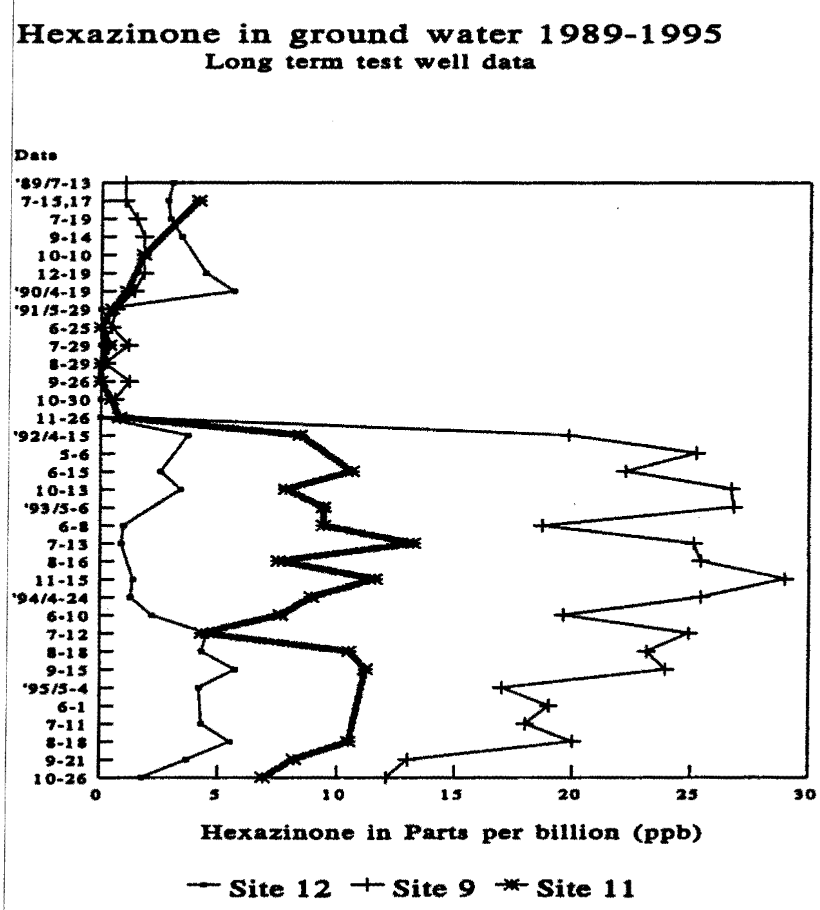
DEVELOPING BEST MANAGEMENT PRACTICES TO REDUCE HEXAZINONE IN GROUND WATER IN WILD BLUEBERRY FIELDS

D.E. Yarborough and J.J. Jemison[1]

ABSTRACT

Hexazinone is a preemergence herbicide used in wild blueberry fields since 1983 to suppress weeds and has been a contributing factor in increasing the wild blueberry threefold over the past 12 years. This herbicide is also highly soluble and has been detected in the groundwater in Maine. Best management practices have been developed to minimize the leaching this herbicide into ground water. Field trials have shown the effectiveness of reducing rates, delaying the timing of application and using a granular formulation in reducing the intrusion of hexazinone in the groundwater.



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MECHANICAL WEED CONTROL IN OATS WITH A ROTARY HOE AND TINE WEEDER

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ABSTRACT

Four weed management treatments were applied to oats in a randomized block design: 2,4-D, cultivation pre-emergence and at the 2-3 leaf stage with a rotary hoe, cultivation with a flex-tine weeding harrow at the same stages, and an untreated check. Cultivation controlled annual weeds more effectively than 2,4-D in one year, 2,4-D was more effective in one year, and the two approaches were about equal in a third year. The rotary hoe and tine weeder also varied in relative effectiveness. Cultivation reduced crop density in two of three years. Despite significant differences in weed control and crop density, oat yields varied little among treatments in all three years. Although integrated strategies might improve weed control, weed management efforts may have little economic benefit in this crop.

INTRODUCTION

Oats are grown on over 100,000 acres per year in New York state (8), making them about tied with wheat as the number two grain crop after corn. Sixty percent of this acreage is treated with 2,4-D, 10% with Bromoxynil or MCPA, and 30% is not treated for weeds (1). Because of possible risks associated with use of 2,4-D (3,4), determining the effectiveness of alternative weed control practices for oats is desirable.

Spike tooth harrows have been used to mechanically control weeds in small grain crops for many years. Recently, European manufacturers have developed improved harrow designs using flexible tines (tine weeders). Several investigations in Europe and elsewhere have found that these devices reduce weed density with little damage to small grain crops (9, 12, 13). Rasmussen (10) found a close correlation between weed control by harrowing and damage to small grain crops, and developed a model to explore these factors affected crop yield (11). Tine weeders have been tested in the United States for weed management in vegetable and row crops (2, 6, 14), but little work has evaluated their effectiveness in small grain production systems in the U.S.

Rotary hoes have long been used for early season weed control in row crops in the U. S. However, we have found no data on use of rotary hoes in small grains. This lack of research on rotary hoes in small grain crops may be the result of their rarity in Europe (J. Ascard, personal communication) where most research on mechanical weed control in small grains has occurred.

The study reported here compared weed biomass, oat stand and oat yield in four treatments differing only in weed control practice: (1) two operations with a rotary hoe, (2) two operations with a tine weeder, (3) 2,4-D applied at late tillering/early stem elongation, and (4) and untreated control.

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MATERIALS AND METHODS

Experiments were run in sections of oat production fields near Aurora, NY in 1992, 1994 and 1995. Consequently, all field operations other than cultivation were carried out as part of a typical production process. Experiment design was a randomized complete block with four replications of four treatments. Soil in all fields was a moderately well drained silt loam (fine-loamy, mixed, mesic Glossoboric Hapludalf). The oat variety was 'Ogle' in 1992 and 'Newdak' in 1994 and 1995. Fertilizer was banded at planting: 336 kg/ha of 15:15:15 in 1992, 280 kg/ha of 15:15:15 in 1994 and 183 kg/ha of 10:20:20 in 1995. Plots were 4.6 m by 30 m except for the 2,4-D treatment which was 9.2 m by 30 m to accommodate the sprayer. Due to wet weather, planting date was late in 1992, somewhat late in 1994, but typical for the region in 1995 (Table 1).

Table 1. Dates of field operations and data collection in 1992, 1994 and 1995.

	1992	1994	1995
Planting	8 May	28 Apr.	17 Apr.
First cultivation	16 May	3 May	24 Apr.
Second cultivation	23 May	20 May	9 May
Stand count	26 May	27 May	22 May
2,4-D application	16 June	10 June	19 May
Weed biomass	16-20 July	21-29 July	12-17 July
Harvest	9 Aug.	10 Aug.	7 Aug.

We cultivated with the tine weeder and rotary hoe before crop emergence and again at the 2-3 leaf stage (Table 1). In 1992 we used a John Deere series 400 rotary hoe, and in 1994 and 1995 an M&W Gear model 1815MT rotary hoe. The tine weeder was a Lely model 450 in all years. Driving speeds were 12 to 15 kmph for the rotary hoe, and 4 to 8 kmph for the tine weeder. Working depth was 2.5 to 4 cm in all operations. Dimethylamine salt of 2,4-D was applied at 0.54, 0.54 and 0.43 kg a.i./ha in 1992, 1994 and 1995 in 140 l/ha of water with a boom sprayer equipped with flat fan nozzles.

Crop density was evaluated 1 to 2 weeks after the second cultivation by counting oat plants in two randomly located 2 m sections of row in each plot (Table 1). Above ground weed biomass was determined in mid July (Table 1) by clipping four randomly located quadrats per plot. Quadrat size was 0.25 m^2 in 1992, but was increased to 0.5 m^2 in 1994 and 1995 when weed biomass was lower. Weeds were clipped near ground level and sorted into annual broadleafs, perennial broadleafs, annual graminoids and perennial graminoids. Broadleafs and graminoids were combined for reporting as this caused little loss of information. To avoid effects of trampling on yield, crop stand counts and weed biomass clipping avoided the central 2 m of each plot. We determined yield by harvesting the center 1.2 m strip with a plot combine. The grain received an additional cleaning, and yields were adjusted to 13.5% moisture for reporting.

All data were subjected to analysis of variance. Weed biomass data were transformed to logarithms prior to analysis to stabilize variance. We used predefined, single-degree-of-freedom orthogonal contrasts to separate treatment effects.

RESULTS AND DISCUSSION

Mechanical treatments significantly reduced biomass of annual weeds in 1992 relative to 2,4-D, and the tine weeder controlled weeds better than the rotary hoe (Table 2). In that year, late planting allowed emergence of a dense cohort of green foxtail (*Setaria viridis* (L.) Beauv.) synchronously with the crop, and this annual grass was not controlled by 2,4-D. In contrast, annual weeds were less with 2,4-D than with the mechanical treatments in 1995. In 1994, the rotary hoeing treatment had an annual weed biomass about equal to that with 2,4-D, and biomass in the tine weeder treatment was significantly higher than in the rotary hoeing treatment. Perennial weeds had lower biomass in the 2,4-D treatment than in mechanical treatments in 1992, but high variability obscured differences in the other two years.

Table 2. Weed biomass in mid-July, 1992, 1994 and 1995.

	1992		1994		1995	
	Annuals	Perennials	Annuals	Perennials	Annuals	Perennials
	g / m^2					
Rotary hoe	49	25	10	15	7	7
Tine weeder	24	23	14	32	7	9
2,4-D	62	14	11	12	3	10
Untreated check	51	23	16	31	5	8
Untreated v. others	N.S.	N.S.	*	N.S.	N.S.	N.S.
Mechanical v. 2,4-D	+	+	N.S.	N.S.	+	N.S.
Rotary hoe v. tine weeder	+	N.S.	+	N.S.	N.S.	N.S.

Statistical significance of orthogonal planned comparisons: +, $P < 0.1$; *, $P < 0.05$; N.S., $P > 0.1$

A Swedish study of tine weeding of oats (12) found greater reduction in weed biomass than we observed. In this study, many weeds survived cultivation because they had become sufficiently large to escape uprooting or burial by the time the crop was large enough to withstand the second cultivation. On the other hand, a substantial proportion of the weeds also escaped 2,4-D, because they were not susceptible species, because they were sheltered by the crop and other weeds, or because they emerged after application (e.g. common milkweed (*Asclepias syriaca* L.). Overall, the three years of data indicate that the rotary hoe and tine weeder were about equally effective. This result is interesting since (1) rotary hoes are rarely used for weed control in small grains, and (2) the rotary hoe runs 2 to 4 time faster than the tine weeder.

The mechanical treatments reduced oat density relative to 2,4-D in 1992, but not in the other two years (Table 3). Oat density was lower in the rotary hoe treatment than in the tine weeder treatment in 1994. These results are in accord with several previous studies indicating that crop damage tends to correlate with the degree of mechanical weed control in small grains (10, 12). The crop survived cultivation better in 1995 when it was planted at 4 cm than with the 2.5 to 3 cm planting depths used in the previous years.

Table 3. Stand density of oats after weed control treatments in 1992, 1994 and 1995.

	1992	1994	1995
	1,000,000's / ha		
Rotary hoe	1.53	1.81	2.00
Tine weeder	1.42	2.46	2.31
2,4-D	1.89	2.06	2.19
Untreated check	2.02	2.61	2.33
Untreated v. others	*	*	N.S.
Mechanical v. 2,4-D	*	N.S.	N.S.
Rotary hoe v. tine weeder	N.S.	*	N.S.

Statistical significance of orthogonal planned comparisons: * $P < 0.05$; N.S. $P > 0.1$

Oat yields did not differ among treatments in any year. Mean yields were 3,500, 3,800 and 3,500 kg/ha in 1992, 1994 and 1995, respectively. Apparently, the crop was sufficiently competitive to withstand even the moderately severe infestation of 1992, and sufficiently plastic to compensate for density reductions due to cultivation. In a Nebraska trial (7) oat yields were improved by herbicdes in only one year out of three. Other studies have similarly shown a lack of response or even a negative response of small grain yield to weed harrowing (9, 12, 13). This is probably related to the inverse relation between weed control and crop survival noted above. An integrated approach in which planting density is increased when using cultivation might help the crop quickly achieve a full canopy despite damage. That in turn could allow some additional yield through either additional capture of resources or competitive suppression of the weeds (5). However, unless the field is quite weedy, the yield increment may be too small to pay for either mechanical or chemical control measures. In the Northeastern U. S., where small grains constitute a relatively small proportion of the crop mix, a better strategy may be to concentrate weed control measures on the preceding row crop, plant into a relatively clean field, and forgo chemical and mechanical measures on the small grain crop.

ACKNOWLEDGEMENTS

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TOLERANCE OF FINE FESCUES TO CLETHODIM

Larry J. Kuhns And Tracey L. Harpster[1]

ABSTRACT

In past studies it was found that fine fescues were immune to the effects of two of the most commonly used graminicides, fluazifop-p-butyl and sethoxydim. This study was initiated to determine the tolerance of three fine fescues; chewings (*Festuca rubra* spp. *commutata* Gaud.-Beaup.), hard (*Festuca longifolia* Thuill.), and creeping red (*Festuca rubra* L.); to clethodim alone or with a crop oil concentrate (COC) or a non-ionic surfactant (NIS)[2]. The treatments presented in Table 1 were applied on October 23, 1995. The percent green cover was rated on May 22 and July 9, 1996. The treatments presented in Table 2 were applied on May 31, 1996 and were evaluated on July 9, 1996. All treatments were applied with a CO_2 pressurized test plot sprayer at 30 psi through an 8004E nozzle at 22 GPA. A randomized complete block design with three replications per treatment and species was used.

Applied in the fall at 0.25 lb/a alone or with NIS, clethodim had little effect on chewings or creeping red fescue (Table 1). With hard fescue, some injury was evident on May 22, but it recovered by July 9. The addition of COC resulted in moderate injury to all three species, with only partial recovery by July 9. Severe injury of all species from clethodim applied at 1 lb/a was evident on May 22. The amount of recovery that occurred by July 9 was dependent on the spray additive used. With none, all of the grasses recovered fairly well. With NIS, moderate injury to hard fescue persisted; and with COC, unacceptable injury to all species persisted.

Similar results were obtained when the treatments were applied in the spring (Table 2). The 0.25 lb/a rate caused slight injury, regardless of additive. The 1.0 lb/a rate caused severe injury, with treatments including COC injuring hard fescue slightly worse than those including NIS. The 0.5 lb/a rate caused an intermediate degree of injury.

None of the clethodim treatments totally killed any of the fine fescues. However, unacceptable injury was caused by the 0.5 and 1.0 lb/a rates, regardless of additive, and by the 0.25 lb/a + COC treatment. Injured turf was invaded by broadleaved weeds and was lower quality even after recovering from initial injury.

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Table 1. Differences between ratings of percent green cover on chewings, hard, and creeping red fescues taken prior to application on October 23, 1995; and when rated on May 22 and July 6, 1996.

Chemical	Rate (lbs/A)	Differences in % Green Cover[1/] Chewings 5/22	Chewings 7/9	Hard 5/22	Hard 7/9	Creeping Red 5/22	Creeping Red 7/9
Control		10 a	13 a	23 a	33 a	22 a	27 a
Clethodim	0.25	10 a	23 a	3 b	26 a	0 ab	13 a
Clethodim +NIS (0.25%)	0.25	-3 a	10 a	-8 bc	17 ab	-5 ab	10 ab
Clethodim + COC (1.0%)	0.25	-30 b	-15 ab	-23 c	20 a	-12 b	5 ab
Clethodim	1.0	-68 c	0 ab	-53 d	6 ab	-53 c	8 ab
Clethodim + NIS (0.25%)	1.0	-63 c	-7 ab	-62 d	-28 c	-58 c	4 ab
Clethodim +COC (1.0%)	1.0	-86 c	-33 b	-65 d	-15 bc	-75 c	-18 b

[1/] Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

Table 2. Percent green cover in chewings, hard, and creeping red fescues treated on May 31 and evaluated on July 9, 1996.

Chemical	Rate (lb/A)	% Green Cover[1/] Chewings	Hard	Creeping Red
Control		90 a	95 a	93 a
Clethodim + NIS(0.5%)	0.25	70 a	85 ab	83 b
Clethodim + NIS(0.5%)	0.5	40 b	75 abc	67 c
Clethodim + NIS(0.5%)	1.0	38 b	55 c	60 cd
Clethodim + COC (1.0%)	0.25	73 a	78 abc	80 b
Clethodim + COC (1.0%)	0.5	72 a	62 bc	62 cd
Clethodim + COC (1.0%)	1.0	30 b	30 d	58 d

[1/] Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

CONTROLLING QUACKGRASS WITH CLETHODIM

Larry J. Kuhns and Tracey L. Harpster[1]

ABSTRACT

The objective of this study was to determine the optimum conditions under which to apply clethodim to achieve control of quackgrass (*Elytrigia repens* (L.) Nevski). Clethodim was applied at 0.125 or 0.188 lb/a in the morning and evening, with or without ammonium sulfate. Clethodim was applied in combination with sethoxydim, each at 0.094 lb/a, in the morning and evening. Sethoxydim was applied alone at 0.188 lb/a in the morning and evening for comparison. All treatments included crop oil concentrate at 1% v/v. They were applied to a mix of perennial grasses including quackgrass on May 20, 1996. The quackgrass was 10-18 inches tall. A randomized complete block design with four replications was established. Treatments were applied with a CO_2 powered test plot sprayer with an 8004E nozzle, at 30 psi, in 45 GPA. Morning applications were made between 9:00 and 10:00 AM; evening applications between 8:00 and 8:30 PM. Percent quackgrass stand reduction was rated on July 8 and August 23.

By July 8, all of the treatments had caused a significant reduction in the amount of quackgrass (Table 1). However, no consistent differences occurred between any of the variables. When the average of all AM treatments were compared to PM treatments, there were no differences. The only distinctive difference was sethoxydim applied in the PM was more effective than when applied in the AM. The addition of ammonium sulfate caused faster decline of the quackgrass, but did not result in increased stand reduction. The combination of low rates of clethodim and sethoxydim was as effective as any other treatment.

By August 23, the quackgrass had regrown and there was no difference between any of the treatments and the control. These treatments should have been applied several weeks earlier when the quackgrass was smaller, and a repeat application would be necessary for more thorough control.

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Table 1. Treatments were applied May 20 between 9:00 and 10:00 AM or 8:00 and 8:30 PM. All treatments contained 1% crop oil concentrate. Percent quackgrass stand reduction was rated on July 8, seven weeks after treatment.

Chemical	Rate / Acre	% Stand Reduction[1/]
Control		3 e
Clethodim (AM)	0.125	59 cd
Clethodim (AM)	0.188	62 bcd
Clethodim (AM) + Ammonium Sulfate	0.125	85 ab
Clethodim (AM) + Ammonium Sulfate	0.188	64 bcd
Clethodim (PM)	0.125	61 cd
Clethodim (PM)	0.188	74 abc
Clethodim (PM) + Ammonium Sulfate	0.125	69 abcd
Clethodim (PM) + Ammonium Sulfate	0.188	88 a
Clethodim (AM)	0.094	73 abc
+ Sethoxydim	0.094	
Clethodim (PM)	0.094	85 ab
+ Sethoxydim	0.094	
Sethoxydim (AM)	0.188	49 d
Sethoxydim (PM)	0.188	88 a

1/ Means followed by the same letter, do not differ at the 5% level of significance (DMRT).

BELTSVILLE SUSTAINABLE AGRICULTURE RESEARCH FOR FIELD AND VEGETABLE CROPS

C. Benjamin Coffman and John R. Teasdale[1]

ABSTRACT

The Beltsville Sustainable Agriculture Research Program began in the fall of 1992 with the creation of the Field Crops Demonstration Project. This research/demonstration project was developed to evaluate reduced tillage systems for sustaining productive soils on erodible land while minimizing environmental degradation. Plots ca 0.13 ha are located on a 6 ha site having 2 to 15% slopes. Each treatment follows a 2-yr rotation of corn-wheat-soybean and includes 1) no-tillage with recommended synthetic fertilizers and herbicides, 2) no-tillage with recommended synthetic fertilizers and herbicides and a crownvetch (*Coronilla varia* L.) living mulch, 3) no-tillage with winter annual cover crops such as hairy vetch (*Vicia villosa* Roth) before corn (*Zea mays* L.) and wheat (*Triticum aestivum* L) before soybean [*Glycine max* (L.) Merr.], with reduced fertilizer and herbicide inputs, and 4) chisel plowed organic system using animal and plant manures and mechanical weed management.

In 1992 the Sustainable Vegetable Production Research Project was established to develop management practices for summer and fall vegetables. Conventional practices including synthetic fertilizers and plastic mulches are compared with cover crops and reduced synthetic inputs. Cover crops for summer vegetables include hairy vetch, crimson clover (*Trifolium incarnatum* L.), and rye (*Secale cereale* L.), with forage soybean and German millet [*Setaria italica* (L.)] cover crops for winter vegetables.

The Farming Systems Project was established on 16 ha at Beltsville in 1993 with an objective to investigate the effects of long-term alternative crop production systems on biological, environmental, and economic aspects of field crop production. After 3-yr of uniformity trials field plots were established in 1996. A short-term goal is to investigate the transition effect of change from conventional methods to farming systems that differ in crop diversity, weed management, and nutrient source strategies. Systems presently being studied include cash grain rotations with varying length and intensity using synthetic fertilizers, fresh and composted manures, and green manure.

Component projects include 1) studies of the feasibility of using farm, municiple, and industrial byproducts as soil amendments, 2) in-depth investigations of composting variables, and 3) comparison of an ARS developed strain of *Bradyrhizobium* with conventional strains of rhizobia for soybean production.

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SOIL SOLARIZATION AS A WEED MANAGEMENT TOOL IN NEW ENGLAND

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ABSTRACT

Soil solarization may fit into a few specific "niches" in crop production in New England, despite the fact that our soil temperatures and sunlight levels are generally lower than those in the parts of the world in which solarization is regularly practiced. Experiments were conducted over a five-year period to determine the suitability of soil solarization as a tool for weed management in Massachusetts. Maximum soil temperature recorded at a 0.5-inch depth was 142 F, at one inch 127 F, at two inches 125 F, and at three inches 118 F. Weed seedling emergence from soils taken from solarized plots varied, but was significantly lower than in non-solarized plots in all but one experiment. This reduction in emergence was found to persist to the following spring. Some weed emergence occurred, however, in nearly all samples taken from solarized soil. Inhibition of shoot growth of Canada thistle (*Cirsium arvense* (L.)Scop.) was found in one trial, but plot areas were quickly reinvaded by rhizomes from outside the plot area the following season. Solarization has potential to reduce weed emergence from the top layer of soil, but is not likely to reliably produce the control rates needed to avoid crop losses due to weed interference. However, soil solarization may be useful in reducing seed banks or in serving as an adjunct to other weed management methods for growers with weed problems which are difficult to control in other ways.

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The 1996 NEWSS Collegiate Weed Contest

W. S. Curran, D. D. Lingenfelter, E. L. Werner, and D. T. Messersmith[1]

ABSTRACT

The Northeastern Weed Science Society (NEWSS) Collegiate Weed Contest was hosted by Penn State University this year. This was the 14th annual collegiate weed contest for the NEWSS. The contest took place on August 29 and 30th in State College, Pennsylvania and at the Penn State University Agronomy Farm, near Rock Springs. This year, 21 undergraduates and 28 graduate students from seven universities competed as individuals and as teams. This year's winners included:

Undergraduate Teams
1st place - SUNY, Cobleskill - Art Graves, Scott Jackson, and Matt Cooper
2nd place - NC State - Mary Thurman and Todd Rowe
3rd place - University of Guelph - Shane Diebold, Mark Brock, and Mario Poirier
Graduate Teams
1st place - Michigan State University - Brent Tharp, Jason Fausey, Kelly Nelson, and Christy Sprague
2nd place - North Carolina State University - John Isgrigg, Jimmy Summerland, and Chad Kalaher
3rd place - North Carolina State University - Rick Blum, Brian Horgan, and Paul Garvey
Undergraduate Individuals
1st place - Mark Brock, University of Guelph
2nd place - Wendy Brownell, University of Guelph
3rd place - Todd Rowe, North Carolina State University
Graduate Individuals
1st place - John Isgrigg, North Carolina State University
2nd place - Dan Posten, Virginia Tech
3rd place - Christy Sprague, Michigan State University

The individuals that helped with this year's weed contest included the following:
1996 Weed Contest Committee:
Curran, Bill, PSU; Bean, Ted, Valent; Dutt, Tim, Monsanto; Gover, Art, PSU; Hartwig, Nathan, PSU; Hoffman, Lynn, PSU; Kuhns, Larry, PSU; Lingenfelter, Dwight, PSU; Mayonado, David, Monsanto; Messersmith, David, PSU; Schnappinger, Gary, Ciba; Watschke, Tom, PSU; Werner, Ed, PSU.
1996 Weed Contest Assistants:
Binford, Greg, Pioneer; Bowersox, Randy, PSU; Cain, Nancy, Ontario Ministry of Transportation; Chow, Franklin, Bayer; Craig, Paul, PSU; Dennis, Steve, Zeneca; Ellenberger, John, Agway; Flanagan, John, Ciba; Frey, Travis, PSU; Gerhart, Duane, Agway; Grecos, Jeff, PSU; Hall, Marvin, PSU; Harkcom, Scott, PSU; Harpster, Tracey, PSU; Harrison, Scott, PSU; Hatley, Elwood, PSU; Hinz, John, West Virginia; Hockensmith, Ryan, PSU; Inhoff, George, PSU; Kallenbach, Kathy, PSU; Kiesewetter, Dawn, PSU; Kirk, Bob, Ciba; Kuhns, Mike, Monsanto; Levkulich, Chris, PSU; Neal, Joe, NC State; Orzolek, Mike, PSU; Overdorff, Don, PSU; Rebarchak, Paul, PSU; Rogers, Gerald, PSU; Roth, Greg, PSU; Thomas, Gar, Sandoz; Vance, Jeff, Monsanto; Voight, Del, PSU; Vrabel, Tom, Rhone Poulenc; Weaver, Stephan, PSU.
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HERBICIDE ACTIVITY ON FIELD HORSETAIL AND OTHER WEEDS

Todd L. Mervosh[1]

ABSTRACT

An experiment was conducted at the Valley Laboratory in Windsor, CT to evaluate several herbicides for control of field horsetail (*Equisetum arvense* L.) and other weeds in a field that, after being idle for several years, was disked in August 1994 and April 1995. By August 1995, the field contained a dense and uniform population of field horsetail along with the following weeds: annual grasses [large crabgrass {*Digitaria sanguinalis* (L.) Scop.} and fall panicum (*Panicum dichotomiflorum* Michx.)], an annual sedge (*Cyperus sp.*), common purslane (*Portulaca oleracea* L.), redroot pigweed (*Amaranthus retroflexus* L.), and evening primrose (*Oenothera biennis* L.). The soil was a fine sandy loam with 4% organic matter and pH 5.6. The experiment was conducted in a randomized complete block design with four replications and a plot size of 5 ft by 12 ft. Herbicide treatments, supplemented with X-77 surfactant (0.5%), were applied on August 9, 1995 in a volume of 25 gal/A at 34 psi. Field horsetail was 6 to 8 inches tall at the time of treatment.

Few treatments provided long-term control of field horsetail. Bentazon (1.5 lb ai/A), oxyfluorfen (1 lb ai/A), sulfentrazone (0.5 lb ai/A), and halosulfuron (0.094 lb ai/A) had little or no effect on horsetail. Paraquat (1 lb ai/A), glufosinate (1.5 lb ai/A), 2,4-D ester (1.5 lb ae/A), and triclopyr (1 lb ae/A) burned down emerged horsetail, but new horsetail shoots emerged unaffected the following spring. By 3 weeks after treatment, glyphosate (3 lb ai/A) reduced horsetail vigor about 80%, and new shoots in 1996 were suppressed to a similar extent. Effects of asulam (5 lb ai/A) on horsetail were not apparent until the spring when new growth was suppressed initially by 85%. Sulfometuron (0.094 lb ai/A) activity on weeds was slow to develop, but no vegetation emerged in plots treated with sulfometuron until July 1996, at which time horsetail and annual grasses began to reinvade from the plot margins. Dichlobenil granules (6 lb ai/A), which were applied on March 28, 1996, prevented emergence of horsetail and all other weeds except grasses through August.

Glyphosate, glufosinate, and paraquat provided excellent postemergence control of all other weeds, except paraquat did not control common purslane. In contrast, bentazon did not control any weeds other than annual sedge. Emerged annual sedge was also controlled by sulfentrazone and suppressed by sulfometuron and halosulfuron. Dichlobenil and sulfometuron provided the best residual control of annual sedge, followed by halosulfuron and sulfentrazone. Emerged annual grasses were suppressed by asulam, oxyfluorfen, and sulfometuron. Pigweed was controlled by triclopyr, 2,4-D, sulfometuron, and sulfentrazone; these same herbicides and oxyfluorfen suppressed purslane. All treatments, except bentazon and oxyfluorfen, controlled evening primrose.

In general, sulfometuron and dichlobenil resulted in the best residual control of field horsetail and most other weeds.

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EFFECT OF PREPLANT TILLAGE AND NICOSULFURON ON WIRESTEM MUHLY CONTROL IN CORN

D. D. Lingenfelter and W. S. Curran[1]

ABSTRACT

Wirestem muhly (Muhlenbergia frondosa (Poir.) Fernald) is a warm season, perennial grass species that is becoming a problem in conservation tillage systems. Effective programs currently do not exist for managing wirestem muhly in reduced-tillage corn. Therefore, the following research was designed to evaluate preplant tillage with and without nicosulfuron for wirestem muhly control in corn (Zea mays L.).

In 1994 and 1995, field studies were conducted in central Pennsylvania at locations with established wirestem muhly populations. Spring primary preplant tillage treatments were moldboard plow, chisel plow, heavy disk, and no-till. Secondary tillage was performed where necessary to obtain an appropriate seedbed. Corn was planted in mid to late May and followed with a burndown/PRE treatment for annual weed control. Nicosulfuron at 0.031 lb ai/A plus 0.25% v/v nonionic surfactant was applied postemergence when wirestem muhly was 12 to 18 inches tall and corn was less than 24 inches tall (V4-V5 stage). A split-plot design with three replications was used in this study. The herbicide was applied with a CO_2-backpack sprayer that delivered 20 gpa.

End of season results from the study showed that nicosulfuron in combination with moldboard plow, chisel plow, or heavy disk treatments provided greater than 92% control of wirestem muhly. Moldboard plow, chisel plow, and disk without a POST treatment were less effective, only providing 45 to 60% control. The year following tillage and herbicide application, wirestem muhly control ranged from 89 to 98% for all tillage systems that included nicosulfuron. Tillage treatments without the POST herbicide provided less than 45% control. In general, control in treatments that included nicosulfuron was better than for treatments without the herbicide.

In 1994, corn grain yield was 80 bu/A for no-till without nicosulfuron and 90 bu/A with the herbicide treatment. All other treatments, except chisel plow and no POST herbicide, yielded 100 to 117 bu/A. Corn yields from the 1995 season, a drought year, ranged from 51 to 75 bu/A. None of the combination treatments differed.

In summary, these results show that wirestem muhly can be more effectively managed when a combination of control measures are used. In general, spring primary tillage followed by an application of nicosulfuron was more effective than tillage or herbicide alone. Corn yield was not greatly affected by the presence of wirestem muhly, although competitive indices for wirestem muhly in corn have not yet been studied or established. For areas where tillage is not feasible, nicosulfuron will suppress the wirestem muhly until additional control measures can be accomplished in other crops (e.g., soybeans).

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FOMESAFEN IN SNAP BEAN

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ABSTRACT

Fomesafen controls numerous annual broadleaf weeds in soybean [Glycine max (L.) Merr.] and has been effective in snap bean (Phaseolus vulgaris L.) without causing crop injury. However, in previous studies in Virginia, snap bean did not recover from acifluorfen, another diphenylether herbicide, POST. These studies were conducted to determine if fomesafen would control broadleaf weeds in snap bean without causing lingering crop response or adversely affecting snap bean yield. Research was conducted on spring- and fall-planted snap bean in 1995 and 1996. Following conventional land preparation, snap bean were planted and metolachlor was applied preemergence at 1.0 lb ai/A to all plots. In the fall of 1996, one study was conducted in snap bean planted no-till in wheat stubble. In this study metolachlor (1.0 lb/A) plus clomazone (0.15 lb ai/A) was applied PRE. Fomesafen was applied POST to snap bean that were in the 2 to 3 trifoliate-leaf stage and to seedling weeds that were generally 1-in tall or less. In the no-till study, weed control was high so fomesafen was applied to blooming snap bean approximately 2 w prior to harvest to evaluate crop response. Fomesafen rates varied somewhat with study but were repeatedly between 0.19 lb ai/A and 0.38 lb/A with some studies containing rates above or below these. All fomesafen treatments included a non-ionic surfact at 0.25% v/v in the spray mix. Fomesafen controlled weeds at rates of 0.12 and above with generally no differences between rates. Weed species controlled were common lambsquarters (Chenopodium album L.), smooth pigweed (Amaranthus hybridus L.) wild radish (Raphanus raphanistrum L.), jimsonweed (Datura stramonium L.) and morningglory species (Ipomoea spp.). Although some initial crop response was generally observed, injury was low and recovery was rapid in all instances. Snap bean yields were high in these studies and yields of snap bean treated with fomesafen were always comparable to or higher than the metolachlor or metolachlor plus clomazone standard. It is concluded that fomesafen can be used to control broadleaf weeds in snap bean at rates as low as 0.12 lb/A and will not reduce snap bean yield or quality.

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PENNMULCH, A NEW MULCH FOR TURFGRASS ESTABLISHMENT

G. W. Hamilton, J. S. Gregos, and L. P. Tredway

ABSTRACT

Mulches are used in turfgrass establishment to decrease the germination time, support uniform seedling development, and decrease the potential for soil erosion. A new pelletized paper mulch developed at Penn State University utilizes recycled paper as a base and is pelletized to provide easy application and handling. This mulch contains a 1-3-1 starter fertilizer and is weed free. Field and greenhouse experiments were conducted to evaluate the effects of various rates of pelletized paper mulch and straw mulch on the establishment of Kentucky bluegrass. 'Merit' Kentucky bluegrass was established on a silt loam soil and seeded at 122 kg/ha. Three rates of straw were included in the test, each with and without starter fertilizer to provide a total of six treatments. The fertilizer rates were equivalent to that provided in the pelletized paper mulch treatments. Volunteer oat seedlings were counted in both field and greenhouse studies. Data was subjected to analysis of variance and treatment means were separated using Fishers Protected LSD test. The pelletized paper provided similar mulching effects to that of straw with significantly lower oat seedling counts.

EFFICACY RATINGS FOR FIELD CORN HERBICIDES: A NATIONAL SUMMARY

L. P. Gianessi and M. B. Marcelli[1]

ABSTRACT

The National Center for Food and Agricultural Policy (NCFAP) created a national database, compiling 1996 data from 28 weed control guides for field corn (*Zea mays*). Herbicide performance in weed control for field corn was summarized for 42 states. Mean, standard deviation, minimum and maximum were calculated for the efficacy of a total of 78 treatments applied to 87 weed species across the U. S. The 78 treatments included applications of herbicides alone or in combination using different methods of application. Each treatment average shows the rating for a specific weed, herbicide and application method in the U. S. as a whole; minimum and maximum show the variations among states. This variation in weed control might result from differences in: planting time, timing of weed emergence, precipitation, temperature, soil, etc., affecting herbicide performance in different states.

Introduction

Each year, state extension services release weed control guides for field crops. These guides are meant to inform the states' growers of the range of choices available to control specific weeds for each crop. The guides also advise growers on the expected performance of available herbicide treatments to control specific weeds in each crop in the state. The weed control guides provide information on newly registered herbicides, new combination products and any changes in performance of the available treatments.

In 1996, weed control guides for field crops were contained in 28 reports issued by state cooperative extension services. Twenty-four of the weed control guides are specific for an individual state. Four of the weed control guides cover more than one state: Pacific Northwest (three states), New England (six states), Mid-Atlantic (six states) and one report for Montana, Utah and Wyoming. Thus, the 28 reports cover 42 states. (The six coterminous states not covered by an annual state weed control recommendation report are Oklahoma, Texas, Nevada, Arizona, New Mexico and Louisiana.) Three reports

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cover the states in the Northeast (1), (2), (3). In addition to the New England and Mid-Atlantic reports, that cover 12 northeastern states, Cornell University issues a separate set of recommendations covering New York.

One common feature of the 28 field crop recommendation reports is a table that rates the effectiveness of individual herbicide treatments in controlling specific weed species in field corn. The efficacy rating for a particular herbicide treatment to control a specific weed species is developed by extension specialists based on experimental work and the experiences of farmers in the state.

Generally, the rating tables include five broad categories of control effectiveness: none, poor, fair, good and excellent. These ratings are associated with a range of percent control of the weed species. For example, a common range for a "good" rating is 80-90% control. In some of the reports the ratings tables contain numerical entries of 0-10 that correspond to percent controls of 0% to 100%. The ratings tables group herbicide treatments according to their timing: preplant incorporated (ppi), pre-emergence (pre) or postemergence (pos). An individual herbicide treatment can be listed in more than one of these categories, as appropriate. In most cases, ratings are published for individual herbicide products. Products that contain the same active ingredient(s) are rated generally as a single entry (such as Partner, Lasso, Microtech). In some cases, the rating tables include tank-mix combinations of several products. None of the ratings tables contain any non-chemical techniques for weed species control in field corn.

Methods

As part of a project to develop a national corn weed control model, the National Center for Food and Agricultural Policy (NCFAP) has created a database that contains all of the individual weed control ratings for field corn from the 28 Extension Service reports. A single data record in the NCFAP file contains an individual rating from an Extension Service report that is specific by herbicide application method and weed species. The names of the products have been standardized in terms of active ingredient names. In cases where an Extension Service report includes products with different active ingredients on the same rating line, NCFAP created separate lines of data for the different active ingredients. (Thus, a single rating for "Dual, Microtech or Frontier" means separate records for metolachlor, alachlor and dimethenamid.)

The individual ratings have been translated into numerical entries, based on the midpoint of the range for the control category. (A rating of "good" with an associated range of 80-90% control has been entered as 85% in the database.) Each record includes an identification of the timing of the treatment as POS, PRE or PPI.

In all, NCFAP entered 11,427 individual records from the 28 weed control ratings tables for field corn. Each line of data in the NCFAP database includes a reference code that identifies the individual report from which it has been drawn.

The NCFAP database contains control ratings for 87 weed species, whose names have been standardized. The NCFAP database contains ratings for 78 individual herbicide treatments that are specific according to active ingredients and timing. In all, the NCFAP database contains 2,927 treatment ratings, that are specific to active ingredients and weed species. The NCFAP corn weed control efficacy database is summarized in a report that includes a diskette copy of the entire database (4). The efficacy database was analyzed using the SAS system to generate descriptive statistics, such as number of observations, mean, maximum, minimum and standard deviation.

Results

Table 1 summarizes the weed control efficacy ratings for common ragweed for nine single postemergence active ingredients. Table 1 represents nine of the records of the 2927 treatment ratings from the national database. As can be seen, not all state reports rate all possible control methods. While 20 to 21 reports include common ragweed control ratings for atrazine and dicamba, only 7 to 12 reports include similar ratings for flumiclorac, halosulfuron or clopyralid. There is a considerable range in the efficacy ratings for individual active ingredients. For example, common ragweed control ratings for bentazon range from 50% to 95%. No statistical analysis has yet been performed to determine whether there are patterns with regard to the discrepancies.

Discussion

The 28 reports that include ratings of the control efficacies of corn herbicides represent a major source of systematically-organized information that synthesizes research results with expected field performance. The control ratings provide a valuable source of information to farmers, crop consultants and regulatory agencies who need to assess the relative performance of individual products in the design of control programs or in the establishment of restrictions on use. Regulatory agencies need to consider the relative performance of products that may serve as replacements if a currently-used active ingredient is restricted or banned. There are real differences in the way that products perform in different regions of the country as a result of soil type, precipitation, temperature, planting times, weed emergence times and/or type of tillage operation. Analysis of the national weed efficacy control database over time may indicate trends in reduced efficacy resulting from resistance development. The efficacy database may indicate improved effectiveness on certain weed control because of new products or new combinations of products, or the expanded use of existing products on newly developed resistant crops.

TABLE 1

CORN WEED CONTROL EFFICACIES (SELECTED)

Active Ingredient	Timing	Weed Species	No. of Obs.	% Control Min.	% Control Max.	% Control Avg.	Stand. Dev.
2,4-D	POS	Common Ragweed	19	62	95	88	8.12
Atrazine	POS	Common Ragweed	21	80	95	91	4.54
Bentazon	POS	Common Ragweed	16	50	95	75	11.69
Bromoxynil	POS	Common Ragweed	19	60	95	85	11.09
Clopyralid	POS	Common Ragweed	7	80	95	89	4.50
Dicamba	POS	Common Ragweed	20	80	100	89	6.06
Flumiclorac	POS	Common Ragweed	12	40	90	71	16.42
Halosulfuron	POS	Common Ragweed	12	80	95	89	5.23
Primisulfuron	POS	Common Ragweed	16	80	95	89	5.31

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THE NATIONAL FIELD CORN HERBICIDE BENEFIT ASSESSMENT MODEL: RATIONALE AND APPLICATIONS IN THE NORTHEAST REGION

L. P. Gianessi and M. B. Marcelli[1]

ABSTRACT

Considerable dissatisfaction exists with currently-used methods of estimating the aggregate benefits of pesticide use. Typically, aggregate benefits estimates rely only on expert opinion of likely yield losses if a currently-used pesticide is withdrawn or banned. Such estimates are poorly documented, non-replicable, difficult to modify, divergent, and prejudicial. Some possible solutions to this problem include: 1) EPA's proposed comparative product performance testing requirements, or 2) the elimination of benefits calculations entirely. Another solution is the development of biologic and economic models and databases that would enable policymakers and regulators to calculate quickly and more accurately the impacts on yields and costs of a potential regulation or policy.

The National Center for Food and Agricultural Policy (NCFAP) has begun a project to assemble the databases and computer routines necessary to estimate the aggregate costs of pesticide regulatory policies. The NCFAP project is based on a benefits methodology developed at the University of Georgia. The system integrates State-specific databases delineating pest infestations, the potential yield losses of uncontrolled pests, and the control efficacies of chemical and non-chemical alternatives.

Alternatives to currently-used pesticides are compared based on efficacy of controlling pests and product and application costs. The model calculates and compares the aggregate costs and pest control benefits of each alternative. The model is easily modified to expand the set of available alternatives to include experimental compounds and non-chemical controls. The database is updated regularly with new prices and products. The results are for currently available alternatives.

NCFAP has assembled state-by-state databases delineating weed species infestations in field corn (*Zea mays*). These infestation estimates are based on a survey of extension service weed scientists, who also provided estimates of potential corn yield losses if the weed species were uncontrolled. NCFAP has computerized all of the weed control ratings for field corn herbicides as published in twenty-eight 1996 state extension service recommendations reports.

The NCFAP model has been used to calculate the yield and herbicide expenditure changes likely to result if atrazine were unavailable for field corn use in the Northeast. These impacts are directly traceable to differences in effectiveness of control of important weed species and average prices of herbicide alternatives. The model's estimates of yield impacts for northeastern states have been compared to expert opinion yield loss estimates provided in the past by university weed scientists.

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COMMON LAMBSQUARTERS CONTROL IN CORN

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ABSTRACT

Two field experiments were conducted in 1996 to evaluate the effectiveness of various herbicides for common lambsquarters control (*Chenopodium album* L.) in corn (*Zea mays* L.). The PRE study was designed to evaluate weed control without triazines. The POST study was designed to evaluate effectiveness of non-volatile herbicides. Common ragweed (*Ambrosia artemisiifolia* L.) density was high in experimental areas and was also rated. The studies were conducted at the University of Delaware's Research and Education Center on sandy loam soils. Both studies were planted on May 15, 1996 with corn hybrid 'Pioneer 3394'. The plots were four rows wide (30 inch rows) and 25 feet long. All treatments were applied broadcast with a backpack sprayer at 29 psi, delivering 25 gpa. The treatments were arranged as a randomized complete block design with three replications.

Preemergence study. All soil-applied herbicides were applied on May 20 and POST treatments on June 12. The treatments are listed in Table 1. None of the treatments resulted in crop injury. Broadstrike+Dual and Prowl were the only soil-applied herbicides that provided effective common lambsquarters control at 7 weeks after planting. All treatments with a POST application provided excellent common lambsquarters control. Common ragweed control was not commercially acceptable with any soil-applied herbicide except Prowl plus Topnotch. All treatments with a POST application provided excellent common ragweed control. Yield was reduced with all soil-applied herbicides applied alone. Yield with either Frontier or Micro Tech plus Permit plus Banvel was reduced due to poor weed control prior to the POST herbicide application.

Postemergence study. The second study examined POST herbicides, all applied on June 7, when the crop was at the fourth collar stage (7 leaves) and 11 inches tall. Treatments are listed in Table 2. Treatments containing Tough showed more injury than other treatments. Common lambsquarters control was highest for Buctril alone and in combination with Permit or Exceed; Tough alone or in combination with Exceed; or Pinnacle. Banvel and 2,4-D also provided excellent common lambsquarters control. Most treatments provided excellent common ragweed control. Pinnacle, Tough alone, and 2,4-D did not provide the same level of common ragweed control as the other treatments.

There are alternatives to volatile and triazine herbicides for use alone or in combination to provide effective common lambsquarters or common ragweed control. However, except for Prowl, these treatments are not as cost-effective as Banvel, 2,4-D, or triazines.

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Table 1. Preemergence common lambsquarters and common ragweed control without triazines, rated 7 weeks after planting, and grain yield.

Treatments	Rate	Timings	CHEAL	AMBEL	Yield
	lb ai/A		--------- % control	---------	bu/A
Broadstrike+Dual	1.68	PRE	100	60	147
Frontier	0.82	PRE	10	50	121
Surpass	1.0	PRE	50	70	143
Topnotch	1.6	PRE	62	73	144
Micro Tech	1.6	PRE	17	17	93
Prowl	1.5	PRE	100	0	115
Frontier Permit Banvel	0.82 0.016 0.125	PRE POST POST	90	100	141
Surpass Permit Banvel	1.0 0.016 0.125	PRE POST POST	93	100	156
Topnotch Permit Banvel	1.6 0.016 0.125	PRE POST POST	94	100	168
Micro Tech Permit Banvel	1.6 0.016 0.125	PRE POST POST	91	100	149
Prowl Permit Banvel	1.5 0.016 0.125	PRE POST POST	92	96	168
Prowl Topnotch	1.5 1.36	PRE PRE	100	80	146
Weedy check			0	0	38
LSD (0.05)			15	20	18

Table 2. Effectiveness of non-volatile herbicides for common lambsquarters and ragweed control, rated 4 weeks after treatment, and grain yield. Crop injury was rated 1 week after treatment.

Treatments[1]	Rate	Crop Injury	CHEAL	AMBEL	Yield
	lb ai/A	----- % -----	--------- % control	---------	-- bu/A --
2,4-D	0.25	8	97	90	111
Banvel	0.125	6	100	100	125
Broadstrike Plus	0.17	10	88	100	106
Broadstrike Plus	0.086	6	83	100	131
Pinnacle	0.004	8	100	75	125
Pinnacle	0.002	5	99	47	86
Scorpion III	0.21	5	100	100	117
Beacon	0.018	3	63	100	113
Buctril	0.25	6	100	99	136
Tough	0.9	12	100	88	125
Exceed	0.027	3	88	100	116
Exceed	0.018	2	75	100	122
Permit	0.032	6	23	100	66
Permit	0.016	3	10	100	88
Exceed + Buctril	0.027 + 0.125	8	100	100	130
Exceed + Tough	0.027 + 0.45	25	99	100	125
Exceed + Tough	0.018 + 0.45	13	99	100	116
Permit + Buctril	0.032 + 0.125	8	98	100	122
Permit + Buctril	0.016 + 0.125	7	97	100	138
Permit + Tough	0.032 + 0.45	11	77	100	126
Permit + Tough	0.032 + 0.45	12	70	100	101
LSD (0.05)		7	12	6	32

[1]All treatments included a non-ionic surfactant at 0.25% v/v.

ANNUAL WEED CONTROL WITH EXP 3113OA IN 1995 AND 1996 UNDER NO-TILLAGE SYSTEM IN CORN

P. C. Bhowmik and R. G. Prostak[1]

ABSTRACT

Field experiments were conducted in 1995 and 1996 to determine the effectiveness of EXP 31130A in controlling annual grass and broadleaf weeds in field corn under a no-tillage system. In 1995, EXP 31130A was evaluated alone at 1.5, 1.88, 2.25 and 3.0 oz ai/A and in combinations at 1.5 and 2.25 oz ai/A with either acetochlor or metolachlor at 1.0 lb/A. Large crabgrass (Digitaria sanguinalis L. Scop.), yellow foxtail [Setaria lutescens (Weigel) Hubb.], fall panicum (Panicum dichotomiflorum Michx.), common lambquarters (Chenopodium album L.) and horseweed [Conyza canadensis (L.) Cronq.] were present at the study site. In 1996, EXP 31130A was evaluated alone at 1.5 and 1.88 oz ai/A and in combinations with 1.0 and 1.5 lb/A of acetochlor and with 1.25 and 1.88 lb/A of metolachlor. Glyphosate at 1.5 lb/A was applied over the entire area prior to no-till planting. Large crabgrass, yellow foxtail, common lambquarters, redroot pigweed (Amaranthus retroflexus L.), galinsoga (Galinsoga parviflora Cav.), and common ragweed (Ambrosia artemisiifolia L.) were present. Plots were 6.7' by 20' and the treatments were replicated three times in a randomized complete block design. With a no-till planter 'Ciba 4385' corn (Zea mays L.) was planted on May 9, 1995 and 'Max 747' was planted on May 20, 1996. Treatments were applied preemergence, using a CO_2-backpack sprayer that delivered 20 gpa at 22 psi. Corn height was determined 5 and 9 WAT (weeks after treatment). Weed control was estimated on a scale of 0 to 100% 2, 4 and 8 WAT in 1995 and 3, 7, and 14 WAT in 1996. Silage and grain yields were also determined.

In 1995, no corn injury was observed with any of the EXP 31130A treatments. All treatments effectively controlled yellow foxtail, large crabgrass, fall panicum, lambquarters, pigweed and horseweed 2, 4 and 6 WAT. EXP 31130A treatments either alone or in combinations without atrazine did not control sulfur cinquefoil (Potentilla recta L.). All treatments effectively controlled common chickweed [Stellaria media (L.) Vill.] 2 WAT. In 1996, EXP 31130A at 1.5 and 1.88 oz ai/A or in combinations with either acetochlor at 1.0 and 1.5 lb/A, or with metolachlor at 1.25 and 1.88 lb/A, or with atrazine at 1.25 and 2.0 lb/A controlled large crabgrass, yellow foxtail, common lambsquarters, redroot pigweed, common ragweed, galinsoga effectively 3, 7, and 14 WAT. The 1.5 oz/A rate of EXP 31130A provided only over 70% control of common ragweed.

EXP 31130A alone at 1.5 to 3.0 oz/A resulted in corn grain yields from 51 to 132 bu/A in 1995 and 105 to 117 bu/A in 1996, and silage yields from 9 to 21 ton/A in 1995 and 17 to 20 ton/A in 1996. The highest grain yields (178 to 206 bu/A) and silage yields (28 to 32 ton/A) were obtained from atrazine combinations with either metolachlor or acetochlor, while the highest grain yield (160 bu/A) and silage yield (26 tons/A) were obtained with the treatment combinations of EXP 31130A, metolachlor and atrazine at 1.5 oz/A, 1.25 and 1.25 lb/A.

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PERFORMANCE OF PREEMERGENCE TREATMENTS OF EXP 3113OA IN WEED CONTROL IN CONVENTIONAL TILLAGE CORN

P. C. Bhowmik, R. G. Prostak and M. K. Swarcewicz[1]

ABSTRACT

Two field experiments were conducted at the University of Massachusetts Research Station in South Deerfield, Massachusetts to evaluate the effectiveness of EXP 31130A in controlling annual grass and broadleaf weeds in conventional tillage corn (Zea mays L.). EXP 31130A was evaluated alone at 1.13, 1.5 and 1.88 oz ai/A and in combination with acetochlor, atrazine, and metolachlor. Treatments of atrazine, metolachlor, and atrazine in combination with acetochlor, alachlor and metolachlor were included to represent commercial standards. Plots were 7.5 by 20 ft. and replicated three times in a randomized complete block design. 'Max 747' corn was planted on May 14, 1996. Treatments were applied on May 15, 1996 using a CO_2-backpack sprayer that delivered 20 gpa at 22 psi. Control of yellow foxtail [Setaria lutescens (Weigel) Hubb.], large crabgrass [Digitaria sanguinalis (L.) Scop.], common lambquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), and common ragweed (Ambrosia artemisiifolia L.) were estimated on a scale of 0 to 100% (0 = no control and 100% = complete control) 2, 4, 8, and 15 weeks after treatment (WAT). Corn injury, silage and grain yields were determined.

All treatments provided excellent corn safety. EXP 31130A alone and in combination with acetochlor, atrazine, and metolachlor controlled large crabgrass, common lambquarters and redroot pigweed effectively up to 15 WAT. All treatments, with the exception of metolachlor at 2.0 lb ai/A, resulted in excellent common ragweed control. EXP 31130A at 1.13, 1.5 and 1.88 oz/A controlled yellow foxtail 60, 53, and 63% 4 WAT, while the same treatments gave only 38, 40, and 55% control 8 WAT. In the second experiment, the same rates of EXP 31130A provide a similar degree of yellow foxtail control. EXP 31130A alone gave poor yellow foxtail control (25% or less) 15 WAT, whereas EXP 31130A when combined with any of the acetamide treatments provided season long control.

Silage yields from EXP 31130A treatments ranged from 7.5 to 17 ton/A and were significantly less than all other treatments (23 to 30 ton/A) with the exception of metolachlor at 2.0 lb ai/A. Grain yields from EXP 31130A (38 to 100 bu/A) were also less than all other treatments (151 to 200 bu/A), with the exception of metolachlor at 2.0 lb ai/A. Yield reductions from EXP 31130A treatments were due to poor yellow foxtail control. Both grain and silage yields of corn resulting from EXP 31130A combination treatments were comparable to commercial standard treatment and hand cultivation.

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METRIBUZIN COMBINATIONS FOR POSTEMERGENCE VELVETLEAF CONTROL IN FIELD CORN

Russell R. Hahn[1]

ABSTRACT

Field experiments were conducted in 1993, 1994, and 1996 to compare postemergence herbicides alone and in combination with 1.5 oz ai/A metribuzin for velvetleaf (*Abutilon theophrasti* Medicus) control in field corn (*Zea mays* L.). Herbicides were applied to 10-by 25-ft plots using 80015 flat spray tips in 25 gpa of spray solution in 1993 and 1994 and using 8002 flat spray tips in 22 gpa of spray solution in 1996. Other annual weeds were controlled with preemergence applications of metolachlor at 1.5 or 2 lb ai/A. A randomized complete block design with four replications was used for each experiment.

Experiments in 1993 and 1994, in Columbia and Livingston counties respectively, compared 0.25 lb ai/A of bromoxynil, 0.25 lb ae/A of 2,4-D amine or 2,4-D ester, and 0.25 lb ai of dicamba alone and with metribuzin. Treatments were applied early postemergence (EPO) when velvetleaf was in the 2-to 4-leaf stage both years and mid-postemergence (MPO) when velvetleaf was in the 4- to 6-leaf stage in 1994. The metribuzin combinations provided better velvetleaf control than the other herbicides applied alone in both years. Velvetleaf control with bromoxynil averaged 83% for the two years while the combination with metribuzin improved control to 97%. The addition of metribuzin increased control from 17 to 89% for 2,4-D amine applied EPO. The 2,4-D ester and dicamba provided 63 and 59% control when applied alone and 95 and 94% control respectively when applied with metribuzin. MPO applications of bromoxynil or 2,4-D ester in combination with metribuzin did not provide better velvetleaf control than when applied alone. The addition of metribuzin increased control from 50 to 85% and from 65 to 96% with 2,4-D amine and dicamba respectively when applied MPO.

In 1996 at the Livingston county site, EPO (cotyledon to 2-leaf velvetleaf) application of 0.25 lb/A of 2,4-D ester alone and with metribuzin resulted in 65 and 75% velvetleaf control respectively compared with 86 and 99% control for EPO applications of 0.5 lb/A of dicamba or 1.5 lb ai/A of pendimethalin plus 1 lb ai/A of atrazine respectively. MPO (4- to 6-leaf velvetleaf) application of 0.25 lb/A of bromoxynil alone and with metribuzin controlled 87 and 97% of the velvetleaf respectively. MPO application of 0.25 lb/A of dicamba controlled 57% of the velvetleaf while the combination with metribuzin controlled 97% of the velvetleaf. Little or no corn injury was observed in the three experiments previously discussed, however, there was significant injury for some of the metribuzin combinations in Columbia County when applied at the V4 stage of corn in 1996. The combination of 0.25 lb/A of bromoxynil with metribuzin caused 20% stunting and 10% chlorosis when evaluated 9 days after treatment. The combination of 0.25 lb/A of dicamba plus metribuzin caused 7% stunting but no chlorosis.

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EFFECT OF TANK-MIXING BASIS WITH POAST ON SETHOXYDIM RESISTANT CORN

Bradley A. Majek[1]

ABSTRACT

Three sethoxydim resistant corn varieties, Asgrow RV 620, Dekalb DK 592, and Cargill 4450 were treated early postemergence with Poast Plus tank-mixed with Basis, or 2,4-D. The Poast Plus treatments were also compared to more traditional treatments that did not include Poast Plus. All herbicides were applied at rates that were consistent with the label and recommendations for corn growers in the mid atlantic states. Preemergence applications of Topnotch, and postemergence applications of Laddock, Marksman, and Accent did not cause corn injury. 2,4-D applied postemergence caused slight but significant injury to all corn varieties. The injury caused by the 2,4-D was typical epinastic response occasionally observed one to two weeks after application. Sethoxydim injury was not observed on any of the resistant corn varieties when Poast Plus was added to any of the previously discussed herbicide treatments. Border rows separating the plots were planted with a normal variety that was not sethoxydim resistant. The lower leaves of the variety that was not sethoxydim resistant in the border rows were sprayed and the plants exhibited moderate sethoxydim injury. Tank-mixing Basis with Poast Plus applied early postemergence caused injury to the three sethoxydim resistant corn varieties. Symptoms included stunting, whitening of new leaves, and some twisting and buggy whipping of new growth. The injury was similar to the injury observed on the variety that was not sethoxydim resistant and received a directed application of Poast Plus in the border rows. Further research is needed to investigate the interaction observed between sethoxydim and rimsulfuron and/or thifensulfuron, the two components of Basis. Additionally, the possibility of interactions with other sulfonyl urea herbicides needs to be pursued.

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FIRST YEAR'S IMPRESSIONS OF WEED CONTROL IN TRANSGENIC CROPS

M.J. VanGessel, Q. Johnson, and M. Isaacs[1]

ABSTRACT

The weed science program at the University of Delaware had a number of trials with glufosinate-resistant corn (*Zea mays* L.) and soybeans [*Glycine max* (L.) Merr.] and glyphosate-resistant soybeans. This was the first opportunity for a new weed scientist to examine this technology. Glufosinate- and glyphosate-resistant crops were evaluated for effectiveness of annual weed control.

Glufosinate was compatible with ten different POST corn herbicides, representing triazines, ALS-inhibiting herbicides, and benzoics. Although, in this study, glufosinate alone was as effective as any tank-mixture.

Glufosinate appears to hve a wide window of application. Application to corn resulted in similar results when applied to 8 or 14 inch corn. Although, as expected, higher rates (> 0.2 lbs ai/A) were needed for later applications to obtain highest level of control.

A trial compared the effectiveness of glufosinate and glyphosate applied at various timings for weed control and yield loss potential. Glufosinate and glyphosate applications to their respective transgenic soybean varieties, provided good to excellent control of common ragweed (*Ambrosia artemisiifolia* L.), jimsonweed (*Datura stramonium* L.), common lambsquarters (*Chenopodium album* L.), and fall panicum (*Panicum dichotomiflorum* Michx.) when applied from the first to fifth trifoliolate soybean stages.

Glufosinate- and glyphosate-resistant crops will provide a new and effective approach to weed management. This technology relies on many integrated weed management principles, but as such, requires additional management on part of the growers.

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EVALUATION OF WEED CONTROL AND CROP TOLERANCE WITH POSTEMERGENCE HERBICIDES IN SETHOXYDIM-TOLERANT CORN

J. E. Ashley, Jr., and E. S. Hagood, Jr.[1]

ABSTRACT

Field experiments were conducted in 1995 and 1996 at four locations to evaluate strategies for the use of sethoxydim-tolerant hybrids in Virginia corn production. The specific objectives of this research were to evaluate sethoxydim-based herbicide programs for the control of bermudagrass (*Cynodon dactylon* L.) in corn, to evaluate similar programs for annual grass and broadleaf weed control, and to evaluate the response of sethoxydim-tolerant hybrids to either broadcast or directed applications of sethoxydim, fluazifop-P, clethodim, or quizalofop. All experiments were conducted using a randomized complete block design with four replications. Individual plots consisted of 4 corn rows 7.6 m in length in which the two inner rows received treatment and the outer rows served as borders. All herbicide applications were made with a CO_2-pressurized backpack sprayer delivering 210 L/ha of water at 220 kPa using flat fan spray tips. The dependent variables evaluated included crop response to herbicide treatments, weed control by species, corn stand, and corn yield. All data were subjected to analysis of variance and appropriate mean separation techniques at the 0.05 significance level.

Excellent bermudagrass control was obtained from broadcast or directed applications of sethoxydim, fluazifop-P, quizalofop, clethodim, and fluazifop-P plus fenoxaprop. Broadcast applications of fluazifop-P and both broadcast and directed applications of clethodim caused significant crop injury, however. Combinations of sethoxydim with bentazon, bentazon plus atrazine, flumiclorac, and halosulfuron resulted in reduced bermudagrass control relative to that control afforded by sethoxydim alone. In experiments to evaluate control of annual species including smooth pigweed (*Amaranthus hybridus* L.), common lambsquarters (*Chenopodium album* L.), giant foxtail (*Setaria faberi* Herrm.), ivyleaf morningglory (*Ipomoea hederacea* L. Jacq.), jimsonweed (*Datura stramonium* L.), large crabgrass (*Digitaria sanguinalis* L. Scop.), and a perennial, yellow nutsedge (*Cyperus esculentus* L.), excellent broad spectrum weed control was achieved with sethoxydim in combination with bentazon, bentazon plus atrazine, nicosulfuron, or primisulfuron. Crop tolerance to these treatments was excellent. In experiments to evaluate sethoxydim-tolerant hybrids and susceptibility to graminicides, no rate of sethoxydim caused significant injury to any hybrid tested. Tolerance of these hybrids to 1x rates of fluazifop-P and quizalofop was also demonstrated, although higher rates (4x and 8x) caused significant injury. Clethodim at all rates of application caused significant crop injury. Differential responses to graminicides among hybrids were noted.

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RIMSULFURON/THIFENSULFURON ACTIVITY IN NO-TILL CORN

P. A. KALNAY AND S. GLENN[1]

ABSTRACT

Giant foxtail (*Setaria faberi*), common lambsquarters (*Chenopodium album*), and hemp dogbane (*Apocynum cannabinum*) control in no-till corn (*Zea mays*) following POST applications of a package mix of rimsulfuron/thifensulfuron alone or in combination with various herbicides were studied in Western Maryland. Experiments were designed as a randomized complete block with 3 replications and a plot size of 6 rows (30 inches) by 35 feet. Postemergence treatments were applied when giant foxtail and common lambsquarters were 2 to 4 inches high and hemp dogbane was 6 to 20 inches high. In 1995 and 1996, giant foxtail control ranged from 82 to 85% and 75 to 80%, respectively 8 weeks after treatment (WAT) with rimsulfuron/thifensulfuron (0.016 and 0.031 lbs /A) applied alone. Giant foxtail that was not controlled with POST applications of rimsulfuron/thifensulfuron emerged after applications. Lower giant foxtail control in 1996 compared to 1995 was due to greater emergence of the grass after POST applications in 1996 than 1995. Applications of rimsulfuron/thifensulfuron alone completely controlled lambsquarters (100%) 8 WAT, but hemp dogbane control was poor (27 to 33%). Tank mixtures of primisulfuron, halosulfuron, or primisulfuron/prosulfuron with 0.016 lbs/A rimsulfuron/ thifensulfuron produced similar giant foxtail (65 to 82%) and lambsquarters control (100%), but poor hemp dogbane control (30 to 47%). Tank mixtures of 0.016 lbs/A rimsufuron/thifensulfuron with 0.125 and 0.25 lbs/A dicamba controlled giant foxtail (75 and 77%) and lambsquarters (100%), but combinations with 0.5 lbs/A dicamba reduced giant foxtail control (63%). All dicamba combinations with rimsulfuron/thifensulfuron improved hemp dogbane control compared to rimsulfuron/thifensulfuron applied alone. Hemp dogbane control following combinations with 0.0125, 0.25, and 0.5 lbs/A dicamba was 68, 83, and 80%, respectively. Postemergence applications of rimsulfuron/thifensulfuron effectively controlled giant foxtail and lambsquarters, but combinations with dicamba were required to control the perennial broadleaf weed, hemp dogbane.

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EFFECTS OF EXP 3113OA AND FOE 5043 ON WEED CONTROL AND CORN YIELD

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ABSTRACT

Three field experiments were conducted at the Agronomy Research Farm, South Deerfield to study the effects of EXP 31130A and FOE 5043 on weed control and corn (Zea mays L.) in 1996. EXP 31130A at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 oz ai/A and FOE 5034 0.25, 0.5, 0.75, 1.0, 1.25 and 1.5 lb/A were examined separately in randomized complete block design. The split plot design had two growth stages of herbicide application (PRE and POST at the 1- to 2-leaf stage of corn) as main plots, and treatment combinations of EXP 31130A at 1.0, 1.5 and 2.0 oz/A and FOE 5043 at 8, 12 and 16 oz/A and a premix combination of atrazine + metolachlor at 2.5 lb/A as sub-plots. Treatments were replicated three times in all experiments. Weed counts were taken 3, 6 and 9 weeks after treatment (WAT) and weed dry weights were determined 3, 6, 9, and 12 WAT. Weed control was estimated on a scale of 0 to 100, where 0=no control and 100=100% control, at 8, 9, 12, and 15 WAT. Silage and grain yields of corn were determined.

