experimentals PPG139, FMC25213, HOE 23408 and VEL4207 failed to give significant goosegrass control.

Table 1. Preemergence crabgrass control in Kentucky bluegrass turf with several experimental herbicides applied April 25, 1974, New Brunswick, N. J.

Chemical	Rate lbs a.i./A	Crabgrass Control (%) August 31
bensulide, 3.6 gr	10	87
DCPA, 5 gr	12	83
siduron*, 4.57 gr	18	38
RP 17623, 2 gr	3	93
PPG139, 5 gr	10	85
FMC25213, 4 ec	3	0
EL131, 50 w	1½	38
EL131, 50 w	2¼	52
EL131, 50 w	3	65
benefin, 2½ gr	1½	68
A820, 2.3 gr	16	100
CG10832, 1 gr	1½	98
HOE22870, 3 ec	3	8
HOE23408, 3 ec	3	8
LSD at .05	-	16

*Applied May 24, 1974

Table 2. Effect of April versus May application on preemergence crabgrass control in Kentucky bluegrass with several herbicides, 1974, New Brunswick, N. J.

Chemical	Rate lbs a.i./A	Date of Application	Crabgrass Control (%) August 31
DCPA, gr	12	April 25	83
DCPA, gr	12	May 24	58
benefin, gr	1½	April 25	68
benefin, gr	1½	May 24	87
CG10832, gr	1½	April 25	98
CG10832, gr	1½	May 24	99

Table 3. Influence of dry versus water carriers on crabgrass control obtained with several preemergence herbicides applied to Kentucky bluegrass turf, April 1974, New Brunswick, N. J.

Chemical	Rate lbs a.i./A	Carrier	Crabgrass Control (%) August 31
DCPA	12	6 fl	72
"	12	5 gr	83
PPG139	10	3 fl	0
"	10	5 gr	85
benefin (1)	1½	50 w	5
benefin (2)	1½	2½ gr	68
CG10832	1½	4 ec	12
CG10832	1½	1 gr	98

(1) benefin packaged as Emblem
(2) benefin packaged as Balan

Table 4. Goosegrass control from several preemergence herbicide treatments on mixed turf. 1974.

Chemical	Rate lbs a.i./A	Goosegrass Control (%) Buena (1)	Goosegrass Control (%) Cream Ridge (1)	Turfgrass Injury (%) Cream Ridge
bensulide, gr	10	80	50	39
DCPA, gr	12	68	0	0
DCPA, gr	12 + 9 (1)	90	4	0
RP17623, gr	3	64	94	46
PPG139, gr	10	0	0	0
FMC25213, ec	1½	0	0	0
HOE23408, ec	3	0	18	0
VEL4207	1	-	2	0
benefin, gr	1½	12	0	0
benefin, w	1½	23	2	0
A820, gr	8	94	97	29
CG10832, ec	1½	24	0	2
CG10832, gr	1½	68	27	7

(1) Applied May 17 and May 29, respectively.

LITERATURE CITED

(1) Engel, R. E. and J. H. Dunn (1967). Preemergence crabgrass herbicide performance as influenced by dry versus spray treatments and variations of application date of spring treatments on lawn turf. Turfgrass Research Bulletin 818: 112-121.

(2) Engel, R. E. and C. W. Bussey (1974). Factors in the performance of preemerge herbicides for crabgrass control. Rutgers Turfgrass Proceedings. S.C. 5: 47-54.

Preemergence Herbicides For Control of Annual Grassy Weeds in Cool-Season Turf

J. R. Hall[1/]

ABSTRACT

Bensulide ((O,O,diisopropyl phosphorodithioate)s-ester with N-(2 mercaptomethyl)benzenesulfonamide), profluralin (N-(cyclopropylmethyl)-α,α,α,-trifluoro-2,6-dinitro-N-propyl-p-toluidine), butralin (4-(1,1-dimethylethyl)-N-(1-methylpropyl)-2,6-dinitrobenzenamine), DCPA (dimethyl tetrachloroterephthalate), PPG-139 (chemistry not released), oxadiazon (2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)-Δ^2-1,3,4-oxadiazolin-5-one) and benefin (N-butyl-N-ethyl-α,α,α,-trifluoro-2,6-dinitro-p-toluidine) were evaluated at two application dates (April 17, 1974 and May 15, 1974) as varying formulations at several rates for control of goosegrass (*Eleusine indica* (L.) Gaertn.) and smooth crabgrass (*Digitaria ischaemum* L.). Plots containing profluralin (2G) at 4 lb ai/A and oxadiazon (2G) at 2,3 and 4 lb ai/A contained less than 15% goosegrass on October 16, 1974 regardless of time of application (Check plots 40%). Single degree of freedom non-orthogonal linear contrasts were utilized to determine which formulations provided best control of goosegrass. On October 16, 1974 13% less ($P < .05$) goosegrass was found in plots containing butralin 2.3% granular on vermiculite (2.3GV) at 4,5 and 6 lb ai/A than in plots receiving butralin (50 WP) at 4,5 and 6 lb ai/A. PPG-139 (5GC) plots at 10 and 15 lb ai/A contained 19% goosegrass which was significantly less ($P < .01$) than that found in the PPG-139 3 lb ai/gal flowable (FL3) plots (43%). Percent of plot area in goosegrass was similar for PPG-139 (FL3) plots (43%) and the PPG-139 (5GV) plots (30%). Percent of plot area in goosegrass with profluralin (2G) at 2 and 4 lb ai/A, PPG-139 (5GC) at 10 and 15 lb ai/A and oxadiazon (2G) at 2,3 and 4 lb ai/A was respectively 15% ($P < .05$), 12% ($P < .10$) and 27% ($P < .01$) less than that found in the bensulide (3.6G) plots at 7.5 and 10 lb ai/A.

[1/] Assistant Professor, Department of Agronomy, University of Maryland, College Park, Maryland 20742.

POSTEMERGENCE CRABGRASS AND NUTSEDGE CONTROL IN TURFGRASS WITH HERBICIDES[1]

John A. Jagschitz[2]

Abstract. Four studies were initiated in lawn-type turfgrass to evaluate herbicides for postemergence control of crabgrass and yellow nutsedge. In the nutsedge studies the effect of treatment dates, repeat applications, formulations, spray gallonage and control in grass or open soil areas were investigated. Effective crabgrass control was obtained from DSMA and a newer material HOE-22870. Results with HOE-23408 appear limited because of injury to the turfgrass, while EL-131 needs further study. Promising results for nutsedge control were obtained from certain treatments of bentazon, cyperquat, methanearsonates, and perfluidone. Results from two formulation of bentazon and cyperquat were comparable. No effect was noted from the use of either 50 or 172 gallons of water in applying bentazon, cyperquat or DSMA. Less herbicide and/or fewer applications were required for nutsedge control (1) as the season progressed from late spring to midsummer and (2) in grass areas rather than open soil areas.

INTRODUCTION

Methanearsonates have been used for several years for postemergence control of crabgrass (*Digitaria ischaemum* (Schreb.) Muhl.) in turfgrass areas. These herbicides usually cause turfgrass discoloration and require two or more applications to be effective and consequently attempts have been made to find more suitable treatments (2,4). One test reported in this paper evaluates some new herbicides that may be less phytotoxic and more effective. Yellow nutsedge (*Cyperus esculentus* L.) has spread and has become a common weed in turfgrass areas. It has been difficult to control but certain herbicides are showing promise in controlling it (1,3). Three tests were conducted to evaluate several herbicides and to determine the effect of repeat applications, date of treatment, spray gallonage, and control in grass and in open soil areas.

MATERIALS AND METHODS

The crabgrass test was conducted at the R. I. Agricultural Experiment Station in 1974. The turf was eight years old and contained predominately red fescue (*Festuca rubra* L.) with some Kentucky bluegrass (*Poa pratensis* L.) and colonial bentgrass (*Agrostis tennis* Sibth.). The turf was maintained at a one inch height and watered to avert drought conditions. Herbicide treatments were started on July 12 when most crabgrass was in the 5 to 7 leaf stage and readily visible. The herbicides, rates and dates of use are shown in Table 1. The plots were 4 x 5 feet and replicated three times. All materials were applied as sprays in water at the rate of 172 gallons per acre (gpa). Visual estimates

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[1] Contribution No. 1573, Agricultural Experiment Station, Kingston, Rhode Island
[2] Assistant Professor, Department of Plant & Soil Science.

of turfgrass injury were made periodically on a scale of 0 to 10, with 0 no injury, and 10 being brown or dead turf. Estimates of crabgrass cover in each plot were made on September 4. Percent control was determined by comparing treated to check plots.

Three nutsedge tests were conducted at the Kingston Turf Farms in 1974 on Kentucky bluegrass seeded the year before and maintained at a height of about two inches. Emergence of nutsedge began in May 1974 and the tests were initiated June 13, July 1, and July 22. Duplicate tests were run in soil areas that contained nutsedge but no grass on June 13 and July 1. On June 13 the nutsedge plants were in the 4 to 6 leaf stage in the grass area and in the 7 to 11 leaf stage in the soil area and averaged 18 and 25 plants per square foot in the grass and soil areas, respectively. Some plants emerged in July. The herbicides, rates, and dates of application are shown in Tables 2, 3, and 4. All herbicides were applied as sprays in 50 or 172 gallons of water per acre. The plots were 4 x 5 feet and replicated three times. Starting five hours after the June 21 treatments there was about one-inch of rainfall during a 16 hour period. This may have reduced the effectiveness of these treatments. Visual estimates of turfgrass injury were made periodically up to September using the scale of 0 to 10 as described earlier. On August 27 estimates of nutsedge cover were made in each plot in the soil test areas. In the grass areas plant counts were made in two or three random square foot areas per plot. Percent control was determined by comparing treated to check plots.

RESULTS AND DISCUSSION

Crabgrass control

The results from herbicides applied for postemergence crabgrass control are presented in Table 1. Three applications of DSMA or MSMA provided excellent control (90-100%), but there was moderate or objectionable injury (2.0 or greater) to the turfgrass. This injury occurred after the third application and was primarily to fescue and bentgrass. Two applications of DSMA provided excellent control without objectionable injury. The three new materials, EL-131, HOE-22870 and HOE-23408, show a potential for crabgrass control. Excellent control with only slight turfgrass injury (less than 2.0) was obtained with two applications of HOE-22870 at the 4 lb rate. Results with HOE-23408 indicate that injury to turfgrass may limit its usefulness, while with EL-131, higher or split rates should be investigated.

Nutsedge control

The results from herbicides applied in late spring for the control of nutsedge are presented in Table 2. Treatments receiving two applications of a herbicide should be viewed with reservation since one inch of rainfall occurred five hours after the second application. Only six of the 18 treatments applied to the grass area gave fair (70-79%) to excellent control of nutsedge. None of these six treatments applied in the soil area showed more than 54% control. This could indicate that nutsedge plants growing in competition with grass are easier to kill than those growing in open soil. Excellent control was provided by the single application of perfluidone at the 4 lb rate while at the 2 lb rate control

Table 1. Crabgrass control and turfgrass injury from postemergent herbicide treatments applied in 1974 to a fescue-bentgrass-bluegrass lawn.