EXP 31130A at 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 oz/A controlled large crabgrass [Digitaria sanguinalis (L.) Scop.] and common lambsquarter (Chenopodium album L.) over 95%. This was reflected by the reduction of weed number and weed dry weights. The 3.0 oz/A rate of EXP 31130A controlled yellow foxtail [Setaria lutescens (Weigel) Hubb.] only over 70% 8 WAT with reduced control later in the season. None of the EXP 31130A treatments resulted in silage or grain yields comparable to that of the cultivated check (23.3 ton/A and 143.3 bu/A).

In second experiment, FOE 5034 at 0.5, 0.75, 1.0, 1.25 and 1.5 lb/A gave over 95% control of yellow foxtail and large crabgrass. FOE 5043 at 0.75 to 1.5 lb/A controlled common lambsquarter over 85% throughout the entire season. All FOE 5043 treatments except the 0.25 lb/A resulted in corn silage and grain yields comparable to that of the cultivated check (26.7 ton/A and 167 bu/A).

In third experiment, all treatment combinations of EXP 31130A and FOE 5043, regardless of the timing of application, resulted in over 95% control of large crabgrass and common lambsquarter. All treatment combinations whether applied PRE or at the 1- to 2-leaf stage controlled yellow foxtail over 80%. However, yellow foxtail control was reduced later in the season. Atrazine + metolachlor combination treatment gave better yellow foxtail control when applied at the 1- to 2-leaf stage compared to the PRE application. Regardless of the timing of application, all treatment combinations resulted in corn silage and grain yields comparable to that of the cultivated check (27.6 ton/A and 182.1 bu/A).

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EVALUATION OF HERBICIDE PROGRAMS FOR MUGWORT CONTROL IN CORN

M.Y. Day, E.S. Hagood, Jr., and S.M. Johnson[1]

ABSTRACT

Field experiments were conducted in 1995 and 1996 in Westmoreland County, Virginia to evaluate herbicide programs for the control of mugwort (*Artemisia vulgaris* L.) in field corn (*Zea mays* L.). All experiments were conducted using a randomized complete block design with four replications on a Leaf silt loam soil of pH 6.2 and 1.5% organic matter content. Corn ('Pioneer 3163') was planted in 76-cm rows at approximately 48,900 seeds/ha on May 8, 1995 and May 25, 1996. Individual plots consisted of 4 corn rows 7.6 m in length, where the inner two rows received treatment and the outer rows served as borders. Herbicide applications were made with a CO_2-pressurized backpack sprayer delivering 210 L/ha of water at 220 kPa using flat fan spray tips. In both experiments, the effects of two primary independent variables, herbicide treatment and application timing, were evaluated. Herbicide application timings included preemergence to corn, early postemergence (5-6 leaf corn), and late postemergence (10-15 leaf corn). Mugwort heights in 1995 and 1996 were 5-15 and 5-10 cm, 20-25 and 15-20 cm, and 30-45 and 20-25 cm for preemergence, early postemergence, and late postemergence application timings, respectively. Herbicide treatments included 2,4-D, clopyralid, flumetsulam plus clopyralid, 2,4-D plus clopyralid, and 2,4-D plus clopyralid plus flumetsulam. One rate of 2,4-D was used, while varying rates of clopyralid and/or flumetsulam were evaluated. Dependent variables evaluated included crop response, mugwort control, and corn yield. All data were subjected to appropriate analysis of variance and mean separation at the 0.05 significance level.

No herbicide treatment caused a significant reduction in corn vigor in either 1995 or 1996. Mugwort control was highly dependent on herbicide treatment, rate, and timing of application. No treatment which did not contain clopyralid afforded greater than 58% mugwort control in either year. Among clopyralid containing treatments, mugwort control varied as a function of clopyralid rate and timing of application. Neither the addition of 2,4-D nor flumetsulam to clopyralid provided greater mugwort control than the control observed with clopyralid alone. In 1995, applications of clopyralid made at the early postemergence timing provided significantly greater control than applications made at the earlier or later timing, where the 0.15 kg/ha rate afforded approximately 70% control and the 0.30 kg/ha rate approximately 85% control. In 1996, clopyralid applications made at the late postemergence timing provided significantly greater mugwort control than that observed with earlier applications, where rates of 0.15 and 0.30 kg/ha again provided approximately 70 and 85% control, respectively. In both studies, the timing of optimum susceptibility occurred when mugwort was 20-25 cm in height. No significant effects of herbicide treatments on corn stand were observed, and corn yield varied as a function of mugwort control.

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Effect of POST Application Timing of Five Herbicides on Burcucumber Control in Corn.

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ABSTRACT

Burcucumber (Sicyos angulatus L.) is becoming an increasingly difficult to control weed in agronomic crops throughout the Northeast. Several new postemergence corn (Zea mays L.) herbicides may be effective on burcucumber, however specific data on burcucumber control is lacking.

A postemergence timing study was conducted on established populations of burcucumber in corn at two Pennsylvania locations in 1995 and again in 1996. Prosulfuron, primisulfuron, halosulfuron, and flumichlorac were applied at a single rate (0.036, 0.036, 0.063, and 0.040 lb ai/A respectively) and two postemergence timings. A prosulfuron + primisulfuron treatment (0.036 lb ai/A) was added to the study in 1996. Crop oil concentrate was included with all treatments at 1.0% (v/v) except flumichlorac which received non-ionic surfactant at 0.25% (v/v). Treatments were applied 10 to 14 days apart either early postemergence to 3-leaf corn and cotyledonary to 2-leaf burcucumber or late postemergence to 6-leaf corn and 5-leaf burcucumber. Individual plot size measured 10 by 25 feet, and treatments were arranged in a randomized complete block design with 4 replications. Parameters measured included burcucumber density, visual estimates of burcucumber control, and burcucumber biomass production.

Burcucumber emergence started in early May and continued through mid-August each year in the untreated plots. Early June burcucumber density across all locations ranged from 0 to 1 plant/square foot and averaged 0.35 plants/square foot. Regardless of June burcucumber density, untreated plots were over run with burcucumber by late season. Prosulfuron provided 98 and 96% control of burcucumber in 1995 and 1996, respectively. Control with primisulfuron was 85% in 1995 and 93% in 1996, and differences between prosulfuron and primisulfuron were seldom significant. Burcucumber biomass production in the prosulfuron and primisulfuron treatments was not different in either year. The prosulfuron + primisulfuron combination was similar to either product alone. Flumichlorac and halosulfuron were ineffective at providing season long control of burcucumber in both years of the study. The late postemergence treatments appeared to provide better late season control of burcucumber, especially in 1996, although the differences were not significant. This study suggests that prosulfuron, primisulfuron, and prosulfuron + primisulfuron can be effective for managing burcucumber in corn. However, more research is needed to identify optimum postemergence application timing.

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GLUFOSINATE-AMMONIUM HERBICIDE UPDATE FOR CORN IN THE NORTHEAST

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ABSTRACT

Glufosinate-ammonium is a non-selective, postemergence herbicide currently being developed for the management and control of grass and broadleaf weeds in agricultural and specialty crops. Glufosinate-ammonium is the synthetic equivalent to a naturally occurring compound, phosphinothricin, which is a metabolite of the soil bacteria Streptomyces viridochromogenes. In the target plant, glufosinate-ammonium binds irreversibly to glutamine synthetase, an enzyme located in the chloroplasts and cytoplasm. Glutamine synthetase is involved in the conversion of glutamate plus ammonia into useful glutamine, which is an important step in the nitrogen assimilation process. By inhibiting glutamine synthetase, ammonia accumulates within plant tissues, and is accompanied by a decrease in amino acid levels. Exposure to high levels of ammonia is toxic to plants, which results in damage to plant cell structure and function. The photosynthesis process also is inhibited as a result of glutamine synthetase inhibition in the plant by glufosinate-ammonium.

Recent advances in plant genetics and biotechnology have resulted in the ability of desired plants and food and fiber crops to gain resistance to glufosinate-ammonium. The gene responsible for establishing resistance to glufosinate-ammonium was discovered in the early 1980s. Since then, AgrEvo USA Company has pioneered the effort to develop glufosinate-ammonium resistant corn, soybeans, and other crops. Due to the non-selective, broad spectrum weed control properties of glufosinate-ammonium, the compound is suitable for use in crops specifically developed with resistance to the herbicide.

The effectiveness of glufosinate-ammonium to control a wide range of grass and broadleaf weeds has been demonstrated in field trials throughout the Northeast and Midwest USA. In previously reported experiments, genetically engineered corn and soybean plants exhibited resistance to postemergence treatments of glufosinate-ammonium applied at $\leq$ 1500 g ai ha^{-1}. In efficacy field trials during the 1994 to 1996 growing seasons with glufosinate-ammonium resistant corn, postemergence treatments of the herbicide applied at 250 to 400 g ai ha^{-1} were effective. Successful weed management and control results in corn also were observed when glufosinate-ammonium was applied in conjunction with preemergence herbicides, and when applying glufosinate-ammonium alone or tank-mixed with current postemergence herbicides. The development of crops with resistance to glufosinate-ammonium represents an opportunity for the herbicide to be utilized as an additional weed management tool for use in corn, and eventually in soybeans and other food and fiber crops.

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PREEMERGENCE CONTROL OF SMOOTH CRABGRASS IN 1996

T. L. Watschke and J. A. Borger[1]

ABSTRACT

Twenty-six preemergence herbicide treatments were applied to a mixed stand of cool season turfgrasses at the Landscape Management Research Center, University Park, PA. As several treatments were applied using fertilizer as a carrier, all treatments regardless of carrier were maintained at the same nitrogen fertility level. Date of application was April 25 and 26, May 2, and June 8 for sequential treatments. Germination of crabgrass was first observed on May 13. Sprayed applications were made using a hand held CO_2 boom sprayer with 6504 nozzles at 30 psi calibrated to deliver 80 gpa. Granular formulations were applied using a shaker jar. Irrigation was applied after application (approximately 0.5 inch) and at various times during the course of the study to maintain the turf free of dormancy. Crabgrass control was rated on August 20, 1996. No phytotoxicity was observed during the course of the study. S-6617 at a product rate of 109.3 lbs/A applied sequentially, S-6619 at a product rate of 109.3 lbs/A applied sequentially, oxadiazon at a rate of 3 lbs ai/A, pendimethalin on Scott's 22-0-6, pendimethalin on 18-5-9 at a rate of 2 lbs ai/A, prodiamine 65WG at rates of 0.48, 0.65, and 0.75 lbs ai/A, prodiamine at an initial rate of 0.5 followed by 0.25 eight weeks later, prodiamine at a rate of 0.65 and 0.75 lbs ai/A on fertilizer, prodiamine at a rate of 0.5, 0.65, and 0.75 on Lebanon fertilizer, dithiopyr 1 EC at a rate of 0.18, 0.25, and 0.38, AD 443 and AD 445 at rates of dithiopyr of 0.18 and 0.25, respectively, all provided at least 90% control of smooth crabgrass which was considered to be commercially acceptable. Several of the above materials were applied at lower rates and at lower rates sequentially; however, in all cases, control of smooth crabgrass was not found to be acceptable. Dithiopyr on fertilizer did have control rated at 88 and 89% for rates of 0.06 and 0.09 lbs ai/A, respectively. Clearly, the potential for dithiopyr/fertilizer combinations to provide an acceptable level of control at very low rates appears possible.

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THE EFFECT OF FALL-APPLIED PRODIAMINE ON SPRING OVERSEEDING

T. L. Watschke and J. A. Borger[1]

ABSTRACT

This research was conducted at the Landscape Management Research Center, University Park, PA, on a mature Kentucky bluegrass (Poa pratensis L.) turf to assess whether perennial ryegrass (Lolium perenne L.) could be successfully overseeded in the spring where prodiamine was applied the previous fall.

There were two randomized complete block design studies with three replications (plot size 3' x 10'). The preemergence treatments were applied on November 13, 1995 using a three ft hand held CO_2 powered boom sprayer with two 6504 flat fan nozzles calibrated to deliver 80 gpa at 30 psi and with a shaker jar for the prodiamine/fertilizer combinations. On May 13, 1996, one half of each plot was treated with glyphosate at a rate of 5 lb ai/A. On May 29, 1996, the killed area of each plot was verticut in three directions and the debris removed. The area was then overseeded at 5 lbs/1000 ft^2 with Renovator perennial ryegrass in two directions using a three foot drop spreader. Both test sites received 1 lb N/1000 ft^2 from a starter fertilizer. Both sites were maintained at 2 1/2" using a 21" walk behind rotary mower returning the clippings to the site and the site received irrigation as needed.

In one study, prodiamine was applied at 0.5, 0.75, and 1.13 lbs ai/A. Control of crabgrass rated on 8/20/96 was 93, 95, and 95 percent, respectively. The percentage perennial ryegrass cover was 88, 80, and 75%, respectively for prodiamine rates, while the untreated control had 88% perennial ryegrass cover. Although a slight decrease in perennial ryegrass establishment was observed as the prodiamine rate increased, turf treated with the 0.75 rate (which is higher than recommended in Pennsylvania) still was similar in perennial ryegrass establishment to areas not receiving prodiamine treatment.

In the second study, prodiamine was applied using four different fertilizer carriers at a rate of 0.75 lbs ai/A. Three of the four materials provided crabgrass control at 90% or better. The nonprodiamine-treated, but overseeded, areas in this study had 83% perennial ryegrass cover. The fertilizer/prodiamine-treated areas all had very similar perennial ryegrass cover (within three percentage points of 75).

It appears that fall-applied prodiamine (at recommended use rates) does not preclude successful overseeding with perennial ryegrass the following spring.

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USE OF SLUDGE BASED FERTILIZERS FOR TURFGRASS

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ABSTRACT

Sewage sludge is a semi-solid material created during biological and physical wastewater treatment. Limited information exists on the effects of sludge based fertilizers on the efficacy of preemergence herbicides. Greenhouse experiments were conducted with Bay State Organic product (Massachusetts Water Resource Authority) at 0, 40, 80, and 120 lbs/1000 sq. ft. and Milorganite product (Milwaukee Natural Organic Fertilizer) at 0, 25, 50, and 100 lbs/1000 sq. ft. Fifty crabgrass [Digitaria sanguinalis (L.) Scop.] seeds were sown in 4-in pots. Sludge was applied over the seeds and covered with a 1/8 inch layer of soil. Pendimethalin at 0, 0.5, 1.0 and 1.5 lb. ai/A was applied preemergence with a CO_2-backpack sprayer to deliver 50 gpa at 22 psi. Crabgrass seedlings were counted weekly and dry weights were determined at harvest. All pendimethalin treatments at all rates of both sludge products controlled crabgrass effectively.

In a second greenhouse study, the effect of sludge products on the growth and quality of 'Baron' Kentucky bluegrass (Poa pratensis L.) was investigated. Kentucky bluegrass seeds were sown at 2.0 lb/1000 sq. ft. in 4-in pots. Bay State Organic product at 0, 20, 40, 80, 160, and 240 lbs/1000 sq. ft. and Milorganite product at 0, 12.5, 25, 50, 100, and 150 lbs/1000 sq. ft. were applied. Kentucky bluegrass seedling emergence was determined. Turfgrass clippings were weighed weekly in the fall. Turfgrass density was visually rated on a scale of 1 to 9, where 1 = bare ground and 9 = full ground cover. Turf color was rated on a scale of 1 to 9, where 1 = light yellow color, and 9 = dark green color. Dry weight of turfgrass clippings increased as the sludge rates increased. There were no differences in seedling emergence of Kentucky bluegrass among the different rates of both sludge products, except when Milorganite at 150 lbs/1000 sq. ft. reduced emergence. Kentucky bluegrass fertilized with Bay State Organic emerged earlier than bluegrass fertilized with Milorganite and the differences in density were not observed 25 days later. Turfgrass color improved as the rate of sludge products increased.

Field experiments were conducted on a newly seeded "Baron" Kentucky bluegrass stand to evaluate the effects of Bay State Organic and Milorganite products on the preemergence activity of pendimethalin and on the growth and quality of the turfgrass. Kentucky bluegrass was planted at 2.0 lbs/1000 sq. ft. Bay State Organic product at 0, 20, 40, and 80 lbs/1000 sq. ft., and Milorganite product at 0, 12.5, 25, and 50 lbs/1000 sq. ft. were applied. Pendimethalin at 0, 0.5, 1.0, and 1.5 lbs ai/A was applied preemergence. Crabgrass plants were counted at the end of the season, and color and density ratings were taken bi-weekly throughout the season. All combinations of sludge and pendimethalin treatments effectively controlled crabgrass. Color and density of the turfgrass improved as the rates of both sludge products increased.

These results show that sludge based fertilizer products did not influence the herbicidal activity of pendimethalin for crabgrass control in Kentucky bluegrass. Sludge products improved turf quality and color with increased rates.

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ECOLOGICAL ASPECTS OF CRABGRASS INFESTATION IN COOL-SEASON TURF

T. J. Kim[1], J. C. Neal[2] and F. S. Rossi[1]

ABSTRACT

Crabgrass (*Digitaria* spp.) continue to be troublesome in turf management systems, but current information on the ecological aspects of those infestations is limited. The development of more efficient control strategies will require an improved understanding of seedling establishment, growth and survival. The objectives of this study were to investigate how much open space (gap size) is required for crabgrass seedling survival, how growth rate differs between gap sizes in Cool-season turf and to identify potential causes for differences in crabgrass survival and growth based on environmental monitoring.

Field experiments were conducted in 1996 on a mature stand of turf-type tall fescue (*Festuca arundinacea*) with a history of heavy (site A) and no smooth crabgrass infestation (site B). Five gap sizes of 2.5 to 20.0 cm diameter were created by spot treatment with 2.0 % (v/v) Finale (glufosinate) and arranged in a randomized complete block design. After the turf died, half of the gaps were disturbed (dead grass and thatch removed and replaced with soil); the remaining gaps were undisturbed. All plots were mowed bi-weekly at 2.5" height; clippings were removed, and gap sizes were maintained by clipping the encroaching grass blades once a week. Three grass weed species, smooth crabgrass (*D. ischaemum*), large crabgrass (*D. sanguinalis*) and goosegrass (*Eleusine indica*) were overseeded on 22 May in the gaps. Seedling emergence rate and tiller development were counted weekly from May to August. Throughout the month of August, weekly seedhead counts were recorded. Soil temperatures at 2.5 and 5 cm depth were continuously monitored from 24 May to 19 July at 30 minute intervals with in-ground thermocouples and a Cambell CR10X data logger.

Mean daily temperatures were not substantially different for 2.5 and 5 cm soil depth. However, daily temperature fluctuations were significantly different among the gap sizes, with higher and lower temperatures recorded in the largest gap. Significantly more smooth crabgrass plants emerged in gaps compared to no gap; but there were no differences in number of crabgrass plants emerged among the gap sizes. Therefore, gaps of any size could lead to smooth crabgrass infestations. Following seedling emergence, tiller development was more rapid in larger than smaller gaps. This suggests that the timing of postemergence herbicide treatments will be more critical in open turf (with larger gaps) than in a denser turf (smaller gaps) as plants will more rapidly achieve the size that is more difficult to control in more open turf areas.

In experiment B, goosegrass did not emerge when no gaps were created. While small numbers of crabgrass seedlings were evident in no-gap areas, however, these seedlings did not survive. Seedling emergence of three species were significantly influenced by thatch, however, there was no thatch by gap size interaction. The emergence and survival of smooth crabgrass were similar to what was observed in experiment A in gaps, while that of goosegrass was significantly lower, especially in gaps with thatch. Seedhead production was not effected by gap sizes and was greater for crabgrass than goosegrass.

In summary, the minimum gap size for crabgrass emergence and survival was between 0 and 2.5 cm. In contrast, a gap size of 2.5 cm was required for goosegrass emergence and 5.0 cm for survival to seed production. These data confirm the paradigm that dense turf will exclude seed-propagated weeds. However, it also illustrates that weed species differ in the minimum turf density required to prevent weed infestations. This research suggest that both the prevention of weed seed germination and inhibition of weed seedling growth and development are active components of this competitive relationship.

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EFFECT OF ISOXABEN APPLIED POSTEMERGENCE FOR BROADLEAF WEED CONTROL

Rakesh S. Chandran[1] and Jeffrey F. Derr

Broadleaf weed control continues to be an important aspect of turfgrass management. Isoxaben, used primarily as a preemergence (PRE) broadleaf herbicide, was recently reported to possess postemergence (POST) activity on certain broadleaf weeds pertinent to agronomic crops. Two greenhouse experiments were conducted to determine the POST activity of isoxaben on dandelion (*Taraxacum officinale* Weber.), white clover (*Trifolium repens* L.), buckhorn plantain (*Plantago lanceolata* L.), common yellow woodsorrel (*Oxalis stricta* L.), common lespedeza (*Lespedeza striata* Thunb.), black medic (*Medicago lupulina* L.), spotted spurge (*Euphorbia maculata* L.), and Florida betony (*Stachys floridana* Shuttlew.). Isoxaben applied at 0.56, 1.12, and 2.24 kg ai/ha, and a 3-way tank mix of isoxaben, 2,4-D amine, and dicamba at 1.12, 1.12, and 0.37 kg/ha, respectively, were compared to a 2-way tank mix of 2,4-D amine plus dicamba at 1.12 and 0.37 kg /ha, for broadleaf weed control. Percent reduction in regrowth of Florida betony following shoot harvest was also assessed. Isoxaben applied POST at all rates provided poor to no control of all the weed species mentioned above, except Florida betony, based on weed control ratings taken 3 weeks after treatment (WAT) and shoot fresh weights taken 6 WAT. Florida betony control increased with increasing rates of isoxaben, ranging from 40% control at 0.56 kg/ha to 75% control at 2.24 kg/ha. Isoxaben at 2.24 kg/ha reduced Florida betony shoot regrowth by 90%. The combination of 2,4-D plus dicamba gave at least 75% control of white clover, lespedeza, black medic, and dandelion in both studies based on control ratings taken 3 WAT. However, this treatment gave poor to fair control (10-60%) of yellow woodsorrel and spotted spurge. The 3-way tank mix of isoxaben with 2,4-D and dicamba exhibited a complementary effect, numerically improving control of common lespedeza, buckhorn plantain, yellow woodsorrel, Florida betony, and dandelion by 13, 12, 11, 9 and 8%, respectively, compared to 2,4-D plus dicamba applied alone. Although isoxaben is not effective as a POST herbicide for the weed species studied in this experiment, the effect of tank mixing this herbicide with growth regulator type herbicides may prove beneficial for POST and PRE broadleaf weed control.

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Pendimethalin plus Fenoxaprop for Crabgrass Control in Kentucky Bluegrass

J. F. Derr[1]

ABSTRACT

A prepackaged tank mix of pendimethalin plus fenoxaprop was evaluated for preemergence and postemergence crabgrass control in an established stand of 'Baron' Kentucky bluegrass (Poa pratensis L.) . In the first study, the pendimethalin plus fenoxaprop tank mix was applied at two rates: 2.0 plus 0.06 lb ai/A, and 4.0 plus 0.12 lb ai/A. These two treatments were applied at the one to two leaf stage of crabgrass, and at the early tillering stage. A 0.57 lb ai/gal formulation of fenoxaprop was applied at 0.12 lb/A for comparison.

At one month after application, both rates of the tank mix gave 100% control of large crabgrass [Digitaria sanguinalis (L.) Scop.] and smooth crabgrass [Digitaria ischaemum (Schreb. ex Schweig.) Schreb. ex Muhl.]. About 90% crabgrass control was observed one month after treatment with fenoxaprop applied alone at either crabgrass growth stage. By the end of August, no crabgrass plants were observed at the higher rate of the tank mix applied at the early tillering stage, with less than 1 crabgrass plant per plot with the earlier application timing. Crabgrass counts at the lower rate of the tank mix were 9.3 and 4.0 at the earlier and later timing, respectively. Crabgrass counts in plots treated with fenoxaprop at the earlier and later timing were 12 and 10, respectively. Approximately 100 crabgrass plants per plot were observed in untreated plots. Fenoxaprop and the higher rate of the combination product injured Kentucky bluegrass, but injury did not exceed 20%. Injury to Kentucky bluegrass decreased over time.

In the second study, the pendimethalin plus fenoxaprop tank mix was applied at three rates: 1.5 plus 0.05 lb/A, 2.0 plus 0.06 lb/A, and 3.0 plus 0.9 lb/A at the early tillering stage of crabgrass. These three treatments were applied at 25 gal/A using flat fan nozzles, and at 80 gal/A using a spray gun. For comparison, dithiopyr was applied at 0.5 lb/A and fenoxaprop was applied at 0.09 lb/A using both methods of application. All flat fan applications of the tank mix gave 90% or greater control of crabgrass at one month after application. Control using the spray gun ranged from 70% at the lowest rate to 88% at the two higher rates. Fenoxaprop gave 95% control using flat fan nozzles, but only 78% control using the spray gun. Dithiopyr gave approximately 80% crabgrass control with both methods of application.

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PRE/POST CRABGRASS CONTROL AS TWO GROWTH STAGES

T. L. Watschke and J. A. Borger[1]

ABSTRACT

Two experiments were conducted in 1996 to evaluate the control of smooth crabgrass after emergence into a mature stand of predominately perennial ryegrass (Lolium perenne L.) turf. One study was conducted when the crabgrass was in the pre-tillering stage (application made on June 20 with sequential applications for selected treatments 14 days later). A second study was initiated on July 1 (after crabgrass had begun to tiller). Treatments were applied using a hand-held boom CO_2 powered sprayer with two 6504 nozzles at 30 psi calibrated to deliver 80 gpa. All experiments were rated for crabgrass control on August 20, 1996.

Treatments that provided acceptable control (85%) where crabgrass was in the pre-tillering stage included pendimethalin and fenoxaprop combinations (individual rates undisclosed). Both the low and high rate treatments provided acceptable control. Dithiopyr at 0.5 lbs ai/A and MSMA at 2.0 lbs ai/A followed by another 2.0 lbs ai/A 14 days later did not control crabgrass at an acceptable level (70% and 75%, respectively). Fenoxaprop and fenoxaprop Extra did not control crabgrass acceptably, although fenoxaprop did provide 82% control at 0.12 lbs ai/A.

In the post-tillering experiment, the pendimethalin/fenoxaprop combination controlled crabgrass at an acceptable level. However, fenoxaprop at 0.18 and fenoxaprop Extra did provide acceptable control.

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EXTENDED EFFECTIVENESS OF POSTEMERGENCE CRABGRASS CONTROL

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ABSTRACT

Pendulum Post and Preclaim are similar mixtures of fenoxaprop and pendimethalin. These formulations were not directly compared to each other since they are essentially the same; however, they were compared to fenoxaprop as Acclaim and Acclaim Extra and in some cases to a few preemergence herbicides. The more active fenoxaprop isomer in Acclaim Extra is also in Pendulum Post and Preclaim.

In 1995, Pendulum Post provided excellent crabgrass control for 10 weeks as compared to Acclaim Extra for less than 6 weeks. Bluegrass quality also remained good until crabgrass control became poor at 15 weeks. With the temporary injury occurring with Acclaim Extra, bluegrass quality was below acceptable and in open or thin turfgrass, crabgrass occurred at 6 weeks. Similar injury occurred with Pendulum Post; however, pendimethalin reduced further emergence of crabgrass in the thin bluegrass, Dithiopyr gave 90% crabgrass control (1 to 3 tiller stage) and was similar to Acclaim Extra after 3 weeks in regard to crabgrass control and turfgrass quality.

During 1996, pendimethalin and dithiopyr applied preemergence gave excellent crabgrass control for 16 weeks. Pendulum Post applied on 4 leaf crabgrass was equally effective during this period. Acclaim Extra gave excellent crabgrass control for 4 weeks and allowed reoccurrence before 9 weeks. Bluegrass injury was slightly less when fenoxaprop was applied later in the season. Bluegrass quality was acceptable during the entire period with pendimethalin and dithiopyr applied preemergence; however, quality of bluegrass was slightly more variable with Pendulum Post.

Preclaim provided excellent crabgrass control for 14 weeks and did not appear influenced by triclopyr alone. However, broadleaf herbicides (triclopyr + clopyralid and 2,4-D + mecoprop + dicamba) reduced the effectiveness of Preclaim for crabgrass control after 8 weeks. Tank mixtures of Acclaim Extra with 2,4-D + mecoprop + dicamba also showed a similar response on crabgrass.

Quinclorac at 0.75 lb ai/A provided excellent crabgrass control but 0.50 lb ai/A was less effective at 4 weeks.

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Gallery* for Weed Prevention and Callback Reduction in Home Lawns

R. J. Keese and C. L. Forth, CPAg
DowElanco and TruGreen-ChemLawn

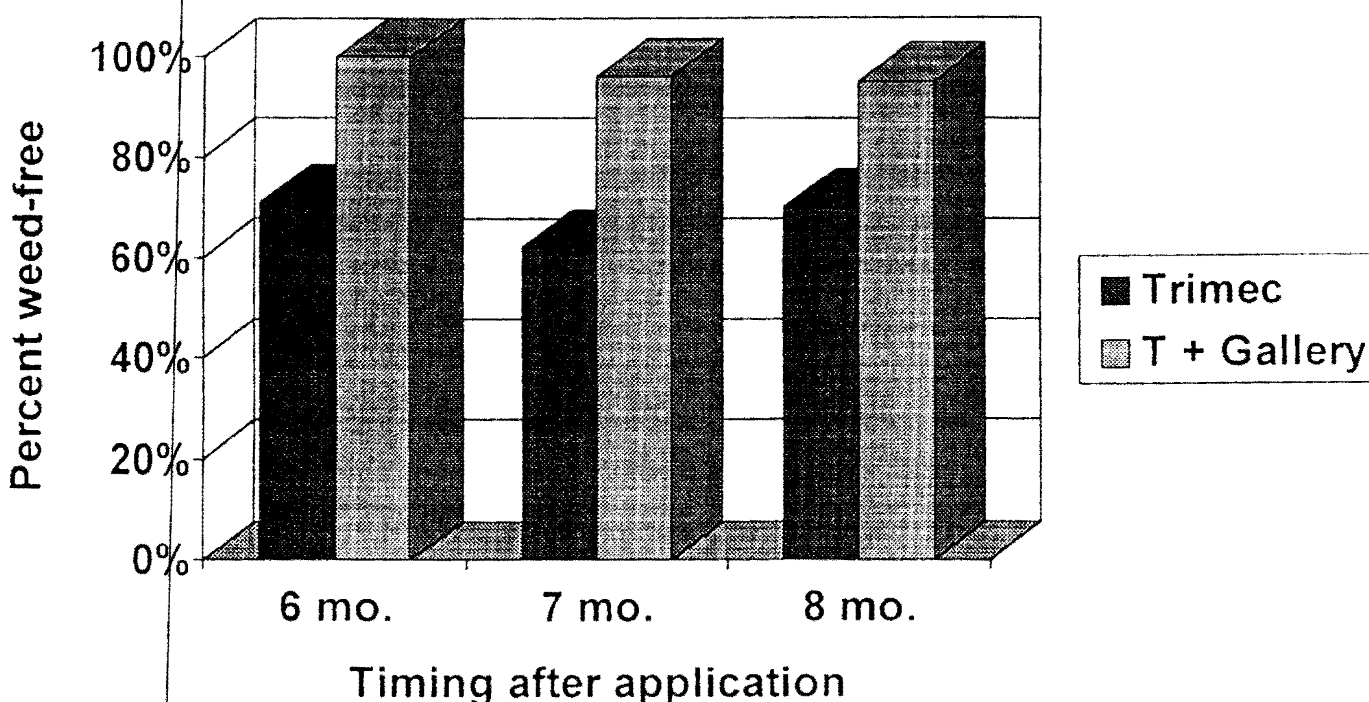
Small lawns, averaging 3,500 to 4,000 square feet, were targeted for treatment in the Baltimore, MD area. Prior to herbicide and 4-1-2 fertilizer applications, weed populations were identified. Properties were treated as a split plot design, where half the property received a standard Trimec 959 (3.125 pt/A rate) application, and the other half received Trimec 959 plus Gallery* (1.0 lb ai/A). Trimec, a postemergence product, will only control only the weeds visible at the time of application. Gallery* adds a barrier to protect against emergence of additional weeds.

Evaluations were made 6, 7 and 8 months after herbicide application. Weeds observed in the study included dandelion (Taraxacum officinale), plantains (Plantago sp.), white clover (Trifolium repens), spurge (Euphorbia sp.), oxalis (Oxalis sp.), chickweed (Cerastium sp.), veronica (Veronica sp.), and ground ivy (Glechoma hederacea). At six months after treatment, weed control was excellent in the Gallery* treated areas, and weeds were emerging in the Trimec alone treatment. There was a statistical difference between the treatments when analyzed as a Wilcoxson Signed Rank Test. A Pearson Chi-Square Contingency Table analysis gives a p-value of 0.012, which suggests a significant relationship between the lack of weeds and Gallery*. At seven and eight months after application, this trend continued. Weeds emerging included dandelion, chickweed, oxalis, and violets.

A typical residential route was also treated with Gallery* for a week, which allowed comparison to the routes where standard applications of herbicide were used. Dandelion bloom varies from region to region, and can be an indication of the success of weed control programs. Lawn care companies around Baltimore were receiving approximately 30 calls a week per specialist, during the month of May when dandelions began flowering. No weed control complaints were received from the route treated with Gallery*. Fewer callbacks and extended weed control allow lawn care operators more flexibity in their day to day operations, yielding a better bottom line.

* Trademark of DowElanco

Effect of Gallery* on small lawn weed control



*Trademark of DowElanco

POTENTIAL USE OF EXP-31130A FOR WEED CONTROL IN COOL-SEASON TURFGRASS

P. C. Bhowmik and R. G. Prostak[1]

ABSTRACT

Selective control of one turfgrass species in an established monoculture turfgrass is a difficult task. There are not many options in selective control of one species. Search continues to explore the possibility of selective control of one turfgrass species in a mono- or mixed-turfgrass stands. Our objective was to examine the tolerance of various turfgrass species to EXP-31130A. Both greenhouse and field experiments were conducted. Turfgrass species included in these studies were 'Penncross' creeping bentgrass (Agrostis palustris Huds.), 'SDF' bentgrass (a local New England type creeping bentgrass), Kentucky bluegrass (Poa pratensis L.), perennial ryegrass (Lolium perenne L.), tall fescue (Festuca arundinaceae Schreb.), fine fescue (Festuca rubra L.) and annual bluegrass (Poa annua L.).

Turfgrass plugs (10.2 cm-diameter) were taken from established monoculture turfgrass stands in the field. These plugs were established on sand culture pots in the greenhouse. Pots were watered daily as needed and the turfgrass was mown to 2 cm once a week. After 4 weeks of growth in the greenhouse, EXP-31130A at 0, 100, 200, 400, 600, and 800 g ai ha^{-1} was applied postemergence to these species. Treatments were applied with a CO_2-backpack sprayer at a pressure of 152 kPa in 675 L ha^{-1}. Foliar injury to turfgrass species was visually assessed on a scale of 0 to 100% over a 8-wk period. Also, dry weights of above-ground biomass were determined for final evaluation.

Creeping bentgrass, SDF bentgrass, Kentucky bluegrass showed differential tolerance to EXP-31130A. Creeping bentgrass was most susceptible (70% reduction), while 'SDF' bentgrass exhibited 55 to 60% reduction at the 200 g ha^{-1}. Tall fescue was most tolerant to EXP-31130A with only 5 to 14% dry weight reduction at the 200 to 800 g ai ha^{-1}, respectively. Red fescue, perennial ryegrass, and Kentucky bluegrass were moderately tolerant (5 to 20% reduction) to the 200 g ai ha^{-1} rate. However, the highest rate (800 g ha^{-1}) resulted in 40 to 55% dry weight reduction. In another experiment, annual bluegrass was tolerant to the postemergence application of EXP-31130A at 105 g ai ha^{-1} rate. However, only 20 to 30% injury to annual bluegrass was noted at the 140 to 175 g ai ha^{-1} rates. In contrast, EXP 31130A applied preemergence reduced annual bluegrass stand, ranging from 18 to 60% stand with 17.5 to 175 g ha^{-1}.

In summary, differential turfgrass species tolerance to EXP-31130A could be ranked tall fescue as the most tolerant species, followed by red fescue, perennial ryegrass, Kentucky bluegrass, 'SDF' bentgrass, and 'Penncross' creeping bentgrass. Results indicate potential use of this product in selective control of creeping bentgrass in other established turfgrass species.

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EVALUATIONS OF ISOXAFLUTOLE AS A POSTEMERGENCE HERBICIDE IN TURF

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ABSTRACT

Field experiments were conducted during 1995 and 1996 to evaluate control of crabgrass (Digitaria ischaemum (Schreb.) Muhl.), broadleaf weeds and turfgrass tolerance to isoxaflutole (R-P EXP 31130A). Studies were conducted at the URI turf research farm on a mixed turf containing about 70 percent Jamestown II Chewings fescue (Festuca rubra var. commutata) maintained at 1.25 inches. Additional studies were conducted on an old athletic field turf of Kentucky bluegrass (Poa pratensis L.) mowed at 1.75 inches. Experiments were randomized complete block designs with four replicates. Plots were five feet wide by eight feet long with a two foot untreated strip between plots. Soils were Bridgehampton silt loams. Treatments were applied with a backpack sprayer in 40 GPA. All rates are given in lb ai/A.

Crabgrass was treated at the early- and mid-postemergence stage. Broadleaf weeds were treated on June 9 and July 5, 1996. Weed stands were moderate-heavy in all cases. Broadleaf weeds consisted mainly of white clover (Trifolium repens L.) and dandelion (Taraxacum officinale Weber). Weed control ratings were on a scale of 0-10 with 10 being perfect control and <7.0 unacceptable. Turf injury ratings were also on a 0-10 scale, with 10 being perfect tolerance and $\leq$9.0 being objectionable.

In 1995, isoxaflutole applied as a single application at the early-postemergence stage or as a split treatment (early-& mid-post), gave mixed results. Early-post treatments of 0.18, 0.36, and 0.72 lb/A gave September crabgrass control ratings of 8.1 - 8.8. Objectionable turf injury occurred early but was gone by 8 weeks after treatment. Other early-post applications of 0.18, 0.36 and 0.5 lb/A gave crabgrass ratings of 9.3 - 9.7 in mid-September. Early turf injury disappeared in 4 weeks.

In 1996, 0.18, 0.36 and 0.5 lb/A applied early- or mid-post as single or split treatments provided season-long crabgrass control of $\geq$9.3 for early-post and split treatments, but late-post applications were less effective. Injury to the turfgrasses was unique among species and occurred at all rates with severity increasing at higher rates. Injury to the fescue was displayed as an overall lighter color whereas Kentucky bluegrass had fully bleached leaf tips. Both forms were only temporary. Injury to patches of volunteer bentgrasses was severe. Colonial bentgrass (Agrostis tenuis Sibth.) was killed. Some creeping bentgrass (Agrostis palustris Huds.) patches were killed while others seemed to partially recover.

Broadleaf weed control with isoxaflutole was dependent on species. White clover was controlled by a single early-spring application of 0.09 lb/A, but even a second application of 0.18 lb/A failed to control all dandelion and broadleaf plantain. (Plantago major L.)

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PREEMERGENCE CONTROL OF PROSTRATE KNOTWEED

J. C. Neal[1]

ABSTRACT

Prostrate knotweed (*Polygonum aviculare* L. #POLAV) is a common weed in turfgrass thinned due to compaction, traffic, athletic use or pest damage. It is difficult to control postemergently with available herbicides and is best controlled preemergently. Although, commonly associated with hot, drought-prone sites, prostrate knotweed germinates very early in the spring -- typically before preemergent herbicides are applied. In my previous research, many preemergent herbicides labeled for prostrate knotweed control failed to provide adequate control in golf course fairway turf when applied in early spring. In this study, we investigated the effectiveness of late fall applications of labeled herbicides as compared to spring treatments for preemergence control of prostrate knotweed.

Herbicides were applied on November 30, 1995 or April 12, 1996 to a predominantly *Poa annua* and perennial ryegrass (*Lolium perenne*) golf course fairway mowed at ½ inch. November applications were about 7 weeks after the last mowing for the season. April treatments were only 2 days after snow cover had melted from the plots but prostrate knotweed seed had already germinated; most of the germinated seed were on the soil surface and the primary roots had not yet penetrated the soil surface. The soil surface and 2 inch depth temperatures at the time of the spring treatments were 53 F and 45 F, respectively. The herbicides applied included prodiamine (Barricade) at 0.75 and 1.1 lb ai/A, isoxaben (Gallery) at 0.75 and 1.0 lb ai/A, and pendimethalin (Pre-M) at 1.5 lb ai/A.

Late fall applications of each herbicide controlled prostrate knotweed better than spring treatments. Late fall-applied prodiamine controlled 50 and 83% of the prostrate knotweed at 0.75 and 1.1 lb/A, respectively; spring applications provided only 33% and 43% control. Similarly, late fall application of pendimethalin controlled prostrate knotweed 98% but only 55% with spring treatment. Isoxaben provided complete control at 0.75 lb/A with fall applications but no control with the spring treatments.

In a separate study, the effects of late fall preemergent herbicide applications on spring overseeding was evaluated. In that test, prodiamine and isoxaben were applied on November 30, 1995 at the same rates as in the prostrate knotweed study. The area was treated with Roundup on May 1 and slit seeded with perennial ryegrass on May 9, 1996. Plots were rated once a month. Prodiamine reduced turfgrass cover -- by 70% in July ratings. By the end of August turfgrass had partially recovered with only 20 to 33% reduction in cover from 0.75 and 1.1 lb ai/A, respectively. In contrast, isoxaben caused no stand reduction in June or August ratings. In July ratings, a slight (18%) reduction was observed with 1.0 lb/A isoxaben. In August 1996 ratings, other weeds from seed controlled by November applications of isoxaben at 0.75 lb/A included creeping woodsorrel, (*Oxalis corniculata*), broadleaf plantain (*Plantago major*) and white clover (*Trifolium repens*) from seed.

These data showed that several herbicides were effectively controlled prostrate knotweed when applied in late fall, including prodiamine, pendimethalin and isoxaben. But only isoxaben did so without interfering with spring overseeding.

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SEEDHEAD SUPPRESSION OF ANNUAL BLUEGRASS AND TALL FESCUE

Thomas L. Watschke and Jeffrey A. Borger[1]

ABSTRACT

Two studies were conducted to assess seedhead suppression in 1996. One study was conducted on a mixed stand of creeping bentgrass and Poa annua on the practice green at the Penn State Blue Golf Course in State College, PA. The study was a randomized completed block design with three replications. All of the treatments were applied on April 22, 1996, using a three foot CO_2 powered boom sprayer calibrated to deliver 80 gpa using two 6504 nozzles at 30 psi. The weather conditions at the time of application were sunny with a slight wind (less than 5 mph) and an air temperature of 80°F and a soil temperature of 60°F at two inches. The green was maintained using normal practices for irrigation, mowing, and fertilizer. Seedhead suppression was rated on two dates (5/10/96 and 5/17/96). On May 10, mefluidide Lite provided excellent seedhead suppression (90%). Mefluidide provided 80% suppression, but both products had reduced suppression when supplemented with Ferromec (15-0-0). Even though Ferromec reduced the suppression of mefluidide Lite, there was suppression comparable to mefluidide. Ferromec significantly safened the discoloration that resulted from the mefluidide Lite application. All treated turf had significantly better quality on the May 17 rating date than nontreated turf. This difference was primarily associated with the reduction in quality of the nontreated turf as the result of the presence of seedheads. Mefluidide Lite reduced seedheads significantly more than mefluidide on the May 10 rating date even though the rate of active ingredient applied from both sources was identical.

The second study was conducted at the Landscape Management Research Center, University Park, PA, on a predominately tall fescue turf. The treatments were applied on May 3, 1996 (seedheads not emerged), using a three foot hand held CO_2 powered boom sprayer with two flat fan 6504 nozzles calibrated to deliver 80 gpa. Ratings were taken on a weekly basis for vegetative turf height (excluding the seedheads) and seedhead suppression was rated five weeks after treatment (June 10). Phytotoxicity ratings were taken 19 days after treatment and again near the conclusion of the study as some treatments had not fully recovered. On May 22 and June 10, none of the treated turf was rated below 7 (considered acceptable) for phytotoxicity, although there were differences among the treatments with respect to the phytotoxicity they caused (treatments that included SAN1269H caused more phytotoxicity than the others). Seedhead suppression rated on June 10 was considered acceptable on turf treated with EH1094 at the two highest rates, EH1135 at the two highest rates, mefluidide at 0.2 oz/M and mefluidide plus Event (imazaquin and imazethapyr) at 0.2 oz/M and 0.5 oz/M, respectively.

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THE EFFECT OF TRINEXAPAC-ETHYL ON PUTTING GREEN SPEED

Thomas L. Watschke and Jeffrey A. Borger[1]

ABSTRACT

This study was conducted at The Valentine Turfgrass Research Center, University Park, PA, on a mature mixed stand of Penncross creeping bentgrass (Agrostis palustris) and annual bluegrass (Poa annua).

Two applications of trinexapac-ethyl (1EC) at two rates, 0.06 and 0.125 oz/M, were applied at two application timings to 3'x20' plots in a randomized complete block design. A hand held CO_2 powered boom sprayer, was calibrated to deliver 40 gpa at 30 psi using two 6504 flat fan nozzles. The first application was on May 30, 1996, the second on July 8, 1996.

Data collection was initiated on July 2, 1996, and was completed on July 25, 1996. The test site was mowed, in one direction perpendicular to the roll of the ball at 5/32" on Monday, Wednesday and Friday using a triplex reel mower collecting the clippings. On Tuesdays and Thursdays after the dew was whipped from the test site, (no mowing) stimp meter readings were taken every two hours using three golf balls rolled in two directions (away from and back to a starting point) starting at 6 a.m. and continued until 8 p.m. At the onset of each two hour data collection interval, a visual weather observation and soil temperature was recorded (on some days inclement weather prohibited the completion of the full day's data collection). The test area did not receive any fertilizer, and irrigation was applied on an as needed basis, on non data collection days. In general, the lowest green speed was found early in the day (6 a.m.) and later in the day (4 p.m.). Although, on two occasions, a midday low was recorded. Wind, proximity of rainfall to measurement time, overall growing conditions (air and soil temperature), leaf wetness, and other environmental parameters interact to impact results. Only a slight rate effect was found. At most observation times, trinexapac-ethyl treated turf allowed for slightly faster ball roll (3 to 7 inches), although, on occasion, untreated turf allowed the ball to roll further. Little evidence was found at the rates used, that trinexapac-ethyl treated turf could provide a putting surface which would be of uniform speed throughout the day than non treated turf.

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1996 EUP RESULTS FOR ISOXAFLUTOLE IN CORN

J.R. Stachecki, T.E. Vrabel, and C.B. Williams[1]

ABSTRACT

Isoxaflutole is a member of a new class of isoxazole herbicides from Rhone-Poulenc Ag Company which disrupt pigment biosynthesis in susceptible plant species. Isoxaflutole is formulated as a 75 percent water dispersible granule and will be marketed under the trade name of BALANCE™ . An Experimental Use Permit was conducted across 165 locations in the midwest and northeast with the preemergence application of isoxaflutole on field corn. Objectives were to demonstrate weed control, crop safety, and crop yield response of isoxaflutole applied either alone or in combination with reduced rates of preemergent corn herbicides versus commercial preemergence corn herbicide programs. EUP trials were conducted by Rhone-Poulenc Sales representatives in conjunction with Rhone-Poulenc Field Development representatives.

Results from 195 trials which were conducted indicated minimal crop injury and excellent weed control when isoxaflutole was applied at 105 g ai ha^{-1} either alone or in combination with half of the normal use rate of preemergence corn herbicides such as acetochlor, metolachlor, alachlor, dimethenamid, atrazine or chloracetamide plus atrazine combinations. These isoxafluttoloe treatments provided excellent control of weds such as velvetleaf (*Abutilon theophrasti* Medik.), common ragweed (*Ambrosia artemisiifolia* L.), giant ragweed (*Ambrosia trifida* L.) lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), tall waterhemp (*Amaranthus tuberculatus* (Moq.)J.D. Sauer), common waterhemp (*Amaranthus rudis* Sauer), kochia (*Kochia scoparia* (L.)Schrad.), Pennsylvania smartweed (*Polygonum pensylvanicum* L.), eastern black nightshade (Solanum), Venice mallow (*Hibiscus trionum* L.), wild mustard (*Sinapsis arvensis* L.), giant foxtail (*Setaria faberi* Herrm.), green foxtail (*Setaria viridis* (L.)Beauv.), fall panicum (*Panicum dichotomiflorum* Michx.), wild proso millet (*Panicum mileaceum* L.), woolly cupgrass (*Eriochloa villosa* (Thunb.)Kunth) and barnyardgrass (*Echinochloa crus-galli* (L.)Beauv.). Combinations of isoxaflutole plus half of the recommended use rate of a chloracetamide herbicide provided excellent control of yellow foxtail (*Setaria glauca* (L.) Beauv.). Performance of the isoxaflutole treatments was either comparable or superior to the overall weed control performance provided by the commercial standard herbicide program as chosen by the individual farmer cooperators.

As previously observed in small plot research trials, under dry conditions or in situations where weeds emerge due to non uniform application coverage, control of weed seedlings less than 5 cm tall occurred following rainfall. This "rechargeable activity" was observed occurring in most locations for over 6 weeks following application and was a characteristic of isoxaflutole which was well received by the farmer cooperators. They also liked the low dose technology of isoxaflutole and the ease of handling the dust free 75 WDG formulation.

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PERFORMANCE OF ISOXAFLUTOLE IN PREEMERGENCE AND PREPLANT APPLICATIONS IN CONVENTIONAL TILLAGE CORN

T.E. Vrabel, J.P. Cartier, and M. White[1]

ABSTRACT

Isoxaflutole is a member of a new class of isoxazole herbicides from Rhone-Poulenc Ag Company which disrupt pigment biosynthesis in susceptible plant species. Isoxaflutole is formulated as a 75 percent water dispersible granule and will be marketed under the trade name of BALANCE™.

Isoxaflutole was evaluated in 1996 in 204 conventional tillage field trials conducted by Rhone-Poulenc in the United States. It was evaluated in preemergence, preplant surface applied and preplant incorporated applications applied either alone or in combination with other herbicides. Results from these trials were consistent with past year's performance and show that Isoxaflutole provides excellent selective control of both grass and broadleaf weeds in corn (*Zea mays* L.) at low use rates. Isoxaflutole applied alone preemergence at rates of 52 to 105 g ai ha^{-1} provided excellent control of velvetleaf (*Abutilon theophrasti* Medik.), common ragweed (*Ambrosia artemisiifolia* L.), giant ragweed (*Ambrosia trifida* L.) lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), tall waterhemp (*Amaranthus tuberculatus* (Moq.)J.D. Sauer), common waterhemp (*Amaranthus rudis* Sauer), kochia (*Kochia scoparia* (L.)Schrad.), Pennsylvania smartweed (*Polygonum pensylvanicum* L.), eastern black nightshade (Solanum), Venice mallow (*Hibiscus trionum* L.), wild mustard (*Sinapsis arvensis* L.), giant foxtail (*Setaria faberi* Herrm.), green foxtail (*Setaria viridis* (L.)Beauv.), fall panicum (*Panicum dichotomiflorum* Michx.), wild proso millet (*Panicum mileaceum* L.), woolly cupgrass (*Eriochloa villosa* (Thunb.)Kunth) and barnyardgrass (*Echinochloa crus-galli* (L.)Beauv.). Performance was comparable whether isoxaflutole was applied preemergence or preplant incorporated. Under dry conditions following preemergence application performance was improved by shallow incorporation of Isoxaflutole Excellent activity on this weed spectrum was observed in early pre plant applications of Isoxaflutole at 140 g ai ha^{-1} applied up to 14 days prior to planting.

Under dry conditions or in situations where weeds emerge due to non uniform application coverage, control of weed seedlings less than 5 cm tall occurs following rainfall. This "rechargeable activity" is the result of uptake and translocation of isoxaflutole via the weed's root system and can be observed on many weed species for over 6 weeks following application.

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PERFORMANCE OF ISOXAFLUTOLE AS A PREEMERGENCE AND BURNDOWN HERBICIDE IN NO TILL CORN

T.E. Vrabel, J.P. Cartier, and J.R. Collins [1]

ABSTRACT

Isoxaflutole is a member of a new class of isoxazole herbicides from Rhone-Poulenc Ag Company which is formulated as a 75 percent water dispersible granule. Isoxaflutole is formulated as a 75 percent water dispersible granule and will be marketed under the trade name of BALANCE™. It is ideal for use in no till and minimum till applications since it does not tie up on surface trash and does not photodegrade.

Isoxaflutole was evaluated in 1996 in 27 no till field trials conducted by Rhone-Poulenc in the United States. It was evaluated in preemergence, preplant and burndown applications applied either alone or in combination with other herbicides. Results from these trials have shown that isoxaflutole provided excellent selective control of both grass and broadleaf weeds in corn (*Zea mays* L.) at low use rates. Isoxaflutole applied alone preemergence at 105 g ai ha^{-1} provided excellent control of velvetleaf (*Abutilon theophrasti* Medik.), common ragweed (*Ambrosia artemisiifolia* L.), lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), common waterhemp (*Amaranthus rudis* Sauer), barnyardgrass (*Echinochloa crus-galli* (L.)Beauv.), Pennsylvania smartweed (*Polygonum pensylvanicum* L.) and giant foxtail (*Setaria faberi* Herrm.). Combinations of isoxaflutole at 105 g ai ha^{-1} with either 1.4 kg ai ha^{-1} metolachlor or 1.12 kg ai ha^{-1} acetochlor provided excellent control of the aforementioned weeds and added control of yellow foxtail (*Setaria glauca* (L.) Beauv.). These treatments provided comparable control to full rate applications of atrazine plus metolachlor or atrazine plus acetachlor.

Preplant applications of isoxaflutole at 140 g ai ha^{-1} applied in combination with either 2.2 l ha^{-1} crop oil surfactant, 0.5% v/v non ionic surfactant, 0.38 kg ai 2,4-D or 0.56 kg ai glyphosate provided excellent burndown control of difficult to control weeds such as dandelion (*Taraxacum officinale* Webber in Wiggers) and marestail (*Conyza canadensis*(L.) Cronq.) and excellent preemergence control of weeds such as velvetleaf, common waterhemp, Pennsylvania smartweed, common ragweed, lambsquarters, barnyardgrass, giant foxtail and green foxtail. These treatments provided excellent weed control when either water or 28% nitrogen solution was used as the herbicidal carrier.

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ISOXAFLUTOLE COMBINATIONS WITH PREEMERGENCE HERBICIDES FOR ANNUAL WEED CONTROL IN FIELD CORN

Frank J. Himmelstein, Robert J. Durgy [1]

ABSTRACT

Isoxaflutole (Balance) has been shown to be an effective weed control option in Connecticut field corn (Zea mays L.) trials. Two 1996 field trials conducted in Bolton and Lebanon, CT evaluated seven preemergence herbicides applied alone and in combination with isoxaflutole. The studies were split plot designs with three replications. The main plots were isoxaflutole applied at 0.75 and 1.5 oz ai/A and the preemergence herbicide (PRE)treatments applied alone. The sub-plot treatments and applied rates were: thiafluamide + metribuzin [(Axiom) 0.32 and 0.64 lb ai/A], metolachlor [(Dual II) 1 and 2 lb ai/A], dimethenamid [(Frontier) 0.59 and 1.17 lb ai/A], acetochlor [(Harness) 0.88 and 1.75 lb ai/A], alachlor [(Lasso MT) 1 and 2 lb ai/A], acetochlor + safener [(Surpass) 0.9 and 1.8 lb ai/A], and pendimethalin [(Prowl) 0.75 and 1.5 lb ai/A]. Herbicides were applied with a CO_2 backpack sprayer delivering 20 gpa at 32 psi. Weed control was assessed by visual ratings, and weed biomass samples taken from a 2.25 ft^2 quadrat from the center of each plot. Weed species included common lambsquarters [Chenopodium album L.], redroot pigweed (Amaranthus retroflexus L.), common ragweed [Ambrosia artemisiifolia L.], velvetleaf (Abutilon theophrasti Medik.) and giant foxtail [Setaria faberi Herrm.]. Common ragweed was the dominant weed at the Bolton site. Excellent common ragweed control was obtained with the isoxaflutole treatment combinations as indicated by the weed ratings and weed biomass samples taken 53 and 90 DAT, respectively. Average common ragweed dry matter yields were reduced 99% with the isoxaflutole combinations, and 5% for the PRE treatments compared to the check. Giant foxtail and redroot pigweed were the dominant weeds at the Lebanon site, however, velvetleaf, common lambsquarters, and common ragweed proliferated where these weeds were controlled. Weed ratings taken 36 DAT indicated the isoxaflutole treatment combinations resulted in greater control (>90%) of all five weed species compared to the PRE treatments alone. Average control of giant foxtail, velvetleaf, common lambsquarters, redroot pigweed and common ragweed with the PRE treatments alone was 85%, 24%, 35%, 73% and 12% respectively. Weed biomass samples taken 79 DAT indicated there were no significant differences in the average giant foxtail and redroot pigweed biomass between the isoxaflutole treatment combinations and the PRE treatments alone. The average velvetleaf, common lambsquarters, and common ragweed biomass was significantly greater for the PRE treatments alone compared to the isoxaflutole treatment combinations. Isoxaflutole shows great promise for broadspectrum weed control alone and in combination with reduced rates of other preemergence herbicides.

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REDUCED RATE PREEMERGENCE HERBICIDE COMBINATIONS WITH ISOXAFLUTOLE OR PENDIMETHALIN IN FIELD CORN

Frank J. Himmelstein, Robert J. Durgy [1]

ABSTRACT

Isoxaflutole (Balance) and pendimethalin (Prowl) are effective weed control options in field corn (Zea mays L.). Two 1996 field trials conducted in Lebanon, CT evaluated seven preemergence herbicides applied alone and in combination with isoxaflutole or pendimethalin. The studies were split plot designs with three replications. The main plots were isoxaflutole applied at 1.5 oz ai/A, pendimethalin applied at 1.5 lb ai/A, and the preemergence herbicide (PRE) treatments applied alone. The sub-plot treatments and applied rates were: thiafluamide + metribuzin [(Axiom) 0.32 and 0.64 lb ai/A], flumetsulam + clopyralid [(Broadstrike Plus) 0.125 and 0.25 lb ai/A], metolachlor [(Dual II) 1 and 2 lb ai/A], dimethenamid [(Frontier) 0.47 and 0.94 lb ai/A], acetochlor [(Harness) 0.88 and 1.75 lb ai/A], alachlor [(Lasso MT) 1 and 2 lb ai/A], and acetochlor + safener [(Surpass) 0.9 and 1.8 lb ai/A]. Herbicides were applied with a CO_2 backpack sprayer delivering 20 gpa at 32 psi. Weed control was assessed by visual ratings, and weed biomass samples taken from a 2.25 ft^2 quadrat from the center of each plot. Common lambsquarters (Chenopodium album L.) was the dominant weed at the Savin Farm site. Isoxaflutole and pendimethalin treatments gave excellent common lambsquarters control as indicated by weed ratings and weed biomass samples taken 38 and 78 DAT, respectively. Common lambsquarters biomass was reduced 100% with the isoxaflutole and pendimethalin treatments, and 70% for the PRE treatments compared to the check. Velvetleaf (Abutilon theophrasti Medik.) control was lower for the PRE treatments compared to the isoxaflutole and pendimethalin treatments. Common ragweed (Ambrosia artemisiifolia L.) proliferated in several pendimethalin treatments. Isoxaflutole treatments resulted in 100% common ragweed control. All treatments gave effective redroot pigweed (Amaranthus retroflexus L.) control. Redroot pigweed, common lambsquarters, and velvetleaf were the dominant weeds at the Grabber Farm site. Weed ratings taken 39 DAT indicated both the isoxaflutole and pendimethalin treatments gave greater control (95-100%) of all three weed species compared to the PRE treatments. The PRE treatments gave 29%, 81% and 92% control of velvetleaf, common lambsquarters, and redroot pigweed, respectively. Weed biomass samples taken 76 DAT indicated there were no differences in redroot pigweed biomass between the main treatment effects. Velvetleaf and common lambsquarters biomass was greater for the PRE treatments compared to the isoxaflutole and pendimethalin treatments. Where triazine resistant weeds are present, both isoxaflutole and pendimethalin will provide effective redroot pigweed, common lambsquarters and velvetleaf control. Isoxaflutole will provide effective ragweed control.

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Weed Interference in Full Season, No-Tillage Soybeans at Two Row Spacings

A. Para, B.H. Marose, T.W. Patton, and S. Glenn[1]

ABSTRACT

An experiment was initiated in 1996 to evaluate interactions of full season no-tillage soybeans with common cocklebur *(Xanthium strumarium* L.), velvetleaf (*Abutilon theophrasti* Medicus), pitted morningglory (*Ipomoea lacunosa* L.), and fall panicum (*Panicum dichotomiflorum* L.). Soybeans (glyphosate resistant) were planted in 7.5- and 15- inch rows in 10-foot x 50-foot plots. Five weed seeds of one species were planted in three locations five feet apart inbetween the center rows of the plots for yield analysis. In the back half of each plot five seeds of the same species were planted in nine, evenly spaced locations for bioassays. Upon emergence of the weeds, each planting was thinned to one plant. There were eight replications for each weed and each row spacing and the study was arranged in a split block design. Control plots were included to evaluate soybean growth. Desired weeds were covered and the entire study area was treated with 1.0 lb ai/A glysphosate to control unwanted weeds when necessary. Samples were obtained starting three weeks following weed emergence for five consecutive weeks from the bioassays area. Samples included the weed and the closest soybean plant. Leaf area index (LAI) and dry weight were measured for the weed and the soybean. In the fall, the weeds in the harvest area were measured for height, clipped at the base, dried, and weighed. Soybean plants in an adjacent row were harvested in 6-inch increments extending in both directions from the weeds up to 60 inches for plant counts and harvest analysis. The LAI of soybeans 9 weeks after emergence was always lower when competing with weeds compared to the LAI of soybeans growing in weed-fre plots. The LAI of cocklebur, morningglory and fall panicum was 96, 24, and 26% higher in 15-inch soybean rows compared to 7.5- inch rows. The LAI of soybeans in 15-inch rows compared to 7.5- inch rows was 27 and 38% lower when competing with common cocklebur and pitted morningglory, respectively.

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EFFECTS OF RIMSULFURON ON QUACKGRASS (Elytrigia repens) CONTROL IN FIELD CORN

S. Mitra and P. C. Bhowmik[1]

ABSTRACT

Field experiments were conducted in 1996 at the University of Massachusetts Experiment Station in South Deerfield to determine the effects of POST application of rimsulfuron on quackgrass control in field corn. A tank-mix combination of alachlor and linuron at 1.5 and 1.0 kg ha^{-1} was applied preemergence for the control of annual weeds in a heavily infested quackgrass area. In a split-plot design three growth stages of quackgrass (1- to 2-leaf, 2- to 4-leaf and 4- to 6-leaf stage) and four rates of rimsulfuron (8.8, 17.5, 26.6 and 35.0 g ha^{-1}) and nicosulfuron at 35.0 g ha^{-1} were the two factors taken into consideration. The quackgrass rhizomes were sampled from the field to determine the percent of live and dead rhizomes 9 weeks after treatment (WAT).

Rimsulfuron at 26.6 g ha^{-1} applied at the 2- to 4-leaf stage of quackgrass controlled over 90% of the quackgrass 8 WAT compared to only 43% control obtained from the 1- to 2-leaf stage application. The 2- to 4-leaf and 4- to 6-leaf stage did not influence the activity of rimsulfuron. Rimsulfuron at 35.0 g ha^{-1} injured corn when applied at the 4- to 6-leaf stage. The injury was observed on the leaf apex, margin as well as leaf blade. The leaves had a wrinkled appearance which resembles a typical "unironed cotton shirt". Quackgrass control did not improve with increasing the rimsulfuron rate from 26.6 to 35.0 g ha^{-1}, but rimsulfuron at 35.0 kg ha^{-1} had stunting effect on corn 2 WAT. The stunting effect was reflected by both height and dry weight of corn 4 WAT. However, the injured corn plants recovered by 12 WAT. The quackgrass rhizomes from the rimsulfuron (26.6 kg ha^{-1}) treatment applied at the 2- to 4-leaf stage had only 10% germination compared to 90% germination in the untreated plot.

Rimsulfuron, a sulfonyl urea herbicide, inhibits the protein synthesis, chlorophyll formation and enhances chlorophyll degradation. Therefore, yellowing of quackgrass leaves was observed 3 WAT. The quackgrass leaves treated at the 2- to 4-leaf stage 4 WAT were analyzed for the residual chlorophyll content with a spectrophotometer. The absorbance at 663, 645 and 480 nm wavelength on analysis reflected the results observed in the field. The absorbance was not influenced by increasing the rimsulfuron rates from 26.6 to 35.0 g ha^{-1}. Absorbance at 663 nm wavelength for the untreated sample was 2.999 for rimsulfuron at 8.75, 17.5, 26.6 and 35.0 g ha^{-1} was 2.531, 1.885, 0.636 and 0.3557, respectively. Samples treated with nicosulfuron at 35.0 g ha^{-1} had an absorbance of 2.0927. Our data on chlorophyll content confirms the control of quackgrass.

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HERBICIDE STRATEGIES FOR CONTROL OF ACETOLACTATE SYNTHASE (ALS)-RESISTANT SMOOTH PIGWEED (*AMARANTHUS HYBRIDUS* L.)