Herbicide	Rate lb ai/A 7/12	7/22	7/31	Turfgrass injury[a] 7/22	7/30	8/15	9/4	% Crabgrass control 9/4
DSMA	4	4	-	.8	1.2	.5	.4	90
DSMA	4	4	4	.8	1.2	2.8	1.7[b]	99
EL-131	3	-	-	.2	.5	1.4	1.2	74
HOE-23408	2	2	-	.7	3.0	1.5	.4	69
HOE-23408	4	-	-	2.2	2.1	.2	.4	89
HOE-22870	2	2	-	.2	.2	.3	.6	51
HOE-22870	2	2	2	.0	.4	.2	.7	78
HOE-22870	4	4	-	.0	.4	.3	.6	91
MSMA	2.7	2	2	1.3	1.4	3.5	2.2[b]	96
crabgrass in check plots = 60% cover								

[a]scale 0 to 10, 10 = brown (.3 in check plots)

[b]reduction in bentgrass and fescue

Table 2. Effect of herbicides on nutsedge control and turfgrass injury when applied in late spring 1974 to Kentucky bluegrass.

Herbicide	Rate lb ai/A 6/13	6/21[a]	Percent nutsedge control 8/27 Grass area	Soil area	Maximum turfgrass injury[b]
2,4-D	1	-	20	15	.3
2,4-D	1	1	8	22	.5
AMA[c]	3.8	3.8	78	41	1.0
AMA + 2,4-D[c]	2.8+.9	2.8+.9	85	35	1.2
bentazon (liq)	1	-	23	19	.8
bentazon (liq)	1	1	38	63	.0
bentazon (liq)	2	-	31	28	1.3
bentazon (liq)	2	2	33	44	.5
cyperquat (BB6)	2	-	55	28	.7
cyperquat (BB6)	2	2	75	39	.5
cyperquat (BB6)	4	-	88	45	2.0
DSMA[c]	4	4	47	35	.0
perfluidone	2	-	78	28	1.0
perfluidone	4	-	94	54	1.2
bentazon + DSMA	1 + 4	-	24	28	.3
bentazon + cyperquat	1 + 1	-	32	57	.5
cyperquat + DSMA	1 + 4	-	45	28	.3
cyperquat + 2, 4-D	2 + 1	-	68	22	.5
nutsedge in check plots			19 plants per sq ft	49% cover	

[a]rainfall five hours after treatment

[b]scale 0 to 10, 10 = brown (.1 in check plots)

[c]172 gpa, others 50 gpa

was only fair (70-79%). Turfgrass injury was only slight but some retardation of the grass was observed until mid-July. Unpublished results from a 1973 test showed that perfluidone applied preemergent to nutsedge at the 4 and 6 lb rate provided excellent control but retarded growth of the grass and caused objectionable injury at the 6 lb rate. The single application of cyperquat at the 4 lb rate provided good nutsedge control (80-89%) while two applications at the 2 lb rate provided only fair control. At the 4 lb rate, injury to the turfgrass was objectionable. Results with AMA and the reduced rate of AMA in combination with 2,4-D provided comparable results with fair to good control.

The data from herbicides applied in early summer are presented in Table 3. Again there are indications that controlling nutsedge is easier in turfgrass than soil. Comparing the results of early summer with those of late spring, nutsedge is apparently easier to control as the season progresses. Excellent results in both the grass and soil areas were obtained from two applications of bentazon at the 1 or 2 lb rate. Two applications of either DSMA at the 4 lb rate or cyperquat at the 2 lb rate provided excellent control in the grass area but only good control in the soil area. Comparable results were obtained from the BB6 and BB3 formulations of cyperquat. Good to excellent control in grass areas and only fair to good control in soil areas was provided by two applications of AMA or the AMA plus 2,4-D combination. Turfgrass injury however was objectionable with AMA alone.

Table 3. Control of nutsedge and turfgrass injury with herbicides applied to Kentucky bluegrass in early summer 1974.

Herbicide	Rate lb ai/A 7/1	7/11	7/22	Percent nutsedge control 8/27 Grass area	Soil area	Maximum turfgrass injury[a]
AMA[b]	3.8	3.8	-	89	74	2.0
AMA + 2,4-D[b]	2.8+.9	2.8+.9	-	95	86	.8
bentazon (liq)	1	1	-	90	91	.3
bentazon (liq)	1	1	1	98	98	.3
bentazon (liq)	2	2	-	96	95	.3
cyperquat (BB6)	2	-	-	83	67	.0
cyperquat (BB6)	2	2	-	90	87	1.0
cyperquat (BB3)	2	-	-	85	59	.3
cyperquat (BB3)	2	2	-	93	83	.7
DSMA[b]	4	4	-	96	84	.2
DSMA[b]	4	4	4	96	93	.7
nutsedge in check plots				23 plants per sq ft	46% cover	

[a]scale 0 to 10, 10 = brown (.1 in check plots)
[b]172 gpa, others 50 gpa

The results from herbicides applied to a grass area in midsummer are presented in Table 4. Again there is evidence that as the season progresses nutsedge is easier to control. Excellent results were provided by a single application of cyperquat at the 2 lb rate and by two applications of bentazon at the 1 lb rate. Two applications of DSMA at the 4 lb rate gave excellent control, but injury to the turfgrass was objectionable. The data also show that (1) spray applications of the herbicides in 50 or 172 gallons of water per acre provided similar results and (2) the liquid and wettable powder formulations of bentazon were equally effective.

Table 4. Nutsedge control and turfgrass injury in Kentucky bluegrass from herbicides applied in midsummer 1974 using two spray gallonages.

Herbicide	Rate lb ai/A 7/22	7/31	8/8	Percent nutsedge control 8/27 50 gpa	172 gpa	Maximum turfgrass injury[a] 50 gpa	172 gpa
bentazon (liq)	1	1	-	98	99	.3	.2
bentazon (liq)	1	1	1	99	-	.0	-
bentazon (wp)	1	1	-	99	99	.3	.0
bentazon (wp)	1	1	1	100	-	.2	-
cyperquat (BD3)	2	-	-	95	-	.7	-
cyperquat (BD3)	2	2	-	97	98	1.3	1.2
cyperquat (BD3)	4	-	-	98	-	1.7	-
DSMA	4	4	-	-	99	-	2.5
DSMA	4	4	4	99	98	2.7	2.8
nutsedge in check plots				32 plants per sq ft			

[a]scale 0 to 10, 10 = brown (no injury in checks)

LITERATURE CITED

1. Jagschitz, J. A. 1973. Evaluation of herbicides for nutsedge control in turfgrass. Proc. Northeast Weed Sci. Soc. 27:331-333.

2. Perkins, A. T., J. M. Duich, and D. V. Waddington, 1969. Pre- and post-emergence crabgrass control results for 1967-68. Proc. Northeast Weed Cont. Conf. 23:391-397.

3. Schwartzbeck, R. A. and J. W. Pullen 1974. S-21634, 1-methyl-4-phenylpyridinium chloride, for the control of nutsedge. Proc. Northeast Weed Sci. Soc. 28:46.

4. Troutman, B. C. and J. A. Jagschitz. 1971. Evaluation of chemicals for crabgrass control in turfgrass-1970. Proc. Northeast Weed Sci. Soc. 25:91-95.

APPENDIX

A list of herbicides used and the companies supplying them.

Herbicide	Company	Herbicide	Company
AMA	Chevron	2,4-D	Amchem, Chevron
bentazon (BAS-3517)	BASF	HOE-23408	American Hoechst
cyperquat (S-21634)	Gulf Oil	HOE-22870	American Hoechst
DSMA, MSMA	Ansul	perfluidone (MBR-8251)	3-M Company
EL-131	Eli Lilly		

NUTSEDGE CONTROL IN TURF

Larry R. Hawf[1/]

Abstract

Bentazon (3-isopropyl-1H-2,1,3-benzothiadiazin-(4)3H-one 2, 2-dioxide) and cyperquat (1-methyl-4-phenylpyridinium chloride) were evaluated for postemergence yellow nutsedge (Cyperus esculentus L.) control in Kentucky bluegrass (Poa pratensis L.). Evaluations for phytotoxicity were made on several Kentucky bluegrass varieties, Kentucky 31 fescue (Festuca arundinaceae), Astoria Colonial bentgrass (Agrostis tenuis Sibth.) and Zoysia (Zoysia japonica). Both herbicides effectively controlled nutsedge at 1.5 and 3.0 lb a.i./A. However, bentazon gave much quicker kill than cyperquat. Addition of a surfactant to the spray solution had no influence on the rate or extent of nutsedge kill. No Kentucky bluegrass variety or mixture was injured by the 3.0 lb a.i./A rate of either herbicide. In a spring trial, Kentucky 31 fescue sustained some slight foliar tip necrosis from both herbicides. Astoria Colonial bentgrass was severely injured by cyperquat in the spring trial.

Introduction

The lack of effective means of nutsedge control has been a leading problem in turf areas. Several states rank nutsedge as one of the five most important weeds in turf. Several of these states indicate increased numbers of nutsedge infested acres (4).

Two new herbicides have demonstrated some hope for the control of this weed. Bentazon was first evaluated in the United States in 1968 and trials to date have shown selective postemergence control of certain broadleaf weeds (1, 2, 3, 5, 7, 8, 9). Several crops, primarily those in the grass family have tolerance to bentazon. Soybeans Glycine max (L.) Merr. also have shown tolerance and bentazon is experimentally registered for broadleaf control in soybeans. Observations of postemergence nutsedge control have only been made within the last two years.

Cyperquat (formerly S-21634) is a selective postemergence herbicide for the control of nutsedge. Field experience with cyperquat has indicated a high degree of selectivity (6). The only weed to show significant injury has been nutsedge. However, some grass crops, such as corn (Zea mays L.) may demonstrate foliar chlorosis where contacted by this herbicide.

The purpose of the studies reported here was to determine the degree of nutsedge control and turf phytotoxicity from postemergence applications of bentazon and cyperquat.

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

Materials and Methods

All experiments were conducted at the University of Delaware Agricultural Research Farm in Newark, Delaware. The nutsedge control plots were in an area of established Kentucky bluegrass with a scattered nutsedge infestation. Each plot was five feet wide by at least 12 feet in length and replicated three times. Phytotoxicity studies were conducted on the turf research and teaching facility located on the Agricultural Research Farm. Each plot was five feet wide by 5 feet in length and replicated three times. Several established grasses and grass mixtures were utilized (Table 1).

The spray applications were made with a hand carried sprayer equipped with a 5 foot boom using T-jet 11004 spray tips. Carbon dioxide was used as a pressure source at 30 pounds per square inch. All applications were made at 80 gallons per acre of finished spray.

August 1973 treatments

On August 16, 1973 bentazon was applied at 1.5 and 3.0 lb a.i./A to nutsedge in a Kentucky bluegrass turf and to several turf species for phytotoxicity evaluations. The turf had not been mowed for a period of time and the nutsedge and bluegrass were 6 to 8 inches and 4 to 5 inches tall, respectively. The turf in the phytotoxicity area had been mowed and was 1.5 to 2 inches in height. Adjuvan T was added to the spray solution at 0.5% of the total volume. Observation of nutsedge control and turf phytotoxicity symptoms were made daily for the first week and weekly thereafter.

June 1974 treatments

Both, bentazon and cyperquat, were applied to nutsedge infested Kentucky bluegrass and to several other turf species at 1.5 and 3.0 lb a.i./A. All sprays included 0.5% Adjuvan T. The nutsedge and bluegrass in the weed infested area were 3.5 to 4 inches and 3 inches tall, respectively. The other turf species were approximately 2 inches in height. Observation for phytotoxicity symptoms and nutsedge control were made on a 3 to 4 day schedule.

September 1974 treatments

The September 1, 1974 experiments utilized bentazon and cyperquat with or without Adjuvan T in the spray solution. The herbicides were applied at 1.5 and 3.0 lb a.i./A to nutsedge infested bluegrass turf and to several other turf species. The nutsedge was 4 to 6 inches tall and the Kentucky bluegrass about 3 to 4 inches tall previous to spraying. The other turf species were approximately 2 inches in height. Nutsedge control and phytotoxicity evaluations were made on a 3 to 4 day schedule.

Results and Discussion

Nutsedge Control

Bentazon applied in the late summer of 1973 had a rapid influence on nutsedge growth (Table 2). Four days after application the leaf tips of nutsedge were necrotic and leaf tissue desiccated. On August 22, 6 days after spraying, the entire foliage of the plants was dead. Examination of the below ground portion of the plant revealed that the adventitious roots also were dead. Both the 1.5 and 3.0 lb a.i./A rates of bentazon were equally effective in controlling nutsedge.

The activity of bentazon and cyperquat on nutsedge was quite different (Table 3). Both of the materials were applied in the late spring of 1974 to rapidly growing nutsedge plants. Bentazon did not kill nutsedge as rapidly in this test as it did in the August 1973 test. However, in 10 days bentazon treated nutsedge was controlled to the extent of 90 and 99 percent depending upon rate. Whereas, nutsedge treated with cyperquat at the same application rates was injured by 45 and 55 percent. Bentazon activity was apparent as leaf tip necrosis followed rapidly by complete foliar necrosis. Nutsedge treated with cyperquat slowly began showing a slight foliar chlorosis, which became more prominent with time, and then leaf tip necrosis followed by eventual death. Observations made 20 days after treatment revealed death of all treated plants regardless of rate of application.

A test designed to test the influence of a surfactant on the activity of bentazon and cyperquat was initiated on September 1, 1974 (Table 4). The data demonstrates, again, the relatively rapid activity of bentazon in comparison to cyperquat. The symptoms demonstrated by nutsedge by these herbicides were the same as described for the spring 1974 trial. Very small differences have been found between the 1.5 and 3.0 lb a.i./A rate for either of these compounds. The 1.5 lb a.i./A rate has resulted in complete to nearly complete control of nutsedge in all circumstances. No significant influence of surfactant was noted with either bentazon or cyperquat and apparently a surfactant is not needed for acceptable nutsedge control.

Phytotoxicity

Neither, bentazon or cyperquat, appear to be injurious to Kentucky bluegrass turf as evidenced by no injury in any of the three nutsedge trials. Application to any of the Kentucky bluegrass varieties or mixtures in Table 1 resulted in no phytotoxicity symptoms. However, some injury symptoms to bentgrass and tall fescue were evident in the late spring application of 1974. Bentazon at 1.5 lb a.i./A caused some slight leaf tip necrosis and at 3.0 lb a.i./A caused leaf tip necrosis and about a 10% thinning of a Kentucky 31 fescue stand. Some slight leaf tip necrosis was evident on Kentucky 31 fescue with both rates of cyperquat. The 3.0 lb a.i./A rate of cyperquat gave a 40% foliar necrosis injury to Astoria Colonial bentgrass in the late spring test. However, a different formulation of cyperquat was used in the September test than in the June test. It is not known whether the lack of phytotoxicity in September was due to chemical formulation or to timing of application.

LITERATURE CITED

1. Abernathy, J. R. and L. M. Wax. 1971. Control of common cocklebur in soybeans. Proc. N. Cent. Weed Contr. Conf. 26:82.
2. Andersen, R. N., D. D. Warnes, W. E. Lueschen and W. W. Nelson. 1971. Broadleaf weed control in soybeans with postemergence applications of BAS 3512-H. Proc. N. Cent. Weed Contr. Conf. 26:81-82.
3. Andersen, R. N., W. E. Lueschen, D. D. Warnes and W. W. Nelson. 1974. Controlling broadleaf weeds in soybeans with bentazon in Minnesota. Weed Sci. 22:136-142.
4. Anonymous. 1972. Extent and cost of weed control with herbicides and an evaluation of important weeds, 1968. U.S. Dept. of Agr., ARS-H-1 page 168.
5. Fischer, A. 1968. New contact herbicides particularly for the control of mayweeds. Proc. Brit. Weed Contr. Conf. 9:1042-1045.
6. Schwartzbeck, R. A. and J. W. Bullen. 1974. S-21634,1-methyl-4-phenyl-pyridinum chloride, for the control of nutsedge. Proc. N.E. Weed Sci. Soc. 28:46.
7. Wax, L. M., J. R. Abernathy, and R. M. Hayes. 1971. Evaluation of BAS 3512-H for control of weeds in soybeans. Proc. N. Cent. Weed Contr. Conf. 26:49.
8. Weishar, A. L., C. W. Carter and M. A. Veenstra. 1971. BAS 3512-H, a new postemergent broadleaf herbicide for soybeans. Proc. N. Cent. Weed Contr. Conf. 26:50.
9. Zaunbrecker, S. J. and R. L. Rogers. 1971. Effect of size of weeds on performance of selected soybean postemergence herbicides. Proc. S. Weed Sci. Soc. 24:78.

Table 1: List of established grasses and grass mixtures sprayed with bentazon and S-21634 for phytotoxicity evaluations.

Kentucky bluegrass:

Baron	Fylking
Merion	Nugget
Pennstar	South Dakota
Warren A20	Warren A34

Kentucky bluegrass mixtures:

- South Dakota + Kentucky 31 fescue
- Pennstar + Astoria Colonial bentgrass
- Fylking + Astoria Colonial bentgrass
- Warren A34 + Astoria Colonial bentgrass

Others:

- Astoria Colonial bentgrass
- Kentucky 31 fescue
- Zoysia

Table 2: Effect of bentazon* applied August 16, 1973 on postemergence nutsedge control in a Kentucky bluegrass turf.

Treatment	Formulation	Rate (lb a.i./A)	% Nutsedge Control Aug. 20	% Nutsedge Control Aug. 22	% bluegrass injury
bentazon	4 lb/gal.	1.5	50	100	0
		3.0	60	100	0
untreated		-	0	0	0

* Applied at 80 gpa with 0.5% Adjuvan T surfactant

Table 3: Effect of chemicals* applied June 19, 1974 on postemergence nutsedge control in a Kentucky bluegrass turf.

Treatment	Formulation	Rate (lb a.i./A)	% Nutsedge Control June 29	% Nutsedge Control July 9	% bluegrass control
bentazon	4 lb/gal.	1.5	90	100	0
		3.0	99	100	0
cyperquat	3 lb/gal.	1.5	45	100	0
		3.0	55	100	0
untreated		-	0	0	0

* Applied at 80 gpa with 0.5% Adjuvan T surfactant

Table 4: Effect of chemicals applied September 1, 1974 on postemergence nutsedge control in a Kentucky bluegrass turf.

Treatment	Formulation	Rate (lb a.i./A)	% Nutsedge Control Sept. 9	% Nutsedge Control Sept. 18	% bluegrass injury
bentazon	4 lb/gal.	1.5	95	100	0
		3.0	95	100	0
bentazon + surfactant*		1.5	100	100	0
		3.0	100	100	0
cyperquat	0.5 lb/gal	1.5	50	95	0
		3.0	60	100	0
cyperquat + surfactant		1.5	60	100	0
		3.0	65	100	0
untreated		-	0	0	0

* Surfactant = Adjuvan T at 0.5% of total spray volume

Control of Yellow Nutsedge in Cool-Season Turf[1]

J. R. Hall and J. V. Parochetti[2]

ABSTRACT

Bentazon (3-isopropyl-1 H, 2, 1, 3-benzothiadiazinone-(4) 3 H-one 2,2-dioxide), perfluidone (1,1,1-trifluoro-N-(2 methyl-4-(phenylsulfonyl)=phenyl)methanesulfonamide) and 2,4-D ((2,4-dichlorophenoxy)acetic acid) plus DSMA (disodium methanearsonate) were tested for their ability to control yellow nutsedge (*Cyperus esculentus* L.) in a turfgrass mixture of tall fescue (*Festuca arundinacea* Schreb.) and Kentucky bluegrass (*Poa pratensis* L.). Bentazon and 2,4-D plus DSMA affected good initial kill of existing yellow nutsedge. Bentazon and perfluidone injured the tall fescue under the dry, hot post-spray conditions of this experiment. Approximately 13 months after the initial application, bentazon at 0.75 lb ai/A and perfluidone at 4.0 lb ai/A provided 79% and 61% control, respectively, of yellow nutsedge. Bentazon at 1.5 lb ai/A, perfluidone at 3.0 lb ai/A and 2,4-D + DSMA at (1.0 + 5.0 lb ai/A) provided 40%, 16% and 30% control, respectively.

INTRODUCTION

Yellow nutsedge is a serious threat to quality turfgrass production in the Mid-Atlantic region. The life cycle of the plant affords only a limited period of time when it can be effectively sprayed with postemergence herbicides. Control of yellow nutsedge with postemergence herbicides frequently necessitates spraying during periods of dry, hot weather and often results in injury to the desirable cool-season turfgrass species. Herbicides currently available have not provided adequate control of this noxious weed. Experimental materials are available and have received limited testing on turf (3). There is a need for efficacy data for yellow nutsedge control in tall fescue-Kentucky bluegrass turf mixtures. This experiment was designed to compare yellow nutsedge control following applications of bentazon, perfluidone and 2,4-D plus DSMA at various rates on tall fescue-Kentucky bluegrass turf.

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[1]Approved as Scientific Article No. A 2057 and Contribution No. 5010 of the Maryland Agriculture Experiment Station, Department of Agronomy, University of Maryland, College Park.