M. A. ISAACS, H. P. WILSON, and B. MANLEY[1]

ABSTRACT

Field experiments were conducted in 1994 and 1996 at Marion, MD to evaluate selected PRE and POST herbicide programs for control of ALS-resistant smooth pigweed in soybeans (*Glycine max* L. Merr.). PRE treatments included pendimethalin (Prowl, 1.0 lb ai/A), Prowl (0.25 lb ai/A) in combination with pendimethalin plus imazaquin (Squadron, 0.874 lb ai/A), Prowl (0.25 lb ai/A) plus Squadron (0.874 lb ai/A) plus metribuzin (Sencor, 0.25 lb ai/A), dimethenamid (Frontier, 0.938 lb ai/A) in combination with imazaquin plus dimethenamid (Detail, 0.125 lb ai/A), alachlor (Lasso MT, 2.5 lb ai/A), metolachlor (Dual, 1.5 lb ai/A) in combination with linuron plus chlorimuron (Gemini, 0.45 lb ai/A) in 1994, Dual (1.5 lb ai/A) in combination with metribuzin plus chlorimuron (Canopy, 0.188 lb ai/A) in 1996, and flumetsulam plus metolachlor (Broadstrike + Dual, 2.16 lb ai/A). POST treatments were bentazon plus acifluorfen (Storm, 0.75 lb ai/A), lactofen (Cobra, 0.063 lb ai/A), imazethapyr (Pursuit, 0.063 lb ai/A), Pursuit (0.063 lb ai/A) plus Cobra (0.063 lb ai/A), Pursuit (0.063 lb ai/A) plus acifluorfen (Blazer, 0.25 lb ai/A), Pursuit (0.063 lb ai/A) plus flumiclorac (Resource, 0.026 lb ai/A), and Blazer (0.25 lb ai/A) plus CGA-248757(Action, 0.0026 lb ai/A) with COC (1.0 % v/v) or NIS (0.25 % v/v) plus 30 % UAN (1.0 % v/v).

The experimental design was a randomized complete block with four replications. Plots were 10 feet wide (drilled) by 20 feet long, and treatments were applied with a CO_2 backpack sprayer delivering a spray volume of 25 gpa at 30 psi. Data collected consisted of crop injury and pigweed control. Precipitation for 1994 (drought) and 1995 (above average) was significantly different , which lead to dramatic differences in herbicide efficacy over the two years.

In 1994, PRE applications of Prowl provided an average of 22 % control of smooth pigweed three weeks after treatment (WAT). Gemini plus Dual was the most effective treatment, providing 68 % control. POST applications of Storm, Pursuit plus Blazer, and Blazer plus Action provided good control of smooth pigweed (> 85 %). In 1995, PRE applications of Prowl were more effective compared to 1994, yet still provided poor control. Lasso MT and Dual plus Canopy provided good pigweed control (>80 %), while control with Frontier plus Detail was poor (53 %). The addition of Sencor to Prowl plus Squadron greatly enhanced pigweed control (> 94 %) compared to Prowl plus Squadron alone (20 %) three WAT. POST applications of Cobra, Pursuit plus Cobra, Pursuit plus Blazer, Pursuit plus Resource, and Storm provided good control of smooth pigweed . Early crop injury was noted with Cobra applications, yet minimal late in the season.

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CHEMICAL CONTROL OF YELLOW NUTSEDGE: EFFECT ON CORN SILAGE YIELD AND WEED BIOMASS

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ABSTRACT

The control of yellow nutsedge (*Cyperus esculentus* L.) is becoming a problem for corn producers in the Northeast. Through nutlets and rhizomes, nutsedge is easily spread to many fields on tractors and tillage implements. While many products are registered for use on nutsedge, their effectiveness varies depending on the time of application and environmental conditions. Ultra-low rate herbicides are available that may be environmentally safer to use than the more leachable herbicides used at higher rates. These studies were designed to assess the relative effectiveness of different products and times of application.

The predominant weeds in this study were yellow nutsedge, mustard, and quackgrass. We evaluated three control strategies: pre-plant incorporated, preemergence, and post emergence control measures. Each treatment contained product combinations designed to control those weed species, and all products were applied at recommended rates. Each treatment was applied with a backpack sprayer at 20 gpa and 30 psi. Weed biomass was sampled at canopy closure, and silage was harvested by hand at maturity. For the preplant incorporated and preemergence treatments, we used metolachlor and atrazine. In the postemergence treatments, we compared different modes of actions and times of application. We compared halosulfuron and nicosulfuron applied early and late postemergence (earliest and latest times recommended). We compared a single application of bentazon with an application of Laddok followed by bentazon at the recommended stages of corn development. Lastly, we also evaluated nicosulfuron with pyridate as another total postemergence program. We had hand weeded and untreated control plots.

In 1996, environmental conditions were very wet and cool which influenced both corn and nutsedge growth and development. Nutsedge biomass and relative control are presented in Table 1. We found adequate nutsedge control with metolachlor and atrazine pre-plant incorporated and applied preemergence. Applying Laddok early postemergence followed with a second application of bentazon also provided good nutsedge control. The combination of halosulfuron and nicosulfuron applied early postemergence burned back the nutsedge foliage and controlled other weed species present. All other combinations and times of application were generally ineffective. Highest corn yields were found with the preplant incorporated treatments. Mixing the herbicide in the biologically active zone in the soil helped control nutsedge and other weeds early, allowing the corn to get well established with less competition. We found statistically equivalent silage yields with all treatments where nutsedge control was over 95% compared to the untreated checks. By waiting to apply herbicides until the corn was 6 - 8 inches tall, weed competition was too great and yields were impacted. Conditions were extremely favorable for nutsedge development in 1996. Nutsedge was not completely eliminated with the use of any of these products or times of application. By harvest, there was viable nutsedge in all plots.

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Table 1. Effect of Weed Control Treatment on Weed Biomass and Corn Silage Yields

Product	Rate oz/ac	Nutsedge lb/ac	% Control	Other weed biomass lb/ac	% Control	Silage Yields tons/ac
Control	.....	2012.6 a	.....	1364.5	......	15.7 a
Hand weeded	....	14.7 b	***99.3***	2	***99.9***	22.13 b
metolachlor and atrazine - PPI	32 / 64	50.8 b	***97.5***	640	53.0	22.29 b
metolachlor and atrazine - Pre	32 / 64	81.5 b	***96.0***	0.1	***99.9***	19.17 abc
Laddok + bentazon	(38 / 64) + 38	80.9 b	***96.0***	51	***96.2***	18.99 abc
halosulfuron + nicosulfuron (early-post)	1.0 / 0.66	100.9 b	***95.0***	0.8	***99.0***	19.73 abc
atrazine + bentazon	38 / 64	1883.6 a	6.4	384.8	71.2	14.25 c
halosulfuron + nicosulfuron (late-post)	1.0 / 0.66	1190.0 ab	40.9	303.2	77.8	17.66 bc
pyridate + nicosulfuron	8.0 / 0.66	1867.6 a	7.2	70.1	***94.8***	15.79 c

Weed biomass was sampled at canopy closure approximately 8 weeks after planting.

PHYTOTOXICITY AND EFFICACY OF BALANCE FOR WEED CONTROL IN FIELD CORN

Bradley A. Majek[1]

ABSTRACT

Balance was evaluated in no-till and conventionally planted field corn at Rutgers Agricultural Research and Extension Center in 1996. The Balance rate considered as the use rate in the no-till corn was 0.094 lb ai/a, while the rate used in the conventionally planted corn was 0.070 lb ai/a. Large crabgrass Digitaria sanguinalis (L.) Scop., common lambsquarter Chenopodium album L., and smooth pigweed Amaranthus hybridus L. were present in the no-till study. The weeds in the conventionally planted study were giant foxtail Setaria faberi Herrm., common lambsquarter, smooth pigweed, and wild buckwheat Polygonum convolvulus L. Weed control in the No-till corn was marginally unacceptable, where large crabgrass and smooth pigweed control dropped below eighty percent. Control of weeds in the conventionally planted corn was good with the exception of wild buckwheat which was not controlled by Balance. No corn injury was observed in the no-till study due to Balance applications, but slight, nonsignificant injury was observed in the conventionally planted study. Tank-mixing Balance with atrazine improved weed control, including wild buckwheat, without increasing crop injury. Tank-mixes with Dual or Topnotch increased crop injury and did not control wild buckwheat.

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DETECTION AND MOVEMENT PATTERN OF IMAZETHAPYR IN SELECTED SOILS OF NEW JERSEY

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ABSTRACT

Imazethapyr is among the most widely used herbicides for PRE and POST weed control in legumes in world agriculture. Reports from North America have shown that the herbicide has carryover problems which in some instances have injured susceptible follow crops in conventional crop rotations. Studies have also shown that several factors influence the soil persistence behavior of imazethapyr. It is important to understand clearly under what conditions are the carryover problems most likely to occur so the farmer can take this into account in his crop rotation plans.

Between 1991 and 1995, laboratory and greenhouse studies at the Rutgers Agricultural Research and Extension Center, showed that the degree of sugar beets root length suppression caused by imazethapyr applied at 2.5 ppb to Berryland sand (97% sand, 1.5% organic matter [OM]), increased as soil pH increased from 3.75 to 7.48. Among four soils (pH adjusted to 6.5) compared, the lowest concentrations of imazethapyr detectable with sugar beets root length were 0.5 ppb in acid washed sand (90% sand, 0.04% OM); 1.0 ppb in Berryland sand and Aura loamy sand (82% sand, 0.93% OM); and 5 to 10 ppb in Muck soil (72% sand, 46.48% OM). In Berryland sand (pH 6.5), with normal watering and using sugar beets root length as imazethapyr indicator, the residue of imazethapyr applied to soil columns at 0.07 kg ai/ha, remained in the 0 to 15 cm soil layer for three months after application. The herbicide moved further down to 30-cm depth by the fifth month after application, but residue level dropped significantly in the 0 to 5 cm soil layer. Under low pH (5.5) and room temperature (26.7 °C), low level of imazethapyr residue was detected at 5 to 10 cm soil layer only when the soil moisture level was moderately high (approx. 70% field capacity [FC]). Under neutral pH (7.0) and low temperature (10 °C), the dissipation of imazethapyr was slow with high residue level detected in the 0 to 10 and 0 to 15 cm soil layers under low (approx. 50% FC) and moderately high soil moisture respectively, three months after herbicide application (MAHA). Under neutral pH and room temperature, imazethapyr dissipated rapidly, with low residue level detected in the 0 to 30 cm soil layer under low soil moisture, and very low level detected in the 5 to 30 cm soil layer under moderaletly high soil moisture. Imazethapyr residue was not detected beyond 30-cm soil depth in any of the treatments 3 MAHA.

These studies showed that the bioavailability of imazethapyr is significantly enhanced under high soil pH ($\geq$ 6.5) and as low as 0.5 to 1.0 ppb is detectable in sand and loamy sand soils using sugar beets root length as imazethapyr indicator. It was also demonstrated that residue from imazethapyr applied at 0.07 kg ai/ha, does not move beyond 30 cm in the soil profile up to five months after application; and carryover problem may be most serious in low pH soils limed under low temperature and low moisture conditions.

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EFFECT OF PRE AND POSTEMERGENCE HERBICIDES FOR EASTERN BLACK NIGHTSHADE (Solanum ptycanthum Dun.) CONTROL IN SOYBEANS

E. L. Werner, W. S. Curran, J. O. Yocum and M. J. VanGessel[1]

ABSTRACT

Season-long control of eastern black nightshade(Solanum ptycanthum Dun.) has been difficult due to sporadic emergence and the lack of effective soybean(Glycine max) herbicides. Research conducted at Penn State on current available and experimental herbicides for the control of eastern black nightshade may give producers added options.

Small plot field research was conducted in southeastern Pennsylvania in 1995 and 1996 and Townsend, Delaware in cooperation with the University of Delaware for the 1996 growing season. Soybeans were planted to 30 inch rows for the southeastern PA locations and in drilled rows in DE. Preemergence treatments were applied shortly after planting with a CO_2 backpack sprayer. In 1995, postemergence treatments were applied when nightshade was 1 to 2 inches in height. In 1996, early postemergence treatments were applied when nightshade was less than 1 inch tall, while postemergence treatments were applied at 2 inches or greater in height. Crop phytotoxicity, visual weed control ratings, crop yield, and eastern black nightshade biomass and berry production were measured. Greenhouse research was conducted to evaluate the efficacy of several corn and soybean herbicides, and to support eastern black nightshade field studies.

Field studies indicated that application timing had no effect in southeastern PA, however in DE, better control was achieved with the early postemergence application. The lack of control from the later post treatments was probably due to early canopy closure and poor spray coverage from the late treatment. Lactofen, acifluorfen, imazethapyr, and fomesafen offered the most consistent season-long nightshade control of all the postemergence herbicides examined. Chlorimuron + thifensulfuron offered little to no control at all locations, however the addition of lactofen offered excellent season-long control.

Results with preemergence treatments were variable between study years and locations. In 1995, metolachlor, alachlor, dimethenamid, sulfentrazone, imazethapyr and fluamide + metribuzin all gave 90 to 100% control by the end of the season. Imazaquin, chlorimuron + metribuzin and fluamide all offered 80 to 90% control. In 1996 at the southeastern PA location, metolachlor, sulfentrazone and imazethapyr provided 80 to 90% control by the end of the season. All other preemergence herbicides tested had less than 50% control. No soybean injury was observed at the PA location. Early season ratings for the DE location indicated excellent nightshade control with all preemergence herbicides tested, however, CGA277102II, dimethenamid and chlorimuron + metribuzin provided only 60 to 80% control. Due to the sandy soils at this site, significant soybean injury was observed with several preemergence herbicides.

Research at Penn State indicated that postemergence herbicides were overall less active under greenhouse conditions. Ratings 1 WAA indicated activity with most of the herbicides, however, dry weights 3 WAA indicated nightshade regrowth for most of the treatments. Results from the preemergence greenhouse study support field studies with sulfentrazone, metolachlor, dimethenamid and alachlor providing 80 to 100% control 8 WAA. However, some herbicides including imazethapyr and imazaquin were not as active under greenhouse conditions.

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TRAILERING SAFETY: A TRAINING COURSE DESIGNED FOR AGRICULTURAL RESEARCHERS

D. VanWinkle[1], M. Hackworth[2], and M. Spellicy[3]

ABSTRACT

Towing a loaded trailer behind a pickup truck may be one of the most dangerous aspects of an agricultural researcher's job. We all have a healthy respect for the handling of agricultural chemicals, but do we show the same respect for 10,000 lbs. of trailer and equipment pulled behind a pickup at 55 mph? This has been a safety concern for Cyanamid field researchers. American Cyanamid investigated the availability of trailering safety courses in the U.S. and found only courses for tractor-trailers (18-wheelers) to be readily available. These courses did not meet Cyanamid's needs.

A training facility with the interest and capability of developing and conducting a trailering course for Cyanamid field researchers was found in Alabama. A course was developed at the Alabama Traffic Center, on the campus of the University of Montevallo, Montevallo, Alabama, and was a cooperative effort between the Traffic Center and Cyanamid. It was divided almost equally between classroom and practical, driving range activities. Topics covered included:

1) Legal Considerations of Towing
2) Truck Size and Towing Capacity
3) Trailer Hitches and Tire Requirements
4) Braking Systems
5) Loading and Unloading Trailers
6) Defensive Driving, Principles and Procedures
7) In-Cab Safety Procedures
8) A Variety of Field Exercises

During 1996, all Cyanamid field researchers participated in this two-day course to enhance their skills in safe trailering.

The Alabama Traffic Safety Center will make this course available to other organizations upon request.

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FALLINGSNOW ECOSYSTEM PROJECT: CANOPY STRUCTURE OF COMPETING VEGETATION

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Vegetation around 500 spruce seedlings was characterized and quantified on 4 blocks. Each block contained the following treatments: untreated control, brushsaw, Silvana Selective, Vision® [a.i. glyphosate], and Release® [a.i. triclopyr]). These were monitored 1 and 2 years post-treatment. In August of each year, canopy structure (leaf area index [LAI] and mean tip angles [MTA]) of the vegetation was measured at ground level using a LiCor LAI-2000 Plant Canopy Analyzer. Photosynthetic radiation (PAR) reaching the forest floor also was quantified. In separate surveys, vegetation present in 480 (120/block) 4 m^2 circular sub-plots was categorized into 11 plant groups in both years. Cover and height of each category were estimated to the nearest 5% and 10 cm respectively. A vegetation index (VI = cover x ht) was calculated for each category. All canopy structure and light measurements were analysed using ANOVA procedures.

In 1994 (1 year post-treatment), leaf areas of competing vegetation for all conifer release treatments were lower than that for the untreated control treatment, and correlated well (~ 60%) with calculated VI values for the same treatments. The lowest mean LAI was for the Vision® treatment, and differed from all other release treatments. MTA did not differ among treatments. PAR on the forest floor was lowest for the untreated control treatment, highest for the Vision® treatment, and intermediate for all other treatments.

In 1995 (2 years post-treatment), leaf areas of the vegetation for the release treatments was again lower than that for the untreated control treatment. In addition, LAI values were lower (0.4 to 1.1 $m^2\ m^{-2}$) for all treatments on all blocks. Vegetation indices were generally lower in 1995 than in 1994 for herbs, ferns, grasses, sedges, and rushes. They were generally higher in 1995 than in 1994 for conifers, deciduous trees, and shrubs. In 1995, MTA were higher (5.0 to 18.0 °) for all treatments on all blocks.

Because of reduced soil moisture levels in 1995 (20.0% less rain in early summer), leaf elongation was likely reduced resulting in lower LAI values. This decrease was most likely caused by a reduction in leaf area for herbs, ferns, grasses, sedges, and rushes, as evidenced by lower VI values for these plant categories. Plants growing in the forest shrub and tree layers (e.g., hazel and aspen) were apparently less affected by this drought than those in the forest herbaceous layer, presumably because of deeper rooting. During periods of drought, LAI has been observed to decrease from levels normally observed when soil moisture is not limiting.

EVALUATION OF WILDFLOWER ESTABLISHMENT IN TURFGRASSES SUPPRESSED WITH HERBICIDES

Chad W. Spackman, Jon M. Johnson, and Larry J. Kuhns[1/]

ABSTRACT

As part of a cooperative research project between the Pennsylvania Department of Transportation and the Pennsylvania Department of Transportation, a study was conducted in 1995 in which annual flowers were established in tall fescue (*Festuca arundinacea* Schreb.) suppressed with herbicides. The objective was to establish flowers in a suppressed turf that could be mowed in the fall, leaving a stand of established turf. A similar study was established in 1996. Treatments included an untreated check; glyphosate at 0.25, 0.50, 0.75, and 4 lbs/ac; ethephon[2/] at 8 lbs/ac; trinexapac-ethyl at 0.375 and 0.75 lbs/ac; ethephon plus trinexapac-ethyl at 8 and 0.375 lbs/ac, respectively; and imazameth at 0.032 lbs/ac plus 0.125% (v/v) QwikWet 357. All treatments contained Polytex A1001 drift control at 0.25% (v/v). The study area was arranged in a randomized complete block design with three replications. Treatments were applied to 6 by 10 ft plots in an unmowed, mixed stand of tall fescue and Kentucky bluegrass (*Poa pratensis* L.) on May 3, 1996, using a CO_2-powered sprayer equipped with Spraying Systems XR 8004 VS spray tips, delivering 40 GPA at 35 psi. On May 10, 7 days after treatment (DAT), the untreated check was mowed to 1.25 in and clippings removed; the entire study area was verticut two times to a depth of 0.5 in and excess thatch was removed; plots treated with glyphosate at 4 lbs/ac were rototilled to simulate a conventional seeding method; and all plots were seeded with annual flowers at 12 lbs/ac. The annual flower mix contained 68% cosmos (*Cosmos bipinnatus* Cav.), 21.5% cornflower (*Centaurea cyanus* L.), and 10.5% tall plains coreopsis (*Coreopsis tinctoria* Nutt.). The study area was mowed September 25. Turf green cover ratings were taken May 3; May 10; June 4, 32 DAT; July 25, 83 DAT; and October 10, 160 DAT. Average canopy height of the turf was measured at each rating period. A ground cover rating of weed pressure in each plot was taken September 10, 130 DAT. Ratings of ground cover and average heights of the flowers were taken July 25 and September 10. Results of turf ratings are reported in Table 1a and flower ratings in Table 1b.

Plots initially showed no differences in the amount of desirable turf and contained little weed pressure. No turf was present throughout the study in the plots treated with 4 lbs glyphosate and rototilled. The mowed check, ethephon alone, and both trinexapac treatments alone, provided significantly more green cover on June 4 than all other treatments. Only the 0.75 lb rate of glyphosate significantly reduced the turf cover compared to the mowed check in July and October. Glyphosate severely injured the bluegrass but only suppressed the tall fescue. No differences in turf height were observed at any rating period, with initial heights of 5 in and final heights of 14 in. There was a significant difference in the weed pressure at the end of the study, with glyphosate at 0.75 lb plots having 50 percent cover. Glyphosate treated plots at 0.5 and 4 lbs, also had significantly more weeds than the mowed check and plant growth regulator treatments. Glyphosate treated plots provided significantly higher wildflower cover than other treatments at both rating periods. At the September rating, glyphosate at 4 lbs provided the tallest wildflowers with an average of 50 in, and the other glyphosate plots had heights from 31 to 39 inches. The mowed check average height was 20 in. All three species germinated in all plots.

Glyphosate at 4 lbs/ac plus rototilling resulted in increased wildflower cover and height, however no desirable turf remained Glyphosate at 0.75 lbs/ac resulted in increased wildflower cover and height but thinned the turf and had the highest percentage weed cover at the end of the study. Glyphosate at 0.5 lb/ac provided an acceptable stand of wildflowers and desirable turf. The mowed check and plant growth regulator treatments had no reduction in turf and little weed invasion, but had poor stands of wildflowers.

[1/] Research Technologist, Project Assistant, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA.

[2/] Ethrel, 4 lbs ethephon/gal, Rhone-Poulenc, is not currently labeled for use on turf.

TABLE 1a: Herbicide treatments were applied May 3, 1996. Green cover ratings of turfgrass were taken May 3, May 10, June 4, July 25, and October 10, 1996. A weed cover rating was taken September 10, 1996. Turf canopy heights were taken at each rating period, however there was no significant differences. Each value is the mean of three replications.

Herbicide[1/]	Application Rate	Green Cover May 3	May 10	Jun 4	Jul 25	Oct 10	Weed Cover Sep 10
	(lbs/ac)	(%				)	(%)
mowed check	- -	98	100	97	98	99	1
glyphosate	0.25	89	83	76	79	96	11
glyphosate	0.5	99	82	48	78	92	20
glyphosate	0.75	99	77	22	35	78	50
glyphosate	4	98	58	0	0	0	33
ethephon[2/]	8	99	99	94	98	98	1
trinexapac-ethyl	0.375	99	98	95	98	99	0
trinexapac-ethyl	0.75	95	99	90	98	99	1
ethephon[2/] trinexapac-ethyl	8 0.375	99	97	89	98	98	1
imazameth[3/]	0.032	92	97	78	97	99	1
Significance Level (p)		0.15	0.0001	0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)		n.s.	6	7	22	11	13

TABLE 1b: Herbicide treatments were applied on May 3, 1996, and the wildflowers were seeded at 12 lbs/ac on May 10, 1996. Ground cover ratings and average canopy heights of wildflowers were taken July 25 and September 10, 1996. Each value is the mean of three replications.

Herbicide[1/]	Application Rate	Ground Cover Jul 25	Ground Cover Sep 10	Canopy Height Jul 25	Canopy Height Sep 10
	(lbs/ac)	(%	)	(in	)
mowed check	- -	10	20	11	20
glyphosate	0.25	27	50	20	31
glyphosate	0.5	55	82	23	37
glyphosate	0.75	80	93	29	39
glyphosate	4	83	97	32	50
ethephon[2/]	8	10	11	11	22
trinexapac-ethyl	0.375	8	23	11	20
trinexapac-ethyl	0.75	10	27	12	24
ethephon[2/] trinexapac-ethyl	8 0.375	13	24	13	25
imazameth[3/]	0.032	8	30	11	25
Significance Level (p)		0.0001	0.0001	0.0001	0.0001
LSD (p=0.05)		12	15	4	7

[1/] All treatments contained Polytex A1001 drift control agent (Exacto Inc.) @ 0.25% (v/v).
[2/] Ethrel, 4 lbs ethephon/gal, Rhone-Poulenc, is not labeled for use on turf.
[3/] Also contained QwikWet 357 (Exacto Inc.) @ 0.125% (v/v).

FALLINGSNOW ECOSYSTEM PROJECT: MICROCLIMATE

P.E. Reynolds[1], J.A. Simpson[2], R.A. Lautenschlager[3], F.W. Bell[3], A.M. Gordon[2], D.A. Buckley[1], and D.A. Gresch[2]

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Eight Licor weather stations were used to monitor 2 blocks and 4 treatments (unharvested control, untreated control, Vision® [a.i. glyphosate], and brushsaw in 1994 and 1995 (i.e., 1 and 2 years post-treatments. Efforts in 1995 were intensified on blocks 2 (drier, cooler) and 3 (wetter, warmer) to capitalize on microclimatic extremes identified in 1994. Fiberglass thermister/resistance soil cells were also installed at 15 and 30 cm depth at 5 locations/ treatment, inclusive of all 4 blocks and remaining treatments (Silvana Selective and Release® [a.i. triclopyr]). The cells were read bimonthly to determine soil moisture and temperature.

All release treatments increased the amount of photosynthetic radiation (PAR) above (2.0 m) or on the forest floor in 1994. By August, regrowth of non-spruce vegetation resulted in a decline in forest floor PAR for both brushsaw and Vision® treatments, but this decline occurred sooner for the Vision® treatment. The type of regrowth controlled the degree of forest floor irradiation. This was primarily herbaceous (Vision®) and resprouting brush (brushsaw). Increased solar radiation on the forest floor resulted in significant soil warming (duff [~ 5 cm], 15 cm, 30 cm) for release treatments. They were highest for the Vision® and Release® treatments. Mean temperatures near (0.25 m) and 2.0 m above the forest floor did not differ among clearcut treatments by mid-August. Temperatures near the forest floor were generally cooler in late summer than those at 2.0 m; highest for Vision®, intermediate for brushsaw, and lowest for untreated control. Concurrently, relative humidity (RH) near the forest floor was lowest for Vision®, intermediate for brushsaw, and highest for untreated control. Soil moisture levels were highest for conifer release treatments in 1994, but significant differences among these treatments were rarely observed. However, they tended to be highest for the 2 herbicides.

Cumulative precipitation (205.0 mm, June 1 through September 5) was approximately 20% less in 1995 than in 1994. However, by November 6, cumulative precipitation for 1995 (422.0 mm) exceeded that attained in 1994 (336.0 mm). More light was measured on the forest floor for all treatments in 1995 than in 1994, probably because of lower leaf area index resulting from mild drought conditions. Treatment differences persisted into the second post-treatment growing season (1995), especially for soil temperatures, forest floor PAR, and soil moisture. Often these parameters were statistically higher for the two chemical treatments. Significant treatment differences observed for RH near the forest floor in 1994, narrowed or became nonsignificant, likely because of increased revegetation of treated areas. Overall, the 2 control treatments were similar, and the 2 conifer release treatments were similar.

EVALUATION OF BRUSH CONTROL PROVIDED BY ACCORD WITH BASAL BARK APPLICATIONS

Chad W. Spackman, Jon M. Johnson, and Larry J. Kuhns[1/]

ABSTRACT

As part of a cooperative project between the Pennsylvania State University and the Pennsylvania Department of Transportation, a trial was established evaluating the effect of herbicides on the control of tree-of-heaven or ailanthus (*Ailanthus altissima* Mill.), green ash (*Fraxinus pennsylvanica* Marsh.), and red maple (*Acer rubrum* L.) treated with basal bark applications. Treatments included an untreated check, Accord[2/] in combination with Stalker[3/], QwikWet M-399 EX, or water; Accord in combination with Thinvert R[4/]; Garlon 4[5/] plus Penevator Basal Oil; and a combination of Krenite S[6/], Stalker, QwikWet M-399 EX, and water. Treatments were applied to three separate colonies, or replications, of ailanthus divided into equal portions on April 12 and 15, 1996, near Lewistown, PA. Treatments were applied to ten stems each of green ash near Port Matilda, PA, on April 10; and red maple on April 5 near Ebensburg, PA. The experimental layout for ailanthus was a randomized complete block design with three replications; and the layout for ash and maple was completely randomized, with each stem being an experimental unit. Treatments of Accord in combination with only QwikWet M-399 EX plus water or with Thinvert R were applied at a coverage up to a height of 24 in, and all other treatments were applied to a height of approximately 12 in. Application equipment included a CO_2-powered hand held sprayer equipped with a Spraying Systems #5500 adjustable cone jet with a Y2 nozzle, operating at 25 psi. Stem diameters ranged from 0.25 to 5 in for ailanthus, 1 to 6.25 in for ash, and 1 to 5.5 in for maple, with an overall average of 2.5 in. Ratings of tree injury were taken August 9 and 13 for ash and maple, respectively; while tree injury and percent groundcover of resprouts was rated for ailanthus on September 16, 1996. Injury was rated on a scale of 1 to 10; in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. The data were subjected to analysis of variance. Analysis of covariance was used to adjust tree injury values according to stem caliper in ash. Results are reported in Table 1.

Garlon 4 and Krenite S plus Stalker were the only treatments that provided excellent control of all three species. They also allowed little resprouting of ailanthus. Accord plus Stalker provided good control of all three species and ailanthus resprouting.

Accord plus Thinvert R provided no control of maple and poor to moderate control of ash and ailanthus. Accord plus QwikWet M-399 EX provided moderate to excellent control of maple and ailanthus.

Garlon 4 is still the standard by which other basal bark treatments must be judged. Krenite S plus Stalker and Accord plus Stalker provided moderate to excellent control, but at higher cost and risk to adjacent desirable vegetation. QwikWet M-399 EX is a much better surfactant to use with basal bark applications of Accord than Thinvert R.

[1/] Research Technologist, Project Assistant, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA.

[2/] Accord, 4 lb glyphosate/gal, Monsanto Co., St. Louis, MO.

[3/] Stalker, 2 lb imazapyr/gal, American Cyanamid Co., Wayne, NJ.

[4/] Thinvert R, Waldrum Specialties, Doylestown, PA.

[5/] Garlon 4, 4 lb triclopyr ester/gal, DowElanco, Indianapolis, IN.

[6/] Krenite S, 4 lb fosamine ammonium/gal, E.I. du Pont de Nemours and Co., Wilmington, DE.

TABLE 1: Tree injury provided by various basal bark treatments applied to green ash plots April 10, red maple April 5, and ailanthus April 12 and 15, 1996. Treatments were rated August 9 and 13, 1996, for ash and maple, respectively; and September 16 for ailanthus. Average injury was visually rated on a scale of 1 to 10, in which '1' indicates no injury, '5' indicates moderate defoliation including the terminal, and '10' indicates complete control of the treated stem. Each value is the mean of three replications for ailanthus and ten replications for green ash and red maple.

Herbicide	Application Rate	Average Tree Injury Rating: Green Ash[1/]	Average Tree Injury Rating: Red Maple	Average Tree Injury Rating: Ailanthus	Groundcover of Ailanthus Resprouts
	(% v/v)	(---------- average injury rating		----------)	(%)
Untreated Check	- -	1.7 d	1.0	1.3	5
Accord	10	8.8 a	2.7	5.7	47
QwikWet M-399 EX	45				
Water	45				
Accord	25	8.9 a	5.3	9.3	68
QwikWet M-399 EX	37.5				
Water	37.5				
Accord	50	9.1 a	9.0	4.7	37
QwikWet M-399 EX	25				
Water	25				
Accord	10	4.4 c	1.0	7.0	70
Thinvert R	90				
Accord	25	5.5 bc	1.4	6.0	66
Thinvert R	75				
Accord	50	6.6 b	1.2	6.7	43
Thinvert R	50				
Garlon 4	20	9.9 a	10.0	10.0	9
Penevator Basal Oil	80				
Accord	50	10.0 a	6.0	6.7	2
Stalker	5				
QwikWet M-399 EX	22.5				
Water	22.5				
Krenite S	50	9.2 a	7.9	8.3	3
Stalker	5				
QwikWet M-399 EX	22.5				
Water	22.5				
Significance Level (p)		0.0001	0.0001	0.003	0.02
LSD (p=0.05)		- -	1.8	3.4	47

[1/] Means adjusted by analysis of covariance according to stem caliper.

EVALUATION OF BURN-DOWN MATERIALS FOR TOTAL VEGETATION CONTROL UNDER GUIDERAILS

Jon M. Johnson, Chad W. Spackman and Larry J. Kuhns[1/]

ABSTRACT

A study evaluating glufosinate-ammonium (glufosinate) and pelargonic acid (Scythe[2/]) for total vegetation control along roadsides was initiated as part of a cooperative project between The Pennsylvania State University and The Pennsylvania Department of Transportation. Roadside treatments were applied to 3 by 25 ft plots located along a guiderail near State College, PA, on July 20, 1996; using a CO_2-powered hand held sprayer. To compare any potential differences in spray volumes, 40 GPA and 80 GPA were both applied using either two Spraying Systems OC-04 spray tips at 23 psi or two OC-08 spray tips at 36 psi, respectively. Visual ground cover ratings of annual and perennial weed species were taken July 18, to assess the original weed pressure and July 29, 9 days after treatment (DAT); August 30, 41 DAT; and October 4, 1996, 76 DAT. Predominant weed species were common lambsquarters (*Chenopodium album* L.), common ragweed (*Ambrosia artemisiifolia* L.), wild carrot (*Daucus carota* L.), wild parsnip (*Pastinaca sativa* L.), spotted knapweed (*Centaurea maculosa* Lam.), chicory (*Cichorium intybus* L.), white sweetclover (*Melilotus alba* Medik.), giant foxtail (*Setaria faberi* Herrm.), and green foxtail (*Setaria viridis* L.).

The initial green cover ratings were, on average, between 78 and 94 percent for all plots. Glufosinate was the only postemergent product that provided significant early signs of necrosis to the treated plants 9 DAT. By 41 DAT, treatments containing sulfometuron methyl and diuron combined with a postemergent product and imazapyr plus diuron provided significantly better control than all other treatments, with green cover 15 percent or less. Glufosinate alone; glufosinate plus 2,4-D; glufosinate plus imazapyr; Scythe plus glyphosate; and sulfometuron methyl plus diuron all provided poor control.

All treatments began to show an increase in weed pressure 76 DAT. The glufosinate, glufosinate plus 2,4-D, and glyphosate all continued to show excellent long-term control when used in combination with sulfometuron methyl and diuron. The imazapyr and diuron mix also maintained excellent control at this rating period.

Glufosinate, when tank mixed with sulfometuron methyl and diuron, provided statistically similar results at both the 0.5 and 1 lb/a rates. Glyphosate at 2 lb/a performed well at both 41 DAT and 76 DAT when tank mixed with sulfometuron methyl and diuron. Reducing the rate of glyphosate to 1 lb/a and adding Scythe did not significantly reduce control. Treatments 10 and 12 compared Scythe, glyphosate, sulfometuron methyl, and diuron at 40 versus 80 GPA. There was no statistical difference noted at any rating period between these two treatments.

If both rapid burndown and long-term control control are desired, glufosinate at both 0.5 and 1 lb/a, and glufosinate plus 2,4-D , when combined with sulfometuron methyl and diuron can be used.

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[2/] Scythe, 57% pelargonic acid, Mycogen Corp.

TABLE 1: Green cover ratings of weed species located under a guiderail near University Park, PA. Treatments were applied July 20, 1996. Green cover ratings were taken July 18 and 9, 41, and 76 DAT. Ratings are the mean of 3 replications. Unless indicated otherwise, all treatments were applied at 40 GPA.

Treatment[1/]	Application Rate	Green Cover of Weed Species Jul 18	9 DAT	41 DAT	76 DAT
	(lbs/ac)	(%)	(%)	(%)	(%)
1. Untreated Check	---	83	82	85	87
2. glufosinate	1	82	5	62	75
3. glufosinate 2,4-D	1 0.95	81	4	42	65
4. glufosinate sulfometuron methyl diuron	1 0.14 4.8	84	4	4	7
5. glufosinate 2,4-D sulfometuron methyl diuron	1 0.95 0.14 4.8	81	4	2	5
6. sulfometuron methyl diuron	0.14 4.8	94	73	75	88
7. glyphosate sulfometuron methyl diuron	2 0.14 4.8	85	47	7	17
8. glufosinate sulfometuron methyl diuron	0.5 0.14 4.8	89	7	7	15
9. glufosinate imazapyr	1 0.094	89	7	62	78
10. Scythe[2/] glyphosate sulfometuron methyl diuron	0.5 gal 1 0.14 4.8	78	52	15	32
11. Scythe @ 80 GPA glyphosate	0.5 gal 1	88	72	86	88
12. Scythe @ 80 GPA glyphosate sulfometuron methyl diuron	0.5 gal 1 0.14 4.8	86	50	13	28
13. Scythe @ 80 GPA glyphosate sulfometuron methyl diuron	0.375 gal 1 0.14 4.8	94	57	14	35
14. Scythe @ 80 GPA glyphosate sulfometuron methyl diuron	0.25 gal 1 0.14 4.8	81	52	14	28
15. imazapyr @ 80 GPA diuron	0.75 6	91	67	4	11
Significance Level (p)		n.s.	0.0001	0.0001	0.0001
LSD (p=0.05)		--	14	17	21

[1/] All treatments except those with glyphosate contained QwikWet 357 (Exacto Chemical Co.) @ 0.125% (v/v) and all treatments contained Polytex A1001 @ 0.25% (v/v).
[2/] Scythe, 57% pelargonic acid, Mycogen Corp. Application rate listed above for Scythe is in gal product/ac.

FALLINGSNOW ECOSYSTEM PROJECT: WHITE SPRUCE GAS EXCHANGE

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Stomatal conductance (g_s), transpiration (E), and photosynthesis (NA) were measured using a LiCor LI-6200 Portable Photosynthesis Unit for 225 white spruce seedlings in late July 1994 on 3 blocks and 5 treatments/block (harvested control, brushsaw, Silvana Selective, Vision® [a.i. glyphosate], and Release® [a.i. triclopyr]), 1 year post-treatment. Five seedlings were tagged at each of 3 soil temperature/moisture cell locations/treatment. Photosynthetic radiation (PAR) reaching the upper crowns of these seedlings was quantified during gas exchange measurements, along with air and leaf temperatures and leaf vapour pressure deficits (VPD). Concurrently, midday and pre-dawn plant water potentials of these seedlings were measured using a pressure bomb. Height and stem density of shrub, deciduous, and coniferous species surrrounding (1 m^2) each seedling were measured. A competition index (CI = ht x density) was calculated. All data were analyzed using ANOVA procedures.

Conditions for gas exchange were similar on each of three measurement days (1 day/block). Air temperature averaged 28° C and relative humidity 85% during measurements (1200 to 1800 h EST). Soil moisture averaged 38% over all treatments. Vapour pressure deficits were well maintained during measurements, averaging 22.0 kPa, and did not differ among treatments. PAR averaged 1200 umol s^{-1} m^{-2} for all conifer release treatments and was reduced by half for the control treatment. Because of frequent rains in 1994, seedlings were not stressed for water and demonstrated considerable capability to recover from minimal to mild (- 0.7 to - 1.2 MPa) midday water stress. Midday water potentials did not differ significantly between treatments. However, the highest midday water potentials were observed for the 2 herbicide treatments.

Transpiration rates did not differ among treatments, but were highest for Release, Silvana Selective, and Vision treatments and lowest for control and brushsaw treatments. Stomatal conductance differed among treatments, following a similar trend to that observed for transpiration. Photosynthesis increased 1.4 x over controls following the herbicide treatments, and increases were slightly less (1.3 x) following the cutting treatments. Greater photosynthesis for the 2 herbicide treatments was attributed to greater PAR and higher soil moisture for these treatments as compared with the 2 cutting treatments. Although water use efficiency (WUE = NA/E) values averaged 1.2 x higher for all conifer release treatments, they did not differ from each other or from that for the control treatment.

EXOTIC URBAN ARBORESCENT VEGETATION AT HOME SITES, NEW YORK CITY, NEW YORK

Richard Stalter[1]

ABSTRACT

Trees found at forty home sites, Jamaica Estates, New York City, New York, were selected for study October 15 to November 7, 1995. Trees with a DBH (diameter at breast height) greater than 7.6 cm were identified and mapped at each property. Density, relative density, frequency, relative frequency, basal area, relative dominance and importance values for all trees with a DBH greater than 7.6 cm were calculated. Black oak (Quercus velutina) and red oak (Quercus rubra) ranked first and second in relative dominance and importance; oaks (Quercus spp.) collectively have a relative dominance value of 81. Seventy percent of the non-native species occur in the smallest size class category (7.5 25.0 cm), while oaks are most abundant in the three largest size class categories. The transition to a forest of non-native species may be a very gradual process because of the longevity of oaks.

INTRODUCTION

The objective of the present study is determining exotic urban tree diversity by mapping, identifying and measuring DBH (diameter at breast height) of trees at forty home sites at Jamaica Estates, New York City, New York (40 47'N Latitude, 73 38'W Longitude). This study is the first of its kind in the northeastern United States. Jamaica Estates, the site where this study was conducted, lies on the end of the Harbor Hill Moraine, and exhibits a knob and kettle topography.[3] The glacial till is 3 m. to 6 m. deep and is underlain with coarse sand and gravel.The soils at the home sites are classified as Miami Stony Loam. The upper layer of soil, extending from the surface depth of 20-35 cm. is brown loam. Yellow loam forms the subsoil at a depth of 76 cm .[11]

METHODS

The forty home sites selected for study October 15 to November 7, 1995, are located at Jamaica Estates, Queens County, New York. Criteria used in selecting homes for study include the owners' permission and presence of mature trees when the homes were constructed, 1929 to 1953. Trees growing at the home sites were mapped, and the DBH of each tree was recorded. Only trees with a DBH greater than 7.6 cm were sampled. Tree DBH was converted to basal area.

Density (average number of trees per quadrat), relative density (percent density), frequency (percent quadrats occupied by each species), relative frequency and relative dominance (percent basal area), and importance value (the sum of the relative density, relative frequency and relative dominance) were calculated for all trees found at the home sites. Since native trees far outnumbered introduced (planted) non-native trees, separate tables for native trees (Table 1), native planted trees, and non-native planted trees (Table 2) were recorded.

RESULTS

Black oak (Quercus velutina) is the most abundant tree at the home sites with the highest relative dominance value and importance value (Table 1). Red oak (Quercus rubra) ranks second in relative dominance and importance, and third in abundance. Dogwood (Cornus florida) ranks second in abundance, and third in importance, but because of its small size has a relative dominance value of 2.1. Most of the dogwood at the home sites has been planted. Black

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cherry (Prunus serotina) ranks fourth in relative abundance, and occupies 27.5 percent of the home sites. Prunus serotina, a successional species, has a low relative dominance value of 2.7.

Other important trees at urban home sites are red oak, white oak(Quercus alba) and scarlet oak Quercus coccinea) (Table1). These oaks rank two, three, and four respectfully in relative dominance and two, four and eight respectfully in importance.

Trees planted at the home sites including exotic ornamentals, North American species not native to the New York City region and native species have been placed in a separate table, Table 2. Dogwood, a native species, is the most abundant tree, occurring at nearly half of the home sites. Pin oak (Quercus palustris), a native species, ranks second in density and frequency. Pin oaks are commonly planted along city streets in the northeastern United States. Canadian hemlock (Tsuga canadensis), a species native to northern Queens [6] has the second highest density, yet ranks eighth in frequency (percent home-sites occupied). The aforementioned data reflects the use of Tsuga canadensis) as a hedge-row tree. Homeowners plant T. canadensis along property boundaries to provide privacy; the low frequency values indicate that few people at Jamaica Estates plant Canadian hemlock on their property. All hemlocks observed were heavily infested with the woolly adelgid, and are declining.

Two exotics, Japanese maple (Acer palmatum) and Norway maple (Acer platanoides) have been planted at approximately one quarter of the home sites. Ten species are represented by only one or two trees (Table 2).

COMPARISONS WITH OTHER URBAN STUDIES

Urban arborescent vegetation has not been intensively studied [3]. The few studies of urban vegetation within or near New York City include those of Greller [5], Lefkowitz and Greller [8], Airola and Buchholtz[1] Stalter [11] and Stalter and Serrao [12]. Waldron and Dyck [13], Dorney et al. [3], Schmid [10] and Lawson et al [7] have examined lot locations of trees and shrubs in an urban environment.

Schmid [10] researched urban arborescent and frutescent vegetation in several Chicago, Illinois suburbs. The most common trees found at home lots in Schmid's study were elm, silver maple, ash, Norway maple, hawthorn, and bur oak. Schmid compared the vegetation of five neighborhoods reflecting socioeconomic factors on vegetation. He reported that older, wealthier suburban neighborhoods tended to have dense plantings of trees and shrubs, while those in urban areas were more open reflecting differences in age and socioeconomic status of the neighborhoods.

Lawson et al. [7]studied sixty-five lots in 1971 and 1972 in Nakoma Woods, an urban neighborhood in Madison, Wisconsin. In this study, which is comparable to the present study, trees were mapped and trunk diameters measured for future reference. Ulmus americana, Quercus alba (25.7) and Quercus velutina (11.3) ranked one, two, and three in relative dominance.

Not surprisingly, there is a wide range in dominant species in urban locations that reflect climate, soils and pre-existing vegetation. Human factors such as homeowner preference also accounts for differences in species composition, especially differences in the numbers, frequency, and kind at home sites. Socioeconomic status may also account for vegetation differences.[3,10]

There are many large trees at both the home sites and at a nearby New York City Park, Alley Park, including some individual trees with a DBH greater than 100 cm. (Figure 1). The home sites have a low percentage of native trees in the two smallest size classes as few invading trees at the home sites are permitted to grow to maturity. Successional species such as Prunus serotina are generally found along property boundaries or on steep slopes where lawns are nonexistent or poorly maintained. By contrast, many trees are reproducing in Alley Park and are well represented in all size classes.

The arborescent composition of the urban arborescent ecosystem at Jamaica Estates is unique as it is similar to that found in nearby Alley Park today and was similar to the forest of northern Queens County eighty years ago [6] and that of the precolonial forest in northern Queens. By comparison, studies by Dorney et al. [3], Schmid [10], and Waldron and Dyck [13]report a distinct type of urban forest on city lots, one that differs from nearby regional forests.

The developing urban forest at Jamaica Estates is approaching a post-developmental stage, with the death of relic trees and their replacement by planted trees, especially non-native species. The transition to a forest of non-native species may be a very gradual process because of the age structure of oaks and because black, red, and white oaks have been reported to live for three to five hundred years. Oaks are most numerous in the largest three size classes, but comprise a small percentage of the two smaller size classes which presumably contain the youngest trees (Figure 1). Non-native trees makeup seventy percent of the smallest size class category and native trees other than oaks are more numerous than oaks in the smallest two size class categories.

The most important factor influencing the tree composition in Jamaica Estates was the initial decision of the developer to preserve certain trees present at the site when the homes were constructed. The presence of the large number of non-native trees in 1995 and planted native trees such as Cornus florida and Tsuga canadensis represents the personal preference of the home owner. Survival and growth of trees at this urban site in the future will partially depend on the preference of the home owner for specific trees.. The hemlock woolly adelgid, Adelges tsuga may kill Canadian hemlock, (Tsuga canadensis) in the future while dogwood anthracnose, Discula destructiva, is the agent responsible for dogwood decline.[9] Oak decline may be hastened if the trees experience two or more consecutive years of defoliotion by the gypsy moth, Lymantria dispar.

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Table 1. Density, (D), relative density (RD), Frequency (F), relative frequency (RF), relative dominance (RDo), and importance values (IV), for native trees at 40 home sites, New York City, New York.

SPECIES	D	RD	F	RF	Rdo	IV
Quercus velutina	1.125	23.2	55.0	18.0	47.6	88.8
Quercus rubra	0.70	13.8	32.5	10.7	19.8	44.3
Cornus florida	0.775	15.3	47.5	15.6	2.1	33.0
Quercus alba	0.40	7.88	27.5	9.0	8.82	25.6
Prunus serotina	0.50	9.9	27.5	9.0	2.17	21.1
Carya glabra	0.30	5.91	25.0	8.2	4.2	18.3
Quercus coccinea	0.20	2.54	3.9	4.1	4.91	13.0
Carya tomentosa	0.225	4.43	12.5	4.1	2.5	11.0
Sassafras albidum	0.175	3.04	15	4.9	2.2	10.1
Betula lenta	0.25	4.9	12.5	4.1	0.52	9.5
Fraxinus americana	0.10	1.97	10.0	3.3	2.4	7.7
Liquidambar Styraciflua	0.075	1.48	7.5	2.5	1.6	5.6
Acer rubrum	.075	1.48	7.5	2.5	0.94	4.9
Morus alba	0.075	1.48	7.5	2.5	0.36	4.4
Ulmus americana	.05	.99	5.0	1.6	0.1	2.7

Table 2. Density and frequency values for trees planted at home sites, New York City, New York. (1) Trees indigenous to the New York City region.

Species	**Density**	**Frequency**
Cornus florida[1]	.775	47.5
Quercus palustris[1]	.34	22.5
Tsuga canadensis[1]	.325	12.5
Acer palmatum	.275	22.5
Acer platanoides	.25	17.5
Magnolia soulangeana	.25	20.0
Thuja occidentalis	.25	10.0
Pyrus malus	.25	15.0
Prunus avium	.20	17.5
Picea abies	.175	15.0
Taxus spp.	.175	7.5
Picea pungens	.075	7.5
Prunus serrulata	.05	2.5
Cornus Kousa	.05	5.0
Robinia pseudoacacia[1]	.05	5.0
Platanus occidentalis[1]	.05	5.0
Pinus strobus	.025	2.5
Catalpa bignonioides[1]	.025	2.5
Betula populifolia[1]	.025	2.5
Cercis canadensis	.025	2.5
Crataegus sp.	.025	2.5
Pyrus communis	.025	2.5

A NEW BROADSPECTRUM HERBICIDE FOR SPECIALTY CROPS

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ABSTRACT

Azafenidin (DPX-R6447) herbicide represents a new family of chemistry to be used for weed control in apples (Malus domestica Borkh.), stone fruits (Prunus spp.), and other specialty crops. It is an highly effective herbicide characterized by low use rates. Preliminary toxicology studies indicate this herbicide has low acute oral and dermal toxicity. Apples, established stone fruits, and other specialty crops have demonstrated excellent tolerance to azafenidin when used for preemergence or postemergence weed control. Studies to date indicate no phytotoxicity or maturity delays resulting from the use of this herbicide. Preemergence applications of azafenidin, or postemergence applications tank mixed with glyphosate or paraquat, have resulted in control of many problem weeds including: common lambsquarters (Chenopodium album L.), redroot pigweed (Amaranthus retroflexus L.), groundsel (Senecio vulgaris L.), Queen Anne's lace (Daucus carota L.), Pennsylvania and ladysthumb smartweed (Polygonum pensylvanicum and P. persicaria L), red sorrel (Rumex acetosella.L.), common ragweed (Ambrosia artemisiifolia L), common chickweed (Stellaria media L.), giant foxtail (Setaria faberi Herrm.), barnyardgrass (Echinochloa crus-galli (L.) Beauv.), large crabgrass (Digitaria sanguinalis (L.) Scop.), and yellow nutsedge (Cyperus esculentus L.).

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COMPARISON OF ATRAZINE AND PROSULFURON COMBINATIONS WITH PREEMERGENCE HERBICIDES IN SWEET CORN

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ABSTRACT

A study was initiated for fresh market sweet corn (Zea mays saccharata L.) to determine optimum reduced rate combinations of standard labeled herbicides and to evaluate unlabeled and recently labeled herbicides as alternatives to the standards. A 1996 field trial conducted on the Plant Science Research Farm in Storrs, Ct evaluated four preemergence herbicides applied alone and in combination with atrazine applied preemergence or prosulfuron (Peak) applied postemergence. The study was a split plot design with three replications. The main plots were atrazine applied at 1.0 lb ai/A, prosulfuron applied at 0.036 lb ai/A, and the preemergence herbicide (PRE) treatments applied alone. The sub-plot treatments and applied rates were: metolachlor[(Dual II) 2 and 2.5 lb ai/A],dimethenamid [(Frontier) 0.94 and 1.17 lb ai/A], alachlor [(Lasso MT) 2 and 2.5 lb ai/A], and pendimethalin [(Prowl) at 1.25 and 1.5 lb ai/A]. Sweet corn "D'Artagnan" was planted on June 12. Preemergence treatments were applied on June 13. Prosulfuron was applied on July 11, when the sweet corn was at the 8-9 leaf stage, 25-40 cm in height. Herbicides were applied with a CO_2 backpack sprayer delivering 20 gpa at 32 psi. Weed control was assessed by visual ratings, and weed biomass samples taken from a 2.25 ft^2 quadrat from the center of each plot. The dominant weed species were common lambsquarters (Chenopodium album L.), common ragweed (Ambrosia artemisiifolia L.), redroot pigweed (Amaranthus retroflexus L.), and large crabgrass [Digitaria sanguinalis (L.) Scop.] The atrazine and prosulfuron treatments gave greater control of redroot pigweed and common lambsquarter compared to the PRE treatments. Common ragweed control was 100% for the prosulfuron treatments. There were no differences in common ragweed control between the atrazine and PRE treatments. Large crabgrass control was similar among the main treatment effects. Alachlor gave 100% control of redroot pigweed although pigweed biomass was similar between herbicide treatments. Pendimethalin gave greater lambsquarters control compared to the other herbicides. All herbicide treatments gave similar control of large crabgrass and common ragweed. Weed control was similar between the low and high herbicide rates for all weed species. A single harvest of all ears from two 10 foot center rows indicated the sweet corn yield from the prosulfuron plots were reduced 20% compared to the atrazine and PRE treatments. There were no differences in sweet corn yield among the sub-plot treatments or application rates. Culls were not determined for each plot. A random sampling of sweet corn ears indicated the yield reduction attributed to the prosulfuron treatments was more likely due to delayed maturity rather than actual kernel loss. Further studies will be needed.

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Weed Affinity Groups as a Tool in IPM

M.J. Else[1]

ABSTRACT

The weed classification system proposed in this paper is designed to assist growers and those involved in IPM delivery in moving toward ecologically-based weed management strategies. Ecologically-based strategies are defined as those in which it is recognized that weed species differ in their impact on crops and in their responses to crop management practices. In ecological weed management, growers and crop advisors plan for weed management over more than one cropping season. In addition, growers consider weed species and weed seed bank size when planning tillage, cover cropping, and crop and herbicide rotations.

A system of classifying weeds into groups may be useful in providing a means of delivering information needed to implement these ecologically-based strategies. In the "affinity group" approach, common weeds of Massachusetts vegetable and small fruit farms have been placed in six groups based on ecological, biological, and management considerations. The groups are: summer annuals, winter annuals, low-threshold weeds, simple perennials, rhizomatous perennials, and high-threshold weeds. Examples of summer annuals are common lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), and yellow foxtail (*Setaria glauca* L.). Winter annuals include common chickweed (*Stellaria media* L.) and shepherdspurse (*Capsella bursa-pastoris* (L.) Medic.). Low-threshold weeds in Massachusetts include yellow nutsedge (*Cyperus esculentus* L.), hairy galinsoga (*Galinsoga ciliata* (Raf.) Blake), and velvetleaf (*Abutilon theophrasti* Medic.). Examples of simple perennials and rhizomatous perennials, respectively, are dandelion (*Taraxacum officinale* L.) and quackgrass (*Elytrigia repens* (L.) Nevski). High-threshold weeds are short-lived, low-growing weeds with simple, shallow root systems such as common purslane (*Portulaca oleracea* L.), carpetweed (*Mollugo verticillata* L.), and common chickweed. Weeds can belong to more than one group.

Each affinity group is associated with specific management recommendations. Rotation to warm-season crops, for example, can be a way to reduce populations of winter annual weeds on a farm. And classifying weeds as "low-threshold" weeds can be helpful in alerting growers to the need to eradicate or contain these troublesome weeds as they first invade farms.

The affinity group approach is intended to supplement traditional herbicide recommendation approaches used by Extension and other crop advisors with cultural and ecological information. It is designed to be implementable by trained scouts. This system may serve as a vehicle for communicating information about weed ecology as it relates to management, as well as a means of providing specific production recommendations.

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WEED CONTROL IN LIMA BEANS

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ABSTRACT

Herbicides currently labeled for use in lima beans (*Phaseolus lunatus* L.) do not consistently control weed species common in Delmarva. Two studies were conducted to evaluate the potential of new herbicides for weed control and lima bean tolerance. The experimental area had high common ragweed (*Ambrosia artemisiifolia* L.) and ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq.] populations. The first study examined PRE herbicides. The herbicides evaluated were: chloransulam (Firstrate) at 0.01, 0.02, 0.03, and 0.04 lb ai/A; flumetsulam plus metolachlor (Broadstrike+Dual) at 1.2, 1.4, 1.7, and 1.9 lb ai/A; sulfentrazone (Authority) at 0.1, 0.15, 0.2, and 0.25 lbs ai/A; lactofen (Cobra) at 0.2 and 0.25 lb ai/A; and imazethapyr (Pursuit) plus metolachor (Dual) at 0.05 and 1.5 lb ai/A, respectively. A weedy check was also included. Lima bean injury, three weeks after emergence, was lowest for Pursuit plus Dual, the three lowest rates of Firstrate and the two lowest rates of Broadstrike+Dual. The highest rate of Firstrate and the two highest rates of Broadstrike+Dual resulted in <12% injury. Crop injury 6 weeks after planing was similar for all rates of Firstrate (<4%) and Broadstrike (2-10%) and was similar to the standard treatment of Pursuit plus Dual. Authority, at the highest two rates, and Cobra treatments caused unacceptable levels of lima bean injury. Firstrate, Broadstrike+Dual, and Authority at 0.15 lbs ai/A resulted in the highest yields. Yields were reflective of weed control with Firstrate, Broadstrike+Dual, and Pursuit plus Dual because crop injury was minimal and temporary. Whereas with Authority and Cobra, yields reflected both crop injury and poor weed control.

The second study examined POST herbicides, all applied when the crop was at the first to second trifoliolate stage. The herbicides evaluated were: CGA-248757 (Action), CGA-277476 (Expert), flumiclorac (Resource), bentazon (Basagran), imazethapyr (Pursuit), and imazamox (Raptor). A weedy check was also included. Action, Expert, and Resource all resulted in >15% crop injury when rated 1 week after treatment. All other treatments resulted in <10% crop injury. Increased crop safety from tank-mixtures of Basagran plus Pursuit (1 and 0.05 lbs ai/A, respectively) and Basagran plus Raptor (1 and 0.03 lbs ai/A, respectively) was not observed compared to use of these herbicides alone. Yields were highest with Basagran plus Pursuit, at 1 plus 0.05 lbs ai/A, respectively, Basagran plus Pursuit, at 1 plus 0.03 lbs ai/A, respectively, Raptor at 0.03 lbs ai/A, and Basagran plus Raptor, at 1 plus 0.03 lbs ai/A, respectively. These treatments also provided higher levels of weed control.

Based on one year's research, there is potential for Firstrate, Raptor, and reduced rates of Authority to increase herbicide options for lima bean growers that provide broader spectrum of broadleaf weed control than what is currently available.

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NEW TECHNIQUE TO COMPARE EFFICACY OF MECHANICAL CULTIVATORS

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ABSTRACT

Weed communities vary floristically and quantitatively both between and within experimental sites rendering the comparison and interpretation of efficacy between mechanical cultivators difficult. The objective of this study was to evaluate the sensitivity of a new indicator species technique in estimating seedling control following cultivation with different mechanical cultivators and to compare this technique to the quadrat evaluation of *in situ* weed communities. The indicator species technique used two species representing monocots and dicots (mustard and ryegrass) sown perpendicular to crop rows in plots where mechanical weeders were to be tested. This technique created known densities of indicator species at the desired phenological stage in all experimental plots. The weed community was evaluated using six permanent quadrats of 25 cm by 1 m, three of which were placed on the row and three in between the rows. The study was conducted on two sites, one on organic soil and the other on a gravelly sandy loam. A split plot design with four replications was used. The main plots were the mechanical cultivators and the subplots were the evaluation methods. The cultivators compared were a RABEWERK™ tine harrow, a BEZZERIDES™ spring hoe, a BUDDINGH™ wheel hoe, a YETTER™ rotary hoe and a conventional rotary cultivator. Counts of weed seedlings and indicator species were collected before cultivation and five to seven days after cultivation. The indicator species technique identified the wheel hoe as the most effective under hard crusted soil condition at reducing low ryegrass population when seedlings were at the 2 leaf stage. All other cultivators failed to achieve significant seedling reduction under those conditions. In dry organic soil, the spring hoe and rotary cultivator reduced significantly both high and low populations of both monocots and dicots but with the spring hoe displacing a greater number of seedlings. The tine harrow was not effective at reducing seedling populations. In loose soil, no significant difference in seedling survival were noted following cultivation between the two techniques regardless of the mechanical cultivator used. However under hard crusted soil, quadrats estimated a significantly greater plant survival following cultivation than the indicator species technique. This was attributed to the more advanced growth stage of weeds. Quadrats allowed the locatization of the area where the cultivator was effective at destroying seedlings ie: on the row or between the row, while the indicator species technique allowed for effective unbiased comparison between mechanical cultivators with different mode of action under uniform and reproducible conditions and identified their individual faults ie: stimulation of a second germination or displacement and transplantation of seedlings.

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CORRELATION OF LABORATORY, GREENHOUSE, AND FIELD RESPONSE OF GLYPHOSATE RESISTANT TRANSGENIC LETTUCE

J. A. Dusky, R. T. Nagata, T. A. Bewick, R. J. Ferl, D. J. Cantliffe[1]

ABSTRACT

Transgenic plants of the lettuce cultivar (cv.) 'South Bay' were produced using tissue culture methods and seed of regenerated plants was obtained. To evaluate the relative tolerance of transgenic materials to glyphosate, three techniques were utilized; a leaf disc bioassay, a greenhouse screening method, and a field screening method. Leaf discs were obtained from several transgenic lines by taking 1.25 cm leaf discs from the newest fully expanded leaf of 6 wk old plants. Leaf discs were placed on MS medium (supplemented with NAA and BA) containing glyphosate at varying rates and allowed to form callus and shoots for 4 wk. The explants were then harvested, weighed, dried and reweighed. Studies were repeated at least two times. Analysis of variance (ANOVA) was conducted to determine interactions and treatment effects. I_{50} values were determined using regression analysis.

Greenhouse evaluation was done by planting transgenic lettuce seed in trays and allowing them to grow in a greenhouse under natural daylenth and photoperiod. Weed species were also seeded in trays. Weeds utilized were barnyardgrass (*Echinochloa crus-galli*), lambsquarters (*Chenopodium album*), spiny amaranth (*Amaranthus spinosus*), guineagrass (*Panicum maximum*), fall panicum (*Panicum dichotomiflorum*), and common purslane (*Portulaca oleracea*). After 3 wk growth, the plants were sprayed with glyphosate using a CO_2 pressurized back-pack sprayer. Rates utilized ranged from 0 to 32.0 lb ai/A. All treatments contained a surfactant (0.25% v/v). Two weeks after treatment, the plants were harvested, weighed, dried and reweighed. Studies were repeated three times. Data were analyzed as described.

Field studies were conducted by planting transgenic lettuce seed on raised beds. Weeds also were planted and included spiny amaranth, fall panicum, barnyardgrass, and yellow nutsedge (Cyperus esculentus). After 3 wk growth, the plants were sprayed with glyphosate using a back-pack sprayer. Rates ranged from 0 to 32.0 lb ai/A and all spray mixtures contained surfactant. Two weeks after treatment, the plants were harvested, dried and weighed. The experiment was repeated twice. Data were analyzed as described previously.

All transgenic lines were tolerant to glyphosate, although there were relative differences between lines and the method used to evaluate tolerance. Although I_{50} values for the transgenic lettuces lines were different for each screening technique, the relative tolerance of each line was similar. The I_{50} values for the weed species ranged from 0.08 to 1.74 lb ai/A and 2.4 to greater than 8.0 lb ai/A for transgenic lettuce lines. A selectivity index was calculated to determine the relative selectivity for various transgenic lettuce lines and weed complexes.

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PRODUCTION PERFORMANCE OF GLYPHOSATE RESISTANT TRANSGENIC LETTUCE

R. T. Nagata, J. A. Dusky, T. A. Bewick, R. J. Ferl, and D. J. Cantliffe[1]

ABSTRACT

Two field trials were conducted to evaluate glyphosate resistance in transformed 'South Bay' lettuce, *Lactuca sativa* L. Resistance to the herbicide glyphosate was incorporated into 'South Bay' lettuce through the use of *Agrobacterium* mediated transfer of genetic material. From approximately 150 original transformation events, three lines were selected for evaluation under field conditions. Lines designated A-11, B-32 and C-3 were directed seeded into field plots along with 'South Bay'. At 3 weeks post sowing the plants were thinned to 12" in row spacing and plots were treated with 0.0, 0.0312, 0.125, 0.5, 1.0, 2.0, 4.0, and 8.0 lbs ai/A with glyphosate in the first experiment. In the second experiment a treatment of 16.0 lbs ai/A was added. Line B-32 had the highest levels of resistance to glyphosate. Application rates from 0.0 to 8.0 lbs ai/A resulted in no significant differences among mean plant weight. In comparison, plants from line C-3 were similar in weight at 0.0312 and 0.125 lbs ai/A application rate, but significantly smaller at all other treatment levels. Line A-11 was significantly smaller than B-32 and C-3 for all rates of glyphosate applications except at 8.0 lbs ai/A rate for C-3. Observation of nontreated plots seems to suggest low field vigor of A-11. Untreated 'South Bay' survived 0.0312 and 0.125 lbs ai/A application rates, however, plants were small.

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CULTIVATION AND HERBICIDES IN POTATO

H. P. Wilson, T. E. Hines, J. A. Ackley[1]

ABSTRACT

Potato (Solanum tuberosum L. continues to be an economically important crop in the mid-Atlantic region of the U. S. Weed control in potato commonly includes PRE and POST herbicides and cultivation. Few herbicides are registered in potato but recently rimsulfuron has been commercially introduced. Rimsulfuron controls several annual broadleaf and grass weeds and yellow nutsedge (Cyperus esculentus L.). These studies were conducted in 1995 and 1996 to evaluate herbicide and cultivation treatments for weed control in potato. In both years, weed control and potato tuber yield increased when potato were cultivated once but a second cultivation generally did not improve these effects by PRE linuron, PRE metribuzin plus metolachlor, or early POST metribuzin plus rimsulfuron. In the absence of cultivation, control of annual weeds and grass by metribuzin treatments was higher than by linuron. Yellow nutsedge control by metribuzin plus rimsulfuron early POST was lower than had previously occurred from POST rimsulfuron. In a second study, yellow nutsedge control was highest by PRE applications of metribuzin plus metolachlor followed by rimsulfuron POST.