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

MATERIALS AND METHODS

The experiment was conducted on a yellow nutsedge infested, disturbed loam soil (41% sand, 40% silt, 19% clay). The subsurface material was of Christiana origin in Cheverly, Maryland. The existing turf was a mixture of Kentucky-31 tall fescue and Kentucky bluegrass. Kentucky-31 tall fescue was the dominant species covering approximately 80% of the plot area. Soil pH was 5.7; available P_2O_5 135 lb/A, extractable K_2O 90 lb/A, and organic matter 2.9% (1). All applications were applied in water at the rate of 30 gal/A using CO_2 as the source of pressure in a small plot sprayer delivering the material at 30 psi. The perfluidone and 2,4-D plus DSMA treatments were applied with Ortho X-77 surfactant at the equivalent rate of 4 oz/100 gal H_2O. The experimental design was a randomized complete block with 3 replications and unit plot size of 1.5 by 35 ft.

Treatments (Table 1) were applied on August 23, 1973. On this date the air temperature was 75 F and the soil temperature at the 0-6 inch range was 76 F. The turf was maintained at a 2.5 inch mowing height and was fertilized in September and October 1973 and in March of 1974 with a total of 18 lb of 16-8-8 per 1000 sq. ft. applied in three 6 lb applications. The plot area was overseeded to Kentucky-31 tall fescue at the rate of 2 lb/1000 sq. ft. in late October 1973 and 50 lb/1000 sq. ft. of agricultural limestone was applied in March of 1974. To avoid seed dispersal, the clippings were collected on the plot during the period when yellow nutsedge was actively forming inflorescences. Data were taken on September 25 and November 30, 1973 and on September 10, 1974 (33, 99 and 382 days after treatment, respectively). Percent plot area estimations were recorded as the average of two individual's ratings. Yellow nutsedge populations were determined by counting all plants in the 52.5 sq. ft. plot.

RESULTS AND DISCUSSION

Temperatures during the period from August 27 to September 2, 1973 averaged 85 F and were 11 F above normal and precipitation during this same period was 1 inch below normal (2). This hot, dry weather did have varying effects upon the performance of the materials tested. Visual observation indicated good kill of yellow nutsedge was provided seven days after application of bentazon at both rates. The crown tissue exhibited severe necrosis and the plants were easily pulled from the soil. At that time no effect on tall fescue was observed. Yellow nutsedge plants in the perfluidone plots appeared similar to the plants in the check plots after 7 days. The plants in the 2,4-D + DSMA plots were necrotic and the crown tissue was brown 7 days after treatment application. The 2,4-D plus DSMA treatment did provide control of smooth crabgrass (*Digitaria ischaemum* (Schreb.) Muhl.). Eleven days after application it was observed that the yellow nutsedge in the perfluidone plots had stopped initiating new roots and the existing roots did not appear as healthy as those in the check plots. Shoot growth in these plots appeared stunted at this time. In the 2,4-D + DSMA plots the older leaves of the yellow nutsedge were still green eleven days after application but the young leaves near the crown tissue were brown. The 2,4-D + DSMA plots

in the replication that was driest did injure the turf by burning the foliage. This injury was temporary and was not noticeable after 99 days (Table 2).

Bentazon and 2,4-D + DSMA provided quick kill of the above ground yellow nutsedge plant parts (Table 1). Perfluidone was slower acting and by September 25, 1973 many plants still appeared to be living. Both plant counts and visual estimates of the plot area covered with yellow nutsedge confirm this data. The correlation between plant count and visual estimate of plot area covered with yellow nutsedge was highly significant ($r = .979$) indicating the reliability of visual estimates to reflect plant count in this instance.

By September 25, 1973 a reduction in the stand of tall fescue in certain plots was evident (Table 1). Perfluidone and bentazon treatments appeared to significantly reduce the percent of the plot area in tall fescue. This observation could have been influenced by the extremes of weather discussed above. Because of the late October overseeding of the plot area with tall fescue as mentioned above, the permanancy of the tall fescue injury could not be determined.

The bentazon and perfluidone treatments did negatively influence the quality of the predominantly tall fescue turf for at least 99 days (Table 2). These quality differences were primarily the result of thinning of the tall fescue stand in the tall fescue-Kentucky bluegrass mixture (Table 1).

On September 10, 1974, approximately 13½ months after the initial application, yellow nutsedge plant counts were made indicating that the best control of yellow nutsedge with a single application was achieved with bentazon at the .75 lb ai/A rate (Table 2). This degree of control was not significantly different at the 5% level from that achieved with bentazon at 1.5 lb ai/A perfluidone at 4.0 lb ai/A or 2,4-D plus DSMA at (1.0 + 5.0 lb ai/A). The only treatments providing control of yellow nutsedge that were significantly better than the check 382 days after application were bentazon at .75 lb ai/A and perfluidone at 4.0 lb ai/A.

It appears that multiple applications of these materials are necessary for acceptable control of yellow nutsedge.

Table 1. Effect of bentazon, perfluidone and 2,4-D plus disodium methanearsonate upon percent of plot area in nutsedge, number of nutsedge plants per plot and percent of plot area in tall fescue on September 25, 1973, 33 days after treatment.

Treatment Chemical	Rate (lb ai/A)	Area of Plot in living yellow nutsedge[x] (%)	Yellow Nutsedge plants per 52.5 sq. ft. (number)	Area of Plot in tall fescue[x] (%)
Bentazon	.75	0 a[y]	0 a	17 a
	1.5	0 a	0 a	5 a
Perfluidone	3.0	12 b	60 b	20 a
	4.0	12 b	64 b	15 a
2,4-D plus Disodium methanearsonate	1.0 + 5.0	0 a	0 a	38 b
Check	0	32 c	187 c	58 c

[x]Visual estimates recorded as average of two individuals ratings made in 5% increments.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

Table 2. Effect of bentazon, perfluidone and 2,4-D plus disodium methanearsonate upon quality of the turfgrass on November 30, 1973 (99 days after treatment) and percent control of yellow nutsedge on September 10, 1974 (382 days after treatment).

Treatment Chemical	Rate lb ai/A	Turfgrass Quality Rating 11/30/73 (rating)[x]	Yellow nutsedge Control 10/10/74 (%)
Bentazon	.75	4.6 a[y]	79 c[z]
	1.5	4.3 a	40 abc
Perfluidone	3.0	4.0 a	16 ab
	4.0	4.6 a	61 bc
2,4-D plus Disodium methanearsonate	1.0 + 5.0	6.3 a	30 abc
Check	0	6.6 a	0 a

[x]Turfgrass quality rating made on a 0-9 scale with 9=maximum turfgrass quality and 0=bare plot. A rating of 6 or greater is considered acceptable.

[y]Columnar means with the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range test.

[z]Total number of yellow nutsedge plants in each plot was determined and individual control values were calculated within each replicate.

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LITERATURE CITED

1. 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.

2. Felch, Richard E., 1973. Weekly weather and crop bulletin, U.S.D.A., Statistical Reporting Service, Volume 60 (36) pp. 16.

3. Jagschitz, John A., 1973. Evaluation of herbicides for nutsedge control in turfgrass, Proc. Northeast. Weed Sci. Soc. 27:331-333.

GROWTH RETARDANT EFFECTS ON A KENTUCKY BLUEGRASS LAWN

John Jagschitz[1]

The recent introduction of new growth retardant chemicals has regenerated interest in turfgrass growth suppression studies. Tests were conducted in 1972, 1973, and 1974 to evaluate these retardants on Kentucky bluegrass (Poa pratensis L.) maintained at a height of 1.5 or 2 inches.

Materials and Methods

The tests were conducted at the Kingston Turf Farms and the Tuckahoe Turf Farms in Rhode Island. The chemicals and rates used are shown in Tables 1 to 5. Granular materials were applied by hand and sprays were applied at 50 gpa to replicated plots. The mowing schedules and rainfall amounts within 24 hours after treatment are shown in the tables. The fertilizer treatment referred to in Table 5 was a 10-6-4 grade at 1.5 lb nitrogen per 1,000 sq ft applied 5 days after the retardants and the fungicide treatment was a .375 lb of quintozene and .25 lb of benomyl per 1,000 sq ft applied 7 days after the retardants. Growth response was determined by grass height or dry weight, visual estimates of grass injury and color and by seedhead counts or stand estimates and height measurements. Rooting of transplanted sod was evaluated by measuring dry weight of roots from plugs grown on sand and by measuring the force required to lift plugs from soil.

Results and Discussion

The growth responses of Kentucky bluegrass from chemical retardants are shown in Tables 1 to 5. Most chemicals reduced grass height and suppressed seedhead stand and/or height. However, they all produced some grass injury or discoloration. The data suggests that the use of these retardants on lawn-type Kentucky bluegrass will depend upon how much injury or discoloration can be tolerated. The most effective treatments were certain rates of CGA-17020g, MBR-12325, MH, RO-7-6145, Sustar, and UNI-R750 and from the combinations of Ethrel plus RO-7-6145 and of MH plus either CF, EL-509, Ethrel or RO-7-6145.

Mowing several days after the retardants were applied resulted in lower grass height and a more uniform growth, especially with MH and Sustar. The root study data from transplanted sod is shown in Table 2. Root development was inhibited by CF, MH or Sustar when applied several days before or after transplanting.

To properly evaluate retardants, injury data must be recorded after regular mowing is resumed. Data in Table 4 and 5 show increased injury from some treatments. This is aside from scalping injury expected in check plots and

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[1]Assistant Professor, University of Rhode Island, Kingston, Rhode Island

other plots having tall grass. In plots treated with Ethrel the grass blades were removed during mowing because they were located high on elongated, stalk-like stems.

The most interesting aspect of these studies was the effect from the fungicides as shown in Table 5. Fungicides reduced grass injury and improved grass color without altering growth retardation. It is felt this was due to disease control and to a delay in senescence of grass blades possibly caused by benomyl. During growth suppression these dying blades contribute to the overall plot appearance. Although the fertilizer treatment provided some improvement in grass injury and color it reduced the effect of the retardants on grass height.

Table 1. Growth response of Kentucky bluegrass mowed at 1.5 inches four days after chemical treatment on May 12, 1972.

		Grass			Seedhead		
Chemical	Rate	Height 4 wk	Weight 4 wk	Injury 0-4 wk	Stand 4 wk	Count 4 wk	Height 4 wk
	(lb/A)	(in)	(g/sq ft)[a]	(0-10)[b]	(0-10)[b]	(no/sq ft)	(in)
C-19490	10	4.5	3.6	1.0	5	119	6
CF	2	6.8	9.8	1.0	5	180	9
CF	3	6.4	8.3	1.6	6	174	8
CF + MH	1 + 2	6.3	9.3	.0	5	175	8
CF + MH	1 + 3	4.8	4.8	.0	1	42	6
EL-531	3	5.8	6.0	1.0	8	247	11
Ethrel	10	5.2	4.5	.0	8	281	7
MH	2	6.6	9.9	.0	5	217	8
MH	5	4.0	2.3	.0	1	24	5
Sustar	4	4.0	3.0	1.3	1	2	5
Check	-	8.8	12.3	.0	9	335	11

[a]dry clippings above 3.5 inch height

[b]0 = no injury, 10 = brown; 0 = no seedheads, 10 = normal stand

Table 2. Effect of chemicals applied in 1972 on the root development of transplanted Kentucky bluegrass.

		Root[a]		Root[b]	
Chemical	Rate	Weight	Strength	Weight	Strength
	(lb/A)	(g/sq ft)	(lb/sq ft)	(g/sq ft)	(lb/sq ft)
CF	2	.54	92	.83	139
MH	5	.01	31	.24	88
Sustar	3	.04	39	.99	147
Check	-	2.70	258	2.70	267

[a]sod transplanted 11 days after chemicals applied on September 15, 1972 and measurements made 4-5 weeks after transplant.

[b]chemicals applied on October 5, 1972 nine days after sod transplanted and measurements made 3-4 weeks after chemical treatment.

Table 3. Effect of chemicals on the growth of Kentucky bluegrass mowed at 1.5 inches six days after chemical treatment on May 8, 1973.

		Grass				Seedhead	
		Height		Injury		Stand	Height
Chemical[a]	Rate	3 wk	5 wk	0-3 wk	4-5 wk	5 wk	5 wk
	(lb/A)	---(in)----		----(0-10)[b]--		(0-10)[b]	(in)
C-19490	15	2.3	2.4	2.4	6.0	1	1
CF	2	3.9	6.3	2.6	.0	3	8
CF	3	3.9	6.3	3.1	.0	2	7
CF + MH	1 + 3	2.8	4.2	.0	.1	1	4
EL-509g	2	4.4	7.4	.0	.0	9	11
EL-509g	3	3.7	6.3	.0	.3	9	10
EL-509g	4	3.4	4.9	.0	.8	9	9
EL-509	2	4.7	8.3	.0	.0	9	12
EL-509	3	4.0	6.8	.0	.0	7	10
EL-509	4	4.0	6.3	.0	.0	8	10
EL-509 + MH	2 + 2	2.8	4.2	.6	.3	2	4
EL-509 + MH	3 + 2	2.4	3.8	.5	.3	2	4
EL-509 + MH	4 + 2	2.6	3.8	1.0	1.0	2	4
Ethrel	10	2.7	4.0	.0	.0	7	6
Ethrel	15	2.6	4.1	.0	.0	7	6
Ethrel + MH	5 + 3	2.5	3.4	.4	.0	1	3
Sustar	2	3.8	6.1	.0	.0	5	9
Sustar	4	3.2	5.1	.0	.0	1	6
Sustar + MH	2 + 3	2.7	4.1	.1	.1	1	2
MBR-12325	.5	2.3	4.0	1.6	1.1	0	0
MBR-12325	1	2.1	3.6	1.9	1.5	0	0
MH	2	3.5	5.9	.0	.0	1	6
MH	3	2.8	3.9	.0	1.0	1	4
MH	5	2.5	3.0	.0	3.4	1	3
Proxazolon	2	3.7	3.7	.0	.8	8	7
RO-7-6145	6	2.6	5.8	.6	.0	2	7
RO-7-6145	9	2.2	4.5	.3	.0	1	5
RO-7-6145	12	1.9	3.8	1.5	.1	1	4
2,4-D	1.5	4.9	8.5	.0	.0	10	11
check	-	4.8	8.6	.0	.0	9	12

[a]1.26 inches of rain starting 12 hours after treatment

[b]0 = no injury, 10 brown; 0 = no seedheads, 10 = normal stand

Table 4. Kentucky bluegrass response to chemicals applied May 7, 1974 and mowed at a 2-inch height one week later and regularly after six weeks.

		Grass						Seedhead	
		Height		Injury			Color	Stand	Height [a]
		4	6	0-3	4-6	7-10	10	5	5
Chemical	Rate	wk	wk	wk	wk	wk	wk	wk	wk
	(lb/A)	---(in)--		-----(0-10) [b]----			(0-10) [b]	(0-10) [b]	(in)
CF + MH	1 + 3	2.8	3.3	.5	3.2	2.8	6	1	-
CGA-17020	2.5	4.7	7.2	.3	.2	3.8	3	9	9
CGA-17020	5	3.7	5.1	.8	1.0	2.8	4	6	8
CGA-17020	7.5	2.8	4.1	2.0	1.8	2.1	6	4	-
CGA-17020g	5	2.1	3.5	1.0	2.5	2.7	7	1	3
EL-509	2	4.6	7.0	1.7	.2	2.6	5	9	11
EL-509	3	3.8	4.5	2.7	2.2	2.9	5	8	10
EL-509g	2	3.9	4.5	1.2	1.1	3.7	5	9	11
EL-509g	3	3.5	4.0	1.6	2.8	3.7	6	7	9
Ethrel	5	4.0	5.2	.3	.0	6.8	2	9	8
MBR-12325	.25	2.4	3.9	1.3	2.7	2.6	6	1	-
MBR-12325	.5	2.0	3.3	2.4	4.1	2.8	7	0	-
MBR-12325g	.25	5.4	8.5	.5	.0	3.8	3	8	10
MBR-12325g	.5	3.9	5.5	.7	1.0	3.0	4	6	8
MBR-12325-9	.25	2.4	3.7	1.3	2.5	2.1	7	1	3
MBR-12325-9	.5	2.1	3.8	2.8	4.5	2.2	7	1	-
MH	2	3.8	5.3	.5	.9	3.2	4	3	-
MH	3	2.4	3.6	.3	3.5	2.7	6	4	-
MH	4	2.7	2.9	.5	4.5	3.7	6	2	-
RO-7-6145	6	3.1	4.6	1.3	1.4	2.1	4	5	4
RO-7-6145	8	2.3	3.1	1.5	2.7	1.7	5	3	-
RO-7-6145	10	2.3	2.9	2.0	3.0	1.4	6	3	-
Sustar	2	3.8	5.2	.8	1.2	3.4	4	3	6
Sustar	4	3.3	4.5	1.3	1.9	3.1	4	2	4
UNI-R750	2	2.8	4.2	1.7	2.4	2.4	6	3	-
UNI-R750	4	2.2	3.2	1.1	3.5	2.3	8	1	-
UNI-R750	8	2.1	3.0	1.6	3.5	2.9	8	1	-
Ethrel + EL	5 + 3	3.0	3.3	2.8	2.2	2.2	5	7	7
Ethrel + MBR	5 +.25	2.7	3.5	2.0	1.7	2.7	4	1	-
Ethrel + MH	5 + 2	2.8	3.4	.7	1.5	2.8	4	3	4
Ethrel + RO	5 + 6	2.6	3.1	2.3	3.0	1.3	5	2	3
Ethrel + Sustar	5 + 2	3.7	4.5	.7	.8	6.2	2	7	7
MH + EL	2 + 3	2.6	2.9	3.0	3.4	2.8	7	1	-
MH + MBR	2 +.25	2.1	3.4	2.5	3.7	2.3	7	0	0
MH + RO	2 + 6	2.6	3.6	1.9	2.7	1.9	5	2	-
MH + Sustar	2 + 2	3.3	5.0	1.0	2.0	3.2	5	1	-
MBR + EL	.25 + 2	2.0	2.7	5.2	5.2	2.3	8	0	-
MBR + RO	.25 + 6	2.3	3.7	2.2	1.9	1.8	6	1	-
EL + RO	3 + 6	2.6	3.7	3.0	2.7	2.4	7	5	3
check	-	4.8	6.9	.1	.2	3.5	3	9	11

[a] no measurement means height is same or less than grass height.

0 = no injury, 10 = brown; 0 = yellow color, 10 = green; 0 = no seedhead, 10 = normal stand.

Table 5. Growth response of Kentucky bluegrass from chemicals applied May 8 or 9, 1974 and mowed at 1.5 inches seven days later (trim) and regularly after five weeks.

Chemical Treatment[c]	Rate	Grass Height 3 wk	Grass Height 5 Wk	Grass Injury 0-3 wk	Grass Injury 4-5 wk	Grass Injury 6-9 wk	Grass Color 10 wk	Seedhead Stand 5 wk	Seedhead Height 5 wk
	(lb/A)	---(in)--		----	(0-10)[a]---		(0-10)[a]	(0-10)[a]	(in)[b]
CF + MH	1 + 3								
no trim		2.8	3.2	.7	2.8	2.3	6	8	-
trim 1 wk		2.3	2.7	1.2	3.0	2.7	6	8	-
trim + fungicide		2.1	2.3	.4	.9	1.1	8	8	-
trim + fertilizer		2.2	3.1	.7	2.8	1.3	7	6	-
MBR-12325	.5								
no trim		2.0	2.1	3.1	4.5	3.0	6	1	-
trim 1 wk		1.6	1.9	3.2	5.0	2.5	6	1	-
trim + fungicide		1.6	2.6	1.1	1.4	.7	8	1	-
trim + fertilizer		1.6	2.6	4.0	4.7	1.3	6	1	-
MH	4								
no trim		2.8	3.3	1.2	3.0	2.6	6	9	-
trim 1 wk		2.3	2.3	1.2	3.5	3.2	6	8	-
trim + fungicide		2.2	2.4	.2	1.3	1.7	8	9	-
trim + fertilizer		2.5	3.3	1.4	2.5	1.5	7	9	-
RO-7-6145	8								
no trim		2.3	3.4	1.7	.7	1.5	5	6	-
trim 1 wk		2.0	2.8	2.5	1.6	.9	5	6	-
trim + fungicide		2.0	3.0	.9	.1	.1	9	8	-
trim + fertilizer		2.0	3.4	2.5	1.2	.5	7	4	-
Sustar	4								
no trim		2.6	3.9	2.3	1.5	3.2	4	6	-
trim 1 wk		2.1	2.9	2.2	2.3	3.3	4	5	4
trim + fungicide		2.3	3.2	1.8	.2	1.3	6	6	-
trim + fertilizer		2.6	4.7	2.5	1.3	2.0	5	4	-
check	-								
no trim		4.1	8.3	.3	.0	4.8	3	10	11
trim 1 wk		3.8	7.0	1.1	.5	2.4	4	10	10
trim + fungicide		3.6	6.5	.2	.0	.9	4	10	9
trim + fertilizer		4.1	9.3	.7	.0	4.2	3	10	10
Trim 1 week									
Ethrel	3	3.1	4.9	.7	.2	4.7	3	9	7
Ethrel + EL-509	3 + 3	2.4	2.2	2.2	2.3	4.0	4	8	5
Ethrel + MBR	3 + .25	1.8	2.3	3.2	3.3	.8	6	2	-
Ethrel + MH	3 + 2	2.3	2.7	1.3	1.5	1.4	5	6	4
Ethrel + RO	3 + 6	2.3	3.2	2.1	1.2	.4	6	4	-
Ethrel + Sustar	3 + 2	2.4	3.4	1.2	.7	3.4	3	3	6
MH + EL-509	2 + 3	2.1	2.2	2.0	2.2	3.5	4	9	-
MH + MBR	2 + .25	1.7	1.9	3.2	4.5	2.3	7	0	-
MH + RO	2 + 6	2.1	3.3	1.1	1.0	1.2	5	6	-
MH + Sustar	2 + 2	2.3	3.7	2.7	2.0	1.9	4	6	-

[a]0 = no injury, 10 = brown; 0 = yellow color, 10 = green; 0 = no seedheads, 10 = normal stand.