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Managing Interseeded Cover Crops in Potatoes by Varying Seeding Rate and Placement

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Interseeded cover crops have shown potential to suppress weeds in several crops. Field studies were conducted in 1995 and 1996 to evaluate potential weed suppression with two cover crop placement techniques (broadcast and strip-plant) and two seeding rates of hairy vetch (23 and 46 kg/ha), oats (36 and 72 kg/ha), and red clover (7 and 14 kg/ha) to suppress in-season weeds in potatoes. All cover crops were interseeded following hilling 5 weeks after planting (WAP). Cover crops and weeds were regulated with fluazifop (0.22 kg ai/ha) and metribuzin (0.28 kg ai/ha) as-needed. Treatments were compared to bareground and to a chemical standard, metolachlor (1.7 kg ai/ha) and linuron (1.7 kg ai/ha), applied PRE. In both years, the chemical standard provided best weed control, however, differences were not significant. In neither year did cover crop seed placement technique or seeding rate affect weed control. In a dry season (1995), regulated grasses provided better weed suppression than unregulated legumes. In 1996, a season with adequate precipitation, when cover crops were not regulated, legumes tended to provide better weed suppression than grasses. Yield differences were not significant in either year. However, in general, yields with broadcasting tended to be greater than with strip-planting, and yields with lower seeding rates greater than with higher rates. In 1995, yield with grasses were better than with legumes, but in 1996, differences between cover crops were not significant. Thus, neither cover crop placement or seeding rate affected weed suppression. Yield, however, was reduced by higher cover crop seeding rates.

Key words: potato, interseeding, cover crops, competition, seed placement, seeding rate

Weed Seed Germination Pattern and its Implication in Weed Prediction Under Changing Temperatures

GUANGYONG ZOU and RICHARD A. ASHLEY[1]

ABSTRACT

Experiment was conducted to determine the suitability of using a nonlinear poikilotherm rate equation to describe the relationship between germination rate and temperature, and a Weibull function to fit the cumulative seed germination for three annual weed species. Temperatures ranges from 10 to 34°C were evaluated at 3°C intervals. The parameters estimated from this study are applicable to models to predict weed emergence patterns. Coupling both models to a simulation model for weed prediction could improve the accuracy because it avoids the drawbacks of the degree-day approach from both biophysical and statistical aspects. Nomenclature: redroot pigweed (*Amaranthus retroflexus* L. #[2] AMARE), lambsquarters (*Chenopodium album* L. #CHEAL), and large crabgrass (*Digitaria sanguinalis* (L.) Scop. #DIGSA).
Additional index words. Seed germination, temperature, poikilotherm, simulation, Weibull function.

INTRODUCTION

Timing is the core of any integrated pest management (IPM) program. Since the term "IPM" was first coined in the 1960's, there has been a plethora of studies on pest forecast and prediction (2) with the intention of scheduling timely pest control measures.

As opposed to the epidemic nature of other pests, weeds are relatively constant and sessile. This probably delayed the recognition of the importance of weed prediction. The body of knowledge in weed prediction is not as mature as in other pest predictions. Increasing environmental and regulatory concerns have become stimuli to increase weed control efficiency and reduce herbicide usage. Reliable weed prediction is becoming paramount in many integrated weed management programs (7). Specifically, weed emergence pattern prediction can aid producers in selecting the appropriate crop and control practices, and can suggest optimum planting dates to maximize crop competitiveness over weeds. Studies have suggested that weed prediction could decrease the risk of weed control failure in herbicide reduced-rate application programs (12, 13).

Naylor (11) is among the first researchers to predict weed infestation by using a predictive index derived from the number of weed seeds present in the soil. More recent works based on the similar idea include: Wilson et al. (17), Forcella (6) and Mallet (10). All of their work did contribute information for weed management, but they exclude time vector, which limits the applicability, especially given that weed emergence in the field is sporadic. The damages caused by the same absolute weed density with different emergence patterns are quite different (3).

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Since weed germination/emergence patterns are mostly affected by temperature (1, 5, 18), the response of germination under different thermal conditions is often expressed in terms of degree-days. Ghera and Holt (8) give a good review of models using thermal time (degree-days) as predictor in weed science literature. Because those models include time vector, they provide more accessible information for weed management. However, there are some theoretical aspects ignored by this approach. First, the degree-day concept is based on the linearity between organism development rate (here seed germination) and temperature (16). Lack of linearity, which is normally the situation in seed germination, could result in an underestimate near the low temperature threshold and an overestimate near the optimum temperature. Secondly, extrapolating the response curve to the temperature axis to obtain threshold temperature is not justified. Thirdly, those models only predict mean germination time from mean time versus temperature relationships. Excluding the variation in the population loses the information of emergence pattern.

The above drawbacks can be avoided by integrating both rate versus temperature and the germination distribution. Wagner et al. (15) reviewed the progress in temperature versus organism development time and constructed a protocol for insect development time prediction. So far, there is only one study using the approach in perennial weed prediction (9). The justification of the temperature versus plant development approach could provide a biologically and statistically sound method for weed emergence pattern prediction.

The objective of this study was to evaluate the suitability of the protocol of Wagner et al. (15) for modeling annual weed germination patterns, and to highlight the procedure of emergence pattern prediction for three annual weed species that are common in the Northeast region.

MATERIALS AND METHODS

Seeds of redroot pigweed (*Amaranthus retroflexus* L.), lambsquarters (*Chenopodium album* L.), and large crabgrass (*Digitaria sanguinalis* (L.) Scop.) were collected from the Plant Science Research Facility in Mansfield, CT and stored at room temperature for about a year prior to the study.

Five hundred homogeneous (same size and color) seeds of each weed species were germinated in growth chambers under constant temperatures from 10 to 34°C with an interval of 3°C. These temperatures were selected because they represent the temperatures in this region of the country during spring and early summer. Sponge (16.0 cm × 16.0 cm × 1.5 cm) was placed in a 24.5 cm × 24.5 cm × 2.0 cm bioassay dish. The sponge was saturated with D.I. H_2O and covered by one Whatman No. 1 filter paper onto which seeds were placed. Bioassay dishes were kept in the dark in a growth chamber set at the desired temperature. Room light exposures during daily germination evaluations were presumed adequate for light requirements. Before setting up germination tests, the surface sterilization of seed was performed by soaking with 10% commercial Clorox for ten minutes and then rinsing with distilled water. The germinated seeds (radicle emerged at least 1mm) were counted and removed daily. Experiments were terminated when no seed germinated in two successive days after a minimum 14- day test. The experiment was repeated once.

Since germination time curves are normally skewed, median time is a better estimator than mean. Median time to germinate was used to parameterize the poikilotherm rate equation (14):

$$r(T) = \frac{RHO25.T/298.15\exp[HA/R(1/298.15-1/T)]}{1+\exp[HL/R.(1/TL-1/T)]+\exp[HH/R(1/TH-1/T)]} \quad \text{(I)}$$

where r(T) is the mean germination rate at temperature T (°K), and R is the universal gas constant (1.987 cal degree^{-1} mole^{-1}). RHO25 is the germination rate at 25°C, assuming no enzyme inactivation. HA is the enthalpy of activation of the reaction that is catalyzed by a rate-controlling enzyme. TL is the Kelvin temperature at which the rate-controlling enzyme is half active and half low-temperature inactive. HL is the change of enthalpy associated with low temperature inactivation of the enzyme. TH is the Kelvin temperature at which the rate-controlling enzyme is half active and half high-temperature inactive. HH is the change of enthalpy associated with high-temperature inactivation of the enzyme. All of their values were not calculated by measures of enzyme substrate reactions at different temperatures. Instead, they were estimated by non-linear regression.

Cumulative germination distributions with time for each temperature was normalized at their median time in order to provide data suitable to obtain a temperature-independent distribution. The distribution was fitted using the Weibull function, with the form of

$$F(t) = 1 - \exp\{-[(t-\gamma)/\eta]^{\beta}\} \quad \text{(II)}$$

where F(t) is cumulative germination at normalized time t, γ is the lag in the start of germination, η is the germination time constant, and β is a shape parameter.

RESULTS AND DISCUSSION

Temperature influenced the duration of seed germination of three weed species, with the relationships of median germination time and constant temperature forming a curve (Table 1) which refutes the degree-day concept. Median times ranged from 17.67 d at 10°C to 1.52 d at 34°C for redroot pigweed, from 14.20 d at 10°C to 3.80 d at 31°C for lambsquarters, and from 9.88 d at 13°C to 2.47 d at 34°C. For all species, most means are greater than median, thus indicating the distributions skewed to the right. No germination was observed at 10°C for crabgrass and 34°C for lambsquarters.

Table 1. Summary statistics for weed seed germination time (days) under constant temperatures.

Species		Temperature (°C)								
		10	13	16	19	22	25	28	31	34
AMARE	median	17.67	9.58	5.85	4.62	3.66	2.30	2.38	2.23	1.52
	mean	17.14	9.92	6.64	5.23	4.19	2.64	2.76	2.83	1.66
CHEAL	median	14.20	11.00	9.28	7.00	6.48	5.15	4.50	3.80	
	mean	13.43	11.41	9.41	7.14	6.76	5.56	4.73	4.34	
DISGA	median		16.38	9.88	5.43	5.22	3.63	2.79	2.66	2.47
	mean		16.37	10.26	5.83	5.58	3.95	3.16	3.01	2.75

The mechanistic model (equ. I) adequately described the rate versus temperature data (R^2's close to 0.999). Least-square parameter estimates for the model are given in Table 2. The germination rate of pigweed shows low temperature inhibition. The rate of lambsquarters shows no inhibition over the temperature range used in this study. This may account for the reason lambsquaters usually germinates throughout the season, while pigweed germinates only when the weather becomes warm. Crabgrass showed both high and low temperature inhibitions. A TH value of 309.77 and a TL value of 285.41 indicated that seed germination rate was one-half the expected rate at 36.62 and 12.26°C, respectively.

Table 2. **Parameter estimates of the poikilotherm model fitted to median germination rates (1/median time) for three annual weed species germination held under 10 to 34°C with 3°C increment.**

Species	RHO25	HA	TH	HH	TL	HL	Description
AMARE	0.371	100097.67			284.64	-50255.41	Low temp. inhibition
CHEAL	0.189	9599.87					No inhibition
DISGA	0.279	14136.06	309.77	59272.43	285.41	-81808.67	High & low temp. inhibitions

By normalizing the germination time, the distributions at all temperatures for each species generally overlapped, as indicated by their coefficient of variation at 1, 30, 70, and 100% of the cumulative germination (Table 3).

Table 3. **Coefficient of variation (%) at 1, 30, 70, and 100% of cumulative seed germination for three annual weed species.**

Species	1	30	70	100
AMARE	37.6	7.3	10.5	45.1
CHEAL	17.5	3.1	5.3	21.2
DISGA	19.2	4.9	4.2	31.4

The weighted mean times when 1, 5, 10, 15, ..., 90, 95, and 100% of seeds germinated were used to identify a single temperature-independent distribution of normalized germination times for each species. The cumulative Weibull distribution (equ. II) described the data well. Parameter estimates are given in Table 4. The onset of germination occurred sooner for pigweed than for lambsquarters. Crabgrass was the slowest. The difference among η's indicated that the time needed to approach asymptote was shortest for lambsquarters, followed by crabgrass and pigweed. It should be noted that η represents the progression of germination for the population, and doesn't represent a temperature-dependent rate. Lower values of β represents distributions skewed toward longer germination time, signifying the seed population was less homogeneous. The results indicated that lambsquarters was more homogeneous than pigweed and crabgrass. It is generally accepted that lambsquarters seed population is heterogeneous. But in this study, the seeds were selected for uniform size and color.

Table 4. **Parameter estimates of a cumulative Weibull distribution fitted to a standard normalized distribution for seed germination of 4 annual weed species.**

Species	γ	β	η	R^2
AMARE	0.367	1.390	0.851	0.999
CHEAL	0.463	2.237	0.646	0.999
DISGA	0.582	1.589	0.536	0.999

The implication of the above results is that they can be used to construct a simulation model for predicting weed emergence patterns under changing (field) temperature (9, 15). The advantage of this approach includes: 1) It uses the rate-summation instead of thermal summation and therefore, provides a sound foundation for predicting emergence under changing temperatures; 2) It includes a stochastic component that accounts for the emergence pattern. The technical details are provided by Wagner et al. (15). In summary, rates from equation I are accumulated under changing temperatures and act as inputs to equation II for predicting the cumulative proportion germinated through time. Daily maximum and minimum temperatures, which can be obtained from simple instruments or weather stations, combined with parameters of equations I and II, constitute the inputs of the simulation. The output includes information on the day of first emergence, peak emergence, and last emergence for a population. The predicted results can be used to optimize weed control timing, or can be used as input into larger population dynamics models.

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Exploring the Feasibility of Product Performance Testing Guidelines in Snap Beans

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The U.S. Environmental Protection Agency (EPA) requires pesticide performance data for benefits analysis as part of the pesticide registration process. Recently the EPA has made attempts to standardize procedures used in field studies designed to obtain pesticide performance data. A key component of the proposed Field Test Guidelines is the side-by-side comparison of all available pesticide alternatives along with currently practiced cultural and biological control measures. To determine the potential difficulties involved with following the proposed Guidelines, product performance tests for snap beans were conducted in 1993, 1994, and 1995. Trifluralin, EPTC, pendimethalin, metolachlor, bentazon, and fomesafen were tested, individually, and in combinations frequently used by growers [e.g. trifluralin + EPTC; metolachlor (PRE) + fomesafen or bentazon (POST)]. Weedy, handweeded, cultivation, and cultivation + handweeding treatments were included in all three years. Although growers commonly cultivate snap beans, in 1993, none of the herbicide treatments were cultivated. In 1994 and 1995, all herbicide treatments were doubled, with the second recieving supplemental cultivation on an as-needed basis. Efforts were made to evaluate not only weed control and yield, but also the effect of weediness on harvesting and snap bean quality parameters, as required by the proposed Guidelines. Redroot pigweed, common lambsquarters, and hairy galinsoga were the predominant weeds in all three years. Individually, none of the herbicides adequately controlled all three of the weeds. It was clear that herbicide combinations provided more complete control and higher yields. Metolachlor (PRE) followed by either fomesafen or bentazon (POST) tended to out-perform the other treatments. The use of handweeding as an alternative to herbicides in snap beans is cost-prohibitive. Total handweeding required 40 man hours and cost $238/A. Even the cost of spot-weeding (estimated by growers to cost $50/A) would significantly reduce the small profit margin ($150/A) currently required by growers for continued bean production. Cultivation (2X) alone could replace herbicides in snap beans however, the risks associated with untimely rainfall and large acreages are unacceptable to growers. Despite the use of mechanical harvesting equipment, it was not possible to determine differences in snap bean quality. While the usefulness to the EPA of comparative data is clear, the inclusion of all registered products, plus alternatives leads to large and costly experiments that are difficult to analyze statistically and therefore difficult to interpret. Traditional measures of herbicide performance include weed control, phytotoxicity, and yield. Other factors, e.g. interference with harvesting, weed contamination, and weed seed return to the soil, should be considered when evaluating herbicide benefits. The greatest shortcoming with the Guidelines, however, is the implied assumption that one compound can serve as a replacement for another. For any two herbicides, the spectra of weeds controlled varies, so that often the most effective control is achieved by a combination of herbicides. Particularly in the production of minor crops, for which fewer pesticides are registered, loss of a single compound can severely curtail the available pest control options.

COMMON PURSLANE AS A LIVING MULCH IN VEGETABLE CROP PRODUCTION

D.R. Ellis[1], R.G. Adams[2] and K. Guillard[3]

ABSTRACT

Many of the characteristics of common purslane (Portulaca oleracea L.) that categorize this species as a "weed" have been described as desirable traits for a living mulch. These characteristics include: 1) aggressive growth during late spring and summer months; 2) establishment of a dense, prostrate canopy; 3) vegetative reproduction by adventitious root formation on fragmented stems; and, 4) prolific seed production. Common purslane was investigated as a living mulch in vegetable crops and compared with conventional methods of weed management, which included mechanical and chemical methods as well as the use of black plastic in broccoli. Field trials were conducted from 1993 to 1994 in Storrs, Connecticut on spring broccoli (Brassica oleracea L. 'Packman') and snap beans (Phaseolus vulgaris L. 'Gator Green'). Common purslane seed was broadcast over the soil 10 to 14 days prior to transplanting broccoli or sowing snap beans. Fresh weight yields, harvest date, leaf development, and soil temperatures were determined for each crop. Plots in each treatment were rated for weed control and percent ground cover by common purslane. Noncrop biomass, which was comprised of common purslane and weed biomass, was measured under each method of weed management. Critical levels of weed control and noncrop biomass for optimum crop yields were estimated using a linear-plateau model.

Spring broccoli and snap bean yields from plants grown in purslane living mulch were comparable to yields from plants grown under conventional methods of weed management. No differences were found in harvest date or leaf development for either crop across all methods of weed management in comparison with control treatments where weeds were not managed. Late afternoon soil temperatures were significantly lower under purslane living mulch in comparison with soil temperatures which occurred when either crop was grown under mechanical weed management or when spring broccoli was grown under black plastic. Common purslane as a living mulch was able to effectively compete with weeds in spring broccoli and snap beans when between-row areas were kept relatively weed-free during the first two weeks after transplanting or sowing. High levels of weed control and ground cover occurred through the establishment of common purslane between crop rows. Spring broccoli and snap bean plants were tolerant of purslane living mulch and weeds up to critical threshold levels, without any significant reductions in yield.

A periodic cultivation of common purslane and/or weeds between crop rows during the critical weed-free period in the first two weeks after spring broccoli transplanting or snap bean seedling emergence provided a minimal level of weed management which produced acceptable crop yields. Noncrop biomass measured under purslane living mulch was below critical threshold levels and therefore did not reduce yield. While the inclusion of a purslane living mulch into a spring broccoli or snap bean crop production system may be a novel approach to controlling weeds, the strategies involved in this system rely on basic weed management principles, as presented in the study.

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INHIBITING THE DEVELOPMENT OF CIRCLING ROOTS IN CONTAINER GROWN ORNAMENTALS WITH ORYZALIN

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INTRODUCTION

One of the factors that limits the length of time a plant can remain in a container, and also affects its survival and growth following outplanting, is the development of a mat of circling roots around the wall of the container. Spin Out[2] is a commercially available product that has been proven effective in limiting their development on many species of ornamentals. The active ingredient in Spin Out is copper hydroxide, which is carried in a latex paint base. Spin Out is painted on the walls of the containers. When root tips contact the copper they are killed. The injury is localized, though, and simply results in a more branched root system with little or no effect on top growth. A concern with Spin Out is the potential for accumulation of high levels of copper over time in areas in which the containers are painted or in the soil beneath the growing areas.

Oryzalin is a potent root inhibitor that in certain situations has stopped root growth without adversely affecting top growth. For example, roots growing out of the bottoms of containers set on oryzalin treated soil have been stopped without causing injury to the plants. Since oryzalin is decomposed by microorganisms in the soil, its use would have an environmental advantage over the use of Spin Out.

The objectives of this study were to determine the effectiveness of oryzalin in inhibiting the development of circling roots and its effect on plant growth.

METHODS

On July 28, 1995 the insides of 2.5 gallon nursery containers were painted with one of the following treatments: Spin Out; latex paint[3] ; or Surflan 4AS[4] at 0.1, 0.25, 0.5, 2.0, or 4.0% v/v in the latex paint. On July 1 pyracantha (*Pyracantha coccinea* M.J. Roem.) growing in one quart containers were planted in the treated pots in a bark/peat medium. There were 12 pots of each treatment and they were maintained in a completely randomized design. Plants were fertilized and watered to maintain optimum growth. On September 12 and November 14, 1995 the plants were rated for circling roots on a scale of 1 to 10, with 1 = no circling roots and 10 = many circling roots. Plants were harvested and weighed on November 15.

The pots were held over the winter, and on May 2, 1996, perennial ryegrass (*Lolium perenne* L. cv. APM) was seeded into the containers. On July 12 the circling roots were rated and the grass and medium was discarded.

On July 28 the containers were refilled and ajuga (*Ajuga reptans* L. cv. 'Burgundy Glow') was planted in them. Circling roots were rated on October 24, 1996.

On April 26, 1996 the insides of two gallon nursery containers were painted with one of the following treatments: 1 application of Spin Out (1X); 2 applications of Spin Out (2X); Surflan at 0.5, 1.0 or 2.0% v/v in latex paint; Spin Out (1X) + 1% Surflan; Spin Out (1X) + 2% Surflan;

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[2] Spin Out, Griffin Corp., Valdosta, GA 31603-1847

[3] Dutch Boy Extra Acrylic Latex Semi-Gloss Enamel (Black 19-90), Cleveland, OH 44115

[4] DowElanco, Indianapolis, IN 46268-1054

or Surflan at 1% in anti-transpirant[5]. In the Spin Out / Surflan combinations, the Surflan was simply added to the Spin Out prior to application. Euonymus (*Euonymus kiautschovicus* Loes.), forsythia (*Forsythia* x *intermedia* Zab.), and pyracantha plants growing in one gallon containers were planted in the treated pots in a bark/peat medium. There were five pots of each treatment and species and they were maintained in a completely randomized design. On October 24, 1996 the plants were rated for circling roots on the same scale used in the other studies.

RESULTS AND DISCUSSION

In the first study, paint alone did not prevent circling roots or alter the growth of the pyracantha (Table 1). All of the chemical treatments reduced circling roots compared to the control, but the lowest rate of Surflan allowed more circling than would be commercially acceptable. The 0.25% rate of Surflan provided marginally acceptable control of circling roots. All other treatments provided excellent control, with the 4.0% rate of Surflan being the only one that provided total control.

The bottoms of the soil balls from all of the Surflan treated containers had no more roots on the surface than the sides. The bottoms of the soil balls from the Spin Out treated containers were mostly covered with roots. It is possible that the bottom of the container stays moist longer, solubilizing the copper and making it susceptible to leaching.

Regardless of treatment, all of the plants in treated containers were heavier than those in containers that were unpainted or had paint only. By killing root tips, the treatments may have caused the development of a more fibrous root system that absorbed nutrients and water more efficiently than a root system with a lot of circling roots.

The second study with the ryegrass and ajuga was initiated to determine how long the treatments would remain effective. The ryegrass was planted one year after the containers had been painted and the first crop had been grown in them. All of the chemically treated containers provided good to excellent control of circling ryegrass roots (Table 2). Grass roots are known to be especially sensitive to Surflan, so after it was shown that the treatments were still active, the grass plants and soil were discarded.

By October 24, 1996, 18 months after the pots were treated, distinctive differences in root development of the ajuga were becoming apparent. All treatments still reduced circling roots compared to the control or paint alone (Table 2). However, the Spin Out and Surflan at 0.1% no longer provided an acceptable level of control. The Surflan at 0.25 and 0.5% still provided an acceptable level of control, and at 2.0 and 4.0% allowed almost no circling roots.

Plants are rarely grown in containers for more than two years. Treatments that last two years will more than adequately meet the needs of the nursery industry. They would also offer the industry the option of keeping the treated container for reuse and shipping the finished plant in a less expensive untreated container.

The other study in 1996 demonstrated the variability that exists in species response to the different treatments. One application of Spin Out provided good control of euonymus and forsythia roots, but was weak on pyracantha (Table 3). Two applications controlled the roots of all species. All rates of Surflan provided excellent control of pyracantha roots and good control of euonymus roots. The 2.0% rate of Surflan provided marginally acceptable control of forsythia roots, but the 0.5 and 1.0% rates provided poor control. Surflan at 1.0% in anti-transpirant was as effective as 1.0% Surflan in paint for all species. Applying 1.0% Surflan in Spin Out reduced the control of euonymus and pyracantha roots below that provided by 1.0% Surflan in paint.

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[5] 33 % Winter Shield, Rockland Corp., West Caldwell, NJ 07006

However it increased the control of forsythia roots. Mixing 2.0% Surflan in Spin Out provided control of the roots of all species that was similar to 2.0% Surflan in paint.

There is a definite difference in how the different species respond to different root control treatments. Extensive studies will have to be conducted to determine the type and level of treatment needed for each individual species. The alternative is to select single high rate, or combination of products, that will control circling roots in all species. In all of the studies conducted, Surflan has provided control of circling roots at least as good as Spin Out, the industry standard. There is still much work that needs to be done regarding rates, carriers, longevity / decomposition, and fate in the environment, but its potential use has been demonstrated.

Table 1. The average circling root rating and top weight of pyracantha planted on July 1, 1995 into 2.5 gallon nursery containers. Treatments were painted on the inside of the containers. Circling roots were rated on November 14, 1995. Root circling was rated on a scale of 1 to 10, with 1 = no circling roots and 10 = many circling roots. Plants were harvested and weighed November 15. The average of 12 plants per treatment is presented.1/

Treatment	Root Circling	Top Weight (g)
Control	9.8 a	209 c
Latex Paint	10.0 a	209 c
Spin Out	2.3 d	260 a
Surflan (0.1%)	6.8 b	246 ab
Surflan (0.25%)	4.4 c	230 ab
Surflan (0.5%)	2.7 d	234 abc
Surflan (2.0%)	1.8 e	224 bc
Surflan (4.0%)	1.0 f	230 abc

1/ Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

Table 2. The average circling root rating of perennial ryegrass and ajuga planted into 2.5 gallon nursery containers. The treatments were painted on the inside of the containers on June 29, 1995. A crop of pyracantha was grown in 1995 and Harvested. The ryegrass was planted on May 2 and evaluated and discarded on July 12, 1996. The ajuga were planted in a new medium on July 28 and rated October 24, 1996. Root circling was rated on a scale of 1 to 10, with 1 = no circling roots and 10 = many circling roots. The average of 10 plants per treatment is presented.

	Root Circling[1/]	
Treatment	Ryegrass	Ajuga
Control	9.2 a	9.6 a
Latex Paint	9.6 a	10.0 a
Spin Out	2.8 bc	6.4 b
Surflan (0.1%)	3.5 b	6.1 b
Surflan (0.25%)	2.2 cd	3.2 cd
Surflan (0.5%)	1.5 de	3.6 c
Surflan (2.0%)	1.0 e	2.4 de
Surflan (4.0%)	1.3 e	2.2 e

[1/] Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

Table 3. The average circling root rating of euonymus, forsythia, and pyracantha planted in May 7 and rated on October 24, 1996. Root circling was rated on a scale of 1 to 10, with 1 = no circling roots and 10 = many circling roots. Treatments were painted in the inside of 2 gallon nursery containers. The average of 5 plants per treatment is presented.

	Root Circling[1/]		
Treatment	Euonymus	Forsythia	Pyracantha
Control	10.0 a	9.2 a	10.0 a
Spin Out 1 application	3.4 bc	3.8 c	4.6 b
Spin Out 2 applications	3.0 c	3.0 c	2.6 c
Surflan (0.5%)	3.0 c	7.8 ab	1.2 d
Surflan (1.0%)	3.2 c	6.6 b	1.4 d
Surflan (2.0%)	2.6 c	4.6 c	1.2 d
Spin Out 1 application + Surflan (1.0%)	4.6 b	3.0 c	2.4 c
Spin Out 1 application + Surflan (2.0%)	2.4 c	4.0 c	1.2 d
Surflan (1.0%) in anti-transpirant	3.4 bc	6.6 b	1.2 d

[1/] Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

LIVERWORT AND PEARLWORT MANAGEMENT IN CONTAINER-GROWN PERENNIALS

Andrew Senesac and Irene Tsontakis-Bradley[1]

ABSTRACT

Liverwort (Marchantia spp.) and birdseye pearlwort (Sagina procumbens L.); although taxonomically very different, are often found coexisting as troublesome weeds in container-grown perennials. This study was conducted to evaluate control strategies for these weeds which could be adapted to nurseries growing many species of perennials.

A container study was conducted in 1996 at the Long Island Horticultural Research Laboratory to assess the efficacy of several herbicides for liverwort and pearlwort control. Liverwort and pearlwort were grown in 20" X 14" flats in a potting soil mix under shade and irrigated daily and fertilized weekly. While the pearlwort was overseeded, the liverwort infestation was achieved by drenching with a slurry of ground thallose (vegetative) tissue and water. Preemergence treatments were all applied on the day of infestation.

The treatments consisted of: prodiamine 65 WDG at 1.5 lb/a (a.i), dithiopyr 1 EC at 0.5 lb/a, oxadiazon 2G at 3.0 lb/a, napropamide 5G at 4.0 lb/a, oryzalin 4 AS at 3.0 lb/a, sulfentrazone 80 WP at 0.25 lb/a, oryzalin plus napropamide plus oxadiazon at 1.0+1.5+1.0 lb/a , oryzalin plus dithiopyr plus oxadiazon at 1.0 + 0.175 + 1.0 lb/a, and napropamide plus oxadiazon at 4.0 + 2.0 lb/a.

The results of visual evaluations of percent ground cover several weeks after treatment indicate that oryzalin alone and oryzalin in either combination were most effective in controlling both liverwort and pearlwort. Both dithiopyr and oxadiazon controlled liverwort very well, but were fair and poor, respectively for pearlwort control. Prodiamine provided excellent control of pearlwort but was only fair on liverwort. Sulfentrazone and napropamide were not effective in controlling either weed.

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EVALUATIONS OF GLYPHOSATE AND 2,4-D FORMULATIONS IN DORMANT CONIFERS

John F. Ahrens and Todd L. Mervosh[1]

ABSTRACT

In late 1995, Monsanto Chemical Co. announced that glyphosate no longer would be available for ornamentals and turf as Roundup and would be replaced by Roundup PRO. Since Roundup PRO has a higher concentration of surfactant and possibly a different surfactant, selectivity of glyphosate in dormant conifers might be altered. We also evaluated the selectivity in dormant conifers of a non-surfactant form of glyphosate (Accord) with a commercial surfactant (Induce) added. Further evaluations of 2,4-D amine and/or butoxy ethyl ester also were included in our experiments.

Field experiments were conducted in 1996 at the Connecticut Agricultural Experiment Station's Valley Laboratory and at commercial nurseries. In April, Roundup, Roundup PRO, and Accord plus 0.5% v/v Induce were sprayed in 30 gal/A over globe arborvitae (*Thuja occidentalis*) and upright yew (*Taxus cuspidata* var. *capitata*) [0.375 to 0.75 lb ai/A] and over white spruce (*Picea glauca*) and Norway spruce (*Picea abies*) [0.5 to 1.5 lb ai/A]. In addition, 2,4-D at 0.5 to 2 lb ae/A was applied over these dormant conifers. The spruces were selectively sheared one day before treatment.

In a separate experiment in spreading yew (*Taxus cuspidata*), we compared butoxy ethyl ester and amine formulations of 2,4-D. In this experiment the yews were heavily sheared 2 weeks before treatment. In upright yew and the spruces, 2,4-D caused no injury and controlled several winter annual broadleaf weeds. In arborvitae, 2,4-D at 0.5 lb ae/A caused only slight early injury. Higher rates caused early stunting and needle distortion which was barely evident in July. New growth of spreading yews was suppressed in June by all rates of 2,4-D. Growth suppression was greater with the ester than the amine formulation. Plants recovered from the 0.5 and 1.0 lb ae/A rates by July. We suggest that pruning dormant yews before treatment may increase early 2,4-D injury.

Response of the conifers varied greatly to the glyphosate formulations. Injury to the spruces in the form of dwarfed and chlorotic new growth was primarily associated with fresh pruning wounds. Accord plus Induce and Roundup PRO injured more spruces than Roundup, but injury was slight on average. Spruces are very tolerant of glyphosate and comparisons between Roundup and Roundup PRO are inconclusive at this time. In upright yew, no injury was observed with any formulation at rates up to 0.75 lb ai/A. In arborvitae, plant injury was greatest with Accord plus Induce, intermediate with Roundup PRO, and least with Roundup. However, both in yew and arborvitae, it appeared that rates of glyphosate could be reduced about 25% with Roundup PRO as compared with Roundup to provide equivalent weed control with acceptable, slight early plant injury.

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SULFENTRAZONE AND HALOSULFURON: HERBICIDAL EFFICACY AND SAFETY TO WOODY ORNAMENTALS

Todd L. Mervosh and John F. Ahrens[1]

ABSTRACT

Our studies of the herbicides sulfentrazone and halosulfuron were expanded in 1996 to include additional experiments on woody ornamental species.

In the second year of an experiment at Windsor, CT, sulfentrazone (0.125 to 0.5 lb/A) and halosulfuron (0.031 to 0.125 lb/A) were sprayed on June 6, 1996 over the top of actively growing Japanese yew (*Taxus cuspidata*), globe arborvitae (*Thuja occidentalis*), Eastern hemlock (*Tsuga canadensis*), creeping juniper (*Juniperus horizontalis*), and rhododendron (*Rhododendron catawbiense* 'Roseum Elegans'). The only injury observed in plots treated with sulfentrazone was rate-dependent damage to young hemlock needles, which recovered fully later in the season. Halosulfuron caused severe chlorosis and stunting of new growth of yew and rhododendron, and to a lesser extent injured arborvitae. At 16 weeks after treatment, yews were stunted 20 to 50% and arborvitae 10 to 30% relative to untreated plants, but rhododendron injury had diminished.

Higher rates of sulfentrazone (0.375 to 1.5 lb/A) and halosulfuron at the above rates were applied in April over the top of dormant upright Japanese yew (*Taxus cuspidata* var. *capitata*) and globe arborvitae. Sulfentrazone caused no visible injury to either species, but both yew and arborvitae were injured (chlorosis and stunting) by halosulfuron. In other experiments, sulfentrazone (0.375 to 1.5 lb/A) applied in April over the top of dormant Japanese yew, Eastern hemlock, creeping juniper, and actively growing forsythia (*Forsythia x intermedia* 'Lynwood') caused severe injury to forsythia and lesser damage to hemlock. In an experiment in Vermont, dormant fraser fir (*Abies fraseri*) tolerated a May application of sulfentrazone (0.25 to 1.0 lb/A) and a July application 6 weeks after bud break, but the same treatments applied 3 weeks after bud break in June caused substantial injury to fraser fir. In a container experiment, sulfentrazone (0.375 lb/A) applied in late October severely burned foliage of newly potted dwarf mugo pine (*Pinus mugo* 'Mughus') and dwarf Alberta spruce (*Picea glauca* 'Conica').

Both sulfentrazone (0.125 to 0.5 lb/A) and halosulfuron (0.031 to 0.125 lb/A) provided excellent residual control of annual sedge (*Cyperus* sp.). In various experiments, sulfentrazone provided excellent preemergence or early postemergence control of carpetweed (*Mollugo verticillata*), purslane (*Portulaca oleracea*), common lambsquarters (*Chenopodium album*), common groundsel (*Senecio vulgaris*), and northern willowherb (*Epilobium glandulosum*), moderate suppression of annual bluegrass (*Poa annua*), horseweed (*Conyza canadensis*), and yellow woodsorrel (*Oxalis stricta*), and little to no control of large crabgrass (*Digitaria sanguinalis*), prostrate spurge (*Euphorbia supina*), narrowleaf hawksbeard (*Crepis tectorum*), common chickweed (*Stellaria media*), and pearlwort (*Sagina procumbens*). Halosulfuron suppressed or controlled spurge, horseweed, woodsorrel, and chickweed, but had little to no activity on annual bluegrass, crabgrass, carpetweed, purslane, lambsquarters, and hawksbeard.

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SUCCESSES WITHIN THE IR-4 ORNAMENTAL WEED CONTROL PROGRAM IN 1995-1996[1]

J. Ray Frank[2]

ABSTRACT

During 1995 and 1996 over 450 IR-4 ornamental research projects were conducted by state and federal researchers to develop data for use on national label registrations.

In 1995 this research included 209 total projects with 18 herbicides and no plant growth regulators. In 1996 151 herbicide projects were conducted across the United States with 19 herbicides including the following:

Benefin + Oryzalin	Isoxaben	Oxyfluorfen
Bentazon	Lactofen	Oxyfluorfen + Oryzalin
2,4-D Amine	Metolachlor	Oxyfluorfen + Pendimethalin
2,4-D Ester	Napropamide	Prodiamine
Dithiopyr	Oryzalin	Sethoxydim
Fluazifop P Butyl	Oxadiazon	Trifluralin
Halosulfuron		

IR-4 research was conducted in 1996 on the following four plant growth regulators: Chlormequat, Daminozide, Methyl Esters of Fatty Acids and Uniconazole.

Previous research within the IR-4 Program led to 377 new label additions in 1995 and over 800 in 1996.

[1] New Jersey Agricultural Experiment Station Publication No. K-27200-01-97 supported by State, U.S. Hatch Act and other U. S. Department of Agriculture funds.

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Western New York Nursery IPM Program: 1995-1996 Weed Scouting Results

J. C. Neal, C. A. Casey, and K. E. Dean[1]

In 1995 and 1996 three production nurseries, two container nurseries and one field nursery, in Erie County, NY were scouted for weeds as part of a Nursery IPM program. The methods used were adapted from those developed by Dr. Andrew Senesac in the Long Island Nursery Weed IPM Scouting Program and involved an inventory of weeds present in each nursery block, and subsequently highlighting the more prevalent and / or important species in each block. The scouting blocks were defined by the grower's field designations and differed between sites. While each nursery had its own unique weed spectrum, several similarities were observed between container nurseries and between one container nursery and the field nursery.

At site 1, a container nursery producing a variety of woody shrubs, the weeds encountered were fairly typical of this type of nursery with the most prevalent being wind-dispersed, seed-propagated species including hairy galinsoga, fireweed, (*Erechtites hieracifolia*), and horseweed. Other species encountered included creeping woodsorrel, bittercress, dandelion, annual bluegrass, common chickweed, Virginia copperleaf, and an aster (unidentified). There was a clear relationship between the importance of weed species in pots with prevalence in the areas surrounding the pots. Also, pots carried over from the previous year had more weeds than newly potted plants.

Container nursery 2 had some of the same and many different species. The most prevalent species included common groundsel, nodding beggarticks, field violet (*Viola arvensis*), ragweed, wild buckwheat, hairy galinsoga, smartweed (*Polygonum caespitosum*), and occasional pots with quackgrass, mugwort and yellow nutsedge. At this nursery the newly potted plants had more weeds than did pots carried over from the previous season and weed prevalence in adjacent areas was not a good predictor of weed species dominance in the pots. These observations plus evaluation of the potting media components and a quick scouting of the field production areas on that nursery suggested that weed propagules were introduced with the field-grown liners which were potted.

The one field production nursery which was scouted had a greater diversity of weed species but had several weed species in common with the second container site (additionally supporting the suggestion that container nursery 2's weeds were introduced with the field-grown liners). Weed spectrum in each block differed with the type of production but several species were common in each field including field yellowcress (*Rorippa sylvestris*) and field violet, two species which until recently had not been common in the region. Other species encountered in all blocks included yellow nutsedge, horseweed, Powell's amaranth, dandelion and pineappleweed. Blocks differed with respect to other important species. For example: one block was extensively infested with mugwort, with lesser amounts of yellow nutsedge, goldenrod and western salsify. Another block had widespread infestations of hairy nightshade and spotty infestations of quackgrass. A particularly notable species occurring in sporadic patches was bermudagrass. Factors which appear to have influenced the species infesting each field included field history, the amount of cultivation relied upon for weed control, and (probably) introduction of weeds with planting stock.

These data showed that late summer scouting adequately inventoried the weeds in each nursery, demonstrated the diversity of weeds within and between nurseries in this region, emphasized the need for regular weed scouting in all nursery blocks, and suggested the potential role of planting stock in the movement of weed propagules within and between nurseries.

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INVASIVE NON-INDIGENOUS SPECIES AND THE ROLE OF THE NURSERY INDUSTRY

B. Blossey[1]

ABSTRACT

The invasion of non-indigenous plants is a major threat to the integrity of the worlds ecosystems. Thousands of non-indigenous plant species are known to persist outside cultivation in North America. Their cumulative impact on natural and agricultural resources is estimated to cause billions of dollars in economic losses. Of the 300 most serious plant invaders 50% were introduced for ornamental and horticultural purposes. Even after plants have been identified as invasive many are continually sold or promoted for landscaping purposes. An increased awareness of the problem created by introducing non-indigenous species is essential to prevent further ecological disasters. The cooperation of nursery industry and natural areas managers is essential to develop procedures allowing the sale of harmless ornamentals and to establish safeguards preventing the entry or spread of new invasive species.

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COMMON RAGWEED CONTROL IN FIELD CORN WITH PREEMERGENCE HERBICIDES

Frank J. Himmelstein, Robert J. Durgy [1]

ABSTRACT

Common ragweed [Ambrosia artemisiifolia L.] infestations have increased in field corn [Zea mays L.] in Connecticut where triazine herbicide use has been reduced or eliminated and resistance to these herbicides may have occurred. A field study conducted at the Plant Science Research Farm in Storrs, CT. in 1996 evaluated seventeen preemergence herbicide treatments for common ragweed control in field corn. The experimental design was a split plot with three replications. The main plots were pendimethalin (Prowl) applied at 0 and 0.75 lb ai/A. The sub-plots treatments and applied rates were: thiafluamide + metribuzin (Axiom) at 0.64 lb ai/A, isoxaflutole (Balance) at 1.5 oz ai/A, metolachlor + atrazine (Bicep) at 2.7 lb ai/A, metolachlor + atrazine (Bicep Lite) at 2.25 lb ai/A, alachlor + atrazine (Bullet) at 3.0 lb ai/A, dimethenamid + atrazine (Guardsman) at 2.19 lb ai/A, acetochlor (Harness) at 1.75 lb ai/A, acetochlor + atrazine (Harness Xtra 6.0) at 2.75 lb ai/A, acetochlor + atrazine (Harness Xtra 5.6) at 2.5 lb ai/A, micro-encapsulated alachlor (Lasso MT) + atrazine at 2.0 and 0.75 lb ai/A respectively, micro-encapsulated acetochlor (MON 8414) at 1.75 lb ai/A, imazethapyr (Pursuit) at 0.063 lb ai/A, acetochlor + safener (Surpass) at 1.8 lb ai/A, acetochlor + safener + atrazine (Surpass 100) at 3.0 lb ai/A, micro- encapsulated acetochlor + safener (Topnotch) at 1.8 lb ai/A, pendimethalin + atrazine at 1.5 and 1.0 lb ai/A respectively, and pendimethalin + cyanazine (Bladex) at 1.5 and 1.0 lb ai/A respectively. Herbicides were applied with a CO_2 backpack sprayer delivering 20 gpa at 32 psi. Weed control was assessed by both visual ratings, and weed biomass samples taken from a 2.25 ft^2 quadrat from the center of each plot. Field corn 'Pioneer 3395 IR' was planted on June 5, 1996. Herbicide treatments were applied on June 6, 1996. Weed biomass samples taken 70 DAT indicated there were no significant differences in ragweed control between the main effects. The Pursuit treatments resulted in poor ragweed control (<50%). The Bicep Lite and Axiom treatments resulted in unacceptable ragweed control (60-65%). The Prowl + atrazine, Prowl + Bladex, and Bicep treatments resulted in fair ragweed control (75-85%). The Lasso + atrazine, Harness, Balance, Mon 8414, Bullet, Surpass, Guardsman, Topnotch, Surpass 100, and Harness Xtra treatments resulted in excellent ragweed control (>90%). The use of several acetolchlor formulations or isoxaflutole alone provided effective common ragweed control and may reduce dependence on triazine herbicides for weed control in areas where either triazine herbicide use rates must be reduced or eliminated entirely, and where common ragweed resistance to triazine herbicides have occurred.

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REDUCED HERBICIDE RATES FOR NARROW-ROW FIELD CORN

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ABSTRACT

Three field experiments were conducted near Aurora, NY in 1996 to compare effectiveness of reduced herbicide rates as influenced by plant population and row spacing in silage corn (*Zea mays* L.). A split-split plot design with 15- or 30-inch rows as main plots and populations of 30,000 and 45,000 plants/A as subplots was used. Sub-subplots were of full, two-thirds, and one-third rates of a standard treatment and an untreated check. A preemergence (PRE) combination of 1.5 lb ai/A of pendimethalin plus 1.5 lb ai/A of atrazine was used as the standard for an experiment with annual weeds including velvetleaf *(Abutilon theophrasti* Medicus). The other experiments investigated yellow nutsedge (*Cyperus esculentus* L.) and annual weed control. A preplant-incorporated (PPI) treatment of 2 lb ai/A of metoclahlor plus 1.5 lb/A of atrazine was used as the standard for one of these experiments. An early postemergence (EPO) standard of 0.75 oz ai/A of halosulfuron plus 1 lb/A of atrazine with 1% (v/v) of a petroleum-based crop-oil concentrate was used for the other.

Row spacing and plant population had no influence on weed control ratings except in the EPO experiment where green foxtail [*Setaria viridis* (L.) Beauv.] control was better with 15-inch rows than with 30-inch rows. When pendimethalin and atrazine were applied PRE, common ragweed (*Ambrosia artemisiifolia* L.) and velvetleaf control ranged from 91 and 78% respectively with one-third the standard rate up to 100 and 98% respectively with the full rate. The full rate provided better velvetleaf control than the reduced rates and there was a difference between the two-thirds and one-third rates. Although silage yields ranged from 30.7 T/A for the untreated check up to 33.2 T/A, there were no significant differences among the treatments.

When applied PPI, the one-third and full rates of metolalchlor plus atrazine controlled 71 and 89% of the nutsedge respectively. There were differences in nutsedge control between the full rate and the reduced rates and also between the reduced rates. The full rate controlled 99, 97, and 94% of the green foxtail, ladysthumb (*Polygonum persicaria* L.), and common ragweed respectively. These ratings were not different from those with the two-thirds rate but were higher than the 92, 81, and 78% control ratings with the one-third rate respectively. While there were no differences in silage yield among the herbicide treatments, their average yield of 28.3 T/A was higher than the 21.5 T/A from the untreated check. In the EPO experiment, nutsedge control ranged from 74 to 90% for the three halosulfuron plus atrazine treatments and each was different from the others. The average silage yield of 28.0 T/A from the herbicide treatments was significantly higher than the 20.3 T/A from the untreated check.

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CGA-77102: A New Herbicide for Preemergence Weed Control in Corn and Soybeans

D. B. Vitolo, M. G. Schnappinger, T. A. Bauer, B. S. Manley, and S. W. Pruss [1]

ABSTRACT

CGA-77102, the S-chiral isomer of metolachlor, is a new acetamide herbicide being developed by Ciba Crop Protection for preemergence grass and broadleaf weed control in corn (*Zea mays* L.) and soybeans (*Glycine max* L.). Metolachlor is an acetamide herbicide first registered for use in corn by Ciba-Geigy Corp. in November, 1976. Since then, it and various formulations of Dual and Bicep brand herbicides have continued to grow in use. Metolachlor is currently the second highest volume herbicide used in the U.S. Metolachlor is a mixture of isomers, and these isomers, depending on their configurations, can be grouped into R- and S- forms. The majority of the herbicidal activity of metolachlor comes from the S-isomer, designated CGA-77102, while the R-isomer is relatively inactive. Synthesis technology now allows for the selective production of the active isomer.

Replicated field trials were conducted in New York, Maryland, Pennsylvania, Ohio, and Indiana from 1994-1996 to evaluate efficacy, duration of activity and crop tolerance across soil types on yellow nutsedge (*Cyperus esculentus* L.), and a wide range of annual grass and broadleaf weeds. These trials, and others conducted across the U.S., showed an equivalency of CGA-77102 to metolachlor at a ratio of 0.625:1. Corn tolerance trials utilizing rates up to four times the normal use rate were conducted to determine the optimum CGA-77102:benoxacor ratio. These trials indicated a ratio of 20:1, which utilizes the same benoxacor rate per acre as in the current Dual II and Bicep II brands.

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CGA-277476 AND CGA-248757 FOR POSTEMERGENCE WEED CONTROL IN SOYBEANS

M. G. Schnappinger, D. B. Vitolo, T. A. Bauer, B. S. Manley, and S. W. Pruss[1]

ABSTRACT

CGA-277476 is a new sulfonylurea herbicide and CGA-248757 is a protoporphyrinogen oxidase inhibiting herbicide being developed by Ciba Crop Protection for postemergence broadleaf control in soybeans (*Glycine max* L.). CGA-277476 provides broadspectrum broadleaf weed control coupled with short residual activity, which allows for normal northeastern crop rotations without concern for carryover injury. CGA-248757 provides rapid burndown of broadleaf weeds coupled with minimal crop injury and short residual activity to allow for maximum rotational flexibility. CGA-248757 also is an excellent tank mix partner with CGA-277476 and numerous other herbicides to broaden the spectrum and increase the speed of activity on susceptible weed species.

Replicated field trials were conducted in Indiana, Maryland, New York, Pennsylvania, and Ohio from 1994 through 1996 to evaluate broadleaf weed control provided by CGA-277476 applied alone and combined with CGA-248757. CGA-277476 applied postemergence at 66-79 g ai/ha provided control of important weeds such as common ragweed (*Ambrosia artimisiifolia* L.), velvetleaf (*Abutilon theophrasti* Med.), common cocklebur (*Xanthium strumarium* L.), pigweeds (*Amaranthus* spp.), burcucumber (*Sicyos angulatus* L.) and morningglories (*Ipomoea* spp.) while suppression of common lambsquarters (*Chenopodium album* L.) and Canada thistle [*Cirsium arvense* (L.) Scop.] were also noted.

Tank mix combinations of CGA-277476 at 66-79 g ai/ha plus CGA-248757 applied at 4 g ai/ha were found to broaden the weed spectrum, widen the window of application, and increase the speed of activity on several weeds. Velvetleaf was controlled when treated up to a height of one m with the combinations while CGA-277476 applied alone was effective at heights of 15 cm or less. Additional weeds for which control or suppression is enhanced by the combinations include Pennsylvania smartweed (*Polygonum pensylvanicum* L.), eastern black nightshade (*Solanum ptycanthum* Dun.), and spurred anoda (*Anoda cristata* L.)

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POSTEMERGENCE WEED CONTROL IN SOYBEANS WITH CGA-277476

R. L. Ritter and H. Menbere*

ABSTRACT

CGA-277476 (proposed common name - oxasulfuron) is the active ingredient in a new sulfonylurea herbicide being developed by CIBA. Its proposed trade name is Expert. CGA-277476 was evaluated in Maryland in 1995 and 1996 for postemergence control of broadleaf weeds in soybeans ([Glycine max. (L.) Merr.]. Postemergence rates tested ranged from 0.059 to 0.07 lb ai/A. All applications were made in combination with a nonionic surfactant at 0.25% v/v.

Some crop phytotoxicity was observed with CGA-277476 at all rates tested. Yet, soybeans seemed to outgrow these symptoms within 2 weeks after application.

Good control of burcucumber (Sicyos angulatus L.), common cocklebur (Xanthium strumarium L.), common ragweed (Ambrosia artemisiifolia L.), and giant ragweed (Ambrosia trifida L.) was obtained with CGA-277476. Poor control of common lambsquarters (Chenopodium album L.) was observed. The addition of CGA-2488757 (proposed trade name - Action), acifluorfen (Blazer), or thifensulfuron-methyl (Pinnacle) aided CGA-277476 in the control of common lambsquarters.

It was also observed that when combined with clethodim (Select), a reduction in giant foxtail (Setaria faberi Herrm.) control was observed.

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SUPPRESSION OF A CROWNVETCH/BIRDSFOOT TREFOIL LIVING MULCH FOR NO-TILLAGE CORN PRODUCTION

N. L. Hartwig and W. S. Curran[1]

ABSTRACT

Most of the herbicides presently labeled for use on field corn were applied preplant (PP) and/or post to a one year old stand of crownvetch (Coronilla varia L.) and birdsfoot trefoil (Lotus corniculatus L.) that was seeded in corn in 1995. Preplant treatments were applied on May 17, 1996 when the crownvetch was 4 to 8" and birdsfoot trefoil 8 to 10" in height. On May 31 the whole trial area was treated with metolachlor (Dual II) + pendimethalin (Prowl) @ 1 + 0.825#ai/A to control most annual weeds without affecting crownvetch or birdsfoot trefoil growth. Since imazethapyr (Pursuit) was one of the treatments, an imidazolinone resistant corn (Zea mays L) variety was planted. Post treatments were applied June 17, 1996 when crownvetch was 8 to 10 inches and birdsfoot trefoil 8 to 12 inches tall and corn in the 4 to 5 leaf stage.

The soil was a Hublersburg Silt Loam (Typic Hapludult) with a pH of 6.8. All treatments were applied with a tractor mounted small plot sprayer with 80015 extended range flat fan nozzles at 28 psi in 20 gal/A of water. 'Asgrow RX623T' corn was planted in 10 by 25 ft. plots with a four row no-till planter in 30 in. rows on May 22, 1996 with 100 lb/A of 10-30-10 fertilizer in the row. Liquid nitrogen @ 120 lb N/A was applied as a sidedress treatment on May 31. Annual broadleaf weed control was virtually 100% for all treatments and annual grass control was 95% or better. There was some horsenettle (Solanum carolinense L.), hemp dogbane (Apocynum cannabinum L.) and goldenrod (Solidago spp.) scattered through the trial area.

There was a solid stand of birdsfoot trefoil by mid May with a sparse stand of crownvetch mixed with it. The highest corn yield was 135 bu/A where birdsfoot trefoil suppression was 95% and the crownvetch was completely killed. Previous research would suggest that crownvetch suppressed 95% or more for the first 6 weeks after corn planting will seldom compete with corn and the stunted crownvetch canopy may indeed save more moisture that it uses.

Twenty of the 36 herbicide treatments were glyphosate or growth hormone type herbicides applied preplant to the corn after the crownvetch had 4 to 8 inches and birdsfoot trefoil 8 to 10 inches of new growth. This herbicides almost totally killed the one year old crownvetch but did suppress the birdsfoot trefoil about 95% which is probably the right amount. Recovery growth of the birdsfoot trefoil was between 250 and 800 lb/A of biomass by September and generally anything less than 500 lb/A of biomass will not cause a significant loss in corn yield. Glyphosate was used at 0.75 lb/A preplant as a burndown treatment followed by various growth hormone and sulfonylureas which provided some additional birdsfoot trefoil suppression. Well established crownvetch will also tolerate these treatments but a one year old stand is too sensitive.

The best cover crop suppression was obtained with contact herbicides such as paraquat, glufosinate or cyanazine for burndown in combination with or followed by other herbicides such as atrazine, alachlor, metolachlor, acetochlor, dimethanamid, pendimethalin, flumetsulam or flumiclorac for residual weed control and to slow the rate of cover crop recovery. Atrazine at rates 0.5 to 0.75 lb/A is necessary to slow the rate of birdsfoot trefoil recovery. Without atrazine in the mixture the birdsfoot trefoil recovers so fast that it suppresses corn yields excessively. Crownvetch is not suppressed quite as much as birdsfoot trefoil by these treatments but the ultimate goal is to have the crownvetch take over and then manage just the crownvetch as a perennial living mulch.

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EFFECTS OF REPEATED LATE-WINTER HERBICIDE APPLICATIONS ON SEMI-DORMANT ALFALFA

H. Menbere and R. L. Ritter*

ABSTRACT

This study was initiated on a two-year-old stand of 'Legacy' alfalfa (Medicago sativa L.) located at the University of Maryland Hayden Farm in Beltsville, MD. Herbicide applications were made on March 22, 1995 and March 27, 1996 when the alfalfa had approximately 2 to 4 inches of growth. Treatments included imazethapyr (Pursuit) at 0.063 and 0.094 lb ai/A; paraquat (Gramoxone Extra) at 0.23, 0.313, and 0.469 lb ai/A; metribuzin (Sencor/Lexone) at 0.375 lb ai/A; terbacil (Sinbar) at 0.375 lb ai/A; bromoxynil (Buctril) at 0.375 lb ai/A; and 2,4-DB (Butyrac) at 1.5 lb ai/A. These same treatments were applied to the same plots both years. Visual crop tolerance (phytotoxicity) ratings were made in April. Four cuttings were made each year to check for potential yield effects from the herbicide applications.

In 1995, crop tolerance ratings indicated that the highest levels of foliar injury occurred from all three rates of paraquat, ranging from 23 (low rate) to 35% (high rate) on April 5. A significant amount of foliar injury was also observed from metribuzin and terbacil which averaged 18% and 13%, respectively, on April 5. All of the other treatments averaged less than 10% injury on the April 5 rating. Visual ratings made on April 20 found all rates of paraquat and metribuzin still causing a significant amount of crop injury. Similar trends occurred in 1996, whereby the highest levels of foliar injury were obtained from all three rates of paraquat, ranging from 32 to 40% on April 11. Foliar injury was also observed from metribuzin and terbacil (13 and 15%, respectively). Ratings made on April 26 showed continued injury to the alfalfa from these five treatments. All other treatments averaged ratings of 10% or less on both dates.

In 1995, yield data obtained May 6 indicated lower weights from alfalfa treated with the two highest rates of paraquat and the single rate of metribuzin. With the June and July harvests, no yield differences were observed between treatments. Yet, the August harvest found the plots treated with the high rate of paraquat and the single rate of metribuzin were yielding the lowest among all treatments. In 1996, first cutting yield data showed a decrease in yield where the high rate of gramoxone or metribuzin were applied. Subsequent cuttings showed a decline in yield where terbacil had been used.

These data indicate that repeated late-winter herbicide applications on semi-dormant alfalfa may not result in a loss in alfalfa yield over time.

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Fall Versus Early Summer Applications for Control of Hemp Dogbane in Corn

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ABSTRACT

Hemp dogbane (*Apocynum cannabinum* L.) is an herbaceous creeping perennial that is native to North America. It is found throughout Canada, the United States, and especially the mid-Atlantic region. Hemp dogbane is a serious problem weed in both cultivated and noncultivated fields in many parts of Pennsylvania. Although crop reduction due to hemp dogbane varies, some research from Nebraska showed a 15% reduction in corn, 32% loss in sorghum, and 37% loss in soybean grain yield from uncontrolled infestations. In conventional tillage systems, hemp dogbane is rarely a serious weed problem. However, with the increase in conservation tillage systems and lack of effective selective herbicides, hemp dogbane has quickly become a serious problem.

In the fall of 1993, 1994, and 1995, experiments were established in Dauphin County, Pennsylvania to compare fall application of one or more systemic herbicides to postemergence applications in corn. Previous to the fall treatments, the hemp dogbane was allowed to regrow following either wheat harvest in early July or in a fallow field. All field locations had a history of no-tillage. Fall herbicide treatments in 1993 and 1994 included glyphosate at 1 and 2 lb ai/A, dicamba at 0.5 and 1 lb ae/A, dicamba plus 2,4-DLVE at 0.5 lb ae/A each, and glyphosate plus 2,4-DLVE or dicamba at 1 lb plus 0.5 lb/A. Herbicides were applied at two application timings either in early September or in early October. In 1995, only a single timing of glyphosate was applied in late September. Corn was planted no-till the following spring. Both years, a burndown herbicide plus a soil residual grass plus broadleaf program was applied prior to corn planting. Postemergence herbicide treatments in corn included dicamba or 2,4-D amine at 0.5 lb/A and primisulfuron plus dicamba at 0.018 lb ai plus 0.25 lb/A. Only dicamba plus primisulfuron was compared in the 1995 experiment. All herbicide treatments included a nonionic surfactant at 0.25% v/v in the spray mixture. In addition, the 1995 experiment compared the performance of the herbicide treatments in no-till and minimum-till (spring chisel plow) corn. Weed control evaluations included visual estimates of percent control (0 to 100 scale), weed density, and weed biomass.

The hemp dogbane infestation was severe throughout most of the corn in 1994 and 1996 and more variable in 1995. The treatments that included fall applied glyphosate were clearly visible in early summer showing good control (>85%) of hemp dogbane and several other perennial weeds present in the field. However, the emergence of new shoots in some treatments throughout the summer reduced the performance ratings by August. The addition of dicamba or 2,4-D to glyphosate did not improve overall performance on hemp dogbane in 1994 or 1995, although including 2,4-D did improve the control of dandelion. In general, dicamba and 2,4-D performance was less effective than glyphosate and increasing glyphosate rate did not improve control. The September and October timings produced similar results, although the September timing may have had a slight advantage in 1994 because of cold weather and a light frost just prior to the October application. In general, the post applications in corn were equal or less effective than the fall applications. In 1996, although control with primisulfuron plus dicamba was equal to fall applied glyphosate (>85% control), root bud growth was observed on the post corn treated hemp dogbane. Tillage did not influence the level of control in 1996, although more hemp dogbane shoots were observed in some chisel treatments in the mid-summer evaluation. The fall treatment followed by an additional post corn treatment provided some of the best control (> 90%) of hemp dogbane and should allow for better control of a number of perennial weeds.

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FALLINGSNOW ECOSYSTEM PROJECT: NITROGEN MINERALIZATION AND NUTRIENT UPTAKE

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Five hundred spruce seedlings and 300 trembling aspen were monitored, 1 and 2 years post-treatment, on 4 blocks and 5 treatments/block (untreated control, brushsaw, Silvana Selective, Vision® [a.i. glyphosate], and Release® [a.i. triclopyr]). Five spruce were tagged at 5 soil temperature/moisture cell locations/treatment. The closest competing aspen for the 2 cutting and control treatments were also tagged. New spruce and aspen foliage were bulk sampled for foliar nutrient analysis (macronutrients). Concurrently, plant water potential of tagged spruce and aspen were measured using a pressure bomb.

In 1995, soil nitrogen mineralization (NH_4 and NO_3) were measured monthly from June-September at 3 soil depths (~ 5, 15 and 30 cm) for 4 treatments (unharvested and untreated controls, brushsaw, and Vision®) on Blocks 2 (drier, cooler) and 3 (wetter, warmer). All data were analyzed using ANOVA procedures.

In 1994 (1 year post-treatment), elevated foliar N for spruce was observed for both chemical treatments on 3 blocks. Enhanced uptake of N was not observed for brushsaw and Silvana Selective treatments. Significant treatment differences for other nutrients were not observed.

In 1995 (2 years post-treatment), soil temperatures and moisture levels remained elevated for all release treatments, creating ideal conditions for N turnover and NO_3 production. Higher levels of NO_3 were observed for Vision® and brushsaw treatments in July compared with untreated and unharvested controls.

No significant increases in nutrient uptake for treated spruce seedlings over that for untreated control spruce were observed in 1995. Concurrently, foliar concentrations of N, P, K, and Mg for aspens surrounding released spruce seedlings were greater than those for aspen surrounding control spruce. Although white spruce water potentials were lower in 1995 than in 1994, they did not differ among treatments. The lowest spruce water potentials (i.e., most negative) were observed for brushsaw and Silvana Selective treatments, where some of the lowest foliar N concentrations for spruce seedlings also were observed. By contrast, midday water potentials for aspen growing in association with released spruce were generally higher (i.e., less negative) than those for untreated control aspen, and the highest aspen foliar N and P concentrations were observed for the Silvana Selective treatment.

CONTROLLING ROADSIDE VEGETATION WITH THIAZOPYR, OXYFLUORFEN, GLUFOSINATE, AND GLYPHOSATE

Larry J. Kuhns and Tracey L. Harpster[1]

INTRODUCTION

Vegetation must be controlled under guiderails to allow water to flow uniformly away from the road surface and to allow their clear visibility to drivers. The objective of this study was to evaluate the residual activity of two preemergence herbicides, oxyfluorfen and thiazopyr, in the roadside environment. They were used in combination with one of two postemergence herbicides, glufosinate or glyphosate[2], to eliminate existing weeds in the treated areas.

METHODS

The preemergence treatments evaluated were thiazopyr alone at 0.5, 1.0 and 2.0 lb/a; the same treatments plus oxyfluorfen at 1.6 lb/a; oxyfluorfen alone at 1.6 lb/a; and oryzalin plus oxyfluorfen at 4 and 1.6 lb/a, respectively. The postemergence treatments included the addition of glyphosate at 2 lb/a to a set of the preemergence treatments, or applications of either glyphosate at 2 lb/a or glufosinate at 2 lb/a 11 days prior to the application of the preemergence treatments. Table 1 includes a summary of the treatments.

Treatments were applied to 75 ft^2 plots with a CO_2 pressurized test plot sprayer at 30 psi through two 8004E nozzles mounted in a double swivel nozzle body to eliminate the shadow effect around support posts; in 38 GPA. The combination of preemergence herbicides and glyphosate was applied on June 27, 1996. At the same time, the applications of glyphosate or glufosinate alone were made. On July 8, the preemergence treatments were applied over the areas previously treated with glyphosate or glufosinate. Treatments were applied in a randomized complete block design, with three replications.

The study was conducted along a roadside under guiderails in two areas about 400 yards apart. Two replications of the treatments including glyphosate were in one area, and the other replication plus all three replications with glufosinate were in the other. The predominant weeds in the glyphosate areas at the time of application were common ragweed (*Ambrosia artemisiifolia* L.), birdsfoot trefoil (*Lotus corniculatus* L.), wild carrot (*Daucus carota* L.), and crownvetch (*Coronilla varia* L.). Other weeds distributed throughout were wild buckwheat (*Polygonum convolvulus* L.), common speedwell (*Veronica officinalis* L.), bull thistle (*Cirsium vulgare* (Savi) Tenore.), common burdock (*Arctium minus* (Hill) Bernh.), goldenrod (*Solidago* spp), green foxtail (*Setaria viridis* (L.) Beauv.), red fescue (*Festuca rubra* L.), and garlic mustard (*Alliaria petiolata* (Bieb.) Cavara & Grande). Ragweed was 6 to 12 inches tall, all others were 3 to 6 inches tall. The predominant weeds in the glufosinate treated area were wild carrot, common ragweed, spotted knapweed (*Centaurea maculosa* Lam.), birdsfoot trefoil, and yellow foxtail (*Setaria lutescens* (Weigel) Hubb.). The weed density and size in this area was lower than in the area treated with glyphosate.

The percent green cover in each plot was rated on July 22, August 22, and October 24, 1996.

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2 Roundup Pro, Monsanto Co., 800 No. Lindbergh Boulevard, St. Louis, MO 63167.

RESULTS AND DISCUSSION

Glufosinate provided rapid burndown of all of the weeds in the treated areas (Table 1). There was little regrowth in these areas, even where glufosinate alone was used. There was apparently some herbicide residue in this area from prior applications by the Pennsylvania Department of Transportation. No conclusions can be reached on the effectiveness of the preemergence herbicides used in this part of the study.

Initially, all of the treatments including glyphosate provided good to excellent control of all weeds. However, by August 22 it appeared that applying glyphosate prior to the treatments containing oxyfluorfen resulted in better control than applying glyphosate and oxyfluorfen together. The rating on October 24 confirmed this. The oxyfluorfen must injure the weed foliage before the glyphosate can be absorbed and translocated. Perennial weeds were burned down by the combination, but were able to regrow if the oxyfluorfen interfered with the activity of the glyphosate.