[b]no measurement means height is same or less than grass height.

[c].75 inch of rainfall starting 12 hours after RO-7-6145 treatments

GROWTH REGULATION OF TALL FESCUE

T. L. Watschke, D. V. Waddington, and C. L. Forth[1/]

ABSTRACT. Five experimental and three commercially available chemical growth regulators varied in growth suppression and phytotoxicity when applied to tall fescue. Three experimentals (CGA-24705, MBR-12325, and Ro7-6145) retarded growth comparable to Maintain 3 (maleic hydrazide) and CF-125 (chlorflurenol). MBR-12325 caused the greatest growth suppression. All materials caused objectionable discoloration when applied at rates that caused retardation, but induced an increase in green color as plants recovered from the chemical stress.

INTRODUCTION

Labor hours have been decreased in the management of turf facilities by larger, more efficient equipment, but mowing operations still require a major portion of maintenance time. Chemical mowing would offer an alternative for further reduction in mowing. Growth retarding chemicals have been applied to turf since maleic hydrazide was introduced in 1949. Unfortunately, discoloration and thinning of turf has accompanied growth suppression. Consequently, use of retardant chemicals has been restricted to roadsides, non-use, or hazardous-to-mow areas. There has been a renewed interest in turfgrass growth retardation in recent years, and new chemicals have been developed for use on fine turf. The objective of this study was to evaluate growth regulation and injury of five experimental and three commercial growth regulators on 'Kentucky 31' tall fescue (*Festuca arundinacea*, Schreb.).

MATERIALS AND METHODS

This research was conducted at the Joseph Valentine Turfgrass Research Center, The Pennsylvania State University. The soil type was a Hagerstown silt loam and the turf was a three-year-old stand of Kentucky 31 tall fescue.

All treatments were applied on July 22, 1974, and no rainfall occurred for at least 24 hours following application. Sprayed materials were applied using a two-nozzle hand-held boom at approximately 40 psi and 50 gpa. Granular formulations were applied using a shaker bottle. Three replications were used and plot size was 3 x 10 ft.

[1/] Assistant Professor, Associate Professor, and Graduate Assistant respectively, Department of Agronomy, The Pennsylvania State University, University Park, Pa. 16802.

The commercial materials used were Sustar (N-[3-(1,1,1-Trifluoromethylsulfonyl) amino-4-methylphenyl] methanesulfonamide). CF-125 (methyl 2-chloro-9-hydroxyfluorene-9-carboxylate; methyl 9-hydrofluorene-9-carboxylate; methyl 2,7 dichloro-9-hydroxyfluorene-9-carboxylate); and Maintain 3 (Diethanolamine salt of 6-hydroxy-3-(2H) pyridazinone). Experimental materials were EL-509 (undisclosed), CGA-17020 and 24705 (undisclosed), MBR-12325 (undisclosed), and Ro7-6145 (undisclosed). Rates of each material are shown in Table 1. Turf was not mowed after application until foliar weights were taken 11 weeks later.

Color and discoloration ratings were taken 10 times (lasting 8 weeks after application). Each treated plot had an adjacent untreated plot to facilitate comparisons.

Four height measurements were taken in each plot seven weeks after application. Height was measured by dropping a semi-rigid plastic sheet (6 x 6 inches) over a one-inch (O.D.) plastic pipe (18 inches long) vertically placed in contact with the soil surface. The sheet was allowed to come to rest on top of the turf canopy and the height was read from 1/4-inch markings on the pipe. Heights of treated plots were subtracted from the heights recorded on adjacent untreated plots.

Clippings were collected over a 9-ft distance using a 20-inch rotary mower set at a 2-inch cutting height. Fresh weights from treated plots were subtracted from fresh weights of adjacent untreated plots.

RESULTS

Color ratings were taken to assess initial loss of color, its duration, and increase in color after the chemical stress subsided. These ratings showed that all materials caused loss of color, with granular formulations having a slower effect than sprays (Table 1). The EC formulation of MBR-12325 at both rates caused the most severe loss of green color. For the high rate, turf color did not return to the level of the check until approximately seven weeks after application. Ro7-6145 and CF-125 caused color loss for approximately five weeks. Once color returned to the level of the check an increase in green color was observed for all treatments except the two lowest rates of EL-509. All rates of EL-509 had the least effect on turf color.

Discoloration was recorded to assess injury and its duration (Table 2). Discoloration varied depending on the chemical; Ro7-6145 caused a yellowing; MBR-12325 a browning; CF-125 and Sustar a bleaching. The EC formulation of MBR-12325 and Ro7-6145 were the most active materials and caused the most immediate injury. CF-125 injury was not as immediate, but was equally severe. EL-509 and both CGA compounds had less discoloration than all others, but even this lower level of injury was considered objectionable.

Height measurements showed that all treatments except the low rate of CGA-17020 and the high rate of granular MBR-12325 caused shorter turf than the check (Table 3). The measurements were made seven weeks after application and consequently the effect of many materials had diminished

in their growth regulation. Other tests at Penn State have indicated that duration of retardation was approximately four weeks, after which growth was stimulated. CGA-24705, EL-509, and the EC formulation of MBR-12325 caused shorter turf than the other materials including those commercially available.

Fresh-weight yields showed that the high rates of CGA-24705, the EC formulation of MBR-12325, and CF-125 caused the greatest growth reduction over 11 weeks. These treatments had also caused the greatest discoloration. Since weights were taken 11 weeks after application the differences were undoubtedly not as great as they would have been if they had been taken earlier. Turf appearance data was desired on unmowed turf, thus the delay in the measurement of foliar weights. Turf treated with both rates of CGA-17020, the low rate of CGA-24705, and the low rate of granular MBR-12325 had larger fresh weights than untreated turf. This result reflected growth stimulation following a period of retardation.

CONCLUSION

This experiment has shown that growth regulation of tall fescue can be accomplished with experimental materials as well as those that are commercially available. The objectionable discoloration that accompanied growth suppression, however, would limit the usefulness of these materials to areas where aesthetic quality is not of primary interest.

Table 1. Color ratings of tall fescue treated with nine growth regulators on July 22, 1974.

Material	Formulation	Rate lb ai/A	Dates 7/25	8/1	8/9	8/15	8/19	8/22	8/29	9/5	9/12	9/19
EL-509	1 G	1.50	8.0*	9.3	9.0	8.7	9.0	8.7	9.0	8.7	8.7	9.3
EL-509	1 G	3.00	8.0	8.3	8.3	8.3	8.3	8.3	8.3	9.0	8.7	9.3
EL-509	1 G	4.00	8.7	8.3	8.0	8.7	9.0	8.7	8.7	8.3	9.3	9.7
CGA-17020	4 EC	6.00	8.3	9.0	9.0	7.7	8.3	8.3	9.3	9.3	10.0	10.0
CGA-17020	4 EC	8.00	7.3	8.0	9.0	7.3	7.7	8.3	9.0	9.3	9.7	9.7
CGA-24705	6 EC	4.0	8.3	8.3	8.0	7.7	8.3	8.0	8.0	8.0	8.7	9.0
CGA-24705	6 EC	6.0	8.3	8.7	9.0	9.3	8.7	8.3	8.3	8.7	9.7	9.7
MBR-12325	1 G	0.50	9.0	9.3	10.0	8.0	8.3	8.7	9.7	9.3	9.7	9.7
MBR-12325	1 G	0.75	8.7	9.0	8.3	7.3	8.0	8.0	8.3	9.0	9.7	9.3
MBR-12325	4 EC	0.125	7.8	8.3	7.0	5.7	5.7	5.7	6.3	7.7	9.0	9.0
MBR-12325	4 EC	0.062	8.0	7.7	6.7	6.0	6.3	6.3	7.0	9.0	9.7	10.0
Ro7-6145	80 W	4.00	7.0	7.3	6.7	7.3	8.0	7.7	8.3	9.0	9.3	9.3
Ro7-6145	80 W	6.00	8.0	7.3	6.3	7.0	8.0	8.0	9.0	9.0	9.7	9.3
Sustar	2 S	1.50	8.3	8.7	7.0	7.3	7.3	7.7	8.0	8.3	9.3	10.0
Maintain 3	3 EC	1.00	8.7	8.7	7.3	7.7	8.0	8.0	9.3	8.7	9.7	10.0
CF-125	1 EC	1.00	8.0	9.0	5.3	5.7	6.3	6.7	8.3	9.3	10.0	9.7
Check			9.0	9.0	9.7	9.3	9.7	9.7	9.0	9.0	9.0	9.7

*Color ratings on a scale of 1 to 10 with 10 = darkest green, 1 = brown

Table 2. Discoloration ratings of tall fescue treated with nine growth regulators on July 22, 1974.

Material	Formulation	Rate lb ai/A	Dates 7/25	8/1	8/9	8/15	8/19	8/29	9/5	9/12	9/19
EL-509	1 G	1.50	1.0*	1.3	0.7	1.3	1.0	0.7	1.3	1.3	1.0
EL-509	1 G	3.00	2.0	2.0	2.0	1.7	1.3	1.3	1.7	1.3	0.3
EL-509	1 G	4.00	0.7	1.3	1.3	1.0	1.0	1.0	1.7	0.3	0.3
CGA-17020	4 EC	6.00	1.0	1.3	0.7	2.0	1.7	0.7	0.7	0.0	0.0
CGA-17020	4 EC	8.00	0.7	1.0	1.0	2.3	2.0	1.0	0.7	0.3	0.3
CGA-24705	6 EC	4.00	0.3	0.7	1.0	2.3	1.7	1.3	2.0	1.3	1.0
CGA-24705	6 EC	6.00	2.0	1.3	1.0	1.3	1.3	2.3	1.3	0.0	0.0
MBR-12325	1 G	0.50	0.3	0.0	0.3	2.0	1.3	0.7	0.7	0.3	0.3
MBR-12325	1 G	0.75	1.0	1.3	1.7	2.7	1.7	1.0	1.0	0.3	0.7
MBR-12325	4 EC	0.125	0.7	2.3	3.7	4.3	4.7	3.7	2.0	1.0	1.0
MBR-12325	4 EC	0.062	1.7	2.3	3.7	3.7	4.0	3.3	1.0	0.3	0.0
Ro7-6145	80 W	4.00	2.0	2.3	3.1	2.7	2.0	1.0	1.0	0.7	0.3
Ro7-6145	80 W	.00	3.0	3.0	3.7	3.0	2.0	0.7	0.7	0.3	0.7
Sustar	2 S	1.50	1.0	1.3	3.0	2.7	2.1	2.0	1.7	0.7	0.0
Maintain 3	3 EC	1.00	1.3	1.0	2.0	2.7	1.7	0.7	1.0	0.3	0.0
CF-125	1 EC	1.00	1.0	0.7	4.7	4.3	3.7	2.0	0.7	0.3	0.3
Check			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Discoloration ratings on a scale of 1 to 10 with 10 = brown, 0 = no discoloration

Table 3. Foliar height and weight of tall fescue treated with nine growth regulators on July 22, 1974. Height and weight measurements were made 7 and 11 weeks after application, respectively.