In this study, adding thiazopyr to the oxyfluorfen did not consistently improve the level of preemergence weed control obtained. In the area to which glyphosate was applied prior to treatment, oxyfluorfen alone or in combination with thiazopyr provided better control than the glyphosate alone. The control provided by thiazopyr at 0.5 lb/a alone was no better than that provided by glyphosate alone. Thiazopyr at 1.0 and 2.0 lb/a alone provided a level of control between glyphosate alone and the treatments including oxyfluorfen

The roadside environment is extremely variable. Soils are mixed, gravel and grit are added in variable amounts, and highly active, long residual herbicides are periodically added. In addition, a wide mixture of annual and perennial weeds may be present. Several years of testing on a variety of sites is necessary to determine the suitability of a herbicide for use along roadsides.

Table 1. Percent green cover ratings in areas treated with preemergence herbicides on June 27 or July 8, 1996. The June 27 applications included glyphosate at 2 lb/a. On June 27 glyphosate or glufosinate, at 2 lb/a, were applied to areas on which the preemergence herbicides were applied on July 8.

Chemical	Rate (lb/A)	% Green Cover[1/] July 22	August 22	October 24
Control		82 a	98 a	90 a
Thiazopyr + Glyphosate	0.5 + 2.0	5 bc	10 cdef	7 e
Thiazopyr + Glyphosate	1.0 + 2.0	8 bc	28 bcd	33 bcd
Thiazopyr + Glyphosate	2.0 + 2.0	10 bc	18 cde	33 bcd
Thiazopyr + Oxyfluorfen + Glyphosate	0.5 +1.6 + 2.0	14 b	43 b	50 b
Thiazopyr + Oxyfluorfen + Glyphosate	1.0 +1.6 + 2.0	9 bc	30 bc	50 b
Thiazopyr + Oxyfluorfen + Glyphosate	2.0 +1.6 + 2.0	14 b	27 bcd	48 b
Oxyfluorfen + Glyphosate	1.6 + 2.0	5 bc	25 bcde	45 bc
Oryzalin + Oxyfluorfen + Glyphosate	4.0 +1.6 + 2.0	5 bc	28 bcd	33 bcd
Glyphosate	2.0	7 bc	22 cde	35 bcd
Thiazopyr[2/]	0.5	9 bc	20 cde	43 bc
Thiazopyr[2/]	1.0	4 c	8 def	13 de
Thiazopyr[2/]	2.0	3 c	6 ef	11 de
Thiazopyr + Oxyfluorfen[2/]	0.5 + 1.6	2 c	4 f	6 e
Thiazopyr + Oxyfluorfen[2/]	1.0 + 1.6	2 c	3 f	4 e
Thiazopyr + Oxyfluorfen[2/]	2.0 + 1.6	1 c	1 f	2 e
Oxyfluorfen[2/]	1.6	1 c	4 f	6 e
Oryzalin + Oxyfluorfen[2/]	4.0 +1.6	2 c	4 f	11 de
Glyphosate[2/]	2.0	2 c	9 def	33 bcd
Thiazopyr[3/]	0.5	1 bc	3 f	4 e
Thiazopyr[3/]	1.0	1 c	3 f	5 e
Thiazopyr[3/]	2.0	1 c	3 f	5 e
Thiazopyr + Oxyfluorfen[3/]	0.5 + 1.6	1 c	4 f	6 e
Thiazopyr + Oxyfluorfen[3/]	1.0 + 1.6	1 c	2 f	3 e
Thiazopyr + Oxyfluorfen[3/]	2.0 + 1.6	1 c	1 f	1 e
Oxyfluorfen[3/]	1.6	1 c	1 f	1 e
Oryzalin + Oxyfluorfen[3/]	4.0 +1.6	1 c	1 f	0 e
Glufosinate[3/]	2.0	1 c	1 f	5 e

[1/] Means within columns, followed by the same letter, do not differ at the 5% level of significance (DMRT).

[2/] Applied July 8, 1996. Glyphosate (Roundup Pro) was applied at 2 lb/a on June 27.

[3/] Applied July 8, 1996. Glufosinate was applied at 2 lb/a on June 27.

EVALUATION OF HERBICIDES FOR CONTROL OF CANADA THISTLE IN FINE FESCUE

Chad W. Spackman, Jon M. Johnson, and Larry J. Kuhns[1/]

ABSTRACT

As part of a cooperative project between the Pennsylvania State University and the Pennsylvania Department of Transportation, a trial was established to evaluate several herbicides for selective control of Canada thistle (*Cirsium arvense* L.) within a stand of fine fescue. The study area was located within an established stand of fine fescue, comprised predominantly of hard fescue (*Festuca longifolia* Thuill.), at Penn State's Landscape Management Research Center and arranged in a randomized complete block design with three replications. Treatments included an untreated check, 0.75 lbs/ac diglycolamine salt of dicamba (dicamba), 0.35 lbs/ac SAN 1269H alone and in combination with 0.5 lbs/ac dicamba, 0.23 lbs/ac clopyralid, 0.75 lbs/ac dicamba in combination with 0.12 lbs/ac clopyralid or 0.012 lbs/ac metsulfuron methyl, 2 lbs/ac glyphosate, 1 lb/ac triclopyr, and 0.188 lbs/ac imazameth. All treatments, except glyphosate, contained 0.125% (v/v) surfactant[2/] and all contained 0.25% (v/v) drift control agent[3/]. Application was made to 6 by 10 ft plots on June 12, 1996, using a CO_2-powered hand held sprayer equipped with Spraying Systems XR 8004 VS spray tips, delivering 40 GPA at 35 psi. Ground cover ratings of the fine fescue were taken June 12; July 24, 43 days after treatment (DAT); and August 30, 79 DAT. An initial count of thistle stems within the plots was taken June 12. A count of uncontrolled thistle stems and thistle resprouts was taken July 24 and August 30. These values were utilized for determining percent thistle resprouts and percent thistle decline, which evaluates the extent of decline of the originally treated stems and was affected by either treatment or natural senescence. Percent decline and resprouting results are reported in Table 1.

All treatments, except triclopyr or imazameth, provided similar levels of thistle decline at the July 24 rating. Triclopyr was slightly lower, while imazameth was not different from the untreated check. Due to natural senescence of the thistle plants, an increase in thistle decline was evident at the August rating, as the untreated check escalated from 15 percent decline in July to 64 percent in August. All other treatments, excluding the check and imazameth, provided similar levels of decline at the August rating. Percent thistle resprouting values at the July rating were similar for all treatments, except triclopyr with the highest level at 37 percent. There was no significant difference among treatments at the August rating except for imazameth, which actually resprouted by 151 percent. None of the treatments thinned the fine fescue stand but imazameth provided slight necrosis to the leaf tips.

All treatments, except imazameth, provided selective control of treated thistles; but all still had significant resprouting occur. No treatment provided an overall acceptable level of control, therefore repeat applications would be necessary to eliminate the thistle.

[1/] Research Technologist, Project Assistant, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA.

[2/] QwikWet 357 (Exacto Inc.)

[3/] Polytex A1001 (Exacto Inc.)

TABLE 1: Herbicide treatments were applied June 12, 1996. Percentage of Canada thistle decline and percentage of thistle resprouts from ratings taken July 24 and August 30, 1996. Each value is the mean of three replications.

Herbicide[1/]	Application Rate	Thistle Decline		Thistle Resprouts	
		July 24	August 30	July 24	August 30
	(lbs/ac)	(--------% -------)		(--------% ---------)	
untreated check	- -	15	64	6	37
dicamba	0.75	90	98	25	79
SAN 1269 H	0.35	90	99	15	72
dicamba SAN 1269H	0.5 0.35	94	98	15	46
clopyralid	0.23	80	99	13	52
dicamba clopyralid	0.75 0.12	90	99	21	49
dicamba metsulfuron methyl	0.75 0.012	87	98	12	78
glyphosate	2	96	99	20	34
triclopyr	1	78	98	37	78
imazameth	0.188	28	84	10	151
Significance Level (p)		0.0001	0.0001	0.2	0.1
LSD (p=0.05)		15	11	22	72

[1/] All treatments, except glyphosate, contained QwikWet 357 (Exacto Inc.) @ 0.125% (v/v) and all treatments contained the drift control agent Polytex A1001 @ 0.25% (v/v).

BRUSH CONTROL PROVIDED BY LOW VOLUME FOLIAR APPLICATIONS

Jon M. Johnson, Chad W. Spackman, and Larry J. Kuhns[1/]

ABSTRACT

As part of a cooperative research project between The Pennsylvania State University and The Pennsylvania Department of Transportation, a study evaluating brush control provided by the diglycolamine salt of dicamba (dicamba) alone and in combination with other herbicides was established along SR 219 near Ebensburg, PA on September 1, 1995. Dicamba was applied alone at rates of 1.5 and 2.0 lb/a; in combination with triclopyr[2/], imazapyr, and glyphosate; and compared to glyphosate, and fosamine ammonium (fosamine) plus imazapyr (Table 1). Thinvert[3/] was used in three of the treatments as a carrier instead of water. The plots were approximately 20 by 50 ft, arranged in a randomized complete block with three replications. A CO_2-powered backpack sprayer equipped with a handgun and a Spraying Systems #5500 Adjustable ConeJet with a X-6 tip, operating at 20 psi was used to approximate an application volume of 20 gal/a for the aqueous treatments. The Thinvert treatments were applied with the same apparatus except for a change to a Thinvert 71031 tip. All aqueous treatments included a surfactant[4/] and a drift control agent[5/] at 0.125 and 0.25 percent v/v, respectively. Each plot contained several tree species in the 3 to 10 ft height range with a few up to 15 ft. The predominant species were red maple (*Acer rubrum* L.), black cherry (*Prunus serotina* Ehrh.), quaking aspen (*Populus tremuloides* Michx.), white oak (*Quercus alba* L.), red oak (*Quercus rubra* L.), green ash (*Fraxinus pennsylvanica* Marsh.), and staghorn sumac (*Rhus typhina* L.). Visual ratings of foliar necrosis were taken September 15, 1995, 14 days after treatment (DAT). Visual ratings of tree injury were taken August 13, 1996 (347 DAT). Average tree injury results are reported in Table 1.

Green ash, staghorn sumac and a few less notable species are not included on Table 1 due to lack of space. The average total tree injury rating on the far right side of the table includes these tree species in the statisical analysis, however. Table 1 includes a T Grouping for determining which treatments are statistically different. Analyzing the data with unequal replication made providing LSD values impractical.

The treatments including glyphosate caused the most foliar necrosis 14 DAT. The treatments providing the highest average tree injury ratings 347 DAT were the 2.00 lb/a dicamba plus 0.25 lb/a imazapyr, 1.5 lb/a dicamba plus 0.38 lb/a imazapyr in Thinvert, 2 lb/a glyphosate, 3.0 lb/a fosamine plus 0.15 lb/a imazapyr, and dicamba at the 2 lb/a rate in combination with glyphosate at 1.5 lb/ac. Although dicamba alone was significantly better than the untreated check, it did not provide satisfactory results.

Two of the three dicamba plus imazapyr combinations evaluated in this trial provided satisfactory first year injury ratings, but used relatively high rates of imazapyr. Due to the soil activity of imazapyr, combinations with dicamba using lower rates of imazapyr need to be evaluated to most efficiently use this combination on rights-of-way.

[1/] Project Assistant, Research Technologist, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA 16802
[2/] Garlon 3A, triethanolamine salt of triclopyr, 3 lb ae/gal, DowElanco, Indianapolis, IN.
[3/] Thinvert, Waldrum Specialties, Doylestown, PA.
[4/] QwikWet 357, Exacto Chemical Co., Richmond, IL.
[5/] Formula 358, Exacto Chemical Co., Richmond, IL.

TABLE 1: Average injury rating and number of stems, by species, for foliar herbicide treatments applied September 1, 1995. Injury was rated August 16, 1996, on a scale of 1 to 5, where '1'=no injury, '2'=slight defoliation, '3'=moderate defoliation including terminal, '4'=severe defoliation and epinasty, '5'=complete control of the tree. Treatment means followed by the same letter within a given column are not significantly different according to Fisher's LSD. A single LSD value is not reported due to unequal replication.

		Average Tree Injury Rating				
Herbicide	Application Rate (lb ai/a)	Maple	Cherry	Populus	Oak	Average Total
		(-------average injury rating (number of stems)T-Grouping-------)				
untreated	- - -	1.0 (40) f	1.1 (37) f	1.0 (63) j	1.0 (28) h	1.0 (283) i
dicamba	1.50	2.7 (13) e	4.4 (10) bc	4.2 (120) cdf	2.9 (22) ef	3.9 (166) f
dicamba	2.00	3.4 (53) cd	3.9 (39) d	3.8 (80) hi	1.7 (11) g	3.6 (188) g
dicamba triclopyr	2.00 0.75	4.5 (6) ab	4.5 (80) c	3.8 (110) ghi	2.0 (2) fgh	4.1 (213) e
dicamba imazapyr	1.50 0.38	4.9 (11) a	5.0 (48) a	4.2 (207) def	4.9 (7) ab	4.4 (309) cd
dicamba imazapyr	2.00 0.25	5.0 (20) a	4.9 (44) a	4.6 (122) ab	4.8 (46) a	4.7 (235) a
dicamba glyphosate	1.50 1.50	3.8 (5) bc	4.9 (90) a	4.1 (169) efg	3.0 (12) ef	4.3 (325) de
dicamba glyphosate	2.00 1.50	4.3 (22) b	5.0 (40) a	4.4 (111) bcd	2.2 (9) fg	4.5 (259) bc
glyphosate	2.00	3.0 (8) de	5.0 (42) a	4.7 (160) a	3.5 (6) de	4.6 (240) ab
fosamine imazapyr	3.00 0.15	5.0 (6) a	4.8 (42) ab	4.5 (78) abc	4.1 (22) bcd	4.6 (149) abc
fosamine imazapyr Thinvert	3.00 0.15 -	5.0 (6) a	5.0 (37) a	4.0 (182) efgh	5.0 (14) a	4.3 (247) de
dicamba Thinvert	2.00 -	3.3 (8) cde	3.1 (19) e	3.6 (94) i	2.2 (9) fg	3.4 (135) h
dicamba imazapyr Thinvert	1.5 0.38 -	4.9 (59) a	4.9 (35) a	4.4 (34) abcdf	4.5 (30) ac	4.7 (158) a

LOW VOLUME WEED AND BRUSH APPLICATIONS WITH THE THINVERT® SYSTEM

R. R. Johnson and J. E. Waldrum[1]

ABSTRACT

The Thinvert Application System utilizes the combination of a thin invert emulsion with a unique new nozzle design to produce small uniform droplets of pesticide sprays. These small uniform droplets permit the accurate application of herbicides to control many invasive, exotic plant species with little or no exposure to desirable vegetation in natural plant areas, wildlife habitat, environmentally sensitive areas, or landscaped areas. Various available nozzle configurations will apply spray patterns as narrow as two to three inches or as wide as 20 feet, at total spray volumes of 3 to 5 gallons per acre. These low volumes allow vegetation managers, wildlife managers, or landscapers to apply herbicide sprays extensively and economically using backpack sprayers, ATV's equipped with small electric spray units, or with other vehicles that produce minimum physical disturbance to the spray site.

Since numerous herbicides and herbicide combinations are available which will control many undesirable invasive exotic plant species, an application technique which will control these exotics with low impact application equipment, accurate placement, and control of spray drift and evaporation can be a valuable environmental management tool. Beginning in 1991, applications of appropriate herbicides were made to non-native plant species to determine whether applications of these herbicides using the Thinvert Application System would provide control of problem non-native species, and to observe effects on non-target vegetation. Since product labels may provide rate per acre or spray concentration recommendations, efforts were made to reproduce the rate per acre recommendations. Because Thinvert applications apply less total spray volume, spray concentration recommendations were increased about three-fold to maintain suggested herbicide rates per acre.

Table 1 indicates the plant species which were treated and the herbicides which were used to control each species. All treatments used Thinvert spray nozzles and used Thinvert thin invert emulsion as a carrier at approximately 4 gal/A total spray volume. Herbicides listed gave effective control of the plants listed at rates recommended with conventional application methods

1. Waldrum Specialties, Inc., Doylestown, PA

TABLE 1: Non-native plant species treated using various Thinvert® nozzles and using Thinvert® thin invert emulsion as a carrier. Spray volume approximately 4 gal/A. Herbicides listed gave effective control of the plants listed at rates recommended with conventional application methods.

NON-NATIVE PLANTS	HERBICIDE USED
Japanese knotweed (Polygonum cuspidatum Sieb & Zucc.)	glyphosate + imazapyr
Japanese honeysuckle (Lonicera japonica Thunb.)	triclopyr or 2,4-D
Multiflora rose (Rosa multiflora)	glyphosate or fosamine
Garlic mustard (Alliaria petiolata Bieb)	glyphosate
White mulberry (Morus alba L.)	glyphosate
Purple loosestrife (Lythrum salicaria L.)	triclopyr
Canada thistle [Cirsium arvense (L.) Scop]	clopyralid
Norway maple (Acer platanoides L.)	tryclopyr
Phragmites [Phragmites australis (Cav.) Trin. ex Steud.]	imazapyr
Melaleuca [Melaleuca quinquinervia (Cav.) Blake]	imazapyr

EVALUATION OF GLYPHOSATE FOR DORMANT APPLICATIONS TO BRUSH RESPROUTS

A.E. Gover, J.M. Johnson, C.W. Spackman, and L.J. Kuhns[1]

ABSTRACT

The objective of this trial was to evaluate varying rates of a commercially available isopropylamine salt of glyphosate, and different carriers for their effect on brush control provided by dormant season applications. Nine treatments were applied to a stand of second year resprouts at the interchange of SR 219 and SR 22, near Ebensburg, PA, on April 5, 1996. The treatments were applied with a CO_2-powered, hand-held sprayer equipped with a Spraying Systems #5500 Adjustable ConeJet, with a Y-2 tip. The herbicide solution was applied to provide complete coverage of the lower 24 to 36 in of each primary stem in a sprout cluster. Six treatments included glyphosate alone, mixed at 10, 25, and 50 percent (v/v) of product[2]; which produced mixtures containing 0.3, 0.75, and 1.5 lb glyphosate ae/gal, respectively; or 0.4, 1.0, and 2.0 lb of the isopropylamine salt/gal. These concentrations of glyphosate were mixed with either water plus QwikWet M-399; or Thinvert R, a ready-to-use invert emulsion carrier. The butoxyethyl ester formulation of triclopyr[3] was mixed at 5 percent (v/v) product, or 0.2 lb/gal, with 2 percent (v/v) crop oil concentrate in water, alone, or with 0.5 percent product (v/v) of the isopropylamine salt of imazapyr[4], providing 0.01 lb/gal. Additionally, glyphosate plus imazapyr, at 10 plus 1 percent product (v/v), or 0.3 plus 0.02 lb/gal, respectively, were mixed with QwikWet M-399 and water. The predominant brush species were green ash (*Fraxinus pennsylvanica* Marsh.), black cherry (*Prunus serotina* Ehrh.), red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.), and red oak (*Quercus rubra* L.). Plant heights ranged from 3 to 10 ft, with most plants falling in the 6 to 8 ft range. Each treated sprout cluster was rated September 14, 1996, using an injury scale of 1 to 10, in which '1' is no injury, and '10' indicates the treated plant is dead. Results are listed by average injury, and by the most common individual species in Table 1.

When mixed with QwikWet M-399 and water, glyphosate alone produced average injury ratings ranging from 8.9 to 9.6, while the average injury ratings ranged from 4.4 to 7.6 when glyphosate was mixed with Thinvert R. Injury to red maple was somewhat less than on other species at the two lowest glyphosate rates, and scattered stems of black birch (*Betula lenta* L.) averaged an injury rating of only 3.0 when treated with the 0.75 lb/gal rate of glyphosate in QwikWet M-399. The high rate glyphosate mixture did not spray as easily as the two lower rates when mixed with QwikWet M-399. The glyphosate formulation did not mix well with the Thinvert R, as constant agitation during application was necessary to prevent separation, particularly at the high glyphosate rate. Triclopyr alone had an average injury rating of 5.2, and triclopyr plus imazapyr averaged 6.1, with most of the increased injury seen on ash. The glyphosate plus imazapyr combination in QwikWet M-399 and water had a lower average injury rating than the same rate of glyphosate alone. Much of this difference was due to the presence of red oak in the plot, which comprised about 20 percent of the stems, and had an injury rating of only 5.7.

Further investigations need to be conducted to determine the range of species effectively controlled by dormant applications of glyphosate, the effect of time of year on injury, as well as whether full circumference coverage of the treated stems is necessary on the smaller stems typical of this trial.

1/ Project Associate, Project Assistant, Research Technologist, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA.

2/ Accord, isopropylamine salt of glyphosate, 3 lb ae/gallon, Monsanto Company, St. Louis, MO.

3/ Garlon 4, butoxyethyl ester of triclopyr, 4 lb ae/gallon, DowElanco, Indianapolis, IN.

4/ Stalker, isopropylamine salt of imazapyr, 2 lb ae/gallon, American Cyanamid, Princeton, NJ.

Table 1: Visual injury ratings taken September 14, 1996, on plants treated April 5, 1996. Injury was rated on a scale of 1 to 10, where '1' indicates no injury, and '10' indicates the plant was dead. Numbers in parentheses indicate the number of stems treated.

Treatment	Product mixture	lb ae/gal	Average	Green Ash	Black Cherry	Red Oak	Red Maple	Sugar Maple
	(% v/v)		(--- Injury (treated stems) ---					)
glyphosate[1/]	10	0.3	8.9 (116)	8.8 (32)	8.8 (12)	-- --	8.1 (20)	9.2 (39)
QwikWet M-399	45							
water	45							
glyphosate	25	0.75	8.9 (110)	9.3 (61)	9.8 (8)	-- --	8.7 (14)	9.4 (18)
QwikWet M-399	37.5							
water	37.5							
glyphosate	50	1.5	9.6 (84)	9.4 (56)	10.0 (21)	-- --	10.0 (4)	10.0 (3)
QwikWet M-399	25							
water	25							
glyphosate	10	0.3	4.4 (40)	7.9 (8)	3.7 (18)	-- --	2.3 (11)	10.0 (1)
Thinvert	90							
glyphosate	25	0.75	6.3 (30)	10.0 (4)	4.9 (9)	-- --	6.3 (16)	6.0 (1)
Thinvert	75							
glyphosate	50	1.5	7.6 (43)	10.0 (6)	7.7 (13)	6.0 (12)	7.8 (11)	10.0 (1)
Thinvert	50							
triclopyr[2/]	5	0.2	5.2 (21)	6.8 (4)	4.9 (8)	-- --	4.9 (8)	5.0 (1)
crop oil concentrate	2							
water	93							
triclopyr	5	0.2	6.1 (37)	8.9 (14)	3.4 (9)	2.0 (1)	4.4 (7)	5.8 (6)
imazapyr[3/]	0.5	0.01						
crop oil concentrate	2							
water	92.5							
glyphosate	10	0.3	7.9 (76)	-- --	9.3 (20)	5.7 (15)	8.3 (23)	7.4 (14)
imazapyr	1	0.02						
QwikWet M-399	44.5							
water	44.5							

1/ Accord, isopropylamine salt of glyphosate, 3 lb ae/gal, Monsanto, St. Louis, MO.
2/ Garlon 4, butoxyethyl ester of triclopyr, 4 lb ae/gal, DowElanco, Indianapolis, IN.
3/ Stalker, isopropylamine salt of imazapyr, 2 lb ae/gal, American Cyanamid, Princeton, NJ.

EVALUATION OF IMAZAMETH FOR WEED CONTROL IN WILDFLOWER ESTABLISHMENT

Chad W. Spackman, Jon M. Johnson, and Larry J. Kuhns[1/]

ABSTRACT

As part of a cooperative project between the Pennsylvania State University and the Pennsylvania Department of Transportation, a study was initiated to evaluate imazameth[2/] at 0.094 and 0.188 lbs/ac for both pre and postemergent weed control in establishment of annual wildflowers. All treatments contained a surfactant[3/] and drift control agent[4/]. The study area was located at Penn State's Landscape Management Research Center and was arranged in a randomized complete block design with three replications. The area was treated with 4 lbs/ac glyphosate on May 6, 1996, to control all existing vegetation. On May 20 it was rototilled to a depth of 8 in, and seeded with an annual wildflower mix containing cosmos (*Cosmos bipinnatus* Cav.), cornflower (*Centaurea cyanus* L.), corn poppy (*Papaver rhoeas* L.), rocket larkspur (*Delphinium ajacis* L.), sweet alyssum (*Dianthus barbatus* L.), and tall plains coreopsis (*Coreopsis tinctoria* Nutt.) at 14 lbs/ac. Preemergent treatments were applied May 31, as a few cosmos seedlings were emerging, to 6 by 10 ft plots using a CO_2-powered hand held sprayer equipped with Spraying Systems XR 8004 VS spray tips, delivering 40 GPA at 35 psi. Postemergent treatments were applied June 28 and all wildflower species, except rocket larkspur, were present within the treated plots. Predominant weeds included smooth pigweed (*Amaranthus hybridus* L.), common yellow woodsorrel (*Oxalis stricta* L.), green foxtail (*Setaria viridis* L.), common lambsquarters (*Chenopodium album* L.) and common dandelion (*Taraxacum officinale* L.), and were uniformly mixed among the flowers. Ground cover ratings and average canopy heights of both wildflowers and weeds were taken June 28, July 25, and September 11. Results of the weed ratings are reported in Table 1a and wildflower ratings in Table 1b.

Imazameth provided excellent preemergence weed control through the September rating period. Compared to the untreated check, the postemergence applications reduced weed height at the July rating, but not weed cover. By September, there were no differences in weed cover or height between the postemergence treated areas and the untreated check. Ground cover by wildflowers was not significantly different for treatments at either the June or September rating periods, however the 0.188 lb/ac post treatment had less cover in July than the pre and untreated plots. Pre treatments provided the lowest wildflower canopy heights in June but were not different from the check in September, while the post treated plots stunted the wildflowers and provided the lowest canopy heights in both July and September. Overall, there was little difference between application rate for either the pre or postemergent treated plots for all ratings of weeds and wildflowers. It was observed that treated plots did affect the growth of the wildflowers compared to the untreated check; especially cosmos, which had a noticeable increase in stem diameter and axillary branching near the base of the stem. A germination test was conducted indoors and all wildflower species germinated; however, rocket larkspur did not germinate in any field plots, including the check. All other species were present within the untreated and postemergent treated plots and these same species, except sweet alyssum, were present within the preemergent treated plots. Weed species present at the end of the study were identical to the initial species.

A preemergent treatment at either application rate provided a significant decrease in the amount of weeds and provided comparable amounts of wildflowers to the untreated check. Sweet alyssum does not appear to be tolerant to a preemergent treatment so species must be carefully selected when seeding. Postemergent applied treatments showed no improvement of weed control compared to the check and temporarily thinned the wildflowers.

[1/] Research Technologist, Project Assistant, and Professor of Ornamental Horticulture, respectively, The Pennsylvania State University, University Park, PA.

[2/] Plateau, American Cyanamid Co., Wayne, NJ.

[3/] QwikWet 357 (Exacto Inc.) @ 0.125% (v/v).

[4/] Polytex A1001 (Exacto Inc.) @ 0.25% (v/v).

TABLE 1a: Herbicide treatments were applied preemergent May 31 and postemergent treatments June 28, 1996. Ground cover ratings of weed pressure and average weed canopy heights were taken June 28, July 25, and September 11, 1996. Each value is the mean of three replications.

Herbicide[1/]	Application Rate	Application Timing	Ground Cover Jun 28	Ground Cover Jul 25	Ground Cover Sep 11	Canopy Height Jul 25	Canopy Height Sep 11
	(lbs/ac)		(----------%	-----------	)	(----- in	------)
untreated check	- -	- -	83	70	33	40	22
imazameth	0.094	pre	3	4	5	36	4
imazameth	0.188	pre	1	1	5	35	4
imazameth	0.094	post	92	67	22	17	11
imazameth	0.188	post	90	58	23	15	9
Significance Level (p)			0.0001	0.002	0.05	0.0001	0.3
LSD (p=0.05)			18	32	21	7	19

TABLE 1b: Herbicide treatments were applied preemergent May 31 and postemergent treatments June 28, 1996. Ground cover ratings of wildflowers and average wildflower canopy heights were taken June 28, July 25, and September 11, 1996. Each value is the mean of three replications.

Herbicide[1/]	Application Rate	Application Timing	Ground Cover Jun 28	Ground Cover Jul 25	Ground Cover Sep 11	Canopy Height Jun 28	Canopy Height Jul 25	Canopy Height Sep 11
	(lbs/ac)		(-----------	% -----------	)	(-----------	in -----------	)
untreated check	- -	- -	28	30	67	11	35	56
imazameth	0.094	pre	21	57	50	3	26	52
imazameth	0.188	pre	24	63	37	3	25	58
imazameth	0.094	post	30	27	70	11	16	35
imazameth	0.188	post	37	8	45	11	12	27
Significance Level (p)			0.7	0.1	0.2	0.0001	0.0006	0.0001
LSD (p=0.05)			25	47	35	2	7	7

[1/] All treatments contained QwikWet 357 (Exacto Inc.) @ 0.125% (v/v) and Polytex A1001 drift control agent @ 0.25% (v/v).

Presidential Address

Delivered January 3, 1996 at the
50th Annual Meeting of the
Northeastern Weed Science Society

Williamsburg Lodge and Convention Center
Williamsburg, Virginia

Bradley A. Majek
Rutgers Agricultural Research & Extension Center
Bridgeton, New Jersey

FIFTY YEARS OF PROGRESS

I would like to welcome all of you to the fiftieth Annual Meeting of the Northeastern Weed Science Society. An anniversary like this is an opportunity to reflect on the history of the Society, and look forward toward the future.

The purpose of the Northeastern Weed Science Society, since its formation in 1947, has been to provide an opportunity for the rapid exchange of information related to weed control. The traditional audience of the Society's information has also been its clientele. The group has always been diverse but have always found common ground in an understanding of agriculture. From Universities, the audience included teaching, research, and extension faculty, and county agents. Researchers, field development representatives, and sales persons from basic herbicide manufacturers have attended our meetings and used the proceedings as a reference. In addition, herbicide retailers and a few farmers have become members to keep up on the newest innovations in weed control. Everyone shared the same common goals, to increase yields and quality of the agricultural commodities produced. Our contribution was achieved by controlling weeds in the short term and by reducing soil erosion through conservation tillage techniques over a longer period of time.

Our audience, however, is changing and is no longer only made up of our clientele. The CAST leadership workshop held this past year emphasized this. In 1900, close to when the Hatch Act was passed in 1887, seventy-five percent of the Gross National Product represented agricultural production, and eighty-five percent of the population was involved in agriculture. In 1995, agricultural output represented only eighteen percent of the Gross National Product and sixteen percent of the population had careers related to agriculture.

In addition to the traditional audience and clientele of persons from universities, basic manufacturers of herbicides, retailers, and farmers; others including consumers, administrators, and politicians are taking an increased notice in weed science. Many of these individuals have no understanding of agriculture, but they control the funding allocated to many agricultural research, teaching, and extension programs.

The objectives of our "new" and inexperienced audience are broader and sometimes less well defined than our traditional objectives. Funding available today for research programs reflects these more diverse and less well defined objectives. Environmentally sound practices are desired, but the impacts of agriculture on the environment do not seem to be always understood. Nature seeks diversity, while agriculture seeks to limit diversity, frequently to maintain a temporary monoculture. Research on and use of "sustainable production systems" is a popular concept, but a consistent definition of "sustainable" cannot be agreed upon. To some, it means agriculture without pesticides. To others it means profitable production systems that improve farm income without concern for the future productivity of the land. The economic viability of rural communities is directly affected by how individuals define "sustainable." Consumers are interested in food safety and cost. The traditional objectives of increased yield and improved quality still exist, but they may seem more difficult to find.

The challenge for future research must be to address the priorities of our audience while continuing to serve our clientele. Environmentally sound agricultural practices must be developed. It must be recognized that those practices must often approach temporary monocultures, which may not be consistent with nature's constant drive toward diversity. The definition of "sustainable production systems" must be resolved. Extreme attitudes, that strive to eliminate the use of all pesticides and those that seek to maximize profit in one year at the expense of the productivity of the land, must be moderated. The income levels of farmers in many areas have reached critically low levels. Farm income must be maintained and increased to sustain agricultural production. The perception and reality of a safe food supply must be reinforced. The use of integrated crop management techniques will be essential to achieve this. Reemphasis on the integration of cultural, mechanical, and where applicable, biological control with chemical weed control is needed. Finally, the maintenance of a readily available supply of food at a reasonable cost to the consumer will require continued efforts to improve the yield and quality of crops.

How much land can ten billion people spare for Nature?

Paul E. Waggoner
The Connecticut Agricultural Experiment Station
New Haven, Connecticut

In the style of a debater, I choose the affirmative of four resolutions: Because human needs are imperative, land for Nature must be spared, not legislated. Farmers amended Malthus' Law into Jefferson's Imperative. Yield can be lifted more to spare more land. And, environmental expense need not cancel the profit of sparing land for Nature.

Land for Nature must be spared

Proclamation of wilderness and purchase of preserves prove the rank Nature has won in minds and affairs. Nevertheless, because human needs are imperative, Nature has to be spared and cannot be successfully legislated.

After talking with a poor woman along a path in the royal preserve of Fontainebleau near Paris, Thomas Jefferson wrote James Madison,

> I asked myself what could be the reason that so many should be permitted to beg who are willing to work in a country where there is a very considerable proportion of uncultivated lands? These lands are kept idle mostly for the sake of game. ... Whenever there is in any country, uncultivated lands and unemployed poor, it is clear that the laws of property have been so far extended as to violate natural right.... If we [allow land to be appropriated and do not provide employment], the fundamental right to labour the earth returns to the unemployed. (Jefferson 1785)

Jefferson hoped for a peaceful evolution, but the French soon cut away the violation of natural right with the guillotine.

I have defended my first resolution: **Because human needs are imperative, Nature must be spared--not legislated.**

Jefferson's Imperative

Lightening the grimness of the first resolution, the second states: Farmers amended Malthus' Law into Jefferson's Imperative.

For what I call Jefferson's Imperative, I let area cropped be A, Population be P, calories per capita be F for Food and Feed, and caloric Yield per area be Y. Then

$$A := \frac{P \cdot F}{Y}$$

The residuum after A is cropped will be spared for other uses, including Nature. Humanity sets the Malthusian people P and food F above the dividing line.

Farmers amend with Y for yield. Ten percent higher yield spares the same 10% land for Nature as 10% fewer people.

From 1700 until 1950 people expanded global cropland faster than they multiplied. In three centuries, cropland per person expanded 20%. Then in only 40 years, it fell 40%, Fig 1.

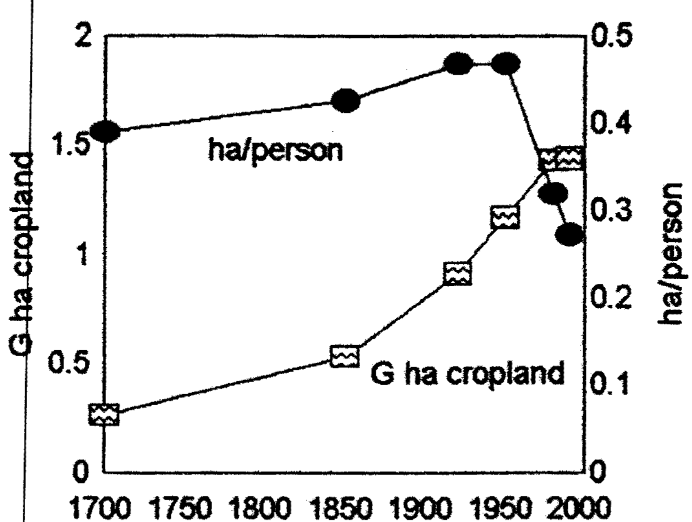


Fig 1. The global courses since 1700 of cropland in billions or G ha and of cropland per capita. (Richards 1990 and Food and Agriculture Organization (FAO) 1992).

Jefferson's Imperative insists only fewer calories or more yield can lower cropland per person. But from 1970 to 1990 food calories per person went up, not down. And animal protein in the food supply went up even faster. Poor countries actually enjoyed a faster rise of calories and protein per person than rich countries. (FAO 1992)

So, land was spared not by less food on top of the line in Jefferson's Imperative but by higher yields in its divisor. If Indian farmers had grown their recent production of wheat at their yields of the 1960's, they would have planted the expanse shown by both the areas labeled used and spared in Fig 2. But their higher yields spared the upper area--4 times the size of Indiana.

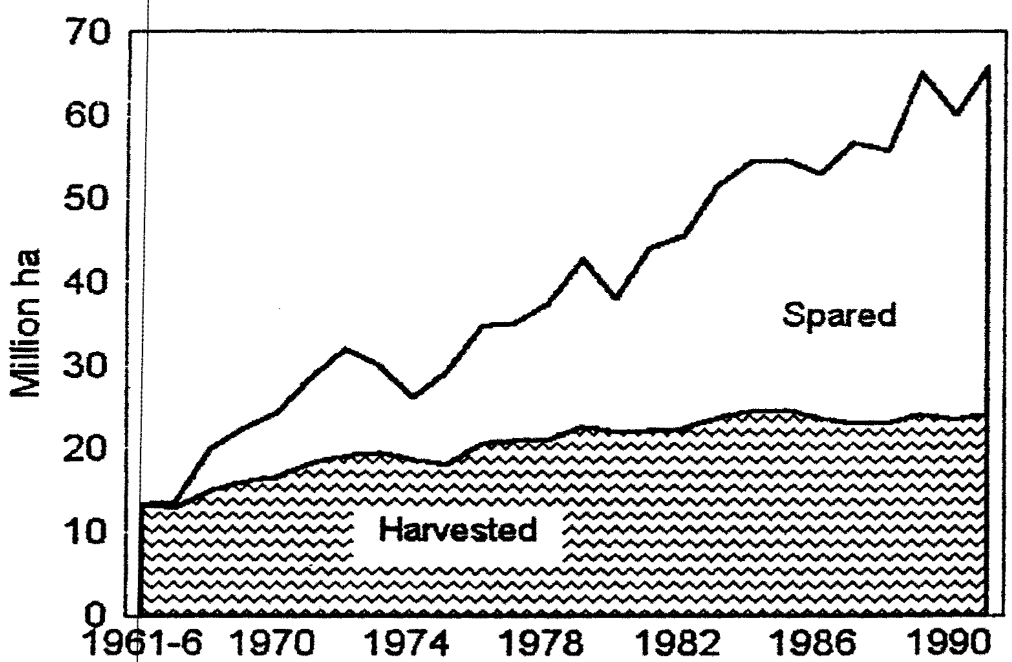


Fig 2. The area Indian farmers used to grow wheat and the area they spared by lifting yields above the average of the 1960's. (Borlaug 1987 and FAO 1991).

I have defended my second resolution: **Farmers and agronomists amended Malthus's rule by dividing by higher yields.** I call the amended rule Jefferson's Imperative.

Room to lift yields--more

My third resolution: Yield can be lifted more to spare even more land. Somewhere yields must strike a ceiling, and Lester Brown of the World Watch Institute heralded the end, "Unfortunately, there are no identifiable technologies waiting in the wings [for] quantum jumps in world food ... For the world's more advanced farmers, there are not many new technologies to draw upon." (Brown 1988)

In fact, despite lifted averages, master farmers stay ahead, Fig 3. The bottom line shows world farmers lifting their average yield of corn, the middle shows Iowans lifting their average, and the top shows Iowa Masters lifting their winning yields. The gap between and opportunity for higher yields continues.

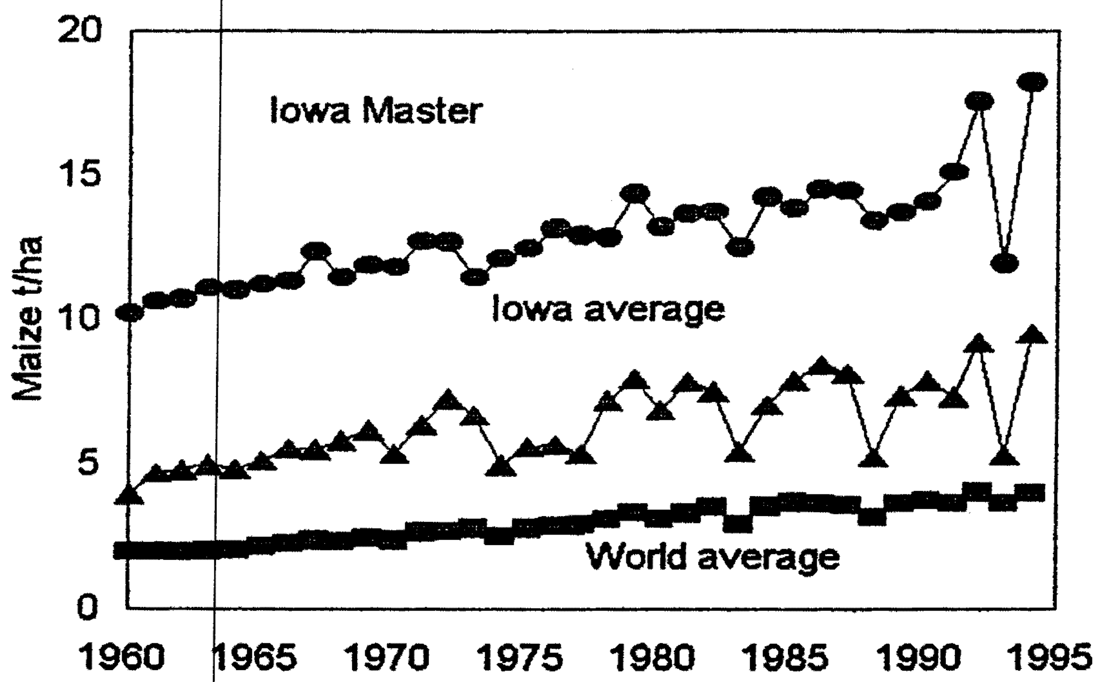


Fig 3. The course of average maize yields in the world and Iowa and the course of winning yields in the Iowa Master Corn Grower's Contest. (Personal communication by W. R. Hansen and USDA and FAO statistics, various years.)

Searching for a ceiling for yields I found the 1992 winner of the national corn contest grew 21 t/ha in Pasco, Fig 4. Farmers can lift the U.S. average corn yields without striking the ceiling.

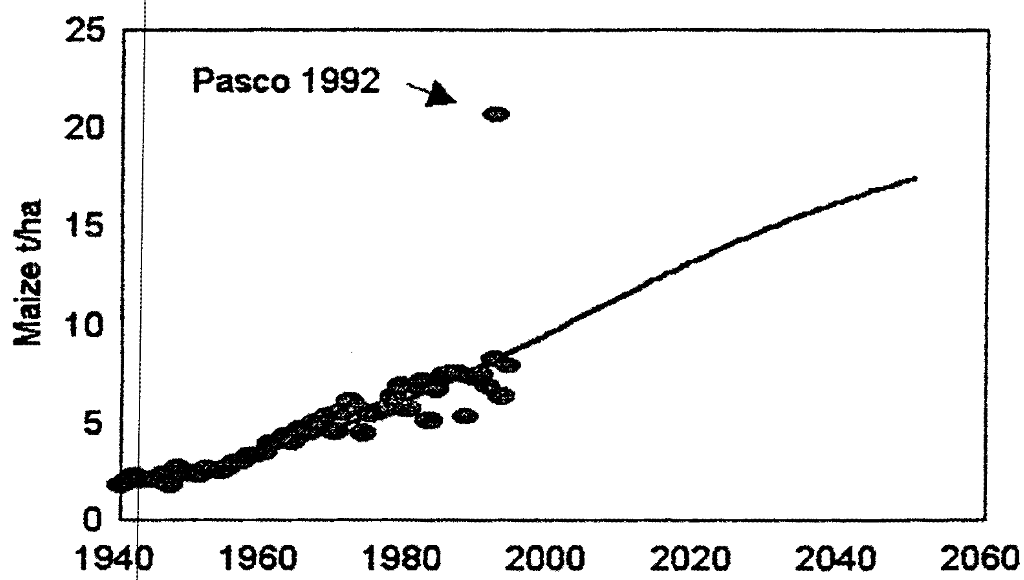


Fig 4. The course of average maize yields in the U.S. since 1940 and a logistic curve rising at 3.6% per year toward a ceiling of 21 t/ha. The yield labeled Pasco is the 21 t/ha grown by the winner of a national contest. (National Corn Growers Association 1993 and USDA statistics, various years.)

I say **lifted** rather than rising yields to emphasize yields do not rise by themselves. Someone must do heavy **lifting**. In fact, the higher farmers **lift** yields above the 1 to 2 t/ha that prevailed for centuries, the more **holding up** needed. To lift the curve, sparing land for Nature, scientists must continually discover, governments set incentives, and farmers and suppliers venture. Otherwise yields will stagnate or fall, and Jefferson's Imperative will take land from Nature.

I have defended my third resolution: **Yield can be lifted more, which Jefferson's Imperative shows spares more land for Nature.**

Environmental expense of sparing land

Jefferson can convince worriers about Nature that, for a given population and consumption per capita, only higher yields can spare land for Nature. Contest winners can stir worriers' hopes that winning yields keep head room open for lifting yields.

But, the worriers still fear that the environmental expense of intensification to lift yields will fallout onto the very land spared for Nature.

So, in the end I must defend: Environmental expense need not cancel the profit of sparing land for Nature. Economists would call environmental expense 'externalities', environmentalists would call it 'impact' and laymen would call it 'pollution'. In other places I have called it 'fallout' but here use the analogy of expense. (Hereafter I often abbreviate 'environmental expense' to simple 'expense'). A complete reckoning must subtract this expense before reaching the bottom line of a profit of land spared for Nature.

Surprising bonuses

After buying a computer to save clerical labor, the boss of Widgets Inc. might be surprised by a bonus of accurate addition of customer's bills. Just so, more tons per hectare can grant environmental bonuses, which should be enumerated before tallying the expenses of lifting yields.

Farmers do some things per area, and higher yields may actually incur less expense than low yields. Erosion and silt appear on all lists of expenses. A farmer must clear, till, and cultivate for low as well as high yields. So by sparing land from the plow, higher yields give a bonus of less erosion and silt.

Irrigation, its consumption of water from streams or aquifers plus its infrastructure of dams and canals plus fallout of salinity, also appears on lists of environmental expenses. Lining ditches and trickle irrigation raise the efficiency of crop harvested per water used. Although often overlooked, higher yields also raise efficiency. Because incoming radiation more or less sets evapotranspiration, all canopies of foliage that shade the ground consume about equal water. So the canopy that photosynthesizes more and yields more for humanity has a higher water use efficiency than one that yields less.

Lush foliage needs little more pesticide to protect it from an insect or a disease than does sparse foliage.

Keeping weeds from the shade beneath the luxuriant foliage of a bumper crop actually may require less herbicide than keeping them from the thin shade beneath the sparse foliage. More than a score of years ago, Knake (1972) demonstrated the fundamental matter, shade stunts foxtail. Now, Fig 5 shows that, while yielding more, denser maize delivers a bonus of shading and weakening weeds. And, Valenti and Wicks (1992) showed, "When nitrogen was applied, winter wheat became increasingly vigorous, [and] increased light interception which reduced weed growth before wheat harvest, thus reducing weed biomass after wheat harvest", granting a bonus of water saved during ecofallow. The sheer pressing of more plants and garnering more yield from a field grants some bonuses while sparing land for Nature.

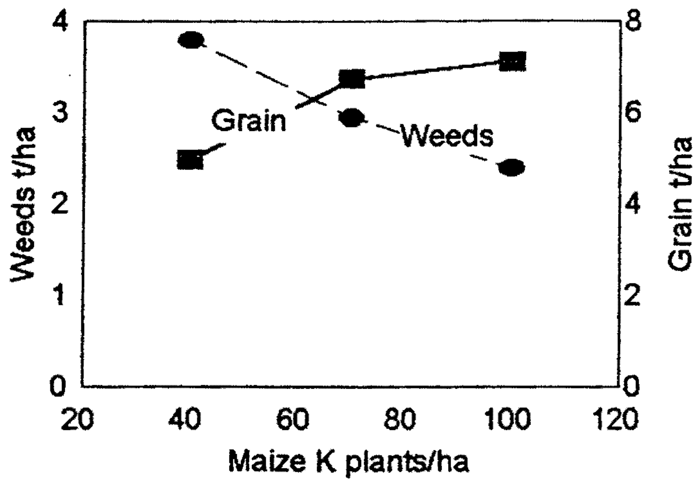


Fig 5. The decline in biomass of weeds beneath increasingly dense maize populations. With high pressure of weeds, their dry weight after silking of maize and the subsequent harvest of maize. (Tollenaar et al. 1994)

Staying in step

At last I must confront the higher rates of factors like fertilizer and pesticide that achieve the higher yields to spare land. I begin with the principle that improving husbandry in step grants bonuses. Several experiments in Bangladesh demonstrated that fertilizer plus weed control raised yields even more than the sum of their individual benefits, Fig 6.

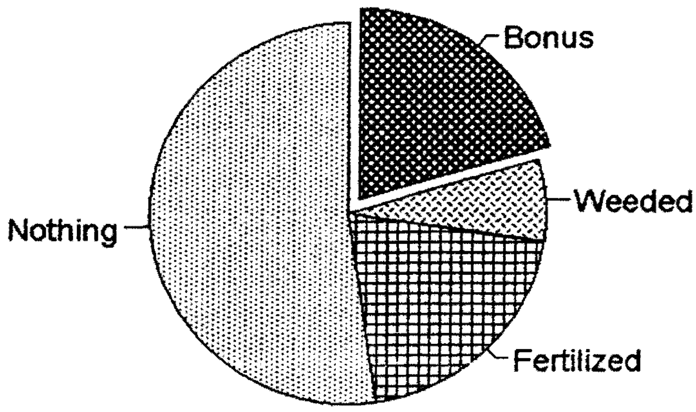


Fig 6. The segment labeled Nothing represents yields without fertilizer or weeding in five experiments. Segment Fertilized represents the increased yield or benefit from fertilizer without weeding and segment Weeded the benefit of weeding without fertilizer. Finally, segment Bonus represents the extra benefit beyond the sum of Fertilized plus Weeded from both fertilizing and weeding. (Moody 1981, table 29).

Such a bonus displays Liebig's law of the minimum: Adding A out of step with B wastes A. Most production resources are used more efficiently as all are improved. DeWit (1992) advised that, to serve both agriculture and environment, research should turn from a search for marginal returns on each resource to find the minimum of each for optimum utilization of all. Improving factors in step grants bonuses.

Expense per product

Although bonuses are welcome, environmental expense must be confronted. I return to Widget Inc. and ask how the boss would reckon expense of the new computer--because in environmental matters we must be at least as wise as commonplace Widgets. The boss would not reckon the expense per year or per square foot of factory space. He would reckon it per widget, the company's reason for being. Just so, we must not reckon environmental expense per year or per hectare of field. We must be at least as wise as Widgets.

Jefferson's Imperative makes food, the population times per capita demand, an independent variable, leaving area to be calculated. So I reckon expense per quantity of food and feed, which humanity requires and is agriculture's reason for being. To keep before us that humanity calls the tune and sets the quantity, I reckon environmental expense for a peculiar 5 tons.

Two environmental expenses, hectares and nitrogen fertilizer, to produce the 5 tons form the coordinates of Fig 7. (Hereafter I abbreviate 'nitrogen fertilizer' as 'fertilizer'.) The expense of fertilizer falls downward and of land decreases leftward on the graph. In the upper right corner, the datum for IR8 rice lies out of sight; a high rate of fertilizer grows luxurious weeds, depresses rice yield and expands the area to grow 5 tons, multiplying the kilograms of fertilizer used. Applying less fertilizer raises the yield of the weedy rice, but still, over 6 hectares are used to grow the 5 tons. Among the weeds, variety C4-63 yields somewhat more, lowering the expense of both land and fertilizer. Free of weeds, variety matters little, and the expenses of both land and fertilizer are small.

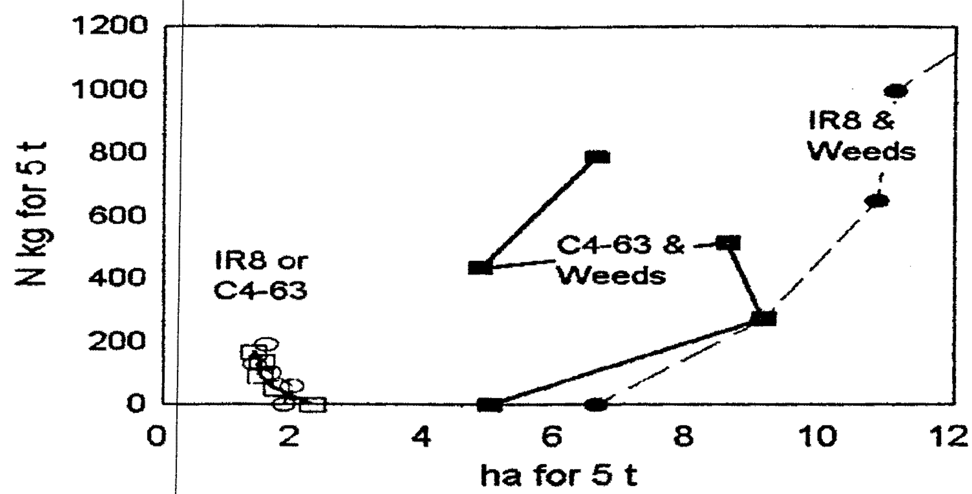


Fig 7. The hectares and fertilizer to produce 5 tons of two varieties of rice, with and without weeds. (Moody 1981, table 19).

Integrating expenses

The boss of Widgets Inc. would compliment us for figuring expense per product rather than factory floor but complain that hectares and kg, varieties and weeds were apples and oranges. He would urge integration into a common currency. Integration means forming into a more complete or harmonious entity, often by adding parts.

No market sets the exchange rates for an environmental currency denominated in 'enviros'. Nevertheless, holistic integration requires an analyst place on each factor relative values, say, 100 enviros per hectare, 20 enviros per kg herbicide and 1 enviro per kg fertilizer. Then integrated expense E of 5 tons of food equals (hectares times 100) plus (kg fertilizer times 200) plus (kg herbicide times 1). In general, I write exchange rates e_a, e_h and e_n for land, herbicide and fertilizer.

But herbicide and fertilizer rates lift yields and shrink the hectares to grow 5 tons. And for a given kg/ha, a farmer applies fewer kg as hectares shrink. For example, concentrating on herbicide, I write

Expense $E = e_a * \text{ha field} + e_h * \text{kg herbicide}$, which becomes

$E = e_a * \text{ha field} + e_h * \text{ha field} * \text{kg/ha herbicide}$

As the thigh bone is connected to the leg bone, kg/ha herbicide is connected to killing weeds, killing weeds to raising yield, and raising yield to shrinking the hectares to grow the 5 tons.

In the first joint, herbicide to weeds, Fig 8 shows that a model of each additional 0.01 kg/ha atrazine killing 3.6% more weeds fits reasonably well. The 3.6% per 0.01 kg/ha means 0.2 kills 50% and 0.8 kg/ha kills 90%.

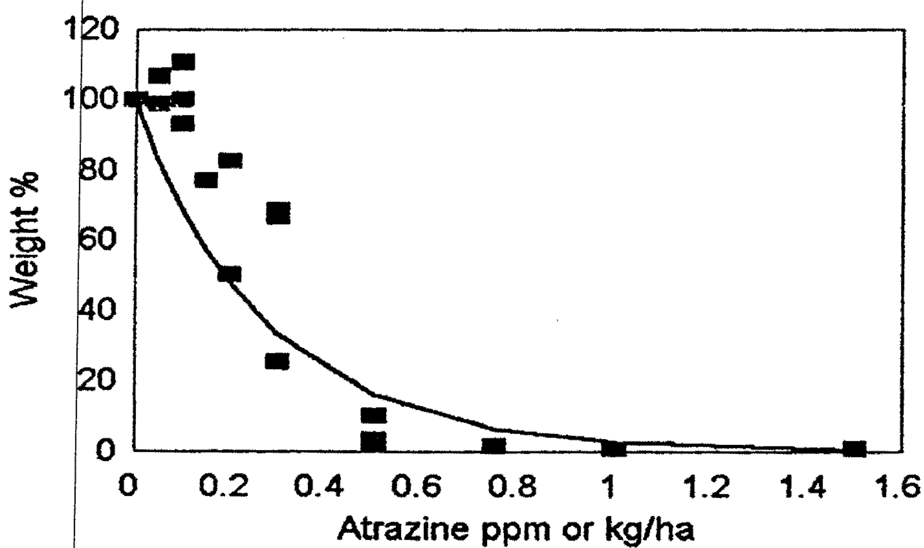


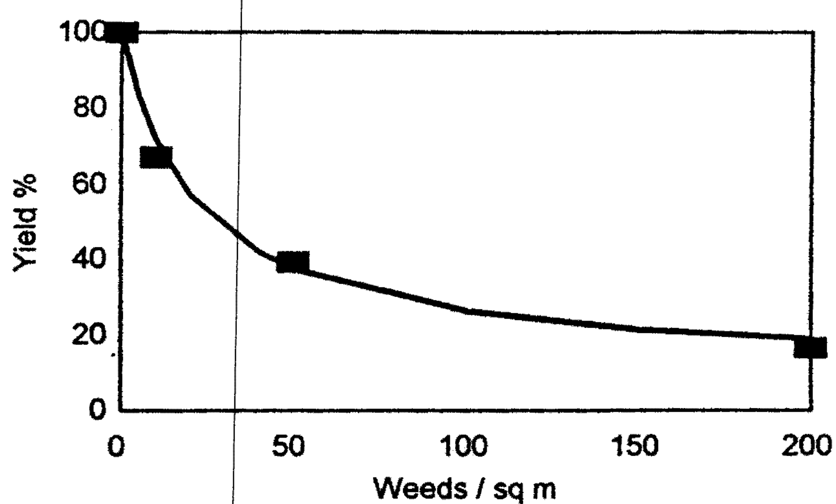
Fig 8. The killing of oats, representing weeds, by increasing doses of atrazine. John Ahrens, who performed the experiments in 1961-2, measured the doses in ppm atrazine per soil, which I assume equal kg/ha.

The next joint is weeds to yield. Cousens (1985) concluded that the model represented by the curve in Fig 9 excelled in fitting observations of weeds and yield. The yield of Norwin wheat grown by Blackman (1994) in 1990-91 declined as

$$\Phi_x \cdot \left(\frac{w}{w + w_2} \right)$$

where weeds w can decrease yield at most by the fraction Φ_x, and w_2 decreases yield by half Φ_x.

Fig 9. The declining yield of Norwin wheat in 1990-91 as the density of the weed, downy brome, increased. (Blackman 1994).



Ortiz-Monasterio (1994) applied nitrogen fertilizer to wheat, and a model resembling that of the harm of weeds fits the benefit of fertilizer. The yield of weed-free wheat equals

$$y_x \cdot \left(\frac{n + n_s}{n + n_s + n_2} \right)$$

where y_x is the maximum yield of weed-free crop. In kg/ha, n is nitrogen added by fertilizer, n_s that from the soil and n_2 fertilizer n that produces a yield of half y_x. I assume that soil furnishes 50 kg/ha of nitrogen and the rest is applied. An n_2 of 50 fits Ortiz-Monasterio's yields.

In an appendix I show equations. In words,

Yield t/ha = Function that increases as herbicide and fertilizer lift weeds.

Ha field = 5 tons/ Yield t/ha.

Expense E = [e(a) * Ha field] +
[e(h) * Ha field * kg/ha herbicide] +
[e(n) * Ha field * kg/ha fertilizer].

After connecting herbicide to weeds, then weeds and fertilizer rate to yield, then area all the way to expense, I can specify exchange rates and reason in an integrated or holistic way.

First I map yield on coordinates of herbicide and fertilizer rates. On the map of Fig 10, the rate of herbicide increases eastward or right from 0 to 2 kg/ha and of fertilizer increases northward toward the top from 0 to 250 kg/ha. The contours of yield rise little up the left, western boundary because the fertilizer is wasted on weedy crop. Because the soil furnishes some nitrogen, the contours of yield do rise eastward along the bottom boundary as herbicide kills weeds. A ridge of high yields curves up northeastward where herbicide and fertilizer increase in step.

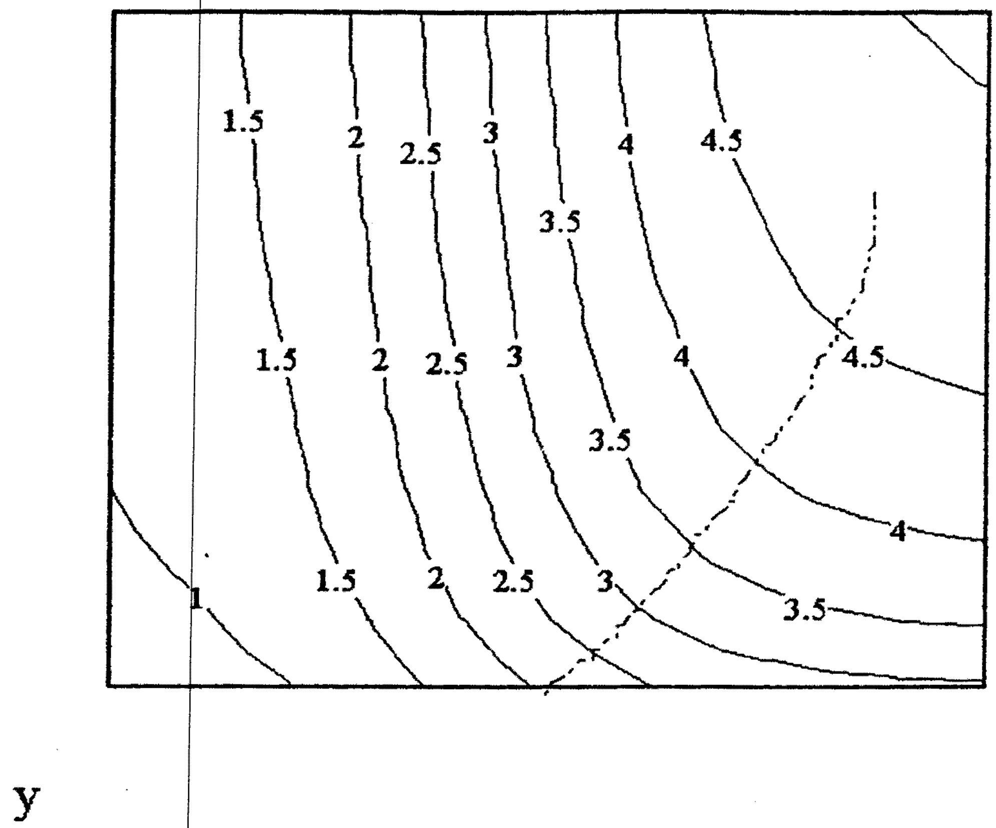
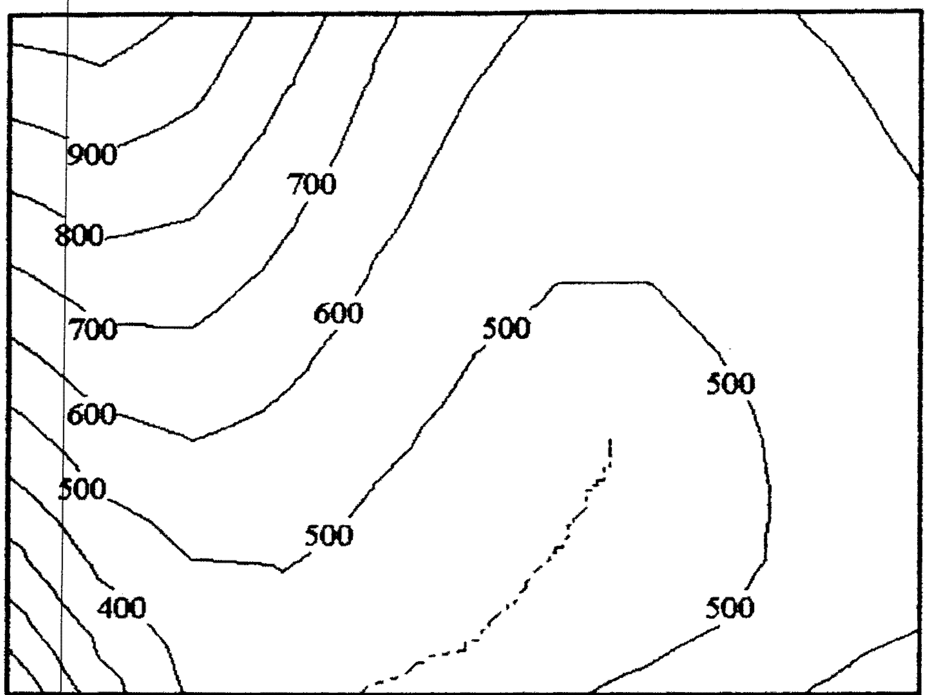


Fig 10. The contours of yield on a map where herbicide increases eastward or right from 0 to 2 kg/ha and fertilizer increases northward or toward the top from 0 to 250 kg/ha.

A critic marching to the drummer of fertilizer and pesticide fallout imputes high exchange rates of environmental currency to a kg of chemical--but zero environmental currency to a hectare of land cropped. The critic might set exchange rates of 200 for herbicide and 1 for fertilizer but 0 for land. The ridge of rising yield in Fig 10 becomes a valley of environmental economy in Fig 11 because the higher yields shrink hectares land to grow the specified 5 tons, causing kg of chemicals to increase less than the rates kg/ha. Nevertheless, high exchange rates for chemicals and zero for tilling land puts minimum expense in the southwest corner where no chemicals are applied over many hectares.