Material	Formulation	Rate lb ai/A	Height(cm)	Weight(g)
EL-509	1 G	1.50	2.8†	65*
EL-509	1 G	3.00	2.8	57
EL-509	1 G	4.00	2.5	35
CGA-17020	4 EC	6.00	-0.5	-43
CGA-17020	4 EC	8.00	0.5	-51
CGA-24705	6 EC	4.00	2.3	- 8
CGA-24705	6 EC	6.00	2.8	101
MBR-12325	1 G	0.50	0.0	-47
MBR-12325	1 G	0.75	-1.8	54
MBR-12325	4 EC	0.125	3.0	199
MBR-12325	4 EC	0.062	1.8	70
Ro7-6145	80 W	4.00	1.8	39
Ro7-6145	80 W	6.00	1.0	50
Sustar	2 S	1.50	1.0	29
Maintain 3	3 EC	1.00	1.8	81
CF-125	1 EC	1.00	0.3	111

*Difference in fresh weight of treated versus untreated turf; negative number denotes treated plot had higher yield than check

†Difference in height of treated versus untreated turf

EFFECTS OF GROWTH RETARDANTS ON THE TOP GROWTH AND ROOT GROWTH OF TURFGRASSES 1/, 2/

A.P. Nielsen and R.C. Wakefield 3/

Abstract

Four growth retardants, Sustar, MBR 12325, Maleic hydrazide (MH), and a combination of MH plus chlorflurenol (CF) successfully reduced top growth of a highway turf mixture mowed at 10 cm. (4 in.). Most discoloration and thinning was overcome by a nitrogen increase from one pound to two pounds per 1000 square feet. Seedheads were significantly reduced by the growth retardants, especially at the higher nitrogen level.

Results of a study using turfgrass plugs showed that MH, MH + CF, Sustar, MBR 12325, and RO 7-6145 significantly reduced top growth, but also suppressed root growth. The MBR 12325 treatment resulted in far less suppression of root growth than other treatments. Rhizomes and seedheads were suppressed by all growth retardants. Top growth weights and seedheads were also significantly reduced in highway median studies.

Introduction

The use of chemical growth retardants on highway turfgrass areas to reduce mowing requirements can be a practical method of minimizing highway maintenance costs. Other benefits include reducing the hazards of operating mowers along highways and simplifying maintenance. For these reasons, research in the field of growth retardants has increased substantially in recent years.

Previous studies (1,2,3,4,5) have found that many growth retardants are effective but decrease the density of turfgrasses as well as cause discoloration. Some studies have shown that nitrogen fertilization can help to overcome these harmful effects of growth retardants, while still allowing a reduction of top growth to occur (2,4,5). Other work has shown that by increasing mowing height, results with growth retardants can be improved (2,5). Another effect of growth retardants which may be injurious to turf is suppres-

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1/Contribution No. 1571, Agricultural Experiment Station, Kingston, R.I.

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3/Research Assistant and Professor respectively, Department of Plant and Soil Science, Agricultural Experiment Station, Kingston, Rhode Island 02881.

of root growth (4).

The objectives of this study were to investigate further the effects of various growth retardants on top growth and root growth of different turfgrasses.

Materials and Methods

The first experiment (Test 1) was conducted on a mixture of Park Kentucky bluegrass (*Poa pratensis* L.), Exeter Colonial bentgrass (*Agrostis tenuis* Sibth), and Pennlawn red fescue (*Festuca rubra* L.) established in 1967 on an Enfield silt loam at the University of Rhode Island and maintained at low fertility to simulate highway conditions. The plots were fertilized with either 1 or 2 pounds of nitrogen per 1000 square feet (lbs N/M) as 10-6-4 fertilizer on April 16, 1973. The entire site was mowed to 10 cm. (4 in.) on April 30, 1973. On May 1, 1973, the growth retardants were applied in water with a 6 foot boom bicycle sprayer delivering 50 gallons per acre. Chemicals with rates of active ingredient per acre (lb. ai/A) are listed in Table 1. Some treatments were split or applied periodically during the course of the study. The experiment involved a total of 13 treatments with 6 x 18 ft. plots randomized in three complete blocks. Fifteen feet of each plot was referred to as the "mowed plots". All the plots were maintained at a high cut of 10 cm. (4 in.) and were mowed when grasses measured at least 20 cm. (8 in.). A 21-inch Toro rotary mower with sample bag was pushed the length of the plot harvesting an area of 26.25 sq. ft. A 3 foot segment of each plot was not mowed in order to investigate the effect of the chemicals on unmowed turf and seedhead suppression. Seedhead counts and dry weights of grasses exceeding 4 in. were taken from 2 square feet of each plot approximately 11 weeks after treatment. Height measurements, color (a visual rating of greeness on a basis of zero to a most desirable ten) and density (also a visual rating on a basis of zero to a most desirable ten, indicating thinness of the turf due to injury and/or suppression of new tillers) were recorded.

The second experiment (Test 2) consisted of a pure stand of 'Jamestown' red fescue (*Festuca rubra* var. *commutata* Gaud.) and a pure stand of 'Fylking' Kentucky bluegrass (*Poa pratensis* L.). The turf was established in 1972 on an Enfield silt loam at the University of Rhode Island and received no supplemental fertilizer before or during the test. On May 2, 1974, the turf was treated with the chemicals listed in Tables 2 and 3. The experiment involved the removal of 50 grass plugs (5 cm. in diameter and to a depth of 5 cm. in the soil) from each treatment and turf species from the treated field plots. The plugs were then placed in outside sand beds and watered daily. At the end of 3 weeks, 10 plugs of each treatment and turf species were removed from the sand beds, washed, and top growth was cut off to a height of 1 cm., dried and washed. All new root growth beyond the original 5 cm. soil plug was cut, dried and weighed. This procedure was repeated at 5, 7, and 9 weeks, also. Counts of new rhizomes in Kentucky bluegrass plugs were recorded and seedhead counts from the field plots were taken.

The third experiment (Test 3) consisted of applying growth retardants to three highway median turf areas on U.S. Rt. 1 in Wakefield, R.I. on May 2, 1974. The bicycle sprayer was used to apply the treatments listed in Table 4. On

May 7, 1974, 2,4-D amine was applied to all plots except the MH + CF plots. The individual plots were 80 feet x 15 feet and replicated at each median (3 replicates). The area sampled from each plot was 280 sq. ft., cut at 10 cm. (4 in.) as in Test 1, approximately 7 and 14 weeks after treatment. Clippings were dried and weighed from each harvest. Seedhead counts were taken, also.

All data were statistically analyzed and evaluated using Duncan's multiple range test.

Results and Discussion

Test 1 - Mowed Turf

Results of visual ratings on density and color of turfgrasses treated with growth retardants indicate that supplemental nitrogen fertilization can be significant in reducing discoloration and thinning of turf while at the same time allowing the growth retarding chemicals to suppress top growth effectively (Table 1). Results of plots that were mowed seven weeks after

Table 1. Effects of growth retardants on a highway turf mixture treated May 1, 1973.

Treatment	Rate lb ai/A	Nitrogen lb N/M	Mowed turf: Clipping weight 7 wk	Clipping weight 11 wk	Clipping weight 15 wk	Clipping weight Accum. 20 wk	Accum. height 20 wk	Color 4 wk	Density 4 wk	Unmowed turf: Seedheads 11 wk	Clipping weight 11 wk
			(kg/ha)				(cm)	(0-10)[d]	(0-10)[d]	(no./m²)	(kg/ha)
Sustar	4	1	599 ef[a]	555 de	831 cd	2578 f	46 gh	7.7 de	7.3 d-f	129 b-d	1092 gh
Sustar	2-2[b]	1	679 d-f	526 e	871 bc	2670 ef	41 h	8.0 c-e	7.3 d-f	341 b	1168 gh
Sustar	1[c]	1	846 c-e	287 f	461 e	2005 g	52 ef	8.3 b-e	7.7 c-f	253 b-d	861 h
Sustar	.5	1	1263 b	574 de	670 d	3043 d-f	63 c	9.0 a-d	8.0 b-e	538 a	1631 d-g
MBR 12325	.375	1	444 f	718 cd	1016 a-c	2771 d-f	42 gh	7.3 e	6.3 e	155 b-d	985 gh
MH	5	1	621 ef	677 de	1052 ab	2970 d-f	48 fg	8.0 c-e	6.7 ef	222 b-d	1222 f-h
MH + CF	3+1	1	832 c-e	878 bc	997 a-c	3301 cd	48 fg	7.7 d-e	7.3 d-f	176 b-d	1491 e-h
Sustar + MH	2+3	1	649 d-f	731 cd	936 a-c	2909 d-f	47 fh	8.3 b-e	7.3 d-f	163 b-d	1292 f-h
Sustar + CF	2+1	1	752 de	605 de	855 c	2806 d-f	43 gh	7.3 e	7.3 d-f	323 bc	1346 e-h
Check	-	1	1328 b	507 e	855 c	3284 c-e	70 b	8.7 a-e	8.7 a-d	623 a	1868 c-f
Sustar	4	2	1093 bc	1148 a	999 a-c	3942 b	57 d-f	10.0 a	9.3 ab	120 b-d	2476 bc
MBR 12325	.375	2	765 de	1183 a	1093 a	3743 bc	55 de	9.3 a-c	6.3 e	75 d	2298 b-d
MH	5	2	920 cd	1158 a	1062 a	3843 bc	59 cd	9.7 ab	7.7 c-f	99 cd	2029 c-e
MH + CF	3+1	2	1279 b	1135 a	1101 a	4216 b	55 de	9.7 ab	9.0 a-c	88 d	2691 b
Check	-	2	1690 a	942 b	1074 a	5332 a	86 a	10.0 a	10.0 a	167 b-d	3375 a

[a] Values with a common letter within columns are not significantly different at the 5% level according to Duncan's multiple range test.

[b] Sustar applied at 2 lbs. on May 1 and May 30, 1973.

[c] Sustar applied every two weeks (10 applications).

[d] 0 = dead and 10 = best.

spraying showed that all growth retardants had significantly reduced top growth as compared to check plots (Table 1). MBR 12325 was particularly effective but there was some reduction in density of the turf. After eleven weeks, only the Sustar treatment at 1 lb. ai/A applied every two weeks showed a significant reduction in growth. At fifteen weeks the Sustar at 1 lb. ai/A and .5 lb. ai/A applied every two weeks showed a significant reduction in growth. Accumulated dry weights for the twenty week period showed that Sustar at 4 lb. and .5 lb. ai/A significantly reduced yields for the season at the lower fertility level and all growth retardants tested at the higher fertility

level also reduced yields significantly. All the chemicals significantly reduced accumulated heights for the twenty week period. It appears that growth retardants can be a practical method of suppressing top growth and seedhead production.