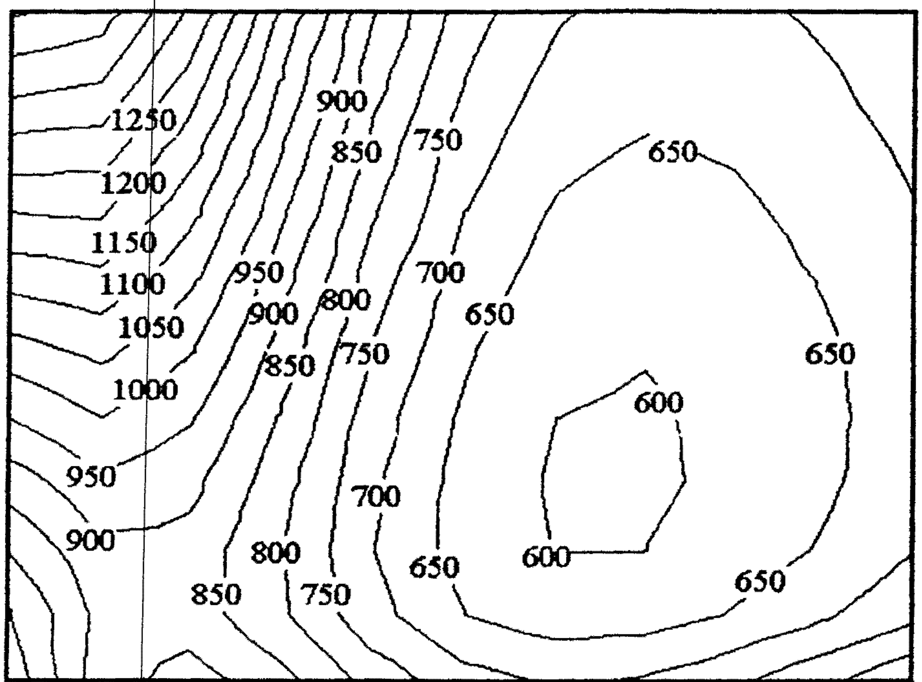


E

Fig 11. The contours of environmental expense when the exchange rates per kg of herbicide and fertilizer are 200 and 1 but no value and so an exchange rate of 0 is given to land. On the map, herbicide increases eastward from 0 to 2 kg/ha and fertilizer increases northward from 0 to 250 kg/ha.

A critic who marches to a balanced band rather than a single drummer, while still setting 200 times the exchange rate on a kg of herbicide as on a kg of fertilizer, might place 100 times the exchange rate on a hectare of land as on 1 kg of fertilizer. The contours of Fig 12 show the consciousness of land use causes an earthquake.

Consciousness of land use locates minimum environmental expense at 1.4 kg/ha herbicide and 75 kg/ha fertilizer where the chemicals are in step and land is spared. When prudent exchange rates are placed on land and chemicals, integration shows improving all factors in step minimizes the environmental expenses of growing the specified crop. Other coefficients and other factors can be substituted for mine, but the framework will accommodate them and likely produce the same commonsense that the boss of Widgets Inc. would recognize and an agronomist could use to cut environmental expense.



E

Fig 12. When the exchange rates per hectare and per kg of herbicide and fertilizer are 100, 200 and 1, the contours of environmental expense. On the map, herbicide increases eastward from 0 to 2 kg/ha and fertilizer increases northward from 0 to 250 kg/ha.

In the end

Earlier I showed Indian wheat farmers spared land. I conclude with America. The lower area on Fig 13 shows cropland harvested in the U.S. since 1932, and the narrow areas show the land for fallow, failed and Federal programs. If cropland per capita had continued as it was in 1932, the top area would have been cropped, too. Improving production factors in step and feeding people better, farmers spared the upper area, 17 times the size of Indiana and 177 times the size of Yellowstone.

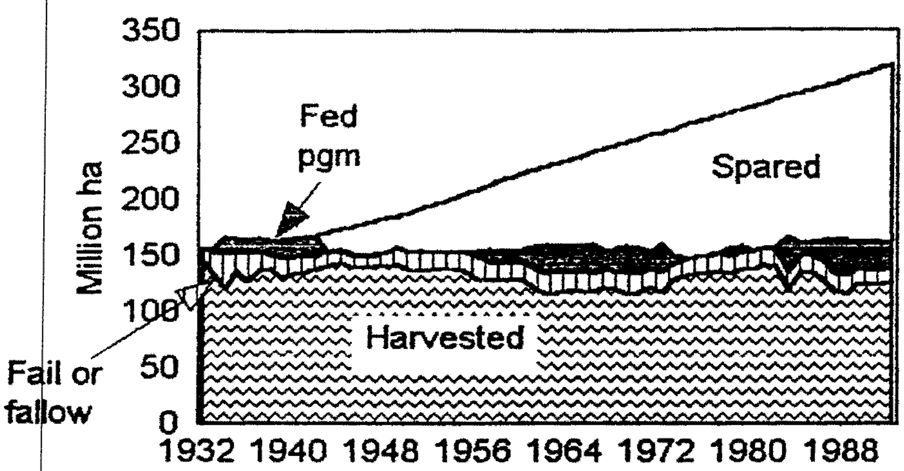


Fig 13. In the U.S. beginning in 1932, the course of harvested and failed or summer fallow cropland and the cropland idled by Federal programs. The land labeled Spared is the product of the population multiplied by the cropland per capita in 1932 less the above three categories of cropland. (Daugherty 1987 and Sandretto 1994).

Acknowledgments: I thank Jesse Ausubel of Rockefeller University and the Council for Agricultural Science and Technology for unfailing support and publication of CAST Report 121, "How much land can ten billion people spare for Nature?" I thank John Ahrens, Bill Barrentine, Ellery Knake, Robert Sweet and Wayne Wright for tutoring me in weeds.

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Appendix

Follows on a separate page.

Appendix

Calculate the environmental expense E of the kg of herbicide and nitrogen fertilizer applied to grow a yield of Y tons.

$Y := 5$

Let herbicide rate h kg/ha increase from 0 to 2 kg/ha in ten steps of 0.2.

$i := 0, 1 .. 10 \quad h_i := 0.2 \cdot i$

Let the herbicide diminish the density of weeds w per square meter from a maximum of 500, achieving a density of 500/e at an herbicide rate of 1/3.6 kg/ha.

$w_x := 500 \quad \eta := 3.6 \quad w_i := w_x \cdot e^{-\eta \cdot h_i}$

Let weeds decrease yields by a maximum of 80% and decrease yields to half 80% at a density of 22 weeds per square meter.

$\Phi_x := 0.80 \quad w_2 := 22 \quad \Phi_i := \Phi_x \cdot \left(\frac{w_i}{w_2 + w_i} \right)$

Let nitrogen fertilizer rate n kg/ha increase from 0 to 250 kg/ha in ten steps of 25.

$j := 0, 1 .. 10 \quad n_j := 25 \cdot j$

Let 50 kg/ha nitrogen produce half the maximum, weed-free yield of 6 t/ha--but let the soil furnish 50 kg/ha of nitrogen.

$n_2 := 50 \quad y_x := 6 \quad n_s := 50 \quad y_{f_j} := y_x \cdot \left(\frac{n_j + n_s}{n_j + n_s + n_2} \right)$

Let the yield be the weed-free yield set by nitrogen diminished by a fraction set by herbicide killing weeds. Divided into the demanded Y tons, the t/ha yield determines the area cropped.

$y_{i,j} := y_{f_j} \cdot (1 - \Phi_i) \quad A_{i,j} := \frac{Y}{y_{i,j}}$

To convert into a common, environmental currency the hectares of land, kg of herbicide and kg of nitrogen fertilizer used, specify exchange rates.

$e_a := 100 \quad e_h := 200 \quad e_n := 1$

Finally, for an integrated or holistic environmental expense, add three contstituent expenses. The first is the exchange rate for cropping a hectare of land times the hectares used. The second and third expenses are exchange rates for herbicide and fertilizer per kg times the kg of each used. The kg used are the hectares of land times the kg/ha rates of the two chemicals.

$E_{i,j} := e_a \cdot A_{i,j} + e_h \cdot (A_{i,j} \cdot h_i) + e_n \cdot (A_{i,j} \cdot n_j)$

IMPACT OF HERBICIDE-TOLERANT GERMPLASM ON PRODUCTION AND MANAGEMENT OF ROW CROPS

A. C. York[1]

One of the most interesting and significant developments in weed science in recent years is herbicide-tolerant cultivars (HTC's). Although differential cultivar tolerance to herbicides is well documented in the literature, only recently has there been a conscious effort to develop lines of agronomic crops with enhanced tolerance to herbicides. Much of this can be attributed to the astronomical cost of developing and registering new chemistry. If one has a herbicide with good activity on a number of problem weeds and good environmental attributes, it may be more practical to adapt additional crops to that herbicide rather than developing new herbicides.

HTC's can be developed using standard selection and backcrossing techniques. Examples include sulfonylurea-tolerant soybean [Glycine max (L.) Merr.], imidazolinone-tolerant corn (Zea mays L.), and corn tolerant of sethoxydim {2-[1-(ethoxyimino)butyl]-5-[2-ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one}. HTC's also can be developed via genetic engineering techniques. Examples include cotton (Gossypium hirsutum L.) tolerant of bromoxynil (3,5-dibromo-4-hydroxybenzonitrile), soybean and cotton tolerant of glyphosate [N-phosphonomethyl)glycine], and corn and soybean tolerant of glufosinate [2-amino-4-(hydroxymethylphosphinyl)butanoic acid].

HTC's have the potential to significantly impact row crop production, although it is too early to fully appreciate the potential long-term impacts as there are many factors that can come into play. However, one can speculate on some of the short-term impacts. Impacts obviously will depend upon how well HTC's are accepted by growers. That in turn will depend upon the value these cultivars bring to the grower. Hence, perhaps the best way to speculate on potential impacts of HTC's is to consider the value or benefits they can offer and how they can improve weed management systems.

One obvious impact of HTC's will be additional options to manage weeds that are difficult to control or perhaps cannot be controlled in some crops with current technology. Compared with horticultural crops, there are a number of options to control most weeds in agronomic crops. However, HTC's may give growers additional options to manage weeds or increased flexibility in how one manages certain problems. Common bermudagrass [Cynodon dactylon (L.) Pers.] in corn is an example. Bermudagrass currently cannot be adequately controlled in a corn crop although there are options for control in most crops grown in rotation with corn or with post-harvest treatments. With sethoxydim- or glyphosate-tolerant corn, growers will have an option to control bermudagrass in the corn crop itself rather than having to do it in a rotational crop. Perennial broadleaf weeds such as common milkweed (Asclepias syriaca L.) and hemp dogbane (Apocynum cannabinum L.) also are examples. These weeds are increasingly becoming problems as growers move more into no-till cropping systems. These weeds can be controlled or suppressed in corn, but there currently is little that can be done to control them in soybean. Glyphosate-tolerant soybean will give growers an option to control or at least suppress these perennials in a soybean crop.

Another obvious impact of HTC's will be effective weed control without the crop injury sometimes associated with current control programs. HTC's will give growers an opportunity to control problem weeds without having to accept risk of crop injury. An example might be sicklepod [Senna obtusifolia (L.) Irwin and Barneby] in soybean. Across the Southeast and Mid-South, sicklepod is a major problem in soybean. No currently available soil-applied herbicide

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alone acceptably controls typical infestations. The most widely used and effective program for sicklepod in soybean revolves around chlorimuron {2-[[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino]suflonyl]benzoic acid} applied postemergence. Chlorimuron causes varying degrees of crop injury, although the injury is usually minor and does not affect yield. However, sicklepod can germinate season-long. In heavily infested fields, there may be times when one would like to make a second application of chlorimuron to control later emerging sicklepod. The potential for significant injury increases with the second application. There also are situations where chlorimuron alone may not adequately handle all of the weeds present. For example, chlorimuron does not control common lambsquarters (Chenopodium album L.). Thifensulfuron {3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophenecarboxylic acid} is very effective on common lambsquarters but combinations of chlorimuron and thifensulfuron can be quite injurious, especially at the higher rates needed for good control of mixtures of sicklepod and larger lambsquarters.

Sulfonylurea-tolerant soybean has excellent tolerance of chlorimuron or combinations of chlorimuron and thifensulfuron, even when multiple applications are made. Without injury and stunting of the crop, one can take advantage of the earlier canopy closure which helps in suppressing later-emerging weeds. In research with drilled sulfonylurea-tolerant soybean in North Carolina, where canopy closure was not impeded by herbicide injury, only one postemergence application of chlorimuron or chlorimuron plus thifensulfuron was necessary for season-long control of heavy sicklepod infestations. Other research in North Carolina has shown excellent season-long control of problem weeds, including sicklepod and morningglory (Ipomoea spp.), in narrow-row soybean with a single postemergence application of glyphosate.

HTC's also can help growers avoid potential injury that sometimes occurs due to certain pesticide interactions. For example, injury is commonly observed when nicosulfuron {2-[[[[4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-N,N-dimethyl-3-pyridinecarboxamide} or primisulfuron {2-[[[[[4,6-bis(difluoromethoxy)-2-pyrimidinyl]amino]carbonyl]amino]sulfonyl]benzoic acid} is applied to corn previously receiving an organophosphate insecticide applied in the furrow. Sethoxydim-tolerant corn, for example, would allow growers to use organophosphate insecticides for control of insects plus an effective herbicide for grassy weeds without injury due to herbicide/insecticide interactions.

Another important benefit from HTC's is the option to use easier or more convenient application methods. This benefit will be particularly evident in cotton. Several herbicides are available that can safely be applied postemergence over-the-top of cotton for annual or perennial grass control. There also are a few that can be applied over-the-top for broadleaf weeds. However, prior to the 1996 growing season, there was no herbicide available that could be applied over-the-top for broadleaf weed control without significant risks of injuring the crop, delaying maturity, and reducing yield. The injury can be avoided by directing the herbicides to the base of the crop. However, directed applications require a height differential between the crop and the weeds. Cotton grows very slowly early in the season, and in many cases the height differential necessary for directed applications is difficult to achieve. Directing herbicides to small cotton requires precision equipment, and it is a very slow and very tedious operation. With bromoxynil-tolerant or glyphosate-tolerant cotton, one can spray overtop small cotton without worrying about injuring the crop. Special equipment is not needed, the application is much easier to make, and it can be done much more quickly.

The ability to apply herbicides over-the-top without concern over crop tolerance also gives growers the potential for aerial application. Aerial application is of great value when wet fields preclude use of ground equipment.

HTC's can offer benefits in the environmental arena. Most growers and weed scientists recognize there are no feasible alternatives to herbicides in the foreseeable future. However, it is obvious use of herbicides and other pesticides is under increasing scrutiny by the general public. Unlike insect control, where crops can be genetically transformed to be resistant to insects, it is hard to imagine a crop that is resistant to weeds. However, crops can be genetically transformed such that they are resistant to herbicides that have more environmentally favorable attributes than perhaps some of the herbicides currently in use.

Perhaps of greatest concern at the current time is groundwater contamination. Triazines and chloroacetamides are of particular concern as they have been detected in a number of groundwater monitoring studies in various states. Herbicides usually are detected in only a small percentage of the wells sampled and the detects are usually under the worst case scenarios. Nevertheless, there have been some detections that appear to result from labelled uses of the herbicides. The EPA, as part of its overall groundwater protection program, will soon be requiring states to develop pesticide specific state management plans to reduce or eliminate herbicide contamination of groundwater. Certain widely used triazines and chloroacetamides will be in the first group for which such plans must be developed. The plans likely will place significant restrictions on use of these herbicides. Cultivars with tolerance of herbicides with good environmental attributes, such as glyphosate, would alleviate this problem.

An area where HTC's, if used wisely, can have a major impact is in herbicide resistance management. Weed resistance is viewed by many weed scientists as a major potential threat to US agriculture. Although resistance to a number of herbicides in various chemical families has been identified, the greatest concern is probably with the ALS inhibitors. As a group, ALS inhibitors seem to be more prone to resistance evolution. The real concern arises from the potential for widespread usage of ALS inhibitors on a number of crops. There is now one or more ALS inhibitors that can be used in every major agronomic row crop in the US except tobacco (Nicotiana tabacum L.). ALS inhibitors are widely used in soybean. Soybean often is rotated with corn, and there are a number of ALS inhibitors that can be used in corn. If use of triazines and/or chloroacetamides is reduced or eliminated because of groundwater or other concerns, growers will depend more heavily on ALS inhibitors in corn. In the Southeast and to a lesser extent in the Virginia-Carolina and Southwest production areas, ALS inhibitors are used in peanut (Arachis hypogaea L.). Pyrithiobac sodium {sodium salt of 2-chloro-6-[(4,6-dimethoxy-2-pyrimidinyl)thio]benzoic acid}, another ALS inhibitor, was registered recently for cotton. To emphasize the potential seriousness of resistance to ALS inhibitors, a biotype of common cocklebur (Xanthium strumarium L.) cross resistant to imidazolinones and pyrithiobac sodium was identified in Missouri before pyrithiobac sodium was even registered.

HTC's such as bromoxynil-tolerant cotton, glyphosate-tolerant cotton and soybean, and glufosinate-tolerant corn and soybean can bring new chemistry into the system to help in managing currently resistant weeds and to avoid further resistance evolution. On the other hand, if the new technology is not used wisely, HTC's could increase the problem with weed resistance. As is the case in so many other areas of crop production, management will be the key to success or failure. Imidazolinone-tolerant corn, for example, increases the likelihood of greater use of imidazolinone herbicides. Use of imidazolinones on corn grown in rotation with soybean which also receives an ALS inhibitor would clearly not be beneficial in terms of resistance management. On the other hand, in regions where corn often is grown continuously, imidazolinone-tolerant corn could be beneficial if the grower rotated imidazolinones with other herbicides such as triazines.

The same argument could be made for sethoxydim-tolerant corn. Biotypes of johnsongrass [Sorghum halepense (L.) Pers.] and several annual grasses are known to be resistant to sethoxydim. Sethoxydim-tolerant corn gives one the opportunity to use sethoxydim annually in corn-soybean, corn-peanut, or corn-cotton rotations. The wisdom of that would be questionable. However, rotation of sethoxydim with nicosulfuron or primisulfuron for control of johnsongrass could be beneficial in a system of continuous corn. Clearly, there will be a continued need for education as HTC's come into the marketplace.

HTC's may have a major impact in some cases by allowing one to expand production areas. An example is cotton production in the Blacklands of North Carolina. This area, characterized by organic soils, has traditionally been a major grain production region. Growers there are beginning to see cotton as a potentially more profitable enterprise than grain crops. Cotton grows well in these soils, but weed control has been a major limitation because typical soil-applied herbicides are ineffective on soils with high organic matter. With the exception of pyrithiobac sodium, which will be available for the first time in 1996, postemergence herbicides for broadleaf weed control in cotton must be applied as directed sprays. Without assistance from soil-applied herbicides, the height differential necessary to direct herbicides often cannot be obtained. The few people who have grown cotton in the Blacklands have had to resort to hand labor to clean up the crop, which of course greatly reduces the profit potential. With bromoxynil and postemergence grass herbicides applied to bromoxynil-tolerant cotton, growers have been able to adequately control weeds without hand labor. When glyphosate-tolerant cotton is commercialized, growers will have additional tools for weed management in this new production area.

Various benefits of HTC's may make weed management easier in some regards, but use of HTC's will not necessarily reduce the management skills needed by the grower. The grower will have to address the potential for drift to non-tolerant crops. He will have to be vigilant in identifying fields planted to transgenic crops so the proper herbicide is applied. He will have to be alert for the population shifts that likely will occur and deal with them accordingly. And in some cases, he will have to plan his management program with an eye on controlling volunteers of herbicide-tolerant crops in rotational crops.

HTC's of corn and soybean likely will not lead to major changes in production systems for these crops. Potentially, having the option to use something such as glyphosate postemergence may increase some growers' confidence in no-till. However, growers have already adopted no-till systems, and for the most part, weed control has not been a major limitation. Availability of HTC's such as glyphosate-tolerant soybean or glufosinate-tolerant corn could encourage more growers to follow a total postemergence system. However, economics and time commitments necessary for other enterprises on the farm will drive that decision more than simply availability of HTC's. One could argue that postemergence systems are more IPM oriented, and with more and better postemergence options, growers might be more inclined to move in that direction and use economic thresholds in their management decisions. This is unlikely. In both corn and soybeans, there already are options for postemergence control of most weeds but very few growers have used economic thresholds in their management decisions. Most fields are sufficiently infested that the question is not whether an application is needed but rather what to treat with. In the small percentage of fields where populations are marginal enough to make one question the need for treatment, the variability in those low weed populations is so great that the intensity of scouting necessary to accurately use thresholds seldom can be economically justified.

In contrast to corn and soybean, HTC's could encourage changes in cotton production systems. In addition to expanding the area of production, as discussed above, HTC's likely will lead to more no-till cotton. Although cotton acreage planted no-till is increasing, fear of weed control failures continues to scare some growers away from no-till cotton.

The impact of HTC's will obviously depend upon how well they are accepted by growers, and that in turn will depend upon the economics of systems using HTC's compared with standard systems. At this point, it is unclear how that ultimately will settle out. A grower must consider the cost of an overall program using HTC's compared with standard systems. Increased cost of seed and various fees for use of the technology must be included. The agronomic performance of HTC's relative to standard cultivars must also be considered. Over time, resistance to particular herbicides will be moved into a number of locally adapted, high yielding cultivars with various desirable traits such as nematode and disease resistance. In the short term, agronomic performance will be a problem in some situations.

IMPACT OF HERBICIDE RESISTANT GERMPLASM ON ROW-CROP VARIETY DEVELOPMENT

A. K. Walker[1]

ABSTRACT

Asgrow Seed Company is a leader in the transferral of new agriculture technology to the farm level. Asgrow Seed Company has been at the forefront in releasing new herbicide tolerant soybean varieties and corn hybrids. Asgrow Seed Company first introduced STS® soybeans in 1993, IMI™ corn in 1994, Roundup Ready™ soybeans in 1996, Poast Compatible™ corn in 1996, and plans to release Liberty Link™ corn in 1997 and Liberty Link™ soybeans in 1998.

The Roundup Ready™ soybeans and Liberty Link™ corn and soybeans are products of transformation, whereas STS® soybeans, IMI™ corn and Poast Compatible™ corn are products of mutagenesis programs. These herbicide tolerant crops allow cost effective, post-emergent weed control with wider application windows and excellent crop safety.

Our Concept Farms provide the demonstration, evaluation, and transferral of these technologies directly to the user. We have observed a rapid adoption of these new varieties and hybrids.

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Thank you for inviting me to participate in this symposium at your 50th annual meeting of the Northeastern Weed Science Society.

This afternoon, I will review Asgrow Seed Company's progress in the development and sales of herbicide tolerant crops. In order to verify statements on gene efficacy and product performance, a summary of data will be presented from Asgrow Research Stations, Concept Farms, and Cooperative University trials.

Asgrow chose to become a leader in herbicide tolerant crops (HTC) because of the following reasons:

1. **Opens new weed management opportunities**:

    - Broader spectrum of weeds controlled
    - Better control of specific weeds
    - Spot treatments
    - Rescue treatments
    - More flexibility in use of adjuvants

2. **Better fit to cultural practices**:

    - No-tillage/minimum tillage
    - Narrow plant spacings

3. **More efficient weed management**:

    - Lower costs
    - More convenience
    - More flexibility in timing

4. **Environmentally friendly features**:

    - Lower use rates
    - Less toxicity to mammalian systems
    - Increased ground water safety
    - Protection against certain carryover chemicals

Asgrow Seed Company's increases in soybean and corn sales have been correlated to the sales of STS® soybeans, Roundup Ready™ soybeans, IMI™ corn and Poast Compatible™ corn. Approximately one-third of the expected soybean sales and one-tenth of the expected corn sales are in herbicide tolerant varieties and hybrids. This should continue to increase as more herbicide tolerant varieties and hybrids are released. Farmers are readily accepting this technology because of product performance, better weed control, management flexibility, improved crop safety, lower input costs, and environmental safety.

STS® Soybeans

STS® soybeans have the following benefits:

1. Broad-spectrum and consistent broadleaf control no matter what the weather;

2. No crop stress for quick canopy cover and moisture conservation;

3. Control over 30 tough broadleaf weeds, including common milkweed, morning glories, giant ragweed, and lambsquarter;

4. Low use rate means less chemical load to the environment; and

5. Wide application window.

The STS® time line:

- **1986** - STS® trait (ALS gene) discovered by Dr. Sebastian, DuPont
- **1987** - W20 crossed to Asgrow varieties
- **1993** - Asgrow sales of A3200
- **1994** - Asgrow sales of A3304, A4045
- **1995** - Asgrow sales of XP2604, A3304, A4045, A5545
- **1996** - Asgrow sales of A2704, A3304, A4045, A5545
- **1997** - New products

The following four tables show the acceptable performance of four STS® varieties being sold in 1996. This data reflects only the genetic potential of the varieties and not the total herbicide-genetic systems performance.

A2704 STS®

YIELD (Bu/A)

Variety	1993	1994	1995	Mean	%
A2704	57.3	67.6	55.6	60.2	99.8
ST2250	57.4	64.6	54.4	58.8	97.5
P9273	59.0	62.2	P9281 55.6	58.9	97.7
A2722	57.8	64.5	55.5	59.3	98.3
A2835	59.9	64.1	57.0	60.3	100.0
No. Loc.	22	25	30	77	
No. Reps	66	75	90	231	

Locations in NE, IA, IL, IN, WI, MI, and OH

A3304 STS®

YIELD (Bu/A)

Variety	1993	1994	1995	Mean	%
A3304	57.7	65.6	51.4	58.2	100.2
P9341	59.8	65.2	53.3	59.4	102.2
P9392	58.2	65.3	51.9	58.5	100.7
A3237	57.9	65.8	50.7	58.1	100.0
A3510	58.6	65.6	50.7	58.3	100.3
No. Loc.	21	23	22	66	
No. Reps	63	69	66	198	

Locations in NE, IA, IL, IN, MO, MI, OH, and MD

A4045 STS®

YIELD (Bu/A)

Variety	1993	1994	1995	Mean	%
A4045	61.1	67.9	50.7	59.9	99.0
A3935	60.0	68.8	52.7	60.5	100.0
P9392	60.1	68.6	51.4	60.3	99.7
HS4110	59.8	73.9	50.7	61.5	101.6
No. Loc.	20	20	17	57	
No. Reps	60	60	51	171	

Locations in NE, KS, MO, IL, IN, OH, and MD

A5545 STS®

YIELD (Bu/A)

Variety	1993	1994	1995	Mean	%
A5545	55.4	65.0	51.9	57.4	97.4
A5403	58.4	64.5	53.8	58.9	100.0
A5560	56.6	68.0	53.9	59.5	101.0
P9521	54.9	66.6	51.4	57.6	97.7
No. Loc.	8	11	8	27	
No. Reps	24	33	24	81	

Locations in AR, MI, TN, KY, IL, and MD

A5545 is adapted more to the east coast than the mid-south. Farmer side-by-side trials in Maryland, Virginia, and North Carolina show an advantage for A5545.

Asgrow Concept Farms and Universities conducted gene efficacy trials in 1995, where weeds were not a factor (i.e., controlled by herbicides or hand-weeded). The following table shows that Reliance™-STS™ and Synchrony™-STS™ allowed yields equal to or better than the control or Pursuit™ treatments with A2704 soybeans. The addition of Cobra to the tank mix had a small impact on yield.

STS® SOYBEANS
GENE EFFICACY TRIAL
8 Locations - 1995

A2704			
Treatment	**Application Growth Stage**	**Bu/A**	**%**
Control	---	45.6	100.0
Pursuit 4 fl oz	V2	44.7	98.0
Reliance or Synchrony 0.5 oz	V2	46.1	101.1
Reliance or Synchrony 0.5 oz	V4	44.8	98.2
Reliance or Synchrony 0.5 oz + Cobra 4 fl oz	V4	43.4	95.2

Towanda, IL; Tuscola, IL; Atlantic, IA; Purdue University; University of Illinois; Kalamazoo, MI; Custer, OH; Williams IA

The benefits of the Synchrony™-STS™ or Reliance™-STS™ system are shown in the following table, where weed control was also a determination in final yields. An average advantage of 2.3 Bu/A for Synchrony™-STS™ and 1.4 Bu/A for Reliance™-STS™ was shown versus the conventional weed control systems of Pursuit™ or Galaxy™/Poast Plus. Results of DuPont's on-farm comparisons in 1994 and 1995 have shown similar results. The Synchrony™-STS™ seed/herbicide system showed a 2.0 Bu/A advantage in side-by-side comparisons in Illinois and Indiana in 1994. In 1995, over 26 locations in the same two states, the yield advantage was 2.0-3.0 Bu/A.

SYNCHRONY™-STS™ SYSTEM (6 Locations - 1995)
or
RELIANCE™-STS™ SYSTEM (1 Location - 1995)

Treatment and Application Growth Stage	Yield* (Bu/A)	%	Yield** (Bu/A)	%
Pursuit 4oz V2	42.2	100.0	57.3	100.0
Galaxy 32oz V2/Poast Plus 24 oz V3	41.8	99.0	58.3	101.7
Synchrony 42 0.5 oz + Assure V2	44.2	104.7	59.7	104.2
Synchrony 42 0.5 oz + Assure V4	44.5	105.4	58.2	101.6
Assure V3/Synchrony 42 0.5 oz + Cobra 4 oz V4	43.4	102.8	55.3	96.5
LSD (.10)	1.1		2.1	

* *A2704 and A3304 at Towanda, IL; Tuscola, IL; Atlantic, IA; Purdue University; Custer, OH; and Oxford, IN.*

** *Reliance substituted for Synchrony at Williams, IA with XP2604 and A2704.*

Roundup Ready™ Soybeans

Roundup® kills plants by blocking the EPSP Synthase Enzyme in plants. This enzyme is part of the pathway that converts carbohydrates to amino acids. Soybean plants with the Roundup Ready™ gene remain unaffected by Roundup® treatment because the continued action of the introduced glyphosate-tolerant EPSP Synthase Enzyme meets the plant's need for aromatic amino acids.

Roundup Ready™ soybeans have the following benefits:

1. Excellent fit with all tillage systems;

2. Broad-spectrum control of grass, broadleaf, and perennial weeds, traditionally an increased problem in no-till acres . . . Hemp Dogbane, Common Milkweed, etc.;

3. Application flexibility;

4. Use of environmentally sound herbicide;

5. New mode of action for in-season soybean weed control with no weed resistance;

6. Increased flexibility to treat weeds "as needed"; and

7. No rotational crop restrictions.

Market surveys and national herbicide sales figures show that the average soybean herbicide cost is around $25.00 per acre. With Roundup Ready™, the input costs of Roundup® and the technology fee for the seed will be much less than the national average of $25.00 per acre.

An excellent review of the development, identification, and characterization of the Roundup Ready™ line 40-3-2 was written by S.R. Padgette et al., *Crop Science 35:1451-1461.*

The Roundup Ready™ time line:

- **1990** - Transformation of A5403

- **1991** - 40-3-2 crossed to Asgrow varieties

- **1996** - Asgrow sales of AG3001, AG3501, AG4401, AG4701, AG5601, AG6101

- **1997** - New products

Government approvals for Roundup Ready™:

- **USDA** - May 1994 Non-exempt status
- **FDA** - November 1994 Regarded as safe
- **EPA** - May 1995 Full registration of over the top use of Roundup® on Roundup Ready™ soybeans

The following four tables show the acceptable performance of five Roundup Ready™ varieties being sold in 1996. This data reflects only the genetic potential of the varieties and not the total herbicide-genetic systems performance.

AG3001 Roundup Ready®

YIELD (Bu/A)

Variety	1994	1995	Mean	%
AG3001	68.5	53.6	61.0	98.5
A2722	69.9	55.5	62.7	101.3
P9273	68.2	P9281 55.6	61.9	100.0
ST2250	68.2	54.4	61.3	99.0
A2835	66.8	57.0	61.9	100.0
No. Loc.	11	30	41	
No. Reps	33	90	123	

Locations in NE, IA, IL, IN, WI, MI, and OH

AG4401 and AG4701
Roundup Ready®

YIELD (Bu/A)

Variety	1994	1995	Mean	%
AG4401	66.3	53.4	59.9	98.5
AG4701	66.0	53.4	59.7	98.2
A4539	---	55.4	---	
A4715	68.3	53.4	60.8	100.0
A4922	69.9	55.6	62.8	103.3
P9451	65.8	---	---	
P9472	---	55.6	---	
P9491	63.7	---	---	
No. Loc.	14	15	29	
No. Reps	42	45	87	

Locations in IN, IL, MO, KY, TN, AR, and MD

AG5601 Roundup Ready®

YIELD (Bu/A)

Variety	1994	1995	Mean	%
AG5601	60.7	54.6	57.6	100.0
A5403	61.5	53.8	57.6	100.0
A5560	63.4	53.9	58.6	101.7
P9551	62.1	---		
P9521	---	51.4		
No. Loc.	12	8	20	
No. Reps	36	32	68	

Locations in AR, MO, TN, KY, IL, and MD

AG6101 Roundup Ready®

YIELD (Bu/A)

Variety	1994	1995	Mean	%
AG6101	61.7	53.8	57.8	99.3
A5885	63.3	53.2	58.2	100.0
A5979	64.7	54.1	59.4	102.1
Hutcheson	61.1	51.1	56.1	96.4
No. Loc.	5	6	11	
No. Reps	15	18	33	

In a later five-location trial, AG6101 yielded 49.4 Bu/A and A6297 69.5 Bu/A in 1995.
~Locations in AR and MS~

Asgrow Concept Farms and Universities conducted gene efficacy/weed control trials in 1995, where weeds were controlled by the herbicide treatments. The following table shows that Roundup® treatments allowed yields equal to or better than the Pursuit™ or Galaxy™/Poast Plus treatments with AG3001 or AG3501.

ROUNDUP READY™ YIELD SUMMARY
11 Locations

Treatments	Rates	Timing	Bu/A	%
Pursuit	4 fl oz/A	V2	48.4	100.0
Galaxy/Poast Plus	32/24 fl oz	V2/V3	47.9	99.0
Roundup	24 fl oz	V2	49.6	102.5
Roundup	32 fl oz	V2	50.0	103.3
Roundup	64 fl oz	V2	49.4	102.1
Roundup/Roundup	32/32 fl oz	V2/R2	49.5	102.3
Roundup/Roundup	32/32 fl oz	V2/R5	48.3	99.8
LSD (.10)			1.2	

Applications:

- Flat-fan nozzles, 10-25 GPA
- COC and UAN as Pursuit™ and Galaxy™/Poast™ Plus adjuvants
- NIS and AMS as Roundup® adjuvants

Design:

- RCB
- 3-5 replications
- AG3001 at Towanda, IL; Tuscola, IN; Custar, OH; Atlantic, IA; Williams, IA; Purdue University; University of Kentucky; Iowa State University; University of Illinois; and AG3501 at Tuscola, IL; and Ohio State University

This data reaffirms the findings of X. Delannay et al., *Crop Science 35:1461-1467.* Their gene efficacy trials at 17 locations in 1992, 23 locations in 1993, and 18 locations in 1994 showed no yield reduction from any Roundup® rate or timing treatment.

With the increased trend in no-tillage and the use of narrower row widths, the use of Roundup Ready™ with these systems is very appealing. Narrow row/no-tillage trials were conducted at three Asgrow Concept Farms in 1995. The following table shows the yield results with or without a burndown treatment.

ROUNDUP READY™/NO-TILL SYSTEM

YIELD SUMMARY

Towanda, IL-15 in.; Williams, IA-7.5 in.; and Atlantic, IA-7.5 in. - 1995

Without Burndown	Bu/A	With Burndown*	Bu/A
Roundup 32 fl oz/A 0 WAP	38.1	Roundup 32fl oz/A 3 WAP	47.5
Roundup 24 fl oz/A 1 WAP	41.8	Roundup 24 fl oz/A 4 WAP	48.0
Roundup 32 fl oz/A 1 WAP	40.7	Roundup 32 fl oz/A 4 WAP	47.8
Roundup 32 fl oz/A 2 WAP	45.3	Roundup 32 fl oz/A 5 WAP	46.4

* *Roundup plus 2,4-D LVE*

Results indicated that farmers need to plant into weed-free conditions and that there is rate and timing flexibility.

Liberty Link™ Soybeans

Liberty Link™ soybeans will provide growers with another broad spectrum herbicide, with many of the same benefits and features of Roundup Ready™ soybeans. Asgrow Seed Company has been cooperating with AgrEvo since 1990 in field trials on Liberty Link™ soybeans. These field trials have evaluated the Liberty Link™ gene for its tolerance with different rates and application timings. New varieties with the Liberty Link™ trait are expected in 1998.

Poast Compatible™ Corn

Asgrow Seed Company will release its first Poast Compatible™ hybrid in 1996. Poast Compatible™ corn benefits are:

1. Targeted weed management, treat weeds if needed;
2. No carryover or rotational restrictions;
3. Environmentally sound;
4. Different mode of action from ALS herbicides;
5. Tank-mix compatible; and
6. No organophosphate insecticide interactions.

Grasses controlled by Poast® are:

- Woolly Cupgrass
- Shattercane
- Wild Proso Millet
- Giant Foxtail
- Green Foxtail
- Yellow Foxtail
- Quackgrass
- Barnyardgrass
- Browntop Panicum
- Fall Panicum
- Texas Panicum
- Large Crabgrass
- Smooth Crabgrass
- Johnsongrass (seedling, rhizome)

The following table shows a gene efficacy trial where weeds were not a factor (i.e., controlled by herbicides or hand-weeded).

POAST COMPATIBLE™ CORN
GENE EFFICACY TRIAL
19 Locations - 1995

	Bu/A		
Poast Treatments	**Asgrow X66041SR**	**DeKalb DK592SR**	**Cargill CA7888PC**
Control 0 oz	113	117	116
Poast 32 oz	113	116	116
Poast 64 oz	115	117	116

Results showed no yield reduction up to 64 oz of Poast®.

<u>IMI™ Corn</u>

The following table shows a gene efficacy trial.

IMI™ CORN
GENE EFFICACY TRIAL
5 Locations - 1995

Pursuit Treatment	Bu/A
Control 0 oz	134.2
Pursuit 4 oz	135.4
Pursuit 8 oz	131.2
LSD (.05)	4.0

Results showed no yield reduction at the normal use rate.
The following table shows the genetics yield potential from over 200 locations.

IMI™ CORN
YIELD PERFORMANCE*
(Bu/A)

	RX623	RX623T**
1993	131.9	131.9
1994	175.4	175.0
1995	146.8	147.2
Mean	154.7	154.8

** Combined Data, Research, Ministrip, and Farmer Strip Trials*
*** Same Moisture*

Liberty Link™ Corn

The following table shows a gene efficacy trial.

LIBERTY LINK™ CORN
GENE EFFICACY TRIAL
4 Locations - 1995

	Bu/A	Moisture
No Liberty	148.2	16.9
Liberty 42 fl oz	154.8	17.2
St. Error	6.1	0.2

Hybrid 1 - Williams, IA; Kalamazoo, MI
Hybrid 2 - Ames, IA; Tuscola, IL

Results showed no yield reduction from the use of Liberty®.

SUMMARY:

Asgrow Seed Company is a leader in the transferral of new agriculture technology to the farm level. Asgrow Seed Company has been at the forefront in releasing new herbicide tolerant soybean varieties and corn hybrids.

Our Concept Farms provide the demonstration, evaluation, and transferral of these technologies directly to the user. We have observed a rapid adoption of these new varieties and hybrids.

Potential Impact of Herbicide-Resistant Crops on Specialty and Minor Crops

Leonard P. Gianessi[1]

This paper covers the potential impacts of genetically engineered herbicide resistant cultivars for minor crops. The paper focuses primarily on vegetables since genetically altering tree and vine crops to tolerate herbicides is not likely to gain much attention. The paper also discusses impacts on minor crops of the development of herbicide resistant field crops such as soybeans.

The minor crop problem is fairly well known. There is an absence of herbicides for most vegetable crops. Over 70% of vegetable crops lack either preemergence or postemergence herbicides that provide effective broad spectrum weed control. As a result, vegetable growers are forced to use expensive hand labor or plastic to control weeds. What's the potential of biotechnology to provide more options for minor crop vegetable growers?

Why aren't there more herbicides for minor crops right now? It's due to the high cost of registration and the potential risk of damaging crops that are worth thousands of dollars an acre. The costs are high, the risks are high and the market is small. Herbicide manufacturers have little interest in marketing herbicides for minor crops even if farmers have a demonstrated need. Will bioengineered plants offer a way out of this problem?

National herbicide sales data demonstrate the disparity in herbicide markets. Soybean growers spend $1.5 billion a year on herbicides. Corn growers spend about the same. Corn, soybeans and cotton justify the millions of dollars required to develop a new herbicide and gain registration. The national market for potato herbicides is $32 million. Thus, an herbicide that would be a good fit for potatoes is unlikely to be developed unless it also has corn, soybean or cotton use. All other vegetables total $91 million in herbicide sales. That's about 30 different crops. These are very small markets.

Some have said that the U.S. doesn't really need another soybean herbicide. There are 26 herbicide active ingredients currently used in soybeans. There is not a lot of handweeding or use of plastic in soybeans. Meanwhile, carrots, lettuce and peppers have three to six herbicides registered and in use. Soybean growers have numerous pre and post-emergence herbicide options. For just about any weed infesting soybeans, there are numerous options for control. However, U.S. growers are going to have another major herbicide added to the soybean weed control arsenal.

Monsanto has developed glyphosate resistant soybeans. Through biotechnology, soybean plants have been engineered to resist glyphosate. Soybean plants without the resistance gene are killed by glyphosate applications. By planting the resistant soybean plants, growers will be able to go over the top of soybean plants with glyphosate for weed control.

One of the reasons why soybean growers are likely to adopt the use of glyphosate is potential reduction of herbicide costs. Currently, soybean growers around the country spend $22 to $32 an acre for their herbicides. The use of glyphosate could potentially reduce this cost to $8

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to $15 an acre depending upon how many sprays are necessary. Thus, there is a major potential benefit to U.S. soybean growers from the glyphosate resistant soybeans. Minor crop growers who are spending hundreds of dollars per acre for weed control look at this kind of data and say: Why not pumpkins? Why not tomatoes? Think of the reductions in vegetable weed control costs with two glyphosate sprays at $15 an acre replacing handweeding, plastic or more expensive herbicides.

What are the costs of developing an herbicide resistant cultivar? The technology isn't cheap. It's estimated that the current transformation of a cultivar costs from $500,000 to $1 million. On top of that, it's necessary to add the costs of the herbicide registration to go with the transformed cultivar. The cost of a single herbicide registration can also range from $500,000 to $1 million. The cost of the herbicide registration can be much lower depending on IR-4 inputs and EPA waivers of test requirements. But it's not clear how the development of herbicide resistant cultivars reduces the cost problem. It appears that the use of biotechnology to develop herbicide resistant crops adds to the cost of development and registration and does not make the cost issue less important.

Nevertheless, some work is ongoing with transforming vegetables. There has been a total absence of herbicides for Florida muck lettuce for ten years. So, there has been some work developing herbicide resistant lettuce plants.

There has been success transforming "South Bay" head lettuce so that some of the transformed lettuce lines tolerate up to 32 pounds of glyphosate over the top. Much of this research was conducted by university researchers in Gainesville. It's not a Monsanto undertaking. Currently, the researchers are assessing the horticultural acceptability of the transformed lettuce. Does it taste the same? Does it look the same? Does it weigh the same? As a result of changing a characteristic in the plant, other characteristics may be affected. Consumers want certain types of lettuce, and if the herbicide resistant cultivar has an unacceptable horticultural characteristic, it will not be planted.

One other issue is whether other lettuce lines will be transformed. "South Bay" head lettuce is a cultivar adapted to southern Florida. What about leaf lettuce? What about romaine? There are several lettuce cultivars of importance in the Northeast, and some group would have to incur the expense of transforming these cultivars and assessing horticultural acceptability and weed control and securing the manufacturers' cooperation to apply for an herbicide registration.

Some recent experience in Idaho with transformed potatoes is illustrative of this horticultural acceptability problem. Researchers successfully transformed "Lemhi Russet" potatoes to tolerate bromoxynil. They inserted a gene and the transformed potatoes tolerated up to four and one half kilograms per hectare of bromoxynil. Again, a successful use of biotechnology in producing an herbicide resistant cultivar with benefits for weed control.

The researchers estimate that the use of bromoxynil at low rates per acre could potentially reduce the pounds of herbicides used in Idaho potatoes from between 40 and 85%. In Idaho, there are metribuzin resistant pigweeds, and over the past ten years, it has been necessary to increase herbicide use. With bromoxynil, weed control problems could be reduced with a significant reduction of pounds of herbicides on the ground. However, the bromoxynil resistant cultivars are not likely to be developed commercially.

Although weed control was excellent and although overall yields were equivalent, the best performing clones produced yields of U.S. Number One potatoes that were 70% to 85% of the untransformed control. That's what's meant by testing for horticultural acceptability. U.S. Number One potato yields are a very important characteristic. Because the transformed cultivars don't perform as well at producing U.S. Number One's, there is no commercial interest in pursuing this herbicide resistant cultivar.

There are some other constraints on herbicide use in vegetables. One of the constraints is the use of complex rotations in vegetable production. Vegetable growers have to use chemicals that have residual action very carefully lest a rotational crop is damaged. If vegetables are transformed to tolerate certain herbicides, then the resistance will have to be developed for a majority of vegetable crops so that rotational flexibility is not constrained. Complex rotations are a major limitation and consideration in vegetable herbicide use.

Another constraint on the use of herbicides in vegetable production is the tendency of certain vegetable crops, such as peas, watermelons, tomatoes and potatoes to become weeds in the following cropping season. This may result in a major weed problem if the weedy vegetable was resistant to the herbicides that are used in the following crop. This is the downside of developing resistance to the same herbicide in many vegetable crops. On the one hand, rotational flexibility is not constrained. On the other hand, it may complicate the problem of weedy vegetables.

One possibility in the future is that genetic engineering will become routine and inexpensive. It may be the case that genetic engineers will be able to routinely insert any genetic characteristics they want in any cultivar at low cost. It's really too early to tell if this will happen, but it might and the routine-ness could lead to new herbicide resistant cultivars for vegetable crops.

The development of herbicide resistant soybeans has implications for minor use crops. Some weed scientists worry that the increased use of glyphosate in soybeans will result in a decreased use for some currently used herbicides that are also currently used by vegetable growers. The concern is that if the soybean market declines for some of these herbicides, they may become unprofitable to produce and be voluntarily withdrawn for soybeans and for vegetable crops as well. That happened with chloramben. One inadvertent effect of herbicide resistant soybeans may be the loss of herbicides for minor crops.

On the other hand, it might lead to the exact opposite result. If glyphosate use on soybeans leads to the reduced use of other soybean herbicides, the labels for those herbicides might be expanded to include more minor uses. Afterall, if the soybean market is declining for an herbicide, it would make sense for the manufacturer to look around for other markets for expansion. With numerous herbicides being used in soybeans, manufacturers may exhibit more interest in the minor crop market. Thus, an inadvertent effect of herbicide resistant soybeans may be the expansion of herbicide labels for minor uses. It's too early to tell.

One recent occurrence has been the increased pace of registration requests at EPA. In November 1995, EPA reported a dramatic increase in registration applications for conventional pesticides: new active ingredients, experimental use permits and new uses for existing active ingredients. For the past five years or so, pesticide manufacturers have been incurring costs to reregister older pesticides. Now that re-registration costs are largely behind them, companies are increasingly focussed on commercializing new active ingredients. Some of these new applications will be for minor crop herbicides. Much of the gloomy thinking about minor crops has been the result of all the lost registrations in the past five years. In the future, it is likely that registrants will look to minor crops for increased sales.

With regard to herbicide resistant crops for minor uses, if registrants select an herbicide with prior clearance on another crop, then much of the cost of EPA clearance already would already have been expended. As a result, it may be economical for a chemical company to obtain EPA clearances for genetically-altered minor crops. On the other hand, if an herbicide is effective and not phytotoxic to a minor crop and is registered for a major crop, it may be a good candidate for minor crop registration whether it is the result of genetically engineering or not. Thus, the logic of label expansion for minor crops applies to all herbicides, not just those that would be effective with a genetically altered cultivar.

On the other hand, some industry analysts keep suggesting that the market size for minor crops is small and may not justify registration expenses even with the help of IR-4. There is a large financial risk problem for manufacturers with regard to minor crops. With a vegetable crop worth several thousand dollars an acre, the registrant takes an enormous risk if that crop is damaged in order to sell $10 worth of herbicides per acre. It is not the same with corn or soybeans where the crop is worth only hundreds of dollars an acre. This financial risk problem is a concern whether it is for an herbicide registration based on non-transformed cultivars or an herbicide registration that depends on genetically engineered tolerance.

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Herbicide resistant turfgrasses: potential and concerns

Peter R. Day and Lisa Lee[1,2]

Creeping bentgrass (*Agrostis palustris* Huds.) is a self-sterile outbreeding perennial grass that reproduces clonally by stolons. It belongs to the genus *Agrostis* which has many species. Creeping bentgrass (*A. stolonifera* L., *A. palustris* Huds.) is native to Eurasia but has become naturalized in North America. Plants of creeping bentgrass spread close to the soil surface by long, leafy stolons which are capable of rooting and developing new plants at each node.

The common name bentgrass is applied to all turfgrasses within the genus with the exception of redtop (*A. alba.*). The growth habits of bentgrass vary from a bunch type with limited stoloniferous growth to forms that establish extensive stolon systems. Bentgrass is one of the most tolerant cool season turfgrassess which, because of its prostrate growth habit, can tolerate continuous, close mowing at heights as low as 0.2". When closely mowed, bentgrass can form an extremely fine textured, dense, high quality and uniform turf which meets the exacting standards of golf course greens keepers. Its fine leaves, prostrate habit and tolerance to very low cutting heights have made it the principal species used for putting greens and fairways on the golf courses of temperate climates around the world. It is established in these locations by sowing seed on very carefully prepared and levelled seed beds. In North America annual seed production of the species, principally in Oregon and Washington, approximates 3-4 million pounds.

Creeping bentgrass regeneration and transformation

To transform creeping bentgrass, we developed a tissue culture regeneration system. About 6 - 8 weeks after surface sterilized seeds were placed on callus initiation medium, embryogenic callus cultures were selected from germinating seedlings. Depending on the cultivar used, between 5-30% of seeds can produce embryogenic callus cultures. Upon transfer to regeneration medium (MS medium without hormone), from 200-400 plants can be obtained from each gram (fresh weight) of callus. Callus cultures were used to establish suspension cultures by placing approximately 1-2 grams of callus into liquid MS medium (50ml) in 250 ml flasks in the dark on a rotary shaker (125 rpm). By subculturing to fresh medium twice a week, suspension cultures with small cell clusters were established for transformation. Both embryogenic callus and suspension cultures were used as target tissues in transformation.

Biolistic transformation was carried out using a Bio-Rad PDS-1000/He Biolistic Delivery System. This device uses a pulse of helium at high pressure to accelerate very small (1-3 μ) metal particles coated with transforming DNA to hit target plant cells placed in their path. Target tissues, either suspension cells or callus cultures, were placed on sterile filter disks in dishes containing medium prior to bombardment and kept in the dark. In the biolistic experiments, purified DNA was mixed with gold particles. The *bar* gene was obtained from Jonathan Jones (plasmid pSLJ02011) and Mike Fromm (plasmid pBARGUS) and prepared as described by Sanford et al., (1993).

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Herbicide was added to the tissue culture medium to select transformed cells from bombarded materials. Selection commenced 3-4 days after bombardment and continued for 8 weeks. The bombarded tissues were then transferred to regeneration medium. Regenerants appeared within 2-8 weeks. Shoots were transferred to phytatrays™ with regeneration medium and roots appeared within 2-4 weeks. Plants were transplanted to soil and tested for herbicide resistance in the greenhouse. It takes about 6 months from tissue bombardment to obtain plants in soil.

Protoplasts were isolated from four-day old suspension culture cells by enzyme digestion. Protoplasts were transformed with foreign DNA using polyethylene glycol (PEG) treatment to enhance the uptake of DNA. We have developed a system for culturing the protoplasts back to cells and subsequently to embryogenic callus cultures which then form plants by regeneration (Lee et al., 1996). Transformed protoplasts were treated with herbicide 16 days after protoplast isolation and resistant cell colonies were detected 3-4 weeks after selection began. Resistant colonies were transferred to regeneration medium and plants were regenerated. Once rooted, these were transferred to soil. It takes about 5-6 months from protoplast isolation to the production of transgenic plants in soil.

Greenhouse herbicide tests: All regenerants were treated with Herbiace™. Application rates were determined by applying different concentrations of Herbiace to control plants by painting them with a brush. Herbicide at 2 mg/ml was used as this caused death of control plants in all cases. The herbicide was applied at the rate of 120 ml/flat (24 plants/flat).

Creeping bentgrass clones resistant to Herbiace were obtained from three cultivars: Emerald, Southshore, and Cobra. In five experiments, involving 12 independent bombardment events, some 900 plants were regenerated for testing. Of these, 55 plants survived. The transformation frequency for herbicide-resistant plants ranged from 0 - 13.7%. Thirty Cobra plants were obtained in 3 later bombardment experiments. Cobra transgenic plants were also obtained from protoplast transformation. A total of 153 plants were regenerated from 2 resistant colonies obtained through protoplast transformation. All these plants survived the 2 mg/ml application rate. More than 200 transgenic plants of Emerald, Southshore, and Cobra survived 2 mg/ml herbicide applications in greenhouse tests and are resistant to 5x the field rate. Transgenic plants were confirmed by southern blot hybridization to show incorporation of the *bar* gene into the plant genome and by northern blot hybridization to show expression of the *bar* gene.

Field tests of herbicide-resistant creeping bentgrass were conducted in the summer of 1994 and 1995 at Rutgers' Research and Development Center at Upper Deerfield, NJ. Field test permits were obtained from USDA-APHIS. Transgenic plants from bombardment experiments and protoplast transformation of Cobra, Emerald, Putter, and Southshore were tested for resistance to the herbicide Ignite at 1x (0.75 lb active ingredient/acre) and 3x (2.25 lb AI/A) the label rate.

All plants that survived the 2 mg/ml greenhouse tests were completely resistant to both 1x and 3x field rates in the field tests. They remained green and unaffected like untreated plants in the control plot. No control plants (Cobra, Emerald, and Southshore plants grown from seeds) survived. More than 30 transgenic clones, of creeping bentgrass from two tissue clones of Emerald and one tissue clone of Southshore, were resistant to the 3x field rate. Cobra transgenic plants obtained from protoplast transformation were all resistant to the 3x field rate.

The resistant transgenic plants from the 1994 field test were left in place over winter to vernalize. Before flowering in the spring of 1995, a number were returned to a containment greenhouse for pollination and seed production to determine the inheritance of herbicide resistance. Transgenic plants remaining in the field were destroyed, before flowering, with another herbicide. Progeny of transgenic mother plants showed germination rates ranging from 57 to 99%, compared with control seeds from 47 to 93%. Tests for herbicide resistance are incomplete but indicate that several of the mother plants behave as heterozygotes with approximately 50 percent of progeny resistant.

The implications of herbicide resistant turfgrass

The excellent playing surfaces desired by golf course managers require intensive turfgrass cultural practices for their maintenance. These include the use of fertilizers, and pesticides, including some herbicides that may be highly toxic to nontarget organisms or may have the potential to pollute ground water. The production of turfgrasses that can be treated with less toxic herbicides and that require fewer fungicide and insecticide treatments, through biotechnology by transformation, should help by reducing dependence on chemicals with adverse environmental impacts. Our reports of successful transformation of creeping bentgrass have attracted considerable interest among commercial and other breeders of this important turfgrass species. Because of this widespread interest it is important to ensure that commercial introduction occurs in a way that imposes minimal destructive environmental impacts and maximizes the benefits that biotechnology offers over the long term.

The introduction of transgenic turfgrasses poses two potential environmental risks: the transgenic forms themselves may become important weeds or, through horizontal flow of the transgenes, produce forms of related weed grasses that are more difficult to control. Transgenic forms of turfgrass that are herbicide resistant may also threaten the viability of programs to introduce the same herbicide resistance genes carried by the turfgrasses into such widely grown crops as soybean and corn. There is presently considerable commercial activity in testing and releasing new cultivars with resistance to such broad spectrum herbicides as Round-up™ (glyphosate), Pursuit™ (imizethapyr), and Finale™ (glufosinate or bialaphos).

The commercial owners of the major herbicide resistance genes presently available are reluctant to allow their use in turfgrass because they fear that release of herbicide resistant grass varieties may compromise their use of the same genes, with correspondingly larger scale applications of their herbicides, in major agronomic crops like corn, soybean and cotton. They reason that the transgenic turfgrass itself may become a weed and/or that the transgene may spread to other grasses that are already weeds and, through introgression, produce weedy forms that can no longer be controlled by the herbicide in question.

The herbicide resistant creeping bentgrass (*Agrostis palustris* Huds.) clones in our laboratory provide a means of assessing these risks through laboratory and field studies using the trait herbicide resistance to monitor the occurrence and frequency of gene flow under conditions designed to maximize the opportunities for cross pollination. We plan to study the horizontal transfer of a transgene *(bar)* for resistance to the herbicide Finale between creeping bentgrass clones and other grasses within the genus *Agrostis,* and in the related genus *Eragrostis,* in greenhouse and field studies of out-crossing. Some of these species are recognized as weeds. The viability and fertility of resultant hybrids between *A. palustris.* and the other species, detected by their carrying the gene for bialaphos resistance *(bar)*, will also be assessed in the greenhouse and field.

Agrostis palustris, or creeping bentgrass, is not recorded as a weed of field crops although it can at times be a weed in Kentucky blue grass lawns. The literature on attempts to hybridize species of *Agrostis* that are commonly found in North America is limited (Stucky and Banfield, 1946; Jones, 1956; Bradshaw, 1958). A wide range of divergent types and intermediate forms exist among creeping, colonial, and velvet bentgrasses, with chromosome numbers ranging from 2n = 14 to 46, X =7. It appears likely that most interspecific hybrids involving A. *palustris* are sexually sterile and thus very unlikely to contribute to the relevant gene pools. In any case very few of the other *Agrostis spp.* have been reported as weeds. We plan to use herbicide resistant transgenic forms of *A. palustris* to establish the frequency with which this species hybridizes with other *Agrostis* species commonly found in North America. If, as we expect, the frequency of hybrid formation is low this will be significant and important in establishing policies for the future release of herbicide resistant and other transgenic forms of this species. If the frequency is high, and introgression of the gene appears to be likely because fertile hybrids are produced, this will call for more caution before proceeding with releases that could result in grasses that are difficult to control and which, through subsequent rounds of introgression with other transgenics, may be resistant to several different herbicides.

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Interactions Between Herbicide Use and Turfgrass Diseases

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Herbicides are valuable tools for the maintenance of quality turfgrass stands. During development of herbicides, turfgrasses are screened thoroughly for tolerance to the materials before labels are obtained. Good tolerance to healthy stands of grasses for which the materials are labelled is usually obtained. However, occasionally, unforeseen or unusual stress conditions may lead to turfgrass injury. Sometimes the stress can predispose the plant to greater susceptibility to pathogens, and sometimes the herbicide adds to environmental stress or interacts with the host turfgrass plant to influence susceptibility to pathogens.

Herbicides and plant growth regulators don't always cause problems with diseases. For example, some triazole fungicides, such as fenarimol (RUBIGAN), have herbicidal and/or growth regulator characteristics as well as fungicidal activity. In the Southeastern U.S., fenarimol is utilized as a preemergence herbicide for *Poa annua* control as much as for its fungicidal properties. In other cases, herbicides or plant growth regulators affect nontarget organisms and may predispose turfgrasses to greater damage from pathogens, as well as inhibit the recovery of the turf after "active" disease has subsided.

Some of the affected non-target organisms may be stimulated or inhibited by herbicides. The effects can be direct or indirect, for instance, by influencing a pathogen's virulence through effects on mycelial growth, spore germination, or sclerotium survival (Altman and Campbell, Hodges). It is also possible that herbicides can act indirectly by modifying the relationship between the pathogen and certain antagonists, or the pathogen's environment. However, usually, documented effects have been in the realm of "predisposition" where the host physiology and susceptibility to pathogens is altered.

There has not been much research in turf concerning herbicide-turfgrass disease interactions. However, Madison observed a severe attack of brown patch in Kentucky bluegrass following application of 2,4,5-T and disodium methyl arsenate. Turgeon, et.al., reported increasing incidence of stripe smut of Kentucky bluegrass following bandane application. Karr et. al. found in greenhouse investigations that benefin and bensulide slightly increased severity of Rhizoctonia blight and dollar spot in bermudagrass and Pythium blight on annual ryegrass. Other examples are in the literature.

It was observed in the turfgrass plots at Clemson

University's main campus that Rhizoctonia blight (brown patch) in warm-season grasses seemed to be a chronic problem when certain preemergence herbicides were being utilized, particularly the triazines, atrazine and simazine (A.R. Mazur, personal communciation). This observation led to research by Mr. Steve Millett for his M.S. degree in plant pathology.

Millett examined several herbicides in greenhouse and field experiments. Herbicides examined were atrazine and simazine, at 1.1 and 2.2 kg a.i./ha, pendimethalin at 1.7 and 3.4 kg a.i./ha, oxadiazon at 2.25 and 4.5 kg a.i./ha, and dithiopyr at 0.27 and 0.54 kg a.i./ha. His experiments also included no herbicide treatments. In each experiment, swards of hybrid bermudagrass, 'Tifway II', centipedegrass 'Oklawn' or 'Tennessee Hardy', and St. Augustinegrass 'Raleigh' were inoculated with a virulent strain of *Rhizoctonia solani*, obtained from bermudagrass originally. He rated disease over time, to construct disease progress curves, and analyzed the curves for differences by treatment. In most instances, the grasses treated with triazines had greater disease incidence and/or recovered from the effects of disease slower than other treatments. Pendimethalin and oxadiazon also sometimes led to increased disease, but dithiopyr applications did not apparently influence disease (Millett). In general, the magnitude of the increases observed were greater on centipede and St. Augustinegrass than on hybrid bermudagrass.

Another herbicide-pathogen system we have investigated involves plant parasitic nematodes. In the well-drained, highly weathered, sandy soils in the Southeastern United States, plant parasitic nematodes are endemic and cause significant problems on many cultivated plants, including turfgrasses. Common nematodes that cause problems in turf include the sting nematode (*Belonolaimus longicaudatus*), lance (*Hoplolaimus galeatus*), stubby root (*Trichodorus* spp.), ring (*Criconemella* spp.), and sometimes certain species of root-knot (*Meloidogyne* spp.). Others occasionally cause problems if infestations are unusually high.

Sting nematodes are particularly damaging to turfgrasses. They are relatively large nematodes (up to a millimeter in length), and have a tendency to prefer root tips as a feeding site. They also have a relatively long stylet used to probe root tips, and cause significant damage at low numbers. In South Carolina, the current threshold is 20 nematodes per 100 cc or ml or soil. They are only found in relatively sandy soils, and are common in the coastal sandy soils and in sand ridge (Sandhill) regions of the Southeast. Also, they do quite well in putting greens constructed with high percentages of sand in the rootzone mix.

I have observed that sting nematodes are present and feeding even before bermudagrass visually comes out of winter dormancy in the spring. In the Coastal regions of South Carolina, this is in early March. This is also the time (late February to mid-March) when preemergence herbicides are applied for summer annual weeds, such as crabgrass and goosegrass. Commonly, herbicides in the dinitroanaline class are used for this purpose for well-known reasons. These herbicides work by inhibition of cell division. With certain of these herbicides, new stolons of bermudagrass may be inhibited from establishment because of inhibition of root penetration into treated soil. If nematodes are also present, the scenario for interaction or added detrimental effects is set. In fact, it has been observed that some bermudagrass was not recovering from nematicide treatment, even when the treatment apparently inhibited nematodes by assaying the soil for their numbers following treatment. In questioning management practices, dinitroaniline herbicides were used in many cases.

Experiments were conducted in the field to examine the possibility that herbicides were involved in a detrimental interaction with nematodes. Sites were used that had natural infestations of sting nematodes; counts taken prior to initiating experiments showed averages of around 30 nematodes/100 cc of soil, considered a moderate infestation. Experiments were conducted on a golf course fairway or on a sod farm in the region. The first site was common bermudagrass, and the second was Tifway bermudagrass. Herbicide treatments included priodiamine, at 1.0 lb a.i./acre (1.5 lb Barricade 65WG), pendimethalin, at 3.0 lb a.i./acre (5.0 lb Pre-M 60DG), oxadiazon, at 4.0 lb a.i./acre (200 lb Ronstar G), and dithiopyr, at 0.5 lb a.i./acre (2 qt Dimension 1EC). Plots not treated with herbicides were also used. Within herbicide treatments, in a standard split-plot design, nematicide treatments were applied. These included ethoprop, at 20 lb a.i./acre (200 lb Mocap 10G), fenamiphos, at 10 lb a.i./acre (100 lb Nemacur 10G), or plots that were not treated with nematicide. Herbicide were applied in late February or the first week in March, and nematicides were applied in mid-April. Turf quality (0-9 scale, with 9 being best) was rated in all plots throughout the summer. Also, turf cores were taken to about 20-cm depth, and roots extracted and measured.

Results of these experiments indicated that the turf response to treatments, as measured by turf quality, varied among the treatments. Usually, the bermudagrass responded to nematicide treatments, with fenamiphos treatment having a greater efficacy than ethoprop. There was usually very little difference in spring greenup among plots, although in one year, plots treated with pendimethalin were delayed in greenup and in the next year, plots treated with oxadiazon were delayed in greenup. In both cases, noticeable effects only remained about 2 weeks. In early and mid-summer ratings, there was little difference among herbicides, but in August ratings, plots treated with oxadiazon and fenamiphos had significantly better turf quality than other treatments. In 1995, fresh root weights measurements and root length measurement were greater in oxadiazon-fenamiphos plots compared to pendimethalin-fenamiphos plots. Considering only nematicide treatments, fenamiphos treatments increased root weight and length compared to no nematicide treatments. It was concluded that herbicide choice could have an influence on turf quality and turf recovery from nematode damage after nematicide treatment.

This presentation has only examined two herbicide-disease systems where herbicide choice seemed to influence disease susceptibility or turf recovery from disease. Turfgrass managers are faced with a daunting task of balancing pesticide inputs, including herbicides, fungicides, insecticides, etc. and developing integrated systems of management for the particular pests in question. Managers can best do this by carefully studying growth patterns of the turfgrasses under culture, and determining when the turf is likely to be under stress from environmental and/or pest pressures. At these critical times, the choice of a pesticide or perhaps the choice of no pesticide application may be critical to obtaining the best chance of sustaining turf quality but limiting detrimental effects on the turf or the environment. No doubt, as managers are provided with more tools in the way of pesticides and growth regulators, these decisions will be more difficult. The more we can learn about potential interactions, the better we will be prepared.

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SITE PREPARATION WITH GRANULAR HEXAZINONE INCREASES STEM VOLUME OF BAREROOT BLACK SPRUCE SEEDLINGS

Phillip E. Reynolds[1] and Michael J. Roden[1]

ABSTRACT

Granular (PRONONE 10G and 5G) and liquid (VELPAR L) hexazinone (1 to 4 kg ai/ha) were applied to a northern New Brunswick clearcut to reduce raspberry competition. Treatment, using skidder-mounted herbicide application equipment, occurred in May and September 1986, with planting of 2+2, bareroot, black spruce seedlings in June of 1986 and 1987. Seedling survival and growth were measured yearly for 5 growing seasons after planting. By August 1991, hexazinone formulation did not affect raspberry control, seedling survival, or growth. Raspberry cover for 3 treatments remained less than that for controls. Survival of seedlings planted approximately 1 month after spring treatment was less than controls, but seedling stem volume was greater than that of control seedlings for most treatments. Survival and stem volume of seedlings planted 1 yr after spring treatment or 9 months after fall treatment were greater than that of control seedlings for most treatments. Best survival and growth occurred for seedlings planted 1 yr after spring treatment. Fifth-year stem volume was best correlated (r^2 = 0.58 and 0.72 for spring and fall treatments, respectively) with raspberry height, decreasing as raspberry height increased. We conclude that the use of the PRONONE 10G formulation offers operational advantages over the liquid formulation.

INTRODUCTION

Red raspberry [Rubus idaeus L. var. strigosus (Michx.) Maxim.] is often the major competitor threatening the establishment of spruce plantations in eastern Canada and in northeastern Maine (12). Presently, few herbicides effective in controlling raspberry competition are registered for forestry use in Canada. Glyphosate (VISION), a conifer release herbicide, is the primary herbicide used to reduce raspberry competition (3). Two site preparation herbicide products that also provide effective raspberry control are registered for silvicultural use in Canada. They include the liquid (VELPAR L) and granular (PRONONE) formulations of hexazinone. Depending upon application rate, a typical aircraft can treat up to 7 times more area per load with PRONONE than with VELPAR L in a water carrier (3). Therefore, if both formulations perform equally, the use of PRONONE offers a significant operational advantage that should result in considerable cost savings.

This work reports raspberry control through 6 growing seasons after hexazinone site preparation and survival and growth of black spruce [Picea mariana (Mill.) B.S.P.] seedlings through 5 growing seasons after planting. Evaluations of PRONONE and VELPAR L efficacy

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during the 1st or 2nd growing seasons after treatment demonstrated that both formulations are effective in controlling raspberry (13, 14). Seedling mortality increased through August 1989 for all treatments, but was highest for seedlings planted 1 month after spring treatment (15, 17). The number of seedlings overtopped by raspberries declined over time, and differences in overtopping between treated and control seedlings were generally significant (16). By August 1989, most seedlings planted into herbicide treatments were taller than surrounding raspberries, whereas most control seedlings were shorter. Overtopped seedlings generally exhibited poor growth morphology (i.e., tall, skinny and twisted stems), were characterized by chlorotic or numerous brown needles, and frequently suffered extensive needle loss. In 1989, the health of seedlings taller than surrounding raspberries, was better than that of seedlings that remained overtopped (Reynolds and Roden, unpublished statistical data).

Objectives of this study were: (1) to quantify raspberry competition in treated and control plots; (2) to investigate survival and growth of bareroot, black spruce seedlings planted at different time intervals after spring or fall site preparation with different formulations of hexazinone; and (3) to determine the best time of treatment and hexazinone formulation to achieve optimal seedling survival and growth during the establishment phase of the plantation.

METHODS

Site and experimental design

The clearcut treatment area is located on J.D. Irving, Ltd. property near St. Leonard (approximately 47°17' latitude and 67°43' longitude), in northwest New Brunswick at approximately 240 m elevation. Soils are fine-textured, including loams, silty loams, clay loams, silty clays, and clays. Mean sand, silt, and clay content of the soils is 29.7, 44.3, and 26.0%, respectively. The duff layer varies from 3 to 11 cm, organic matter from 2.4 to 25.5%, CEC from 6.2 to 18.9 meq/100 g, and pH from 3.6 to 4.9. Annual precipitation averaged 108 cm, falling mostly as rain between May and October. Approximately 7, 5, 14, 18, 11, and 5 cm of rain was received each month, respectively, from May through October 1986. Soil freezing occurred in early November 1986.

The site was clearcut in the fall of 1984 and mechanically site prepared in the summer of 1985, using a 125-ton Letourneau crusher to fell snags and break up residual logging slash. Prior to being harvested, the site supported a stand consisting of approximately 45% balsam fir [Abies balsamea (L.) Mill.], 35% black spruce, and 20% hardwoods composed primarily of aspen (Populus tremuloides Michx.) and a variety of other northern hardwoods. Following site preparation, portions of the site not treated with hexazinone, were rapidly revegetated with a dense cover of raspberries.

All treatments were replicated 4 times on 0.5 ha plots using a completely randomized layout of treatment plots. No significant differences in soil characteristics (i.e., pH, organic matter, CEC, % sand, % silt, % clay) were observed among treatments. All plots were separated by 25 m buffers.

Treatments and planting

Ten percent granular hexazinone (PRONONE 10G, 1, 2, and 4 kg ai/ha) and 5% granular hexazinone (PRONONE 5G, 2 kg ai/ha) were applied on May 27, 1986 using a skidder fitted with a hydraulic blower unit (OMNI system) designed for application of granular herbicides. Liquid hexazinone (VELPAR L, 2 kg ai/ha) was applied in 364 l/ha water on May 29, 1986 using a skidder-mounted hydraulic sprayer, equipped with a cluster nozzle. PRONONE 10G (2 kg ai/ha) and VELPAR L (2 kg ai/ha, 436 l/ha) were applied on September 18, 1986 using the same skidder-mounted application equipment.

Controls and half of each spring hexazinone plot (split-plot design) were planted (2.1 m spacing) in June 1986 and in June 1987 with local 2+2, bareroot black spruce seedlings obtained from the Irving nursery. Fall hexazinone plots were planted in June 1987 with the same bareroot stock. A total of 480 (i.e., 80 per treatment) seedlings planted in 1986 and 640 seedlings planted in 1987 were randomly selected and staked for yearly measurement.

Measurements and analysis

Seedling survival (%), height (cm), and basal stem diameter (mm) were measured annually (August). Stem volume (cm^3) was computed using the formula for a cone: area/3 x length = 1/3 x pi x r^2 x height (1). Cover (%) of the dominant competitor, raspberry, was estimated visually within a 1 m radius of each staked seedling to the nearest 5% value. The height of raspberry stems within each quadrant of the circle was measured to the nearest cm.

Analyses of variance (ANOVA's) were performed on black spruce seedling growth and raspberry competition data. Treatment means were compared via Tukey's Studentized Range (HSD) Test at 5% level of significance. The frequency of occurrence of live seedlings was compared with a Likelihood Ratio Chi-Squared (G-Squared) Test (23). Regression analyses were performed on 5th-year seedling growth vs. raspberry cover or height. Where slopes were judged to be statistically significant, analyses of covariance (ANCOVA) were performed to establish significant treatment differences due to planting time, treatment time, or formulation.

RESULTS

By August 1991 (i.e., six growing seasons after treatment [GSAT]), mean raspberry cover had increased to 92% in untreated plots (Table 1), and was greater than in spring plots ($P = 0.008$) treated with granular hexazinone at 4 kg ai/ha (32%) or in fall (i.e., 5 GSAT) plots ($P = 0.013$) treated with liquid or granular hexazinone at 2 kg ai/ha (42% each). No treatment difference in raspberry height was observed in 1991. No differences in raspberry control (cover or height), attributable to formulation (5% granular vs. 10% granular vs. liquid at 2 kg ai/ha), were observed throughout this study.

TABLE 1. Mean raspberry cover (%) and height (cm) in August 1990 and in August 1991 for spring and fall treatments.

Treatment	Cover				Height			
	1990		**1991**		**1990**		**1991**	
	mean	SE	mean	SE	mean	std err	mean	std err
CONTROL	92.3 a	4.6	91.7 a	4.7	83.9 a	9.7	82.8 a	12.2
SPRING:								
10 % granular								
1 kg ai/ha	71.4ab	15.7	77.6 a	12.7	56.9ab	14.0	58.2 a	14.4
2 kg ai/ha	63.9ab	9.8	65.9ab	8.7	52.3ab	6.9	51.2 a	7.4
4 kg ai/ha	39.1 b	14.0	32.5 b	10.9	37.2 b	12.8	32.0 a	10.7
5 % granular								
2 kg ai/ha	48.0ab	11.5	65.6ab	14.1	45.8ab	12.1	61.0 a	19.3
liquid								
2 kg ai/ha	52.4ab	7.5	54.6ab	7.6	43.4ab	5.1	42.0 a	4.7
FALL:								
10 % granular								
2 kg ai/ha	-	-	42.1 b	19.8	-	-	37.0 a	17.3
liquid								
2 kg ai/ha	-	-	42.3 b	10.2	-	-	32.4 a	8.6

a-b Numbers within columns followed by the same letter are not significantly different at the 5% level according to Tukey's Studentized Range (HSD) Test.

Survival of seedlings planted approximately 1 month after spring treatment was less than controls (Table 2). Survival of seedlings planted approximately 1 yr after spring treatment or 9 months after fall treatment was greater than that of control seedlings for most treatments. Differences in black spruce seedling survival, attributable to formulation, were noted during earlier growing seasons. For seedlings planted 1 yr after spring treatment, survival was lower for the liquid hexazinone treatment and higher for both granular (2 kg ai/ha) treatments during the 2nd through 4th growing seasons after planting (GSAP). No difference in survival was observed for the two 2 kg granular treatments.

Initial black spruce seedling stem volume did not differ significantly among treatments (Figure 1). Significant stem volume increases over control seedlings were first observed 2 GSAP ($P = 0.022$) for seedlings planted 1 yr after spring hexazinone treatments, and continued through the 5th GSAP ($P = 0.004$). Significant stem volume increases over control seedlings also were first observed 2 GSAP ($P = 0.002$) for fall hexazinone treatments, and also continued through the 5th GSAP ($P = 0.001$). Significant stem volume increases over control seedlings were first observed 3 GSAP ($P = 0.022$) for seedlings planted 1 month after spring hexazinone treatments, and also continued through the 5th GSAP ($P = 0.001$). Five years after planting, no differences in stem volume, attributable to formulation, were observed among spring or fall hexazinone treatments.

TABLE 2. Survival (%), 5 GSAP, of bareroot, black spruce seedlings planted after spring or fall site preparation with liquid and granular hexazinone formulations.

Treatment	Spring Treatment Planted June **1986**	 Planted June **1987**	Fall Treatment Planted June **1987**
CONTROL	86.4 a	67.2 b	67.2 b
10 % granular			
1 kg ai/ha	70.0 b	80.0 a	-
2 kg ai/ha	63.0 b	88.9 a	85.0 a
4 kg ai/ha	66.7 b	60.0 b	-
5 % granular			
2 kg ai/ha	73.8 b	80.0 a	-
liquid			
2 kg ai/ha	82.5 a	76.0 a	69.5 a

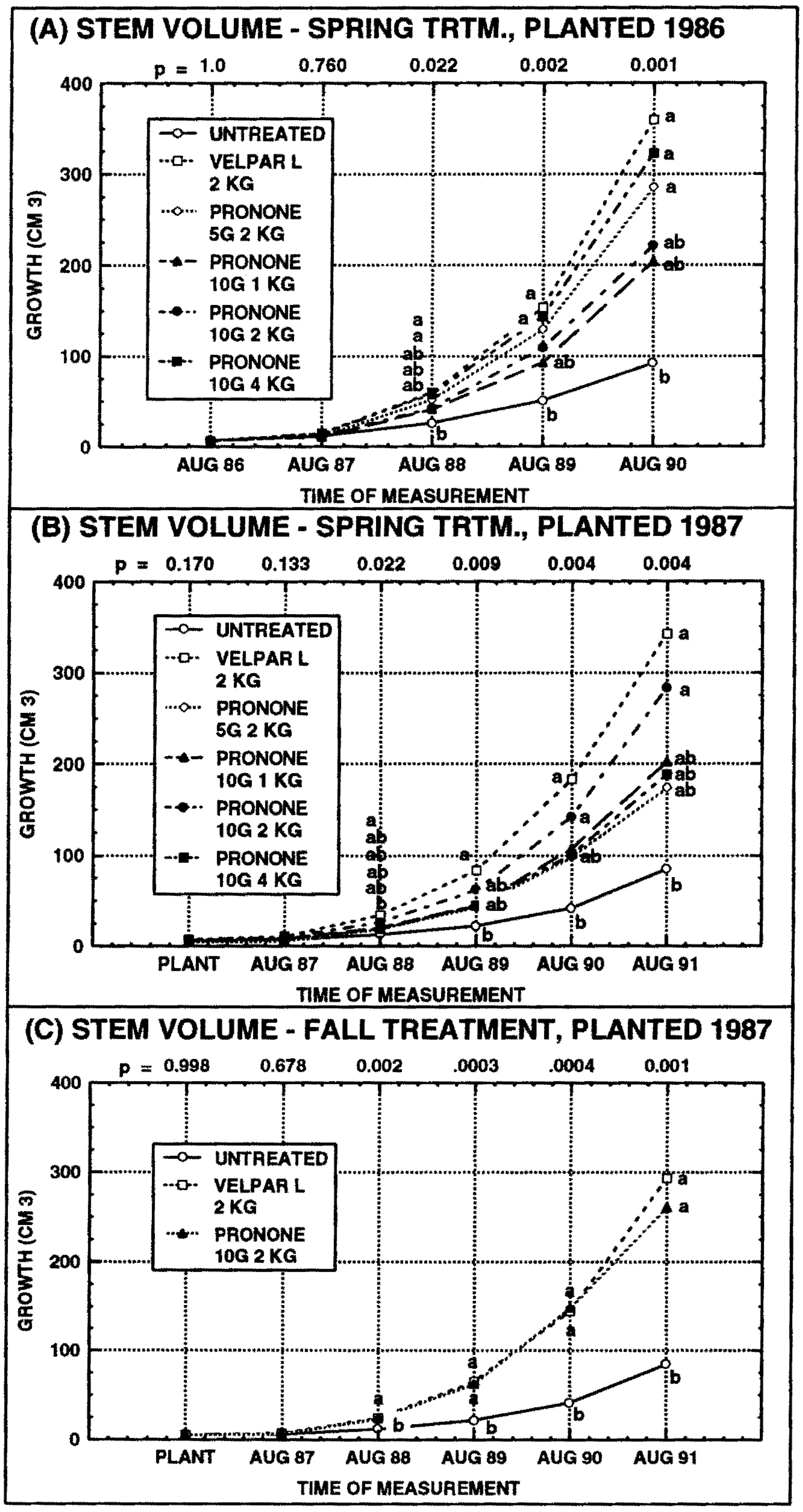
a-b Numbers within columns followed by the same letter are not significantly different at the 5% level according to G-Squared Test.

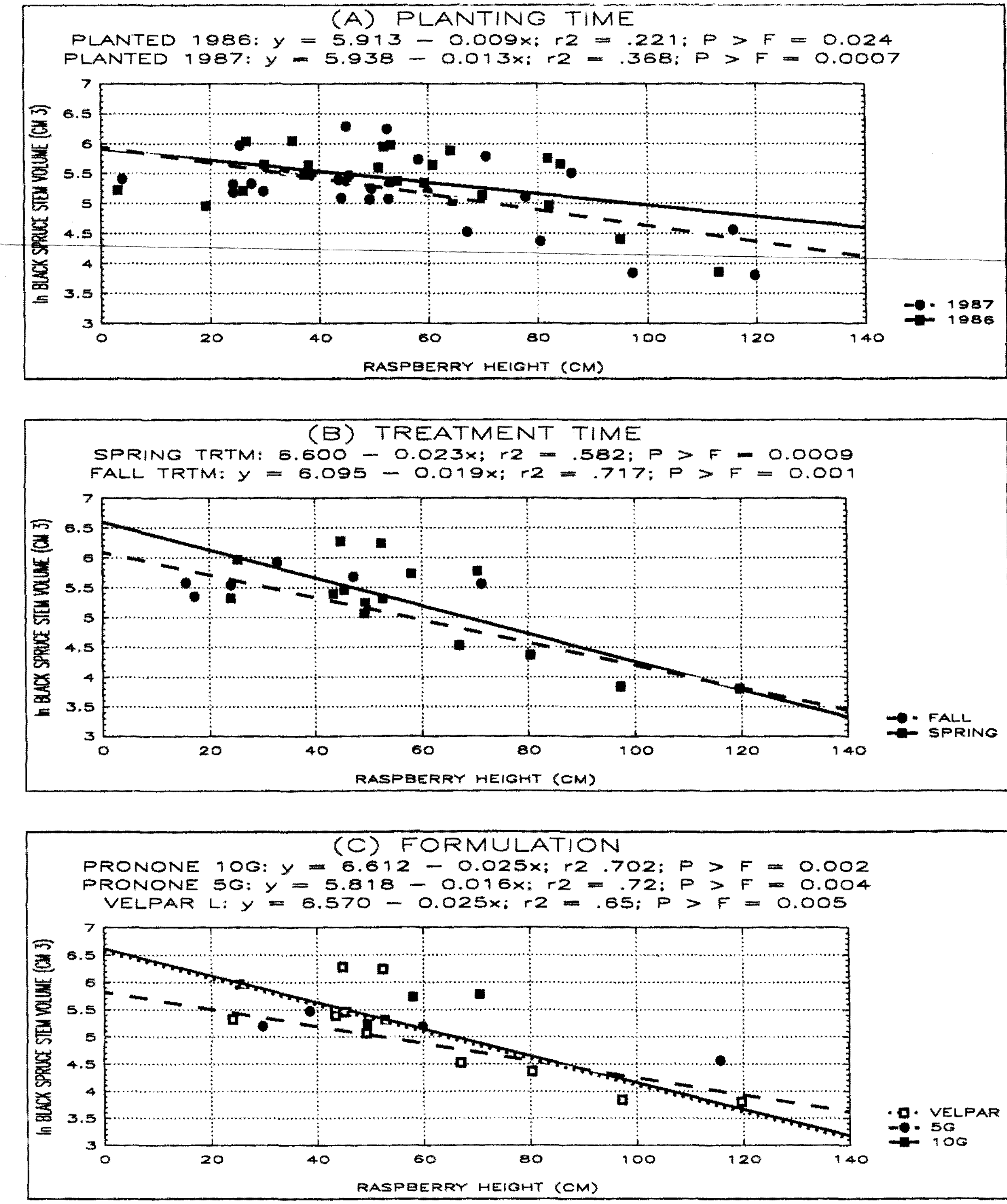
Fifth-year seedling stem volume was significantly correlated with raspberry competition, decreasing as competition increased. All relationships were somewhat curvilinear, and subsequent natural log transformations of stem volume data generally resulted in better correlations. Linear regressions relating 5th-yr black spruce seedling stem volume to 1990 or 1991 raspberry cover or height explained up to 72% of the variation in volume for spring or fall treatments, and the best relationships were generally with raspberry height (Figure 2). A linear regression model (i.e., includes control and 2 kg ai/ha treatments) relating 5th-yr stem volume to 1991 raspberry cover for seedlings planted 1 yr after spring hexazinone treatments only explained 35% of the variation in stem volume, whereas the same relationship with raspberry height (Figure 2B) as a covariant explained 58% of the variation in stem volume. Analyses of covariance (ANCOVA) for possible treatment differences due to planting time, (Figure 2A), treatment time (Figure 2B), and formulation (Figure 2C) revealed no significant treatment differences.

DISCUSSION

Reducing raspberry competition with hexazinone enhanced black spruce survival and growth for bareroot seedlings planted approximately 1 yr after spring hexazinone treatment. Reducing raspberry competition with fall hexazinone treatment also enhanced black spruce seedling survival and growth. Wood et al. (25) reported significant growth increases for bareroot, black spruce seedlings planted at differing time intervals after site preparation with liquid hexazinone (VELPAR L). Wood et al. (26) reported significant black spruce growth increases for seedlings planted in the spring after winter site preparation with PRONONE.

Sufficient rainfall was received in June 1986 (5.3 cm) to ensure the release of nearly all hexazinone from PRONONE granules into the soil. Feng et al. (5, 6) studied release of hexazinone from PRONONE 10G granules under both laboratory and field conditions. They


(A) STEM VOLUME - SPRING TRTM., PLANTED 1986
p = 1.0 0.760 0.022 0.002 0.001
GROWTH (CM 3)
UNTREATED
VELPAR L 2 KG
PRONONE 5G 2 KG
PRONONE 10G 1 KG
PRONONE 10G 2 KG
PRONONE 10G 4 KG
AUG 86 AUG 87 AUG 88 AUG 89 AUG 90
TIME OF MEASUREMENT
(B) STEM VOLUME - SPRING TRTM., PLANTED 1987
p = 0.170 0.133 0.022 0.009 0.004 0.004
GROWTH (CM 3)
UNTREATED
VELPAR L 2 KG
PRONONE 5G 2 KG
PRONONE 10G 1 KG
PRONONE 10G 2 KG
PRONONE 10G 4 KG
PLANT AUG 87 AUG 88 AUG 89 AUG 90 AUG 91
TIME OF MEASUREMENT
(C) STEM VOLUME - FALL TREATMENT, PLANTED 1987
p = 0.998 0.678 0.002 .0003 .0004 0.001
GROWTH (CM 3)
UNTREATED
VELPAR L 2 KG
PRONONE 10G 2 KG
PLANT AUG 87 AUG 88 AUG 89 AUG 90 AUG 91
TIME OF MEASUREMENT


(A) PLANTING TIME
PLANTED 1986: y = 5.913 − 0.009x; r2 = .221; P > F = 0.024
PLANTED 1987: y = 5.938 − 0.013x; r2 = .368; P > F = 0.0007
ln BLACK SPRUCE STEM VOLUME (CM 3)
RASPBERRY HEIGHT (CM)
1987
1986
(B) TREATMENT TIME
SPRING TRTM: 6.600 − 0.023x; r2 = .582; P > F = 0.0009
FALL TRTM: y = 6.095 − 0.019x; r2 = .717; P > F = 0.001
ln BLACK SPRUCE STEM VOLUME (CM 3)
RASPBERRY HEIGHT (CM)
FALL
SPRING
(C) FORMULATION
PRONONE 10G: y = 6.612 − 0.025x; r2 .702; P > F = 0.002
PRONONE 5G: y = 5.818 − 0.016x; r2 = .72; P > F = 0.004
VELPAR L: y = 6.570 − 0.025x; r2 = .65; P > F = 0.005
ln BLACK SPRUCE STEM VOLUME (CM 3)
RASPBERRY HEIGHT (CM)
VELPAR
5G
10G

concluded that 5.1 cm of simulated rain resulted in 91.5% release, and under field conditions (northern Alberta), 90.6% release resulted after 11.7 mm of rainfall. Release was virtually complete after 26.2 mm of cumulative rainfall.

Delaying planting 1 yr generally improved survival and growth of seedlings planted into spring hexazinone treatments. Improved survival and growth resulted from lower hexazinone exposure. Once in the soil, hexazinone persists up to 1 yr after application (4, 11, 22), but had no apparent negative effect on height or diameter of these bareroot seedlings (18). In New Brunswick, at a nearby site characterized by loam soils (47.9% sand, 32.5% silt, and 19.6% clay), aerially treated with 3.8 kg ai/ha hexazinone (VELPAR L), Feng and Feng (4) found 0.05 kg/ha hexazinone at 15-30 cm soil depth after 361 days, and reported DT_{90} = 319 days. No residues were found 453 and 537 days after application. In northern Ontario, Roy et al. (22) reported slightly higher residues for a finer-textured clay soil after one year. Approximately 13.5% of original hexazinone residues remained 365 days after initial soil treatment at 4 kg ai/ha.

Based upon this estimate, one might expect residues ranging from 0.2 to 0.4 kg ai/ha after 1 yr at the present New Brunswick site, which is characterized by finer-textured soils (mean silt and clay content = 44.3 and 26.0%, respectively) than those studied by Feng and Feng (4). For the 4 kg ai/ha treatment, sufficient residues evidently remained after 1 yr to reduce seedling survival, since seedlings planted into this treatment 1 yr after site preparation with hexazinone continued to exhibit lower survival than control seedlings.

At a third nearby New Brunswick site (mean silt and clay content = 42.7 and 25.8%, respectively), no difference in survival among treatments was observed for containerized (multipot) black spruce seedlings planted 2 or 14 months after site preparation with liquid and dry-flowable hexazinone formulations (19, 20). Both hexazinone formulations were applied in June 1987.

In Ontario, for boreal soils with high clay and organic matter content, Wood et al. (25) reported that both bareroot and containerized black spruce seedlings could be safely planted 4 weeks after site preparation with hexazinone at dosages up to 2 kg ai/ha. At higher dosages (i.e., up to 4 kg ai/ha), seedling damage was avoided only by delaying planting by about 1 yr.

Normally, soil adsorption of hexazinone increases with increased clay or organic matter content, making it less available for absorption by seedlings. At high hexazinone rates, this adsorptive capacity may be saturated, making hexazinone residues more available for absorption by seedlings. The high clay content of the Ontario soil may be the explanation as to why bareroot seedlings could be safely planted 1 month after hexazinone treatment, whereas they could not in New Brunswick. However, at 4 kg ai/ha, the adsorptive capacity of the Ontario soil appeared to be exceeded. In New Brunswick, a 1 month difference in planting times for bareroot and containerized (multipot) stock allowed for a longer degradation period in soils of nearly identical silt and clay content, but residues were likely still quite high 2 months after treatment. Therefore, we speculate that poor survival of bareroot seedlings may have also been caused by greater exposure of their roots to hexazinone residues than that experienced by multipot seedlings. Presumably, bareroot seedlings were more vulnerable to these residues when first planted, since their root systems were more disturbed than multipot seedlings. Collectively, the New Brunswick and Ontario results suggest that soil texture, organic matter content, stock type, and planting time all play roles in determining black spruce seedling survival, and that the use of containerized seedlings may help reduce seedling mortality due to hexazinone exposure.

Several survival differences, attributable to formulation (i.e., liquid vs. granular, 2 kg ai/ha) were observed throughout this study. For seedlings planted 1 yr after spring treatment with hexazinone, lowest survival was achieved with the liquid formulation. Wood et al. (26) reported that survival of bareroot and containerized black spruce planted in the spring following winter site preparation with PRONONE was not adversely affected by application rates up to 6 kg ai/ha, whereas both types of seedlings were damaged by dosages of more than 2 kg ai/ha of VELPAR L when planted within 4 weeks of a spring herbicide treatment. Both hexazinone applications occurred at nearby sites within northern Ontario's Clay Belt Region. They speculated that this discrepancy may have resulted from differences in the formulations used, and that hexazinone released from PRONONE granules may have entered the soil more slowly than hexazinone contained in the liquid formulation. Despite differences in timing for the two Ontario applications, the present results seem to confirm that there is a difference in black spruce seedling survival associated with the use of the 2 formulations.

Although significant differences in raspberry control affected by formulation were not observed, Minogue et al. (9) reported that treatment with liquid hexazinone resulted in better hardwood control and loblolly pine growth than treatment with granular hexazinone, for soils with less than 60% sand content. Mean sand content for soils in this study was approximately 30%, and may explain why greater growth and lower survival were observed with the liquid formulation. Seedlings planted 1 yr after site preparation with liquid hexazinone demonstrated lower survival than granular treatments, but grew the most, due to lesser amounts of raspberry competition.

We conclude that spring treatment with PRONONE 10G (2 kg ai/ha), with planting delayed by approximately 1 yr, provided the best treatment to achieve both optimal black spruce seedling survival and growth during the establishment phase of the plantation (21). Poor survival (i.e., less than control seedlings) was observed for seedlings planted 1 month after spring treatment. Better survival was most often observed with the granular formulations than with liquid hexazinone, for seedlings planted 1 yr after hexazinone treatments. Since 5th-yr survival and stem volume for the 10% granular and liquid formulations did not differ, operational needs should be considered when selecting the best treatment. Operationally, a typical aircraft can treat more hectares per load with the PRONONE 10G formulation, because this formulation does not require a water carrier. These survival and/or growth increases over that of untreated seedlings are comparable with those reported by other researchers who have studied spruce growth response following hexazinone site preparation for herbaceous vegetation control (10, 24, 25). They are generally greater than those reported for spruce using other vegetation management techniques such as manual cutting, prescribed burning, and certain types of scarification (2, 7, 8).

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AGRICULTURE NEEDS MORE WEED SCIENTISTS

Larry J. Kuhns and Tracey L. Harpster[1]

INTRODUCTION

Weeds must be controlled to produce marketable crop yields, for human safety, and for aesthetic reasons. Physical methods of weed control are highly labor and/or energy intensive, and in many cases are more dangerous to crops and people than herbicides. They are not practical solutions to most weed problems in developed countries. Non-chemical control methods used to control insects and diseases, such as selecting and breeding crops for resistance, or developing biological controls, have limited applications in weed control.

METHODS AND MATERIALS

In 1995, current and historical data on pesticide production and use were collected from government and industry sources. It was organized and summarized to show the significance of herbicides to late twentieth century agriculture.

At the same time a survey of 15 of the leading universities in the country in entomology (Alabama, Arizona, California, Florida, Georgia, Indiana, Michigan, Nebraska, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Virginia, and Washington); plant pathology (Arizona, California, Colorado, Iowa, Kansas, Kentucky, Minnesota, New York, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, Virginia, and Wisconsin); and weed science (Alabama, Arkansas, California, Colorado, Florida, Indiana, Iowa, Kentucky, Michigan, Mississippi, Nebraska, North Carolina, North Dakota, Oklahoma, and Wisconsin) was conducted. The number of Masters and PhD degrees conferred to U.S. citizens and foreign students, graduate students currently enrolled, courses offered, and teaching faculty were determined. All data represent averages of the 15 programs surveyed.

RESULTS AND DISCUSSION

Chemicals are needed to efficiently and effectively control weeds. Only 4.2% of farm expenditures were used for all pesticides in 1993 (Table 1). Based on the data in Table 2 (56% of pesticides used are herbicides), only about 2.3% of farm expenditures were used on herbicides.

Herbicide use steadily increased until 1984 (Table 3). The decrease in use since 1984 is probably due to the introduction of new products that are applied at extremely low rates of ai/ha compared to older materials.

Herbicide use, in terms of product used or expenditures, is greater by a wide margin than that of insecticides and fungicides combined (Tables 2,3,4).

The U.S. produced about 1.3 billion pounds of pesticide with a sales value of $8.25 billion in 1993 (Table 5). About two thirds of all pesticides produced in, and exported from, the U.S. are herbicides (Table 6).

About 40% of all of the herbicides used in the world are used in the U.S. (Table 7). Only 32% of the insecticides and 14% of the fungicides are used in the U.S.

[1] Prof. of Ornamental Horticulture and Research Associate, Dept. of Horticulture, The Pennsylvania State University, University Park, PA 16802

In 1987 $682 million was spent on pesticide research and development. $173 million was spent on EPA registration-related R&D. In 1993 $303 million was spent on EPA related R&D alone. The total figure was not available (Table 8).

In 1993 there were over 1.3 million certified pesticide applicators in the U.S.. Pesticides were applied on over 1 million farms and around 69 million households (Table 9).

To properly work with and apply herbicides, researchers and applicators should have a knowledge base that includes information on weed taxonomy, anatomy, and biology; herbicide chemistry and modes of action; spray adjuvants and carriers; soil characteristics and environmental factors that affect herbicide performance; application equipment technology; the development of herbicide resistance; alleleopathy; and the biological control of weeds.

As of 1981 no university in the world had a full weed science department (2). A three year study by an expert panel from the European Weed Research Society reported for Europe, "It appears that the number of hours spent teaching weed science or weed control to academic agriculturists, or even specialists in crop protection, is often little more than that considered necessary to train a technician to apply herbicides correctly and is far less than that devoted to entomology or plant pathology". There are more full-time official entomologists and plant pathologists in North America than there are weed specialists in the entire world (and a greater disparity exists if the academic qualifications are considered).

The survey was conducted to determine the current status of weed science programs relative to entomology and plant pathology programs. According to the information received, compared to weed science, there were 15% and 34% more graduate degrees earned by students in entomology and plant pathology in 1993 and 1994 (Figure 1). About five times as many U.S. students received degrees in weed science as foreign students. Twice as many U.S. students received degrees in entomology as foreign students. In plant pathology, almost as many foreign students as U.S. students received graduate degrees.

As of Fall semester, 1995, entomology had the most (20) U.S. graduate students enrolled. The number of U.S. graduate students in weed science and plant pathology programs was about equal (11 and 12). There were very few foreign students in graduate programs in weed science (3). Entomology and plant pathology had equal numbers of foreign students in Masters degree programs (3), but plant pathology had more students in PhD programs than entomology (10 and 7). The relatively high numbers of graduate students in PhD programs in plant pathology can be linked to the data presented in Table 10. While the U.S. accounts for 41% of the herbicides and 32% of the insecticides used in the world, it only uses 14% of the fungicides. Diseases are apparently more serious problems in other parts of the world.

There are few faculty teaching courses in weed science (3). There are four and five times as many faculty teaching plant pathology and entomology courses. There are few undergraduate or graduate courses taught in weed science (5 total). There are three to four times as many courses taught in plant pathology (18) and six to seven times as many courses taught in entomology (32).

It is astounding that with a fraction of the teaching faculty and courses offered that there were almost as many students graduated from weed science programs as either entomology or plant pathology programs. However, the number of students currently enrolled in these programs indicate that this relationship will change and that in the future more students will graduate from entomology and plant pathology than from weed science programs.

On the average, the leading universities in the country have only three faculty teaching courses in weed science, and they teach only two undergraduate and three graduate courses each year. By comparison, there are 15 faculty teaching 13 undergraduate and 19 graduate courses in the leading entomology programs in the country.

Who is going to provide the education and training in weed science to all of the future researchers, students in agriculture, county agents, crop consultants, ag chem. personnel, distributors, sales staff, the 1 million certified applicators and the people that work for them; now and in the future? Especially in this time when pesticide applications are being so closely monitored and controlled; and all applicators, including university research personnel, must be trained, licensed and attend update training sessions to maintain their licenses.

Table 1. Importance of pesticide expenditures to farmers (4,5,6). Excludes wood preservatives and disinfectants.

	1984	1988	1993
Total farm production expenditures	$140.0 bil.	$132.0 bil.	$147.0 bil
Farm pesticide expenditure	4.8	5.1	6.1
Percent	3.4 %	3.9%	4.2%

Table 2. User expenditures for pesticides in the U.S.(millions of dollars) (4,5,6).

	Herbicides			Insecticides			Fungicides		
	1983	1988	1993	1983	1988	1993	1983	1988	1993
Agriculture	2800	3080	3987	1300	1110	1248	450	775	895
Ind./Comm./Govt.	600	500	550	300	440	427	120	200	159
Home/Garden	250	350	219	500	660	875	98	125	124
Total	3650	3930	4756	2100	2210	2550	668	1100	1178
Percent	57	54	56	33	31	30	10	13	14

Table 3. Pesticide use in the U.S. (million pounds a.i.) (1,3,4,5,6). Data for 1964 and 1971 are for major agronomic field crops. For later years, pesticides used in fruits and vegetables are included. If pesticide use on rights-of-way were included the percentage of pesticide use that was herbicides would be even higher.

Year	Herbicides	%	Insecticides[1/]	%	Fungicides[2/]	%	Total
1964	71	37	117	60	6	3	194
1971	213	61	128	37	6	2	347
1983	575	63	255	28	78	9	908
1984	675	66	270	26	80	8	1025
1988	660	62	268	25	132	13	1060
1993	620	62	247	25	131	13	998

1/ Includes miticides and nematicides
2/ Does not include wood preservatives

Table 4. Pesticide use in the U.S. by type and market sectors (million pounds a.i.) (4,5,6).

	Herbicides			Insecticides			Fungicides		
	1983	1988	1993	1983	1988	1993	1983	1988	1993
Agriculture	445	510	481	185	185	171	103	150	159
Ind./Comm./Govt.	105	120	112	40	45	44	20	40	41
Home/Garden	25	30	27	30	38	32	10	12	14
Total	575	660	620	255	268	247	133	202	214
Percent	60	58	57	26	24	23	14	18	20

Table 5. 1993 U.S. production, imports, exports, and net supply of conventional pesticides at the producer level (6).

	Active ingredient (million pounds)	Sales Value (billion $)
U.S. Production	1300	8.25
U.S. Exports	440	2.48
U.S. Imports	210	2.16

Table 6. U.S. pesticide production and exports in 1988 (millions of pounds a.i.) (1).

	Production	%	Exports	%
Herbicides	475	63	158	65
Insecticides	222	30	61	25
Fungicides	54	7	25	10

Table 7. U.S. and world market sales in 1984, 1988, and 1993 (millions of dollars). (4,5,6). Data for 1984 and 1988 represent values at the basic producer level. Data for 1993 represents value at the user level.

	U.S. Market			World Market			U.S. % of World Market		
	1984	1988	1993	1984	1988	1993	1984	1988	1993
Herbicides	2750	2770	4756	6100	7700	11700	45	36	41
Insecticides	1400	1200	2550	6080	6100	7900	23	20	32
Fungicides	400	580	584	2700	3500	4130	15	17	14

Table 8. Cost of EPA data requirements relative to pesticide user expenditures in the U.S. (in millions of dollars) (4,5,6).

	1984	%	1987	%	1993	%
Pesticide user expenditures	6500	-	6850	-	8484	-
Total pesticide R&D expenditures	385	5.9	682	10.0	-	-
EPA registration-related R&D exp.	115	1.8	173	2.5	303	3.6

Table 9. The numbers of firms, individuals, and sites involved in the production, distribution and use of pesticides in 1993 (6).

Leading producers	120	
Formulators	2200	
Producing locations	7300	
Distributors	17200	
Certified Pesticide Applicators	1,300,000	
Application Sites	1,000,000	farms
	69,000,000	households

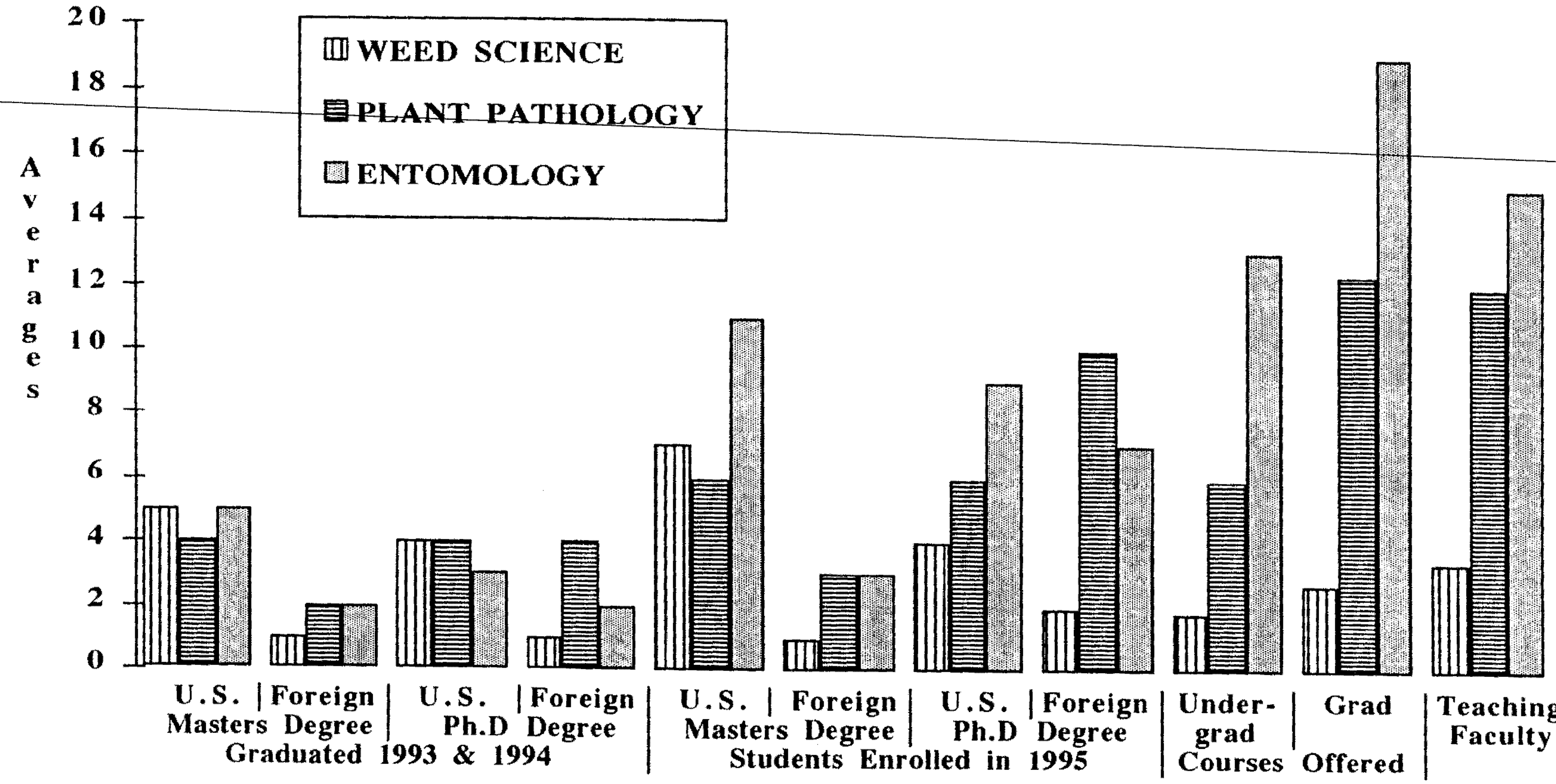

Figure 1: This data represents fifteen of the top programs in the country for each discipline: Weed Science (Alabama, Arkansas, California, Colorado, Florida, Indiana, Iowa, Kentucky, Michigan, Mississippi, Nebraska, North Carolina, North Dakota, Oklahoma, and Wisconsin); Plant Pathology (Arizona, California, Colorado, Iowa, Kansas, Kentucky, Minnesota, New York, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, Virginia, and Wisconsin); and Entomology (Alabama, Arizona, California, Florida, Georgia, Indiana, Michigan, Nebraska, North Carolina, Oregon, Pennsylvania, South Carolina, Tennessee, Virginia, and Washington).

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50th Annual Business Meeting
of the
NORTHEASTERN WEED SCIENCE SOCIETY

Williamsburg Lodge and Conference Center, Williamsburg, Virginia, January 4, 1996

I. **Call to Order:**

The 50th Annual Business Meeting was called to order by President Brad Majek at 4:19 PM on Thursday, January 4, 1996.

II. **Acceptance of Minutes:**

Arthur Bing moved to accept the minutes of the 49th Annual Business Meeting as written in Volume 50, Proceedings of the NORTHEASTERN WEED SCIENCE SOCIETY pages 191-194. The motion was seconded by Garry Schnappinger. Brad asked if there was any discussion and, without any, the motion was unanimously approved by the membership.

III. **Necrology Report:**

Andy Senesac reported the death of Barbara Emerson. Barbara worked in the field of agrochemicals for Amchem Products, Union Carbide and Rhone-Poulenc. She was a recipient of the Award of Merit and Distinguished Member Award from NEWSS. Andy Senesac asked the membership to observe a moment of silence in memory of Barbara.

IV. **Executive Committee Reports:**

Brad Majek asked the membership to review the annual reports in the handout. Copies of the Constitution and Manual of Operations were available for review by the membership.

Officers:	Committees:
B. A. Majek, President	R. D. Sweet, CAST Representative
T. E. Vrabel, President-Elect	S. Glenn, Editor
J. C. Neal, Vice President	A. R. Bonanno, Legislative
B. D. Olson, Secretary-Treasurer	J. F. Derr, Public Relations
A. F. Senesac, Secretary-Treasurer Elect	W. S. Curran, Research Coordinator
	D. J. Mayonado, Sustaining Membership
	D. B. Vitolo, WSSA Representative

V. **Secretary/Treasurer Update: Brian Olson / Andy Senesac**

Attendance at the 50th Annual Meeting of the Northeastern Weed Science Society was 246 for the entire meeting, with an additional 54 preregistered for the Friday Turf Workshop. Projected attendance at the 1996 Meeting should be about 300. Andy reminded the graduate students participating in the Graduate Student Paper Contest to bring their receipts to the registration desk Friday morning to receive their room reimbursement.

Brian reported that expenses exceeded income by $500.21 for fiscal year 1994-1995. He stated that three items contributed to an expenditure totaling

$6,000. These were: $2,000 for the partial support of a Congressional Fellow, $2,000 to Joe Neal for support of the publication of *Weeds of the Northeast*, and $2,000 for the AESOP group representing the Society in Washington D.C.

WSSA Representative Dave Vitolo was called on to describe AESOP to the membership. AESOP is a private enterprise which provides proactive liaison functions between its clients and Congress. The WSSA has committed to funding an AESOP staff member at 25% Faculty Teaching Equivalent (FTE) and has asked the regional societies for an equivalent commitment. A WSSA Washington Liaison Committee has been set up to provide rapid responses to the needs of the AESOP group. Dave Vitolo is the NEWSS representative on that Committee.

VI. Audit Committee Report:

Dan Ramsdell reported that he and Grant Jordan had reviewed the books on January 4, 1996. They found an accurate reporting of the balance of the accounts and everything was in order.

VII. Awards

A. Innovator of the Year & Applied Research Awards:

Brad asked Bill Curran, Research Coordinator, to come forward and announce the winners. Jim Orr received the Innovator of the Year Award; Larry Kuhns of Pennsylvania State University received the Applied Research Award in Turf, Ornamentals and Vegetation Management; and Scott Hagood of Virginia Tech, received the Applied Research Award in Food and Feed Crops. The Awards were previously announced and presented to the awardees at the Awards luncheon on January 3, 1996.

B. 1995 Collegiate Weed Contest:

Ron Ritter, in the absence of Past President, Wayne Wright, introduced Russ Hahn to review the winners. Russ acknowledged the generous support of fifteen sponsoring companies that supported the Contest. Cornell University hosted the Contest at the H.C. Thompson Vegetable Research Farm in Freeville, NY on August 8, 1995. Robin Bellinder and Russ co-chaired the event. Ron Ritter asked the membership to show its appreciation for their efforts with a round of applause.

- Dwight Lingenfelter of The Pennsylvania State University placed first in the graduate division. John Isgrigg of North Carolina State University and Mark Czarnota of Virginia Tech placed second and third, respectively, in the graduate division. Top honors in the undergraduate division went to Jimmy Summerlin of North Carolina State University. Mark Brock and Deb Campbell, both of the University of Guelph, placed second and third, respectively.

- Graduate team winners were: first place, Virginia Tech–members: Rakesh Chandran, Mark Czarnota and Sydha Salihu, coaches: Jeffrey Derr and Claude Kenley; and second place, North Carolina State University–members: Jim Chaote, John Isgrigg and Lee Prochaska, coach: John Wilcut and third place, University of Guelph–members: Bill Deen and John McAdam, coaches: Clarence Swanton, David Chikoye and Peter Sikkema.

- Undergraduate team winners were: first place, University of Guelph–members: Mark Brock Deb Campbell and Marie Longtin, coaches: Clarence Swanton, David Chikoye and Peter Sikkema; and second place, State University of NY-Cobleskill–members: Art Graves and Jim Saik, coaches: Doug Goodale and Ted Bruetsch; and third place, Penn State University–members: Jeff Gregos and Roxy Grossnickle, coach: Ed Werner.

C. Photo Contest:

Ron Ritter, chair of the Photo Contest judging committee, thanked committee members Gar Thomas, John Grande, and Lewis Walker.

- Print Competition:
  1st prize, Richard Uva, Cornell University
  2nd prize, Ray Taylorson, University of Rhode Island
  3rd prize, Sydha Saliha, Virginia Tech
- Slide Competition
  1st prize, Ray Taylorson, University of Rhode Island
  2nd prize, Joe Neal, Cornell University
  3rd prize, Richard Uva, Cornell University

D. Outstanding Student Presentation Contest

Ron Ritter thanked Committee members Wayne Wright, Roy Johnson, Stan Pruss and Prasanta Bhowmik. Ron commented that 17 papers were judged and were of a high standard of quality. Bill Sciarappa of BASF, sponsor of the awards, presented the checks.

- The 1st Prize winner was Dwight Lingenfelter for his presentation "Effect Of Glyphosate And Several ACCase Inhibitor Herbicides on Wirestem Muhly Control", co-authored by William Curran.
- The 2nd Prize went to Mark Isaacs for his presentation "Rimsulfuron plus Thifensulfuron Combinations with other Corn Herbicides.", co-authored by H. P. Wilson, Q. R. Johnson and J. E Toler.
- The Honorable Mention was awarded to Jed Colquhoun for his presentation "Potential Herbicides for Dry Beans." co-authored by Robin Bellinder.

F. Research Poster Award:

Ron introduced Mark VanGessel, Chair of the Research Poster Awards Committee. Mark thanked the Committee members: Jules Jaeger, Ed Beste and Matt Mahoney. Bill Sciarrappa of BASF, sponsor of the award, presented the checks.

- 1st Prize winner was C.B. Coffman, "Preemergence and Postemergence Weed Management in 38 and 76 cm Corn."

- 2nd Prizewinner was B.S. Manley, H.P. Wilson and T.E. Hines, "Common Cocklebur Response to Chlorimuron and Imazaquin."

VIII. Presentation of Gavel

Tom Vrabel, in the absence of Past President, Wayne Wright, thanked outgoing President Brad Majek for his service to the Society and presented him with a plaque commemorating his service as president. Brad presented the gavel to incoming President Tom Vrabel.

IX. New Business

A. Call for Resolutions

Grant Jordan, Chair of the Resolutions Committee, stated that no resolutions had been submitted to the Resolutions Committee in 1995. Tom Vrabel asked if there were any resolutions from the floor. There were none.

B. Nominating Committee Report

Bill Sciarappa, Chair of the Nominating Committee, thanked Nominating Committee members Steve Dennis, Frank Himmelstein and Stan Gorski. The Committee presented David Vitolo to the membership as a candidate for Vice President. President Vrabel asked if there were any nominations from the floor. With no new nominations, Russ Hahn moved to close the nominations for Vice President. Joe Neal seconded the motion. Dave Vitolo was unanimously elected as Vice President of the Society.

C. Election of 1996 Nominating Committee

Tom Vrabel named Frank Himmelstein and Bill Chism as members of the 1996 Nominating Committee. He asked for nominations from the floor. Renee Keese, Ray Taylorson and Ed Beste were nominated from the floor. Joe Neal moved to close nominations and approve the five nominees and Rich Bonanno seconded. The membership unanimously approved the Nominating Committee candidates.

D. Collegiate Weed Contest - 1996

Bill Curran announced that The Pennsylvania State University is proud to host the 1996 Collegiate Weed Contest. The Contest will be held on July 30 at the Rock Springs Research Facility, near the University Park main campus.

F. Meeting Site - 1997

President Vrabel announced that the 1997 Annual Meeting will be held January 6-9, 1997 at the Newport Marriott, Newport, RI.

G. Other New Business

Joe Neal raised the issue that several members were concerned that the traditional meeting dates of the first week of January can cause hardship for some members in preparing for and traveling to the meeting when it occurs so close to the New Year, as it did this year. There was discussion about the pros and cons of this meeting time. The primary advantage is the ability of the society to obtain favorable contract prices from hotels. Moving the meeting to the second week will erode the ability of the Society to get these lower rates and likely raise the cost of registration and hotel room rates.

Scott Glenn moved that when the Annual Meeting begins within a few days of the New Year, the Executive Committee shall bring it to the attention of the membership at the Annual Meeting two years prior, for discussion and a decision on a possible change in meeting dates. Bob Devlin seconded the motion. The motion was carried by the membership.

X. 1996-1997 Executive Committee

Tom Vrabel, NEWSS President, introduced the 1996-7 Executive Committee. President-Elect, J. C. Neal; Vice President, D. B. Vitolo; Secretary/Treasurer, A.F. Senesac; Past President, B. A. Majek; CAST Representative, R. D. Sweet; Editor, S. Glenn; Legislative, A. R. Bonanno; Public Relations, J. F. Derr; Research Coordinator, W. S. Curran; Sustaining Membership, D. J. Mayonado and WSSA Representative, R. M. Herrick.

XI. Adjournment

President Vrabel asked for a motion to adjourn. Garry Schnappinger moved that the Annual Meeting adjourn and Brian Olson seconded the motion. The membership unanimously approved the motion to adjourn at 5:04 PM.

NEWSS financial statement for 1995.
November 1, 1994 - October 31, 1995

INCOME:
Sustaining membership $3,900.00
Membership $4,357.50
Registration $10,140.00
Proceedings $5,690.00
Awards $600.00
Interest $1,381.35
Coffee Break Support $1,200.00
Weed Contest $4750.00
Other Income $0.00
Subtotal $32,018.85
EXPENSE:
Administration $1,527.23
Annual Meeting $10,326.17
Proceedings $4,272.60
NEWSS NEWS $3,248.44
Awards $1,382.48
Weed Contest $5,542.14
Miscellaneous $6,220.00
Subtotal $32,519.06

Total Income/Expense (1995) .... $(500.21)

Balance forwarded from NOW account (1994) $30,314.44
Balance forwarded from savings certificate (1994) $14,623.59

TOTAL NET WORTH $44,437.82

October 31, 1995 Savings Certificate Account (IDS Financial Services, Inc). .. $15,306.97
October 31,1995 Checking Account (North Fork Bank) $3,984.85
October 31, 1995 Checking Account (National Bank of Geneva) $27,591.00
Outstanding checks as of October 31, 1995 .... ($2,445.00)
Total $44,437.82

The NORTHEASTERN WEED SCIENCE SOCIETY checking account and savings certificate were reviewed by the undersigned and are in order.

Daniel R Ramsdell
2/27/96

Grant L Jordan
03/13/96

Executive Committee Reports of the NORTHEASTERN WEED SCIENCE SOCIETY Presented at the 50th Annual Business Meeting Williamsburg Lodge and Conference Center Williamsburg, Virginia, January 4, 1996

PRESIDENT

Bradley A. Majek

This is the 50th annual meeting of the Northeastern Weed Science Society, and an excellent time to reflect on the past while looking ahead to the future. We are all looking forward to celebrating the Society's anniversary at the Colonial Williamsburg Lodge and Convention Center, Williamsburg, Virginia. Preparations for the meeting have gone smoothly, and the Executive Committee is anticipating a good turnout. Colonial Williamsburg has ranked high on recent surveys conducted to determine potential sites for our meeting. The Historical Area has a great deal to offer visitors, and hopefully everyone will find an opportunity to enjoy the location.

An excellent program has been assembled for our 50th annual meeting. The featured speakers at the General Session will be five of our past presidents. Each will reflect on one decade of the society. Dr. Robert Sweet will recall the establishment of the Northeastern Weed Science Society, then called the Northeastern Weed Control Conference. John Gallagher will discuss the flood of selective herbicides that followed. Dr. James Parochetti will remember the on farm successes that resulted from the use of selective herbicides. Dr. Russ Hahn will evaluate the some of the problems that resulted from the use of the newly developed weed control techniques. Finally, Dr. Henry Wilson will address the use of genetically enhanced herbicide selectivity in crops, and the challenges this new technology presents to all of us. An Awards Luncheon has been scheduled as part of the 50th Meeting Celebration. Past presidents have been asked to reflect briefly on some of the "lighter" memorable moments of their terms. With the help of a little candid honesty, we will have a memorable meal.

An outstanding symposium has been scheduled to discuss the management of herbicide resistant crops, the integration of the technology onto the farm, and the impact on agricultural production.

The 12th Annual Northeastern Collegiate Weed Contest was held on August 8, 1995 at Cornell University, Ithaca, New York. The event was a tremendous success. Special thanks go to Dr. Robin Bellinder and Dr. Russ Hahn, co-chairs of the contest for 1995. Also, I would like to express my thanks to all that volunteered time and support for the event.

I would like to extend my sincere appreciation and thanks to all those who assisted me during my tenure as President of the Northeastern Weed Science Society, particularly those on the Executive Committee. Special thanks are in order for Dr. Wayne R. Wright, the immediate past president, for his help this past year. It has been an honor and a highlight of my career to serve the Society as President.

PRESIDENT-ELECT

Thomas E. Vrabel

The Site for the 1997 meeting of the Northeastern Weed Science Society will be the Marriott Hotel in Newport, Rhode Island. Our meeting dates are January 6 - 9, 1997. This site won out over New York City because the overall cost of the New York City site was well in excess of our society's modest means. The deciding factor was the cost for coffee breaks and other functions in public areas. Coffee breaks (for simply coffee only) at the New York site under consideration would cost us approximately $ 8.00 per person per coffee break!!! This was primarily due to union control over these functions and the hotel staff had no leeway in this matter. In addition, catered breakfasts would cost at least $ 40.00 per person and lunches would start at $ 50.00 per person. These costs, in addition to the parking fees, liquor costs, and AV costs, made the New York site in the final analysis cost prohibitive.

The Newport Marriott is a property which will do an excellent job of meeting the needs of our society. Newport Marriott is providing a room rate of $79.00 single or double occupancy, suite rates of $150.00, free parking, nearby airport access, and a wide variety of fine restaurants and delicatessens within walking distance of the hotel. The restaurants at the Newport Marriott are large enough to handle our members' breakfast and lunch needs rapidly and have an excellent selection of entrees. Another plus of this hotel is that it is of ample size to hold our meeting but is small enough to insure that we will be the only group in residence.

VICE PRESIDENT

Joseph C. Neal

For the 50th annual meeting we had 115 volunteered presentations with 18 students in the student competition. This represents an increase of approximately 20 presentations over 1995.

Section	Chair & Chair - Elect	# Papers
Research Posters	Russ Wallace, Cornell Univ. Mary Jane Else, Univ. of Mass.	17
Agronomy	David Mayonado, Monsanto Co. Lewis Walker, Amer. Cyanamid	41
Industrial, Forestry, & Conserv.	W. Sherksnas, UAP Mark Rice Dupont AgProd.	16
Turf & PGRS	David Spak, AgrEvo Wayne Bingham, VPI & SU	22
Ornamentals	Andrew Senesac, Cornell Coop. Exten. Todd Mervosh, Univ. CT	9
Vegetables and Fruit	Robin Bellinder, Cornell Univ.	10
TOTAL		115

In addition, we had as special events, the General Session commemorating 50 years of progress in weed science in the Northeastern US. Highlights of each decade were presented. Dr. Robert Sweet presented the 1950's - "in the beginning". John Gallagher discussed the "heyday of herbicide development" in the 1960's; Jim Parochetti discussed the 1970's - "the decade of success"; Russ Hahn discussed the 1980's as a "time for reevaluation"; and Henry Wilson discussed the "challenges of genetically enhanced selectivity" which we are encountering in the 1990's. This is followed by an awards luncheon. The General Symposium is on the "Impact of Herbicide Resistant Crops on the Future of Crop Management and Cultural Development". Presentations included the potential impact on row crop management by Alan York of NC State Univ., the impact on cultivar development by Alan Walker of Asgrow seed, potential inpacts on specialty crops by Leonard Gianesse of the National Center of Food & Agricultural Policy, and the potential an concerns of herbicide resistant turfgrasses by Peter Day of the Rutgers Center for Agricultural Molecular Biology. On Friday, a special outreach symposium on Golf and Sports Turf Weed Management was presented with participation of over 50 local turfgrass managers and golf course superintendents.

For the 1998 meeting site I have been focusing my search in the southern part of our region with emphasis on Washington DC. Several properties have submitted proposals which look very good.

SECRETARY / TREASURER

Brian D. Olson

Attendance at the 1995 annual meeting in Boston was 296 compared to 335 the previous year in Baltimore. Total membership for 1995 was 321.

In 1995, expenses exceeded income by $500.21. As of October 31, 1995 the net worth of the NEWSS was $44,437.82.

NEWSS Financial Statement

INCOME:	
Sustaining membership	$3,900.00
Membership	$4,357.50
Registration	$10,140.00
Proceedings	$5,690.00
Awards	$600.00
Interest	$1,381.35
Coffee Break Support	$1,200.00
Weed Contest	$4750.00
Other Income	$0.00
Subtotal	$32,018.85
EXPENSE:	

Administration	$1,527.23
Annual Meeting	$10,326.17
Proceedings	$4,272.60
NEWSS NEWS	$3,248.44
Awards	$1,382.48
Weed Contest	$5,542.14
Miscellaneous	$6,220.00
Subtotal	$32,519.06
Total Income/Expense (1995)	$(500.21)
Balance forwarded, NOW account (1994)	$30,314.44
Balance forwarded, savings cert. (1994)	$14,623.59
TOTAL NET WORTH	$44,437.82

EDITOR

Scott Glenn

There were 115 new abstracts and papers in the 1996 Proceedings compared to 100 abstracts and papers in 1995. There were a total of 288 printed pages in the Proceedings of the 1996 meeting. This was a slight increase from the previous year. There was also a slight increase in the printing cost of the Proceedings and the Program. The individual and team winners of the Collegiate Weed Contest were included in the Proceedings Supplement for the first time this year. A high percentage of the abstracts were submitted with different titles than the title sent in on the Title Submission Form. This can cause confusion and creates a discrepancy between the Program and the Proceedings. I encourage the members of the Society to examine your Title Submission Forms before you write your abstracts. The 5 year Cumulative Index is complete through 1995 thanks to Joe Neal. I plan to finish this publication shortly. At the July Executive Board meeting it was decided that this publication should be made available for purchase at the 1997 Annual meeting.

PUBLIC RELATIONS

Jeffrey F. Derr

Three issues (April, August, and November 1995) of the NEWSS newsletter were assembled. Photographs of the 1995 Executive Committee, the award winners, symposium speakers, past presidents, and the passing of the gavel were taken at the annual meeting in Boston. Information on the 1995 NEWSS meeting in Boston, along with the photographs taken, were included in the April 1995 newsletter. The August issue contained information on accommodations, call for papers, and other information for the 1996 annual meeting in Williamsburg. Photographs of the award winners were taken at the NEWSS student contest at Cornell. These photographs were included in the November issue of the newsletter. The November issue contained additional information on the upcoming meeting in Williamsburg, along with biographical sketches of the candidates for NEWSS offices.

For the 1996 meeting in Williamsburg, information on the program was sent to approximately 50 organizations and trade magazines. The release advertised the upcoming meeting and provided a contact person for additional information. Photographs of the NEWSS Executive Committee and the winners of the student contest were submitted to the WSSA newsletter. Photographs from the 1994 and 1995 annual meetings and from the 1994 student contest, and transcripts from the 1993 and 1994 ornamental weed control symposiums were sent to George Bayer for the archives.

SUSTAINING MEMBERSHIP

David Mayonado

We have currently received 29 membership checks totaling $2,900 for sustaining membership. Sixteen other parties were solicited and have not yet replied. Five companies agreed to support the coffee breaks. To date, 5 companies have sent checks for a total of $1,000. I expect 12 members to require table space for commercial displays and 7 companies requested time for the New Developments session. This session is currently not scheduled in the program. Along with membership solicitation, position announcements have been collected and made available to the society during the program. These announcements will be forwarded to the WSSA display at the national meeting.

RESEARCH COORDINATOR

William S. Curran

The research coordinator worked in the following areas in 1995. Weed Science field day dates were scheduled for participating universities. Dates were promoted through the NEWSS Newsletter.

Nominations for Applied Research Awards for Food and Feed and Turf, Ornamentals, and Vegetation Management and for Innovator of the Year were solicited from society members. A committee consisting of the Research Coordinator and Drs. Henry Wilson and Prasanta Bhowmik reviewed and selected the awardees. Biographical information was prepared for award recipients for the award brochure.

Working in conjunction with the NEWSS Editor, new or changing herbicide nomenclature was reviewed and assembled and updated for the herbicide indices section of the Proceedings.

Pesticide recertification credits for 12 of 13 northeastern U.S. states were arranged for the 1996 annual meeting. Pesticide Coordinators from each state were contacted and the authorization was obtained to accredit the 1996 program in eleven different sessions. The recertification process will be completed by individuals in all states at the registration desk during posted office hours.

CAST REPRESENTATIVE

R.D. Sweet

This past year CAST added two major events to its normal activities. In the winter it sponsored a national workshop on the 1995 Farm Bill and Sustainable Agriculture. The meeting was notable because invitations went to many groups outside the traditional farm organizations and commodity representatives. The "outsiders" included a wide range from the Sierra Club to Organic Farmers. Several attendees were members of NEWSS. The event was highly successful. Discussion was constructive and strident negative comments were conspicuous by their absence. Of course not many issues and problems were actually solved, but in quite a few instances issues were clarified and agreements reached as to the approaches that would likely lead to solutions. The only criticism was that CAST was too lavish in its spending for the event. The Board heard the comment and put appropriate budget controls in place. A second special event was a workshop for professional societies whose members deal directly or indirectly with agriculture and food. It was financed by a grant from the W.K. Kellogg Foundation and was held in St. Louis in mid-October. The purpose was to assist societies in dealing with change. The 30 societies which make up CAST plus about 15 others each sent 2-3 delegates. Rich Bonanno and Dave Vitolo represented NEWSS. I do not know their reactions. However I have recently reviewed the manuscript which summarizes the meeting and which should appear in January. Although the overall purpose as stated was to aid professional societies, the manuscript contained quite a few comments about the need for change in the Land Grant University system. This past year has seen CAST's recognition increase dramatically. It is now viewed not only as a good source of accurate information but also as an organization which can bring diverse groups together for discussion of issues involving agriculture. Of course traditional publications are continuing. Later this winter one will appear which deals with the complex issues concerning grazing cattle and sheep on western public lands. This is particularly timely in view of the "Western Republican "which is being reported in the print media.

LEGISLATIVE

A. Richard Bonanno

This year, Dr. Robin Bellinder (NY), Dr. Dan Kunkel (IR-4), and Mr. Leonard Gianessi (NCFAP) served on the NEWSS Legislative Committee.

On November 16, 1994 the USEPA proposed regulations to address plant pesticides. In general they are looking to exempt most from regulation. "The Agency believes that plant pesticides can offer an opportunity to reduce the use of conventional pesticides that are applied to agricultural plants and reduce the overall health and environmental risks from pesticides. The Agency believes that many plant pesticides would **not** pose risks that require regulation by EPA. However, the Agency believes some type of oversight is appropriate for plant-pesticides that are new to the plant and have a toxic mode of action".