Test 1 - Unmowed Turf

At the low nitrogen level total seedhead production was significantly reduced by all growth retardants, except for Sustar at .5 lb. ai/A (Table 1). High nitrogen levels significantly reduced seedhead production as compared to low levels of nitrogen. Total dry weight at eleven weeks showed that Sustar at 4, 2 + 2, and 1 lb. ai/A significantly reduced growth at the low nitrogen level. Chemical treatments at the higher nitrogen level significantly reduced yields as compared to the high nitrogen check.

Test 2

Periodic harvesting of growth from turfgrass plugs showed that after seven weeks all the growth retardants had significantly reduced top growth of Kentucky bluegrass as compared to the check plots (Table 2). MH-treated

Table 2. Effects of growth retardants on turf plugs taken from field plots treated on May 2, 1974.

Treatment	Rate lb ai/A	Kentucky bluegrass				Red fescue			
		3 wk	5 wk	7 wk	9 wk	3 wk	5 wk	7 wk	9 wk
		Top growth (gm/plug)							
MH	5	5.8 mn[a]	8.5 j-m	8.7 i-m	15.6 g	8.3 lm	10.2 kl	13.8 h-j	19.6 ef
MH + CF	3+1	7.4 k-n	11.8 hi	16.9 fg	19.5 ef	10.7 j-l	11.3 jk	13.1 i-k	16.8 f-h
MBR 12325	.375	5.0 n	7.9 k-n	15.1 g	30.5 ab	8.5 lm	13.1 i-k	14.8 g-i	27.5 b
MBR 12325	.75	7.2 l-n	8.0 k-n	15.0 g	32.6 a	6.7 m	11.1 j-l	14.0 h-j	27.9 b
Sustar	4	8.8 i-m	8.7 i-m	16.6 fg	22.5 cd	9.8 k-m	10.6 j-l	17.8 f-g	17.9 fg
RO 7-6145	8	9.2 h-l	11.0 h-k	20.6 de	28.5 b	12.6 i-k	12.5 i-k	21.7 de	23.6 cd
RO 7-6145	16	8.3 j-m	10.1 h-l	17.3 fg	21.3 de	10.7 j-l	13.2 i-k	24.9 bc	23.8 cd
Check	-	11.4 h-j	12.2 h	25.1 c	31.8 a	10.5 j-l	14.8 g-i	19.7 ef	29.6 a
		Root growth (gm/plug)							
MH	5	0.0 m[a]	0.0 m	2.3 m	5.5 l	0.0 n	0.4 mn	3.8 j-m	22.2 fg
MH + CF	3+1	0.0 m	1.4 m	6.5 kl	14.4 hi	0.0 n	1.3 mn	6.4 j	15.4 h
MBR 12325	.375	2.4 m	6.6 kl	18.5 g	36.1 b	3.3 j-h	9.8 i	37.8 c	43.9 b
MBR 12325	.75	1.6 m	9.9 j	19.6 g	43.9 a	2.3 l-m	10.4 i	29.2 e	48.8 a
Sustar	4	0.0 m	1.3 m	8.1 jk	12.5 i	1.5 l-m	6.2 j	15.9 h	19.2 g
RO 7-6145	8	0.6 m	8.9 j	22.2 f	27.0 d	2.3 k-m	9.7 i	21.1 fg	34.1 d
RO 7-6145	16	0.2 m	5.5 l	14.2 hi	15.9 h	2.6 k-m	5.7 jk	21.0 fg	23.4 f
Check	-	1.8 m	15.0 h	24.6 e	31.0 c	4.3 j-l	14.1 h	21.5 fg	38.2 c

[a] Values with a common letter within species are not significantly different at the 5% level according to Duncan's Multiple Range Test.

turf showed the greatest reduction in top growth at this time. After nine weeks, all the growth retardants, except for MBR 12325, had significantly reduced top growth of Kentucky bluegrass. The results with red fescue were similar with MH, MH + CF, and Sustar showing the greatest reduction in top growth after nine weeks. Root growth was significantly reduced after nine weeks by all the growth retardants as compared to the check, except for MBR 12325, which significantly increased root growth in both turf species.

All chemical treatments significantly reduced rhizome production of Kentucky bluegrass after nine weeks with MBR 12325 at .375 lb. ai/A giving the least suppression (Table 3). All growth retardants significantly reduced seedhead numbers as shown by counts taken from the treated field plots.

Table 3. Effects of growth retardants on rhizome and seedhead production.

Treatment	Rate lb ai/A	Kentucky bluegrass rhizomes 3 wk	5 wk	7 wk	9 wk	Seedheads Ky. blue	Red fescue
		(Rhizomes/plug)				(No./m^2)	
MH	5	.9 k[a]	1.2 jk	1.9 i-k	3.3 d-h	18 b	251 f
MH + CF	3+1	1.2 jk	2.1 h-k	3.5 d-g	3.5 d-g	25 b	180 f
MBR 12325	.375	1.8 i-k	2.5 f-j	3.1 e-i	7.4 b	29 b	455 e
MBR 12325	.75	1.8 i-k	2.1 h-k	2.5 f-j	5.6 c	24 b	298 ef
Sustar	4	3.1 e-i	3.3 d-h	3.8 c-f	4.2 c-e	32 b	1120 c
RO 7-6145	8	2.6 f-i	3.1 e-i	3.7 c-g	4.2 c-e	29 b	2038 b
RO 7-6145	16	2.5 f-j	2.4 g-j	2.6 f-i	2.5 f-j	11 b	904 d
Check	-	2.4 g-j	3.7 c-g	4.6 cd	9.1 a	162 a	2655 a

[a] Values with a common letter within species are not significantly different at the 5% level according to Duncan's multiple range test.

Test 3

Studies on treated highway medians found that after seven weeks top growth was significantly reduced by all chemical treatments as compared to the check plots, except for plots where 2,4-D had been applied alone (Table 4). After fourteen weeks, all chemical treatments including 2,4-D

Table 4. Effects of growth retardants on highway median turf treated May 2, 1974.

Treatment	Rate lb ai/A	Top growth 7 wk	14 wk	Seedheads 7 wk
		(Kg/ha)		(No./m^2)
MH	5	59 c[a]	98 bc	178 d
MH + CF	3+1	68 c	88 bc	188 d
MBR 12325	.5	73 c	94 bc	186 d
Sustar	4	96 bc	75 c	398 c
RO 7-6145	8	95 bc	106 bc	385 c
2,4-D	1	178 ab	156 bc	723 b
Check	-	261 a	262 a	907 a

[a] Values with a common letter within factors are not significantly different at the 5% level according to Duncan's multiple range test.

alone had significantly reduced clipping weights. Total seedhead production was reduced by all chemicals as indicated by counts taken at seven weeks.

Literature Cited

1. Dore, A.T., R.C. Wakefield and J.A. Jagschitz. 1970. Effect of four growth retardants on Kentucky bluegrass and red fescue used for roadside turf. NEWSS Proc. 25:123-130.

2. Dore, A.T. and R.C. Wakefield. 1972. Chemical growth control of a highway turf mixture. NEWSS Proc. 26:224-231.

3. Engel, R.E. 1971. The effect of growth regulators on turfgrass species. NEWSS Proc. 25:131-140.

4. Wakefield, R.C. and A.J. Clapham. 1968. Management of turfgrass treated with Maleic hydrazide. Highway Research Record, National Academy of Sciences. Washington, D.C. pp. 36-43.

5. Wakefield, R.C. and A.T. Dore. 1973. Growth control for highway turf. Proc. of the Second International Turfgrass Research Conference.

Appendix

Growth retardants used in this study were as follows (companies supplying materials are noted):

1. MBR-12325-4-S. A diethanolamine salt formulated as a 4 lbs ai/gal. solution. Chemistry of material undisclosed. 3-M Company.

2. Maleic hydrazide (MH). Slo-Gro. 1,2-dyhydro-3, 6-pyridazinedione. 3 lbs. ai/gal. Uniroyal Chemical Company.

3. MH + CF refers to a combination of the following chemicals:

   a) Maleic hydrazide (MH). Maintain 3. 1,2-dyhydro-3, 6-pyridazinedione. 3 lbs. ai/gal. U.S. Borax & Chemical Corporation.

   b) Chlorflurenol (CF). Maintain CF-125. Methyl 2-chloro-9-hydroxy-fluorene-9-carboxylate -- 8.8%; Methyl-9-hydroxyfluorene-9-carboxylate -- 2.1%; Methyl 2,7 dichloro-9-hydroxyfluorene-9-carboxylate-- 1.6%. 1 lb. ai/gal. U.S. Borax & Chemical Company.

4. RO 7-6145. The water soluble sodium salt powder (80% ai). Chemistry of material undisclosed. HLR Sciences, Inc.

5. Sustar 2-S. A diethalomine salt of 3' - (Trifluoromethylsulfonamido)-p-acetotoluidide. 2 lbs. ai/gal. 3-M Company.

6. 2,4-D amine. Weedone 638. (2,4-dichlorophenoxy) acetic acid. 1 lb. ai/gal. AmChem Products, Inc.

CONTROL OF *ZOYSIA JAPONICA* 'MEYER' BY HERBICIDES

Dayton L. Klingman[1/]

ABSTRACT

Zoysia japonica becomes a problem when it spreads from the yard where it was planted to a yard that is growing cool-season lawn grasses. We killed all zoysia plants in small plots by spraying with *N*-(phosphonomethyl)glycine (glyphosate) at 2 and 4 lb/A as repeated treatments in June, July, and September 1973. Ratings were made in September 1974. One percent or less zoysia survived when we applied glyphosate at 4 lb/A at any one of the three dates. Dalapon (2,2-dichloropropionic acid), at 10 lb/A as repeated treatments in July and September, also killed all grass plants. Siduron [1-(2-methylcyclohexyl)-3-phenylurea], when applied at 20 and 40 lb/A in July in combination with glyphosate and paraquat (1,1-dimethyl-4,4-bipyridinium ion), provided no additional control over the use of the other herbicides alone. When siduron was applied alone, even as repeated treatments on three dates, it did not injure zoysia. Paraquat, at 2 lb/A as repeated treatments in June, July, and September in combination with a July treatment of siduron, left an average of 7 percent stand of zoysia in the plots. Glyphosate and dalapon are promising chemicals for renovation treatments where zoysia is the problem species. Glyphosate has an advantage over dalapon in that it has shorter residual time in the soil and it is not washed to adjoining untreated turf. These latter observations are based on other research not included in this experiment.

1/ Research Agronomist, Field Crops Laboratory, Beltsville Agricultural Research Center, U.S. Department of Agriculture, Beltsville, Maryland 20705.