Mike Espy stepped down as Secretary of Agriculture and former (1976-1994) Congressman Dan Glickman of Kansas has been tapped by the President. In his acceptance address to the President, Glickman comments that his "highest priority will be meeting your commitment to our farmers and ranchers, and everyone in rural America -- the commitment to sustain a solid economy that provides opportunity for growth and prosperity. I intend to keep your commitment to insure that America's consumers have the world's most abundant, wholesome food supply. Today's farm programs helped create those opportunities -- a lesson we should never forget. "During a recent commentary, newscaster Paul Harvey referred to farm programs as "consumer subsidies" and encouraged the public to support them. Senate confirmation hearings have taken place and Mr. Glickman received the unanimous vote of the Senate Ag Committee. A vote of the full Senate is expected in early April. While in the House, he served as Chairman of the Subcommittee on General Commodities and as a member of the Subcommittee on Department Operations and Nutrition. He is recognized as a national leader in the areas of food safety and food labeling. A quote by Glickman from the hearings: "I have long believed that our national strength, indeed our national security, is grounded in the strength of American agriculture. The abundant food supply we enjoy - that we take for granted - is a rarity in human history."

FDA gave the go-ahead to companies seeking federal endorsement for seven genetically altered products including herbicide-tolerant cotton and soybeans. The manufacturers voluntarily submitted their products to FDA, which concluded that these plants appear to be as safe as their non-altered counterparts. APHIS and EPA will still need to comment.

The USDA, FDA, and EPA have formed a partnership with several grower organizations and utility companies to promote environmental stewardship in pesticide use in the United States. This "stewardship program" will be a voluntary program and is intended to circumvent the need for mandated pesticide reduction regulation or legislation. Many of the grower groups have taken specific steps to demonstrate their commitment to the partnership. They have committed to more research and demonstration into IPM techniques and programs, the development of prediction models for more targeted and precise pesticide applications, education programs to encourage alternative pest control technologies, and cooperation with equipment manufacturers to find application techniques that maintain pest control efficacy while reducing application rates.

USDA is still discussing a 75% IPM goal by the year 2000. This appears to be coupled with the stewardship program and will be in the form of research funding and educational efforts.

The Pesticide Performance Guidelines appear to be stalled indefinitely. They will not be a part of the new registration guidelines. Word at the WSSA annual meeting was that they are "dead".

The CAST report entitled "Public Perceptions of Agrichemicals" has been released. The report surveys the public on both pesticide and animal drug issues. The full 35-page report is available for $10 plus $3 postage and handling from CAST, 4420 West Lincoln Way, Ames, Iowa 50014-3447.

CAST recently sponsored a conference in Washington, D.C. entitled "Sustainable Agriculture and the 1995 Farm Bill. The NEWSS sent Mr. Earl Anderson, research associate with Leonard Gianessi of NCFAP (National Center for Food and Agricultural Policy).Very little in regard to weed science or pesticides in general was discussed; however, what little was said was not negative. Much of the discussion revolved around commodity programs. Earl commented that the conference was well organized, well attended, and ran on time. Several prominent Congressman were in attendance, including Rep. Charlie Stenholm of Texas who said that pesticide reform, including a science-based Delaney revision, will happen after the first 100 days and before discussion of the Farm Bill begins.

The WSSA Pesticide Use/Risk Reduction Committee (Robin Bellinder, Chair; Rich Bonanno and Leonard Gianessi, members) drafted a response to the Tap Water Blues document for consideration in Seattle at the WSSA meeting. The weed scientists quoted by the EWG (Environmental Working Group) were against such a response and appeared to be comfortable with the broad interpretations and misrepresentations of the EWG. The statement was modified into a WSSA Position Statement on Herbicide Use/Risk Reduction Policy.

Jim Barrentine, WSSA President, has appointed Rich Bonanno as Chair of the WSSA Legislative Committee for 1995.

Leonard Gianessi has been quite active in Washington, D.C. in trying to educate EPA about various aspects of agriculture and pest management. He has organized a seminar "opportunity" for those of us that may be in the D.C. area. While in D.C. in March for the IR-4 Annual Meeting, Rich Bonanno presented a seminar at EPA entitled "Dealing with Mother Nature and the Federal Government". The seminar discussed the challenges faced on intensive vegetable farms in the Northeast. Dr. Clyde Elmore (CA), who is finishing a sabbatical at Penn State Univ. will present the next seminar in April. If you will be in D.C. and have the inclination to participate, please contact Leonard at 202/328-5057.

According to both Janet Anderson and Hoyt Jameson at EPA there is much progress being made relative to reorganization within the Agency. There will likely be 3 major divisions for pesticide registrations: Herbicide/Fungicide, Insecticide/Rodenticide, and Biopesticide. On November 16, 1994 the USEPA proposed regulations to address plant pesticides. In general they are looking to exempt most from regulation. "The Agency believes that plant pesticides can offer an opportunity to reduce the use of conventional pesticides that are applied to agricultural plants and reduce the overall health and environmental risks from pesticides..The Agency believes that many plant pesticides would **not** pose risks that require regulation by EPA. However, the Agency believes some type of oversight is appropriate for plant-pesticides that are new to the plant and have a toxic mode of action".

The Supreme Court recently ruled on the Sweet Home case involving inadvertent destruction of habitat under the Endangered Species Act (ESA).In a 6-3 ruling, the court said that the ESA provides "comprehensive protection for endangered and threatened species" and regulations protecting habitat are reasonable. The Interior secretary has "reasonably construed the intent of Congress when he defined 'harm' to include 'significant habitat modification or degradation that actually kills or injures wildlife'" the justices said. "As the law stands, you can face prosecution for the lawful use of your property if that use unintentionally modifies the habitat of an endangered species that may not actually occupy the land. That is clearly not acceptable" said American Farm Bureau president Dean Kleckner.

The ESA issue is tied to another that resulted from the earlier Supreme Court ruling on the South Carolina land taking. This has resulted in proposed legislation that landowners be compensated by the government if regulation reduces the value of their land by a certain amount (50% in some cases).Needless to say, the Enviros want to take away the use without compensation. So does USDA Undersecretary for Natural Resources and Environment James R. Lyons.

The 1995 Farm Bill was not passed by the September 30 deadline. The holdup has been the budget debate.

C. Robert Taylor (Auburn Univ.), Ron Knutson (Texas A&M), and Leonard Gianessi (NCFAP) presented briefings of a pesticide study to House and Senate staff members in mid June. The meat of these briefings states that "a drastic reduction or elimination of pesticides would bring substantially higher fruit and vegetable prices without significantly increasing America's already high level of food safety."

Although we are unlikely to see a 50% mandated pesticide reduction bill, a 50% reduction in pesticide use by 2005 has been listed as a benchmark by EPA. The voluntary Environmental Stewardship Program is one way EPA hopes to accomplish this.

IR-4 funding appears stalled at $5.7 million. Although it appeared that the joint House/Senate committee would allow the $6.7 million amount, $1 million was cut. The $5.7 million matches the current funding level. It is doubtful that any change will take place before final budget approval (whenever that happens).

The hot topic on the legislative front has been the Food Quality Protection Act of 1995 (S1166 and HR 1627).This legislation is also known as FIFRA/Delaney reform). The House version would:

-Replace the Delaney clause with a negligible risk standard;

-Require the federal government to coordinate and implement procedures to insure that tolerances protect the health of infants and children;

-Streamline EPA's authority to remove certain pesticides from the market by requiring EPA to complete the cancellation and suspension of dangerous pesticides within one year;

-Provide regulatory relief for public health and minor use pesticides;

-Provide streamlined registration procedures for antimicrobial pesticides.

Until the House completes work on this bill, the Senate will not take action on it. This will provide time for Senator Lugar to find more than the current 9 cosponsors. This effort is the subject of the recent letter to WSSA members urging them to write to members of the Senate Agriculture Committee and the Senate Commerce, Science, and Transportation Committee. By the end of 1995, no progress had been made regarding this legislation.

There was another Delaney reform bill that had been circulating (S 343 by Dole/Johnston).This bill appears dead.

REGIONAL ISSUES

The Pesticide Product Registration division in New York State has alarmed many members of the NEWSS by suggesting that no research on "unregistered" pesticides may be conducted in New

York State. It is still unclear what will be done; however, there will likely be a permit or reporting process involved. Rich Bonanno contacted Dr. Maureen Serafini regarding this issue. A copy of the letter is attached. To date, she has not responded.

There appears to be a move by the manufacturers of home/specialty pesticide products (Chemical Specialty Manufacturer's Association or CSMA) to change state registration fee structures. This grouped had worked in New Hampshire and Vermont to change the usual one level system into a multi-tiered system. Their rationale appears to be that home and specialty uses of pesticides pose a reduced risk to the environment. In Vermont they have, as yet, been unsuccessful in their efforts which also includes lower fees for these products. In New Hampshire, however, they were successful in creating a multi-tiered system but not in separating fees.

WSSA REPRESENTATIVE

D. B. Vitolo

Activities this year included attending both the winter and summer WSSA Board of Directors meetings. 1995 was the first year that regional society and at-large board members could vote at the summer meeting. Various matters of regional interest were acted on, including awards, resolutions, and budget matters. I am currently the NEWSS representative on the WSSA's new "Washington Liaison Committee", set up to provide rapid responses to the needs of the AESOP group representing us in Washington, DC. The WSSA Board of Directors was reorganized, and the NEWSS representative sits on the Finance Sub-Committee. Discussions were held with Anne Legere, WSSA Editor, on the issue of data tables accompanying Abstracts in the NEWSS Proceedings. Anne, unlike her predecessor, has no problem with that data being included in papers submitted to Weed Science or Weed Technology, as long as it does not constitute the bulk of the data submitted. Specific guidelines will be written.

As members of the NEWSS Executive Committee, Rich Bonanno and I represented the Society at the CAST Workshop.

PAST PRESIDENT

W. G. Wright

A key function for the Past President is serving as Awards Chairman. Nominations for Distinguished Member and Award of Merit awards were solicited in the newsletter. Response by members was good. Many candidates were properly written up and supported. Bill Curran served as Chair for the Innovator of the Year and the Outstanding Applied Research Awards for Food and Feed Crops and Turf, Ornamental and Vegetation Management. Ron Ritter chairs the Photo Award Committee and Matt Mahoney, the Poster Awards. Nominees for Distinguished Member, Award of Merit, Applied Research Awards and Innovator of the Year were presented to the Executive Committee and received unanimous approval. Awards were presented at the Awards Luncheon, January 3, 1996. Distinguished Members were Roy R. Johnson and Edward R. Higgins. Award of Merit were received by Robert M. Devlin, Wilbur F. Evans, Raymond B. Taylorson and S. Wayne Bingham. Jim Orr was Innovator of the Year. E. Scott Hagood received the Applied Research Award for Food and Feed Crops and Larry Kuhns for Turf, Ornamental and Vegetation Management. See the Luncheon Brochure for more detail.

The Poster, Photo and Best Graduate Student Paper will be presented at the Annual Business Meeting, January 21, 1996.

The Constitution and Bylaws were reviewed for possible revision. Only minor corrections were identified. These were recorded in the October 23, Executive Committee Minutes. Since the changes are minor, they will be carried forward and incorporated in the next significant revision.

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as of October 1, 1996

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Delaware	11	2		2	3	4	
District of Columbia	4		2	1			1
Florida	1			1			
Georgia							
Illinois	3			3			
Indiana	7			7			
Maine	7	1		3		3	
Maryland	34	5	2	13	5	9	
Massachusetts	10			3	1	6	
Minnesota	1			1			
Missouri	3			3			
New Hampshire	1					1	
New Jersey	13	1		6	2	4	
New York	28			8	3	16	1
North Carolina	22	1		11	1	9	
Ohio	4			4			
Ontario	2		1		1		
Pennsylvania	63	6	1	32	2	18	4
Quebec	2		1	1			
Rhode Island	2			1		1	
South Carolina	3					3	
Virginia	29	1	1	12	2	12	1
West Virginia	2		1	1			
Wisconsin							
Total	260	18	9	115	22	89	7
Percentage	100	7	3	44	8	34	3

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Delaware	1	4		2	3	2	1			2	
District of Columbia	2				1	1	2				
Florida							1				
Georgia											
Illinois	1			2						1	
Indiana	2			5		1				3	
Maine	1	2		2		3				2	
Maryland	2	5	6	10	6	11	1	3	4	7	
Massachusetts	3	3				4	1	1	2		
Minnesota				1							
Missouri	1			2							
New Hampshire		1									
New Jersey	4	1		5		7			2	4	
New York	2	7	1	4	2	13	1	5	1		1
North Carolina	2	3		6	1	9	1	5	3	4	
Ohio				3		1	1			2	
Ontario		1		1		2					
Pennsylvania	13	8	3	14	1	24	12	2	3	7	2
Quebec						1	1				
Rhode Island				1		1				1	
South Carolina		1	1			2		1	1		
Virginia	3	6		4		8	6	6	1	1	2
West Virginia						2					
Wisconsin											
Total	40	45	13	62	15	95	28	24	18	35	5
Percentage	15	17	5	24	6	37	11	9	7	13	2

Areas of specialization of NEWSS members in 1996.

State or Province	Aquatics	Field Crops	Forage	Forestry	Fruits	Non-Crop	Ornamentals	Physiology	Right-of-Way	Soils	Turf	Vegetables
Colorado		1	1									
Connecticut		1			1		2			2		3
Delaware	1	10	2	1	1	3	2	2	3	1	2	6
District of Columbia	2	3	2	2	3	2	2	2	2	1	2	3
Florida	1	1		1	1	1	1		1	1	1	1
Georgia											1	
Illinois		2				1			1			
Indiana	4	1		4	1	4	3		4	1	2	
Maine		1		3	1					1		
Maryland	2	24	4	1	2	6	5	3	6	3	3	6
Massachusetts		3	2	1	2			3	3	1	3	1
Minnesota		1										
Missouri		1					2				2	
New Hampshire		1	1									
New Jersey		6	1	1	2		1		1	1	6	4
New York		10	4	1	6		5	1	5	1	8	10
North Carolina		14	3		2		1		1	1	8	3
Ohio	1	1			1	1	1		1		2	1
Ontario				1				1	2	1		
Pennsylvania	1	26	14	6	15	11	12	1	19	4	18	18
Quebec				1					1			1
Rhode Island		1					1				1	
South Carolina							2				2	
Virginia		13	2	2	5	2	5		3		9	6
West Virginia		1			2			1				
Wisconsin												
Total	12	122	36	25	45	31	45	14	53	19	70	63
Percentage	5	47	14	10	17	12	17	5	20	7	27	24

NEWSS PAST PRESIDENTS

GILBERT H. AHLGREN	1947-49
ROBERT D. SWEET	1949-50
HOWARD L. YOWELL	1950-51
STEPHEN M. RALEIGH	1951-52
CHARLES E. MINARIK	1952-53
ROBERT H. BEATTY	1953-54
ALBIN O. KUHN	1954-55
JOHN VAN GELUWE	1955-56
L. L. DANIELSON	1956-57
CHARLES L. HOVEY	1957-58
STANFORD N. FERTIG	1958-59
GORDON UTTER	1959-60
E. M. RAHN	1960-61
LAWRENCE SOUTHWICK	1961-62
DONALD A. SHALLOCK	1962-63
ANTHONY J. TAFURO	1963-64
ROBERT A. PETERS	1964-65
GIDEON D. HILL	1965-66
RICHARD D. ILNICKI	1966-67
JOHN E. GALLAGHER	1967-68
JOHN A. MEADE	1968-69
HOMER M. LEBARON	1969-70
JOHN F. AHRENS	1970-71
GEORGE H. BAYER	1971-72
ARTHUR BING	1972-73
RALPH HANSEN	1973-74
WALTER A. GENTNER	1974-75
HENRY P. WILSON	1975-76
RICHARD J. MARRESE	1976-77
C. EDWARD BESTE	1977-78
JAMES D. RIGGLEMAN	1978-79
JAMES V. PAROCHETTI	1979-80
M. GARRY SCHNAPPINGER	1980-81
RAYMOND B. TAYLORSON	1981-82
STEPHAN DENNIS	1982-83
THOMAS L. WATSCHKE	1983-84
JAMES C. GRAHAM	1984-85
RUSSELL R. HAHN	1985-86
EDWARD R. HIGGINS	1986-87
MAXWELL L. MCCORMACK, JR.	1987-88
ROY R. JOHNSON	1988-89
STANLEY F. GORSKI	1989-90

JOHN B. DOBSON	1990-91
PRASANTA C. BHOWMIK	1991-92
STANLEY W. PRUSS	1992-93
RONALD L. RITTER	1993-94
WAYNE G. WRIGHT	1994-95
BRADLEY A. MAJEK	1995-96

AWARD OF MERIT

1971	Gilbert H. Ahlgren	Rutgers University
	Homer Neville	L.I. Ag. & Tech., Farmingdale, NY
	Claude E. Phillips	University of Delaware
	M. S. Pridham	Cornell University
	Stephen M. Raleigh	Penn State Univ.
1972	Robert Bell	Univ. of Rhode Island
	Stuart Dunn	Univ. of New Hampshire
	Alfred Fletcher	NJ State Dept. of Health
	Frank N. Hewetson	Penn Fruit Res. Lab.
	Madelene E. Pierce	Vassar College
	Collins Veatch	West Virginia University
	Howard L. Yowell	Esso Research Lab.
1973	Moody F. Trevett	University of Maine
1974	Robert H. Beatty	Amchem Products, Inc.
	Arthur Hawkins	University of Connecticut
1975	Philip Gorlin	NY City Environ. Cont.
	Herb Pass	CIBA-GEIGY Corporation
	Robert D. Sweet	Cornell University
1976	C. E. Langer	Univ. of New Hampshire
	Charles E. Minarik	U.S. Dept. of Agr.-ARS
	Herb Pass	CIBA-GEIGY Corporation
1977	L. L. Danielson	U.S. Dept. of Agr.-ARS
	Madelene E. Pierce	Vassar College
	Lawrence Southwick	Dow Chemical Company
	John Stennis	U.S. Bureau of Fish. & Wildlife
1978	None Awarded	
1979	Carl M. Monroe	Shell Chemical Company
	Charles Joseph Noll	Penn State Univ.
	Jonas Vengris	University of Mass.
1980	Otis F. Curtis, Jr	NY Agr. Exp. Sta.
	Theodore R. Flanagan	University of Vermont
	Oscar E. Shubert	Virginia University

1981	Dayton L. Klingman	U.S. Dept. of Agr.-ARS
	Hugh J. Murphy	University of Maine
	John Van Geluwe	CIBA-GEIGY Corporation
1982	Robert D. Shipman	Penn State Univ.
1983	Arthur Bing	Cornell University
	William E. Chappel	VPI & SU
	Barbara H. Emerson	Union Carbide Agr. Prod.
1984	William H. Mitchell	University of Delaware
	Roger S. Young	West Virginia University
1985	John A. Jagschitz	Univ. of Rhode Island
1986	John R. Havis	University of Mass.
1987	None Awarded	
1988	J. Lincoln Pearson	Univ. of Rhode Island
1989	Robert A. Peters	Univ. of Connecticut
1990	Bryant L. Walworth	American Cyanamid Co.
1991	Donald T. Warholic	Cornell University
1992	Robert Duel	Rutgers Univ.
	Richard D. Ilnicki	Rutgers Univ.
	William V. Welker	U.S. Dept. of Agr. - ARS
1993	None Awarded	
1994	John F. Ahrens	Conn. Ag. Expt. Sta.
	John B. Dobson	American Cyanamid Co.
	J. Ray Frank	USDA/ARS/IR-4

1995	**Francis J. Webb**	**Univ. of Delaware**
1996	**Robert M. Devlin**	**Univ. of Mass**
	Wilber F. Evans	**Rhone-Poulenc Ag Co**
	Raymond B. Taylorson	**Univ. of Rhode Island**
	S. Wayne Bingham	**VPI & SU**

DISTINGUISHED MEMBERS

1979.	George H. Bayer	Agway Inc.
	Robert A. Peters	University of Connecticut
	Robert D. Sweet	Cornell University
1980.	John F. Ahrens	Conn. Agr. Exp. Sta.
	John E. Gallagher	Union Carbide Agr. Prod.
	Richard D. Ilnicki	Rutgers University
1981.	Robert H. Beatty	Amchem Products, Inc.
	Arthur Bing	Cornell University
	John A. Meade	Rutgers University
1982.	Walter A. Gentner	U.S. Dept. of Agr.-ARS
	Hugh J. Murphy	University of Maine
1983.	L. L. Danielson	U.S. Dept. of Agr.-ARS
1984.	Barbara H. Emerson	Union Carbide Agr. Prod.
	Henry P. Wilson	Virginia Truck & Orn. Res. Sta.
1985.	None Awarded	
1986.	Chiko Haramaki	Penn State Univ.
	Dean L. Linscott	U.S. Dept. of Agr.-ARS, Cornell University
1987.	Gideon D. Hill	E. I. Du Pont De Nemours
	William V. Welker	U.S. Dept. of Agr.-ARS
1988.	Wendell R. Mullison	Dow Chemical U.S.A.
	James V. Parochetti	U.S. Dept. of Agr.-CSRS
1989.	None Awarded	
1990.	Robert M. Devlin	Univ. of Mass.
1991.	John (Jack) B. Dobson	American Cyanamid
	Robert D Shipman	Penn. State University
1992.	Gary Schnappinger	Ciba-Geigy Corporation
1993	Stephan Dennis	Zeneca Ag. Products
	James Graham	Monsanto Ag. Co.
1994	Russell Hahn	Cornell University
	Maxwell Mcormack	University of Maine

1995	Richard Ashly	University of Connecticut
	Richard Marrese	Hoechst-Noram
1996	Roy R. Johnson	Waldrum Specialties Inc.
	Edward R. Higgins	Ciba Crop Protection

OUTSTANDING APPLIED WEED SCIENTISTS IN FOOD AND FEED CROPS

1991	Russell R. Hahn	Cornell University
1992	Henry P. Wilson	VPI, Virginia
1993	None Awarded	
1994	Robin Bellinder	Cornell University
1995	None Awarded	
1996	E. Scott Hagood	VPI, Virginia

OUTSTANDING APPLIED WEED SCIENTISTS IN TURF, ORNAMENTALS,AND VEGETABLE MANAGEMENT

1991	Wayne Bingham	Virginia Polytechnic Institute
1992	John F. Ahrens	Connecticut Agric. Expt. Station, Windsor
1993	Joseph C. Neal	Cornell University
1994	Prasanta C. Bhowmik	University of Massachusetts
1995	Andrew F. Senesac	Long Island Hort. Research Lab
1996	Larry J. Kuhns	Penn State University

OUTSTANDING GRADUATE STUDENT PRESENTATION

1979	1 - Bradly A. Majek .... Cornell Univ. 2 - Betty j. Hughes .... Cornell Univ.
1980	1 - John Cardi .... Penn State Univ. 2 - Timothy Malefyt .... Cornell Univ.
1981	1 - A. Douglas Brede .... Penn State Univ. 2 - Ann S. McCue .... Cornell Univ.
1982	1 - Thomas C. Harris .... Univ. of Maryland 2 - Barbara J. Hook .... Univ. of Maryland HM - L.K. Thompson .... VPI & SU HM - Timothy Malefyt .... Cornell Univ.
1983	1 - Anna M. Pennucci .... Univ. of Rhode Island 2 - Michael A. Ruizzo .... Ohio State Univ. HM - I. M. Detlefson .... Rutgers Univ.
1984	1 - Robert S. Peregoy .... Univ. Of Maryland 2 - Ralph E. DeGregorio .... Univ. of Connecticut
1985	1 - Stephan Reiners .... Ohio State Univ. 2 - Erin Hynes .... Penn State Univ.
1986	1 - Elizabeth Hirsh .... Univ. of Maryland 2 - Ralph E. DeGregaorio .... Univ. of Connecticut 2 - Avraham Y. Tietz .... Ohio State Univ.
1987	1 - Russell W. Wallace .... Cornell Univ. 2 - Daniel E. Edwards .... Penn State Univ. 2 - Frank J. Himmelstein............ Univ. of Massachusettes
1988	1 - William K. Vencill .... VPI & SU 2 - Lewis K. Walker .... VPI & SU HM - Scott Guiser .... Penn State Univ. HM - Frank J. Himmelstein .... Univ. of Massachusettes
1989	1 - Frank S. Rossi .... Cornell Univ. 1 - Amy E. Stowe .... Cornell Univ.
1990	1 - William J. Chism .... VPI & SU 2 - Russell W. Wallace .... Cornell Univ.

1991	**1 - Elizabeth Maynard ....Cornell Univ.** **2 - Daniel A. Kunkel ....Cornell Univ.**
1992	**1 - J. DeCastro ....Rutgers Univ.** **2 - Ted Blomgren ....Cornell Univ.** **3 - Fred Katz ....Rutgers Univ.**
1993	**1 - E. D. Wilkins ....Cornell Univ.** **2 - H. C. Wetzel ....Univ. of Maryland**
1994	**1 - Jed B. Colquhoun ....Cornell Univ.** **2 - Eric D. Wilkins ....Cornell Univ.**
1995	**1 - S. Salihu ....VPI & SU** **2 - J. A. Ackley ....VPI & SU** **HM - Jed B. Colquhoun ....Cornell Univ.**
1996	**1 - D. Lingenfelter .... Penn State Univ.** **2 - M. Issacs ....Univ. of Delaware** **HM - J. Colquhoun ....Cornell Univ.**

COLLEGIATE WEED CONTEST WINNERS

1983 - Wye Research Center, Maryland

Graduate Team: Univ. of Guelph
Undergraduate Team: Penn State Univ.
Graduate Individual: Mike Donnelly, Univ. of Guelph
Undergraduate Individual: Bob Annet, Univ. of Guelph

1984 - Rutgers Res. and Dev. Center, Bridgeton, New Jersey

Graduate Team: Univ. of Guelph
Undergraduate Individual: D. Wright, Univ. of Guelph
Graduate Individual: N. Harker, Univ. of Guelph

1985 - Rhom and Haas, Spring House, Pennsylvania

Graduate Team: University of Maryland
Undergraduate Individual: Finlay Buchanan, Univ. of Guelph
Graduate Individual: David Vitolo, Rutgers Univ.

1986 - FMC, Princeton, New Jersey

Graduate Team:
Undergraduate Team: Univ. of Guelph
Undergraduate Individual: Bill Litwin, Univ. of Guelph
Graduate Individual: R. Jain, VPI & SU

1987 - DuPont, Newark, Delaware

Graduate Team: Univ. of Guelph
Undergraduate Team: Univ. of Guelph
Undergraduate Individual: Allen Eadie, Univ. of Guelph
Graduate Individual: Lewis Walker, VPI & SU

1988 - Ciba Geigy Corp., Hudson, New York

Graduate Team: VPI & SU
Undergraduate Team: Univ. of Guelph
Undergraduate Individual: Del Voight, Penn State Univ.
Graduate Individual: Carol Moseley, VPI & SU

1989 - American Cyanamid, Princeton, New Jersey

Graduate Team: Cornell Univ.
Undergradaute Team: SUNY Cobleskill
Undergraduate Individual: Anita Dielman, Univ. of Guelph
Graduate Individual: Paul Stachowski, Cornell Univ.

1990 - Agway Farm Res. Center, Tully, New York

Graduate Team: VPI & SU
Undergraduate Team: SUNY Cobleskill
Undergraduate Individual: Dwight Lingenfelder, Penn State Univ.
Graduate Individual: Brian Manley, VPI & SU

1991 - Rutgers University, New Brunswick, New Jersey

Graduate Team: VPI & SU
Undergraduate Team: Univ. of Guelph
Undergraduate Individual: Tim Borro, University of Guelph
Graduate Individual: Carol Moseley, VPI & SU

1992 - Ridgetown College, Ridgetown, Canada

Graduate Team: Michigan State Univ.
Undergraduate Team: Ohio State
Undergraduate Individual: Jeff Stackler, Ohio State Univ.
Graduate Individual: Troy Bauer, Michigan State Univ.

1993 - VPI & SU, Blacksburg, Virginia

Graduate Team: VPI & SU
Undergraduate Team: SUNY Cobleskill
Undergraduate Individual: Brian Cook, Univ. of Guelph
Graduate Individual: Brian Manley, VPI & SU

1994 - Lower Eastern Shore Res. & Educ. Center, Salisbury, Maryland

Graduate Team: VPI & SU
Undergraduate Team: Univ. of Guelph
Undergraduate Individual: Robert Maloney, Univ. of Guelph
Graduate Team: Brian Manley, VPI & SU

1995-Thompson Vegetable Research Farm, Freeville, NY

Graduate Team: VPI & SU
Undergraduate Team: Univ. Of Guelph
Undergraduate Individual: Jimmy Summerlin
Graduate Individual: Dwight Lingenfelter

1996- Penn State Agronomy Farm, Rock Springs, PA

Graduate Team: Michigan State University
Undergraduate Team: SUNY,Cobleskill
Undergraduate Individual: Mark Brock
Graduate Individual: John Isgrigg

RESEARCH POSTER AWARDS

1983 1 - Herbicide Impregnated Fertilizer for Weed Control in No-Tillage Corn - R. Uniatowski and W. H. Mitchell, Univ. of Delaware, Newark

2 - Effect of Wiper Application of Several Herbicides and Cutting on Black Chokeberry - D. E. Yarborough and A. A. Ismail, Univ. of Maine, Orono

HM - Corn Chamomile Control in Winter Wheat - R. R. Hahn, Cornell Univ., Ithaca, NY and P. W. Kanouse, NY State Cooperative Extension, Mt. Morris

1984 1 - Herbicide Programs and Tillage Systems for Cabbage - R. R. Bellinder, VPI & SU, Blacksburg, and T. E. Hines and H. P. Wilson, Virginia Truck and Orn. Res. Sta., Painter

2 - Triazine Resistant Weeds in New York State - R. R. Hahn, Cornell Univ., Ithaca, NY

HM - A Roller for Applying Herbicides at Ground Level - W. V. Welker and D. L. Peterson, USDA-ARS, Kearneysville, WV

1985 1 - No-Tillage Cropping Systems in a Crown Vetch Living Mulch - N. L. Hartwig, Pennsylvania State Univ., University Park

2 - Anesthetic Release of Dormancy in Amaranthus retroflexus Seeds - R. B. Taylorson, USDA-ARS, Beltsville, MD and K. Hanyadi, Univ. of Agricultural Science, Keszthely, Hungary

2 - Triazine Resistant Weed Survey in Maryland - B. H. Marose, Univ. of Maryland, College Park

HM - Wild Proso Millet in New York State - R. R. Hahn, Cornell Univ., Ithaca, NY

1986 1 - Discharge Rate of Metolachlor from Slow Release Tablets - S. F. Gorski, M. K. Wertz, and S. Reiners, Ohio State Univ., Columbus

2 - Glyphosate and Wildlife Habitat in Maine - D.Santillo, Univ. of Maine, Orono

1987 1 - Mycorrhiza and Transfer of Glyphosate Between Plants - M. A. Kaps and L. J. Khuns, Pennsylvania State Univ., University Park

1987 2 - Redroot Pigweed Competition Study in No-Till Potatoes - R. W. Wallace, R. R. Bellinder, and D. T. Warholic, Cornell Univ., Ithaca, NY

1988	1 -	Growth Suppression of Peach Trees with Competition - W. V. Welker and D. M. Glenn, USDA-ARS, Kearneysville, WV
	2 -	Smooth Bedstraw Control in Pastures and Hayfields - R. R. Hahn, Cornell Univ., Ithaca, NY
1989	1 -	Burcucumber Responses to Sulfonylurea Herbicides – H. P. Wilson and T. E. Hines, VPI + SU, Painter, VA
	2 -	Water Conservation in the Orchard Environment Through Management - W.V. Walker,Jr. USDA-ARS Appalachian Fruit Res. Sta.,Kearneysville, WV.
1990	1 -	Reduced Rates of Postemergence Soybean Herbicides - E. Prostko, J. A. Meade, and J. Ingerson-Mahar, Rutgers Coop. Ext., Mt. Holly, N.J.
	2 -	The Tolerance of <u>Fraxinus</u>, <u>Juglans</u>, and <u>Quercus</u> Seedlings to Imazaquin and Imazethapyr - L.J. Kuhns and J. Loose, Pennsylvania State Univ., University Park.
1991	1 -	Johnsongrass Recovery from Sulfonylurea Herbicides - T.E. Hines and H.P. Wilson, VPI & SU, Painter, VA.
	2 -	Growth Response of Young Peach Trees to Competition with Several Grass Species - W.V. Welker and D.M. Glenn, USDA-ARS, Kearneysville, WV.
1992	1-	Teaching Weed Identification with Videotape - B. Marose, N. Anderson, L.Kaufman-Alfera, and T. Patten, Univ. of MD, College Park
	2 -	Biological control of Annual Bluegrass (<u>Poa</u> <u>annua</u> L. <u>Reptans</u>) with <u>Xanthomonas</u> <u>campestris</u> (MYX-7148) Under Field Conditions - N.D. Webber & J.C. Neal, Cornell Univ., Ithaca, NY.
1993	1 -	Development of an Identification Manual for Weeds of the Northeastern United States - R.H. Uva and J.C. Neal, Cornell Univ., Ithaca, NY.
	2 -	Optimum Time of Cultivation for Weed Control in Corn - Jane Mt. Pleasant, R. Burt, and J. Frisch, Cornell Univ., Ithaca, NY
1994	1 -	Herbicide Contaminant Injury Symptoms on Greenhouse Grown Poinsettia and Geranium - M. Macksel and A. Senesac, L. I. Hort. Res. Lab., Riverhead, NY, and J. Neal, Cornell Univ., Ithaca, NY.
	2 -	Mow-kill Regulation of Winter Cereals Grown for Spring No-till Crop Production - E.D. Wilkins and R. R. Bellinder, Cornell Uni., Ithaca, NY.

1995 1 - A Comparison of Broadleaf and Blackseed Plantains Identifcation and Control - J. C. Neal and C. C. Morse, Cornell University, Ithaca, NY.

2 - Using the Economic Threshold Concept as a Determinant for Velvetleaf Control in Field Corn - E. L. Werner and W. S. Curran, Penn. State University, University Park, PA.

1996 1 - Preemergence and Postemergence Weed Management in 38 and 76 cm Corn - C. B. Coffman, USDA/ARS, Beltsville, MD.

2 - Common Cocklebur Response to Chlorimuron and Imazaquin - B. S. Manley, H. P. Wilson, and T. E. Hines, VPI&SU, Blacksburg, VA.

INNOVATOR OF THE YEAR

1986 **Nathan Hartwig ....Penn. State University**

1987 **Thomas Welker ....USDA-ARS Appalachian Fruit Res. Station, W. Va.**

1988 **None Awarded**

1989 **John E. Waldrum ....Union Carbide Agr. Prod.**

1990 **None Awarded**

1991 **Thomas L. Watschke ....Penn. State University**

1992 **E. Scott Hagood ....VPI, Virginia**
Ronald L. Ritter ....University of Maryland

1993 **None Awarded**

1994 **George Hamilton ....Penn. State University**

1995 **Kent D. Redding ....DowElanco**

1996 **James Orr..Asplundh Tree Expert Co.**

OUTSTANDING PAPER AWARDS

1954 Studies on Entry of 2,4-D into Leaves - J. N. Yeatman, J. W. Brown, J. A. Thorne, and J. R. Conover, Camp Detrick, Frederick, MD

The Effect of Soil Organic Matter Levels on Several Herbicides - S. L. Dallyn, Long Island Vegetable Research Farm, Riverhead, NY

Experimental Use of Herbicides Impregnated on Clay Granules for Control of Weeds in Certain Vegetable Crops - L. L. Danielson, Virginia Truck Exp. Sta., Norfolk, VA

Cultural vs. Chemical Weed Control in Soybeans - W. E. Chappell, Virginia Polytechnical Institute, Blacksburg, VA

Public Health Significance of Ragweed Control Demonstrated in Detroit - J. H. Ruskin, Dept. of Health, Detroit, MI

1955 A Comparison of MCP and 2,4-D for Weed Control in Forage Legumes - M. M. Schreiber, Cornell Univ., Ithaca, NY

1956 None Awarded

1957 Herbicidal Effectiveness of 2,4-D, MCPB, Neburon and Others as Measured by Weed Control and Yields of Seedling Alfalfa and Birdsfoot Trefoil - A. J. Kerkin and R. A. Peters, Univ. of Connecticut, Storrs

Progress Report No. 4 - Effects of Certain Common Brush Control Techniques and Materials on Game Food and Cover on a Power Line Right-of-Way - W. C. Bramble, W. R. Byrnes, and D. P. Worley, Pennsylvania State Univ., University Park

1958 Effects of 2,4-D on Turnips - C. M. Switzer, Ontario Agricultural College, Guelph, Canada

Ragweed Free Areas in Quebec and the Maritimes - Elzear E. Compagna, Universite Laval at Ste-Anne-de-la-Pocatiere, Quebec, Canada

1959 Yields of Legume-Forage Grass Mixtures as Affected by Several Herbicides Applied Alone or in a Combination During Establishment - W. G. Wells and R. A. Peters, Univ. of Connecticut, Storrs

1959 Influence of Soil Moisture on Activity of EPTC, CDEC, and CIPC - J. R. Havis, R. L. Ticknor, and P. F. Boblua, Univ. of Massachusetts, Amherst

1960 The Influence of Cultivation on Corn Yields when Weeds are Controlled by Herbicides - W. F. Meggitt, Rutgers Univ., New Brunswick, NJ

1961 Preliminary Investigation of a Growth Inhibitor Found in Yellow Foxtail (Setaria glauca L.) - H. C. Yokum, M. J. Jutras, and R. A. Peters, Univ. of Connecticut, Storrs

1962 The Effects of Chemical and Cultural Treatment on the Survival of Rhizomes and on the Yield of Underground Food Reserves of Quackgrass - H. M. LeBaron and S. N. Fertig, Cornell Univ., Ithaca, NY

Observations on Distribution and Control of Eurasian Watermilfoil in Chesapeake Bay, 1961 - V. D. Stotts and C. R. Gillette, Annapolis, MD

1963 The Relation of Certain Environmental Conditions to the Effectiveness of DNBP for Post-Emergence Weed Control in Peas - G. R. Hamilton and E. M. Rahn, Univ. of Delaware, Newark

The Influence of Soil Surface and Granular Carrier Moisture on the Activity of EPTC - J. C. Cialone and R. D. Sweet, Cornell Univ., Ithaca, NY

The Determination of Residues of Kuron in Birdsfoot Trefoil and Grasses - M. G. Merkle and S. N. Fertig, Cornell Univ., Ithaca, NY

1964 Control of Riparian Vegetation with Phenoxy Herbicides and the Effect on Streamflow Quality - I. C. Reigner, USDA-Forest Service, New Lisbon, NJ; W. E. Sopper, Pennsylvania State Univ., University Park; and R. R. Johnson, Amchem Products, Inc., Ambler, PA

EPTC Incorporation by Band Placement and Standard Methods in Establishment of Birdsfoot Trefoil - D. L. Linscott and R. D. Hagin, Cornell Univ., Ithaca, NY

1965 1 - Corn Chamomile (Anthemis arvensis L.) Responses to Some Benzoic Acid Derivatives - Barbara M. Metzger, Judity K. Baldwin, and R. D. Ilnicki, Rutgers Univ., New Brunswick, NJ

2 - The Physical Properties of Viscous Sprays for Reduction of Herbicide Drift - J. W. Suggitt, The Hydro-Electric Power Commission of Ontario, Canada

1966 1 - Weed Control Under Clear Plastic Mulch - Carl Bucholz, Cornell Univ., Ithaca, NY

2 - A Chemical Team for Aerial Brush Control on Right-of-Way - B. C. Byrd and C. A. Reimer, Dow Chemical Co.

1967	1 - Influence of Time of Seeding on the Effectiveness of Several Herbicides Used for Establishing an Alfalfa-Bromegrass Mixture - R. T. Leanard and R. C. Wakefield, Univ. of New Hampshire, Durham
	2 - Weed Competition in Soybeans - L. E. Wheetley and R. H. Cole, Univ. of Delaware, Newark
1968	None Awarded
1969	1 - Weed and Crop Responses in Cucumbers and Watermelons - H. P. Wilson and R. L. Waterfield, Virginia Truck and Orn. Res. Sta., Painter
	2 - Effect of Several Combinations of Herbicides on the Weight and Development of Midway Strawberry Plants in the Greenhouse - O. E. Schubert, West Virginia Univ., Morgantown
1970	1 - Effects of RH-315 on Quackgrass and Established Alfalfa - W. B. Duke, Cornell Univ., Ithaca, NY
1971	1 - Activity of Nitralin, Trifluralin and ER-5461 on Transplant Tomato and Eggplant - D. A. Broaden and J. C. Cialone, Rutgers Univ., New Brunswick, NJ
	2 - Field Investigations of the Activities of Several Herbicides for the Control of Yellow Nutsedge - H. P. Wilson, R. L. Waterfield, Jr., and C. P. Savage, Jr., Virginia Truck and Orn. Res. Sta., Painter
1972	1 - Study of Organisms Living in the Heated Effluent of a Power Plant - Madelene E. Pierce, Vassar College and Denise Allessandrello, Marist College
	2 - Effect of Pre-treatment Environment on Herbicide Response and Morphological Variation of Three Species - A. R. Templeton and W. Hurtt, USDA-ARS, Fort Detrick, MD
1973	1 - A Simple Method for Expressing the Relative Efficacy of Plant Growth Regulators - A. R. Templeton and W. Hurtt, USDA-ARS, Fort Detrick, MD
	2 - Agronomic Factors Influencing the Effectiveness of Glyphosate for Quackgrass Control - F. E. Brockman, W. B. Duke, and J. F. Hunt, Cornell Univ., Ithaca, NY
1974	1 - Weed Control in Peach Nurseries - O. F. Curtis, Cornell Univ., Ithaca, NY 2 - Persistence of Napropamide and U-267 in a Sandy Loam Soil - R. C. Henne, Campbell Inst. for Agr. Res., Napoleon, OH

1975	1 - Control of Jimsonweed and Three Broadleaved Weeds in Soybeans - J. V. Parochetti, Univ. of Maryland, College Park HM - The Influence of Norflurazon on Chlorophyll Content and Growth of Potomogeton pectinatus - R. M. Devlin and S. J. Karcyzk, Univ. of Massachusetts, East Wareham HM - Germination, Growth, and Flowering of Shepherdspurse, -E. K. Stillwell and R. D. Sweet, Cornell Univ., Ithaca, NY
1976	1 - Top Growth and Root Response of Red Fescus to Growth Retardants - S. L. Fales, A. P. Nielson, and R. C. Wakefield, Univ. of Rhode Island, Kingston HM - Selective Control of Poa annua in Kentucky Bluegrass - P. J. Jacquemin, O. M. Scott and Sons, and P. R. Henderlong, Ohio State Univ., Columbus HM - Effects of DCPA on Growth of Dodder - L. L. Danielson, USDA-ARS, Beltsville, MD
1977	1 - The Effects of Stress on Stand and Yield of Metribuzin Treated Tomato Plants - E. H. Nelson and R. A. Ashley, Univ. of Connecticut, Storrs HM - The Influence of Growth Regulators on the Absorption of Mineral Elements - R. M. Devlin and S. J. Karcyzk, Univ. of Massachusetts, East Wareham HM - Quantification of S-triazine Losses in Surface Runoff: A Summary - J. K. Hall, Pennsylvania State Univ., University Park
1978	1 - Annual Weedy Grass Competition in Field Corn - Jonas Vengris, Univ. of Massachusetts, Amherst HM - Metribuzin Utilization with Transplanted Tomatoes - R. C. Henne, Campbell Inst. for Agr. Res., Napoleon, OH
1979	1 - Herbicides for Ground Cover Plantings - J. F. Ahrens, Connecticut Agr. Expt. Sta., Windsor 2 - Weed Control Systems in Transplanted Tomatoes - R. C. Henne, Campbell Inst. for Agr. Res., Napoleon, OH
1980	1 - Integrated Weed Control Programs for Carrots and Tomatoes - R. C. Henne and T. L. Poulson, Campbell Inst. for Agr. Res., Napoleon, OH 2 - Suppression of Crownvetch for No-Tillage Corn - J. Cardina and N. L. Hartwig, Pennsylvania State Univ., University Park

HM - Effect of Planting Equipment and Time of Application on Injury to No-Tillage Corn from Pendimethalin-Triazine Mixtures - N. L. Hartwig, Pennsylvania State Univ., University Park

1981 1 - Weed Control in Cucumbers in Northwest Ohio - R. C. Henne and T. L. Poulson, Campbell Inst. for Agr. Res., Napoleon, OH

2 - Prostrate Spurge Control in Turfgrass Using Herbicides - J. A. Jagschitz, Univ. of Rhode Island, Kingston

HM - Some Ecological Observations of Hempstead Plains, Long Island - R. Stalter, St. John's Univ., Jamaica, NY

1982 1 - Differential Growth Responses to Temperature Between Two Biotypes of *Chenopodium album* - P. C. Bhowmik, Univ. of Massachusetts, Amherst

2 - Chemical Control of Spurge and Other Broadleaf Weeds in Turfgrass - J. S. Ebdon and J. A. Jagschitz, Univ. of Rhode Island, Kingston

HM - Influence of Norflurazon on the Light Activation of Oxyfluorfen - R. M. Devlin, S. J. Karczmarczyk, I. I. Zbiec, and C. N. Saras, Univ. of Massachusetts, East Wareham

HM - Analysis of Weed Control Components for Conventional, Wide-Row Soybeans in Delaware - D. L. Regehr, Univ. of Delaware, Newark

1983 1 - Comparisons of Non-Selective Herbicides for Reduced Tillage Systems - R. R. Bellinder, VPI & SU, Blacksburg and H. P. Wilson, Virginia Truck and Orn. Res. Sta., Painter

2 - The Plant Communities Along the Long Island Expressway, Long Island, NY - R. Stalter, St. John's Univ., Jamaica, NY

HM - Effect of Morning, Midday and Evening Applications on Control of Large Crabgrass by Several Postemergence Herbicides - B. G. Ennis and R. A. Ashley, Univ. of Connecticut, Storrs

1984	1 - Pre-Transplant Oxyfluorfen for Cabbage - J. R. Teasdale, USDA-ARS, Beltsville, MD
	2 - Herbicide Programs and Tillage Systems for Cabbage - R. R. Bellinder, VPI & SU, Blacksburg, and T. E. Hines and H. P. Wilson, Virginia Truck and Orn. Res. Sta., Painter
1985	1 - Peach Response to Several Postemergence Translocated Herbicides - B. A. Majek, Rutgers Univ., Bridgeton, NJ
1986	1 - Influence of Mefluidide Timing and Rate on Poa annua Quality Under Golf Course Conditions - R. J. Cooper, Univ. of Massachusetts, Amherst; K. J. Karnok, Univ. of Georgia, Athens; and P. R. Henderlong and J. R. Street, Ohio State Univ., Columbus
	2 - The Small Mammal Community in a Glyphosate Conifer Release Treatment in Maine - P. D'Anieri, VPI & SU, Blacksburg; M. L. McCormack, Jr., Univ. of Maine, Orono; and D. M. Leslie, Oklahoma State Univ., Stillwater
	HM - Field Evaluation of a Proposed IPM Approach for Weed Control in Potatoes - D. P. Kain and J. B. Sieczka, Cornell Univ. Long Island Hort. Res. Lab., Riverhead, NY; and R. D. Sweet, Cornell Univ., Ithaca, NY
1987	None Awarded
1988	1 - Bentazon and Bentazon-MCPB Tank-mixes for Weed Control In English Pea - G. A. Porter, Univ. of Maine, Orono; R. A. Ashley, Univ. of Connecticut, Storrs; R. R. Bellinder and D. T. Warholic, Cornell Univ., Ithaca, NY; M. P. Mascianica, BASF Corp., Parsippany, NJ; and L. S. Morrow, Univ. of Maine, Orono
	2 - Effects of Herbicide Residues on Germination and Early Survival of Red Oak Acorns - R. D. Shipman and T. J. Prunty, Pennsylvania State Univ., University Park
	2 - Watershed Losses of Triclopyr after Aerial Application to Release Spruce Fir - C. T. Smith, Univ. of New Hampshire, Durham, and M. L. McCormack, Jr., Univ. of Maine, Orono
1989	None Awarded
1990	None Awarded
1991	Award Discontinued

CHEMICAL INDEX I

COMMON NAMES, TRADE NAMES, AND CHEMICAL NAMES

Common or Code name	Trade Name	Chemical Name
AC-263,222	Cadre	------
acetochlor,	Harness	2-chloro-N(ethoxymethyl)-6'ethyl-o-acetotoluidide
acifluorfen	Blazer	sodium 5-(2-chloro-4-(trifluromethyl-phenoxyl)-2
acrolein		2-propenal
alachlor	Lasso	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
ametryn	Evik	2-(ethylamino)-4-(isopropylamino)-6-(methylthio)-s triazine
amidochlor	Limit	N-[(acetylamino)methyl]-2-chlor-N-(2,6-diethylphenyl)acetamide
amitrole	Amizol Amitrol-T	3-amino-s-triazole
AMS	Ammate	ammonium sulfamate
asulam	Asulox, others	methyl[(4-aminophenyl)sulfonyl)]carbamate
atrazine	AAtrex, others	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine
barban	Carbyne	4-chloro-2-butynyl-3-chlorophenylcarmbamate
benazolin	Asset, Benazalox	4-chloro-2-oxobenzo-thiazolin-3-yl acetic acid
benefin	Balan	N-butyl-N-ethyl-a,a,a-trifluro-2,6-dinitro-p-toluidine
bensulide	Betasan, Prefar	0,0-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl)benzenesulfonamide
benoxacor	unnamed	4-(dichloroacetyl)-3,4-dihydro-3-methyl-2H-1,4-benzoxazine
bensulfuron	Londax	2-[[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl] amino]sulfonyl]methyl]benzoic acid
bentazon	Basagran	3-(1-methylethyl)-1H-2,1,3-benzothiadiazin-4(3H)-one2,2 dioxide

Common or Code name	Trade Name	Chemical Name
benzofluor		N-[4-ethylthio)-2-(trifluoromethyl)phenyl]methanesulfonamide
benzoylprop		N-benzoyl-N-(3,4-dichlorophenyl)-DL-alanine
bifenox	Modown	methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate
bioherbicide	Casst	Allernaria cassae
bromacil	Hyvar-X	5-bromo-3sec-butyl-6-methyluracil
bromoxynil	Buctril, Brominal	3,5-dibromo-4-hydroxybenzonitrile
busoxinone	AC-310448	3-[5-(1,1-dimethylethyl)-3-isoxazolyl]-4-hydroxyl-1-methyl-2-imidazolidione
butachlor	Machete	N-(butoxymethyl)-2-chloro-2',6'-diethyl-acetanilide
buthidazole	Ravage	3-[5-1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-4-hydroxy-1-methyl-2-imidazolidinone
butralin	AMEX820, TAMEX	[4-(1, 1 dimethylethyl)-N-(1-methylpropyl)-2,6 dinitro-benzenamine]
butylate	Sutan	S-ethyl bis(2-methylpropyl)carbamothioate
cacodylicacid		dimethylarsinic acid
CGA-136872		2-[[[[4,6-bis(difluoro-methyl)-2-pyrimidinyl]carbonyl] amino]sulfonyl]benzoic acid methyl ester or 3-[4,6-bis(difluoromethyl)-pyrimidine-2-yl]-1-(2-methoxy-carbonyl-phenyl)sulfonyl)-urea
chlorbromuron	Maloran	3-(4-bromo-3-chlorophenyl)-1-methoxy-1-methylurea
chlorflurenol	Maintain CF 125	methyl-2-chloro-9-hydroxyfluroene-9-carboxylate
chlorimuron	Classic	2-[[[[4-chloro-6-methoxy-2-pyrimidinyl) amino] carbonyl]amino]sulfonyl]benzoic acid
chloroxuron	Tenoran	3-[p-(p-chlorophenoxy)phenyl-1-1,-dimethyl-urea

Common or Code name	Trade Name	Chemical Name
chlorpropham	Furloe, Chloro IPC	isopropyl-m-chlorocarbanilate
chlorsulfuron	Glean, Finesse	2-chloro-N-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino] carbonyl] benzenesulfonamide
cinmethylin	Cinch	exo-1-methyl-4-(1-methylethyl)-2-[(2-methylphenyl) methoxy-7-oxabicylco]2.2.1]heptane
clethodim, RE-45601	Select	(E,E)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]butyl]-RE-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexene-1-one
clomazone	Command	2-[(2-chlorophenyl)methyl-4,4-dimethyl-3-isoxazolidinone
cloproxydim	Selectone	(E,E)-2-1[1-[(3-chloro-2-propenyl) oxy imino butyl]-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexene-1
clopyralid	Lontrel, Stinger Reclaim, Transline	3,6-dichloro-2-pyridine carboxylic acid
CMA/MAA	Weed-E-RAD	calcium methanearsenate
cyanazine	Bladex	2-[4-chloro-6-(ethylamino)-s-triazine-2-yl]-2-methylpropionitrile
cycloate	Ro-Neet	S-ethyl N-ethylthiocyclohexanecarbamate
cycloxydim	Focus, Laser	2-[1-(ethoxyimino)-butyl]-3-hydroxy-5-(2H-tetrahydrothiopyran-3-yl)-2-cyclohexene-1-one
cyometrinil (Safener)	Concep	-(cyanomethoximino]benzacetonitrile]
2,4-D	Many	(2,4-dichlorophenoxy) acetic acid
2,4-DB	Butoxone, Butyrac	4-(2,4-dichlorophenoxy)butyric acid
dalapon	Dowpon, Basfapon	2,2-dichloropropionic acid
dazomet	Dazomet	tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione
DCPA	Dacthal	dimethyl tetrachloroterephthalate

Common or Code name	Trade Name	Chemical Name
desmedipham	Betanex	ethyl m-hydroxycarbanilate carbanilate
dicamba	Banvel	3,6-dichloro-o-anisic acid
dichlobenil	Casoron, Norosac	2,6-dichloro-o-anisic acid
dichlorprop	Weedone 2,4-DP	2-(2,4-dichlorophenoxy)propionic acid
diclofop	Hoelon	2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid
diethatyl	Antor	N-(chloroacetyl)-N-(2,6-diethylphenyl) glycine
dietholate	R-33865	O,O-diethyl O-phenyl phosphorothioate
difenzoquat	Avenge	1,2-dimethyl-3,5-diphenyl-1H-pyrazolium methylsulfate
dinitramine	Cobex	N^4,N^4-diethyl-a,a,a-trifluoro-3,5-dinitrotoluene-2,4-diamine
diphenamid	Enide	N,N-dimethyl-2,2-diphenylacetamide
dipropetryn	Sancap	6-(ethylthio)-N, N'-bis(1-methylethyl)-1,3,5-Triazine-2,4-diamine
diquat	Diquat	6,7-dihydrodipyrido 1,2a:2',1'-c] pyrazinediium ion
dithiopyr	Dimension	S,S-dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridine-dicarbothioate
diuron	Karmex	3-(3,4-cichlorophenyl)-1,1-dimethylurea
DSMA	DSMA Liquid	disodium methanearsenate
endothall	Aquathol	7-oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
ethalfluralin	Sonalan	N-ethyl-N-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benezenamine
ethametsulfuron	Muster	2-[[[[[4-ethoxy-6-(methylamino)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonlyl]benzoic acid
ethiolate	Prefox	S-ethyl diethylthiocarbamate

Common or Code name	Trade Name	Chemical Name
ethiozin	Tycor	4-amino-6-(1,1-diethylethyl)-3-(ethylthio)-1,2,4-triazin5(4H)-one
ethofumesate	Norton, Prograss	(±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate
fenac	Fenac	(2,3,6-trichlorophenyl)acetic acid
fenarimol	Rubigan	-(2-chlorophenyl)-a-(4chlorophenyl)-5-pyrimidine-methanol
fenoxaprop	Whip, Acclaim	(±)-2-[4-[6-chloro-2-benzoxazolyl)oxy]phenoxy] propanoic acid
fenuron	Beet-Kleen	N,N-dimethyl-N'-phenylurea
flumetsulam	Broadstrike	N-(2,6difluorophenyl)-5-methy[1,24]triazolo[1,5-a]pyrimidine-2-sulfonamide
fluazifop	Fusilade	(±)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy] phenoxy]propionate
fluazifop-P	Fluazifop-P	(R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy] phenoxy]propanoic acid
fluchloralin	Basalin	N-(2-chloroethyl)-2,6-dinitro-N-propyl-4-(trifluoromethyl)aniline
flumetralin	Prime	2-chloro-N-[2,6-dinitro-4-(trifluoromethyl)phenyl]-N-ethyl-6-fluorobenzenemethanamine
fluometuron	Cotoran	1,1-dimethyl-3-(a,a,a-trifluoro-m-tolyl)urea
fluorochloridone	Racer	1-(m-trifluoromethylphenyl)-3-chloro-4-chloromethyl-2-pyrrolidone
Fluoroglycofen		carboxymethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate
fluoroxypyr	Dowco 433	4-amino-3,5-dichloro-6-fluor-2-pyridyl-oxacetic acid
flurazole	Screen	phenylmethyl-2-chloro-4-(trifluoromethyl)-5-thiazolecarboxylate

Common or Code name	Trade Name	Chemical Name
fluridamid	Sustar	3-trifluoromethylsulfonamido-p-acetotoluide
fluridone	Sonar	1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1H)-pyridinone
flurprimidol	Cutless	-(methylethyl)- -[4-(trifluromethoxy)phenyl]-5-pyrimidinemethanol
flurtamone	Benchmark	5-(methylamino)-2-phenyl-4[3-trifluoromethyl phenyl]-3(2H)-furanone
fomesafen	Reflex	5-[2-chloro-4-(trifluoromethyl)phenoxyl]-N-(methylsulfonyl)-2-nitrobenzamide
fosamine ammonium	Krenite	ethyl hydrogen(aminocarbonyl)phosphonate
glufosinate	Ignite, Finale	ammonium-DL-homoalanin-4-yl(methyl)phosphinate
glyphosate	Roundup, Rodeo, Ranger, Honcho, Accord	N-(phosphonomethyl) glycine
halosafen	ICI Americas	5-[2-chloro-6-fluoro-4-(trifluoromethyl)phenoxy-N-(ethylsulfonyl)-2-nitrobenzamide
haloxyfop	Verdict	2-[4-[[3-chloro-5(trifluoromethyl)-2-pyridinyl]oxy] phenoxy]propanoic acid
hexazinone	Velpar	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1H,3H)-dione
imazamethabenz	Assert	m-toluic acid,6-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-methyl ester and p-toluic acid,2-(4-isopropyl)-4-methyl)-5-oxo-2-imidazolin-2-yl)omethyl ester
imazapyr	Arsenal, Chopper	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid
imazaquin	Sceptor	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imadazol-2-yl]-3-quinolinecarboxylic acid

Common or Code name	Trade Name	Chemical Name
imazethapyr	Pursuit	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid
ioxymil		4-hydroxy-3,5-diiodobenzonitrile
isopropalin	Paarlan	2,6-dinitro-N,N-dipropylcumidine
isouron	Conserve	N^1-[5-(1,1-dimethylethyl)-3-isoxazolyl]-N,N-dimethylurea
isoxaben	Gallery	N-[3-(1-ethyl-1-methylpropyl)-5-isoxazoyl]-2,6-dimethoxybenzamide
karbutilate	Tandex	tert-butylcarbamic acid ester with 3-(m-hydroxyphenyl)-1,1-dimethylurea
lactofen	Cobra	1'-(carboethoxy)ethyl 5-[2-chloro-4-(trifluoromethyl) phenoxy]-2-nitrobenzoate
linuron	Lorox	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea
maleic hydrazide	MH30, Slo-Gro	1,2-dihydro-3,6-pyridazinedione
MCPA (mecoprop)	Weedar sodium, Vacate	[(4-chloro-o-tolyl)oxy]acetic acid
MCPB	Can-Trol, Thistrol	4-[(4-chloro-r-tolyl)oxy]butyric acid
mefluidide	Embark, Vistar	N-[2,4-dimethyl-5-[[(trifluoromethyl) sulfonyl] amino] phenyl]acetamide
metham		methylcarbamodithioic acid
methazole	Probe	2-3,4-dichlorophenyl-4-methyl-1,2,4-oxadiazolidine-3,5-dione
metholachlor	Dual, Pennant	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl) acetamide
metribuzin	Lexone, Sencor	4-amino-6-tert-butyl-3-(methylthio)-as-triazin-5(4H)-one

Common or Code name	Trade Name	Chemical Name
methoxsulam		N-(2,6-dichloro-3-methylphenyl)-5-7-dimethoxy[1,2,4]triazolo[1,5-a]pyrimidine-2-sulfonamide
metsulfuron	Ally, Escort	2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-methylyl) amino]carbonyl]amino]sulfonyl]benzoic acid
molinate	Ordam	S-ethyl hexahydro-1H-azepine-1-carbothioate
MSMA	Daconate, Bueno, Arsonate Liquid	monosodium methanearsonate
napropamide	Devrinol	2-(a-naphthozy)-N,N-diethylpropionamide
naptalam	Alanap	N-1-naphthylphthalamic acid
nicosulfuron	Accent	2-amino-4-(hydroxymethylphosphinyl)butanoic acid
nitrofen	TOK	2,4-dichlorophenyl p-nitrophenyl ether
norea		N,N-dimethyl-N-(octahydro-4,7-methano-1H-inden-5-yl)urea 3 a ,45,7,7a-isomer
norflurazon	Evital,Solicam, Zorial	4-chloro-5-(methylamino)-2-(a,a,a-trifluoro-m-tolyl)-3-(2H)-pyridazinone
oryzalin	Surflan	3,5-dinitro-N^4,N^4-dipopylsulfanilamide
oxadiazon	Ronstar	2-tert-butyl-4-(2,4-dichloro-5-isopropoxy-phenyl) ^{2}-1,3,4-ozadiazolin-5-one
oxyfluorfen	Goal	2-chloro-1-(3-ethoxy-4-nitrophenoxy(-4-(trifluoromethyl)benzene
paclobutrazol	Bonzi, Clipper, Profile, Scotts TGR	(2RS,3RD)-1-(-4-chlorophenyl)-4,4-dimethyl-2-(1N-1,2,4-triazol-1-yl)pentan-3-ol
paraquat	Gramoxone Extra	1,1'-dimethyl-4,4'-bipyridinium ion
pebulate	Tillam	S-propyl butylethylthiocarbamate
pendimethalin	Prowl, Pre-M, Stomp, Pendulum	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobezenamine

Common or Code name	Trade Name	Chemical Name
perfluidone	Destun	1,1,1-trifluoro-N-2-methyl-4-(phenylsulfonyl)phenyl] methanesulfonamide
phenmedipham	Spin Aid, Betanal	methyl m-hydroxycarbanilate m-methylcarbanilate
picloram	Tordon	4-amino-3,4-5-trichloropicolinic acid
primisulfuron	DPX-E-9636	N-[[4,6-dimethoxy-2-primidinyl)amino]amino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide
primisulfuron-methyl	Beacon-Rifle	3-[4,6-bis(difluoromethoxy)-pyrimidin-2-yl]-1-(2 methoxy-carbonyl phenyslufonyl)-urea
prodiamine	Barricade, Rydex	2,4-dinitro-N^3,N^3-dipropyl-6-(trifluoro-methyl)-1,3-benzenediamine
profluralin	Tolban	N(cyclopropylmethyl)-a,a'a-trifluoro-2,6-dinitro-N-propyl-p-toluidine
prometon	Pramitol	2,4-bis(isopropylamino)-6-methoxy-s-triazine
prometryn	Caparol	N,N'-bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine
pronamide	Kerb	3,5-dichloro(N-1,1-dimethyl-2-propynyl) benzamide
propachlor	Ramrod	2-chloro-N-isopropylacetanilide
propanil	Stam	3',4'-dichloropropionanilide
propaquizafop		(R)-2-[[(1-methylethylidene)amino]oxy]ethyl 2-[4-[(6-chloro-2-quinoxalinyl)oxyl]phenoxy]propanoate5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone
propazine	Milograd	6-chloro-N,N'-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine
propham	Chem Hoe	isopropyl carbanilate
prosulfalin	Sward	N-[[4-dipropylamino)-3,5-dinitrophenyl]sulfonyl]-S-dimethylsulfilimine

Common or Code name	Trade Name	Chemical Name
pyrazon	Pyramin	5-amino-4-chloro-2-phenyl-3(2H)-pyridazinone
pyridate	Tough	O-(6-chloro-3-phenyl-4-pyridazinyl-S-octyl-carbonothioate
quinclorac	Drive, Facet	3,7-dichloro-8-quinoline-carboxylic acid
quizalofop	Assure	(±)-2-[4[(6-chloro-2-quinoxa (inyl) oxy] phenoxy] propanoic acid
sethoxydim	Poast, Vantage	2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexen-1-one
siduron	Tupersan	1-(2-methylcyclohexyl)-3-phenylurea
simazine	Princep, Aquazine	2-chloro-4,5-bis(ethylamino)-s-triazine
sulfometuron	Oust	2-[[[[4,6-dimethyl-2-pyrimidynl)amino] carbonyl] amino]sulfony]benzoic acid
sulfosate	Touchdown	trimethylsulfonium carboxymethylaminomethyl-phosphonate
tebuthiruron	Spike	N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea
terbacil	Sinbar	3-tert-butyl-5-chloro-6-methyluracil
terbutryn	Igran	2-(tert-butylamino-4-(ethylamino-6-(methylthio)-5-triazine
thiazopyr	MON-13200	methy 2-(difluoromethyl)-5-(4,5-dihydro-2-thiazolyl)-4-(2-methylpropyl)-6-(triflaoromethyl)-3-pyridinecarboxylate
triflusulfuron	DPX-66037	2-[[[[[4-(dimethylamino)-6-(2,2,2-trifluorethoxyl)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl]-3-methybenzoic acid
thifensulfuron-methyl	Harmony, Pinnacle	3-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) amino] carbonyl]amino]sulfonyl]-2-thiophenecarboxylate
thiobencarb	Bolero	S-[4-chlorophenyl)methyl]diethyl-carbamothioate

Common or Code name	Trade Name	Chemical Name
triallate	Far-go	S-(2,3,3-trichloroallyl)diisopropyl-thiocarbamate
triasulfuron	Amber	2-(2-chloroethyoxy)-N-[[(4-methyl-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzene-sulfonamide
triclopyr	Garlon	[(3,5,6-trichloro-2-pyridinyl)oxy] acetic acid
trifluralin	Treflan	a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
trinexapac-ethyl	Primo	4-(cyclopropyl-alpha-hydroxy-methylene)-3,5-dioxo-cyclohexanecarboxylic acid ethyl ester
vernolate	Vernam	S,propyl dipropylthiocarbamate

AUTHOR INDEX

CHEMICAL INDEX - II

CROP INDEX

SUBJECT INDEX

WEED INDEX